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Katherine Kelly Vidal

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PTO/SB/05 (08-08)
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UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Attorney Docket No.	NEG-1440PCT-US2CT
First Inventor	Jun Awano
Title	COMMUNICATION SYSTEM, FORWARDING NODE, PATH MANAGEMENT SERVER, COMMUNICATION METHOD, AND PROGRAM
Express Mail Label No.	

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

1. ☑ **Fee Transmittal Form** (e.g., PTO/SB/17)
2. ☐ **Applicant claims small entity status.** See 37 CFR 1.27.
3. ☑ **Specification** [*Total Pages* 61]
   Both the claims and abstract must start on a new page
   (For information on the preferred arrangement, see MPEP 608.01(a))
4. ☑ **Drawing(s)** (*35 U.S.C. 113*) [*Total Sheets* 20]
5. **Oath or Declaration** [*Total Sheets* 1]
   a. ☑ Newly executed (original or copy)
   b. ☐ A copy from a prior application (37 CFR 1.63(d))
   (for continuation/divisional with Box 18 completed)
   i. ☐ DELETION OF INVENTOR(S)
   Signed statement attached deleting inventor(s) name in the prior application, see 37 CFR 1.63(d)(2) and 1.33(b).
6. ☑ **Application Data Sheet.** See 37 CFR 1.76
7. ☐ **CD-ROM or CD-R** in duplicate, large table or Computer Program *(Appendix)*
   ☐ Landscape Table on CD
8. **Nucleotide and/or Amino Acid Sequence Submission**
   (if applicable, items a. – c. are required)
   a. ☐ Computer Readable Form (CRF)
   b. Specification Sequence Listing on:
      i. ☐ CD-ROM or CD-R (2 copies); or
      ii. ☐ Paper
   c. ☐ Statements verifying identity of above copies

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Alexandria VA 22313-1450

ACCOMPANYING APPLICATION PARTS

9. ☐ **Assignment Papers** (cover sheet & document(s))
   Name of Assignee NEC CORPORATION
   Tokyo, Japan
10. ☐ **37 CFR 3.73(b) Statement** *(when there is an assignee)* ☑ **Power of Attorney**
11. ☐ **English Translation Document** *(if applicable)*
12. ☑ **Information Disclosure Statement** (PTO/SB/08 or PTO-1449)
    ☐ Copies of citations attached
13. ☐ **Preliminary Amendment**
14. ☐ **Return Receipt Postcard** (MPEP 503)
    (Should be specifically itemized)
15. ☐ **Certified Copy of Priority Document(s)**
    (if foreign priority is claimed)
16. ☐ **Nonpublication Request** under 35 U.S.C. 122(b)(2)(B)(i). Applicant must attach form PTO/SB/35 or equivalent.
17. ☐ Other:

18. If a CONTINUING APPLICATION, *check appropriate box, and supply the requisite information below and in the first sentence of the specification following the title, or in an Application Data Sheet under 37 CFR 1.76:*

☑ Continuation ☐ Divisional ☐ Continuation-in-part (CIP) of prior application No.: 13/176,610

Prior application information: *Examiner* Aung, Sai *Art Unit:* 2475

19. CORRESPONDENCE ADDRESS

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Country	USA	Telephone	(703) 761-4100	Email	ADMIN @ MCGINNIPLAW.COM

Signature	Scott Mandir	Date	4/08/14
Name (Print/Type)	Scott L. Mandir	Registration No. (Attorney/Agent)	67,186

This collection of information is required by 37 CFR 1.53(b). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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FEE TRANSMITTAL

Complete if known	
Application Number	Not Yet Assigned
Filing Date	Concurrently Herewith
First Named Inventor	Jun Awano
Examiner Name	Not Yet Assigned
Art Unit	Not Yet Assigned
Practitioner Docket No.	NEG-1440PCT-US2CT

☐ Applicant asserts small entity status. See 37 CFR 1.27.

☐ Applicant certifies micro entity status. See 37 CFR 1.29. Form PTO/SB/15A or B or equivalent must either be enclosed or have been submitted previously.

TOTAL AMOUNT OF PAYMENT ($) 2520

METHOD OF PAYMENT (check all that apply)

☐ Check ☐ Credit Card ☐ Money Order ☐ None ☐ Other (please identify): _____

☑ Deposit Account Deposit Account Number: 50-0481 Deposit Account Name: McGinn IP Law Group, PLLC

For the above-identified deposit account, the Director is hereby authorized to (check all that apply):

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FEE CALCULATION

1. BASIC FILING, SEARCH, AND EXAMINATION FEES (U = undiscounted fee; S = small entity fee; M = micro entity fee)

	FILING FEES			SEARCH FEES			EXAMINATION FEES			
Application Type	**U ($)**	**S ($)**	**M ($)**	**U ($)**	**S ($)**	**M ($)**	**U ($)**	**S ($)**	**M ($)**	**Fees Paid ($)**
Utility	280	140*	70	600	300	150	720	360	180	1,600.00
Design	180	90	45	120	60	30	460	230	115	
Plant	180	90	45	380	190	95	580	290	145	
Reissue	280	140	70	600	300	150	2,160	1,080	540	
Provisional	260	130	65	0	0	0	0	0	0	

* The $140 small entity status filing fee for a utility application is further reduced to $70 for a small entity status applicant who files the application via EFS-Web.

2. EXCESS CLAIM FEES

Fee Description	**Undiscounted Fee ($)**	**Small Entity Fee ($)**	**Micro Entity Fee ($)**
Each claim over 20 (including Reissues)	80	40	20
Each independent claim over 3 (including Reissues)	420	210	105
Multiple dependent claims	780	390	195

Total Claims		**Extra Claims**	**Fee ($)**		**Fee Paid ($)**
21	-20 or HP =	1	x 80	=	

HP = highest number of total claims paid for, if greater than 20.

Indep. Claims		**Extra Claims**	**Fee ($)**		**Fee Paid ($)**
5	-3 or HP =	2	x 840	=	

HP = highest number of independent claims paid for, if greater than 3.

Multiple Dependent Claims	
Fee ($)	**Fee Paid ($)**

3. APPLICATION SIZE FEE

If the specification and drawings exceed 100 sheets of paper (excluding electronically filed sequence or computer listings under 37 CFR 1.52(e)), the application size fee due is $400 ($200 for small entity) ($100 for micro entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).

Total Sheets		**Extra Sheets**		**Number of each additional 50 or fraction thereof**		**Fee ($)**		**Fee Paid ($)**
82	- 100 =		/ 50 =		(round **up** to a whole number) x		=	

4. OTHER FEE(S) **Fees Paid ($)**

Non-English specification, $130 fee (no small or micro entity discount) _____

Non-electronic filing fee under 37 CFR 1.16(t) for a utility application, $400 fee ($200 small or micro entity) _____

Other (e.g., late filing surcharge): _____ _____

SUBMITTED BY

Signature	/Scott Mandir/	Registration No. (Attorney/Agent) 67,186	Telephone (703) 761-4100
Name (Print/Type)	Scott L. Mandir		Date 4/03/13

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COMMUNICATION SYSTEM, FORWARDING NODE, PATH MANAGEMENT SERVER, COMMUNICATION METHOD, AND PROGRAM

TECHNICAL FIELD

[0001]

[CROSS REFERENCES TO RELATED APPLICATIONS]

This application is a Continuation Application of U.S. Patent Application S/N 13/176,610, filed on July 5, 2011, which in turn is a Continuation Application of International Patent Application No. PCT/JP2010/065712, filed on September 13, 2010, and claims priority to Japanese Patent Application No. 2009-212221, filed on September 14, 2009, all of which are incorporated herein by reference in their entireties.

The present invention relates to a communication system, a forwarding node, a path management server, a communication method, and a computer program, and in particular relates to a communication system, a forwarding node, a path management server, a communication method, and a computer program, which implement communication by forwarding a packet by a forwarding node arranged in a network.

BACKGROUND

[0002]

Fig. 20 shows a network configuration using IP (Internet Protocol). In Fig. 20, communication nodes 100 (communication node 100a and communication node 100b) are communication nodes that perform communication using IP. When a forwarding node 200 receives an IP packet transmitted by a communication node 100, it determines a forwarding destination of the IP packet and forwards to the determined forwarding destination. Forwarding nodes repeat this, and ultimately forward the IP packet to a communication node that is

the destination.

[0003]

In determining the forwarding destination of the IP packet, the forwarding node 200 uses a routing table held internally. The routing table is a table indicating which network destination packet should be transmitted, though which interface, to a forwarding node that takes on the next forwarding processing; and a corresponding destination network address, next forwarding destination IP address, and destination interface are listed in the table as one entry. The entry includes information outside of the abovementioned information, but here this is omitted for simplicity.

[0004]

The network address is an address obtained by extracting a number of upper bits of an IP address, and is expressed in a format such as 192.168.1.0/24. In this case, the upper 24 bits of the address are the network address, and addresses from 192.168.1.1 to 192.168.1.255 are included in the network in question. On this occasion, 24 is called a prefix length.

[0005]

When appropriate route information is determined from the routing table, the forwarding node 200 uses a method known as a longest match method. This is a method in which a destination address of the IP packet and respective entries of the routing table are compared, to determine an entry where there is a match of a longer number of bits from an upper bit of the destination address.

[0006]

The routing table is set in advance by a method such as a manual setting in the forwarding nodes 200, or automatically by a protocol for exchanging route information called a routing protocol.

[0007]

In an IP network, packets are forwarded by the above forwarding method, but there is a problem in that, in this case, packet forwarding depends on the routing table of the respective forwarding nodes, and paths cannot be completely controlled. Furthermore, since the

forwarding destination is determined by only the destination address, there is a problem in that exact path control is not possible due to differences concerning which application the communication is performed by, or of source address.

[0008]

As a way of performing the above-mentioned path control, there is a method known as source routing. Source routing is a method in which a node that is a source (for example, communication node 100a) explicitly lists up, in a packet to be transmitted, addresses of forwarding nodes 200 that are desired to be in a forwarding path. In this case, the communication node 100a can forward a packet to a node (for example, communication node 100b) that is a destination by a forwarding path intended by an application or the like that is being used.

[0009]

Furthermore, in packet forwarding technology known as MPLS (Multi-Protocol Label Switching) also, technology exists that corresponds to source routing. MPLS is a technology in which a label is assigned to a received packet, and forwarding processing is performed based on the label.

[0010]

Assigning the label is performed when, after the packet is received by a forwarding node arranged at a boundary of an MPLS network, the packet is forwarded, and forwarding nodes inside the MPLS network thereafter repeat forwarding processing while re-attaching the label each time the packet is forwarded. When forwarding to an external network by a forwarding node arranged at the boundary of the MPLS network, the label is removed by the forwarding node in question.

[0011]

In the MPLS, technology corresponding to the source routing is CR-LDP (Constraint Routing - Label Distribution Protocol). LDP is a protocol for exchanging the label among forwarding nodes in the MPLS network, and with an object of traffic engineering or the like,

LDP, which has an object of strictly indicating a packet forwarding path, is CR-LDP.

[0012]

Patent Document 1 discloses a method where, in an ad hoc network, the total amount of control packets can be reduced, not by having all mobile terminal devices transmit link information between neighboring mobile terminal devices, but by only a mobile terminal device, which is a cluster head, transmitting the link information.

[0013]

Furthermore, similarly with regard to performing path control, Non-Patent Document 1 proposes a technology known as OpenFlow. In OpenFlow, communication is taken as end-to-end flow, and path control, recovery from failure, load balancing, and optimization are performed in flow units. An OpenFlow switch functioning as a forwarding node is provided with a secure channel for communication with an OpenFlow controller, and operates according to a flow table in which appropriate addition or rewriting is indicated by an OpenFlow controller. In the flow table are definitions of sets of rules for collation with packet headers, actions defining processing content, and flow statistical information.

[0014]

For example, when an OpenFlow switch receives a first packet, an entry is searched for, which has a rule (FlowKey) conforming to header information of the received packet, from the flow table. As a result of the search, in a case where an entry conforming to the received packet is found, the OpenFlow switch implements processing content described in an action field of the entry in question, with respect to the received packet. On the other hand, as a result of the search, in a case where an entry conforming to the received packet is not found, the OpenFlow switch forwards the received packet to the OpenFlow controller via a secure channel, requests determination of a path of the packet based on source and destination of the received packet, receives a flow entry for realizing this, and updates the flow table.

[0015]

[Patent Document 1]

Japanese Patent Kokai Publication No. JP-P2007-235444A

[0016]

[Non-Patent Document 1]

Nick McKeown, and 7 others, 'OpenFlow: Enabling Innovation in Campus Networks', [online], [search conducted July 17, 2009] Internet URL:

http://www.OpenFlowswitch.org//documents/OpenFlow-wp-latest.pdf

SUMMARY

[0017]

The entire disclosures of the abovementioned Patent Document 1 and Non-Patent Document 1 are incorporated herein by reference thereto. An analysis of related technology according to the present invention is given as follows. Forwarding nodes based on IP technology, more specifically, routing tables held by switches and routers, have been steadily growing larger, and a problem called routing information explosion has been pointed out. As a result of the increase in routes, the required amount of memory for holding routing tables increases, and, since time is taken for route determination processing, packet forwarding processing capability declines.

[0018]

In MPLS, route determination time can be reduced in comparison with IP routing, but if varied forwarding policies are applied, the number of entries in a routing table increases, leading to a decline in processing capability.

[0019]

As described above, curtailing the number of entries in a routing table is an important problem for forwarding nodes from the viewpoint of memory reduction and improvement in processing performance.

[0020]

However, in the abovementioned source routing, since addresses

of forwarding nodes 100 are contained in a packet, there is a problem in that a net data amount that can be included in a packet decreases. Accordingly, source routing is limited to certain applications such as network tests and the like, and is not used in packets (referred to below as 'data packets') that are used in communication such as with applications. It is to be noted that that information outside of net data is referred to as overhead. More specifically, the abovementioned problem can be restated as a problem where the overhead becomes large.

[0021]

Furthermore, in packets used in CR-LDP, information of forwarding nodes for each forwarding action (for each 1 hop) is included, similar to the source routing in the abovementioned IP routing. As forwarding node information, for example IPv4 addresses or IPv6 addresses are used, but in this case also, when all forwarding node information is listed up within the forwarding path, the information in question increases, so that use outside of control packets is not realistic. As a result, when the forwarding path of a data packet is strictly determined, there arises a necessity to set the forwarding information for each forwarding policy inside the forwarding node, by the CR-LDP or the like.

[0022]

A method of Patent Document 1 relates to an ad hoc network that does not require equipment of a mobile communication network infrastructure, and is configured by only a plurality of mobile terminal devices. Since network configurations are always changing, this method cannot realize path control in which a source can specify a path as in the abovementioned source routing.

[0023]

Furthermore, in the method of Non-Patent Document 1, each forwarding node has to refer to a flow table, as in the method of referring to the routing table mentioned at the start of this specification, and it is considered that, accompanying an increase of entries, latency (delay time) occurs and loads are imposed on the

nodes.

[0024]

As in the above description, in the method of adding entries for each of various types of forwarding policy to a routing table or flow table, there is a problem of processing load for adding, updating, and removing entries, and of increase in the information amount in the routing table; and in source routing or the like that explicitly indicates forwarding routes, there is a problem in that the overhead becomes large, and is not suitable for transmission of data packets.

[0025]

The present invention has been carried out in view of the abovementioned matter and it is an object of the invention to provide a communication system, a forwarding node, a path management server, a communication method, and a computer program, that can be implemented using a simplified forwarding table, and moreover can also be applied to path control for data packets.

[0026]

According to a first aspect of the present invention, there is provided a communication system including: a path management server that configures forwarding path information by arranging identifiers for identifying communication interfaces provided in respective forwarding nodes in a forwarding path of a data transfer network or links extending between the respective forwarding nodes and neighboring nodes thereof; and a forwarding node that performs packet forwarding processing in accordance with the forwarding path information, with regard to a packet to which is added a header containing the forwarding path information.

[0027]

According to a second aspect of the present invention, there is provided a forwarding node connected to a path management server that configures forwarding path information by arranging identifiers for identifying communication interfaces provided in respective forwarding nodes in a forwarding path of a data transfer network or links extending between the respective forwarding nodes and

neighboring nodes thereof, wherein the forwarding node performs packet forwarding processing in accordance with the forwarding path information, with regard to a packet to which is added a header containing the forwarding path information.

[0028]

According to a third aspect of the present invention, there is provided a path management server that creates forwarding path information included in a header to be added to a packet transmitted from a source communication node.

[0029]

According to a fourth aspect of the present invention, there is provided a communication method including respective forwarding nodes on a forwarding path of a data transfer network receive a packet to which is added a header containing forwarding path information configured by arranging identifiers for identifying communication interfaces provided in respective forwarding nodes in a forwarding path of a data transfer network or links extending between the respective forwarding nodes and neighboring nodes thereof, and performing packet forwarding processing in accordance with the forwarding path information with regard to the packet. The present method is linked with a specific apparatus, known as a forwarding node that forms the data transfer network.

[0030]

According to a fifth aspect of the present invention, there is provided a computer program(s) that is executed on a computer for configuring the abovementioned forwarding node(s) or path management server. It is to be noted that this program(s) can be recorded in a computer readable storage medium. That is, the present invention can be embodied as a computer program product.

[0031]

The meritorious effects of the present invention are summarized as follows.

According to the present invention, path control of a packet is possible without using a large volume forwarding table, and

furthermore, there is no pressure on net data amount. A reason for this is that a forwarding node is configured so as to perform packet forwarding processing in accordance with forwarding path information included in a packet header, and also the forwarding path information is configured by arranging identifiers of links or communication interfaces.

BRIEF DESCRIPTION OF THE DRAWINGS

[0032]

Fig. 1 is a diagram showing a communication system according to a first exemplary embodiment of the present invention.

Fig. 2 is a diagram showing a configuration of a boundary forwarding node of the communication system according to the first exemplary embodiment of the present invention.

Fig. 3 is a diagram showing a forwarding table recorded in a recording unit of a boundary forwarding node and an internal forwarding node.

Fig. 4 is an example of a format of a header for path forwarding added to a boundary forwarding node.

Fig. 5 is a diagram showing a configuration of an internal transfer node of the communication system according to the first exemplary embodiment of the present invention.

Fig. 6 is a diagram showing a configuration of a path management server of the communication system according to the first exemplary embodiment of the present invention.

Fig. 7 is a diagram showing neighbor information from respective forwarding nodes.

Fig. 8 is an example of a network topology configured from the neighbor information of Fig. 7.

Fig. 9 is a flowchart showing operation when a boundary forwarding node receives a packet.

Fig. 10 is a flowchart showing details of forwarding processing of Fig. 9.

Fig. 11 is a flowchart showing operation when an internal forwarding node receives a packet.

Fig. 12 is a flowchart showing an operation in which a boundary

forwarding node and an internal forwarding node transmit neighbor information notification.

Fig. 13 is a flowchart showing operation when a path management server receives neighbor information notification.

Fig. 14 is a flowchart showing an operation when a path management server requests path information.

Fig. 15 is a sequence diagram showing a flow of a packet forwarding when a communication node transmits a packet to an opposing communication node.

Fig. 16 is a diagram showing a configuration of a boundary forwarding node of the communication system according to a second exemplary embodiment of the present invention.

Fig. 17 is a flowchart showing operation when a boundary forwarding node of the second exemplary embodiment of the invention receives a packet.

Figs. 18A and 18B are diagrams showing content of a path information cache included in a boundary forwarding node or an internal forwarding node of the second exemplary embodiment of the present invention.

Fig. 19 is a sequence diagram showing a flow of a packet forwarding when packet transmission is performed to a source of a packet received by a communication node, in the communication system of the second exemplary embodiment of the present invention.

Fig. 20 is a diagram showing a communication system performing packet forwarding, as a description of background technology.

PREFERRED MODES

[0033]

First, an outline of preferred mode of the present invention is described. A forwarding node of a communication system of the present exemplary embodiment, in a case where a header including forwarding path information is assigned to a received packet, performs forwarding processing based on path information in the header.

[0034]

Here, the forwarding path can be such that respective

forwarding nodes disposed on the forwarding path arrange, in forwarding order, identifiers that enable identification of communication interfaces that are destinations. It is sufficient if the identifiers have a length that is adequate for uniquely ensuring a destination in each forwarding node.

[0035]

The identifiers forming the forwarding path information in the present invention, different from source routing mentioned at the start of the present specification, can be described by short information, 1 byte long, for example, so that the influence on net data amount is minor or insignificant. Accordingly, it is possible to contain information describing the forwarding path for each 1 hop, with regard to not only some control packets, but all packets, such as data packets, and high level forwarding control becomes possible.

[0036]

Furthermore, it is sufficient if the respective forwarding nodes hold correspondence relationships between the identifiers and communication interfaces of destinations, and since there is no necessity to hold a forwarding table such as a routing table mentioned at the start of the specification, having a large number of items, it is possible to reduce the amount of memory. Furthermore, since determination of a destination can be performed simply and quickly, it is possible to reduce packet forwarding delay also. In addition, CPU processing ability of the respective forwarding nodes can be low.

[0037]

It is to be noted that addition and removal of the header including the forwarding path information described above may be performed as follows, among forwarding nodes, in a forwarding node (boundary forwarding node) disposed at a boundary with an external network. The boundary forwarding node, which receives a packet from the external network, acquires a forwarding path of the packet in question from information recorded in a separately provided path management server or the boundary forwarding node in question, and assigns a header containing information of the forwarding path to the

received packet. Furthermore, the boundary forwarding node removes the header in a case of transmitting a packet to the external network.

In the following preferred modes will be further described in more detail by way of exemplified embodiments with reference to the drawings.

[0038]

[First Exemplary Embodiment]

Next, a detailed description is given concerning a first exemplary embodiment of the present invention making reference to the drawings. Fig. 1 is a diagram showing a communication system according to the first exemplary embodiment of the present invention. Referring to Fig. 1, communication nodes 100a and 100b, boundary forwarding nodes 300a and 300b, internal forwarding nodes 400, and a path management server 500 are shown.

[0039]

A data transfer network 600 is a network for performing forwarding processing of a packet by a method of the present invention, and an external network 700 is a network for performing packet forwarding processing by a method different from the network 600, as in an IP network or the like. However, it can be said to be a external network if the manager of external network 700 is different from the manager of network 600 even though the forwarding methods of both networks are the same. Here, a description is given with the external network 700 as an IP network. The external network 700 is connected to the data transfer network 600 via the boundary forwarding nodes 300a and 300b.

[0040]

The communication nodes 100a and 100b are each communication nodes belonging to the external network 700, and transmission and reception of packets is performed in accordance with a packet forwarding method of the external network 700. That is, in the present exemplary embodiment, these are nodes for performing transmission and reception of IP packets. Since the communication nodes 100a and 100b are similar to a general IP node, a detailed

description thereof is omitted.

[0041]

The boundary forwarding nodes 300a and 300b are disposed between the data transfer network 600 and the external network 700, and in a case of receiving a packet transmitted from the communication nodes 100a or 100b, assign a header including forwarding path information, to be described later, (referred to below as 'path information header'), and in addition, forward the packet in question to an internal forwarding node 400 in the data transfer network 600 based on the forwarding path information in the header.

[0042]

Furthermore, in a case of receiving a packet transmitted from an internal forwarding node 400 and a determination being made from the forwarding path information in the header thereof that this is a final forwarding path within the data transfer network 600, the boundary forwarding nodes 300a and 300b remove the header from the received packet, and thereafter transmit the packet to the communication nodes 100a and 100b of the external network 700.

[0043]

It is to be noted that in the following a description is given in which the forwarding path information is acquired from the path management server 500, but there is no limitation thereto, and the forwarding path information may be generated from information held within a boundary forwarding node 300.

[0044]

A configuration is described below in the order of the boundary forwarding node 300a (300b), the internal forwarding nodes 400, and the path management server 500, in the present exemplary embodiment.

[0045]

Fig. 2 is a diagram showing a configuration of the boundary forwarding nodes 300a and 300b of Fig. 1. As shown in Fig. 2, a boundary forwarding node 300 is configured by being provided with communication interfaces 310, a packet forwarding unit 320, a header

operation unit 330, a local ID determination unit 340, a neighbor information notification unit 350, a path acquisition unit 360, and a recording unit 370.

[0046]

A communication interface 310 is an interface for performing transmission and reception of packets, and is realized by a Network Interface Card (NIC) such as a LAN card or the like, and software (a driver) for driving the card. However, there is no limitation to only a physical interface as mentioned above, and a logical interface is also possible. In this case, it is possible to use one physical interface and make it operate as if a plurality of interfaces were provided.

[0047]

A boundary forwarding node 300 is provided with one or more physical interfaces as described above, or a logical interface. Each communication interface 310 is connected with an internal forwarding node 400 within the data transfer network or another boundary forwarding node 300. Furthermore, some of the communication interfaces 310 are also connected to a communication node 100 of the external network 700. Furthermore, some of the communication interfaces 310 are also connected to the path management server 500. The path management server 500 may be disposed within the data transfer network 600, and connections may be via a dedicated network of the path management server 500.

[0048]

The packet forwarding unit 320, in a case where a path information header is assigned to a received packet, is provided with a function that transmits a header based on information recorded in the recording unit 370, and the path information header.

[0049]

A forwarding table is recorded in the recording unit 370, as shown in Fig. 3, with a local ID, a communication interface that forms a destination, and information corresponding to an identifier of an internal forwarding node 400 or a neighbor boundary forwarding node 300 connected with the communication interface 310 in question, as

one entry. The packet forwarding unit 320 can forward a packet to a next node corresponding to the local ID.

[0050]

It is to be noted that in the following, the boundary forwarding node 300 and the internal forwarding node 400 are generically referred to as a forwarding node. Furthermore, nodes that are directly connected (communication node 100, boundary forwarding node 300, internal forwarding node 400) are referred to as neighboring nodes.

[0051]

Fig. 3 is a diagram showing a forwarding table recorded in a recording device of the boundary forwarding node 300 and the internal forwarding node 400. In the present exemplary embodiment as shown in Fig. 3, as a local ID, an identifier (link ID) is used that is assigned to a physical link or a logical link, between neighboring forwarding nodes or between the boundary forwarding node 300 and the communication node 100a (100b). Therefore, the link ID is set in a field 'local ID'. In a field 'interface' indicating a communication interface as destination, information that identifies the communication interface 310 connected to a link to which the link ID is assigned, is set. Furthermore, in the example of Fig. 3, an identifier of a forwarding node connected to the link is set in a field 'next hop' indicating information of a neighboring node.

[0052]

It is to be noted that in a case where the communication interface as destination is connected to a communication node 100a (100b) that performs communication by IP, an IP address of the communication node 100a (100b), for example, can be used as the identifier of the 'next hop' field. On the other hand, in a case of the boundary forwarding node 300 or the internal forwarding node 400, a uniquely assigned identifier (for example, Node_1 or Node_2 of Fig. 3) is used. The identifier of the forwarding node may be set in advance, or a method may be used in which the identifier is set from an external node such as the path management server 500 or the like. Furthermore, the identifier of the 'next hop' field need not necessarily

be used in forwarding processing and can be omitted.

[0053]

It is possible to use information identifying the communication interface 310 as the local ID. Since it is desirable that information identifying the communication interface 310 can be described using a small amount of information (for example, about 1 to 2 bytes), in a case where the information for identifying the communication interface 310 is long (for example, in a case where a communication interface name or the like is used), another identifier that can be described with a short piece of information such as 1 byte or the like is separately assigned and applied as the local ID. It is to be noted that where no particular description is given herein, the description is for using a link ID as the local ID.

[0054]

Since there are basically of the order of several tens of communication interfaces, which are provided with an L3 switch or router that performs general layer 3 forwarding processing, and an L2 switch that performs layer 2 forwarding processing, the link identifier and the communication interface identifier can be adequately expressed by 1 byte. In a case of a long item of information where an actual communication interface identifier requires several bytes, an identifier of a range than can be contained in 1 byte or in 2 bytes may be separately created and associated with the communication interface identifier.

[0055]

It is to be noted that the forwarding table of Fig. 3 is shown as an example for concisely describing the present invention, and other information may be further associated with the respective entries and recorded.

[0056]

Fig. 4 is one example of a format for a path information header used in the present exemplary embodiment. In Fig. 4, 'Direction' indicates a forwarding direction. For example, '1' indicates a regular (forward) direction with respect to forwarding, and '2' indicates a

reverse direction with respect to forwarding. In 'Current Offset', offset information is set for local ID information to be referred to when forwarding (units are bytes). The value is indicated by the number of offset bytes from 'Local ID #0'. When a path information header is assigned in the boundary forwarding node 300, the value of the 'Current Offset' is set to '0'. 'Header Length' indicates the length of the header after 'Route Length' in number of bytes. In consideration of packet formation, a 4 byte unit value is used. In a case where the end of the net data does not fit a 4 byte unit boundary, stuffing (padding) is performed (dummy information with a setting of 0 is post-positioned). 'Route Length' indicates the total number of bytes of path information indicated by a list of local IDs following thereafter. In 'Local ID #n', the local ID, which is to be referred to as a destination by the boundary forwarding node 300 of the nth hop or the internal forwarding node 400, is set. The format of the abovementioned Fig. 4 is only an example, and information in various types of modified formats may be contained.

[0057]

As described above, by using a local ID that is unique in a local range among neighboring forwarding nodes or within a forwarding node, as information of the forwarding path, it is possible to reduce the amount of information in the path information header. It is to be noted that in the present exemplary embodiment, each of the local IDs was made to have 1 byte, but there is a possibility of not being able to represent a logical link by 1 byte. In this case, the uppermost bit of the 'Local ID #n' may be used as a local ID extension flag indicating whether the local ID has a 1 byte notation or a 2 byte notation. That is, in this case, when the uppermost bit is 0, the local ID may be interpreted as a 1 byte identifier, and when the uppermost bit is 1, the local ID may be interpreted as a 2 byte identifier.

[0058]

In a case where the 'Direction' field of the path information header of a received packet is '1', that is, when a forwarding in a regular direction is indicated, the packet forwarding unit 320 refers to

the 'Current Offset' of the path information header, and after referring to a corresponding local ID and determining a communication interface 310 of a destination, the length amount (for example, 1 byte or 2 bytes) of a local ID referring to the value of the 'Current Offset' is increased, and a packet is transmitted from the determined communication interface 310. On the other hand, in a case where the 'Direction' is '2', that is, when forwarding in a reverse direction is indicated, reference is made to the 'Current Offset' of the path information header, reference is made to a local ID that is one ahead of the corresponding local ID, and the communication interface 310 that is the destination is determined. Thereafter, a reduction is made by a length amount of the local ID referring to the value of the 'Current Offset' of the path information header, and a packet is transmitted from the determined communication interface 310.

[0059]

It is to be noted that a description is given in the present exemplary embodiment in which forwarding is performed in both directions, but in the communication system, forwarding in only one direction is also possible. In this case, '1' may be set at all times in the 'Direction' field, or the field in question may not be present.

[0060]

The header operation unit 330 is provided with a function that, in a case of receiving a packet from the external network 700, acquires, from a path acquisition unit 360, path information for each 1 hop as far as the boundary forwarding node 300 that is an exit from the boundary forwarding node in question, forms a path information header shown in Fig. 4, and assigns the path information header to the packet. For example, when the path information header is assigned, the header operation unit 330 sets '1' indicating frowarding in a regular direction in 'Direction', sets '0' in 'Current Offset', and sets path information (local ID) for each 1 hop, which has been acquired, in 'Local ID #n'. Furthermore, the header operation unit 330 sets appropriate values for other respective fields in accordance with a rule described above.

[0061]

The header operation unit 330 is provided with a function that removes the path information header, in a case of forwarding a packet that has been assigned a path information header to an external network 700.

[0062]

The local ID determination unit 340 is provided with a function that performs information exchange between the boundary forwarding node 300 in question and a neighboring node, and determines a non-duplicating link ID. For example, in the following method, it is possible to avoid a duplicated setting of a link ID with a neighboring node.

[0063]

First, a forwarding node proposes a link ID candidate by transmitting to a neighboring node a packet in which a link ID is set, which is not the link ID already assigned to itself. The neighboring node to which the link ID is proposed confirms whether or not the link ID is duplicated within its own node, and in a case where there is no duplicated link ID, transmits a response packet in which the proposed link ID and identifier information of its own node are set, to a forwarding node that is the proposal source. On the other hand, in a case where there is a duplicated link ID in the neighboring node, transmission is performed of a response packet in which its own node identifier is set and information indicating that there is duplication. This processing is repeated until there is no duplicated link ID.

[0064]

The link ID determined in this way and the neighboring node information are recorded as a forwarding table in the recording unit 370.

[0065]

An example of a method of determining the link ID was shown above, but the link ID may also be determined by another method. For example, with the path management server 500 or the like, other nodes may be determined, and notification given to respective

forwarding nodes.

[0066]

It is to be noted that in a case of using an identifier of a communication interface as a local ID, when forwarding in a reverse direction as described above is unnecessary, it is possible to omit negotiation with the abovementioned neighboring nodes. On the other hand, in a case where forwarding in a reverse direction is necessary, when an identifier of an interface is used as a local ID, by performing negotiation with neighboring nodes it is possible to acquire information as to which communication interface of neighboring forwarding nodes is connected to its own communication interface, and similar to the case of using the link ID as described above, it is possible to select an interface according to a forwarding direction that is in accordance with Direction.

[0067]

The neighbor information notification unit 350 is provided with a function for transmitting neighbor information containing the link ID determined as the local ID by the local ID determination unit 340, the identifier of a neighboring node connected to the link, and a self-identifier, to the path management server 500. In a case where the communication nodes 100a and 100b of the external network 700 are connected to the link, information by which a determination of a node of the external network can be made, is added to the information. Furthermore, for path calculation by the path management server 500, the neighbor information may include information such as a band of each link, reliability, and congestion state, and neighboring node malfunction information and the like. A trigger for transmitting the neighbor information to the path management server 500 may be at timing at which the processing for determination of the local ID is completed, or transmission may be performed at a prescribed time interval. Furthermore, in a case of a transmission including the link information and the neighboring node malfunction information, the transmission may be triggered by a change occurring in this information.

[0068]

The path acquisition unit 360 is provided with a function that, when a packet is received from the communication nodes 100a and 100b of the external network 700, transmits a path request signal containing an identifier of the boundary forwarding node 300 and information of the received packet to the path management server 500, and acquires the forwarding path of the packet in question. The information of the received packet is information that may affect the forwarding path determination, and in the simplest case is only a destination address. However, in a case of implementing more precise path control, in addition to the destination address, it is possible to include some or all of information such as: a source address, protocol information that is contained after the header of the packet in question, a destination port number when using TCP (Transmission Control Protocol) or UDP (User Datagram Protocol), and a source port number. In addition, other information may be included.

[0069]

As a result of transmitting the path request signal, a path response signal is returned from the path management server 500. Information listing local IDs for each 1 hop is contained in the forwarding path information included in the path response signal, in accordance with the forwarding path with the boundary forwarding node 300 as starting point.

[0070]

It is to be noted that information that may affect the forwarding path, such as the destination address and the like, and information corresponding to a group of local IDs indicating a forwarding path can be set beforehand in the boundary forwarding node 300 in question, and can be received from the path management server in advance. In this case, the path acquisition unit 360 acquires the forwarding path information from information set internally, not the path management server 500.

[0071]

Furthermore, in the abovementioned example, the boundary forwarding node 300 has as a starting point a local ID that can identify a communication interface that is a first forwarding destination, but the starting point may be a local ID that can identify a communication interface 310 that has received the packet.

[0072]

The recording unit 370 holds a forwarding table shown in Fig. 3, and this is referred to by the packet forwarding unit 320, the local ID determination unit 340, and the neighbor information notification unit 350.

[0073]

The internal forwarding node 400 is disposed inside the data transfer network 600, and is provided with a function such that, in a case of receiving a packet transmitted from a neighboring node, the packet in question is transmitted to a neighboring node inside the data transfer network 600 based on information of the path information header in the packet.

[0074]

Fig. 5 is a diagram showing a configuration of the internal forwarding node 400 of Fig. 1. The internal forwarding node 400, as shown in Fig. 5, is configured to be provided with communication interfaces 410, a packet forwarding unit 420, a local ID determination unit 430, a neighbor information notification unit 440, and a recording unit 450.

[0075]

The communication interfaces 410, the packet forwarding unit 420, the local ID determination unit 430, the neighbor information notification unit 440, and the recording unit 450 are respectively equivalent to the communication interfaces 310, the packet forwarding unit 320, the local ID determination unit 340, the neighbor information notification unit 350, and the recording unit 370, of the boundary forwarding node 300, and detailed descriptions thereof are omitted here.

[0076]

That is, the internal forwarding node 400 can be regarded as having the header operation unit 330 and the path acquisition unit 360 taken away from the boundary forwarding node 300. Conversely, the boundary forwarding node 300 can be said to be a forwarding node obtained by adding the header operation unit 330 and the path acquisition unit 360 to the internal forwarding node 400.

[0077]

The path management server 500 collects neighbor information notified from boundary forwarding nodes 300 and internal forwarding nodes 400, and configures network topology information describing connection relationships of the internal forwarding nodes 400 and the boundary forwarding nodes 300 inside the data transfer network 600. The network topology information also includes connection information for the communication nodes 100a and 100b connected to the boundary forwarding nodes 300. In a case where information (congestion state, malfunction state, and the like) indicating the state of forwarding nodes and links between respective forwarding nodes is included in the notified path information, this is also associated with the connection information and managed. A function is provided that, in a case where forwarding path information is requested from a boundary forwarding node 300, performs a calculation obtaining an appropriate forwarding path using information included in the path request and the network topology information configured internally, and with the boundary forwarding node 300 that performed the path request as a starting point, responds with information listing local IDs (link IDs) for each 1 hop, for a forwarding path as far as the boundary forwarding node 300 that is an exit to the external network 700.

[0078]

Fig. 6 is a diagram showing a configuration of the path management server 500 of Fig. 1. The path management server 500, as shown in Fig. 6, is configured to be further provided with a communication interface 510, a path information collection unit 520, a path request processing unit 530, a path calculation unit 531, and a path information recording unit 540.

[0079]

The communication interface 510 is an interface for performing transmission and reception of packets. As described above, realization is possible by an NIC such as a LAN card, for example, and by software (a driver) for operation thereof.

[0080]

When the path information collection unit 520 receives neighbor information sent from the boundary forwarding node 300 and the internal forwarding node 400, it uses an identifier of the node that transmitted the neighbor information, contained in the neighbor information, a local ID (link ID), and a neighboring node identifier, to configure network topology information within the data transfer network 600, in the path information recording unit 540. In a case where the neighbor information includes accompanying information such as link band, reliability, congestion state, and neighboring node malfunction information, the accompanying information is associated with and recorded in the network topology information. These items of information can be used, for example, as a link cost when calculating a path, to be described later.

[0081]

Fig. 7 is an example of neighbor information received from respective forwarding nodes. Fig. 8 is an example of a network topology configured from the neighbor information of Fig. 7. In the example of Fig. 8, for simplicity, the accompanying information is omitted. Furthermore, the external network is assumed to be an IP network.

[0082]

In Fig. 7, 'sender ID' indicates an identifier of a forwarding node that transmits neighbor information. In Fig. 7, 'Link ID' indicates a link ID assigned to a link to which the forwarding node is connected. In Fig. 7, 'neighbor ID' indicates an identifier of a neighboring node connected to the link. Since the external network is assumed to be an IP network, an IP address is used as an identifier of a communication node 100. Furthermore, since negotiation is carried

out among neighboring nodes as described above, a link ID is not set to be duplicated in one forwarding node, but it is permitted for non-neighboring forwarding nodes to use the same link ID. For example, a link with Link ID = 1 is used between a node of ID = 1 and a node of ID = 10, and between a node of ID = 5 and a node of ID = 6, but in each forwarding node it is possible to identify a link uniquely. That is, it is sufficient if the length of the link ID has a length that is enough to ensure uniqueness within one forwarding node.

[0083]

In a case where neighbor information of Fig. 7 is obtained, for example, the path information collection unit 520 configures the network topology as shown in Fig. 8, and records the topology in the path information recording unit 540.

[0084]

The link ID is used in the neighbor information of Fig. 7 and in the network topology information of Fig. 8 that is configured based on the neighbor information of Fig. 7, but when other information such as an interface identifier is used as a local ID, it is possible to configure the network topology information in the same way.

[0085]

The path request processing unit 530 receives a path request signal transmitted from the boundary forwarding node 300, and information included therein, and notifies same to the path calculation unit 531 together with the path calculation requests.

[0086]

When the path request processing unit 530 acquires the forwarding path information (information in which the link ID for each 1 hop is listed in order of the forwarding path) from the path calculation unit 531, the path response signal containing the forwarding path information is transmitted to the boundary forwarding node 300 that is a source of the path request signal.

[0087]

When notified of the path calculation request from the path request processing unit 530, with the identifier of the boundary

forwarding node 300 that is the path request source and the destination address, both of which are inputted, as respective start and end points, the path calculation unit 531 uses the network topology information as in Fig. 8 that is recorded in the path information recording unit 540, to perform calculation of the path. In the path calculation, an algorithm for obtaining the shortest path known as the Dijkstra method can be applied. However, it is also possible to apply other algorithms.

[0088]

In a case where the source address of the IP packet is included in the path calculation request, the source address (that is, the identifier of the communication node 100a or 100b that is the source of the packet received by the boundary forwarding node 300) may also be used as a starting point. Furthermore, in performing the path calculation as described above, the path calculation may be performed using other information such as a TCP or UDP destination/source port number or the like. In addition, information (band, congestion state, and the like) accompanying the link, or information such as an identifier of a malfunctioning boundary or internal forwarding node may also be used.

[0089]

The network topology information as shown in Fig. 8, from the path information collection unit 520, is recorded in the path information recording unit 540. The network topology information is referred to, from the path calculation unit 531 in order to calculate the path.

[0090]

The communication interfaces 310, 410, and 510, described above in the exemplary embodiment of the present invention, can be implemented, as mentioned above, by an NIC such as a LAN card for example, or by software (a driver) that drives the NIC.

[0091]

Furthermore, the recording unit 370, the recording unit 450, and the path information recording unit 540 can be realized by a device

that can record information, such as a semiconductor memory, a hard disk drive or the like.

[0092]

Other function blocks can be realized by a computer program (software) executed in one or a plurality of CPUs installed in respective devices, or by hardware. Some of the processing to be performed by the functional blocks may be implemented by software, and the remainder may be implemented by hardware.

[0093]

Next, a detailed description is given concerning operation of the present exemplary embodiment, making reference to the drawings. First, operation of the boundary forwarding node 300 is described.

[0094]

Fig. 9 shows processing in a case where the boundary forwarding node 300 receives a packet from the data transfer network 600 or the external network 700.

[0095]

First, on receiving a packet via the communication interface 310, the packet forwarding unit 320 checks whether or not a path information header is assigned to the packet (step S100).

[0096]

In a case where the path information header is assigned, control proceeds to 'Y', and forwarding processing is performed in accordance with the path information header (step S103). On the other hand, in a case where the path information header is not assigned, control proceeds to 'N', and path acquisition processing that acquires the forwarding path information by transmitting a path request signal to the path management server 500, from the path acquisition unit 360, is performed (step S101).

[0097]

When the acquisition of the forwarding path information is complete, the header operation unit 330 sets the local ID to the local ID field ('Local ID #n') of the path information header of Fig. 4, in accordance with the order of the forwarding path of the acquired

forwarding path information. Furthermore, the header operation unit 330 sets the 'Direction' to '1' and the 'Current Offset' to '0'. On setting other fields also to appropriate values, the header operation unit 330 assigns the path information header to the head of the received packet (step S102).

[0098]

The packet forwarding unit 320 implements forwarding processing in accordance with the path information header described above (step S103).

[0099]

Fig. 10 is a flowchart representing details of forwarding processing of step S103 of Fig. 9. Referring to Fig. 10, first the packet forwarding unit 320 checks the 'Direction' field of the path information header and decides whether to forward in a regular (forward) direction or to forward in a reverse direction (step S200).

[0100]

In a case where the value of the 'Direction' field indicates forwarding in a regular direction ('1'), control proceeds to 'Y', and a decision is made as to whether or not the destination of the packet in question is the external network 700 (step S201). In forwarding in the regular direction, the decision as to whether to forward to the external network 700 can be decided by comparing 'Current Offset' and 'Route Length'. As another decision method, a value may be used that can distinguish whether or not the local ID is to be forwarded to the external network 700, and information indicating an end may be contained after the final local ID in the path information header. Other methods may also be used.

[0101]

In a case of a decision not to forward to the external network 700, control proceeds to 'N', and the number of bytes of 1 hop are added to the 'Current Offset' of the path information header (step S202). The number of bytes of 1 hop is the number of bytes of the 'Local ID #n' currently being referred to. Here, the local ID that is referred to before adding to the value of the 'Current Offset', is held.

[0102]

The packet forwarding unit 320 uses the local ID that is held and performs forwarding processing of the packet in a regular direction (step S206). Specifically, a communication interface 310 that is to be a destination is determined from the local ID using the information of the forwarding table recorded in the recording unit 370, and the packet is forwarded from the communication interface 310 in question.

[0103]

On the other hand, in a case where in step S200 the value of the 'Direction' field indicates forwarding in a reverse direction ('2'), control proceeds to 'N', and a decision is made as to whether or not the forwarding destination of the packet in question is the external network 700 (step S203). In forwarding in the reverse direction, the decision as to whether or not to forward to the external network 700 can be decided according to whether or not the value of the 'Current Offset' is '0' (when the value is '0', the transfer is to the external network). This is a decision method for a case where a link ID for links between the communication nodes 100a and 100b that first transmit the packet and the boundary transfer node 300 that receives the packet is not used as the first local ID. In a case where the link ID is used as the first local ID, when the present 'Current Offset' has a value with 1 hop amount subtracted of '0', a decision can be made to forward to the external network. As another decision method when forwarding in a reverse direction, a value may be used that can distinguish whether or not the local ID is to be forwarded to the external network 700, and information indicating a start may be contained before the first local ID in the path information header. Other methods may also be used.

[0104]

In a case of a decision not to forward to the external network 700, control proceeds to 'N', and 1 hop amount is subtracted from the value of the 'Current Offset' of the path information header (step S204). Here, the local ID, which is referred to by the 'Current

Offset' after the subtraction, is held.

[0105]

The packet transfer unit 320 uses the local ID that is held and performs forwarding processing of the packet in a reverse direction (step S206). Specifically, a communication interface 310 that is to be a forwarding destination is determined from the local ID using the information of the forwarding table recorded in the recording unit 370, and the packet is forwarded from the communication interface 310 in question.

[0106]

When a decision is made to forward to the external network 700 in the abovementioned step S201 or S203, control proceeds to 'Y' in each case, and processing of removing the path information header is performed by the header operation unit 330 (step S205). Here, before removal of the path information header, the local ID that is a forwarding destination is held.

[0107]

The packet transfer unit 320 uses the local ID that is held and performs forwarding processing of the packet to the external network 700 (step S206). Specifically, the communication interface 310 that is to be the forwarding destination is determined from the local ID using the information of the forwarding table recorded in the recording unit 370, and the packet is forwarded from the communication interface 310 in question.

[0108]

It is to be noted that in a case where the 'Direction' field is not used and forwarding is always in the regular (forward) direction, the decision concerning the forwarding direction of step S200 is unnecessary, and it is sufficient to perform a decision as to whether or not to forward to the external network of step S201.

[0109]

Next, operation of the internal forwarding nodes 400 is described.

[0110]

Fig. 11 shows processing in a case where an internal forwarding node 400 receives a packet from the boundary forwarding node 300 of the data transfer network 600 or a other internal forwarding node.

[0111]

Referring to Fig. 11, first, on receiving a packet via the communication interface 410, the packet forwarding unit 420 checks whether or not a path information header is assigned to the packet in question (step S300).

[0112]

In a case where the path information header is assigned, control proceeds to 'Y', a check is made of the 'Direction' field of the path information header, and a decision is made as to whether to forward in a regular direction or to forward in a reverse direction (step S302). On the other hand, in a case where the path information header is not assigned, control proceeds to 'N', and the received packet is dropped (step S301).

[0113]

In a case where the value of the 'Direction' field checked in step S302 indicates forwarding in a regular direction ('1'), control proceeds to 'Y', and the number of bytes of 1 hop are added to the 'Current Offset' of the path information header (step S303). Here, the local ID that is referred to before adding to the value of the 'Current Offset' is held.

[0114]

On the other hand, in a case where the value of the 'Direction' field checked in step S302 indicates forwarding in a reverse direction ('2'), control proceeds to 'N', and the number of bytes of 1 hop are subtracted from the 'Current Offset' of the path information header (step S304). Here, the local ID, which is referred to by the 'Current Offset' after subtraction, is held.

[0115]

Finally, forwarding processing of the packet is performed based on the local ID held in the abovementioned step S303 or step S304. Specifically, the communication interface 410 that is to be the

destination is determined from the local ID using the information of the forwarding table recorded in the recording unit 450, and the packet is forwarded from the communication interface 410 in question (step S305).

[0116]

It is to be noted that in a case where the 'Direction' field is not used and forwarding is always in a regular direction, the decision regarding the forwarding direction in steps S320 is unnecessary, and the 'Current Offset' addition processing of step S303 is always performed.

[0117]

Next, a description is given concerning processing of giving notification of determination of the local ID by the boundary forwarding node 300 and the internal forwarding node 400 and a result thereof, as neighbor information to the path management server 500.

[0118]

Fig. 12 is a flowchart showing an operation in which the boundary forwarding node 300 and the internal forwarding node 400 transmit a neighbor information notification.

[0119]

Referring to Fig. 12, first, the local ID determination unit 340 (430) determines the local ID (step S400). In a case of using a link ID as the local ID, the link ID is determined by implementing negotiation between neighboring nodes and the link ID. It is to be noted that in a case of using an identifier of the communication interface as the local ID, an identifier assigned to the communication interface 310 (410), which is provided in the boundary forwarding node 300 in question or the internal forwarding node 400, is the local ID.

[0120]

Here, the link ID is determined with regard to all physical or logical links that can be used by the boundary forwarding node 300 or the internal forwarding node 400. In the same way, the identifier of the communication interface is determined with regard to all physical

or logical communication interfaces. However, for management or other reasons, some links and communication interfaces may be excluded.

[0121]

Next, the local ID determination unit 340 (430) associates the determined local ID and the communication interface information (information necessary for deciding the communication interface in question as the destination), to be recorded in the forwarding table (refer to Fig. 3) in the recording unit 370 (450) (step S401). Identifiers of neighboring nodes connected ahead of each link are associated and recorded in the forwarding table. Furthermore, information related to each link, and malfunction information of neighbor links and the like, may be recorded as accompanying information.

[0122]

When the recording to the forwarding table is complete, the neighbor information notification unit 350 (440) configures the local ID and neighbor information setting neighboring node identifiers (refer to Fig. 7), from information of the forwarding table recorded in the recording unit 370 (450), and transmits this to the path management server 500 (step S402). Furthermore, information related to each link, and malfunction information of neighboring nodes and the like, may be stored as accompanying information in the neighbor information.

[0123]

Next, operation of the path management server 500 is described.

[0124]

Fig. 13 is a flowchart representing processing of the path management server 500 that receives the abovementioned neighbor information. Referring to Fig. 13, first, when neighbor information sent from the boundary forwarding node 300 or the internal forwarding node 400 is received at the path information collection unit 520 (step S500), the path management server 500 acquires a local ID and identifier of a neighboring node from the received neighbor

information, and uses the acquired information to configure the network topology information to be recorded in the recording unit 540 (step S501).

[0125]

Fig. 14 is a flowchart representing processing of the path management server 500 from which path information is requested from the boundary forwarding node 300. Referring to Fig. 14, first when a path request signal is received from the boundary forwarding node 300, the path request processing unit 530 provides notification of information included in the path request signal to the path calculation unit 531 (step S600).

[0126]

Next, the path calculation unit 531 performs calculation of the optimal forwarding path, according to information included in the path request signal notified in step S600, and the network topology information recorded in the path information recording unit 540 (step S601). When the calculation of the forwarding path is complete, the path calculation unit 531 reads a local ID for each 1 hop in forwarding order of the determined path, and provides notification to the path request processing unit 530.

[0127]

The path request processing unit 530 that has received a result of the calculation of the forwarding path sets the forwarding path information that has been notified (arrangement of local IDs) in a path information response signal, to be transmitted to the boundary forwarding node 300 that is the source of the path request signal (step S602).

[0128]

Finally, referring to a sequence diagram of Fig. 15, a description is given of a flow sequence in which the communication node 100a, which is an IP node, transmits a packet to the boundary forwarding node 300a, sequential forwarding processing thereof is performed, and finally delivery is made to a communication node 100b, which is an IP node.

[0129]

Here, as an example a description is given in which a connection state of the respective nodes is as in a network topology that is shown in Fig. 8. The boundary forwarding node 300a is equivalent to a node with ID = 1 in Fig. 8. The boundary forwarding node 300b is equivalent to a node with ID = 8 in Fig. 8. The source address of an IP packet is 192.168.0.50, and a destination address is 192.168.0.20.

[0130]

When the IP packet transmitted from the communication node 100a reaches the boundary forwarding node 300a (step S700), the boundary forwarding node 300a performs processing in accordance with a flowchart shown in Fig. 9. Here, since a path information header is not assigned to the IP packet, the path information request signal in step S101 of Fig. 9 is transmitted to the path management server 500 (step S701).

[0131]

The path management server 500 that receives the path information request signal, after calculating the path information and determining the forwarding path, in accordance with a flowchart of Fig. 14, transmits the path information response signal to the boundary forwarding node 300a (step S702).

[0132]

In a case of calculating the shortest path without considering link band or congestion state, the forwarding path is calculated as follows. With regard to the shortest path in the network topology of Fig. 8, a node of ID = 1 -> a node of ID = 10 -> a node of ID = 8 -> a node of 192.168.0.20 (an IP node of an external network that is a destination of the packet) is selected as a forwarding path. Therefore, values of 1, 2, 0, which are link IDs on a path of the network topology of Fig. 8 are contained in the abovementioned order as local IDs, in the path information response signal.

[0133]

Here, a link ID (= 0) between a node of ID = 192.168.0.50 (an

IP node of the external network 700) and the node of ID = 8, may be included in the path information response. In this case, the storing order of local IDs included in the path information response signal is 0, 1, 2, 0. Conversely, not having the link ID (= 0) to the external network (the communication node 100b) included in the path information response is also possible. In this case, the storing sequence of the local IDs. is 1, 2.

[0134]

Furthermore, an IP address was used as the ID of the IP node of the external network, but use is also possible as a network address where an arbitrary bit length is extracted from the upper end of the IP address, and layer 2 information such as a MAC (Media Access Control) address and the like, or other information may be used.

[0135]

When the boundary forwarding node 300 receives the path information response signal (step S703), in accordance with processing after step S102 in Fig. 9, the path information header is assigned to the IP packet received in step S700, and thereafter, in step S103 of Fig. 9, in accordance with the assigned path information header, the packet is transmitted from the communication interface corresponding to the local ID (= 1) to be forwarded (step S704). As a result, the packet is forwarded to the internal forwarding node 400 of ID = 10.

[0136]

On receiving the packet that has been assigned the path information header (step S705), the internal forwarding node 400 performs forwarding processing in accordance with the flowchart shown in Fig. 11 (step S706). Here, in accordance with the forwarding path information, the packet is transmitted from the communication interface corresponding to the local ID (= 2) that is to be forwarded, and the packet is forwarded to the boundary forwarding node 300b of ID = 8.

[0137]

On receiving the packet that has been assigned the path

information header (step S707), the boundary forwarding node 300b performs forwarding processing in accordance with the flowchart shown in Fig. 9. Furthermore, in step S103 of Fig. 9, forwarding processing shown in the flowchart shown in Fig. 10 is additionally implemented. Here, since forwarding to the external network is decided in step S201 in Fig. 10, after the path information header is removed from the received packet, the boundary forwarding node 300b, in accordance with the information of the path information header before removal, transmits the packet from the communication interface corresponding to the local ID (= 0) that is to be forwarded (step S708). As a result, the IP packet is finally forwarded to the communication node 100b.

[0138]

According to the present exemplary embodiment as described above, the configuration is such that a forwarding destination is indicated by using a local ID whose uniqueness is ensured in a local range such as within the forwarding node or among neighboring forwarding nodes, not with path information whose uniqueness is assured globally such as by an IP address or the like. As a result, a forwarding path of 1 hop amount can be contained in an information amount of about 1 byte or 2 bytes, and in a case where information of the forwarding path in question is contained in the path information header and assigned to the packet, it is possible to curtail overhead due to the assigned header to a very small size. As a result, it becomes possible to contain the path information header in all packets without limitation to applications.

[0139]

Furthermore, in the present exemplary embodiment, it is possible to have a number of entries in a forwarding table provided in a forwarding node approximately a number of communication interfaces which are provided in the respective forwarding nodes. In addition, it is possible to curtail the size of memory necessary for forwarding nodes and CPU processing power, in order to contain, update, and use the forwarding table, and low cost forwarding nodes

are possible.

[0140]

From a result thereof, according to the present exemplary embodiment, even in a case where the forwarding path is strictly specified for each 1 hop, it is possible to foraward net information with good efficiency, and furthermore at high speed.

[0141]

[Second Exemplary Embodiment]

Next, a detailed description is given concerning a second exemplary embodiment of the present invention in which a modification has been added to the first exemplary embodiment of the present invention, making reference to the drawings.

[0142]

Since an overall configuration of the second exemplary embodiment of the present invention has a configuration and functionality that are nearly the same as the first exemplary embodiment, a description given below is centered on points of difference thereof.

[0143]

Fig. 16 is a diagram representing a configuration of a boundary forwarding node 301 of the second exemplary embodiment of the present invention. Referring to Fig. 16, the boundary forwarding node 301 of the present exemplary embodiment has a configuration in which a cache management unit 380 is added to the configuration of a boundary forwarding node 300 of the first exemplary embodiment. Furthermore, operations of a path acquisition unit 360A and information recorded in a recording unit 370A are different from the first exemplary embodiment.

[0144]

The path acquisition unit 360A is provided with a function that is nearly the same as the path acquisition unit 360 of the first exemplary embodiment of the present invention, but it is further provided with a function that searches a path information cache, to be described later, before making a request for forwarding path

information to a path management server 500. As a result of searching the path information cache, in a case where a path information cache corresponding to a received packet is found, the forwarding path information is acquired from the found path information cache, without making a request for the path information to the path management server 500. Furthermore, in a case where the path information cache is not found, a path acquisition unit 360A transmits information of the received packet and forwarding path information acquired from the path management server 500 to the cache management unit 380 for recording as the path information cache.

[0145]

The cache management unit 380 is provided with a function that associates the information of the received packet and information set in the path information header, and recording in the recording unit 370A as the path information cache, when the path acquisition unit 360A acquires the forwarding path information from the path management server 500, and when a header operation unit 330 removes the path information header.

[0146]

In the present exemplary embodiment, a destination address and a source address are recorded as the information of the received packet. However, other information may be used in addition to the destination address and the source address.

[0147]

After a fixed period of time has elapsed, or when there is an accumulation of a fixed amount of the path information cache, the path information cache may be removed from an old path information cache. Furthermore, an arbitrary path information cache may be removed for management reasons or the like.

[0148]

The recording unit 370A, in addition to information recorded by the recording unit 370 in the first exemplary embodiment, further records the path information cache. Management such as adding,

updating, and removing, is performed by the cache management unit 380 with regard to the path information cache.

[0149]

Next, operation of the boundary forwarding node 301 in the abovementioned second exemplary embodiment is described.

[0150]

Fig. 17 shows processing in a case where the boundary forwarding node 301 receives a packet from a data transfer network 600 or an external network 700.

[0151]

Referring to Fig. 17, first, on receiving a packet via a communication interface 310, the packet forwarding unit 320 checks whether or not a path information header is assigned to the packet in question (step S800).

[0152]

In a case where the path information header is assigned, control proceeds to 'Y', and forwarding processing is performed in accordance with the path information header (to step S809). On the other hand, in a case where the path information header is not assigned, control proceeds to 'N', and the path acquisition unit 360A performs search processing of the path information cache in a regular (forward) direction (step S801). In the search of the path information cache in the regular (forward) direction, it is possible to perform a comparison of a destination address of the received packet and a destination address in the path information cache.

[0153]

As a result of the search of the path information cache in the regular (forward) direction, in a case where the path information cache is found ('Y' in step S802), the path information cache in question is used to perform processing to add the path information header (to step S808).

[0154]

On the other hand, as a result of the search of the path information cache in the regular (forward) direction, in a case where

the path information cache is not found ('N' in step S802), the path acquisition unit 360A performs processing to search the path information cache in a reverse direction (step S804). In the search of the path information cache in the reverse direction, it is possible to perform a comparison of the destination address of the received packet and a source address in the path information cache.

[0155]

As a result of the search of the path information cache in the reverse direction, in a case where the path information cache is found ('Y' in step S805), the path information cache in question is used to perform processing adding the path information header (to step S808).

[0156]

On the other hand, as a result of the search of the path information cache in the reverse direction, in a case where the path information cache is not found ('N' in step S805), the path acquisition unit 360A transmits a path request signal to the path management server 500 and performs path acquisition processing for acquiring the forwarding path information (step S806).

[0157]

When the acquisition of the forwarding path information is complete, the cache management unit 380 associates the destination address and the source address included in the received packet, and the forwarding path information acquired in step S806 and performs recording in the recording unit 370A as the path information cache (step S807).

[0158]

Furthermore, the header operation unit 330 forms the path information header, in accordance with the order of the forwarding path of the acquired forwarding path information or the path information cache, to be added to the head of the received packet (step S808). Values set in respective fields of the path information header are as follows.

[0159]

In a case where the forwarding path information is acquired

from the path management server 500, the path information is set in accordance with the forwarding order, to a local ID field ('Local ID #n') of the path information header shown in Fig. 4. Furthermore, 'Direction' is set to '1' and 'Current Offset' is set to '0'.

[0160]

Furthermore, in a case where path information is acquired from the path information cache in a regular (forward) direction cache search in step S801, 'Direction' is set to '1' and 'Current Offset' is set to '0'. A value recorded in the path information cache is set in 'Local ID #n', while maintaining the order as it is.

[0161]

On the other hand, in a case where path information is acquired from the path information cache in a reverse direction cache search in step S804, 'Direction' is set to '2' and 'Current Offset' is set to a value recorded in the path information cache. A value recorded in the path information cache is set in 'Local ID #n', while maintaining the order as it is.

[0162]

It is to be noted that in a case of acquiring path information from the path information cache in the reverse direction cache search in step S804, a value recorded in the path information cache can be set in 'Local ID #n' in reverse order. In this case, 'Direction' is set to '1', and 'Current Offset' is set to the number of offset bytes indicating a local ID #n that is a first forwarding destination.

[0163]

The packet forwarding unit 320 implements forwarding processing in accordance with the path information header configured as above (step S809). Details of the processing of step S809 are nearly the same as the forwarding processing of the boundary forwarding node 300 in the first exemplary embodiment shown in Fig. 10, and thus are omitted. However, in the present exemplary embodiment, in step S205 of Fig. 10, when the path information header is removed, the cache management unit 380 associates information of a received packet and information set in the path information header,

and performs recording in the recording unit 370A as the path information cache.

[0164]

Next, a description is given of flow of processing of a packet forwarding between a communication node 100a and a communication node 100b in the second exemplary embodiment.

[0165]

A first (outward) packet forwarding procedure is nearly the same as in the first exemplary embodiment, and a packet is forwarded as in a sequence diagram shown in Fig. 15. However, in step S703 and step S707 in Fig. 15, a path information cache shown in Fig. 18A and 18B is created in a recording unit 370 of each of a boundary forwarding node 301a and a boundary forwarding node 301b.

[0166]

Values set in fields of the same name in the path information header are recorded in 'Direction', 'Current Offset', 'Route Length' recorded in the path information fields in the path information cache of Figs. 18A and 18B. The value of a 'Local ID #n' field of the path information header is recorded in 'Local IDs', while maintaining the order as it is.

[0167]

In a case of acquiring the path information from the path management server 500, '0' is recorded in 'Direction', and '0' is recorded in 'Current Offset'. In addition, total byte length of the local IDs for the number of acquired forwarding paths, and the local IDs for the number of forwarding paths are respectively set in 'Route Length' and 'Local IDs'. It is to be noted that values in parentheses indicate values recorded in a case of processing packet forwarding in accordance with the sequence diagram of Fig. 15.

[0168]

Creation time information is also included in the path information cache of Figs. 18A and 18B, but this is not necessarily required. It is to be noted that the creation time information of HH:MM:SS indicates hours, minutes, and seconds, respectively.

[0169]

Next, making reference to a sequence diagram of Fig. 19, a description is given of a flow sequence in which, after a packet transmitted by the communication node 100a is forwarded to a destination of the communication node 100b, now the communication node 100b transmits a packet to the communication node 100a, forwarding processing thereof is performed in order, and finally delivery is made to the communication node 100a, which is an IP node.

[0170]

In what follows, a description is given in which a connection state of each nodes is as in a network topology that is shown in Fig. 8. The boundary forwarding node 301a is equivalent to a node with ID = 1 in Fig. 8. The boundary forwarding node 301b is equivalent to a node with ID = 8 in Fig. 8. A source address of an IP packet is 192.168.0.20, and a destination address is 192.168.0.50.

[0171]

When the IP packet is transmitted from the communication node 100b (step S900) and reaches the boundary forwarding node 300b, the boundary forwarding node 301b performs processing in accordance with a flowchart shown in Fig. 17 (step S901). First, since a path information header is not assigned to the IP packet, a path information cache search in a regular direction is performed in step S801 of Fig. 17. That is, processing is performed to scan destination address fields of the path information cache shown in Fig. 18B, and to search for an entry having the destination address of 192.168.0.50.

[0172]

In the path information cache shown in Fig. 18B, since there is no entry having the destination address of 192.168.0.50 in the destination address field, now, a path information cache search in a reverse direction is performed in step S804 of Fig. 17. That is, processing is performed to scan source address fields of the path information cache shown in Fig. 18B, and to search for an entry having the destination address of 192.168.0.50.

[0173]

In an example of the path information cache shown in Fig. 18B, there is an entry having the destination address of 192.168.0.50 in a source address field. The path acquisition unit 360A reads path information of the entry found by the search.

[0174]

The path information read from the path information cache shown in Fig. 18B is as follows.

'Direction' = 1

'Current Offset' = 2

'Route Length' = 3

'Local IDs' ={1, 2, 0}

[0175]

Here, when configuring the path information header from the read path information, the order of the forwarding path 'Local IDs' is maintained. In this case, respective fields of the path information headers are set as follows.

[0176]

'Direction' = 2

'Current Offset' = 2

'Header Length' = 4

'Route Length' = 3

'Local ID #0' = 1

'Local ID #1' = 2

'Local ID #2' = 0

[0177]

In this way, since 'Direction' is '2', forwarding in a reverse direction is performed.

[0178]

Furthermore, in the forwarding processing in a regular (forward) direction as shown in the sequence diagram of Fig. 15, a configuration can be considered that does not include information corresponding to forwarding to an external network, in information of a local ID contained in the path information header. In this case, the information in question is not included in the path information cache,

and as a result, respective fields of the configured path information header are as follows.

'Direction' = 2

'Current Offset' = 2

'Header Length' = 4

'Route Length' = 3

'Local ID #0' = 1

'Local ID #1' = 2

[0179]

After the path information header has been configured, the path information header is assigned to the received packet, and forwarding processing is performed (step S902). As a result, the packet is transmitted from a communication interface corresponding to a local ID (= 2), and the packet is forwarded to an internal forwarding node 400 of ID = 10.

[0180]

On receiving the packet assigned to the path information header, the internal forwarding node 400 follows a flowchart shown in Fig. 11, and executes forwarding processing with a packet having the path information header assigned and forwarding in a reverse direction (step S903). Here, in accordance with the forwarding path information, the packet is transmitted from a communication interface corresponding to the local ID (= 2) that is to be forwarded, and the packet is forwarded to the boundary forwarding node 301a of ID = 1 (step S904).

[0181]

On receiving the packet to which the path information header is assigned, the boundary forwarding node 301a follows the flowchart shown in Fig. 17, and executes forwarding processing with a packet having the path information header assigned and forwarding in a reverse direction (step S905).

[0182]

Furthermore, since 'Current Offset' of the path information header is '0', a decision is made to forward to the external network in

step S203 of Fig. 10, and the path information header is removed in step S205. At this time, since an entry shown in Fig. 18A is already recorded in the path information cache of the boundary forwarding node 301A, the recording time of the entry is updated, without newly adding a path information cache in which content is duplicated. Thereafter, forwarding processing is implemented using information (destination address 192.168.0.50) of the packet after removal of the path information header. As a result, the packet is forwarded to the communication node 100a that is a destination (step S906).

[0183]

According to the second exemplary embodiment of the present invention as described above, on acquiring the path information from the path management server 500, or on removing the path information header, the boundary forwarding nodes 301a and 301b record path information acquired from the path management server 500 and path information included in the path information header, to be used as the path information cache. Therefore, the frequency of transmitting path requests to the path management server 500 is reduced, and it is possible to reduce the load on the path management server 500.

[0184]

Furthermore, according to the second exemplary embodiment of the present invention, since a cache of path information, which is recorded when a packet is transmitted to a destination, is used when forming a path information header for a packet transmitted to a source of a reverse direction packet, that is, the abovementioned packet, it is possible to improve an effect of reducing the load on the path management server 500.

[0185]

A description has been given above of preferred exemplary embodiments of the present invention, but the present invention is not limited to the abovementioned exemplary embodiments, and further modifications, substitutions, and adjustments can be added within a scope that does not depart from a fundamental technological concept of the present invention. For example, in each of the abovementioned

exemplary embodiments, a description has been given using link IDs shared among neighboring nodes of both link ends, but it is also possible to use identifiers of the communication interfaces as the local IDs. In this case, where forwarding in both directions is implemented, identifiers of communication interfaces may be interchanged among neighboring nodes, and information may be shared. Clearly, one-directional forwarding can also be implemented, without performing interchanging of identifiers of the communication interfaces among the neighboring nodes.

[0186]

In addition, instead of a link ID or a communication interface identifier, it is possible to use a modified configuration in which a third local ID is used as a data index, and this is attached to the link ID and the communication interface.

[0187]

Furthermore, for example, in the abovementioned exemplary embodiments, a description has been given in which each of the forwarding nodes is provided with a local ID determination unit, and each local ID is determined, but it is possible to use a configuration in which, in a case where it is possible to obtain configuration information of each forwarding node in the path management server, the path management server determines the local ID and records a forwarding table in a recording unit of each thereof. In this case, it is possible to omit the local ID determination unit of each of the forwarding nodes. Moreover, the path management server can obtain connection relationships of each of the forwarding nodes, and in a case where it is possible to set local IDs such that neighboring nodes are not duplicated, it is possible to omit the neighbor information notification unit of each of the forwarding nodes.

[0188]

Furthermore, the path management server 500 of the abovementioned exemplary embodiments can be realized by an open flow controller of Non-Patent Document 1, and in this case, the forwarding nodes can be realized by an open flow switch.

[0189]

The path management server 500 of the abovementioned exemplary embodiments can be realized as a dedicated server, and it is possible to realize, outside of the abovementioned open flow switch, a router in an IP network, or an MPLS switch in an MPLS network, as the forwarding nodes. Otherwise, as long as a network is such that a server can perform central control of forwarding nodes in the network, application of the present invention is possible.

INDUSTRIAL APPLICABILITY

[0190]

In a commercial network such as a data center, it is necessary to strictly control packet forwarding paths according to various conditions such as destination address, source address, and protocol used, for purposes of QoS (Quality of Service) or load sharing. According to the present invention, it is possible to strictly specify a forwarding path while curtailing packet overhead, without increasing path information. Therefore, the present invention can be preferably applied to commercial networks such as a data center.

In the following, preferred modes are summarized.

Mode 1

A communication system comprising: a path management server for configuring forwarding path information by arranging identifiers for identifying communication interfaces provided in respective forwarding nodes in a forwarding path of a data transfer network or links extending between the respective forwarding nodes and neighboring nodes thereof, and a forwarding node for performing packet forwarding processing in accordance with the forwarding path information, with regard to a packet to which is added a header containing the forwarding path information.

Mode 2

The communication system according to mode 1, wherein the identifiers are unique inside at least one forwarding node.

Mode 3

The communication system according to mode 1, wherein the

identifiers are unique among at least one forwarding node and a forwarding node that neighbors the forwarding node.

Mode 4

The communication system according to any one of modes 1 to 3, wherein the header further includes information indicating forwarding direction.

Mode 5

The communication system according to any one of modes 1 to 4, wherein, among the forwarding nodes, a forwarding node (boundary forwarding node) positioned at a boundary with an external network comprises a header operation unit for performing addition of a header containing the forwarding path information to a packet received from the external network, or for performing removal of a header containing the forwarding path information from a packet transmitted to the external network.

Mode 6

The communication system according to mode 5, wherein the boundary forwarding node further comprises a cache management unit for holding information included in the header, and a header formed using the held information is assigned to a packet having an identical destination.

Mode 7

The communication system according to mode 5, wherein the boundary forwarding node further comprises a cache management unit for holding information included in the header, when the header is removed, and a header formed using the held information is assigned to a packet in a reverse direction transmitted to a source of the packet from which the header was removed.

Mode 8

The communication system according to any one of modes 5 to 7, wherein the header can include information so that the boundary forwarding node distinguishes between a case of forwarding to an external network, and another case.

Mode 9

The communication system according to any one of modes 5 to 8, further comprising a path management server for holding connection information of the respective forwarding nodes, and for creating and providing forwarding path information, in response to a request from the boundary forwarding node.

Mode 10

The communication system according to mode 9, wherein each of the forwarding nodes comprises a neighbor information notification unit for providing notification, to the path management server, of an identifier in order to distinguish a communication interface of the forwarding node or a link extending between the forwarding node itself and neighboring node, and the path management server creates forwarding path information to be provided to the boundary forwarding nodes, based on information notified from each of the forwarding nodes.

Mode 11

The communication system according to mode 4, wherein each of the forwarding nodes performs information exchange with neighboring forwarding nodes, acquires correspondence relationships of communication interfaces between itself and neighboring nodes, and performs packet forwarding processing based on a forwarding direction included in the header.

Mode 12

A forwarding node connected to a path management server for configuring forwarding path information by arranging identifiers for identifying communication interfaces provided in respective forwarding nodes in a forwarding path of a data transfer network or links extending between the respective forwarding nodes and neighboring nodes thereof, the forwarding node performing packet forwarding processing in accordance with the forwarding path information, with regard to a packet to which is added a header containing the forwarding path information.

Mode 13

The forwarding node according to mode 12, wherein the identifiers are

unique inside at least one forwarding node.

Mode 14

The forwarding node according to mode 12, wherein the identifiers are unique among at least one forwarding node and a forwarding node that neighbors the forwarding node.

Mode 15

The forwarding node according to any one of modes 12 to 14, comprising a neighbor information notification unit for providing notification, to the path management server for managing the forwarding path information, of an identifier in order to distinguish a communication interface of the forwarding node or link extending between the forwarding node itself and neighboring node thereof.

Mode 16

A boundary forwarding node disposed at a boundary of a data transfer network and an external network, the node comprising a header operation unit, that: performs packet forwarding processing in accordance with forwarding path information, with regard to a packet to which is added a header containing forwarding path information configured by arranging identifiers for identifying communication interfaces provided in respective forwarding nodes in a forwarding path of a data transfer network or links extending between the respective forwarding nodes and neighboring nodes thereof, and performs addition of a header containing the forwarding path information to a packet received from the external network or removal of a header containing the forwarding path information from a packet transmitted to the external network.

Mode 17

The boundary forwarding node according to mode 16, further comprising a cache management unit for holding information included in the header, wherein a header formed using the held information is assigned to a packet having an identical destination.

Mode 18

The boundary forwarding node according to mode 16, further comprising a cache management unit for holding information included

in the header when the header is removed, wherein a header formed using the held information is assigned to a packet in a reverse direction transmitted to a source of the packet from which the header was removed.

Mode 19

A path management server comprising: a path calculation unit for creating forwarding path information configured by arranging identifiers for identifying communication interfaces provided in respective forwarding nodes in a forwarding path of a data transfer network or links extending between the respective forwarding nodes and neighboring nodes thereof; and a path request processing unit for transmitting the created forwarding path information, in response to a request from a boundary forwarding node disposed at a boundary of the data transfer network and an external network.

Mode 20

The path management server according to mode 19, wherein the path management server creates forwarding path information in which are arranged identifiers that are unique inside at least one forwarding node.

Mode 21

The path management server according to mode 19 or 20, wherein the path management server creates forwarding path information that arranges identifiers that are unique among at least one forwarding node and a forwarding node that neighbors the forwarding node.

Mode 22

The path management server according to any one of modes 19 to 21, wherein the path management server, in addition to the forwarding path information, transmits information indicating forwarding direction to the boundary forwarding node, and creates a header including information indicating a forwarding direction in the boundary forwarding node.

Mode 23

The path management server according to any one of modes 19 to 22, wherein the path management server, in addition to the forwarding

path information, transmits information to the boundary forwarding node, so that the boundary forwarding node distinguishes between a case of forwarding to an external network and another case, and creates a header including information as to whether or not forwarding is to the external network.

Mode 24

The path management server according to any one of modes 19 to 23, comprising a path information collection unit for configuring network topology information in a data transfer network, based on information notified from the respective forwarding nodes, wherein the path calculation unit performs a path calculation based on the network topology information.

Mode 25

A communication method comprising: respective forwarding nodes in a forwarding path of a data transfer network receive a packet to which is added a header containing forwarding path information configured by arranging identifiers for identifying communication interfaces provided in respective forwarding nodes in a forwarding path of a data transfer network or links extending between the respective forwarding nodes and neighboring nodes thereof, and performing packet forwarding processing in accordance with the forwarding path information with regard to the packet.

Mode 26

A program for executing on a computer configuring forwarding nodes disposed in a data transfer network, the program comprising: a process of receiving a packet to which is added a header containing forwarding path information configured by arranging identifiers for identifying communication interfaces provided in respective forwarding nodes in a forwarding path of a data transfer network or links extending between the respective forwarding nodes and neighboring nodes thereof, and a process, with regard to the packet, of forwarding a packet in accordance with the forwarding path information of the packet.

Mode 27

A program for executing on a computer configuring a boundary

forwarding node disposed at a boundary of a data transfer network and an external network, the program comprising: a process of receiving a packet to which is added a header containing forwarding path information configured by arranging identifiers for identifying communication interfaces provided in respective forwarding nodes in a forwarding path of a data transfer network or links extending between the respective forwarding nodes and neighboring nodes thereof, a process, with regard to the packet, of forwarding a packet in accordance with the forwarding path information of the packet, and a process of performing a header operation of adding a header containing the forwarding path information to a packet received from the external network or removing a header containing the forwarding path information from a packet transmitted to the external network.

Mode 28

A program for executing on a computer configuring a path management server for holding connection information of rep forwarding nodes disposed in a data transfer network, the program comprising: a process of creating forwarding path information configured by arranging identifiers for identifying communication interfaces provided in respective forwarding nodes in a forwarding path of a data transfer network or links extending between the respective forwarding nodes and neighboring nodes thereof, in response to a request from a boundary forwarding node disposed at a boundary of a data transfer network and an external network, and a process of transmitting the created forwarding path information to the boundary forwarding node.

It is to be noted that each disclosure of the abovementioned patent document and non-patent document are incorporated herein by reference. Modifications and adjustments of embodiments and examples are possible within the bounds of the entire disclosure (including the scope of the claims) of the present invention, and also based on fundamental technological concepts thereof. Furthermore, a wide variety of combinations and selections of various disclosed elements is possible within the scope of the claims of the present invention. That is, the present invention clearly includes every type

of transformation and modification that a person skilled in the art can realize according to the entire disclosure including the scope of the claims and to technological concepts thereof.

EXPLANATIONS OF SYMBOLS

[0191]

100, 100a, 100b communication node

200 forwarding node

300, 300a, 300b, 301, 301a, 301b boundary forwarding node

310 communication interface

320 packet forwarding unit

330 header operation unit

340 local ID determination unit

350 neighbor information notification unit

360 path acquisition unit

370 recording unit

360A path acquisition unit

370A recording unit

380 cache management unit

400 internal forwarding node

410 communication interface

420 packet forwarding unit

430 local ID determination unit

440 neighbor information notification unit

450 recording unit

500 path management server

510 communication interface

520 path information collection unit

530 path request processing unit

531 path calculation unit

540 path information recording unit

600 data transfer network

700 external network

WHAT IS CLAIMED IS:

1. A packet forwarding node, comprising:

a storage unit to store a packet forwarding table used for forwarding a packet based on an identifier which identifies a link between nodes on a packet forwarding path; and

a forwarding unit to receive an incoming packet including a plurality of the identifiers, and to forward the incoming packet based on an identifier corresponding to the packet forwarding node.

2. The packet forwarding node according to claim 1, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link within a predetermined domain.

3. The packet forwarding node according to claim 1, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link within a predetermined local domain.

4. The packet forwarding node according to claim 1, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link within the packet forwarding node.

5. The packet forwarding node according to claim 1, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link among the packet forwarding nodes.

6. A packet forwarding node, comprising:

a storage unit to store a packet forwarding table used for forwarding a packet based on an identifier which identifies an interface of a packet forwarding node; and

a forwarding unit to receive an incoming packet including a

plurality of identifiers, and to forward the incoming packet based on an identifier corresponding to the packet forwarding node.

7. The packet forwarding node according to claim 6, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies a link within a predetermined domain.

8. The packet forwarding node according to claim 6, wherein the storage unit stores the table used for forwarding the packet based on an identifier which uniquely identifies a link within a predetermined local domain.

9. The packet forwarding node according to claim 6, wherein the storage unit stores the table used for forwarding the packet based on an identifier which uniquely identifies a link within the packet forwarding node.

10. The packet forwarding node according to claim 6, wherein the storage unit stores the table used for forwarding the packet based on an identifier which uniquely identifies a link among the packet forwarding nodes.

11. A packet forwarding node, comprising:

a communication unit to communicate with a server for receiving a plurality of identifiers, each of which identifies a link between nodes on a packet forwarding path; and

a forwarding unit to forward an incoming packet based on an identifier corresponding to a packet forwarding node.

12. The packet forwarding node according to claim 11, wherein the forwarding unit forwards the packet based on an identifier which uniquely identifies a link within a predetermined domain.

13. The packet forwarding node according to claim 11, wherein the forwarding unit forwards the packet based on an identifier which uniquely identifies the link within a predetermined local domain.

14. The packet forwarding node according to claim 11, wherein the forwarding unit forwards the packet based on an identifier which uniquely identifies the link within the packet forwarding node.

15. The packet forwarding node according to claim 11, wherein the forwarding unit forwards the packet based on an identifier which uniquely identifies the link among the packet forwarding nodes.

16. A packet forwarding node, comprising:

a communication unit to communicate with a server for receiving a plurality of identifiers, each of which identifies an interface of a packet forwarding node; and

a forwarding unit to forward an incoming packet based on an identifier corresponding to the packet forwarding node.

17. The packet forwarding node according to claim 16, wherein the forwarding unit forwards the packet based on an identifier which uniquely identifies a link within a predetermined domain.

18. The packet forwarding node according to claim 16, wherein the forwarding unit forwards the packet based on an identifier which uniquely identifies a link within a predetermined local domain.

19. The packet forwarding node according to claim 16, wherein the forwarding unit forwards the packet based on an identifier which uniquely identifies a link within the packet forwarding node.

20. The packet forwarding node according to claim 16, wherein the forwarding unit forwards the packet based on an identifier which uniquely identifies a link among the packet forwarding nodes.

21. A server, comprising:

a first unit to determine a plurality of identifiers, each of which identifies a link between nodes on a packet forwarding path; and

a second unit to send information elements to a packet forwarding node which is capable of forwarding an incoming packet based on an identifier corresponding to the packet forwarding node.

ABSTRACT OF THE DISCLOSURE

A packet forwarding node includes a storage unit to store a packet forwarding table used for forwarding a packet based on an identifier which identifies a link between nodes on a packet forwarding path and a forwarding unit to receive an incoming packet including a plurality of the identifiers, and to forward the incoming packet based on an identifier corresponding to the packet forwarding node.

Declaration of Inventorship

As a below-named inventor, I hereby declare that:

I believe that I am the original inventor or an original joint inventor, of the claimed invention in the Application entitled:

COMMUNICATION SYSTEM, FORWARDING NODE, PATH MANAGEMENT SERVER, COMMUNICATION METHOD, AND PROGRAM

the specification of which (check one):
_X_ is attached hereto
___ was filed as U. S. Application No. or PCT International Application No. _____ on _____.

The Application was made or was authorized to be made by me. I hereby acknowledge that any willful false statement made in this Declaration is punishable under 18 U.S.C. §1001 by fine or imprisonment of not more than five (5) years, or both. I have reviewed and understand the contents of the Application, including the claims, and I am aware of the duty to disclose to the U. S. P. T. O. all information known to be material to patentability as defined in 37 CFR §1.56.

Legal Name of Inventor JUN AWANO

Inventor's Signature Jun Awano Date March 4, 2014

Legal Name of Additional Inventor, If Any _____

Inventor's Signature _____ Date _____

Legal Name of Additional Inventor, If Any _____

Inventor's Signature _____ Date _____

Legal Name of Additional Inventor, If Any _____

Inventor's Signature _____ Date _____

Legal Name of Additional Inventor, If Any _____

Inventor's Signature _____ Date _____

Legal Name of Additional Inventor, If Any _____

Inventor's Signature _____ Date _____

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FIG. 1

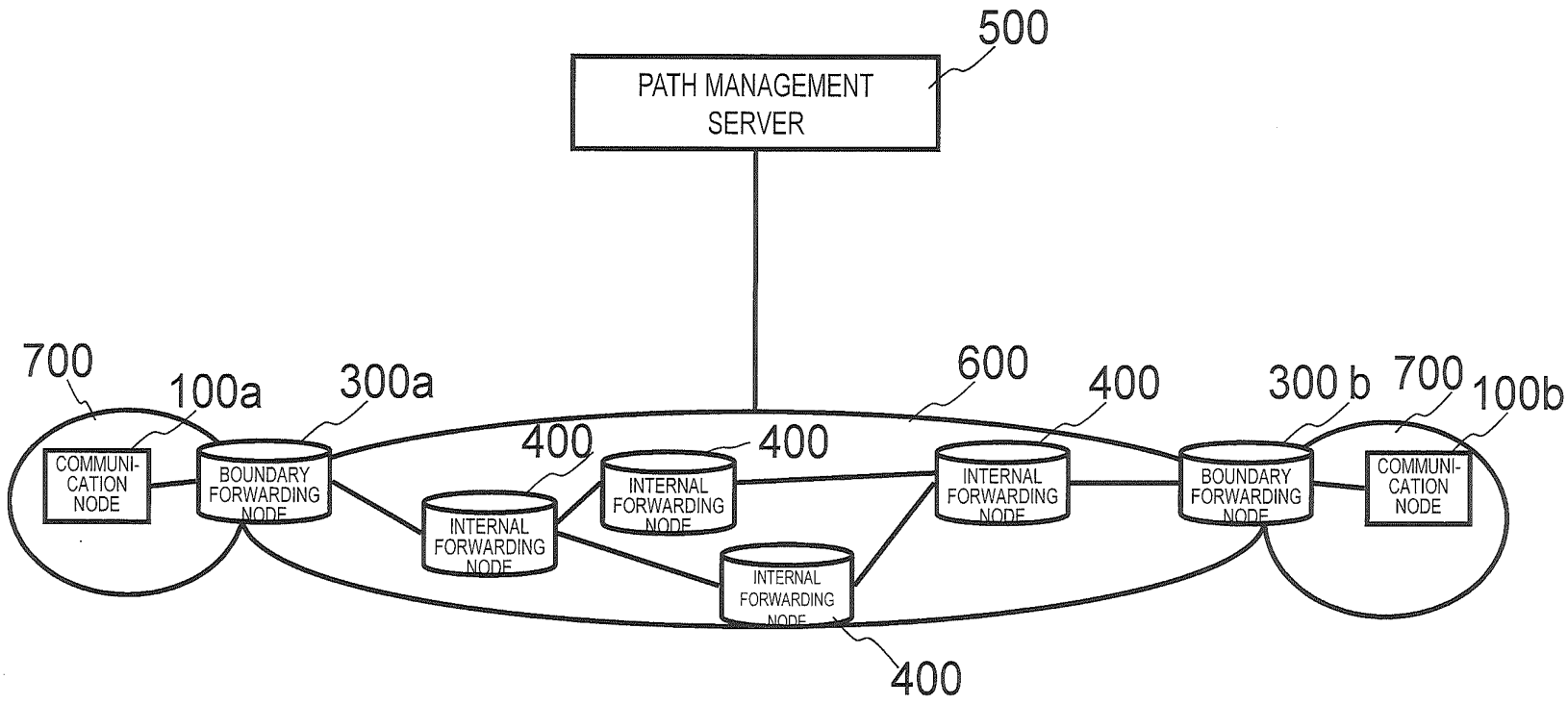

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FIG. 2

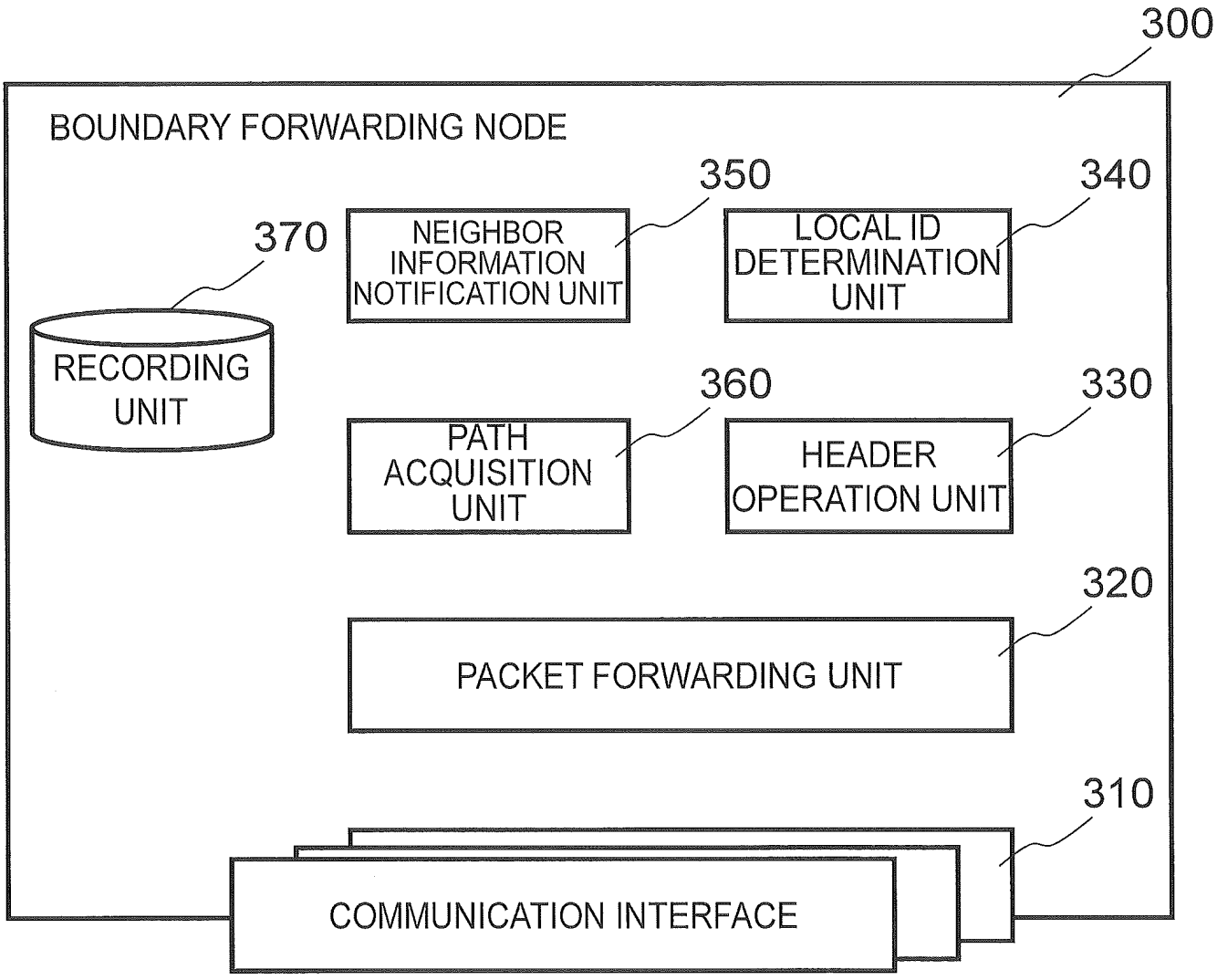
300
BOUNDARY FORWARDING NODE
350
340
370
NEIGHBOR INFORMATION NOTIFICATION UNIT
LOCAL ID DETERMINATION UNIT
RECORDING UNIT
360
330
PATH ACQUISITION UNIT
HEADER OPERATION UNIT
320
PACKET FORWARDING UNIT
310
COMMUNICATION INTERFACE

FIG. 3

LOCAL ID	INTERFACE	NEXT HOP
Link ID_1	IF_1	Node_1
Link ID_2	IF_2	Node_2
Link ID_3	IF_3	Node_3
:		

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FIG. 4

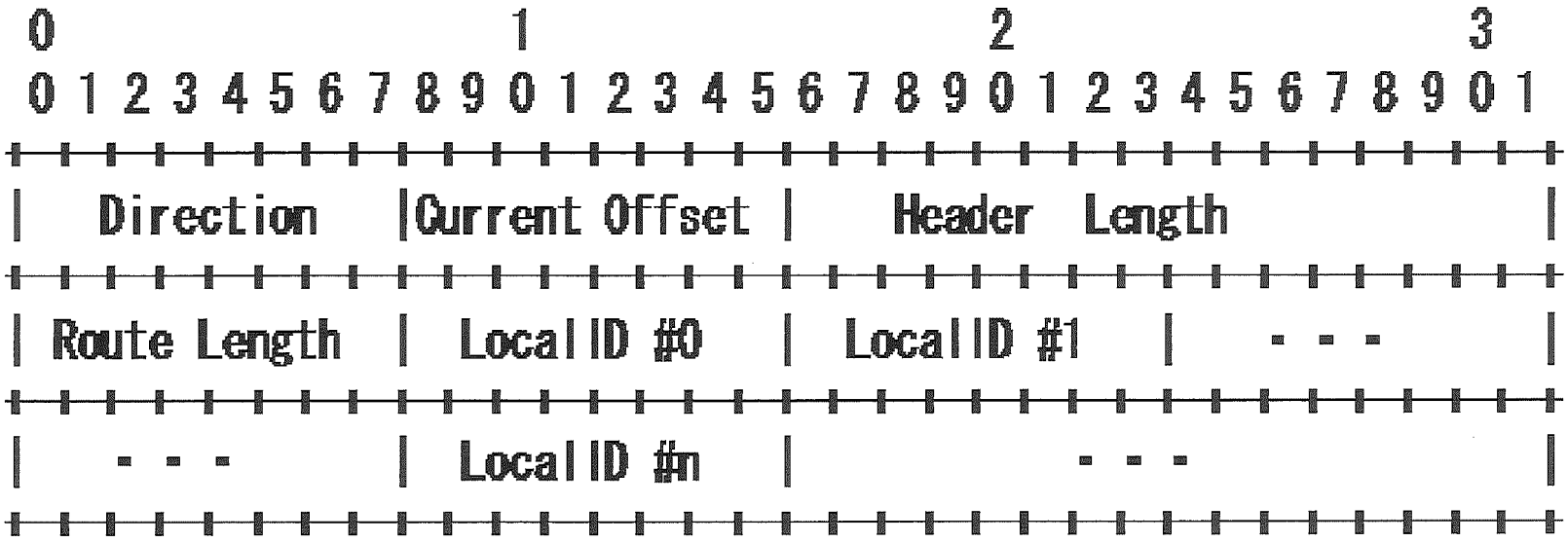

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FIG. 5

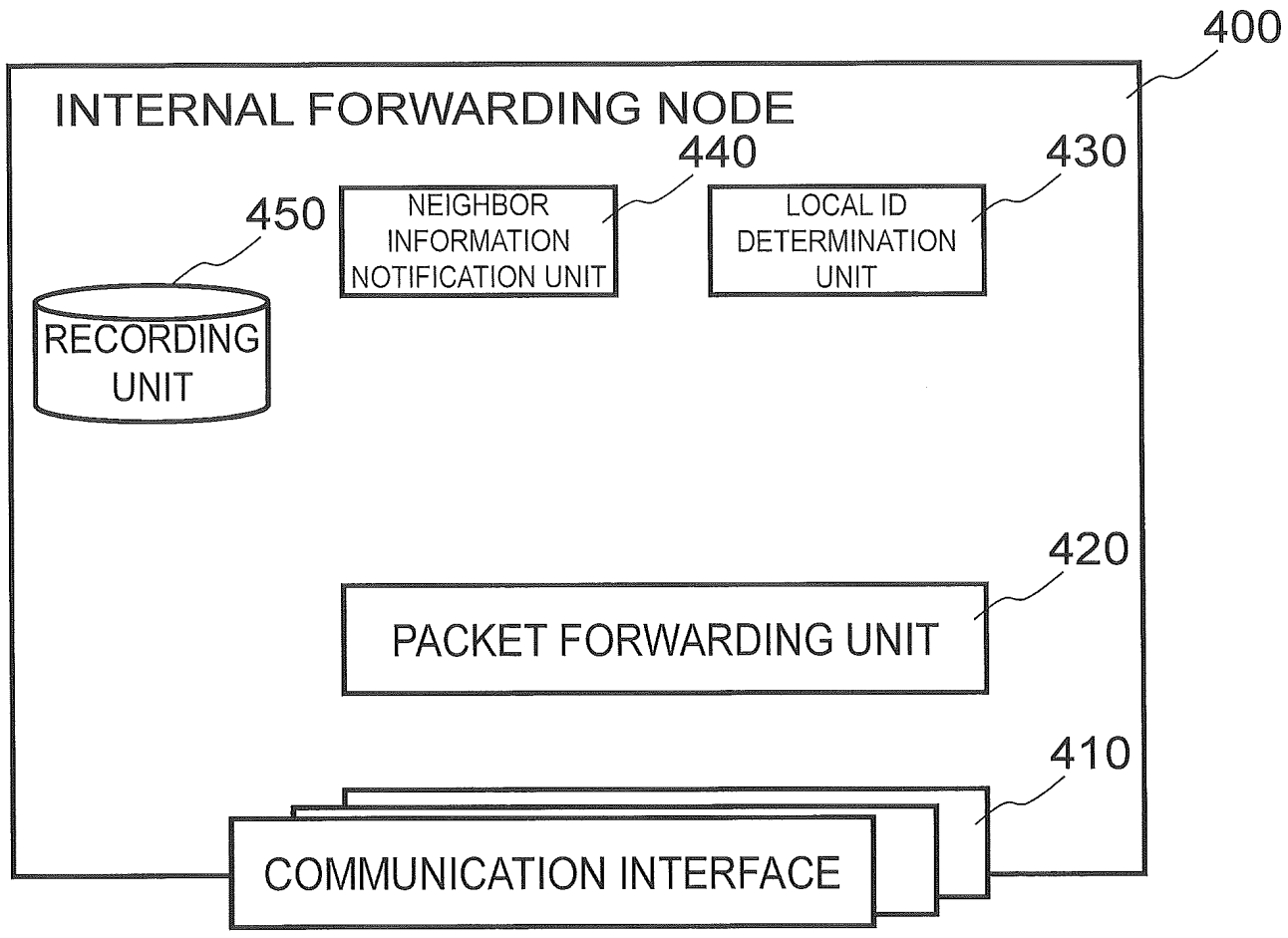
400
INTERNAL FORWARDING NODE
440
430
450
NEIGHBOR INFORMATION NOTIFICATION UNIT
LOCAL ID DETERMINATION UNIT
RECORDING UNIT
420
PACKET FORWARDING UNIT
410
COMMUNICATION INTERFACE

FIG. 6

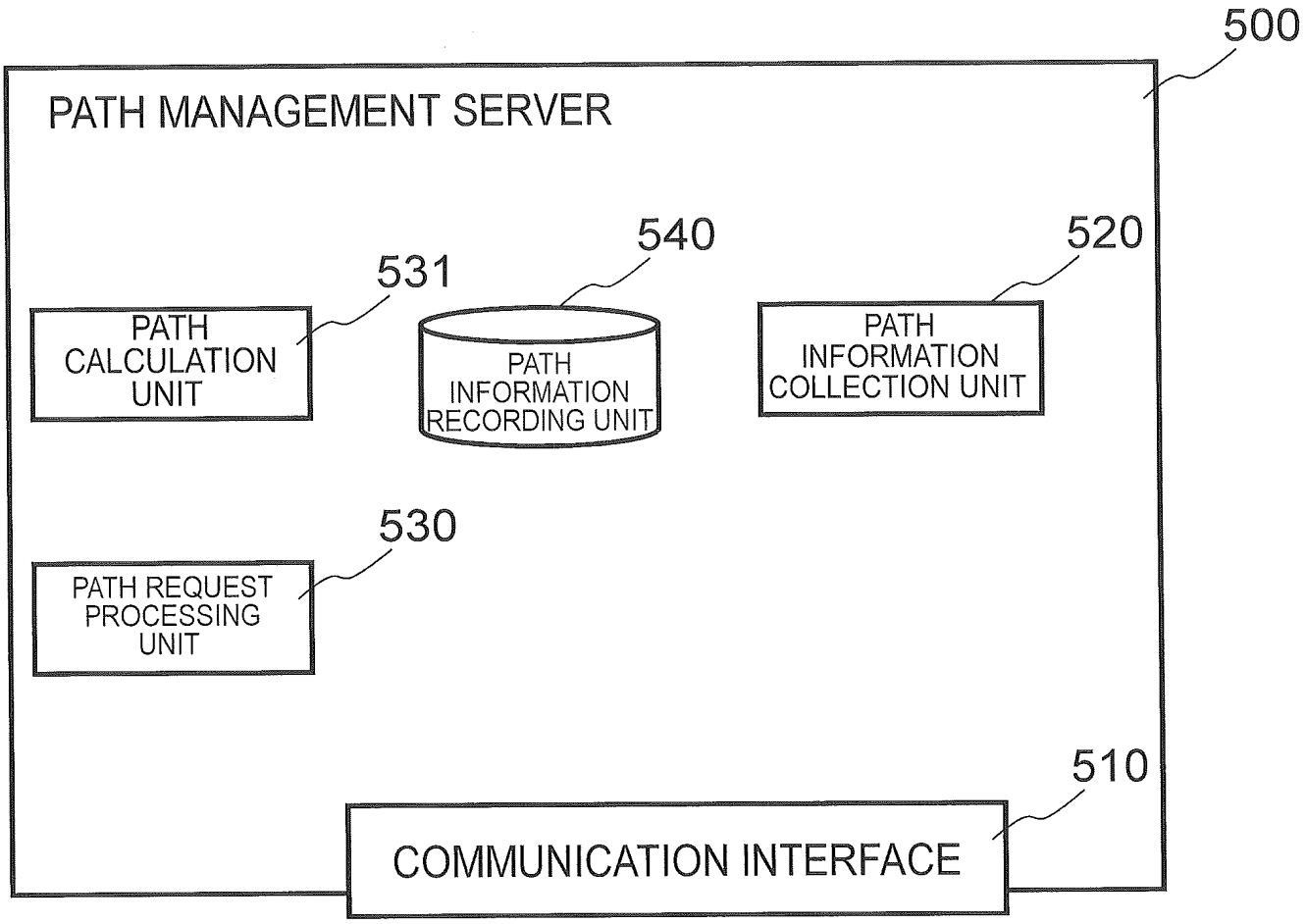
500
PATH MANAGEMENT SERVER
540
520
531
PATH CALCULATION UNIT
PATH INFORMATION RECORDING UNIT
PATH INFORMATION COLLECTION UNIT
530
PATH REQUEST PROCESSING UNIT
510
COMMUNICATION INTERFACE

FIG. 7

NEIGHBOR INFORMATION FROM NEIGHBORING FORWARDING NODE (ID: 1)

sender ID : 1
LinkID: 0, neighborID: 192.168.0.50 (outerIP)
LinkID: 1, neighborID: 10
LinkID: 2, neighborID: 5

NEIGHBOR INFORMATION FROM NEIGHBORING FORWARDING NODE (ID: 8)

sender ID : 8
LinkID: 0, neighborID: 192.168.0.20 (outerIP)
LinkID: 2, neighborID: 10
LinkID: 3, neighborID: 6

NEIGHBOR INFORMATION FROM INTERNAL FORWARDING NODE (ID: 5)

sender ID : 5
LinkID: 1, neighborID: 6
LinkID: 2, neighborID: 1
LinkID: 3, neighborID: 10

NEIGHBOR INFORMATION FROM NEIGHBORING FORWARDING NODE (ID: 6)

sender ID : 6
LinkID: 1, neighborID: 5
LinkID: 3, neighborID: 8

NEIGHBOR INFORMATION FROM NEIGHBORING FORWARDING NODE (ID: 10)

sender ID : 10
LinkID: 1, neighborID: 1
LinkID: 2, neighborID: 8
LinkID: 3, neighborID: 5

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FIG. 8

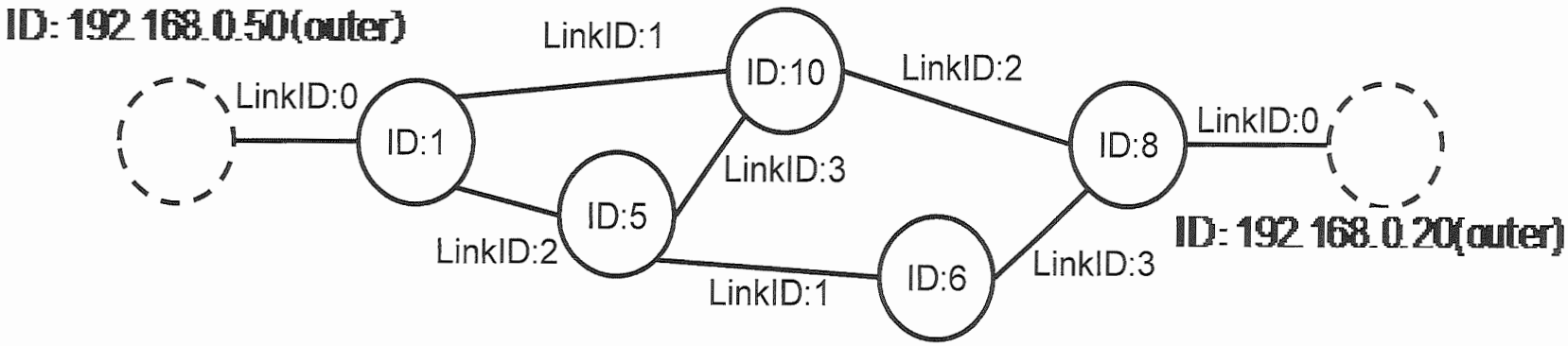

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FIG. 9

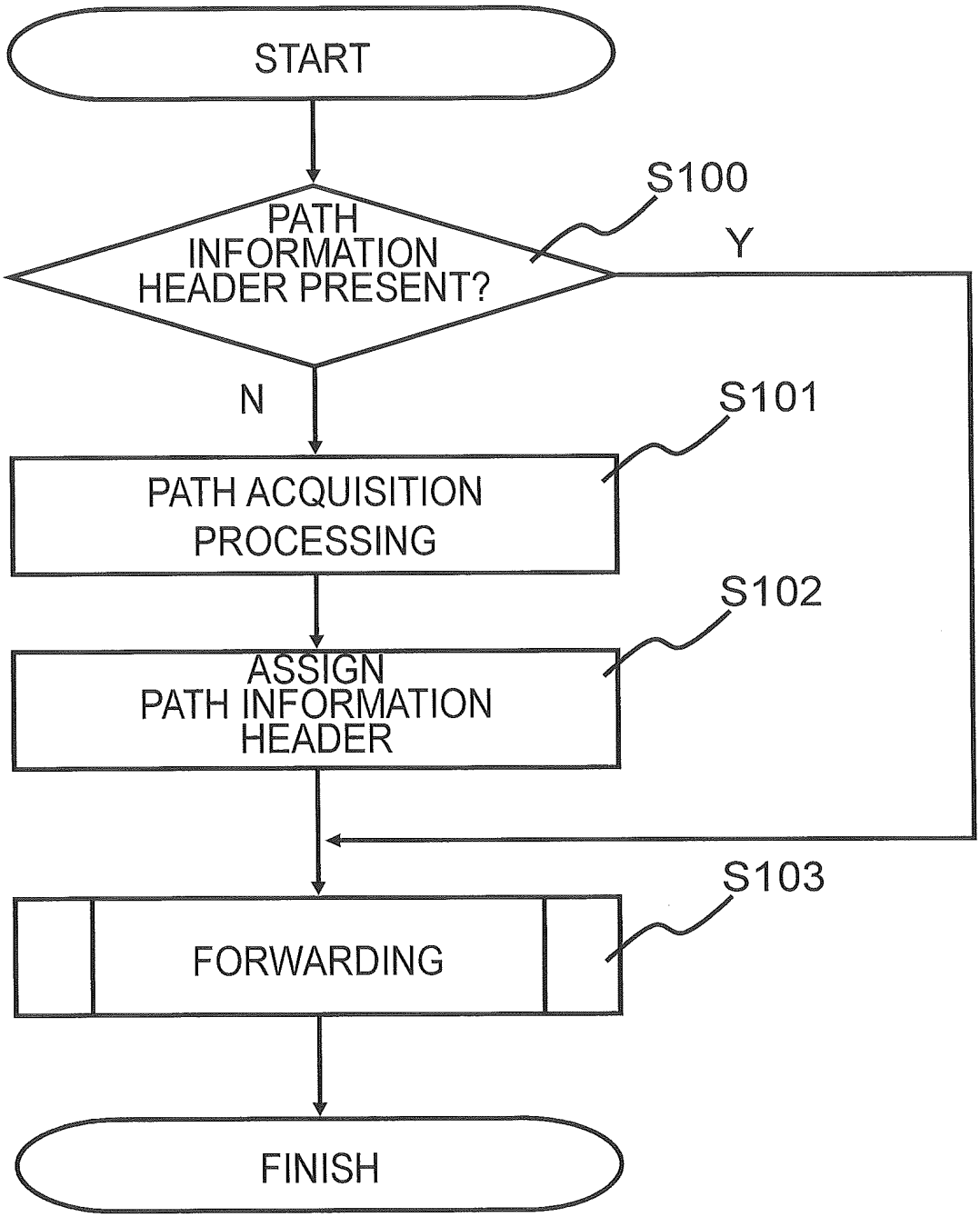
START
S100
PATH INFORMATION HEADER PRESENT?
Y
N
S101
PATH ACQUISITION PROCESSING
S102
ASSIGN PATH INFORMATION HEADER
S103
FORWARDING
FINISH

FIG. 10

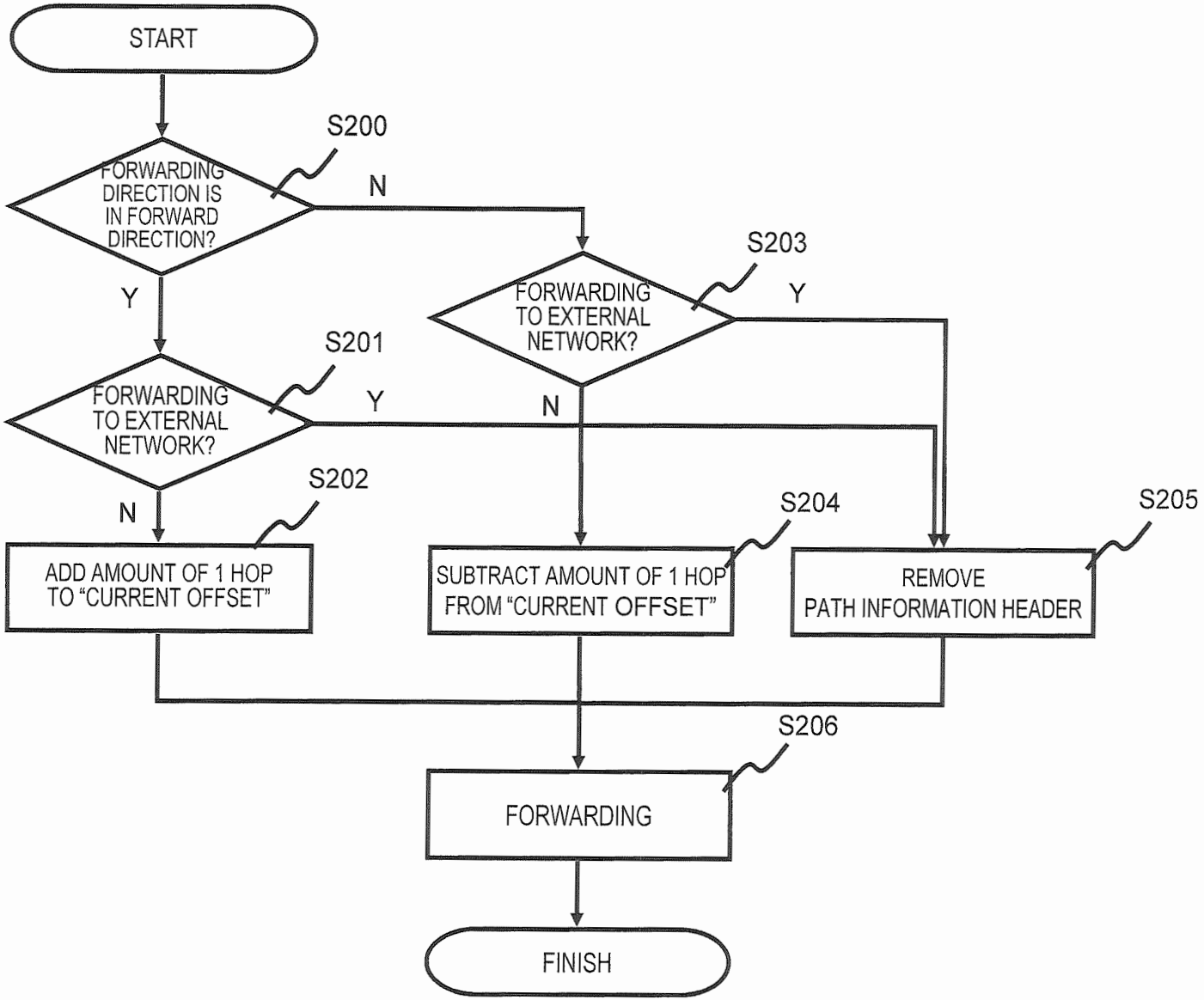

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FIG. 11

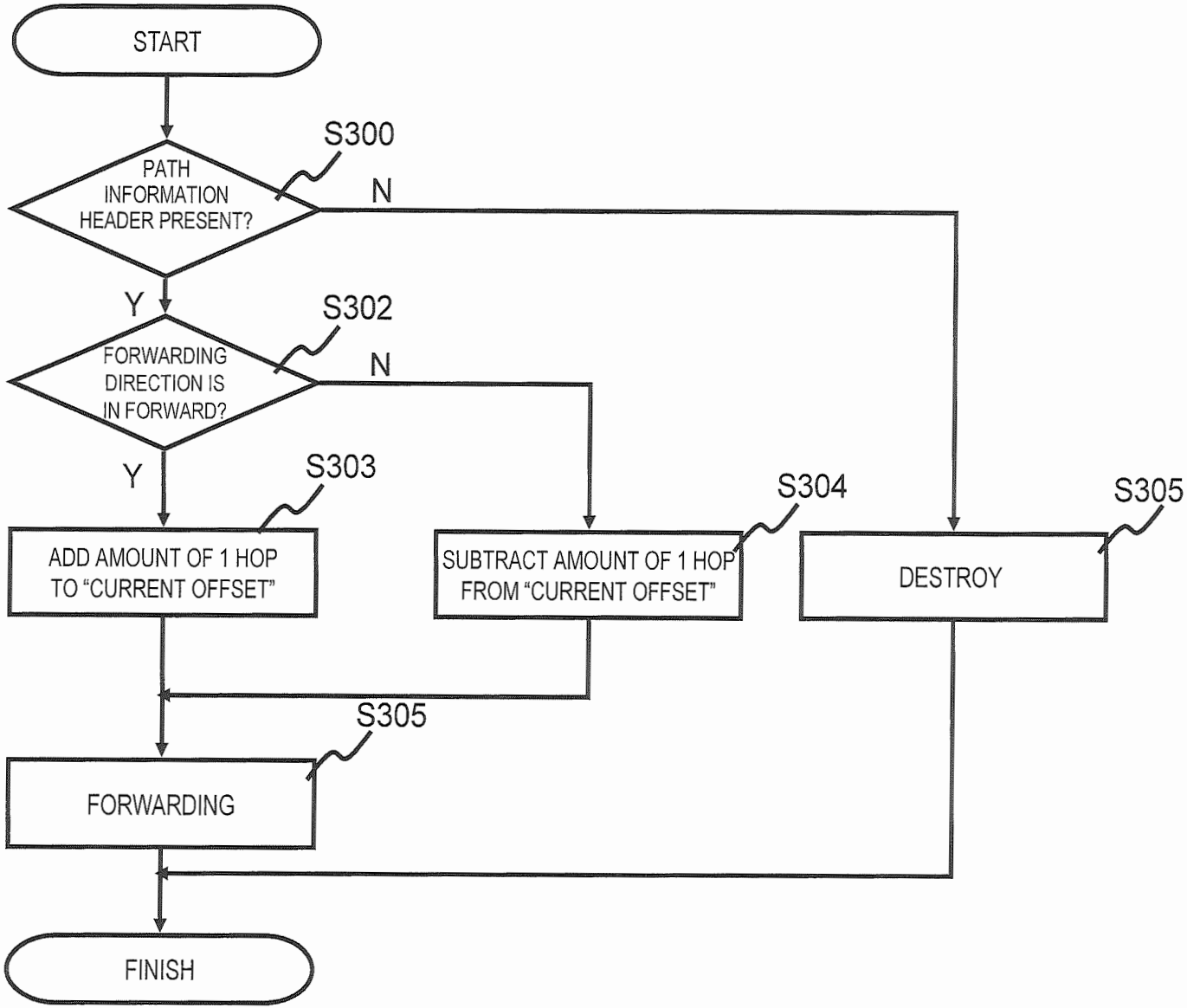

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FIG. 12

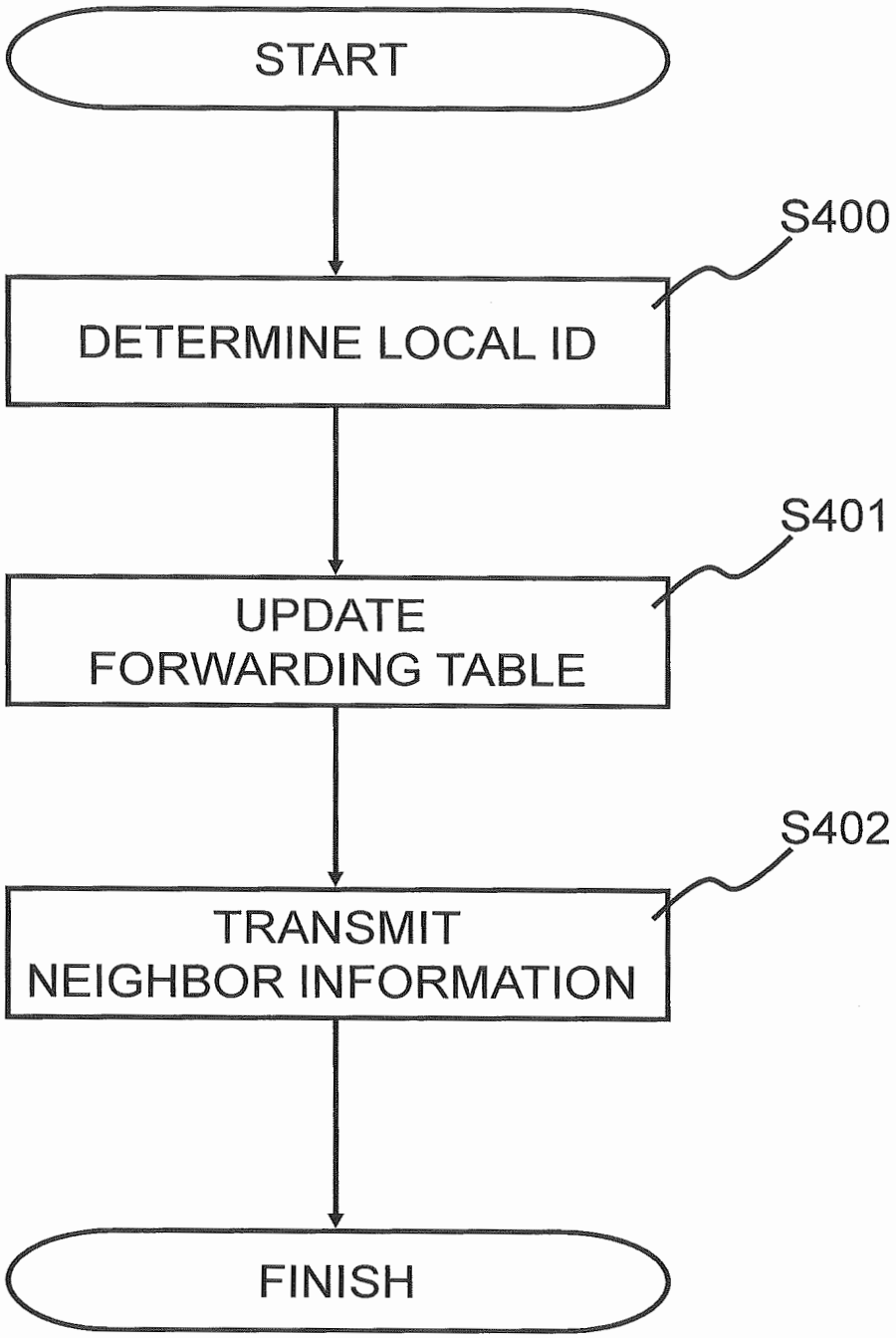
START
S400
DETERMINE LOCAL ID
S401
UPDATE
FORWARDING TABLE
S402
TRANSMIT
NEIGHBOR INFORMATION
FINISH

FIG. 13

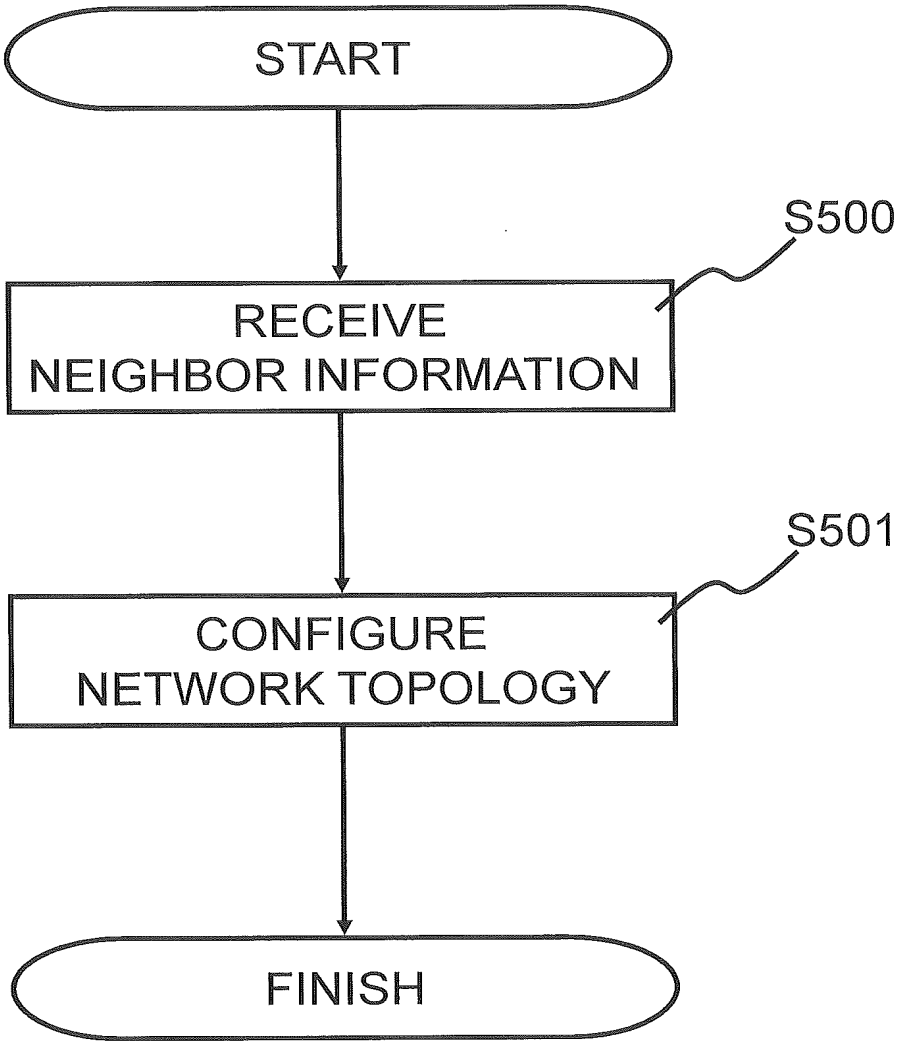
START
S500
RECEIVE
NEIGHBOR INFORMATION
S501
CONFIGURE
NETWORK TOPOLOGY
FINISH

FIG. 14

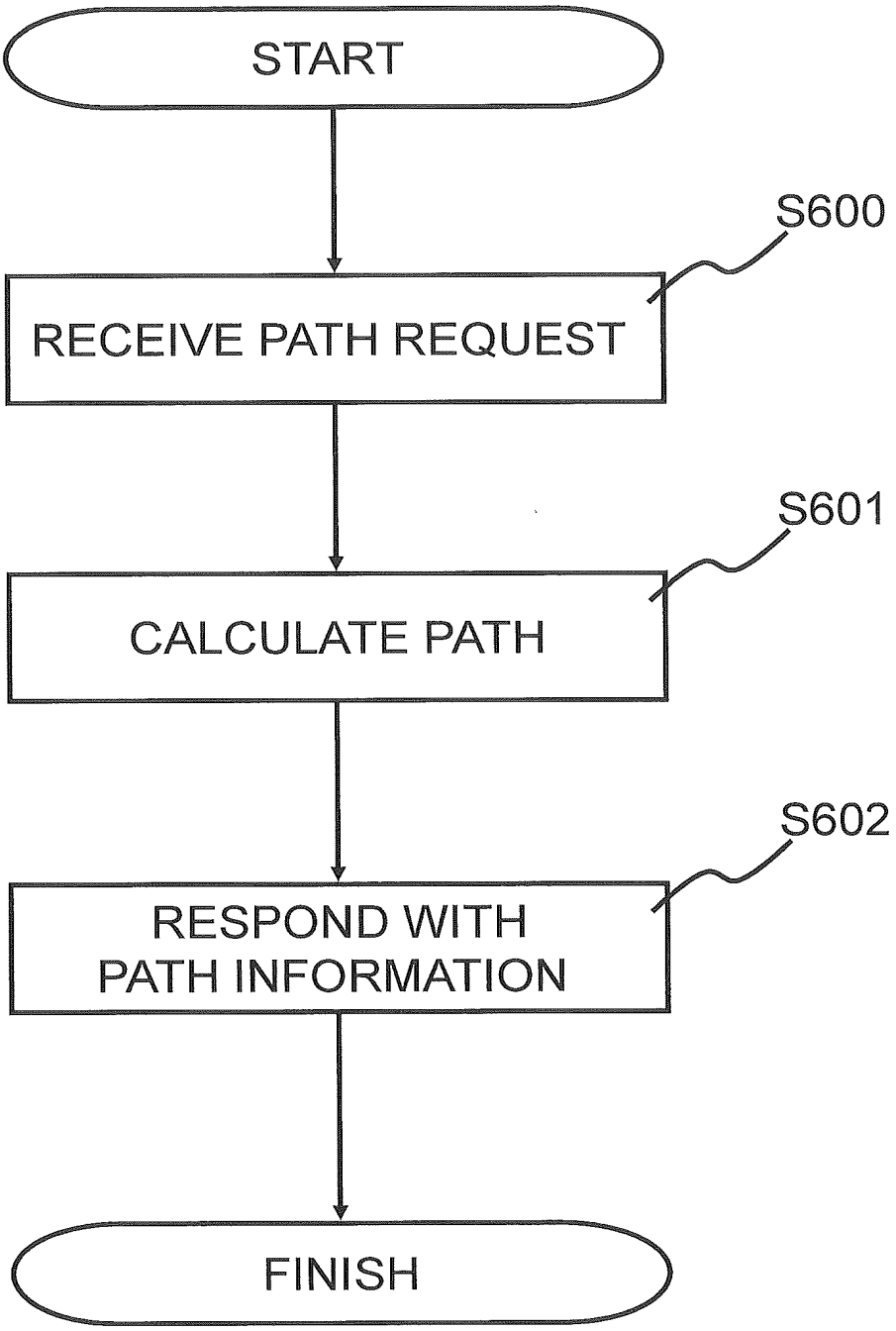
START
S600
RECEIVE PATH REQUEST
S601
CALCULATE PATH
S602
RESPOND WITH
PATH INFORMATION
FINISH

FIG. 15

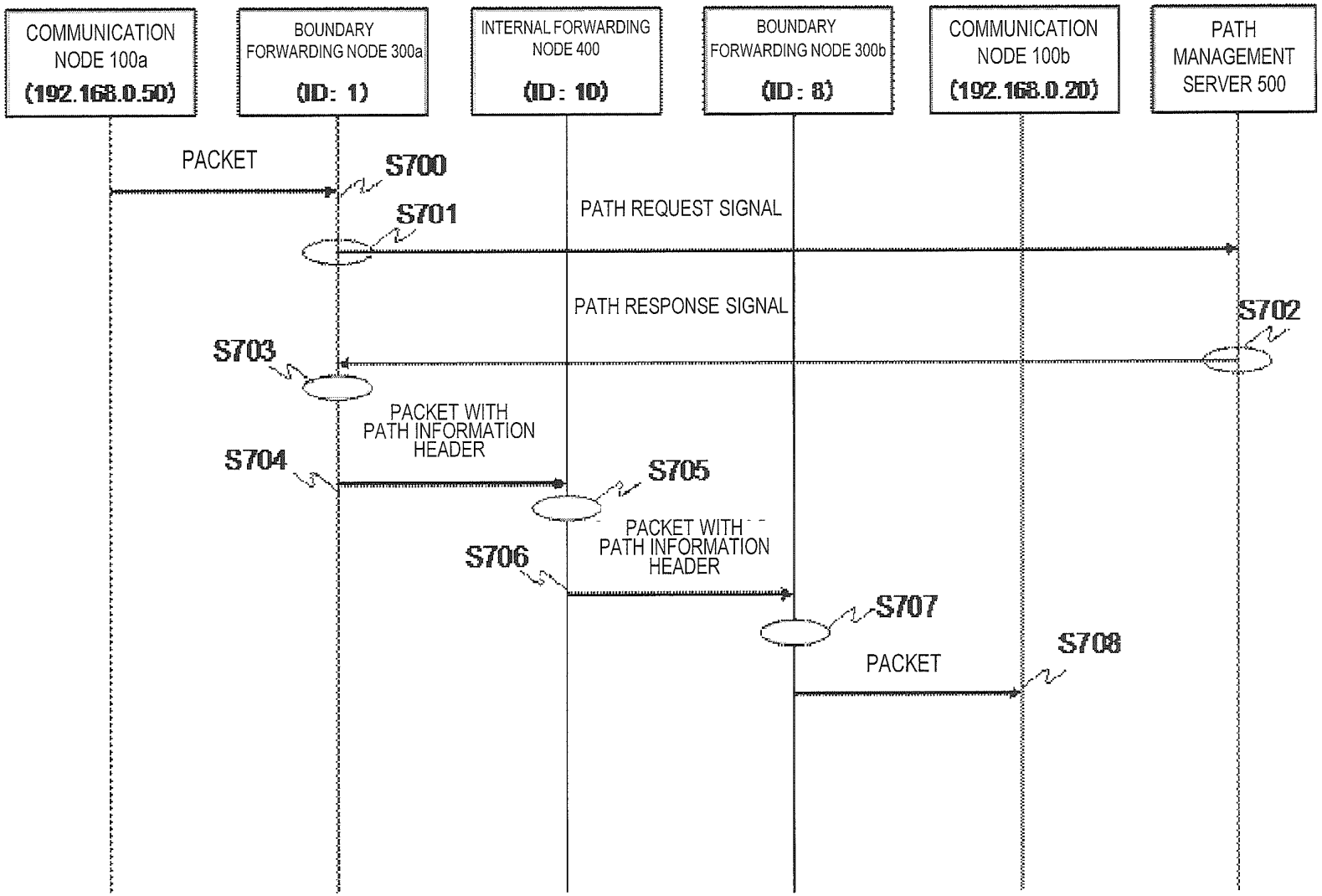

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FIG. 16

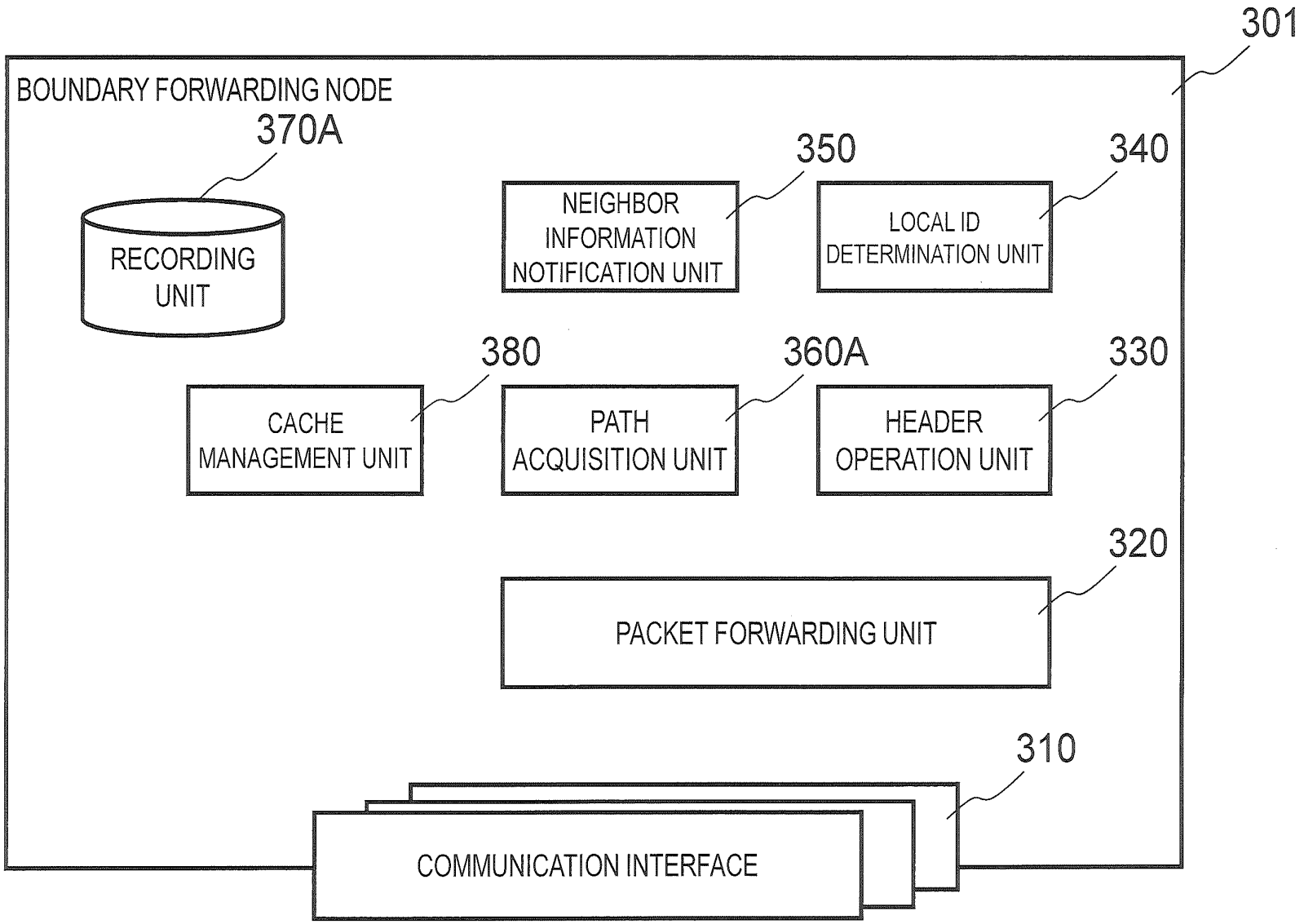

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FIG. 17

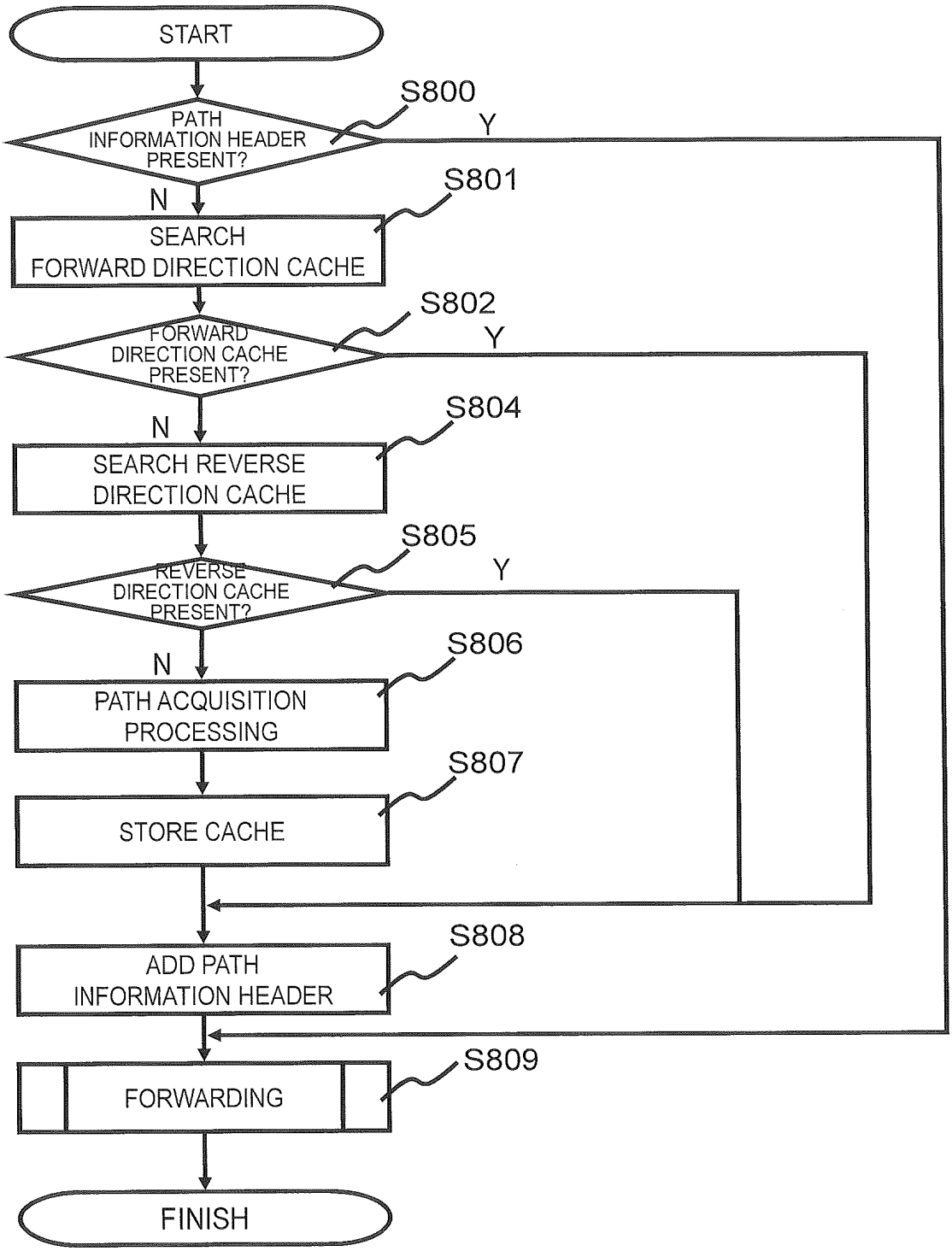
START
S800
PATH INFORMATION HEADER PRESENT?
Y
N
S801
SEARCH FORWARD DIRECTION CACHE
S802
FORWARD DIRECTION CACHE PRESENT?
Y
N
S804
SEARCH REVERSE DIRECTION CACHE
S805
REVERSE DIRECTION CACHE PRESENT?
Y
N
S806
PATH ACQUISITION PROCESSING
S807
STORE CACHE
S808
ADD PATH INFORMATION HEADER
S809
FORWARDING
FINISH

FIG. 18A

PATH INFORMATION CACHE OF BOUNDARY FORWARDING NODE 301a

TIME OF CREATION	SOURCE ADDRESS	DESTINATION ADDRESS	PATH INFORMATION
HHtMMtSS	192.168.0.50	192.168.0.20	Direction (1), CurrentOffset (0), RouteLength (3), LocalIDs (1, 2, 0)
⋮	⋮	⋮	⋮

FIG. 18B

PATH INFORMATION CACHE OF BOUNDARY FORWARDING NODE 301b

TIME OF CREATION	SOURCE ADDRESS	DESTINATION ADDRESS	PATH INFORMATION
HHtMMtSS	192.168.0.50	192.168.0.20	Direction (1), CurrentOffset (2), RouteLength (3), LocalIDs (1, 2, 0)
⋮	⋮	⋮	⋮

FIG. 19

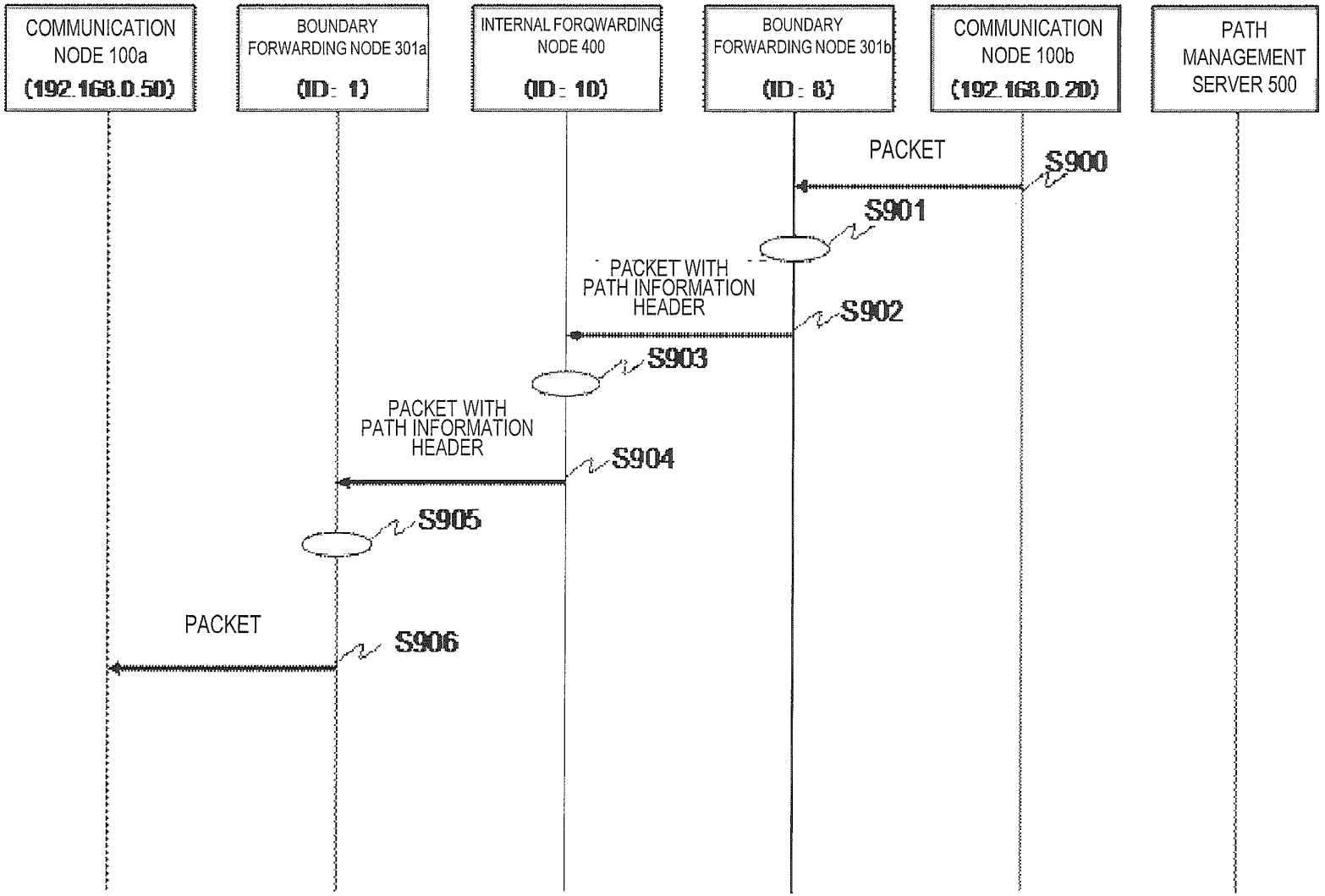

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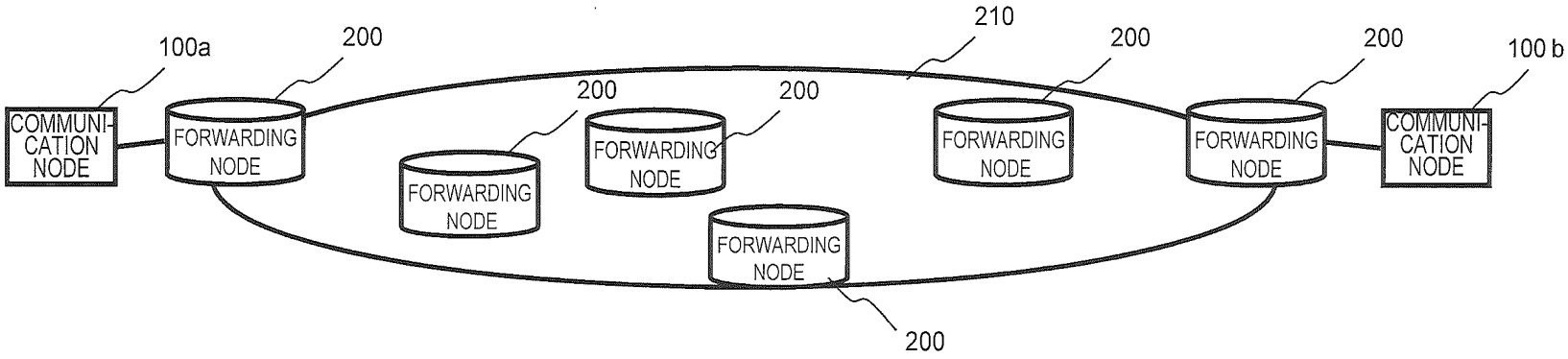
FIG. 20



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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	NEG-1440PCT-US2CT
	Application Number	
Title of Invention	COMMUNICATION SYSTEM, FORWARDING NODE, PATH MANAGEMENT SERVER, COMMUNICATION METHOD, AND PROGRAM	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Inventor Information:

Inventor 1 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Jun		Awano	

Residence Information (Select One) ○ US Residency ◉ Non US Residency ○ Active US Military Service

City	Tokyo	Country of Residence i	JP

Mailing Address of Inventor:

Address 1	c/o NEC CORPORATION		
Address 2	7-1, Shiba 5-chome, Minato-ku,		
City	Tokyo	**State/Province**	
Postal Code	108-8001	**Country** i	JP

All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. Add

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below.
For further information see 37 CFR 1.33(a).

☐ **An Address is being provided for the correspondence Information of this application.**

Customer Number	21254		
Email Address	admin@mcginniplaw.com	Add Email	Remove Email

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	NEG-1440PCT-US2CT
	Application Number	
Title of Invention	COMMUNICATION SYSTEM, FORWARDING NODE, PATH MANAGEMENT SERVER, COMMUNICATION METHOD, AND PROGRAM	

Application Information:

Title of the Invention	COMMUNICATION SYSTEM, FORWARDING NODE, PATH MANAGEMENT SERVER, COMMUNICATION METHOD, AND PROGRAM		
Attorney Docket Number	NEG-1440PCT-US2CT	**Small Entity Status Claimed**	☐
Application Type	Nonprovisional		
Subject Matter	Utility		
Suggested Class (if any)		**Sub Class (if any)**	
Suggested Technology Center (if any)			
Total Number of Drawing Sheets (if any)	20	**Suggested Figure for Publication (if any)**	

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32).
Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for thr Representative Information during processing.

Please Select One:	◉ Customer Number	○ US Patent Practitioner	○ Limited Recognition (37 CFR 11.9)
Customer Number	21254		

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, or 365(c) or indicate National Stage entry from a PCT application. Providing this information in the application data sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.

Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
	Continuation of	13176610	2011-07-05
Prior Application Status	Expired		Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
13176610	Continuation of	PCT/JP2010/065712	2010-09-13

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	NEG-1440PCT-US2CT
	Application Number	
Title of Invention	COMMUNICATION SYSTEM, FORWARDING NODE, PATH MANAGEMENT SERVER, COMMUNICATION METHOD, AND PROGRAM	

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button.

Foreign Priority Information:

This section allows for the applicant to claim benefit of foreign priority and to identify any prior foreign application for which priority is not claimed. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55(a).

Remove

Application Number	Country[1]	Filing Date (YYYY-MM-DD)	Priority Claimed
2009-212221	JP	2009-09-14	◉ Yes ○ No

Additional Foreign Priority Data may be generated within this form by selecting the **Add** button.

Authorization to Permit Access:

☒ Authorization to Permit Access to the Instant Application by the Participating Offices

If checked, the undersigned hereby grants the USPTO authority to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the World Intellectual Property Office (WIPO), and any other intellectual property offices in which a foreign application claiming priority to the instant patent application is filed access to the instant patent application. See 37 CFR 1.14(c) and (h). This box should not be checked if the applicant does not wish the EPO, JPO, KIPO, WIPO, or other intellectual property office in which a foreign application claiming priority to the instant patent application is filed to have access to the instant patent application.

In accordance with 37 CFR 1.14(h)(3), access will be provided to a copy of the instant patent application with respect to: 1) the instant patent application-as-filed; 2) any foreign application to which the instant patent application claims priority under 35 U.S.C. 119(a)-(d) if a copy of the foreign application that satisfies the certified copy requirement of 37 CFR 1.55 has been filed in the instant patent application; and 3) any U.S. application-as-filed from which benefit is sought in the instant patent application.

In accordance with 37 CFR 1.14(c), access may be provided to information concerning the date of filing this Authorization.

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	NEG-1440PCT-US2CT
	Application Number	
Title of Invention	COMMUNICATION SYSTEM, FORWARDING NODE, PATH MANAGEMENT SERVER, COMMUNICATION METHOD, AND PROGRAM	

Applicant 1

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

◉ Assignee	○ Legal Representative under 35 U.S.C. 117
○ Person to whom the inventor is obligated to assign.	○ Person who shows sufficient proprietary interest

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

Name of the Deceased or Legally Incapacitated Inventor :	
If the Assignee is an Organization check here.	☒
Organization Name	NEC CORPORATION

Mailing Address Information:

Address 1	7-1, Shiba 5-chome, Minato-ku,		
Address 2			
City	Tokyo	**State/Province**	
Country	JP	Postal Code	108-8001
Phone Number		Fax Number	
Email Address			

Additional Applicant Data may be generated within this form by selecting the Add button.

Signature:

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications

Signature	/Scott Mandir/			Date (YYYY-MM-DD)	2014-04-03
First Name	Scott L.	Last Name	Mandir	Registration Number	67186

Additional Signature may be generated within this form by selecting the Add button.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	NEG-1440PCT-US2CT
	Application Number	
Title of Invention	COMMUNICATION SYSTEM, FORWARDING NODE, PATH MANAGEMENT SERVER, COMMUNICATION METHOD, AND PROGRAM	

This collection of information is required by 37 CFR 1.76. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Docket No.: NEG-1440PCT-US2CT
KATO.327CONT.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Continuation patent application of 13/176,610, filed on July 5, 2011.

Jun Awano

Serial No.:	Not Yet Assigned	**Group Art Unit:**	Not Yet Assigned
Filed:	Concurrently Herewith	**Examiner:**	Not Yet Assigned

For: COMMUNICATION SYSTEM, FORWARDING NODE, PATH MANAGEMENT SERVER, COMMUNICATION METHOD, AND PROGRAM

Honorable Commissioner of Patents
Alexandria, Virginia 22313-1450

INFORMATION DISCLOSURE STATEMENT

Sir:

Under the provisions of 37 CFR §1.97 through §1.98 and pursuant to applicant's duty of disclosure under 37 CFR §1.56, applicant respectfully brings the following documents listed on the attached form PTO-1449, to the attention of the Examiner in charge of the above-identified application. These references were either cited or submitted in parent Application No. 13/176,610, and thus copies of these references are not provided in accordance with 37 C.F.R. §1.98(d).

This citation does not constitute an admission that the references are relevant or material to the claims. They are only cited as constituting related art of which applicant is aware.

It is respectfully requested that the listed references be considered by the Examiner and formally made of record in this application.

Please charge any deficiencies in fees and credit any overpayment of fees to Attorney's Deposit Account No. 50-0481.

Respectfully submitted,

Scott L. Mandir, Esq.
Registration No. 67,186
Sean M. McGinn, Esq.
Registration No. 34,386

Date: 4/03/14

MCGINN INTELLECTUAL PROPERTY LAW GROUP, PLLC
8321 Old Courthouse Road, Suite 200
Vienna, Virginia 22182-3817
(703) 761-4100, Customer No. 21254

Information Disclosure Citation	Docket Number NEG-1440PCT-US2CT	Application Number Not Yet Assigned
	Applicant NEC Corporation	
	Filing Date Concurrently Herewith	Group Art Unit Not Yet Assigned

U. S. Patent Documents

Examiner Initial	Ref	Document Number	Date	Name	Class	Subclass	Filing Date (If Appropriate)	
		US 2007/0280102 A1	12-2007	Vasseur et al.				
		US 2008/0123651 A1	05-2008	Vasseur et al.				
		US 2008/0279196 A1	11-2008	Friskney et al.				
		US 7,447,151 B2	11-2008	McDysan, David E.				
		US 7,522,603 B2	04-2009	Vasseur, Jean-Philippe				
		US 2010/0165995 A1	07-2010	Mehta et al.				
		US 8,125,928 B2	02-2012	Mehta et al				
		US 7, 706,344 B2	04/27/2010	Kobayashi et al.				
		US 2003/0053427 A1	03-2003	Kanda et al				
		US 2008/0137615 A1	06-2008	Park et al				

Foreign Patent Documents

Examiner Initial	Ref	Document Number	Date	Country	Class	Sub-class	Translation	
							Yes	No
		CN 1988498 (A)	06-27-2007	China			ABS	
		CN 101047614 (A)	10-03-2007	China			ABS	
		CN 101505278 (A)	08-12-2009	China			ABS	
		JP 2002-198989 A	07-12-2002	JAPAN			ABS	
		JP 2004-80637 A	3-11-2004	JAPAN			ABS	

		JP 7-336383 A	12-22-2004	JAPAN			ABS	
		JP 2004-356883 A	12-16-2004	JAPAN			ABS	
		JP 2007-235444 A	09-13-2007	JAPAN			ABS	

Other Documents (Including Author, Title, Date, Pertinent Pages, etc.)		
		Notice of Allowance for App. No. 13/176,610 dated February 1, 2014
		Final Office Action for App. No. 13/176,610 dated October 9, 2013
		Non-Final Office Action for App. No. 13/176,610 dated March 7, 2013
		Petri Jokela et al, "LIPSIN: Line Speed Publish/Subscribe Inter-Networking", SIGCOMM' 09, August 21, 2009, Barcelona, Spain, p.p. 195-206.
		Nick McKeown, et al., 'Open Flow: Enabling Innovation in Campus Networks', [online], [search conducted July 17, 2009] Internet URL: http://www.OpenFlowSwitch.org//documents/OpenFlow-wp-latest.pdf; March 14, 2008.

Examiner	**Date Considered**

Examiner: Initial if citation considered, whether citation is in conformance with MPEP Section 609; Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to Applicant.

PTO/AIA/82A (07-12)
Approved for use through 11/30/2014. OMB 0651-0035
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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TRANSMITTAL FOR POWER OF ATTORNEY TO ONE OR MORE REGISTERED PRACTITIONERS

NOTE: This form is to be submitted with the Power of Attorney by Applicant form (PTO/AIA/82B or equivalent) to identify the application to which the Power of Attorney is directed, in accordance with 37 CFR 1.5. If the Power of Attorney by Applicant form is not accompanied by this transmittal form or an equivalent, the Power of Attorney will not be recognized in the application.

Application Number	Not Yet Assigned
Filing Date	Concurrently Herewith
First Named Inventor	Jun Awano
Title	COMMUNICATION SYSTEM, FORWARDING NODE, PATH MANAGEMENT SERVER, COMMUNICATION METHOD, AND PROGRAM
Art Unit	Not Yet Assigned
Examiner Name	Not Yet Assigned
Attorney Docket Number	NEG-1440PCT-US2CT

SIGNATURE of Applicant or Patent Practitioner

Signature	Scott Mandir	Date	4/03/14
Name	Scott L. Mandir	Telephone	(703) 761-4100
Registration Number	67,186		

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications.

☐ *Total of _____ forms are submitted.

This collection of information is required by 37 CFR 1.31, 1.32 and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

POWER OF ATTORNEY BY APPLICANT

I hereby revoke all previous powers of attorney given in the application identified in the attached transmittal letter.

I hereby appoint:

Practitioner(s) associated with the following Customer Number:

21254

as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (Form PTO/AIA/82A or equivalent).

Please recognize or change the correspondence address for the above-identified patent to:

The address associated with the above-mentioned Customer Number.

I am the Applicant:

- ☐ Inventor or Joint Inventor
- ☐ Legal Representative of a Deceased or Legally Incapacitated Inventor
- ☑ Assignee or Person to Whom the Inventor is Under an Obligation to Assign
- ☐ Person Who Otherwise Shows Sufficient *Proprietary* Interest (*e.g.*, a Petition under 37 CFR 1.46(b)(2) was granted in the application or is concurrently being filed with this document)

SIGNATURE of Applicant for Patent

Signature	H. Nishimoto	Date	April 1, 2014
Name	Hiroshi Nishimoto	Telephone	+81-3-3798-6990
Title and Company	Department Manager Development Promotion Department Intellectual Property Management Division NEC Corporation		

NOTE: Signature - This form must be signed by the applicant or applicant's representative in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. Submit multiple forms for more than one signature, see below*.

☐ Total of 1 forms are submitted.

Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	Communication system, forwarding node, path management server, communication method, and program
First Named Inventor/Applicant Name:	JUN AWANO
Filer:	Scott Louis Mandir
Attorney Docket Number:	NEG-1440PCT-US2CT

Filed as Large Entity

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Utility application filing	1011	1	280	280
Utility Search Fee	1111	1	600	600
Utility Examination Fee	1311	1	720	720
Pages:				
Claims:				
Claims in Excess of 20	1202	1	80	80
Independent claims in excess of 3	1201	2	420	840
Miscellaneous-Filing:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**2520**

Electronic Acknowledgement Receipt

EFS ID:	18669384
Application Number:	14244701
International Application Number:	
Confirmation Number:	2010
Title of Invention:	Communication system, forwarding node, path management server, communication method, and program
First Named Inventor/Applicant Name:	JUN AWANO
Customer Number:	21254
Filer:	Scott Louis Mandir
Filer Authorized By:	
Attorney Docket Number:	NEG-1440PCT-US2CT
Receipt Date:	03-APR-2014
Filing Date:	
Time Stamp:	18:29:03
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$2520
RAM confirmation Number	4887
Deposit Account	500481
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

Charge any Additional Fees required under 37 C.F.R. Section 1.16 (National application filing, search, and examination fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.17 (Patent application and reexamination processing fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.19 (Document supply fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.20 (Post Issuance fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Transmittal of New Application	Transmittal.pdf	293692 deb8d3066d8318dbbf3a8f3775715083f3a9626b	no	2
Warnings:					
Information:					
2	Specification	Specification.pdf	5790731 9e734aeeb2d3d70b6717f497e630b6f7c708dbb9	no	61
Warnings:					
Information:					
3	Oath or Declaration filed	dec.pdf	70600 b839701432f3f85dcd7b935e19275dd9acbafbfa	no	1
Warnings:					
Information:					
4	Drawings-only black and white line drawings	fd.pdf	1526914 ea6ab65bb856ecfd32db748fc3a1567c148dbf79	no	20
Warnings:					
Information:					
5	Application Data Sheet	ADS.pdf	666087 c9b379e275787af15d5d746997f625b8e4499469	no	6
Warnings:					
Information:					
This is not an USPTO supplied ADS fillable form					
6	Transmittal Letter	IDS.pdf	286651 09a88a7e61a19469ba8c2f53538522fe0abf0245	no	3
Warnings:					
Information:					
7	Power of Attorney	POA.pdf	243529 3cef3cf8db701a45194b44ca68dd8ba12e679c50	no	2
Warnings:					
Information:					

8	Fee Worksheet (SB06)	fee-info.pdf	37714 b0276aa56407ba32604b65b330f2374cfce669f8	no	2

Warnings:	
Information:	
Total Files Size (in bytes):	8915918

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 14/244,701

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	280
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	600
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	720
TOTAL CLAIMS (37 CFR 1.16(i))	21 minus 20 =	* 1			OR	x 80 =	80
INDEPENDENT CLAIMS (37 CFR 1.16(h))	5 minus 3 =	* 2				x 420 =	840
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						0.00
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	2520

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".

The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
14/244,701	04/03/2014	2465	2520	NEG-1440PCT-US2CT	21	5

CONFIRMATION NO. 2010

21254
MCGINN INTELLECTUAL PROPERTY LAW GROUP, PLLC
8321 OLD COURTHOUSE ROAD
SUITE 200
VIENNA, VA 22182-3817

FILING RECEIPT

OC00000068029764

Date Mailed: 04/25/2014

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Inventor(s)
JUN AWANO, Tokyo, JAPAN;

Applicant(s)
NEC CORPORATION, Tokyo, JAPAN

Assignment For Published Patent Application
NEC CORPORATION, Tokyo, JAPAN

Power of Attorney: The patent practitioners associated with Customer Number 21254

Domestic Priority data as claimed by applicant
This application is a CON of 13/176,610 07/05/2011
which is a CON of PCT/JP2010/065712 09/13/2010

Foreign Applications (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.)
JAPAN 2009-212221 09/14/2009

Permission to Access - A proper **Authorization to Permit Access to Application by Participating Offices** (PTO/SB/39 or its equivalent) has been received by the USPTO.

Request to Retrieve - This application either claims priority to one or more applications filed in an intellectual property Office that participates in the Priority Document Exchange (PDX) program or contains a proper **Request to Retrieve Electronic Priority Application(s)** (PTO/SB/38 or its equivalent). Consequently, the USPTO will attempt to electronically retrieve these priority documents.

If Required, Foreign Filing License Granted: 04/24/2014

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 14/244,701**

Projected Publication Date: 08/07/2014

Non-Publication Request: No

Early Publication Request: No

Title

Communication system, forwarding node, path management server, communication method, and program

Preliminary Class

370

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

DELL - Exhibit 1002 - Page 104

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign AssetsControl, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

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【書類名】明細書
【発明の名称】通信システム、転送ノード、経路管理サーバ、通信方法およびプログラム
【技術分野】
【０００１】
本発明は、通信システム、転送ノード、経路管理サーバ、通信方法およびプログラムに関し、特に、ネットワークに配置された転送ノードによりパケットを転送して通信を実現する通信システム、転送ノード、経路管理サーバ、通信方法およびプログラムに関する。
【背景技術】
【０００２】
図２０にＩＰ（Ｉｎｔｅｒｎｅｔ　Ｐｒｏｔｏｃｏｌ）を使ったネットワーク構成を示す。図２０において、通信ノード１００（通信ノード１００ａおよび通信ノード１００ｂ）は、ＩＰを使って通信を行う通信ノードである。転送ノード２００は、通信ノード１００が送信したＩＰパケットを受信した際に、前記ＩＰパケットの転送先を決定し、決定された転送先に転送する。転送ノードは、これを繰り返し、最終的に宛先とする通信ノードにＩＰパケットを転送する。
【０００３】
前記ＩＰパケットの転送先の決定には、転送ノード２００が内部に保持するルーティングテーブルが使用される。ルーティングテーブルとは、どのネットワーク宛のパケットを、どのインタフェースを介して次の転送処理を担う転送ノードに送れば良いかを示すテーブルであり、宛先ネットワークアドレス、次の転送先のＩＰアドレス、送信先とするインタフェースの対応を１つのエントリとして、これを列挙したテーブルである。エントリには前述した情報以外の情報も含むが、ここでは簡単のため省略する。
【０００４】
前記ネットワークアドレスとは、ＩＰアドレスの内、上位から一部のビット数を抜き出したアドレスであり、例えば、１９２．１６８．１．０／２４といった形式で表現される。この場合、アドレスの上位２４ｂｉｔがネットワークアドレスであり、当該ネットワークには、１９２．１６８．１．１から１９２．１６８．１．２５５までのアドレスが含まれる。このとき、２４をプレフィクス長と呼ぶ。
【０００５】
転送ノード２００は、ルーティングテーブルから適切なルート情報を決定する際に、ロンゲストマッチという方法を使用する。これは、ＩＰパケットの宛先アドレスとルーティングテーブルの個々のエントリを比較し、前記宛先アドレスの上位ビットから、より長いビット数が一致したものに決定するという方法である。
【０００６】
前記ルーティングテーブルは、転送ノード２００に手動などの方法により事前に設定するか、ルーティングプロトコルと呼ばれるルート情報を交換するプロトコルにより自動的に設定される。
【０００７】
ＩＰネットワークでは、以上の転送方式によりパケットを転送するが、この場合パケットの転送は、個々の転送ノードのルーティングテーブルに依存し、経路を完全には制御できないという問題点がある。また、宛先アドレスのみで転送先を決定するので、送信元アドレスや、どのアプリケーションによる通信か、といった違いによる緻密な経路制御ができない問題点もある。
【０００８】
上記経路制御を行う方式として、ソースルーティングという手法が存在する。ソースルーティングとは、送信元となるノード（例えば、通信ノード１００ａ）が、転送経路としたい転送ノード２００のアドレスを送信パケット中に明示的に列挙する方法である。この場合、通信ノード１００ａは使用するアプリケーションなどにより意図した転送経路で宛先とするノード（例えば、通信ノード１００ｂ）にパケットを転送することができる。
【０００９】

また、ＭＰＬＳ（Ｍｕｌｔｉ－Ｐｒｏｔｏｃｏｌ　Ｌａｂｅｌ　Ｓｗｉｔｃｈｉｎｇ）というパケット転送技術にも、ソースルーティングに相当する技術が存在する。ＭＰＬＳは、受信したパケットに対してラベルを付与し、ラベルに基づいて転送処理を行う技術である。

【００１０】

前記ラベルの付与は、パケットがＭＰＬＳネットワークの境界に配置された転送ノードに入力された後、当該パケットを転送する際に実施され、以降ＭＰＬＳネットワーク内の転送ノードは、当該パケット転送するたびラベルを張り替えながら、転送処理を繰り返す。そして、ＭＰＬＳネットワークの境界に配置された転送ノードにより外部のネットワークへ転送される際に、当該転送ノードによりラベルが除去される。

【００１１】

ＭＰＬＳにおける、ソースルーティングに相当する技術とは、ＣＲ－ＬＤＰ（Ｃｏｎｓｔｒａｉｎｔ　Ｒｏｕｔｉｎｇ－Ｌａｂｅｌ　Ｄｉｓｔｒｉｂｕｔｉｏｎ　Ｐｒｏｔｏｃｏｌ）である。ＬＤＰは、ＭＰＬＳネットワーク内の転送ノード間で前記ラベルを交換するためのプロトコルであるが、トラフィック・エンジニアリングなどの目的で、パケットの転送経路を厳密に指定することを目的としたＬＤＰがＣＲ－ＬＤＰである。

【００１２】

特許文献１には、アドホックネットワークにおいて、すべての移動端末装置が、隣接する移動端末装置との間のリンク情報を送信するのではなく、クラスタヘッドとなった移動端末装置のみがリンク情報を送信することによって制御パケットの総量を削減できる方法が開示されている。

【００１３】

また同じく経路制御を行うものとして、非特許文献１にオープンフロー（ＯｐｅｎＦｌｏｗ）という技術が提案されている。オープンフローは、通信をエンドツーエンドのフローとして捉え、フロー単位で経路制御、障害回復、負荷分散、最適化を行うものである。転送ノードとして機能するオープンフロースイッチは、オープンフローコントローラとの通信用のセキュアチャネルを備え、オープンフローコントローラから適宜追加または書き換え指示されるフローテーブルに従って動作する。フローテーブルには、フロー毎に、パケットヘッダと照合するルールと、処理内容を定義したアクションと、フロー統計情報との組が定義される。

【００１４】

例えば、オープンフロースイッチは、最初のパケット（ｆｉｒｓｔ　ｐａｃｋｅｔ）を受信すると、フローテーブルから、受信パケットのヘッダ情報に適合するルール（ＦｌｏｗＫｅｙ）を持つエントリを検索する。検索の結果、受信パケットに適合するエントリが見つかった場合、オープンフロースイッチは、受信パケットに対して、当該エントリのアクションフィールドに記述された処理内容を実施する。一方、前記検索の結果、受信パケットに適合するエントリが見つからなかった場合、オープンフロースイッチは、セキュアチャネルを介して、オープンフローコントローラに対して受信パケットを転送し、受信パケットの送信元・送信先に基づいたパケットの経路の決定を依頼し、これを実現するフローエントリを受け取ってフローテーブルを更新する。

【先行技術文献】

【特許文献】

【００１５】

【特許文献１】特開２００７－２３５４４４号公報

【非特許文献】

【００１６】

【非特許文献１】Nick McKeownほか７名、“OpenFlow: Enabling Innovation in Campus Networks”、［online］、［平成21年7月17日検索］、インターネット〈URL：http://www.openflowswitch.org//documents/openflow-wp-latest.pdf〉

【発明の概要】

【発明が解決しようとする課題】
【００１７】
ＩＰ技術に基づく転送ノード、すなわちスイッチやルータが保持するルーティングテーブルは増大の一途をたどり、ルート情報の爆発と呼ばれる問題が指摘されている。ルート増大の結果、ルーティングテーブルを保持するためのメモリの必要量が増えるとともに、ルート決定処理に時間がかかるため、パケット転送処理能力が劣化する。
【００１８】
ＭＰＬＳは、ＩＰルーティングと比してルート決定時間が削減できるものの、多様な転送ポリシを適用すれば、やはりルーティングテーブルのエントリ数は増大し、処理性能の劣化につながる。
【００１９】
以上のように、ルーティングテーブルのエントリ数の抑制は、メモリ削減や処理能力向上の観点で転送ノードの重要な課題となっている。
【００２０】
一方、上記したソースルーティングでは、パケット中に転送ノード１００のアドレスを格納するため、パケットが含むことができる正味のデータ量が小さくなってしまうという問題点がある。このため、ソースルーティングは、ネットワークの試験など一部の用途に限られ、アプリケーションなどの通信で使われるパケット（これを以降「データパケット」と呼称する。）には使用されない。なお、正味のデータ以外の情報をオーバヘッドと呼ぶ。すなわち、前述の問題は、オーバヘッドが大きくなる問題と言い換えられる。
【００２１】
また、ＣＲ－ＬＤＰで使われるパケット中には、前述のＩＰルーティングにおけるソースルーティングと同様に、転送毎（１ｈｏｐ毎）の転送ノードの情報が含まれる。転送ノードの情報としては、例えばＩＰｖ４アドレスやＩＰｖ６アドレスが使われるが、この場合も転送経路中のすべての転送ノードの情報を列挙する場合は当該情報が大きくなるため、制御用パケット以外に用いるのは現実的ではない。結果として、データパケットの転送経路を厳密に決定する際には、前記ＣＲ－ＬＤＰなどで、転送ポリシごとの転送情報を転送ノード内に設定する必要が生じる。
【００２２】
特許文献１の方法は、移動通信ネットワークの基盤となる設備を要せず、複数の移動端末装置のみで構成されるアドホックネットワークに関するものである。ネットワークの構成も絶えず変わりうるため、上記したソースルーティングのような送信元が経路を指定できる経路制御を実現するものではない。
【００２３】
また、非特許文献１の方法は、冒頭に述べたルーティングテーブルを参照する方式と同様に、個々の転送ノードが、フローテーブルを参照する必要があり、エントリの増大に従って、レイテンシ（遅延時間）の発生やノードへの負荷が掛かってしまうことが考えられる。
【００２４】
以上説明したように、ルーティングテーブルやフローテーブルに様々な転送ポリシごとのエントリを追加する方式は、エントリの追加・更新・削除の処理負荷と、ルーティングテーブルの情報量が増大するという問題点があり、転送経路を明示的に指定するソースルーティング等は、オーバヘッドが大きくなり、データパケットの送信には適さないという問題点がある。
【００２５】
本発明は、上記した事情に鑑みてなされたものであって、その目的とするところは、簡略化された転送テーブルを用いて実現可能であり、しかも、データパケットの経路制御にも適用できる通信システム、転送ノード、経路管理サーバ、通信方法およびプログラムを提供することにある。
【課題を解決するための手段】

【００２６】
本発明の第１の視点によれば、データ転送ネットワークの転送経路上の個々の転送ノードに備えられている通信インタフェースまたは前記個々の転送ノードとその隣接ノードとの間に張られたリンクを識別するための識別子を並べることによって転送経路情報を構成する経路管理サーバと、前記転送経路情報を格納したヘッダが付加されたパケットについて、前記転送経路情報に従ってパケット転送処理を実行する転送ノードを含む通信システムが提供される。
【００２７】
本発明の第２の視点によれば、データ転送ネットワークの転送経路上の個々の転送ノードに備えられている通信インタフェースまたは前記個々の転送ノードとその隣接ノードとの間に張られたリンクを識別するための識別子を並べることによって転送経路情報を構成する経路管理サーバと接続され、前記転送経路情報を格納したヘッダが付加されたパケットについて、前記転送経路情報に従ってパケット転送処理を実行する転送ノードが提供される。
【００２８】
本発明の第３の視点によれば、送信元の通信ノードから送信されたパケットに付加するためのヘッダに含める転送経路情報を作成して提供する経路管理サーバが提供される。
【００２９】
本発明の第４の視点によれば、データ転送ネットワークの転送経路上の個々の転送ノードが、個々の転送ノードが備える通信インタフェースまたは自装置隣接する転送ノード間に張られたリンクを識別するための識別子を並べることによって構成されている転送経路情報を格納したヘッダが付加されたパケットを受信するステップと、前記パケットについて、前記転送経路情報に従ってパケット転送処理を実行するステップとを含む通信方法が提供される。本方法は、データ転送ネットワークを構成する転送ノードという、特定の機械に結びつけられている。
【００３０】
本発明の第５の視点によれば、上記した転送ノード、経路管理サーバを構成するコンピュータに実行させるプログラムが提供される。なお、このプログラムは、コンピュータが読み取り可能な記憶媒体に記録することができる。即ち、本発明は、コンピュータプログラム製品として具現することも可能である。
【発明の効果】
【００３１】
本発明によれば、膨大なボリュームの転送テーブルを用いずに、しかも、正味データ量を圧迫しない、パケットの経路制御が可能となる。その理由は、転送ノードがパケットヘッダに含まれる転送経路情報に従ってパケット転送処理を実行するように構成するとともに、その転送経路情報を、通信インタフェースまたはリンクの識別子を並べた構成としたことにある。
【図面の簡単な説明】
【００３２】
【図１】本発明の第１の実施形態に係る通信システムを示す図である。
【図２】本発明の第１の実施形態に係る通信システムの境界転送ノードの構成を示す図である。
【図３】境界転送ノードおよび内部転送ノードの記録部に記録される転送テーブルを示す図である。
【図４】境界転送ノードにて付加される経路転送ヘッダのフォーマットの例である。
【図５】本発明の第１の実施形態に係る通信システムの内部転送ノードの構成を示す図である。
【図６】本発明の第１の実施形態に係る通信システムの経路管理サーバの構成を示す図である。
【図７】各転送ノードからの近隣情報を示す図である。

【図８】図７の近隣情報から構築したネットワークトポロジの例である。
【図９】境界転送ノードがパケットを受信した際の動作を示すフローチャートである。
【図１０】図９の転送処理の詳細を示すフローチャートである。
【図１１】内部転送ノードがパケットを受信した際の動作を示すフローチャートである。
【図１２】境界転送ノードおよび内部転送ノードが近隣情報通知を送信する動作を示すフローチャートである。
【図１３】経路管理サーバが近隣情報通知を受信した際の動作を示すフローチャートである。
【図１４】経路管理サーバが経路情報を要求された際の動作を示すフローチャートである。
【図１５】通信ノードが、パケットを対向の通信ノードに送信した際のパケット転送の流れを示すシーケンス図である。
【図１６】本発明の第２の実施形態に係る通信システムの境界転送ノードの構成を示す図である。
【図１７】本発明の第２の実施形態の境界転送ノードがパケットを受信した際の動作を示すフローチャートである。
【図１８】本発明の第２の実施形態の境界転送ノードまたは内部転送ノードが含む経路情報キャッシュの内容を示す図である。
【図１９】本発明の第２の実施形態の通信システムにおいて、通信ノードが受信したパケットの送信元にパケット送信した際のパケット転送の流れを示すシーケンス図である。
【図２０】背景技術として説明する、パケット転送を行う通信システムを示す図である。

【発明を実施するための形態】

【００３３】
はじめに、本発明の概要を説明する。本発明の通信システムの転送ノードは、受信パケットに、転送経路情報が含まれるヘッダが付与されている場合、ヘッダ内の経路情報に基づき転送処理を実施する。

【００３４】
ここで、前記転送経路は、転送経路上に配置された各々の転送ノードが転送先とする通信インタフェースを識別可能な識別子を転送順に並べたものとすることができる。前記識別子は、各転送ノード内で、転送先の一意性を確保するに足る長さがあればよい。

【００３５】
冒頭に述べたソースルーティングと異なり、本発明の転送経路情報を構成する識別子は、例えば１バイト長などの短い情報で記述することが可能となるため、正味のデータ量に与える影響は軽微である。従って、一部の制御用パケットのみならず、データパケットなど、すべてのパケットに対して、転送経路を１ｈｏｐ毎に記述した情報を格納することが可能となり、高度な転送制御が可能となる。

【００３６】
さらに、個々の転送ノードは、前記識別子と、転送先の通信インタフェースとの対応関係を保持すればよく、膨大な数となる冒頭に述べたルーティングテーブル等の転送テーブルを保持する必要はないため、メモリ量が削減できる。また、転送先の決定も、簡単かつ高速に行えるため、パケットの転送遅延も小さくすることが可能となる。さらに、個々の転送ノードのＣＰＵの処理能力も低くて済む。

【００３７】
なお、上記転送経路情報を含んだヘッダの付加および削除は、転送ノードのうち、外部ネットワークとの境界に配置された転送ノード（境界転送ノード）に次のように実行させればよい。外部ネットワークからパケットを受信した境界転送ノードは、当該パケットの

転送経路を、別途設けられた経路管理サーバまたは当該境界転送ノード内に記録された情報から取得し、前記転送経路の情報を格納したヘッダを受信したパケットに付与する。また、境界転送ノードは、外部ネットワークにパケットを送信する場合、前記ヘッダを削除する。

【００３８】

［第１の実施形態］

続いて、本発明の第１の実施形態について図面を参照して詳細に説明する。図１は、本発明の第１の実施形態に係る通信システムを示す図である。図１を参照すると、通信ノード１００ａ、１００ｂと、境界転送ノード３００ａ、３００ｂと、内部転送ノード４００と、経路管理サーバ５００とが示されている。

【００３９】

データ転送ネットワーク６００は、本発明の方式によりパケットの転送処理を行うネットワークであり、外部ネットワーク７００は、ＩＰネットワークなどのように、ネットワーク６００とは異なる方式によりパケット転送処理を実施するネットワークである。ただし、ネットワーク６００と同様の転送方式を使っている場合も、管理者が異なる場合は外部ネットワーク７００となり得る。ここでは外部ネットワーク７００は、ＩＰネットワークとした説明を行う。外部ネットワーク７００は、データ転送ネットワーク６００と、境界転送ノード３００ａ、３００ｂを介して接続される。

【００４０】

通信ノード１００ａ、１００ｂは、それぞれ外部ネットワーク７００に属する通信ノードであり、外部ネットワーク７００のパケット転送方式に沿ったパケットの送受信を行う。つまり、本実施形態においてはＩＰパケットの送受信を行うノードである。通信ノード１００ａ、１００ｂは、一般的なＩＰノードと同様であるので詳細な説明は省略する。

【００４１】

境界転送ノード３００ａ、３００ｂは、データ転送ネットワーク６００と外部ネットワーク７００との間に配置され、通信ノード１００ａ、１００ｂから送信されたパケットを受信した場合には、後述の転送経路情報を含むヘッダ（以降、「経路情報ヘッダ」と呼称する。）を付与し、さらにヘッダ中の転送経路情報に基づきデータ転送ネットワーク６００内の内部転送ノード４００に当該パケットを転送する。

【００４２】

また、境界転送ノード３００ａ、３００ｂは、内部転送ノード４００から送られたパケットを受信した場合であってそのヘッダ中の転送経路情報からデータ転送ネットワーク６００内の最後の転送経路であると判定された場合、受信したパケットから前記ヘッダを削除し、その後、外部ネットワーク７００の通信ノード１００ａ、１００ｂ側にパケットを送信する。

【００４３】

なお、以下の説明では、転送経路情報は、経路管理サーバ５００から取得するものとして説明するが、これに拘らず、境界転送ノード３００内に保持した情報により転送経路情報を生成しても良い。

【００４４】

以下、本実施形態の境界転送ノード３００ａ（３００ｂ）、内部転送ノード４００、経路監視サーバ５００の順に、その構成を説明する。

【００４５】

図２は、図１の境界転送ノード３００ａ、３００ｂの構成を示す図である。図２に示すとおり、境界転送ノード３００は、通信インタフェース３１０と、パケット転送部３２０と、ヘッダ操作部３３０と、ローカルＩＤ決定部３４０と、近隣情報通知部３５０と、経路取得部３６０と、記録部３７０とを備えて構成される。

【００４６】

通信インタフェース３１０は、パケットの送受信を行うためのインタフェースであり、例えばＬＡＮカードのようなＮｅｔｗｏｒｋ　Ｉｎｔｅｒｆａｃｅ　Ｃａｒｄ（ＮＩＣ）

と、それを動作させるソフトウェア（ドライバ）により実現される。ただし、前記のような物理的なインタフェースのみならず、論理的なインタフェースであっても良い。この場合、物理的なインタフェース１つを使って、複数のインタフェースを備えているように動作させることができる。

【００４７】

境界転送ノード３００は、上記のような１つ以上の物理インタフェース、あるいは論理インタフェースを備える。各々の通信インタフェース３１０は、データ転送ネットワーク内の内部転送ノード４００や他の境界転送ノード３００と接続される。また、一部の通信インタフェース３１０は、外部ネットワーク７００の通信ノード１００とも接続される。さらに、一部の通信インタフェース３１０は、経路管理サーバ５００とも接続される。経路管理サーバ５００は、データ転送ネットワーク６００内に配置していても構わないし、経路管理サーバ５００専用のネットワークを介して接続することとしても構わない。

【００４８】

パケット転送部３２０は、受信パケットに経路情報ヘッダが付与されていた場合、前記経路情報ヘッダと、記録部３７０に記録された情報に基づき、パケットを転送する機能を備える。

【００４９】

記録部３７０には、図３に示すとおり、ローカルＩＤと、転送先とする通信インタフェースと、当該通信インタフェース３１０と接続している近隣の境界転送ノード３００、あるいは内部転送ノード４００の識別子の対応情報を１つのエントリとした転送テーブルが記録されている。パケット転送部３２０は、前記ローカルＩＤに対応する次ノードにパケットを転送することができる。

【００５０】

なお、以降では、境界転送ノード３００と内部転送ノード４００の総称を転送ノードとする。また、直接接続しているノード（通信ノード１００、境界転送ノード３００、内部転送ノード４００）同士を近隣ノードと呼称する。

【００５１】

図３は、境界転送ノード３００および内部転送ノード４００の記録装置に記録される転送テーブルを示す図である。本実施形態では、図３に示すとおり、ローカルＩＤとして、隣接する転送ノード間あるいは境界転送ノード３００と通信ノード１００ａ（１００ｂ）間の、物理リンクあるいは論理リンクに割当てた識別子（リンクＩＤ）を使用する。したがって、「ローカルＩＤ」のフィールドには前記リンクＩＤが設定される。転送先とする通信インタフェースを示す「インタフェース」のフィールドには、リンクＩＤが割当てられたリンクに接続した通信インタフェース３１０を識別する情報が設定される。また、図３の例では、近隣ノードの情報を示す「次ホップ」のフィールドに、前記リンクに接続された転送ノードの識別子が設定されている。

【００５２】

なお、転送先とする通信インフェースがＩＰにより通信を行う通信ノード１００ａ（１００ｂ）と接続されていた場合は、「次ホップ」のフィールドの識別子として、例えば、通信ノード１００ａ（１００ｂ）のＩＰアドレスを使用できる。一方、境界転送ノード３００、あるいは内部転送ノード４００の場合は、一意に割当てた識別子（例えば、図３のＮｏｄｅ＿１、Ｎｏｄｅ＿２等）を使用する。前記転送ノードの識別子は、事前に設定することとしても良いし、経路管理サーバ５００など、外部のノードから設定する方式としても構わない。さらに、前記「次ホップ」フィールドの識別子は、転送処理に必ず必要なわけではなく、省略することもできる。

【００５３】

また、ローカルＩＤとして、通信インタフェース３１０を識別する情報そのものを使うこともできる。通信インタフェース３１０を識別する情報は、短い情報量（例えば、１～２バイト程度）で記述できる情報であることが望ましいため、通信インタフェース３１０を識別する情報が長い場合（例えば、通信インタフェースの名前などを使う場合）は、１

バイトなど短い情報で記述できる別の識別子を別途割り振った上でローカルＩＤとして適用する。ただし、ここでは特に説明しない場合、ローカルＩＤとしてリンクＩＤを使用するものとして説明する。

【００５４】

一般的なレイヤ３で転送処理を行うルータやＬ３スイッチ、また、レイヤ２での転送処理を行うＬ２スイッチが備えている通信インタフェースは基本的に数十個程度であるため、リンクの識別子や通信インタフェースの識別子は、１バイトで十分表現できる。実際の通信インタフェースの識別子が数バイトを要するような長い情報である場合は、１バイト、あるいは２バイトに格納可能な範囲とした識別子を別途作成し、通信インタフェースの識別子に対応づければよい。

【００５５】

なお、図３の転送テーブルは、本発明を端的説明するために例示したものであり、個々のエントリに、他の情報をさらに対応づけて記録することとしても構わない。

【００５６】

図４は、本実施形態で用いる経路情報ヘッダのフォーマットの１例である。図４において、’Ｄｉｒｅｃｔｉｏｎ’は転送方向を示す。例えば、’１’なら順方向の転送を示し、’２’なら逆方向の転送を示す。’Ｃｕｒｒｅｎｔ　Ｏｆｆｓｅｔ’は、転送時に参照すべきローカルＩＤ情報のオフセット情報が設定される（単位はバイト）。この値は、’ＬｏｃａｌＩＤ　＃０’からのオフセットバイト数で示される。境界転送ノード３００で経路情報ヘッダを付与する際には、’Ｃｕｒｒｅｎｔ　Ｏｆｆｓｅｔ’の値は’０’に設定される。’Ｈｅａｄｅｒ　Ｌｅｎｇｔｈ’は、’Ｒｏｕｔｅ　Ｌｅｎｇｔｈ’以降のヘッダの長さをバイト数で示す。パケットの整形を考慮し、４バイト単位の値とする。正味のデータの終わりが４バイト単位の境界に合わない場合は、スタッフィング（パディング）を行う（０を設定したダミーの情報を後置する。）。’Ｒｏｕｔｅ　Ｌｅｎｇｔｈ’は、後に続くローカルＩＤの列挙により示された経路情報の合計バイト数を示す。’Ｌｏｃａｌ　ＩＤ＃ｎ’は、ｎ　ｈｏｐ目の境界転送ノード３００、あるいは内部転送ノード４００が転送先として参照すべきローカルＩＤが設定される。上記図４のフォーマットはあくまで一例であり、種々の変形フォーマットで情報を格納したとしても構わない。

【００５７】

上記のように、転送経路の情報として、転送ノード内、あるいは、隣接する転送ノード間といった局所的な範囲において一意となるローカルＩＤを用いることで、経路情報ヘッダの情報量を削減できる。なお、本実施形態では、各々のローカルＩＤは１バイトとしたが、論理的なリンクでは１バイトでは表現できない可能性がある。この場合は、’ＬｏｃａｌＩＤ＃ｎ’の最上位ｂｉｔを、ローカルＩＤが１バイト表記か２バイト表記かを示すローカルＩＤ拡張フラグとして使用しても良い。すなわち、この場合、最上位ビットが０の場合は、ローカルＩＤを１バイトの識別子と解釈し、最上位ビットが１の場合、ローカルＩＤを２バイトの識別子として解釈するものとすればよい。

【００５８】

パケット転送部３２０は、受信パケットの経路情報ヘッダの’Ｄｉｒｅｃｔｉｏｎ’フィールドが’１’であった場合、すなわち順方向への転送を示していた場合、経路情報ヘッダの’Ｃｕｒｒｅｎｔ　Ｏｆｆｓｅｔ’を参照し、対応するローカルＩＤを参照して転送先の通信インタフェース３１０を決定した後、’Ｃｕｒｒｅｎｔ　Ｏｆｆｓｅｔ’の値を参照したローカルＩＤの長さ分（例えば、１バイト、あるいは２バイト）増やし、前記決定した通信インタフェース３１０からパケットを送出する。一方、’Ｄｉｒｅｃｔｉｏｎ’が’２’である場合、すなわち逆方向への転送を示していた場合、経路情報ヘッダの’Ｃｕｒｒｅｎｔ　Ｏｆｆｓｅｔ’を参照し、対応するローカルＩＤの１つ手前のローカルＩＤを参照し、転送先とする通信インタフェース３１０を決定する。その後、経路情報ヘッダの’Ｃｕｒｒｅｎｔ　Ｏｆｆｓｅｔ’の値を参照したローカルＩＤの長さ分減らし、決定した通信インタフェース３１０からパケットを送出する。

【００５９】

なお、本実施形態では双方向の転送を行うものとして説明するが、一方向の転送しか実施しない通信システムとしても構わない。この場合、’Ｄｉｒｅｃｔｉｏｎ’フィールドを常に’１’に設定するようにしても構わないし、当該フィールドをなくしても構わない。

【００６０】

ヘッダ操作部３３０は、外部ネットワーク７００からパケットを受信した場合、経路取得部３６０から、当該境界転送ノード３００から出口となる境界転送ノード３００までの１ｈｏｐ毎の経路情報を取得し、図４に示した経路情報ヘッダを構成し、前記パケットに付与する機能を備える。例えば、ヘッダ操作部３３０は、経路情報ヘッダを付与する際には、’Ｄｉｒｅｃｔｉｏｎ’には順方向への転送を意味する’１’を、’ＣｕｒｒｅｎｔＯｆｆｓｅｔ’には’０’を、’ＬｏｃａｌＩＤ＃ｎ’には取得した１ｈｏｐ毎の経路情報（ローカルＩＤ）を設定する。また、ヘッダ操作部３３０は、上述したルールに従い、他のフィールドにもそれぞれ適切な値を設定する。

【００６１】

ヘッダ操作部３３０は、また、経路情報ヘッダが付与されていたパケットを外部ネットワーク７００に転送する場合は、経路情報ヘッダを削除する機能を備える。

【００６２】

ローカルＩＤ決定部３４０は、当該境界転送ノード３００と近隣ノードとの間で情報交換を行って、重複しないリンクＩＤを決定する機能を備える。例えば、以下の方法で隣接するノードとのリンクＩＤの重複設定を回避することができる。

【００６３】

まず、転送ノードは、自身が既に割当てたリンクＩＤ以外のリンクＩＤを設定したパケットを近隣ノードに送信することでリンクＩＤ候補を提案する。リンクＩＤを提案された近隣ノードは、自ノード内に重複したリンクＩＤがないかどうか確認し、重複するリンクＩＤがない場合は、提案されたリンクＩＤと自ノードの識別情報を設定した応答パケットを、提案元となる転送ノードに送信する。一方、近隣ノードにおいて重複するリンクＩＤがあった場合は、重複することを意味する情報と自ノードの識別子を設定した応答パケットを送信する。この処理を、重複するリンクＩＤがなくなるまで繰り返す。

【００６４】

このようにして決定されたリンクＩＤや、近隣ノードの情報は、記録部３７０に転送テーブルとして記録される。

【００６５】

以上、リンクＩＤの決定方法の例を示したが、他の方法でリンクＩＤを決定することとしても構わない。例えば、経路管理サーバ５００など、他のノードが決定し、各転送ノードに通知することとしても良い。

【００６６】

なお、ローカルＩＤとして通信インタフェースの識別子を使う場合において、前記した逆方向の転送が不要である場合には、上記近隣ノードとのネゴシエーションを省略することができる。一方、逆方向への転送が必要である場合には、ローカルＩＤとしてインタフェースの識別子を使う場合においても、近隣ノードとネゴシエーションを行うことにより、近隣の転送ノードのどの通信インタフェースが、自身の通信インタフェースに接続されているかの情報を取得することができ、上記したリンクＩＤを用いる場合と同様に、Ｄｉｒｅｃｔｉｏｎによる転送方向によるインタフェースの選択が可能となる。

【００６７】

近隣情報通知部３５０は、ローカルＩＤ決定部３４０によりローカルＩＤとして決定したリンクＩＤと、リンクに接続された近隣ノードの識別子と、自らの識別子と、を格納した近隣情報を経路管理サーバ５００に送信する機能を備える。リンクに接続されているのが外部ネットワーク７００の通信ノード１００ａ、１００ｂであった場合は、外部ネットワークのノードと判定できる情報も前記情報に追加する。また、経路管理サーバ５００での経路計算のため、前記近隣情報には、各リンクの帯域、信頼性、混雑状況といった情報

や、近隣ノードの故障情報などを含めることとしても良い。経路管理サーバ５００に前記近隣情報を送信する契機は、ローカルＩＤの決定処理が完了したタイミングでも良いし、所定の時間間隔で送信するものとしてもよい。また、リンクの情報や、近隣ノードの故障情報も含めて送信する場合は、これらの情報に変化が生じた契機で送信しても良い。

【００６８】

経路取得部３６０は、外部ネットワーク７００の通信ノード１００ａ、１００ｂからパケットを受信した際に、当該受信パケットの情報と、当該境界転送ノード３００の識別子を格納した経路要求信号を経路管理サーバ５００に送信し、当該パケットの転送経路を取得する機能を備える。前記受信パケットの情報とは、転送経路決定に影響を与えうる情報であり、最も単純な場合は、宛先アドレスのみである。しかし、より緻密な経路制御を実施する場合には、宛先アドレスに加え、送信元アドレス、当該パケットヘッダ以降に格納されたプロトコル情報、ＴＣＰ（Ｔｒａｎｓｍｉｓｓｉｏｎ　Ｃｏｎｔｒｏｌ　Ｐｒｏｔｏｃｏｌ）あるいはＵＤＰ（Ｕｓｅｒ　Ｄａｔａｇｒａｍ　Ｐｒｏｔｏｃｏｌ）使用時の宛先ポート番号、送信元ポート番号といった情報の一部、あるいはすべてを含めることができる。さらに、他の情報を含むこととしてもかまわない。

【００６９】

前記経路要求信号を送った結果、経路管理サーバ５００から経路応答信号が返される。前記経路応答信号に含まれる転送経路情報には、当該境界転送ノード３００を起点とした転送経路に沿って、ローカルＩＤを１ｈｏｐ毎に列挙した情報が格納される。

【００７０】

なお、宛先アドレスなど、前記転送経路に影響を与えうる情報と、転送経路を示すローカルＩＤ群との対応情報は、当該境界転送ノード３００に事前に設定し、予め経路管理サーバから受信しておくこともできる。この場合は、経路取得部３６０は、経路管理サーバ５００ではなく、内部に設定された情報から転送経路情報を取得する。

【００７１】

また、上記の例では、当該境界転送ノード３００が最初に転送先とする通信インタフェースを識別可能なローカルＩＤを起点としたが、前記パケットを受信した通信インタフェース３１０を識別可能なローカルＩＤを、起点としても構わない。

【００７２】

記録部３７０は、図３に示す転送テーブルを保持し、パケット転送部３２０や、ローカルＩＤ決定部３４０や、近隣情報通知部３５０に、参照させる。

【００７３】

内部転送ノード４００は、データ転送ネットワーク６００内に配置され、近隣ノードから送信されたパケットを受信した場合には、パケット中の経路情報ヘッダの情報に基づきデータ転送ネットワーク６００内の近隣ノードに当該パケットを転送する機能を備える。

【００７４】

図５は、図１の内部転送ノード４００の構成を示す図である。内部転送ノード４００は、図５に示すように、通信インタフェース４１０と、パケット転送部４２０と、ローカルＩＤ決定部４３０と、近隣情報通知部４４０と、記録部４５０とを備えて構成されている。

【００７５】

通信インタフェース４１０、パケット転送部４２０、ローカルＩＤ決定部４３０、近隣情報通知部４４０および記録部４５０は、それぞれ、境界転送ノード３００の、通信インタフェース３１０、パケット転送部３２０、ローカルＩＤ決定部３４０、近隣情報通知部３５０、記録部３７０と同等であるため、ここでは詳細な説明を省略する。

【００７６】

つまり内部転送ノード４００は、境界転送ノード３００から、ヘッダ操作部３３０と、経路取得部３６０を差し引いたものとみなすことができる。反対に、境界転送ノード３００は、内部転送ノード４００に、ヘッダ操作部３３０と、経路取得部３６０を追加した転送ノードであるということができる。

【００７７】
経路管理サーバ５００は、境界転送ノード３００と内部転送ノード４００から通知された近隣情報を収集し、データ転送ネットワーク６００内の境界転送ノード３００および内部転送ノード４００の接続関係を記述したネットワークトポロジ情報を構築する。このネットワークトポロジ情報には、境界転送ノード３００に接続する通信ノード１００ａ、１００ｂとの接続情報も含まれる。前記通知された経路情報に、各転送ノード間のリンクや転送ノードの状態を示す情報（混雑状況、故障状況など）が含まれていた場合は、それも前記接続情報に対応づけて管理する。そして、境界転送ノード３００から、転送経路情報を要求された場合には、経路要求に含まれる情報と、内部に構築したネットワークトポロジ情報を使って適切な転送経路を求める計算を実施し、経路要求を行った境界転送ノード３００を起点として、外部ネットワーク７００への出口となる境界転送ノード３００までの転送経路を、１ｈｏｐ毎のローカルＩＤ（リンクＩＤ）を順に列挙した情報として応答する機能を備える。
【００７８】
図６は、図１の経路管理サーバ５００の構成を示す図である。経路管理サーバ５００は図６に示すようにさらに、通信インタフェース５１０と、経路情報収集部５２０と、経路要求処理部５３０と、経路計算部５３１と、経路情報記録部５４０とを備えて構成されている。
【００７９】
通信インタフェース５１０は、パケットの送受信を行うためのインタフェースである。前述のように、例えばＬＡＮカードのようなＮＩＣと、それを動作させるソフトウェア（ドライバ）により実現できる。
【００８０】
経路情報収集部５２０は、境界転送ノード３００および内部転送ノード４００から送られた近隣情報を受信すると、近隣情報に格納された、前記近隣情報を送信したノードの識別子、ローカルＩＤ（リンクＩＤ）、近隣ノード識別子を使って、経路情報記録部５４０内にデータ転送ネットワーク６００内のネットワークトポロジ情報を構築する。前記近隣情報に、リンクの帯域、信頼性、混雑状況や、近隣ノードの故障情報といった付帯情報が含まれていた場合は、前記ネットワークトポロジ情報に前記付帯情報を関連づけて記録する。これらの情報は、例えば、後述する経路計算のときにリンクのコストとして使用することができる。
【００８１】
図７は、各転送ノードから受信した近隣情報の例である。図８は、図７の近隣情報から構築したネットワークトポロジの例である。図８の例では、簡単のため、付帯情報は省略している。また、外部ネットワークはＩＰネットワークであることを想定している。
【００８２】
図７中の’ｓｅｎｄｅｒＩＤ’は近隣情報を送信した転送ノードの識別子を示している。図７中の’ＬｉｎｋＩＤ’は、前記転送ノードが接続するリンクに割当てたリンクＩＤを示している。図７中の’ｎｅｉｇｈｂｏｒＩＤ’は前記リンクに接続している近隣ノードの識別子を示している。外部ネットワークはＩＰネットワークとの想定なので、通信ノード１００の識別子としてＩＰアドレスを使用する。また、上述のように隣接する転送ノード間でネゴシエーションが行われているため、リンクＩＤは、一の転送ノードに重複して設定されないが、隣接しない転送ノード同士が同一のリンクＩＤを用いることは許容される。例えば、ＬｉｎｋＩＤ＝１のリンクは、ＩＤ＝１のノードと、ＩＤ＝１０のノード間およびＩＤ＝５のノードと、ＩＤ＝６のノード間に用いられているが、それぞれの転送ノード内で一意にリンクを識別することが可能である。つまり、リンクＩＤの長さは、一の転送ノード内で一意性を確保するに足る長さがあればよい。
【００８３】
経路情報収集部５２０は、例えば、図７の近隣情報が得られている場合、図８に示すようなネットワークトポロジを構築し、経路情報記録部５４０に記録する。

【００８４】
図７の近隣情報と、それに基づいて構築された図８のネットワークトポロジ情報にはリンクＩＤを使ったが、インタフェース識別子など、他の情報をローカルＩＤとした場合でも、同様にネットワークトポロジ情報の構築は可能である。
【００８５】
経路要求処理部５３０は、境界転送ノード３００から送信された経路要求信号を受信し、そこに含まれる情報と共に、経路計算要求を経路計算部５３１に通知する。
【００８６】
経路要求処理部５３０はまた、経路計算部５３１から、転送経路情報（１ｈｏｐ毎のリンクＩＤを転送経路順に列挙した情報）を取得した際に、当該転送経路情報を格納した経路応答信号を前記経路要求信号の送信元となる境界転送ノード３００に送信する。
【００８７】
経路計算部５３１は、経路要求処理部５３０から経路計算要求を通知された場合、共に入力された、経路要求元の境界転送ノード３００の識別子と、宛先アドレスをそれぞれ始点、終点ポイントとして、経路情報記録部５４０に記録された図８のようなネットワークトポロジ情報を使って、経路の計算を行う。経路計算には、Ｄｉｊｋｓｔｒａ法と呼ばれる最短経路を求めるアルゴリズムを適用することができる。ただし、他のアルゴリズムを適用することとしても構わない。
【００８８】
経路計算要求にＩＰパケットの送信元アドレスを含む場合は、始点として送信元アドレス（即ち境界転送ノード３００が受信したパケットの送信元となる通信ノード１００ａまたは１００ｂの識別子）を使っても良い。また、前記したように経路計算を行う上で、ＴＣＰ、あるいはＵＤＰの宛先／送信元ポート番号など、他の情報を使って経路計算を行っても良い。さらには、リンクに付帯する情報（帯域、混雑具合など）や、故障した境界／内部転送ノードの識別子といった情報を経路計算に使用しても良い。
【００８９】
経路情報記録部５４０は、経路情報収集部５２０により、図８に示すようなネットワークトポロジ情報が記録される。前記ネットワークトポロジ情報は、経路計算のため経路計算部５３１から参照される。
【００９０】
以上本発明の実施の形態で説明した、通信インタフェース３１０、４１０、５１０は、前記したとおり、例えばＬＡＮカードのようなＮＩＣと、それを動作させるソフトウェア（ドライバ）により実現できる。
【００９１】
また、記録部３７０、記録部４５０、経路情報記録部５４０は、半導体メモリ、ハードディスクドライブなど情報を記録可能な装置で実現することができる。
【００９２】
その他の機能ブロックについては、それぞれの機器に搭載された１つあるいは複数のＣＰＵにて実行されるコンピュータプログラム（ソフトウェア）あるいはハードウェアで実現できる。機能ブロックが行うべき処理の一部をソフトウェアで実施し、それ以外をハードウェアで実施することとしても良い。
【００９３】
続いて、本実施形態の動作について図面を参照して詳細に説明する。はじめに、境界転送ノード３００の動作を説明する。
【００９４】
図９は、境界転送ノード３００が、データ転送ネットワーク６００あるいは外部ネットワーク７００からパケットを受信した場合の処理を示している。
【００９５】
まず、パケット転送部３２０は、通信インタフェース３１０を介してパケットを受信すると、当該パケットに経路情報ヘッダが付与されているかどうかをチェックする（ステッ

プＳ１００）。
【００９６】
経路情報ヘッダが付与されていた場合は’Ｙ’に進み、その経路情報ヘッダに従って転送処理が行われる（ステップＳ１０３へ）。一方、経路情報ヘッダが付与されていなかった場合は’Ｎ’に進み、経路取得部３６０から、経路要求信号を経路管理サーバ５００に送信することで転送経路情報を取得する経路取得処理が行われる（ステップＳ１０１）。
【００９７】
転送経路情報の取得が完了すると、ヘッダ操作部３３０は、前記取得した転送経路情報の転送経路の順に従って、図４の経路情報ヘッダのローカルＩＤフィールド（’ＬｏｃａｌＩＤ＃ｎ’）に、ローカルＩＤを設定する。また、ヘッダ操作部３３０は、’Ｄｉｒｅｃｔｉｏｎ’を’１’に設定し、’Ｃｕｒｒｅｎｔ　Ｏｆｆｓｅｔ’を’０’に設定する。ヘッダ操作部３３０は、その他のフィールドも適切な値に設定した上で、経路情報ヘッダを、前記受信したパケットの先頭に付加する（ステップＳ１０２）。
【００９８】
パケット転送部３２０は、前記した経路情報ヘッダに従って転送処理を実施する（ステップＳ１０３）。
【００９９】
図１０は、図９のステップＳ１０３の転送処理の詳細を表したフローチャートである。図１０を参照すると、まず、パケット転送部３２０は、経路情報ヘッダの’Ｄｉｒｅｃｔｉｏｎ’フィールドをチェックし順方向への転送をすべきか、逆方向の転送をすべきかを判定する（ステップＳ２００）。
【０１００】
’Ｄｉｒｅｃｔｉｏｎ’フィールドの値が順方向の転送を示す（’１’）場合は、’Ｙ’に進み、当該パケットの転送先が外部ネットワーク７００であるかどうかが判定される（ステップＳ２０１）。順方向の転送において、外部ネットワーク７００への転送かどうかの判定は、’Ｃｕｒｒｅｎｔ　Ｏｆｆｓｅｔ’と’Ｒｏｕｔｅ　Ｌｅｎｇｔｈ’を比較することにより判定できる。判定方法は他にも、ローカルＩＤを外部ネットワーク７００への転送かどうかを区別可能な値とすることとしても良いし、経路情報ヘッダ中の最後のローカルＩＤの後に、終端を意味する情報を格納しても良い。さらに、他の方法としても構わない。
【０１０１】
外部ネットワーク７００への転送でないと判定された場合は、’Ｎ’に進み、経路情報ヘッダの’Ｃｕｒｒｅｎｔ　Ｏｆｆｓｅｔ’に１ｈｏｐ分のバイト数が加算される（ステップＳ２０２）。１ｈｏｐ分のバイト数とは、現在参照している’ＬｏｃａｌＩＤ＃ｎ’フィールドのバイト数となる。ここで、’Ｃｕｒｒｅｎｔ　Ｏｆｆｓｅｔ’の値を加算する前に参照先となっていたローカルＩＤを保持しておく。
【０１０２】
そして、パケット転送部３２０は、前記保持しておいたローカルＩＤを用いて、順方向へのパケットの転送処理を行う（ステップＳ２０６）。具体的には、記録部３７０に記録された転送テーブルの情報を使ってローカルＩＤから、転送先とすべき通信インタフェース３１０を決定し、当該通信インタフェース３１０からパケットを転送する。
【０１０３】
一方、ステップＳ２００にて’Ｄｉｒｅｃｔｉｏｎ’フィールドの値が逆方向の転送を示す（’２’）場合は、’Ｎ’に進み、当該パケットの転送先が外部ネットワーク７００であるかどうかが判定される（ステップＳ２０３）。逆方向の転送における、外部ネットワーク７００への転送かどうかの判定は、’Ｃｕｒｒｅｎｔ　Ｏｆｆｓｅｔ’の値が’０’かどうかにより判定することができる（’０’のとき外部ネットワークへの転送）。これは、パケットをはじめに送信する通信ノード１００ａ、１００ｂと、それを受信する境界転送ノード３００間のリンクのリンクＩＤを、１番最初のローカルＩＤとして使わない場合の判定方法となる。前記リンクＩＤを１番最初のローカルＩＤとして使う場合は、現

在の’Ｃｕｒｒｒｅｎｔ　Ｏｆｆｓｅｔ’を、１ｈｏｐ分減算した値が’０’の場合、外部ネットワークへの転送と判定できる。逆方向への転送時の判定方法は他にも、ローカルＩＤを、外部ネットワーク７００への転送かどうかを区別可能な値とすることとしても良いし、経路情報ヘッダ中の最初のローカルＩＤの前に、開始を意味する情報を格納しても良い。さらに、他の方法としても構わない。

【０１０４】

外部ネットワーク７００への転送でないと判定された場合は、’Ｎ’に進み、経路情報ヘッダの’Ｃｕｒｒｅｎｔ　Ｏｆｆｓｅｔ’の値が１ｈｏｐ分減算される（ステップＳ２０４）。ここで、減算後の’Ｃｕｒｒｅｎｔ　Ｏｆｆｓｅｔ’で参照先となるローカルＩＤを保持しておく。

【０１０５】

そして、パケット転送部３２０は、前記保持しておいたローカルＩＤを用いて、逆方向へのパケットの転送処理を行う（ステップＳ２０６）。具体的には、記録部３７０に記録された転送テーブルの情報を使ってローカルＩＤから、転送先とすべき通信インタフェース３１０を決定し、当該通信インタフェース３１０からパケットを転送する。

【０１０６】

上記ステップＳ２０１またはＳ２０３において、外部ネットワーク７００への転送と判定された場合は、それぞれ’Ｙ’に進み、ヘッダ操作部３３０により、経路情報ヘッダの除去処理が行われる（ステップＳ２０５）。ここで、経路情報ヘッダを除去する前に、転送先となるローカルＩＤを保持しておく。

【０１０７】

そして、パケット転送部３２０は、前記保持しておいたローカルＩＤを用いて、外部ネットワーク７００へのパケットの転送処理を行う（ステップＳ２０６）。具体的には、記録部３７０に記録された転送テーブルの情報を使ってローカルＩＤから、転送先とすべき通信インタフェース３１０を決定し、当該通信インタフェース３１０からパケットを転送する。

【０１０８】

なお、’Ｄｉｒｅｃｔｉｏｎ’フィールドを使わず、常に順方向に転送する場合は、ステップＳ２００の転送方向の判定は不要であり、ステップＳ２０１の外部ネットワークへの転送であるか否かの判定を行うようにすればよい。

【０１０９】

続いて、内部転送ノード４００の動作を説明する。

【０１１０】

図１１は、内部転送ノード４００が、データ転送ネットワーク６００の境界転送ノード３００あるいは内部転送ノード４００からパケットを受信した場合の処理を示している。

【０１１１】

図１１を参照すると、まず、パケット転送部４２０は、通信インタフェース４１０を介してパケットを受信すると、当該パケットに経路情報ヘッダが付与されているかどうかをチェックする（ステップＳ３００）。

【０１１２】

経路情報ヘッダが付与されていた場合は’Ｙ’に進み、経路情報ヘッダの’Ｄｉｒｅｃｔｉｏｎ’フィールドをチェックし、順方向への転送をすべきか、逆方向の転送をすべきかを判定する（ステップＳ３０２）。一方、経路情報ヘッダが付与されていなかった場合は’Ｎ’に進み、受信したパケットが破棄処理が行われる（ステップＳ３０１）。

【０１１３】

ステップＳ３０２でチェックした’Ｄｉｒｅｃｔｉｏｎ’フィールドの値が順方向の転送を示す（’１’）場合は、’Ｙ’に進み、経路情報ヘッダの’Ｃｕｒｒｅｎｔ　Ｏｆｆｓｅｔ’に１ｈｏｐ分のバイト数が加算される（ステップＳ３０３）。ここで、’Ｃｕｒｒｅｎｔ　Ｏｆｆｓｅｔ’の値を加算する前に参照先となっていたローカルＩＤを保持しておく。

【０１１４】
一方、ステップＳ３０２でチェックした’Ｄｉｒｅｃｔｉｏｎ’フィールドの値が逆方向の転送を示す（’２’）場合は、’Ｎ’に進み、経路情報ヘッダの’Ｃｕｒｒｅｎｔ　Ｏｆｆｓｅｔ’に１ｈｏｐ分のバイト数が減算される（ステップＳ３０４）。ここで、ここで、減算後の’Ｃｕｒｒｅｎｔ　Ｏｆｆｓｅｔ’で参照先となるローカルＩＤを保持しておく。
【０１１５】
最後に、上記ステップＳ３０３あるいはステップＳ３０４で保持されたローカルＩＤに基づき、パケットの転送処理が行われる。具体的には、記録部４５０に記録された転送テーブルの情報を使ってローカルＩＤから、転送先とすべき通信インタフェース４１０を決定し、当該通信インタフェース４１０からパケットを転送する（ステップＳ３０５）。
【０１１６】
なお、’Ｄｉｒｅｃｔｉｏｎ’フィールドを使わず、常に順方向の転送とする場合は、ステップＳ３０２の転送方向の判定は不要であり、常にステップＳ３０３の’Ｃｕｒｒｅｎｔ　Ｏｆｆｓｅｔ’加算処理が行われる。
【０１１７】
続いて、境界転送ノード３００および内部転送ノード４００によるローカルＩＤの決定およびその結果を経路管理サーバ５００に近隣情報として通知する処理を説明する。
【０１１８】
図１２は、境界転送ノード３００および内部転送ノード４００が近隣情報通知を送信する動作を示すフローチャートである。
【０１１９】
図１２を参照すると、まず、ローカルＩＤ決定部３４０（４３０）が、ローカルＩＤを決定する（ステップＳ４００）。ローカルＩＤとしてリンクＩＤを使う場合は、近隣ノードとリンクＩＤのネゴシエーションを実施することでリンクＩＤを決定する。なお、ローカルＩＤとして、通信インタフェースの識別子を使う場合は、当該境界転送ノード３００あるいは内部転送ノード４００は、自らが備える通信インタフェース３１０（４１０）に割当てた識別子をローカルＩＤとする。
【０１２０】
ここで、前記リンクＩＤは、当該境界転送ノード３００あるいは内部転送ノード４００が使用可能なすべての物理的あるいは論理的なリンクに対して決定される。同じように、通信インタフェースの識別子は、全ての物理的あるいは論理的な通信インタフェースに対して決定される。ただし、管理上の理由などにより、一部のリンクや、通信インタフェースを対象外としても構わない。
【０１２１】
次に、ローカルＩＤ決定部３４０（４３０）は、前記決定したローカルＩＤと通信インタフェース情報（当該通信インタフェースをパケット転送先とするのに必要な情報）とを対応づけて、記録部３７０（４５０）中の転送テーブル（図３参照）に記録する（ステップＳ４０１）。転送テーブルには、各リンクの先に接続された近隣ノードの識別子も対応づけて記録する。さらに、各リンクに関連する情報や、近隣ノードの故障情報なども付帯情報として記録しても良い。
【０１２２】
前記転送テーブルへの記録が完了すると、近隣情報通知部３５０（４４０）が、記録部３７０（４５０）に記録された転送テーブルの情報から、ローカルＩＤと、近隣ノードの識別子を設定した近隣情報（図７参照）を構成し、これを経路管理サーバ５００へ送信する（ステップＳ４０２）。近隣情報には、各リンクに関連する情報や、近隣ノードの故障情報などといった付帯情報も格納することとしても良い。
【０１２３】
続いて、経路管理サーバ５００の動作を説明する。
【０１２４】

図１３は、上記近隣情報を受信した経路管理サーバ５００の処理を表したフローチャートである。図１３を参照すると、まず、経路情報収集部５２０にて境界転送ノード３００あるいは内部転送ノード４００から送られた近隣情報を受信すると（ステップＳ５００）、経路管理サーバ５００は、受信した近隣情報から、ローカルＩＤや近隣ノードの識別子といった情報を取得し、取得した情報を用いてネットワークトポロジ情報を構築し、記録部５４０に記録する（ステップＳ５０１）。

【０１２５】

図１４は、境界転送ノード３００から経路情報を要求された経路管理サーバ５００の処理を表したフローチャートである。図１４を参照すると、まず、境界転送ノード３００から経路要求信号を受信すると、経路要求処理部５３０は、経路要求信号に含まれる情報を経路計算部５３１に通知する（ステップＳ６００）。

【０１２６】

次に、経路計算部５３１は、ステップＳ６００で通知された経路要求信号に含まれていた情報と、経路情報記録部５４０に記録されたネットワークトポロジ情報とにより、最適な転送経路の計算を行う（ステップＳ６０１）。転送経路の計算が完了すると、経路計算部５３１は、決定された経路の転送順に１ｈｏｐ毎のローカルＩＤを読み出し、経路要求処理部５３０に通知する。

【０１２７】

前記転送経路の計算結果を受け取った経路要求処理部５３０は、通知された転送経路情報（ローカルＩＤの並び）を、経路情報応答信号に設定して、経路要求信号の送信元である境界転送ノード３００に送信する（ステップＳ６０２）。

【０１２８】

最後に、図１５のシーケンス図を参照して、ＩＰノードである通信ノード１００ａが境界転送ノード３００ａにパケットを送信し、それが順次転送処理され、最終的にＩＰノードである通信ノード１００ｂに届くまでの一連の流れを説明する。

【０１２９】

ここでは、例として、各ノードの接続状況が図８に示したネットワークトポロジのようになっているものとして説明する。境界転送ノード３００ａは、図８のＩＤ＝１のノードに相当する。境界転送ノード３００ｂは、図８のＩＤ＝８のノードに相当する。ＩＰパケットの送信元アドレスは、１９２．１６８．０．５０であり、宛先アドレスは、１９２．１６８．０．２０であるものとする。

【０１３０】

通信ノード１００ａから送信されたＩＰパケットが境界転送ノード３００ａに届くと（ステップＳ７００）、境界転送ノード３００ａは、図９に示すフローチャートに従った処理を実行する。ここでは、ＩＰパケットには経路情報ヘッダが付与されていないため、図９のステップＳ１０１において経路情報要求信号が経路管理サーバ５００に送信される（ステップＳ７０１）。

【０１３１】

前記経路情報要求信号を受信した経路管理サーバ５００は、図１４のフローチャートに従い、経路情報を計算し、転送経路を決定した後、経路情報応答信号を境界転送ノード３００ａに送信する（ステップＳ７０２）。

【０１３２】

リンクの帯域や、混雑具合は考慮せず、最短パスを計算する場合、以下のとおり、転送経路が計算される。図８のネットワークトポロジの最短パスは、ＩＤ＝１のノード　－＞　ＩＤ＝１０のノード　－＞　ＩＤ＝８のノード　－＞　１９２．１６８．０．２０のノード（パケットの宛先となる外部ネットワークのＩＰノード）が転送経路として選択される。従って、前記経路情報応答信号には、図８のネットワークトポロジのパス上のリンクＩＤである、１、２、０の値がローカルＩＤとして上記順番で格納される。

【０１３３】

ここで、ＩＤ＝１９２．１６８．０．５０のノード（外部ネットワーク７００のＩＰノ

ード）からＩＤ＝８のノード間のリンクＩＤ（＝０）を経路情報応答に含めることとしても構わない。この場合、前記経路情報応答信号に含めるローカルＩＤの格納順序は、０、１、２、０となる。また逆に、外部ネットワーク（通信ノード１００ｂ）へのリンクＩＤ（＝０）を経路情報応答に含めないこととしても構わない。この場合、ローカルＩＤの格納順序は。１、２となる。

【０１３４】

さらに、外部ネットワークのＩＰノードのＩＤとしてＩＰアドレスを使ったが、ＩＰアドレスの上位から任意のｂｉｔ長を抜き出したネットワークアドレスとしても良いし、ＭＡＣ（Ｍｅｄｉａ　Ａｃｃｅｓｓ　Ｃｏｎｔｒｏｌ）アドレスなどレイヤ２の情報や、それ以外の情報を用いても構わない。

【０１３５】

境界転送ノード３００は前記経路情報応答信号を受信すると（ステップＳ７０３）、図９のステップＳ１０２以降の処理にしたがい、ステップＳ７００で受信したＩＰパケットに経路情報ヘッダを付与し、その後、図９のステップＳ１０３において、付与した経路情報ヘッダに従い、転送すべきローカルＩＤ（＝１）に対応した通信インタフェースからパケットを送出する（ステップＳ７０４）。この結果、ＩＤ＝１０の内部転送ノード４００にパケットが転送される。

【０１３６】

内部転送ノード４００は、経路情報ヘッダが付与されたパケットを受信すると（ステップＳ７０５）、図１１に示すフローチャートに従い転送処理を行う（ステップＳ７０６）。ここでは、転送経路情報に従って、転送すべきローカルＩＤ（＝２）に対応した通信インタフェースからパケットが送出され、ＩＤ＝８の境界転送ノード３００ｂにパケットが転送される。

【０１３７】

境界転送ノード３００ｂは、経路情報ヘッダが付与されたパケットを受信すると（ステップＳ７０７）、図９に示すフローチャートにそって処理を実施する。さらに図９のステップＳ１０３では、さらに図１０に示すフローチャートに示した転送処理が実施される。ここでは、図１０のステップＳ２０１で外部ネットワークへの転送と判定されるため、境界転送ノード３００ｂは、前記受信したパケットから経路情報ヘッダが除去した後、除去前の経路情報ヘッダの情報に従い、転送すべきローカルＩＤ（＝０）に対応した通信インタフェースからパケットを送出する（ステップＳ７０８）。この結果、最終的に通信ノード１００ｂへとＩＰパケットが転送される。

【０１３８】

以上のとおり、本実施形態によれば、ＩＰアドレス等のグローバルに一意性が確保される経路情報ではなく、転送ノード内、あるいは、隣接する転送ノード間といった局所的な範囲での一意性だけが保証されたローカルＩＤを使って転送先を指定するよう構成している。このため、１バイトあるいは２バイト程度の情報量に１ｈｏｐ分の転送経路が格納可能となり、当該転送経路の情報を経路情報ヘッダに格納してパケットに付与した場合でも、付与するヘッダによるオーバヘッドを極めて小さいサイズに抑制することが可能になる。この結果、用途を限らずすべてのパケットに経路情報ヘッダを格納することが可能となる。

【０１３９】

また本実施形態では、転送ノードに備える転送テーブルのエントリ数を、各転送ノードが備える通信インタフェースの数程度とすることが可能になる。また、転送テーブルの格納・更新・利用のため、転送ノードに必要とされるメモリのサイズやＣＰＵの処理能力も抑制可能となり、転送ノードを安価とすることができる。

【０１４０】

これらの結果として、本実施形態によれば、転送経路を１ｈｏｐ毎に厳密に指定した場合においても正味の情報を効率よく、さらに高速に転送可能となる。

【０１４１】

［第２の実施形態］
続いて、本発明の第１の実施形態に変更を加えた本発明の第２の実施形態について図面を参照して詳細に説明する。
【０１４２】
本発明の第２の実施形態の全体の構成は、第１の実施形態とほぼ同じ構成、機能であるので、以下、その相違点を中心に説明する。
【０１４３】
図１６は、本発明の第２の実施形態の境界転送ノード３０１の構成を表した図である。図１６を参照すると、本実施形態の境界転送ノード３０１は、第１の実施形態の境界転送ノード３００の構成に、キャッシュ管理部３８０を追加した構成となっている。また、経路取得部３６０Ａの動作や、記録部３７０Ａの記録する情報も第１の実施形態と異なっている。
【０１４４】
経路取得部３６０Ａは、本発明の第１の実施形態の経路取得部３６０とほぼ同じ機能を備えるが、経路管理サーバ５００に転送経路情報の要求を行う前に、後述する経路情報キャッシュを検索する機能をさらに備える。経路情報キャッシュを検索した結果、受信パケットに対応する経路情報キャッシュが見つかった場合、経路管理サーバ５００に経路情報の要求は行なわず、見つかった経路情報キャッシュから転送経路情報を取得する。また、経路情報キャッシュが見つからなかった場合、経路取得手段３６０Ａは、経路情報キャッシュとして記録するようキャッシュ管理部３８０に経路管理サーバ５００から取得した転送経路情報と受信パケットの情報とを送信する。
【０１４５】
キャッシュ管理部３８０は、経路取得部３６０Ａが経路管理サーバ５００から転送経路情報を取得した際、また、ヘッダ操作部３３０が経路情報ヘッダを削除する際、受信パケットの情報と、経路情報ヘッダに設定された情報とを対応づけて経路情報キャッシュとして記録部３７０Ａに記録する機能を備える。
【０１４６】
本実施形態では、前記受信パケットの情報として、宛先アドレスおよび送信元アドレスを記録するものとする。ただし、宛先アドレスおよび送信元アドレスに加え、他の情報を使っても良い。
【０１４７】
経路情報キャッシュは、一定の時間の経過や、一定量の経路情報キャッシュが蓄積されたことを契機として古い経路情報キャッシュから削除することとしても良い。また、管理上の理由などで、任意の経路情報キャッシュを削除しても良い。
【０１４８】
記録部３７０Ａは、第１の実施形態における記録部３７０が記録する情報に加えて、さらに、経路情報キャッシュを記録する。経路情報キャッシュは、キャッシュ管理部３８０により、追加・更新・削除といった管理がなされる。
【０１４９】
続いて、上記第２の実施形態の境界転送ノード３０１の動作を説明する。
【０１５０】
図１７は、境界転送ノード３０１が、データ転送ネットワーク６００あるいは外部ネットワーク７００からパケットを受信した場合の処理を示している。
【０１５１】
図１７を参照すると、まず、パケット転送部３２０は、通信インタフェース３１０を介してパケットを受信すると、当該パケットに経路情報ヘッダが付与されているかどうかをチェックする（ステップＳ８００）。
【０１５２】
経路情報ヘッダが付与されていた場合は’Ｙ’に進み、その経路情報ヘッダに従って転送処理が行われる（ステップＳ８０９へ）。一方、経路情報ヘッダが付与されていなかっ

た場合は’Ｎ’に進み、経路取得部３６０Ａが、順方向の経路情報キャッシュの検索処理が行われる（ステップＳ８０１）。前記順方向の経路情報キャッシュの検索は、受信パケットの宛先アドレスと、経路情報キャッシュ中の宛先アドレスとを比較することで行うことができる。

【０１５３】

前記順方向の経路情報キャッシュの検索の結果、経路情報キャッシュが見つかった場合（ステップＳ８０２の’Ｙ’）、当該経路情報キャッシュを用いた経路情報ヘッダの付加処理が行われる（ステップＳ８０８へ）。

【０１５４】

一方、前記順方向の経路情報キャッシュの検索の結果、経路情報キャッシュが見つからなかった場合（ステップＳ８０２の’Ｎ’）、経路取得部３６０Ａは、逆方向の経路情報キャッシュの検索処理を行う（ステップＳ８０４）。前記逆方向の経路情報キャッシュの検索は、受信パケットの宛先アドレスと、経路情報キャッシュ中の送信元アドレスとを比較することで行うことができる。

【０１５５】

前記逆方向の経路情報キャッシュの検索の結果、経路情報キャッシュが見つかった場合（ステップＳ８０５の’Ｙ’）、当該経路情報キャッシュを用いた経路情報ヘッダの付加処理が行われる（ステップＳ８０８へ）。

【０１５６】

一方、前記逆方向の経路情報キャッシュの検索の結果、経路情報キャッシュが見つからなかった場合（ステップＳ８０５の’Ｎ’）、経路取得部３６０Ａは、経路管理サーバ５００に経路要求信号を送信し転送経路情報を取得する経路取得処理を行なう（ステップＳ８０６）。

【０１５７】

転送経路情報の取得が完了すると、キャッシュ管理部３８０が、受信パケットに含まれる宛先アドレスおよび送信元アドレスと、ステップＳ８０６で取得した転送経路情報とを対応づけて経路情報キャッシュとして記録部３７０Ａに記録する（ステップＳ８０７）。

【０１５８】

また、ヘッダ操作部３３０は、経路情報キャッシュまたは前記取得した転送経路情報の転送経路の順に従って、経路情報ヘッダを構成し、前記受信したパケットの先頭に付加する（ステップＳ８０８）。経路情報ヘッダの各フィールドに設定する値は、次のようになる。

【０１５９】

経路管理サーバ５００から転送経路情報を取得した場合は、図４に示す経路情報ヘッダのローカルＩＤフィールド（’ＬｏｃａｌＩＤ＃ｎ’）に、転送順に従って経路情報を設定する。また、’Ｄｉｒｅｃｔｉｏｎ’を’１’に設定し、’Ｃｕｒｒｅｎｔ　Ｏｆｆｓｅｔ’を’０’に設定する。

【０１６０】

また、ステップＳ８０１の順方向キャッシュ検索において経路情報キャッシュから経路情報を取得した場合には、’Ｄｉｒｅｃｔｉｏｎ’を’１’に、’Ｃｕｒｒｅｎｔ　Ｏｆｆｓｅｔ’を’０’に設定する。’ＬｏｃａｌＩＤ＃ｎ’には、経路情報キャッシュに記録された値を、順番を維持したまま設定する。

【０１６１】

一方、ステップＳ８０４の逆方向キャッシュ検索において経路情報キャッシュから経路情報を取得した場合には、’Ｄｉｒｅｃｔｉｏｎ’を’２’に、’Ｃｕｒｒｅｎｔ　Ｏｆｆｓｅｔ’を経路情報キャッシュに記録された値に設定する。’ＬｏｃａｌＩＤ＃ｎ’には、経路情報キャッシュに記録された値を、順番を維持したまま設定する。

【０１６２】

なお、ステップＳ８０４の逆方向キャッシュ検索において経路情報キャッシュから経路情報を取得した場合には、経路情報キャッシュに記録された値を、逆の順番で’Ｌｏｃａ

ｌＩＤ＃ｎ’に設定することもできる。この場合は、’Ｄｉｒｅｃｔｉｏｎ’を’１’に、’Ｃｕｒｒｅｎｔ　Ｏｆｆｓｅｔ’を最初の転送先となるローカルＩＤ＃ｎを示すオフセットバイト数に設定する。

【０１６３】

パケット転送部３２０は、上記のように構成した経路情報ヘッダに従って転送処理を実施する（ステップＳ８０９）。ステップＳ８０９の処理の詳細は、図１０に示した第１の実施形態における境界転送ノード３００の転送処理とほぼ同様であるので省略する。ただし、本実施形態においては、図１０のステップＳ２０５において、経路情報ヘッダが削除される際にキャッシュ管理部３８０が、受信パケットの情報と、経路情報ヘッダに設定された情報とを対応づけて経路情報キャッシュとして記録部３７０Ａに記録する。

【０１６４】

続いて、第２の実施形態における通信ノード１００ａおよび通信ノード１００ｂ間のパケット転送処理の流れを説明する。

【０１６５】

最初（往路側）のパケットの転送手順は、第１の実施形態とほぼ同様であり、図１５に示したシーケンス図のとおりパケットが転送される。但し、図１５のステップＳ７０３と、ステップＳ７０７において、それぞれ、境界転送ノード３０１ａ、境界転送ノード３０１ｂの記録部３７０に、図１８（ａ）、（ｂ）に示す経路情報キャッシュが作成される。

【０１６６】

図１８の経路情報キャッシュ中の経路情報フィールドに記録された’Ｄｉｒｅｃｔｉｏｎ’、’ＣｕｒｒｅｎｔＯｆｆｓｅｔ’、’ＲｏｕｔｅＬｅｎｇｔｈ’には、経路情報ヘッダの同名のフィールドに設定された値が記録される。’ＬｏｃａｌＩＤｓ’には、経路情報ヘッダの’ＬｏｃａｌＩＤ＃ｎ’フィールドの値が、順番を維持したまま記録される。

【０１６７】

経路管理サーバ５００から経路情報を取得した場合は、’Ｄｉｒｅｃｔｉｏｎ’に’０’を、’ＣｕｒｒｅｎｔＯｆｆｓｅｔ’に’０’を記録する。また’ＲｏｕｔｅＬｅｎｇｔｈ’、’ＬｏｃａｌＩＤｓ’には、それぞれ取得した転送経路数分のローカルＩＤの総バイト長、転送経路数分のローカルＩＤが設定される。なお、カッコの中の値は、図１５のシーケンス図に従ってパケット転送を処理した場合に記録される値を示している。

【０１６８】

図１８の経路情報キャッシュには、作成時刻情報も含めているが、これは必ずしも必要ではない。なお、作成時刻情報のＨＨ：ＭＭ：ＳＳはそれぞれ、時：分：秒を示す。

【０１６９】

続いて、図１９のシーケンス図を参照して、通信ノード１００ａにより送信されたパケットが宛先の通信ノード１００ｂに転送された後、今度は、前記通信ノード１００ｂが、通信ノード１００ａにパケットを送信し、それが順次転送処理され、最終的にＩＰノードである通信ノード１００ａに届くまでの一連の流れを説明する。

【０１７０】

以下においても、各ノードの接続状況が図８に示したネットワークトポロジのようになっているものとして説明する。境界転送ノード３０１ａは、図８のＩＤ＝１のノードに相当する。境界転送ノード３０１ｂは、図８のＩＤ＝８のノードに相当する。ＩＰパケットの送信元アドレスは、１９２．１６８．０．２０であり、宛先アドレスは、１９２．１６８．０．５０であるものとする。

【０１７１】

通信ノード１００ｂからＩＰパケットが送信され（ステップＳ９００）、境界転送ノード３００ｂに届くと、境界転送ノード３０１ｂは、図１７に示すフローチャートに従った処理を実行する（ステップＳ９０１）。まず、ＩＰパケットには経路情報ヘッダが付与されていないため、図１７のステップＳ８０１において順方向の経路情報キャッシュ検索が実行される。すなわち、図１８（ｂ）に示す経路情報キャッシュの宛先アドレスフィール

ドを走査して、宛先アドレス１９２．１６８．０．５０を持つエントリを検索する処理が行われる。

【０１７２】

図１８（ｂ）に示す経路情報キャッシュには、宛先アドレスフィールドに、宛先アドレス１９２．１６８．０．５０を持つエントリはないため、今度は、図１７のステップＳ８０４において逆方向の経路情報キャッシュ検索が実行される。すなわち、図１８（ｂ）に示す経路情報キャッシュの送信元アドレスフィールドを走査して、宛先アドレス１９２．１６８．０．５０を持つエントリを検索する処理が行われる。

【０１７３】

図１８（ｂ）に示す経路情報キャッシュの例では、送信元アドレスフィールドに、宛先アドレス１９２．１６８．０．５０を持つエントリがある。経路取得部３６０Ａは、前記検索により見つかったエントリの経路情報を読み出す。

【０１７４】

図１８（ｂ）に示す経路情報キャッシュから読み出される経路情報は、以下となる。

’Ｄｉｒｅｃｔｉｏｎ’　　＝　１
’ＣｕｒｒｅｎｔＯｆｆｓｅｔ’　＝　２
’ＲｏｕｔｅＬｅｎｇｔｈ’　　＝　３
’ＬｏｃａｌＩＤｓ’　＝｛１、２、０｝

【０１７５】

ここでは、前記読み出された経路情報から経路情報ヘッダを構成する際に、転送経路’ＬｏｃａｌＩＤｓ’の順番を維持するものとする。この場合、経路情報ヘッダの各フィールドは、以下のように設定される。

【０１７６】

’Ｄｉｒｅｃｔｉｏｎ’　　＝　２
’ＣｕｒｒｅｎｔＯｆｆｓｅｔ’　＝　２
’ＨｅａｄｅｒＬｅｎｇｔｈ’　＝　４
’ＲｏｕｔｅＬｅｎｇｔｈ’　　＝　３
’ＬｏｃａｌＩＤ＃０’　　＝　１
’ＬｏｃａｌＩＤ＃１’　　＝　２
’ＬｏｃａｌＩＤ＃２’　　＝　０

【０１７７】

このように、’Ｄｉｒｅｃｔｉｏｎ’が’２’であるため、逆方向の転送が実施される。

【０１７８】

また、図１５のシーケンス図に示す順方向の転送処理において、経路情報ヘッダに格納するローカルＩＤの情報に、外部ネットワークへの転送に対応する情報を含まない構成も考えられる。この場合、経路情報キャッシュには当該情報が含まれず、その結果、構成される経路情報ヘッダの各フィールドは以下のとおりとなる。

’Ｄｉｒｅｃｔｉｏｎ’　　＝　２
’ＣｕｒｒｅｎｔＯｆｆｓｅｔ’　＝　２
’ＨｅａｄｅｒＬｅｎｇｔｈ’　＝　４
’ＲｏｕｔｅＬｅｎｇｔｈ’　　＝　３
’ＬｏｃａｌＩＤ＃０’　　＝　１
’ＬｏｃａｌＩＤ＃１’　　＝　２

【０１７９】

経路情報ヘッダが構成された後、受信パケットに経路情報ヘッダが付与され、転送処理が実行される（ステップＳ９０２）。この結果、ローカルＩＤ（＝２）に対応した通信インタフェースからパケットが送出され、ＩＤ＝１０の内部転送ノード４００にパケットが転送される。

【０１８０】

内部転送ノード４００は、経路情報ヘッダが付与されたパケットを受信すると、図１１に示すフローチャートに従い、経路情報ヘッダが付与されており、かつ逆方向の転送を行うパケットとして転送処理を実行する（ステップＳ９０３）。ここでは、転送経路情報に従って、転送すべきローカルＩＤ（＝１）に対応した通信インタフェースからパケットが送出され、ＩＤ＝１の境界転送ノード３０１ａにパケットが転送される（ステップＳ９０４）。

【０１８１】

境界転送ノード３０１ａは、経路情報ヘッダが付与されたパケットを受信すると、図１７に示すフローチャートに従い、経路情報ヘッダが付与されており、かつ逆方向の転送を行うパケットとして転送処理を実行する（ステップＳ９０５）。

【０１８２】

さらに経路情報ヘッダの’ＣｕｒｒｅｎｔＯｆｆｓｅｔ’が’０’であることから、図１０のステップＳ２０３において外部ネットワークへの転送と判定され、ステップＳ２０５において経路情報ヘッダが削除される。このとき、境界転送ノード３０１ａの経路情報キャッシュには既に図１８（ａ）に示すエントリが記録されているため、内容が重複する新たな経路情報キャッシュを追加することなく、前記エントリの記録時刻の更新を行う。その後、経路情報ヘッダ削除後のパケットの情報（宛先アドレス１９２．１６８．０．５０）を使って転送処理を実施する。この結果、前記パケットは、宛先である通信ノード１００ａへと転送される（ステップＳ９０６）。

【０１８３】

以上のように、本発明の第２の実施形態によれば、境界転送ノード３０１ａ、３０１ｂが、経路管理サーバ５００から経路情報を取得した際、あるいは経路情報ヘッダを削除する際に、経路管理サーバ５００から取得した経路情報、また、経路情報ヘッダに含まれる経路情報を記録し、経路情報キャッシュとして利用する。このため、経路管理サーバ５００に経路要求を送信する頻度を減らし、経路管理サーバ５００の負荷を低減することができる。

【０１８４】

さらに、本発明の第２の実施形態によれば、パケットがある宛先に送られた際に記録された経路情報のキャッシュを、逆方向のパケット、つまり前記パケットの送信元に送られたパケット用の経路情報ヘッダを構成する際にも利用しているため、経路管理サーバ５００の負荷の低減効果を高めることができている。

【０１８５】

以上、本発明の好適な実施形態を説明したが、本発明は、上記した実施形態に限定されるものではなく、本発明の基本的技術的思想を逸脱しない範囲で、更なる変形・置換・調整を加えることができる。例えば、上記した各実施形態では、リンクの両端の近隣ノード間で共有しているリンクＩＤを用いるものとして説明したが、ローカルＩＤとして、通信インタフェースの識別子を用いることも可能である。この場合、双方向の転送を実施する場合は、近隣ノード間で通信インタフェースの識別子を交換し、情報を共有すればよい。もちろん、近隣ノード間で通信インタフェースの識別子の交換を行わずに、一方向の転送を実施することも可能である。

【０１８６】

またさらに、リンクＩＤや通信インタフェースの識別子に代えて、第３のローカルＩＤを採番し、これをリンクＩＤや通信インタフェースに紐付けておく変形構成も採用可能である。

【０１８７】

また、例えば、上記した実施形態では、個々の転送ノードがローカルＩＤ決定部を備えて、それぞれローカルＩＤを決定するものとして説明したが、経路管理サーバにて各転送ノードの構成情報を入手可能である場合には、経路管理サーバがローカルＩＤを決定し、それぞれの記録部に転送テーブルを記憶させる構成も採用可能である。この場合、個々の転送ノードのローカルＩＤ決定部を省略することができる。またさらに、経路管理サーバ

が各転送ノードの接続関係も入手可能であり、隣接するノード同士でが重複しないようにローカルＩＤを設定可能である場合には、個々の転送ノードの近隣情報通知部も省略することが可能である。

【０１８８】

また、上記した実施形態の経路管理サーバ５００は、非特許文献１のオープンフローコントローラにて実現することができ、この場合、転送ノードは、オープンフロースイッチにて実現することができる。

【０１８９】

また、上記した実施形態の経路管理サーバ５００は、専用のサーバとして実現することもでき、転送ノードとしては、上記オープンフロースイッチのほか、ＩＰ網におけるルータ、ＭＰＬＳ網におけるＭＰＬＳスイッチにて実現することができる。その他、サーバがネットワーク内の転送ノードを集中管理するようなネットワークであれば、本発明を適用することが可能である。

【産業上の利用可能性】

【０１９０】

データセンタなどの商用ネットワークでは、ＱｏＳ（Ｑｕａｌｉｔｙ　ｏｆ　Ｓｅｒｖｉｃｅ）や、負荷分散のため、宛先アドレス、送信元アドレス、使用プロトコルといった様々な条件により、パケットの転送経路を厳密に制御する必要がある。本発明によれば、経路情報を増やすことなくパケットのオーバヘッドを抑制しつつ、転送経路を厳密に指定することを可能とする。したがって、本発明はデータセンタなどの商用ネットワークへ好適に適用可能である。

【符号の説明】

【０１９１】

１００、１００ａ、１００ｂ　通信ノード
２００　転送ノード
３００、３００ａ、３００ｂ、３０１、３０１ａ、３０１ｂ　境界転送ノード
　３１０　通信インタフェース
　３２０　パケット転送部
　３３０　ヘッダ操作部
　３４０　ローカルＩＤ決定部
　３５０　近隣情報通知部
　３６０　経路取得部
　３７０　記録部
　３６０Ａ　経路取得部
　３７０Ａ　記録部
　３８０　キャッシュ管理部
４００　内部転送ノード
　４１０　通信インタフェース
　４２０　パケット転送部
　４３０　ローカルＩＤ決定部
　４４０　近隣情報通知部
　４５０　記録部
５００　経路管理サーバ
　５１０　通信インタフェース
　５２０　経路情報収集部
　５３０　経路要求処理部
　５３１　経路計算部
　５４０　経路情報記録部
６００　データ転送ネットワーク
７００　外部ネットワーク

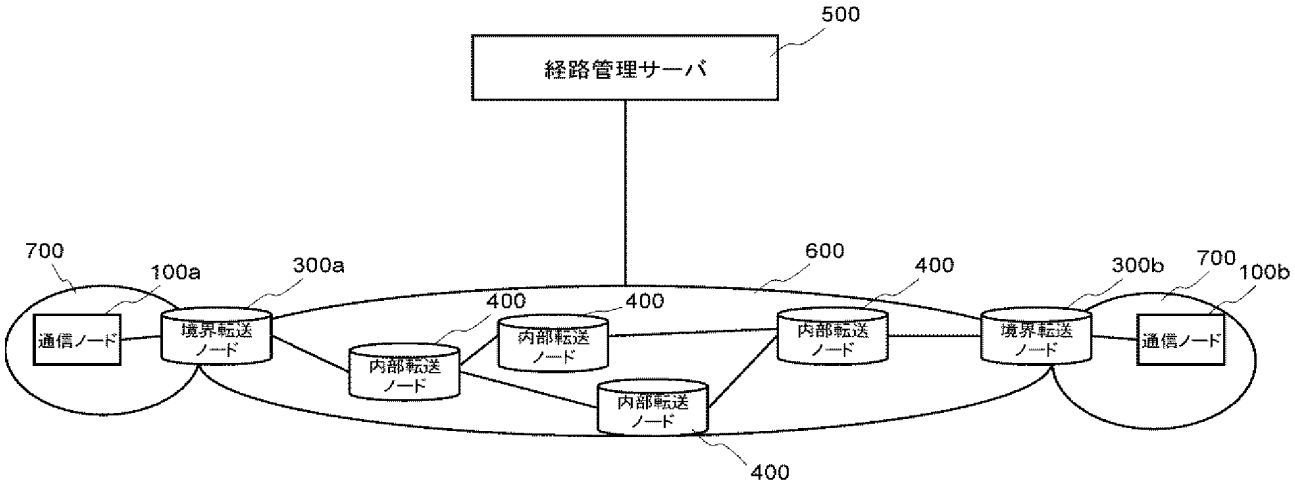
【書類名】特許請求の範囲
【請求項１】
　データ転送ネットワークの転送経路上の個々の転送ノードに備えられている通信インタフェースまたは前記個々の転送ノードとその隣接ノードとの間に張られたリンクを識別するための識別子を並べることによって転送経路情報を構成する経路管理サーバと、
　前記転送経路情報を格納したヘッダが付加されたパケットについて、前記転送経路情報に従ってパケット転送処理を実行する転送ノードを含むことを特徴とする通信システム。
【請求項２】
　前記識別子は、少なくとも一の転送ノード内で一意性を有することを特徴とする請求項１の通信システム。
【請求項３】
　前記識別子は、少なくとも一の転送ノードと、該転送ノードと隣接する転送ノードとの間において一意性を有することを特徴とする請求項１の通信システム。
【請求項４】
　前記ヘッダは、さらに、転送方向を示す情報を含む請求項１から３いずれか一の通信システム。
【請求項５】
　前記転送ノードのうち、外部ネットワークとの境界に位置する転送ノード（境界転送ノード）が、前記外部ネットワークから受信したパケットへの前記転送経路情報を格納したヘッダの付加または前記外部ネットワークへ送信するパケットから前記転送経路情報を格納したヘッダの削除を行うヘッダ操作部を備える請求項１から４いずれか一の通信システム。
【請求項６】
　前記境界転送ノードは、さらに、前記ヘッダに含まれる情報を保持するキャッシュ管理部を備え、
　同一の宛先パケットに対して、前記保持した情報を用いて構成したヘッダを付与する請求項５の通信システム。
【請求項７】
　前記境界転送ノードは、さらに、前記ヘッダを削除した際に、当該ヘッダに含まれる情報を保持するキャッシュ管理部を備え、
　前記ヘッダを削除したパケットの送信元に対して送られた逆方向のパケットに対して、前記保持した情報を用いて構成したヘッダを付与する請求項５の通信システム。
【請求項８】
　前記ヘッダには、外部のネットワークへ転送する場合と、それ以外の場合とを前記境界転送ノードが区別するための情報を含めることが可能である請求項５から７いずれか一の通信システム。
【請求項９】
　さらに、前記個々の転送ノードの接続情報を保持し、前記境界転送ノードからの要求に応じて、転送経路情報を作成して提供する経路管理サーバを備える請求項５から８いずれか一の通信システム。
【請求項１０】
　前記個々の転送ノードが、前記経路管理サーバに対して、自装置に備えられている通信インタフェースまたは自装置と隣接するノードとの間に張られたリンクを識別するための識別子を通知する近隣情報通知部を備え、
　前記経路管理サーバは、前記個々の転送ノードから通知された情報に基づいて、前記境界転送ノードに提供する転送経路情報を作成する請求項９の通信システム。
【請求項１１】
　前記個々の転送ノードが、隣接する転送ノードと情報交換を行って、自装置と隣接する転送ノード間の通信インタフェースの対応関係を取得し、前記ヘッダに含まれる転送方向に基づいたパケット転送処理を実行する請求項４の通信システム。

【請求項１２】
データ転送ネットワークの転送経路上の個々の転送ノードに備えられている通信インタフェースまたは前記個々の転送ノードとその隣接ノードとの間に張られたリンクを識別するための識別子を並べることによって転送経路情報を構成する経路管理サーバと接続され、
前記転送経路情報を格納したヘッダが付加されたパケットについて、前記転送経路情報に従ってパケット転送処理を実行する転送ノード。
【請求項１３】
前記識別子は、少なくとも一の転送ノード内で一意性を有することを特徴とする請求項１２の転送ノード。
【請求項１４】
前記識別子は、少なくとも一の転送ノードと、該転送ノードと隣接する転送ノードとの間において一意性を有することを特徴とする請求項１２の転送ノード。
【請求項１５】
前記転送経路情報を管理する経路管理サーバに対して、自装置に備えられている通信インタフェースまたは自装置とその隣接ノードとの間に張られたリンクを識別するための識別子を通知する近隣情報通知部を備える請求項１２から１４いずれか一の転送ノード。
【請求項１６】
データ転送ネットワークと外部ネットワークとの境界に配置され、
データ転送ネットワークに配置された各転送ノードの通信インタフェースまたは各転送ノードとその隣接ノードとの間に張られたリンクを識別するための識別子を並べることによって構成されている転送経路情報を格納したヘッダが付加されたパケットについて、前記転送経路情報に従ってパケット転送処理を実行するとともに、
前記外部ネットワークから受信したパケットへの前記転送経路情報を格納したヘッダの付加または前記外部ネットワークへ送信するパケットから前記転送経路情報を格納したヘッダの削除を行うヘッダ操作部を備える境界転送ノード。
【請求項１７】
さらに、前記ヘッダに含まれる情報を保持するキャッシュ管理部を備え、
同一の宛先パケットに対して、前記保持した情報を用いて構成したヘッダを付与する請求項１６の境界転送ノード。
【請求項１８】
さらに、前記ヘッダを削除した際に、当該ヘッダに含まれる情報を保持するキャッシュ管理部を備え、
前記ヘッダを削除したパケットの送信元に対して送られた逆方向のパケットに対して、前記保持した情報を用いて構成したヘッダを付与する請求項１６の境界転送ノード。
【請求項１９】
データ転送ネットワークに配置された個々の転送ノードの接続情報に基づいて、前記個々の転送ノードが備える通信インタフェースまたは個々の転送ノードとその隣接ノードとの間に張られたリンクを識別するための識別子を並べることによって構成した転送経路情報を作成する経路計算部と、
前記データ転送ネットワークと外部ネットワークとの境界に配置された境界転送ノードからの要求に応じて、前記作成した転送経路情報を送信する経路要求処理部と、備える経路管理サーバ。
【請求項２０】
少なくとも一の転送ノード内で一意性を有する識別子を並べた転送経路情報を作成する求項１９の経路管理サーバ。
【請求項２１】
少なくとも一の転送ノードと、該転送ノードと隣接する転送ノードとの間において一意性を有する識別子を並べた転送経路情報を作成する請求項１９または２０の経路管理サーバ。

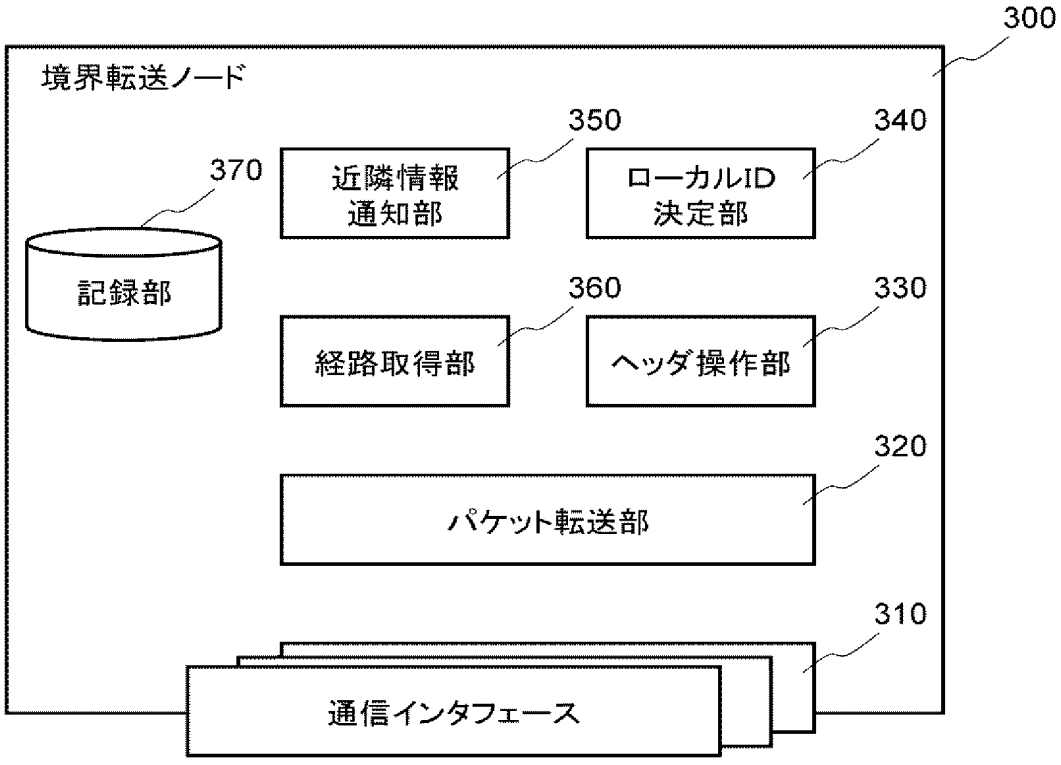
【請求項２２】
前記転送経路情報に加えて、転送方向を示す情報を前記境界転送ノードに送信し、前記境界転送ノードに転送方向を示す情報を含んだヘッダを作成させる請求項１９から２１いずれか一の経路管理サーバ。
【請求項２３】
前記転送経路情報に加えて、前記境界転送ノードに対し、外部のネットワークへ転送する場合とそれ以外の場合とを前記境界転送ノードが区別するための情報を送信し、前記外部のネットワークへ転送するものであるか否かの情報を含んだヘッダを作成させる請求項１９から２２いずれか一の経路管理サーバ。
【請求項２４】
前記個々の転送ノードから通知された情報に基づいて、データ転送ネットワーク内のネットワークトポロジ情報を構築する経路情報収集部を備え、
前記経路計算部は、前記ネットワークトポロジ情報に基づいて経路計算を行う請求項１９から２３の経路管理サーバ。
【請求項２５】
データ転送ネットワークの転送経路上の個々の転送ノードが、個々の転送ノードが備える通信インタフェースまたは個々の転送ノードとその隣接ノードとの間に張られたリンクを識別するための識別子を並べることによって構成されている転送経路情報を格納したヘッダが付加されたパケットを受信するステップと、
前記パケットについて、前記転送経路情報に従ってパケット転送処理を実行するステップとを含む通信方法。
【請求項２６】
データ転送ネットワークに配置された転送ノードを構成するコンピュータに実行させるプログラムであって、
個々の転送ノードが備える通信インタフェースまたは個々の転送ノードとその隣接ノードとの間に張られたリンクを識別するための識別子を並べることによって構成されている転送経路情報を格納したヘッダが付加されたパケットを受信する処理と、
前記パケットについて、前記パケットの前記転送経路情報に従ってパケットを転送する処理と、を前記コンピュータに実行させるプログラム。
【請求項２７】
データ転送ネットワークと外部ネットワークとの境界に配置された境界転送ノードを構成するコンピュータに実行させるプログラムであって、
個々の転送ノードが備える通信インタフェースまたは個々の転送ノードとその隣接ノードとの間に張られたリンクを識別するための識別子を並べることによって構成されている転送経路情報を格納したヘッダが付加されたパケットを受信する処理と、
前記パケットについて、前記パケットの前記転送経路情報に従ってパケットを転送する処理と、
前記外部ネットワークから受信したパケットへの前記転送経路情報を格納したヘッダの付加または前記外部ネットワークへ送信するパケットから前記転送経路情報を格納したヘッダの削除を行うヘッダ操作処理と、を前記コンピュータに実行させるプログラム。
【請求項２８】
データ転送ネットワークに配置された個々の転送ノードの接続情報を保持する経路管理サーバを構成するコンピュータに実行させるプログラムであって、
データ転送ネットワークと外部ネットワークとの境界に配置された境界転送ノードからの要求に応じて、個々の転送ノードが備える通信インタフェースまたは個々の転送ノードとその隣接ノードとの間に張られたリンクを識別するための識別子を並べることによって構成した転送経路情報を作成する処理と、
前記作成した転送経路情報を前記境界転送ノードに送信する処理と、を前記コンピュータに実行させるプログラム。

【書類名】要約書
【要約】
【課題】簡略化された転送テーブルを用いて実現可能であり、しかも、データパケットの経路制御にも適用できる通信システムの提供。
【解決手段】経路管理サーバは、自装置に備えられている通信インタフェースまたは自装置とその隣接ノードとの間に張られたリンクを識別するためのリンクＩＤを並べることによって構成されている転送経路情報を構成する。転送ノードは、前記転送経路情報を格納したヘッダが付加されたパケットについて、前記転送経路情報に従ってパケット転送処理を実行する。
【選択図】図１

【書類名】図面
【図１】


500
経路管理サーバ
700
100a
300a
600
400
300b
700
100b
通信ノード
境界転送ノード
内部転送ノード
400
400
内部転送ノード
内部転送ノード
内部転送ノード
境界転送ノード
通信ノード
400

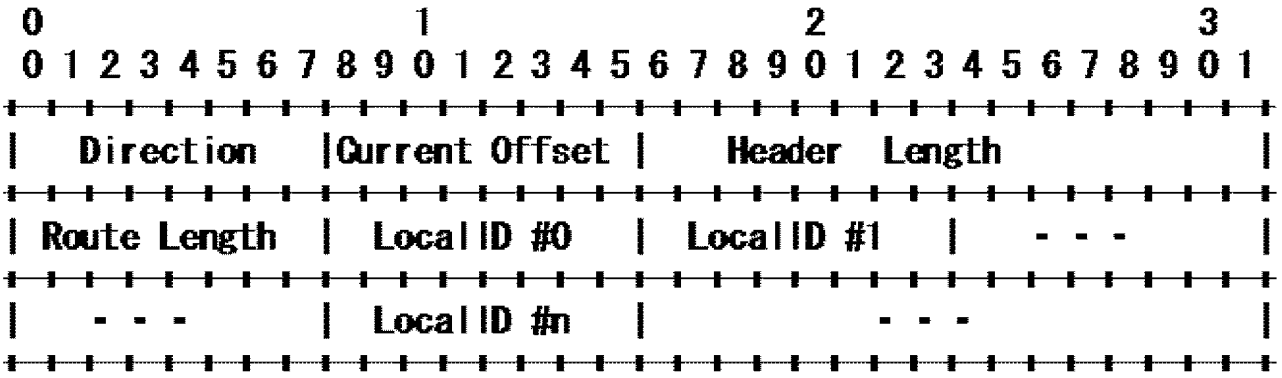
【図２】


300
境界転送ノード
350
340
370
近隣情報通知部
ローカルID決定部
記録部
360
330
経路取得部
ヘッダ操作部
320
パケット転送部
310
通信インタフェース

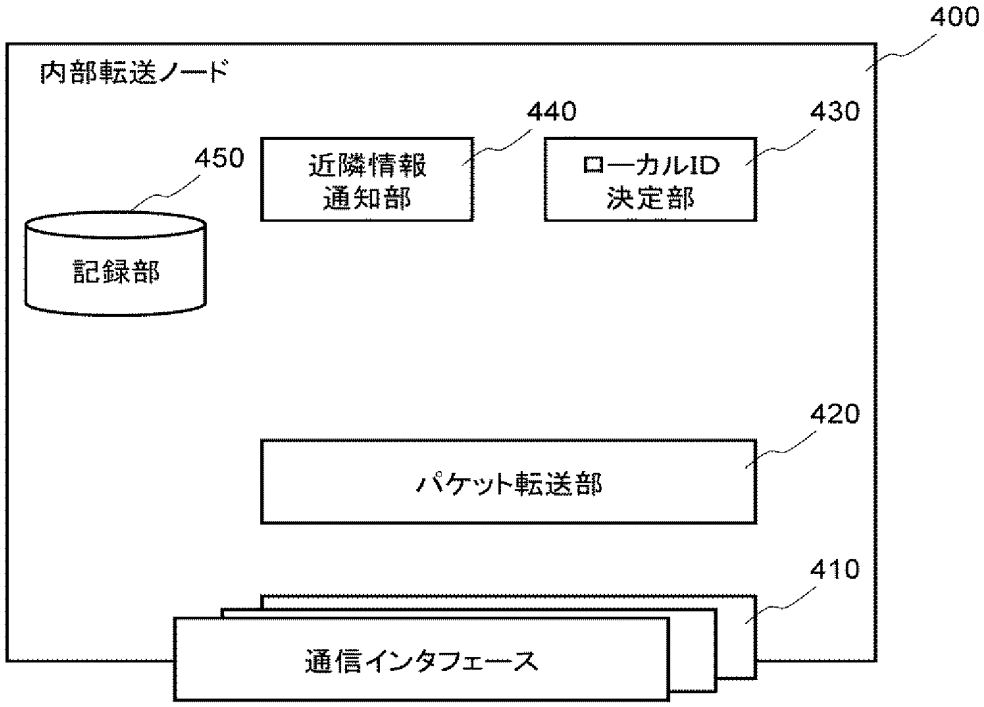
【図３】

ローカルID	インタフェース	次ホップ
Link ID_1	IF_1	Node_1
Link ID_2	IF_2	Node_2
Link ID_3	IF_3	Node_3
:		

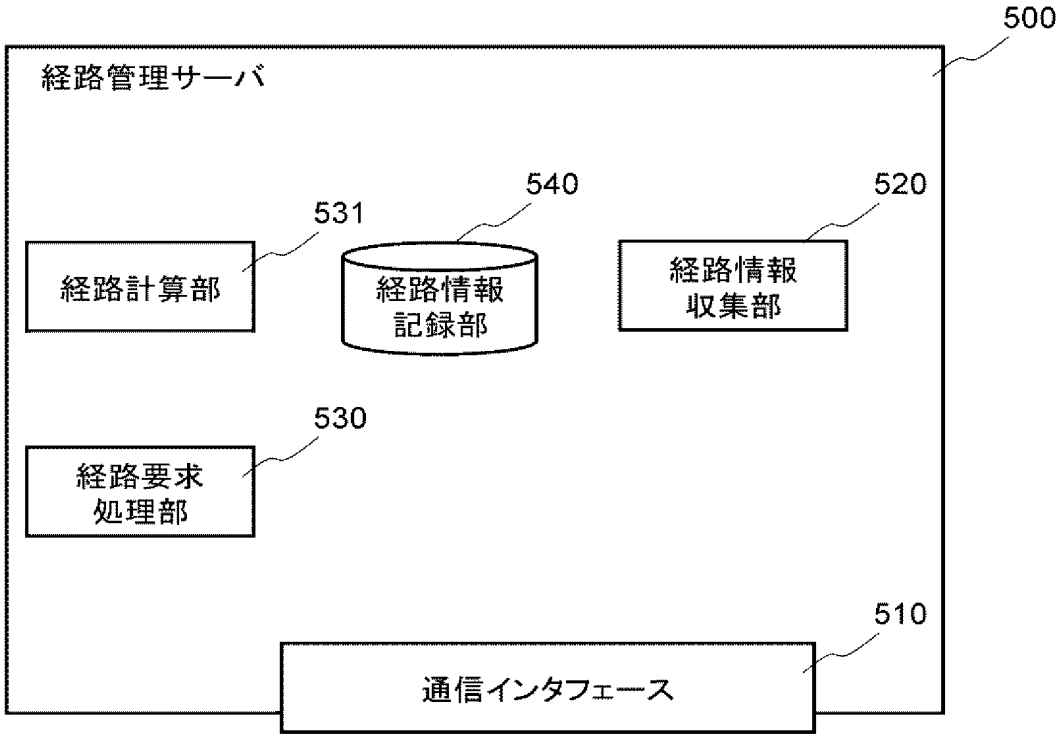
【図４】



【図５】


400
内部転送ノード
440
430
450
近隣情報
通知部
ローカルID
決定部
記録部
420
パケット転送部
410
通信インタフェース

【図６】


500
経路管理サーバ
540
531
520
経路計算部
経路情報
記録部
経路情報
収集部
530
経路要求
処理部
510
通信インタフェース

【図７】

近隣転送ノード(ID:1)からの近隣情報

sender ID : 1
LinkID: 0, neighborID: 192.168.0.50 (outerIP)
LinkID: 1, neighborID: 10
LinkID: 2, neighborID: 5

近隣転送ノード(ID:8)からの近隣情報

sender ID : 8
LinkID: 0, neighborID: 192.168.0.20 (outerIP)
LinkID: 2, neighborID: 10
LinkID: 3, neighborID: 6

内部転送ノード(ID:5)からの近隣情報

sender ID : 5
LinkID: 1, neighborID: 6
LinkID: 2, neighborID: 1
LinkID: 3, neighborID: 10

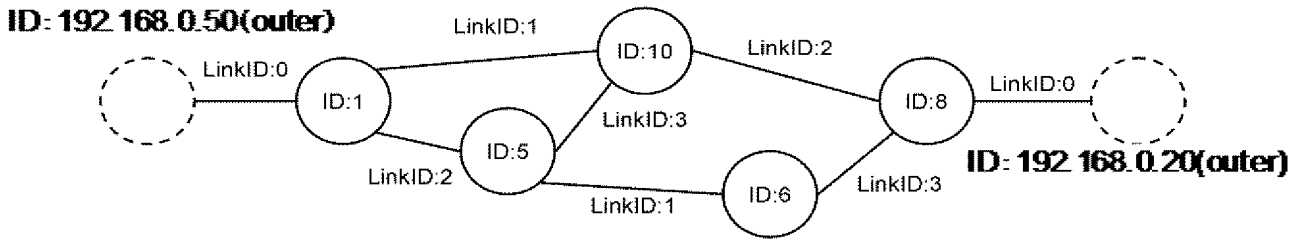
内部転送ノード(ID:6)からの近隣情報

sender ID : 6
LinkID: 1, neighborID: 5
LinkID: 3, neighborID: 8

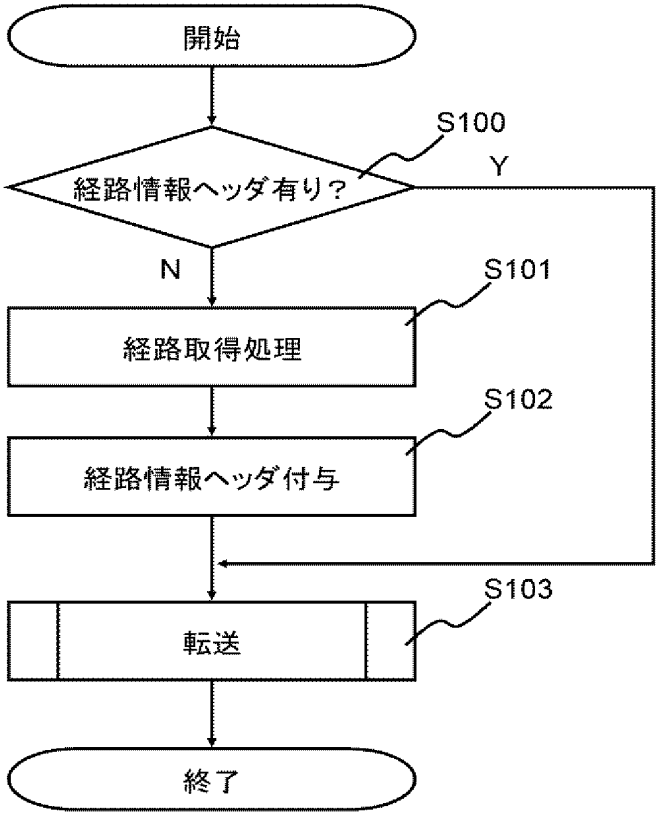
内部転送ノード(ID:10)からの近隣情報

sender ID : 10
LinkID: 1, neighborID: 1
LinkID: 2, neighborID: 8
LinkID: 3, neighborID: 5

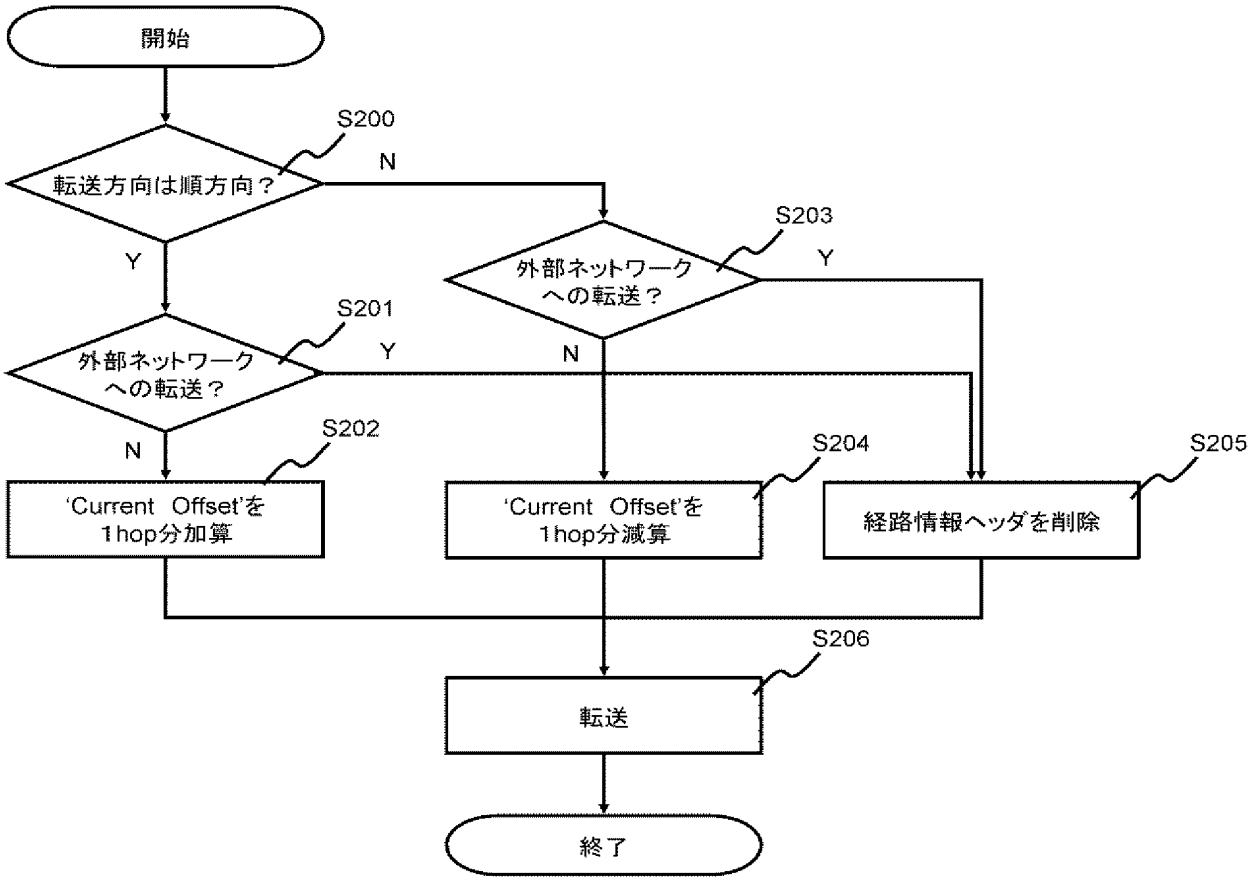
【図８】



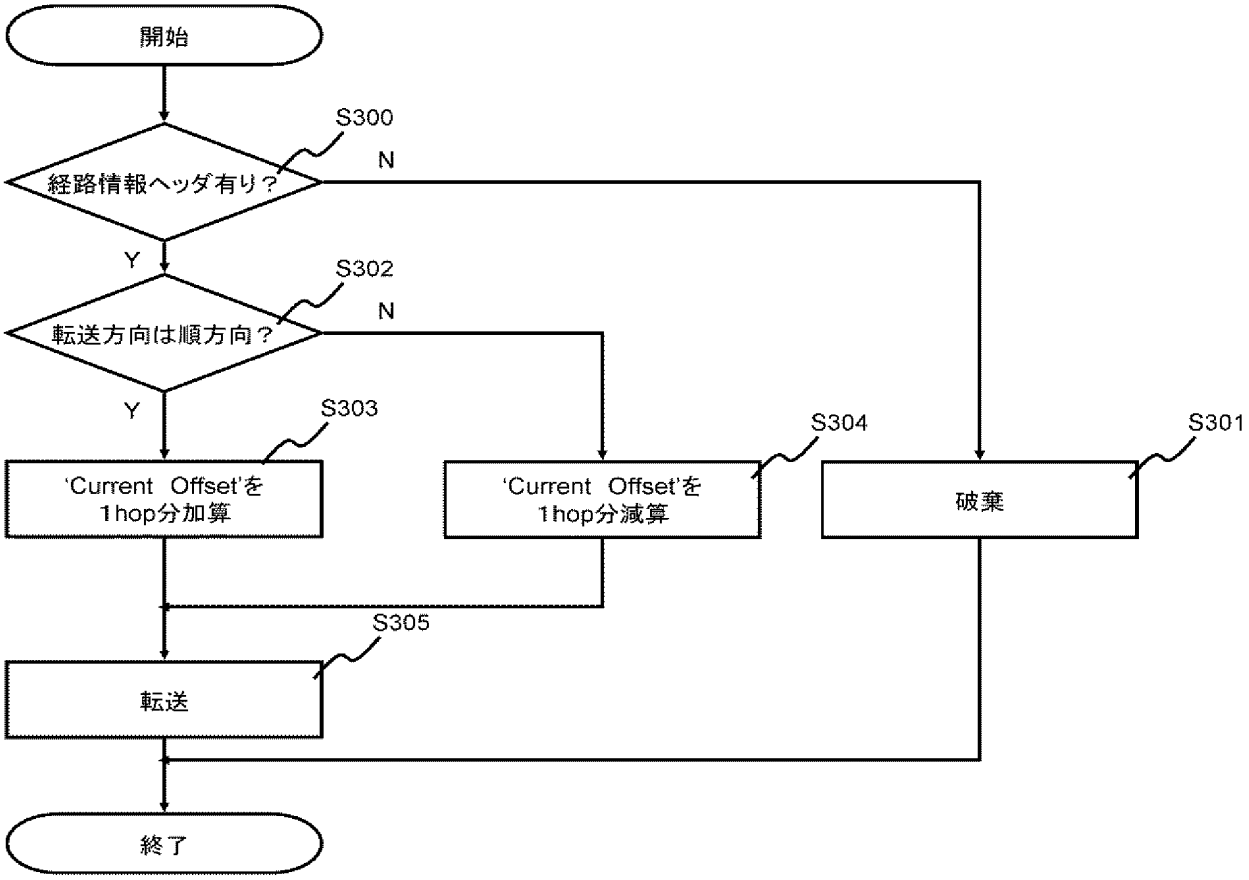
【図９】


開始
S100
経路情報ヘッダ有り？
Y
N
S101
経路取得処理
S102
経路情報ヘッダ付与
S103
転送
終了

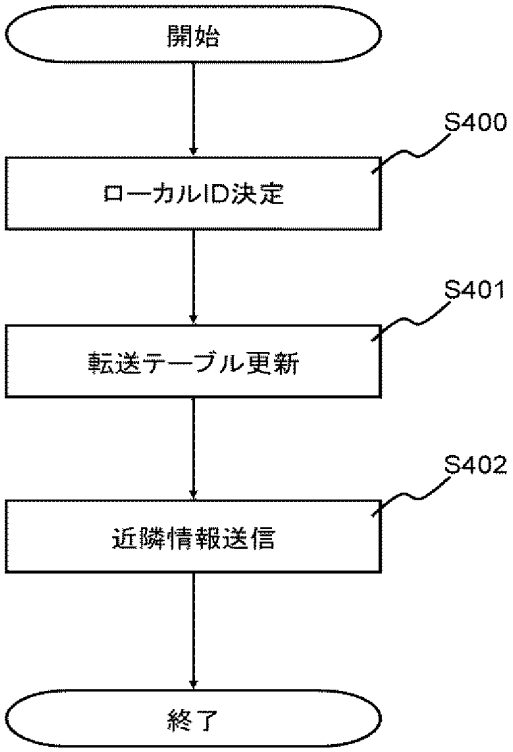
【図１０】


開始
S200
転送方向は順方向？
N
Y
S203
外部ネットワークへの転送？
Y
S201
外部ネットワークへの転送？
Y
N
N
S202
'Current Offset'を1hop分加算
S204
'Current Offset'を1hop分減算
S205
経路情報ヘッダを削除
S206
転送
終了

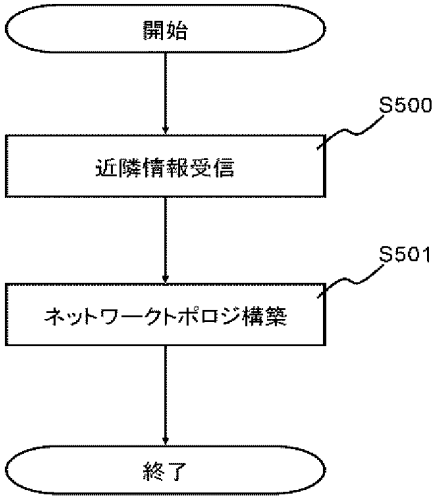
【図１１】


開始
S300
経路情報ヘッダ有り？
N
Y
S302
転送方向は順方向？
N
Y
S303
'Current Offset'を
1hop分加算
S304
'Current Offset'を
1hop分減算
S301
破棄
S305
転送
終了

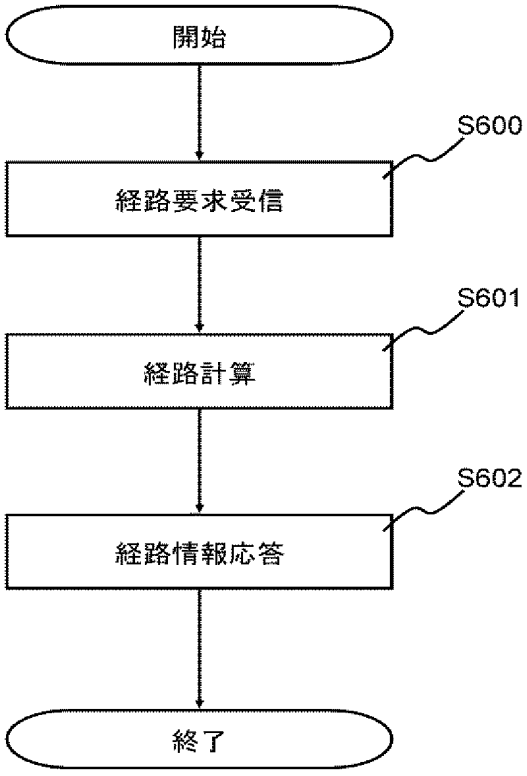
【図１２】


開始
S400
ローカルID決定
S401
転送テーブル更新
S402
近隣情報送信
終了

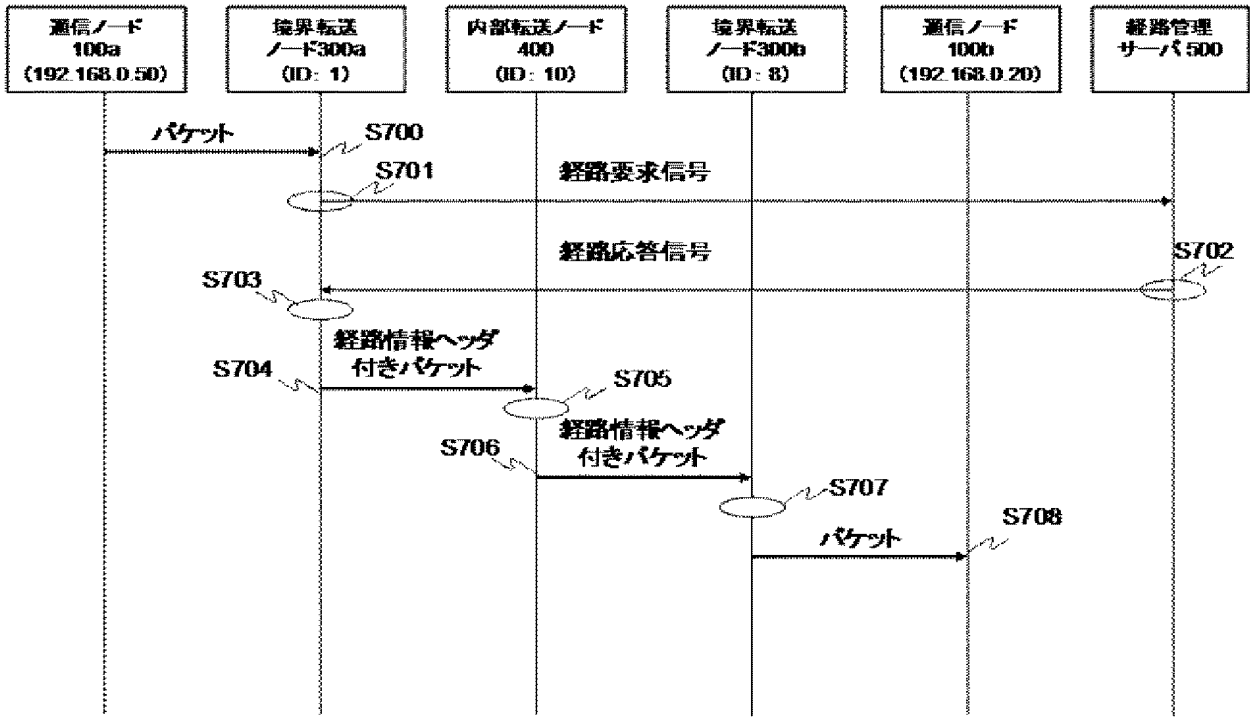
【図１３】


開始
S500
近隣情報受信
S501
ネットワークトポロジ構築
終了

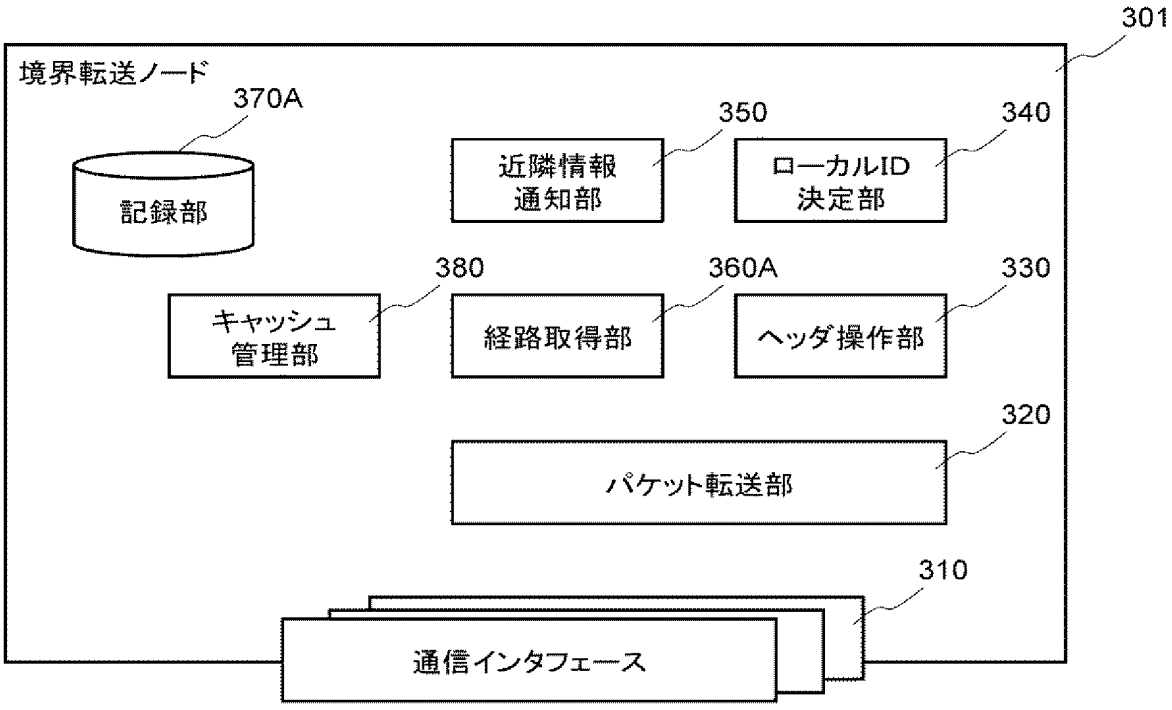
【図１４】


開始
S600
経路要求受信
S601
経路計算
S602
経路情報応答
終了

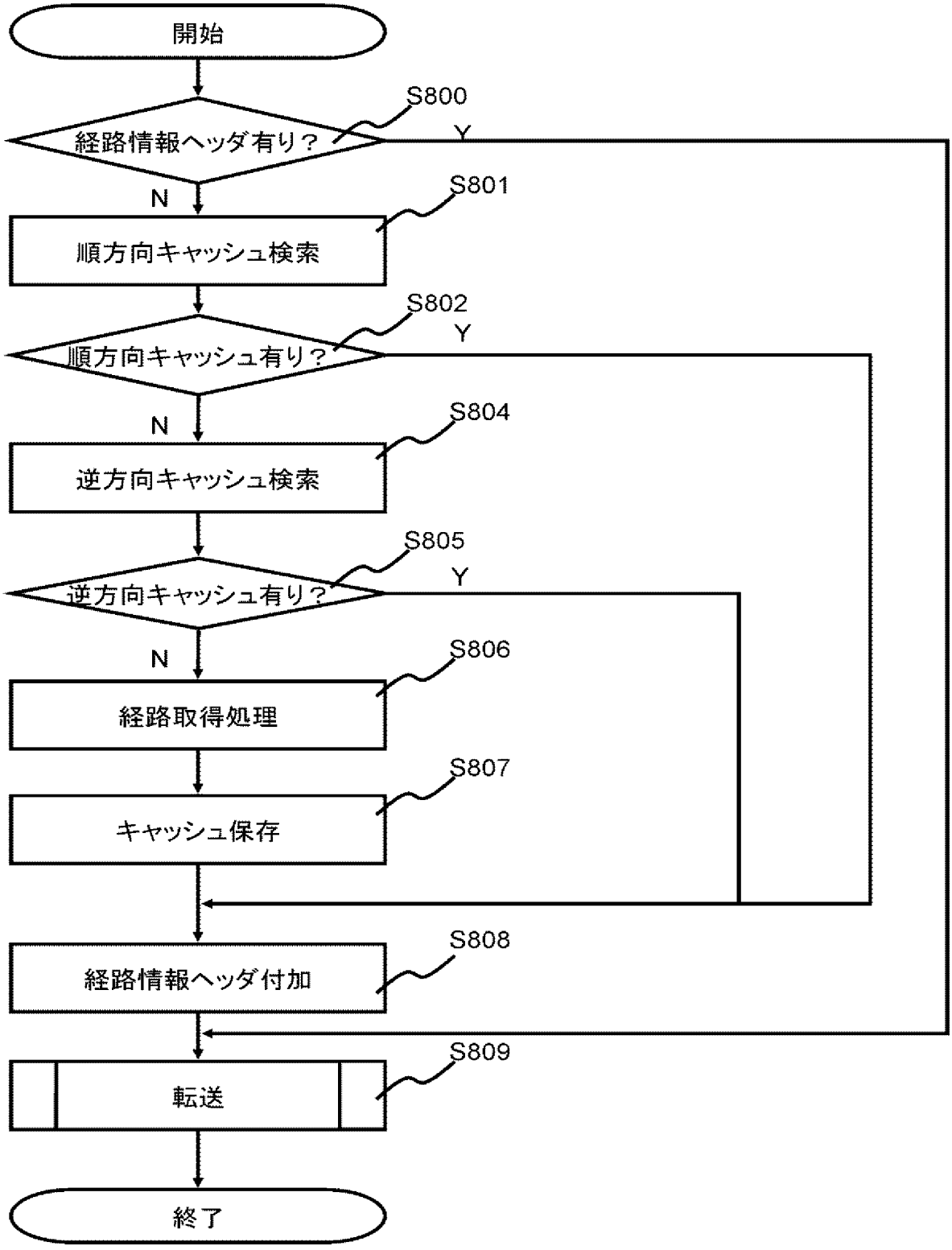
【図１５】


通信ノード
100a
(192.168.0.50)
境界転送
ノード300a
(ID：1)
内部転送ノード
400
(ID：10)
境界転送
ノード300b
(ID：8)
通信ノード
100b
(192.168.0.20)
経路管理
サーバ500
パケット
S700
S701
経路要求信号
経路応答信号
S702
S703
経路情報ヘッダ
付きパケット
S704
S705
経路情報ヘッダ
付きパケット
S706
S707
S708
パケット

【図１６】


301
境界転送ノード
370A
記録部
350
近隣情報
通知部
340
ローカルID
決定部
380
キャッシュ
管理部
360A
経路取得部
330
ヘッダ操作部
320
パケット転送部
310
通信インタフェース

【図１７】


開始
S800
経路情報ヘッダ有り？
Y
N
S801
順方向キャッシュ検索
S802
順方向キャッシュ有り？
Y
N
S804
逆方向キャッシュ検索
S805
逆方向キャッシュ有り？
Y
N
S806
経路取得処理
S807
キャッシュ保存
S808
経路情報ヘッダ付加
S809
転送
終了

【図１８】

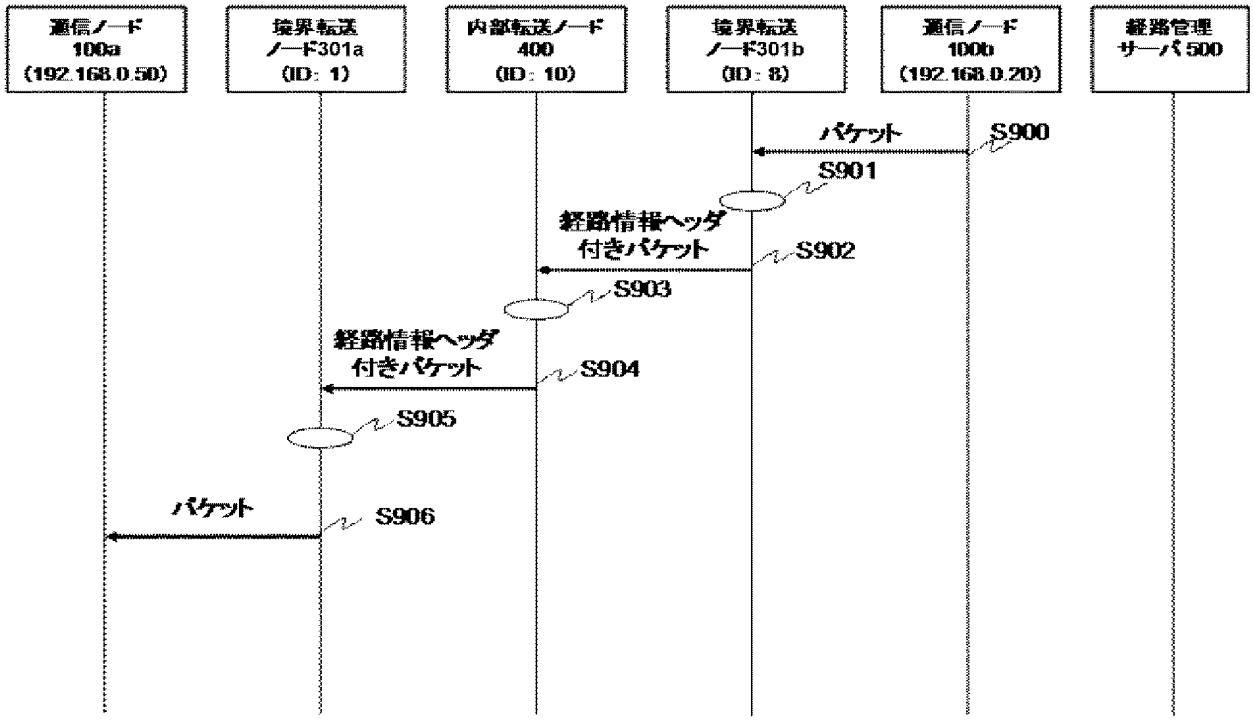
(a) 境界転送ノード 301a の経路情報キャッシュ

作成時刻	送信元アドレス	宛先アドレス	経路情報
HH:MM:SS	192.168.0.50	192.168.0.20	Direction (1), CurrentOffset (0), RouteLength (3), LocalIDs (1, 2, 0)
⋮	⋮	⋮	⋮

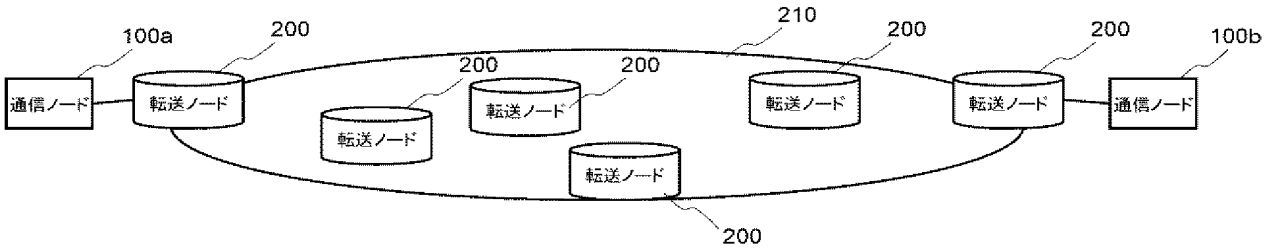
(b) 境界転送ノード 301b の経路情報キャッシュ

作成時刻	送信元アドレス	宛先アドレス	経路情報
HH:MM:SS	192.168.0.50	192.168.0.20	Direction (1), CurrentOffset (2), RouteLength (3), LocalIDs (1, 2, 0)
⋮	⋮	⋮	⋮

【図１９】


通信ノード
100a
(192.168.0.50)
境界転送
ノード301a
(ID: 1)
内部転送ノード
400
(ID: 10)
境界転送
ノード301b
(ID: 8)
通信ノード
100b
(192.168.0.20)
経路管理
サーバ500
パケット
S900
S901
経路情報ヘッダ
付きパケット
S902
S903
経路情報ヘッダ
付きパケット
S904
S905
パケット
S906

【図２０】


100a
200
210
200
200
100b
通信ノード
転送ノード
200
200
転送ノード
転送ノード
転送ノード
転送ノード
転送ノード
通信ノード
200

出願人履歴

０００００４２３７

19900829

新規登録

東京都港区芝五丁目７番１号

日本電気株式会社

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
14/244,701	04/03/2014	JUN AWANO	NEG-1440PCT-US2CT

CONFIRMATION NO. 2010

21254
MCGINN INTELLECTUAL PROPERTY LAW GROUP, PLLC
8321 OLD COURTHOUSE ROAD
SUITE 200
VIENNA, VA 22182-3817

PUBLICATION NOTICE

OC00000070054839

Title: Communication system, forwarding node, path management server, communication method, and program

Publication No.US-2014-0219281-A1
Publication Date:08/07/2014

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

The publication may be accessed through the USPTO's publically available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently http://www.uspto.gov/patft/.

The publication process established by the Office does not provide for mailing a copy of the publication to applicant. A copy of the publication may be obtained from the Office upon payment of the appropriate fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Office of Public Records. The Office of Public Records can be reached by telephone at (703) 308-9726 or (800) 972-6382, by facsimile at (703) 305-8759, by mail addressed to the United States Patent and Trademark Office, Office of Public Records, Alexandria, VA 22313-1450 or via the Internet.

In addition, information on the status of the application, including the mailing date of Office actions and the dates of receipt of correspondence filed in the Office, may also be accessed via the Internet through the Patent Electronic Business Center at www.uspto.gov using the public side of the Patent Application Information and Retrieval (PAIR) system. The direct link to access this status information is currently http://pair.uspto.gov/. Prior to publication, such status information is confidential and may only be obtained by applicant using the private side of PAIR.

Further assistance in electronically accessing the publication, or about PAIR, is available by calling the Patent Electronic Business Center at 1-866-217-9197.

Office of Data Managment, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

DELL - Exhibit 1002 - Page 147

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UNITED STATES DEPARTMENT OF COMMERCE
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www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/244,701	04/03/2014	JUN AWANO	NEG-1440PCT-US2CT	2010

21254 7590 12/16/2014

MCGINN INTELLECTUAL PROPERTY LAW GROUP, PLLC
8321 OLD COURTHOUSE ROAD
SUITE 200
VIENNA, VA 22182-3817

EXAMINER
AUNG, SAI

ART UNIT	PAPER NUMBER
2475	

MAIL DATE	DELIVERY MODE
12/16/2014	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No. 14/244,701	Applicant(s) AWANO, JUN	
	Examiner SAI AUNG	Art Unit 2475	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *04/03/2014*.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5)☒ Claim(s) *1-21* is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6)☐ Claim(s) _____ is/are allowed.

7)☒ Claim(s) *1-21* is/are rejected.

8)☐ Claim(s) _____ is/are objected to.

9)☐ Claim(s) _____ are subject to restriction and/or election requirement.

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☒ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☒ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date _____.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

4) ☐ Other: _____.

DETAILED ACTION

Claims status

1. In the application filed on 04/03/2014, claims 1-21 are currently pending for the examination. The present application is being examined under the pre-AIA first to invent provisions.

Examiner Notes

2. The Examiner cites particular columns and line numbers in the references as applied to the claims below for the convenience of the Applicants(s). Although the specified citations are representative of the disclosings in the art and are applied to the specific limitations within the individual claim, other passages and figures may apply as well. It is respectfully requested that, in preparing response, the Applicant fully consider the references in their entirety as potentially disclosing all or part of the claimed invention, as well as the context of the passage as taught by the prior art or disclosed by the Examiner.

Claim Objections

3. Claim 8-10, 12-15 and 17-20 are objected to because of the following informalities:

Claim 7 recites "an identifier which uniquely identifies" in line 3. It is recommended that "an identifier" be changed to ---the identifier---, if it is referring back to “an identifier” in claim 6.

Claims 12-15 and 17-20 are further objected to because the similar issue exits with the term "an identifier".

Appropriate actions are required.

Duplicate Claim Objection

4. Claim 1 is objected under 37 CFR 1.75 as being a substantial duplicate of claim 6. When two claims in an application are duplicates or else are so close in content that they both cover the same thing, despite a slight difference in wording, it is proper after allowing one claim to object to the other as being a substantial duplicate of the allowed claim. See MPEP § 706.03(k).

Claims 3-5 are further objected under 37 CFR 1.75 as being a substantial duplicate of claims 7-10 respectively. When two claims in an application are duplicates or else are so close in content that they both cover the same thing, despite a slight difference in wording, it is proper after allowing one claim to object to the other as being a substantial duplicate of the allowed claim. See MPEP § 706.03(k).

Claims 7-8, 9-10, 12-15, and 17-20 are further objected under 37 CFR 1.75 as being a substantial duplicated claims.

Appropriate actions are required.

Claim Rejections - 35 USC § 112

5. The following is a quotation of 35 U.S.C. 112(b):

(b) CONCLUSION.—The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the inventor or a joint inventor regards as the invention.

The following is a quotation of 35 U.S.C. 112 (pre-AIA), second paragraph:
The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

6. Claims 1-28, and 49 are rejected under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Claim 1 recites *"an identifier which identifies a link between nodes..."* in line 3 and *"an identifier corresponding to the packet forwarding node."* in line 7.

Claims 2-5 further recite "the identifier" respectively, and create indefiniteness due to unclear antecedent basis. It is unclear to determine that whether "the identifier" refers back to which one of the identifier indicated in the claim 1.

The independent claims 6, 11, and 16 are further rejected under 35 U.S.C 112 because a similar problem exits with the term "the identifier" in each respective claimed limitation.

It is recommended that the claim language be amended such that the exact meaning of the above quoted limitations is clear.

For the purpose of examinations, examiner will interpret the claim as best understood.

Double Patenting

7. The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the "right to exclude" granted by a patent and to prevent possible harassment by multiple assignees. A nonstatutory obviousness-type double patenting rejection is appropriate where the conflicting claims are not identical, but at least one examined application claim is not patentably distinct from the reference claim(s) because the examined application claim is either anticipated by, or would have been obvious over, the reference claim(s). See, e.g., *In re Berg*, 140 F.3d 1428, 46 USPQ2d 1226 (Fed. Cir. 1998); *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); and *In re Thorington*, 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) or 1.321(d) may be used to overcome an actual or provisional rejection based on a nonstatutory double patenting ground provided the conflicting application or patent either is shown to be commonly owned with this application, or claims an invention made as a result of activities undertaken within the scope of a joint research agreement. Effective January 1, 1994, a registered attorney or agent of record may sign a terminal disclaimer. A terminal disclaimer signed by the assignee must fully comply with 37 CFR 3.73(b).

8. **Claims 1-21 are** rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claims 1 and 2 of the U.S. Patent No. **8,750,163**. Although

the conflicting claims are not identical, they are not patentably distinct from each other. This is an **obviousness-type double patenting rejection** because the conflicting claims have not in fact been patented.

Regarding pending claims 1, 6 and 21; the claims recite limitations substantially the same as in the US patent 8750163. These limitations are fully covered by the claims of the US patent 8750163.

The compared table below (i.e. underlined claim elements) shows only Example (sample) of how each of these claims are anticipated and mapped by claims such as claims 1-7, 11, and 18, respectively of the US patent 8750163.

Instant Application: 13/167251	**U.S. Patent#: 8,750,163**
1. A packet forwarding node, comprising: a storage unit to store a packet forwarding table used for forwarding a packet based on an identifier which identifies a link between nodes on a packet forwarding path; and a forwarding unit to receive an incoming packet including a plurality of the identifiers, and to forward the incoming packet based on an identifier corresponding to the packet forwarding node.	1. A communication system comprising: a path management server that configures forwarding path information by arranging identifiers for identifying communication interfaces provided in respective forwarding nodes in a forwarding path of a data transfer network or configures the forwarding path information by arranging identifiers for links extending between said respective forwarding nodes and neighboring nodes thereof; and a forwarding node that performs a packet forwarding processing in accordance with said

	forwarding path information, with regard to a packet to which is added a header containing said forwarding path information, wherein, among said forwarding nodes, a boundary forwarding node positioned at a boundary with an external network…
6. A packet forwarding node, comprising: a storage unit to store a packet forwarding table used for forwarding a packet based on an identifier which identifies an interface of a packet forwarding node; and a forwarding unit to receive an incoming packet including a plurality of identifiers, and to forward the incoming packet based on an identifier corresponding to the packet forwarding node.	2. A communication system comprising: a path management server that configures forwarding path information by arranging identifiers for identifying communication interfaces provided in respective forwarding nodes in a forwarding path of a data transfer network or configures the forwarding path information by arranging identifiers for links extending between said respective forwarding nodes and neighboring nodes thereof; and a forwarding node that performs a packet forwarding processing in accordance with said forwarding path information, with regard to a packet to which is added a header containing said forwarding path information,

	wherein, among said forwarding nodes, a boundary forwarding node positioned at a boundary with an external network…
21. A server, comprising: a first unit to determine a plurality of identifiers, each of which identifies a link between nodes on a packet forwarding path; and a second unit to send information elements to a packet forwarding node which is capable of forwarding an incoming packet based on an identifier corresponding to the packet forwarding node.	2. A communication system comprising: a path management server that configures forwarding path information by arranging identifiers for identifying communication interfaces provided in respective forwarding nodes in a forwarding path of a data transfer network or configures the forwarding path information by arranging identifiers for links extending between said respective forwarding nodes and neighboring nodes thereof; and a forwarding node that performs a packet forwarding processing in accordance with said forwarding path information, with regard to a packet to which is added a header containing said forwarding path information

Claim Rejections - 35 USC § 102

9. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

10. Claims 1-4, 8-9, 11-15 and 19-28 are rejected under 35 U.S.C. 102(b) as being anticipated by **Vasseur** (US 7522 603 B2).

Regarding claim 1; **Vasseur** discloses a packet forwarding node, comprising:

a storage unit to store a packet forwarding table used for forwarding a packet based on an identifier which identifies a link between nodes on a packet forwarding path (See Figs. 2 and 4; Router (i.e., a forwarding node) with forwarding tables 246; Col. 8 l 59-67); and

a forwarding unit to receive an incoming packet including a plurality of the identifiers (See Figs. 2 and 4; Router performs/receives routing information database RIB and forwarding information database FIB; Col. 8 Lines 59-67), and to forward the incoming packet based on an identifier corresponding to the packet forwarding node (See Figs. 2 and 4; a forwarding selection selects a label (i.e. identifier) to route of the destination; Col. 9 Lines 15-24).

Regarding claim 2; **Vasseur** discloses the packet forwarding node wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely

identifies the link within a predetermined domain (See Figs. 4 and 5; CE-PE links (i.e. PE link for predetermined domain); Col. 10 Lines 51-60 and Col. 12 Lines 40-47).

Regarding claim 3; **Vasseur** discloses the packet forwarding node, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link within a predetermined local domain (See Figs. 4 and 5; CE-CE links (i.e. predetermined local domain); Col. 9 Lines 54-60).

Regarding claim 4; **Vasseur** discloses the packet forwarding node wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link within the packet forwarding node (See Figs. 2 and 4; Router (i.e., a forwarding node) with forwarding tables 246; Col. 8 l 59-67); and

Regarding claim 5; **Vasseur** discloses the packet forwarding node wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link among the packet forwarding nodes (See Figs. 2 and 4; Router (i.e., a forwarding node) with forwarding tables 246; Col. 8 l 59-67).

Regarding claims 6-10, the claimed steps of the method correspond with the elements of the device as addressed in claims 1-5 respectively. Since the device has been anticipated, the steps of using the device in its intended manner are also anticipated.

Regarding claim 11; **Vasseur** discloses a packet forwarding node, comprising:

a communication unit to communicate with a server for receiving a plurality of identifiers (See Fig. 2 and 7; Router 200…and… PCC/PCE 248 with Stored Requests Table 500 (i.e. storage unit) and PCE computes the metrics (i.e. identifiers). The requesting CE (i.e. forwarding node) modifies IP/Data Packet corresponding to the CE-CE path metrics; Col. 8 Lines 42-50 and Lines 50-55, and Col. 9 Lines 58-65); and

a forwarding unit to forward an incoming packet based on the identifier corresponding to the packet forwarding node (See Fig. 2; Routing Service 247 forward the incoming data packet using the label found in the packet. PCE computes the metric to set up the routing/forwarding destination of the CE; Col. 9 Lines 55-65).

Regarding claim 12; **Vasseur** discloses the packet forwarding node wherein the forwarding unit forwards the packet based on an identifier which uniquely identifies a link within a predetermined domain (See Fig. 2; Routing Service 247 forward the incoming data packet using the label found in the packet. PCE computes the metric to set up the routing/forwarding destination of the CE; Col. 9 Lines 55-65; and see also Figs. 4 and 5; CE-PE links (i.e. PE link for predetermined domain); Col. 10 Lines 51-60 and Col. 12 Lines 40-47).

Regarding claim 13; **Vasseur** discloses the packet forwarding node, wherein the forwarding unit forwards the packet based on an identifier which uniquely identifies a link within a predetermined domain (See Figs. 4 and 5; CE-CE links (i.e. predetermined local domain); Col. 9 Lines 54-60).

Regarding claim 14; **Vasseur** discloses the packet forwarding node wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link within the packet forwarding node (See Figs. 2 and 4; Router (i.e., a forwarding node) with forwarding tables 246; Col. 8 Lines 59-67); and

Regarding claim 15; **Vasseur** discloses the packet forwarding node wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link among the packet forwarding nodes (See Figs. 2 and 4; Router (i.e., a forwarding node) with forwarding tables 246; Col. 8 Lines 59-67).

Regarding claims 16-20, the claimed steps of the method correspond with the elements of the device as addressed in claims 11-15 respectively. Since the device has been anticipated, the steps of using the device in its intended manner are also anticipated.

Regarding claim 21; **Vasseur** discloses a server, comprising:

a first unit to determine a plurality of the identifiers each of which identifies a link between nodes on a packet forwarding path path (See Fig. 2 and 7; PCC/PCE 248 with Stored Requests Table 500 (i.e. a first unit) and PCE computes the metrics (i.e. identifiers). The requesting CE (i.e. forwarding node) modifies IP/Data Packet corresponding to the CE-CE path metrics; Col. 8 Lines 42-50 and Lines 50-55, and Col. 9 Lines 58-65); and

a second unit to send the information elements to a packet forwarding node (See Fig. 2; Routing Services 247 with Routing Tables 246 (i.e. second unit)...a forwarding selection and new substitute label are determined by using the label found in the incoming packet of the forwarding table; Col. 9 Lines 17-22), and to forward the incoming packet based on the identifier corresponding to the packet forwarding node (See Fig. 2; Routing Service 247 forward the incoming data packet using the label found in the packet. PCE computes the metric to set up the routing destination of the CE; Col. 9 Lines 55-65).

(Note: Claim 21 recites the term "capable of" which is not positively recited claim limitations and produces unnecessary ambiguity. Therefore, any limitations beyond the term "capable of" will not be considered in the examination but the reference does teach the limitations.)

Conclusion

11. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

a. Friskney et al. (US 2008/0279196 A1)

b. **Vasseur** et al. (US 2007/0280102 A1)

c. **Vasseur** et al. (US 2008/0123651 A1)

d. McDysan et al. (US 7447 151 B2).

Contact Information

12. Any inquiry concerning this communication or earlier communications from the examiner should be directed to SAI AUNG whose telephone number is (571)272-3507. The examiner can normally be reached on Monday-Friday, Alt Fridays, 7:30 AM- 5:00 PM (EST).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Dang Ton can be reached on 571-272-3171. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300. Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/S. A./

Examiner, Art Unit 2475

/DANG TON/

Supervisory Patent Examiner, Art Unit 2475/D. T./

Supervisory Patent Examiner, Art Unit 2475

Notice of References Cited	Application/Control No. 14/244,701	Applicant(s)/Patent Under Reexamination AWANO, JUN	
	Examiner SAI AUNG	Art Unit 2475	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-2003/0053427 A1	03-2003	Kanda et al.	370/328
*	B	US-2007/0280102 A1	12-2007	Vasseur et al.	370/225
*	C	US-2008/0123651 A1	05-2008	Vasseur et al.	370/392
*	D	US-2008/0137615 A1	06-2008	PARK et al.	370/332
*	E	US-2008/0279196 A1	11-2008	Friskney et al.	370/395.53
*	F	US-7,447,151 B2	11-2008	McDysan, David E.	370/231
*	G	US-7,522,603 B2	04-2009	Vasseur, Jean-Philippe	370/392
*	H	US-2010/0165995 A1	07-2010	Mehta et al.	370/400
*	I	US-8,125,928 B2	02-2012	Mehta et al.	370/254
	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

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CONFIRMATION NO. 2010

SERIAL NUMBER	FILING or 371(c) DATE RULE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
14/244,701	04/03/2014	370	2475	NEG-1440PCT-US2CT

APPLICANTS

NEC CORPORATION, Tokyo, JAPAN, Assignee (with 37 CFR 1.172 Interest);

INVENTORS

JUN AWANO, Tokyo, JAPAN;

**** CONTINUING DATA ***************************

This application is a CON of 13/176,610 07/05/2011 PAT 8750163
which is a CON of PCT/JP2010/065712 09/13/2010

**** FOREIGN APPLICATIONS ***************************

JAPAN 2009-212221 09/14/2009

**** IF REQUIRED, FOREIGN FILING LICENSE GRANTED ****

04/24/2014

Foreign Priority claimed	35 USC 119(a-d) conditions met	Verified and Acknowledged	Met after Allowance	STATE OR COUNTRY	SHEETS DRAWINGS	TOTAL CLAIMS	INDEPENDENT CLAIMS
☑ Yes ☐ No	☑ Yes ☐ No	/SAI AUNG/ Examiner's Signature	☐ SA Initials	JAPAN	20	21	5

ADDRESS

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UNITED STATES

TITLE

Communication system, forwarding node, path management server, communication method, and program

FILING FEE RECEIVED		
2520	FEES: Authority has been given in Paper No._____ to charge/credit DEPOSIT ACCOUNT No._____ for following:	☐ All Fees ☐ 1.16 Fees (Filing) ☐ 1.17 Fees (Processing Ext. of time) ☐ 1.18 Fees (Issue) ☐ Other _____ ☐ Credit

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	46007	370/389,473,474,352-356,349,310.2,328,338,312.ccls.	US-PGPUB; USPAT	OR	ON	2012/06/19 19:15
S2	17081	370/218-225,401,237,238.ccls.	US-PGPUB; USPAT	OR	ON	2012/06/19 19:15
S3	21369	avaya.as. or (bank new york mellon trust).as.	US-PGPUB; USPAT	OR	ON	2012/06/19 19:15
S4	717668	(switch$4 or rout$4 or gate$4) and (encapsulat$4 or authenticat$4 or encod$4) and (packe$2 or data$1)	US-PGPUB; USPAT	OR	ON	2012/06/19 19:16
S5	400097	(virtu$4 or tunne$3) same (media or access$3 or control$3 or MAC)	US-PGPUB; USPAT	OR	ON	2012/06/19 19:17
S6	364	(source$1 or origi$3) and ((dual or multi$3) adj3 hom$3 adj3 (connect$3 or host$1))	US-PGPUB; USPAT	OR	ON	2012/06/19 19:18
S7	215	(source$3 or origi$4) and ((dual or multi$3) adj3 hom$3 adj3 connect$3)	US-PGPUB; USPAT	OR	ON	2012/06/19 19:18
S9	282	((dual or multi$3) adj3 hom$3 adj3 connect$3)	US-PGPUB; USPAT	OR	ON	2012/06/19 19:19
S10	6566	((dual or multi$3) adj3 hom$3)	US-PGPUB; USPAT	OR	ON	2012/06/19 19:19
S11	124	S10 and S1 and S2	US-PGPUB; USPAT	OR	ON	2012/06/19 19:19
S12	80	S11 and S4	US-PGPUB; USPAT	OR	ON	2012/06/19 19:20
S17	80	S11 and S4 and (media or access$3 or control$3 or MAC)	US-PGPUB; USPAT	OR	ON	2012/06/19 19:34
S19	398071	(switch$4 or rout$4 or gate$4) and (encapsulat$4 or authenticat$4 or encod$4) same (packe$2 or data$1)	US-PGPUB; USPAT	OR	ON	2012/06/19 19:35
S26	400097	(virtu$4 or tunne$3) same (media or access$3 or control$3 or MAC)	US-PGPUB; USPAT	OR	ON	2012/06/20 16:30
S27	6566	((dual or multi$3) adj3 hom$3)	US-PGPUB; USPAT	OR	ON	2012/06/20 16:30
S28	398071	(switch$4 or rout$4 or gate$4) and (encapsulat$4 or authenticat$4 or encod$4) same (packe$2 or data$1)	US-PGPUB; USPAT	OR	ON	2012/06/20 16:30
S29	46007	370/389,473,474,352-356,349,310.2,328,338,312.ccls.	US-PGPUB; USPAT	OR	ON	2012/06/20 16:32
S32	124	S27 and S29 and S31	US-PGPUB; USPAT	OR	ON	2012/06/20 18:44
S33	717668	(switch$4 or rout$4 or gate$4) and (encapsulat$4 or authenticat$4 or encod$4) and (packe$2 or data$1)	US-PGPUB; USPAT	OR	ON	2012/06/20 18:45
S34	80	S32 and S33	US-PGPUB; USPAT	OR	ON	2012/06/20 18:45
S35	38	S34 and S26	US-PGPUB; USPAT	OR	ON	2012/06/20 18:45
S36	468	((dual or multi$3) adj3 hom$3) and S31	US-PGPUB; USPAT	OR	ON	2012/06/20 18:57
S37	8447	(virtu$4 or tunne$3) same (media or access$3 or control$3 or MAC) and "L3"	US-PGPUB; USPAT	OR	ON	2012/06/20 18:58
S38	230	(virtu$4 or tunne$3) same (media or access$3 or control$3 or MAC) and S36	US-PGPUB; USPAT	OR	ON	2012/06/20 18:58
S42	105	(virtu$4 or tunne$3) near10 ((media and access$3) or control$3 or MAC) and S36 not S30	US-PGPUB; USPAT	OR	ON	2012/06/20 19:01
S43	65	(switch$4 or rout$4 or gate$4) and (encapsulat$4 or authenticat$4 or encod$4)	US-PGPUB; USPAT	OR	ON	2012/06/20 19:06

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		same (packe$2 or data$1) and S42				
S65	21392	avaya.as. or (bank new york mellon trust).as.	US-PGPUB; USPAT	OR	ON	2012/06/25 18:18
S66	17095	370/218-225,401,237,238.ccls.	US-PGPUB; USPAT	OR	ON	2012/06/25 18:18
S67	468	((dual or multi$3) adj3 hom$3) and S66	US-PGPUB; USPAT	OR	ON	2012/06/25 18:18
S68	105	(virtu$4 or tunne$3) near10 ((media and access$3) or control$3 or MAC) and S67 not S65	US-PGPUB; USPAT	OR	ON	2012/06/25 18:18
S95	6042098	Encapsulation Method for Transport	US-PGPUB; USPAT	OR	ON	2012/06/27 13:02
S96	1734704	S95 and ethernet frames	US-PGPUB; USPAT	OR	ON	2012/06/27 13:03
S117	48595	370/389,473,474,352-356,349,310.2,328,338,312.ccls.	US-PGPUB; USPAT	OR	ON	2012/10/30 17:56
S118	17789	370/218-225,401,237,238.ccls.	US-PGPUB; USPAT	OR	ON	2012/10/30 17:56
S121	2	("20070195700").PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/02/07 17:42
S125	7644	(rout$5) near4 (setup)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:12
S127	1553238	(flow) with (manage$5 control$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:13
S128	2159	S125 and S127	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:14
S129	1788	@ad<="20090326" and S128	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:15
S130	8916	370/218-225,254.ccls.	US-PGPUB; USPAT	OR	ON	2013/02/07 18:16
S131	42	S130 and S129	US-PGPUB; USPAT	OR	ON	2013/02/07 18:16
S132	5262	370/254.ccls.	US-PGPUB; USPAT	OR	ON	2013/02/07 18:16
S134	42078	(IP near3 rout$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:18
S135	363	S129 and S134	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:18
S136	301	(data with packet) and S135	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:19
S137	284	(request$4) and S136	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:20
S138	271283	(source destination) near5 (node address MAC)	US-PGPUB; USPAT; USOCR;	OR	ON	2013/02/07 18:21

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			FPRS; EPO; JPO; DERWENT; IBM_TDB			
S140	244	S137 and S138	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:21
S141	242	(pre$determin$3 determin$3 reserv$3) and S140	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:22
S142	219	(pre$determin$3 pre$defin$3 reserv$3) and S140	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:22
S143	6	S132 and S142	US-PGPUB; USPAT	OR	ON	2013/02/07 18:23
S144	46911	370/389,352-356,349,310.2,328,338,312.ccls.	US-PGPUB; USPAT	OR	ON	2013/02/07 18:23
S145	71	S142 and S144	US-PGPUB; USPAT	OR	ON	2013/02/07 18:23
S146	26048	370/389,352-356,349.ccls.	US-PGPUB; USPAT	OR	ON	2013/02/07 18:24
S147	64	S142 and S146	US-PGPUB; USPAT	OR	ON	2013/02/07 18:24
S148	7644	(rout$5) near4 (setup)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:33
S149	1553238	(flow) with (manage$5 control$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:33
S150	2159	S148 and S149	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:33
S151	1788	@ad<="20090326" and S150	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:33
S152	42078	(IP near3 rout$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:33
S153	363	S151 and S152	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:33
S154	301	(data with packet) and S153	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:33
S155	284	(request$4) and S154	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:33
S156	271283	(source destination) near5 (node address MAC)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	OR	ON	2013/02/07 18:33

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			IBM_TDB			
S157	244	S155 and S156	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:33
S158	219	(pre$determin$3 pre$defin$3 reserv$3) and S157	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:33
S159	26048	370/389,352-356,349.ccls.	US-PGPUB; USPAT	OR	ON	2013/02/07 18:33
S160	64	S158 and S159	US-PGPUB; USPAT	OR	ON	2013/02/07 18:33
S161	64	S160	US-PGPUB; USPAT	OR	ON	2013/02/07 18:33
S175	31571	370/229-235,251-254,230-236.ccls.	US-PGPUB; USPAT	OR	ON	2013/02/07 22:44
S176	29	S158 and S175	US-PGPUB; USPAT	OR	ON	2013/02/07 22:44
S177	58	(look$up LUT map$4 hash$4) and S161	US-PGPUB; USPAT	OR	ON	2013/02/07 22:55
S178	24	(rout$5 near3 server) and S177	US-PGPUB; USPAT	OR	ON	2013/02/07 22:55
S181	108	S150 and ((server gatewy) near3 (set$up (set$4 adj up)))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 23:47
S183	2837	S175 and S159	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 23:48
S184	28	S181 and S159	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 23:48
S186	135	jean near3 vasseur.in.	USPAT	OR	ON	2013/02/07 23:56
S187	103	(pre$determin$3 pre$defin$3 reserv$3 predict$3) and S186	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 23:57
S188	827364	(switch$4 or rout$4 or gate$4) with (IP or packet or data)	US-PGPUB; USPAT	OR	ON	2013/02/07 23:58
S189	168189	S188 and S149	US-PGPUB; USPAT	OR	ON	2013/02/07 23:58
S190	40	S187 and S189	US-PGPUB; USPAT	OR	ON	2013/02/07 23:58
S191	22	(look$up LUT map$4 hash$4) and S190	US-PGPUB; USPAT	OR	ON	2013/02/07 23:58
S192	21	@ad<="20090326" and S191	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 23:59
S193	273959	(source destination) with (node station)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/22 10:25
S194	215582	(virtu$4 logical pseudo) same (physical)	US-PGPUB; USPAT	OR	ON	2013/02/22 10:27
S195	21741	S193 and S194	US-PGPUB; USPAT	OR	ON	2013/02/22 10:28

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S196	31743	370/229-235,251-254,230-236.ccls.	US-PGPUB; USPAT	OR	ON	2013/02/22 10:28
S197	1843	S196 and S195	US-PGPUB; USPAT	OR	ON	2013/02/22 10:28
S198	1172	(redundant repeat$3 redundan$3) and S197	US-PGPUB; USPAT	OR	ON	2013/02/22 10:57
S199	41964	((virtu$4 logical pseudo) same (physical)) with (link connection path channel)	US-PGPUB; USPAT	OR	ON	2013/02/22 10:58
S200	5393	((source destination) with (node station)) with (redundant repeat$3 redundan$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/22 10:58
S201	339	S199 and S200	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/22 10:58
S202	54	S196 and S201	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/22 10:58
S203	53	@ad<="20110705" and S202	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/22 10:59
S204	48	@pd<="20110705" and S202	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/22 10:59
S208	12	("20090274155" | "8125928" | "20110299535" | "8107457" | "20120147740" | "7447151" | "7339929" | "7535828" | "7782841" | "7995500" | "7411916" | "7969978").PN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/02/22 11:34
S209	324	jean near2 vasseur.in.	US-PGPUB; USPAT; USOCR	OR	ON	2013/02/22 11:36
S210	26	S209 and S200	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/22 11:37
S211	42013	((virtu$4 logical pseudo$5) same (physical)) with (link connection path channel)	US-PGPUB; USPAT	OR	ON	2013/02/22 13:00
S212	73	S209 and S211	US-PGPUB; USPAT	OR	ON	2013/02/22 13:01
S213	54	@pd<="20110705" and S212	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/22 13:01
S214	653	(redundant redundan$3) and S197	US-PGPUB; USPAT	OR	ON	2013/02/22 13:40
S215	1268	((source destination) with (node station)) with (redundant redundan$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/22 13:41
S216	18	S214 and S215 and S199	US-PGPUB; USPAT	OR	ON	2013/02/22 13:41
S217	17	@ad<="20110705" and S216	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/22 13:41
S218	85143	((node station)) with (redundant repeat$3 redundan$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	OR	ON	2013/02/22 13:42

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			IBM_TDB			
S219	20706	((node station)) with (redundant redundan$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/22 13:42
S227	20348	(multiple multi$4) with (logical pseudo$wire virtual) same (link path connection)	US-PGPUB; USPAT	OR	ON	2013/02/22 13:52
S230	32097	((node station)) with (redundant redundan$3 diversity)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/22 14:13
S283	11493	h04w4/00.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/12/19 14:13
S284	12	h04w28/0242.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/12/19 14:13
S285	2586	h04w28/065.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/12/19 14:13
S286	160	h04w52/0222.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/12/19 14:14
S287	81	@ad<="20090326" and S286	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/12/19 14:14
S288	5	S287 and (((updat$ add$4 re$purpo$5 upgrad$4) same3 header) and (table list))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/12/19 14:17
S289	4554	h04w36/12.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/12/19 14:18
S290	74758	h04w36/$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/12/19 14:18
S291	94382	h04w52/$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/12/19 14:18
S292	1119	S291 and (((updat$ add$4 re$purpo$5 upgrad$4) same3 header) and (table list))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/12/19 14:19

EAST Search History (Interference)

< This search history is empty>

12/14/2014 11:02:15 PM
C:\Users\saung1\Documents\EAST\Workspaces\14244701\14244701-A.wsp

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Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14244701	AWANO, JUN
	Examiner	Art Unit
	SAI AUNG	2475

CPC- SEARCHED		
Symbol	Date	Examiner
H04L45/04; H04L45/24; H04L45/66; H04L45/00; H04L45/302; H04L45/50; H04L49/351	12/14/2014	SA

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
370	370/401; 370/392; 370/231; 370/252; 370/352; 370/395.53	12/14/2014	SA

SEARCH NOTES		
Search Notes	Date	Examiner
EAST SEARCH	12/14/2014	SA

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner

/S.A./ Examiner.Art Unit 2475	

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14244701	AWANO, JUN
	Examiner	Art Unit
	SAI AUNG	2475

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	12/12/2014								
	1	✓								
	2	✓								
	3	✓								
	4	✓								
	5	✓								
	6	✓								
	7	✓								
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	14	✓								
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	16	✓								
	17	✓								
	18	✓								
	19	✓								
	20	✓								
	21	✓								

Docket No.: NEG-1440PCT-US2CT
KATO.327CONT.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Continuation patent application of 13/176,610, filed on July 5, 2011.

Jun Awano

Serial No.:	Not Yet Assigned	**Group Art Unit:**	Not Yet Assigned
Filed:	Concurrently Herewith	**Examiner:**	Not Yet Assigned

For: COMMUNICATION SYSTEM, FORWARDING NODE, PATH MANAGEMENT SERVER, COMMUNICATION METHOD, AND PROGRAM

Honorable Commissioner of Patents
Alexandria, Virginia 22313-1450

INFORMATION DISCLOSURE STATEMENT

Sir:

Under the provisions of 37 CFR §1.97 through §1.98 and pursuant to applicant's duty of disclosure under 37 CFR §1.56, applicant respectfully brings the following documents listed on the attached form PTO-1449, to the attention of the Examiner in charge of the above-identified application. These references were either cited or submitted in parent Application No. 13/176,610, and thus copies of these references are not provided in accordance with 37 C.F.R. §1.98(d).

This citation does not constitute an admission that the references are relevant or material to the claims. They are only cited as constituting related art of which applicant is aware.

It is respectfully requested that the listed references be considered by the Examiner and formally made of record in this application.

Please charge any deficiencies in fees and credit any overpayment of fees to Attorney's Deposit Account No. 50-0481.

Respectfully submitted,

Scott Mandir

Scott L. Mandir, Esq.
Registration No. 67,186
Sean M. McGinn, Esq.
Registration No. 34,386

Date: 4/03/14

MCGINN INTELLECTUAL PROPERTY LAW GROUP, PLLC
8321 Old Courthouse Road, Suite 200
Vienna, Virginia 22182-3817
(703) 761-4100, Customer No. 21254

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /S.A./

Information Disclosure Citation	Docket Number NEG-1440PCT-US2CT	Application Number Not Yet Assigned
	Applicant NEC Corporation	
	Filing Date Concurrently Herewith	Group Art Unit Not Yet Assigned

U. S. Patent Documents

Examiner Initial	Ref	Document Number	Date	Name	Class	Subclass	Filing Date (If Appropriate)	
/S.A./		US 2007/0280102 A1	12-2007	Vasseur et al.				
/S.A./		US 2008/0123651 A1	05-2008	Vasseur et al.				
/S.A./		US 2008/0279196 A1	11-2008	Friskney et al.				
/S.A./		US 7,447,151 B2	11-2008	McDysan, David E.				
/S.A./		US 7,522,603 B2	04-2009	Vasseur, Jean-Philippe				
/S.A./		US 2010/0165995 A1	07-2010	Mehta et al.				
/S.A./		US 8,125,928 B2	02-2012	Mehta et al				
/S.A./		US 7, 706,344 B2	04/27/2010	Kobayashi et al.				
/S.A./		US 2003/0053427 A1	03-2003	Kanda et al				
/S.A./		US 2008/0137615 A1	06-2008	Park et al				

Foreign Patent Documents

Examiner Initial	Ref	Document Number	Date	Country	Class	Sub-class	Translation	
							Yes	No
/S.A./		CN 1988498 (A)	06-27-2007	China			ABS	
/S.A./		CN 101047614 (A)	10-03-2007	China			ABS	
/S.A./		CN 101505278 (A)	08-12-2009	China			ABS	
/S.A./		JP 2002-198989 A	07-12-2002	JAPAN			ABS	
/S.A./		JP 2004-80637 A	3-11-2004	JAPAN			ABS	

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /S.A./

/S.A./		JP 7-336383 A	12-22-2004	JAPAN			ABS	
/S.A./		JP 2004-356883 A	12-16-2004	JAPAN			ABS	
/S.A./		JP 2007-235444 A	09-13-2007	JAPAN			ABS	

Other Documents (Including Author, Title, Date, Pertinent Pages, etc.)		
/S.A./		Notice of Allowance for App. No. 13/176,610 dated February 1, 2014
/S.A./		Final Office Action for App. No. 13/176,610 dated October 9, 2013
/S.A./		Non-Final Office Action for App. No. 13/176,610 dated March 7, 2013
/S.A./		Petri Jokela et al, "LIPSIN: Line Speed Publish/Subscribe Inter-Networking", SIGCOMM' 09, August 21, 2009, Barcelona, Spain, p.p. 195-206.
/S.A./		Nick McKeown, et al., 'Open Flow: Enabling Innovation in Campus Networks', [online], [search conducted July 17, 2009] Internet URL: http://www.OpenFlowSwitch.org//documents/OpenFlow-wp-latest.pdf; March 14, 2008.

Examiner /Sai Aung/	**Date Considered** 12/12/2014

Examiner: Initial if citation considered, whether citation is in conformance with MPEP Section 609; Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to Applicant.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /S.A./

14/244,701
NEG-1440PCTUSCOONT
KATO.327CONT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of

JUN AWANO

Serial No.: 14/244,701 Group Art Unit: 2475

Filed: April 3, 2014 Examiner: AUNG, SAI

For: COMMUNICATION SYSTEM, FORWARDING NODE, PATH MANAGEMENT SERVER, COMMUNICATION METHOD, AND PROGRAM

Honorable Commissioner of Patents
Alexandria, VA 22313-1450

AMENDMENT UNDER 37 C.F.R. §1.111

Sir:

In response to Office Action dated **December 16, 2015**, please amend the above identified application as follows:

INTRODUCTORY COMMENTS

Amendments to the Claims begin on page 2 of this paper. The amendments to the claims do not add new matter.

Remarks begin on page 6 of this paper.

AMENDMENTS TO THE CLAIMS

Please amend the claims as follows:

1. (Currently Amended) A packet forwarding node, comprising:

a storage unit to store a packet forwarding table used for forwarding a packet based on an identifier which identifies a link between nodes on a packet forwarding path; and

a forwarding unit to receive an incoming packet including a plurality of the identifiers, and to forward the incoming packet based on [[an]] the identifier corresponding to the packet forwarding node.

2. (Original) The packet forwarding node according to claim 1, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link within a predetermined domain.

3. (Original) The packet forwarding node according to claim 1, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link within a predetermined local domain.

4. (Original) The packet forwarding node according to claim 1, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link within the packet forwarding node.

5. (Original) The packet forwarding node according to claim 1, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link among the packet forwarding nodes.

6. (Currently Amended) A packet forwarding node, comprising:

a storage unit to store a packet forwarding table used for forwarding a packet based on an identifier which identifies an interface of a packet forwarding node; and

a forwarding unit to receive an incoming packet including a plurality of identifiers, and to forward the incoming packet based on [[an]] the identifier corresponding to the packet forwarding node.

7. (Original) The packet forwarding node according to claim 6, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies a link within a predetermined domain.

8. (Currently Amended) The packet forwarding node according to claim 6, wherein the storage unit stores the table used for forwarding the packet based on [[an]] the identifier which uniquely identifies a link within a predetermined local domain.

9. (Currently Amended) The packet forwarding node according to claim 6, wherein the storage unit stores the table used for forwarding the packet based on [[an]] the identifier which uniquely identifies a link within the packet forwarding node.

10. (Currently Amended) The packet forwarding node according to claim 6, wherein the storage unit stores the table used for forwarding the packet based on [[an]] the identifier which uniquely identifies a link among the packet forwarding nodes.

11. (Original) A packet forwarding node, comprising:

a communication unit to communicate with a server for receiving a plurality of identifiers, each of which identifies a link between nodes on a packet forwarding path; and

a forwarding unit to forward an incoming packet based on an identifier corresponding to a packet forwarding node.

12. (Currently Amended) The packet forwarding node according to claim 11, wherein the forwarding unit forwards the packet based on [[an]] the identifier which uniquely identifies a link within a predetermined domain.

13. (Currently Amended) The packet forwarding node according to claim 11, wherein the forwarding unit forwards the packet based on [[an]] the identifier which uniquely identifies the link within a predetermined local domain.

14. (Currently Amended) The packet forwarding node according to claim 11, wherein the forwarding unit forwards the packet based on [[an]] the identifier which uniquely identifies the link within the packet forwarding node.

15. (Currently Amended) The packet forwarding node according to claim 11, wherein the forwarding unit forwards the packet based on [[an]] the identifier which uniquely identifies the link among the packet forwarding nodes.

16. (Original) A packet forwarding node, comprising:

a communication unit to communicate with a server for receiving a plurality of identifiers, each of which identifies an interface of a packet forwarding node; and

a forwarding unit to forward an incoming packet based on an identifier corresponding to the packet forwarding node.

17. (Currently Amended) The packet forwarding node according to claim 16, wherein the forwarding unit forwards the packet based on [[an]] the identifier which uniquely identifies a link within a predetermined domain.

18. (Currently Amended) The packet forwarding node according to claim 16, wherein the forwarding unit forwards the packet based on [[an]] the identifier which uniquely identifies a link within a predetermined local domain.

19. (Currently Amended) The packet forwarding node according to claim 16, wherein the forwarding unit forwards the packet based on [[an]] the identifier which uniquely identifies a link within the packet forwarding node.

20. (Currently Amended) The packet forwarding node according to claim 16, wherein the forwarding unit forwards the packet based on [[an]] the identifier which uniquely identifies a link among the packet forwarding nodes.

21. (Original) A server, comprising:

a first unit to determine a plurality of identifiers, each of which identifies a link between nodes on a packet forwarding path; and

a second unit to send information elements to a packet forwarding node which is capable of forwarding an incoming packet based on an identifier corresponding to the packet forwarding node.

REMARKS

Claims 1-21 are all of the claims presently pending in the application. Applicant has amended various claims to more particularly define the claimed invention and/or for editorial purposes.

Further, Applicant specifically states that no amendment to any claim herein should be construed as a disclaimer of any interest in or right to an equivalent of any element or feature of the amended claim.

Claims 1-28 and 49 stand rejected upon informalities under 35 U.S.C. § 112, second paragraph. Claims 1-21 stand rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claims 1 and 2 of the U.S. Patent No. 8,750,163. Claims 1-4, 8-9, 11-15 and 19-28 stand rejected under 35 U.S.C. § 102(b) as being anticipated by Vasseur (U.S. Patent No. 7,522,603 B2).

These rejections are respectfully traversed in the following discussion.

I. THE CLAIMED INVENTION

The claimed invention (e.g., as defined by exemplary claim 1) is directed to a packet forwarding node, comprising a storage unit to store a packet forwarding table used for forwarding a packet based on an identifier which identifies a link between nodes on a packet forwarding path; and a forwarding unit to receive an incoming packet including a plurality of the identifiers, and to forward the incoming packet based on the identifier corresponding to the packet forwarding node.

II. THE INDEFINITESS REJECTION

The Examiner has rejected claims 1-21 under 35 U.S.C. 112 as allegedly being indefinite. Specifically, for being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

The Office Action says that claims 1-28 and 49 are rejected under 112 second paragraph but there are only claims 1-21 as stated on the information page in the Office Action. Therefore, it is assumed that Examiner intended to refer to claims 1-21.

The Examiner points out that *"Claim 1 recites 'an identifier which identifies a link between nodes...' in line 3 and 'an identifier corresponding to the packet forwarding mode' in line 7. Claims 2-5 further recite 'the identifier' respectively, and create indefiniteness die to unclear antecedent basis. It is unclear to determine that whether 'the identifier' refers back to which one of the identifier indicated in the claim 1".*

Applicant has amended the claims to correct for antecedent basis. Therefore, this rejection should now be removed.

III. DOUBLE PATENTING

Claims 1-21 stand rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claims1 and 2 of the U.S. Patent No. 8,750,163.

The examiner alleges that *"pending claims 1, 6 and 21...recite limitation substantially the same as in the US patent 8,750,163"*. While the Applicant strongly disagrees with the Examiner's assertion, in order to expedite prosecution, Applicant agrees to submit the enclosed Terminal Disclaimer to overcome this rejection.

IV. THE ALLEGED PRIOR ART REFERENCE

The Vasseur Reference

Claims 1-4, 8-9, 11-15 and 19-28 stand rejected under 35 U.S.C. § 102(b) as being anticipated by Vasseur (U.S. Patent No. 7,522,603 B2).

The Examiner alleges that Vasseur teaches the claimed invention of claims. Applicant submits, however, that Vasseur does not teach or suggest each feature of the claimed invention.

Vasseur fails to teach or suggest (e.g., claim 1), "*a storage unit to store a packet forwarding table used for forwarding a packet based on an identifier which identifies a link between nodes on a packet forwarding path.*

The cited reference Vasseur discloses a forwarding table. However, the cited reference does not disclose a forwarding table such as the one in the claimed invention. The forwarding table of the claimed invention includes identifiers which identifies a link between nodes on a packet forwarding path. Those skilled in the art consider that a forwarding table including a set of destination IP address and a forwarding node which are not included in Vasseur, thus making the forwarding table in Vassuer and the forwarding table in the claimed invention different.

Further, in MPLS, only one identifier (label of MPLS) is included in one packet and a plurality of identifiers are not included in one packet as in the claimed invention showing again that the forwarding table in Vasseur and the forwarding table in the claimed invention are not the same.

Moreover, Vasseur recites that "These functions may be configured to manage a routing information database (RIB) and/or a forwarding information database (FIB) containing, e.g., data used to make routing and forwarding decisions, such as in routing/forwarding tables 246." See col. 8, lines 62-66. However, Vasseur is silent as to the forwarding table 246 being based on an identifier which identifies an actual link between nodes on a packet forwarding path.

The Examiner's rejection of anticipation is also improper because the identical invention is not provided in the following. Please note that according to MPEP §2131, the following applies in a 35 U.S.C. §102 rejection:

> "A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." Verdegaal Bros. v. Union Oil Co. of California, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987).."The identical invention must be shown in as complete detail as is contained in the ... claim." Richardson v. Suzuki Motor Co., 868 F.2d 1226, 1236, 9 USPQ2d

> 1913, 1920 (Fed. Cir. 1989). The elements must be arranged as required by the claim, but this is not an ipsissimis verbis test, i.e., identity of terminology is not required. In re Bond, 910 F.2d 831, 15 USPQ2d 1566 (Fed. Cir. 1990).

Therefore, as shown above, that since the identical invention is not provided in as complete details as the arranged in the claims from Vasseur, the claims are clearly not anticipated.

The other independent claims are similarly not taught or suggested.

Therefore, Applicant submits that there are elements of the claimed invention that are not taught or suggested by Vasseur. Therefore, Applicant respectfully requests the Examiner to withdraw this rejection.

V. FORMAL MATTERS AND CONCLUSION

Claim Objections (pages 2-3 of Office Action)

Claims 8 to 10, 12 to 15 and 17 to 20 are objected due to informalities.

With respect to the Examiner's objections, Applicant submits that the claims have been amended in a manner fully responsive to the Examiner's objection. The Examiner indicates that Claim 7 recites "an identifier which uniquely identifies" in line 3. However, it is assumed that the Examiner was referring to claim 6. The claims were amended to correct for antecedent basis. Therefore, this objection should now be removed.

Duplicate Claim Objection (page 3 of Office Action)

The examiner also alleges that claims 1 and 6 substantially the same. Therefore, Claims 1, 3 to 5, 7 to 10, 12 and 15 and 17 to 20 are objected under 37 CFR 1.75. Applicant respectfully submits, however, that this understanding of the Examiner is incorrect. Claim 1 recites an identifier which identifies a link between nodes while claim 6 recites an identifier

which identifies an interface of a packet forwarding nodes. A link and an interface are different, thus making the claims substantially different in what they are claiming. Dependent claims 3-5 and 7-10 depend on different independent claims and therefor are not substantially the same.

Therefore, this claim objection should also be removed.

In view of the foregoing, Applicant submits that claims 1-21 , all of the claims presently pending in the application, are patentably distinct over the prior art of record and are in condition for allowance. Applicant respectfully requests the Examiner to pass the above application to issue at the earliest possible time.

Should the Examiner find the application to be other than in condition for allowance, Applicant requests the Examiner to contact the undersigned at the local telephone number listed below to discuss any other changes deemed necessary in a telephonic or personal interview.

The undersigned authorizes the Commissioner to charge any deficiency in fees or to credit any overpayment in fees to Attorney's Deposit Account No. 50-0481.

Respectfully Submitted,

Date: March 16, 2015

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Registration No. 47,051

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PTO/AIA/26 (04-14)
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TERMINAL DISCLAIMER TO OBVIATE A DOUBLE PATENTING REJECTION OVER A "PRIOR" PATENT	Docket Number (Optional) NEG-1440PCT-US2CT

In re Application of: JUN AWANO

Application No.: 14/244,701

Filed: April 3, 2014

For: Communication system, forwarding node, path management server, communication method, and program

The applicant, NEC Corporation, owner of 100 percent interest in the instant application hereby disclaims, except as provided below, the terminal part of the statutory term of any patent granted on the instant application which would extend beyond the expiration date of the full statutory term of **prior patent** No. 8,750,163 as the term of said **prior patent** is presently shortened by any terminal disclaimer. The applicant hereby agrees that any patent so granted on the instant application shall be enforceable only for and during such period that it and the **prior patent** are commonly owned. This agreement runs with any patent granted on the instant application and is binding upon the grantee, its successors or assigns.

In making the above disclaimer, the applicant does not disclaim the terminal part of the term of any patent granted on the instant application that would extend to the expiration date of the full statutory term of the **prior patent**, "as the term of said **prior patent** is presently shortened by any terminal disclaimer," in the event that said **prior patent** later:

expires for failure to pay a maintenance fee;
is held unenforceable;
is found invalid by a court of competent jurisdiction;
is statutorily disclaimed in whole or terminally disclaimed under 37 CFR 1.321;
has all claims canceled by a reexamination certificate;
is reissued; or
is in any manner terminated prior to the expiration of its full statutory term as presently shortened by any terminal disclaimer.

Check either box 1 or 2 below, if appropriate.

1. ☐ The undersigned is the applicant. If the applicant is an assignee, the undersigned is authorized to act on behalf of the assignee.

I hereby acknowledge that any willful false statements made are punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

2. ☑ The undersigned is an attorney or agent of record. Reg. No. 47,051

/S. S. SAHOTA, Reg. # 47,051/ — Signature
March 16, 2015 — Date

S. S. Sahota — Typed or printed name

Attorney — Title
703-761-4100 — Telephone Number

☑ Terminal disclaimer fee under 37 CFR 1.20(d) included.

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

This collection of information is required by 37 CFR 1.321. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Electronic Patent Application Fee Transmittal

Application Number:	14244701
Filing Date:	03-Apr-2014
Title of Invention:	Communication system, forwarding node, path management server, communication method, and program
First Named Inventor/Applicant Name:	JUN AWANO
Filer:	Saryadvinder S. Sahota/Sarah Feuker
Attorney Docket Number:	NEG-1440PCT-US2CT

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
Statutory or Terminal Disclaimer	1814	1	160	160
		Total in USD ($)		**160**

Electronic Acknowledgement Receipt

EFS ID:	21778877
Application Number:	14244701
International Application Number:	
Confirmation Number:	2010
Title of Invention:	Communication system, forwarding node, path management server, communication method, and program
First Named Inventor/Applicant Name:	JUN AWANO
Customer Number:	21254
Filer:	Saryadvinder S. Sahota/Sarah Feuker
Filer Authorized By:	Saryadvinder S. Sahota
Attorney Docket Number:	NEG-1440PCT-US2CT
Receipt Date:	16-MAR-2015
Filing Date:	03-APR-2014
Time Stamp:	15:00:07
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$160
RAM confirmation Number	1310
Deposit Account	500481
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

Charge any Additional Fees required under 37 C.F.R. Section 1.16 (National application filing, search, and examination fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.17 (Patent application and reexamination processing fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.19 (Document supply fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.20 (Post Issuance fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Amendment/Req. Reconsideration-After Non-Final Reject	Amendment.pdf	830045 6f3ad2a61cd48db9e706c7b5d412f089ec612ba4	no	11
Warnings:					
Information:					
2	Terminal Disclaimer Filed	TerminalDisclaimer.pdf	128137 078de363b96a2d57d0ed16739032094aced73d82	no	1
Warnings:					
Information:					
3	Fee Worksheet (SB06)	fee-info.pdf	30470 43f4117e02300f9eb7f875bdd314256f4d0bc2fc	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	988652		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 14/244,701	Filing Date 04/03/2014	☐ To be Mailed

ENTITY: ☒ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED – PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	

APPLICATION AS AMENDED – PART II

AMENDMENT **03/16/2015**

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	* 21	Minus	** 21	= 0	X $80 =	0
Independent (37 CFR 1.16(h))	* 5	Minus	***5	= 0	X $420 =	0
☐ Application Size Fee (37 CFR 1.16(s))						
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
					TOTAL ADD'L FEE	0

AMENDMENT

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	*	Minus	**	=	X $ =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	X $ =	
☐ Application Size Fee (37 CFR 1.16(s))						
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
					TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".

The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

LIE
/NICOLE C. LAWRENCE/

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Application Number	Application/Control No.	Applicant(s)/Patent under Reexamination	
	14/244,701	AWANO, JUN	

Document Code - DISQ	Internal Document – DO NOT MAIL

TERMINAL DISCLAIMER	☒ APPROVED	☐ DISAPPROVED
Date Filed : 3/16/15	This patent is subject to a Terminal Disclaimer	

Approved/Disapproved by:

Felicia D. Roberts

8,750,163

U.S. Patent and Trademark Office

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www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/244,701	04/03/2014	JUN AWANO	NEG-1440PCT-US2CT	2010

21254 7590 04/15/2015

MCGINN INTELLECTUAL PROPERTY LAW GROUP, PLLC
8321 OLD COURTHOUSE ROAD
SUITE 200
VIENNA, VA 22182-3817

EXAMINER
AUNG, SAI

ART UNIT	PAPER NUMBER
2475	

MAIL DATE	DELIVERY MODE
04/15/2015	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No. 14/244,701	Applicant(s) AWANO, JUN	
	Examiner SAI AUNG	Art Unit 2475	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *04/03/2014*.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5)☒ Claim(s) *1-21* is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6)☐ Claim(s) _____ is/are allowed.

7)☒ Claim(s) *1-21* is/are rejected.

8)☐ Claim(s) _____ is/are objected to.

9)☐ Claim(s) _____ are subject to restriction and/or election requirement.

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)

2) ☒ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date _____.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

4) ☐ Other: _____.

DETAILED ACTION

Claims status

1. In the amended application filed on 03/16/2015, claims 1-21 are currently pending for the examination. The present application is being examined under the pre-AIA first to invent provisions.

Examiner Notes

2. The Examiner cites particular columns and line numbers in the references as applied to the claims below for the convenience of the Applicants(s). Although the specified citations are representative of the disclosings in the art and are applied to the specific limitations within the individual claim, other passages and figures may apply as well. It is respectfully requested that, in preparing response, the Applicant fully consider the references in their entirety as potentially disclosing all or part of the claimed invention, as well as the context of the passage as taught by the prior art or disclosed by the Examiner.

Claim Rejections - 35 USC § 102

3. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

> *(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.*

4. Claims 1-4, 8-9, 11-15 and 19-28 are rejected under 35 U.S.C. 102(b) as being anticipated by **Vasseur** (US 7,522,603 B2).

Regarding claim 1; **Vasseur** discloses a packet forwarding node, comprising:

a storage unit to store a packet forwarding table used for forwarding a packet based on an identifier which identifies a link between nodes on a packet forwarding path ***(See Figs. 2 and 4; Router (i.e., a forwarding node) with forwarding tables 246 and PCE 248 for path computation of the CE-CE paths and current metrics to the remote destination address; Col. 8 Lines 59-67 and Col. 11 Lines 54-60);*** and

a forwarding unit to receive an incoming packet including a plurality of the identifiers ***(See Figs. 2 and 4; Router performs/receives routing information database RIB and forwarding information database FIB; Col. 8 Lines 59-67),*** and to forward the incoming packet based on an identifier corresponding to the packet forwarding node ***(See Figs. 2 and 4; a forwarding selection selects a label (i.e. identifier) to route of the destination; Col. 9 Lines 15-24…and see also Fig. 7; for performing IP traffic routing and selecting the best path; Col. 14 Lines 7-15).***

Regarding claim 2; **Vasseur** discloses the packet forwarding node wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link within a predetermined domain ***(See Figs. 4 and 5; CE-PE links (i.e. PE link for predetermined domain); Col. 10 Lines 51-60 and Col. 12 Lines 40-47).***

Regarding claim 3; **Vasseur** discloses the packet forwarding node, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely

identifies the link within a predetermined local domain ***(See Figs. 4 and 5; CE-CE links (i.e. predetermined local domain); Col. 9 Lines 54-60).***

Regarding claim 4; **Vasseur** discloses the packet forwarding node wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link within the packet forwarding node ***(See Figs. 2 and 4; Router (i.e., a forwarding node) with forwarding tables 246; Col. 8 l 59-67).***

Regarding claim 5; **Vasseur** discloses the packet forwarding node wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link among the packet forwarding nodes ***(See Figs. 2 and 4; Router (i.e., a forwarding node) with forwarding tables 246; Col. 8 l 59-67).***

Regarding claim 6; **Vasseur** discloses a packet forwarding node, comprising:

a storage unit to store a packet forwarding table used for forwarding a packet based on an identifier which identifies an interface of a packet forwarding node ***(See Fig. 2; Each node includes one or more network interfaces that are coupled to a processor to execute memory that store routing forwarding tables and compute CE-CE or PE-CE path metrics to destination address to balance out the traffic load across the network links. (See Fig. 2: Col. 8 Lines 21-32 and Col. 8 Lines 37-47…and see also Fig. 4: Router (i.e., a forwarding node) with forwarding tables 246; Col. 8 Lines 59-67);*** and

a forwarding unit to receive an incoming packet including a plurality of the identifiers ***(See Figs. 2 and 4; Router performs/receives routing information database RIB and forwarding***

information database FIB; Col. 8 Lines 59-67), and to forward the incoming packet based on an identifier corresponding to the packet forwarding node ***(See Figs. 2 and 4; a forwarding selection selects a label (i.e. identifier) to route of the destination; Col. 9 Lines 15-24…and see also Fig. 7; for performing IP traffic routing and selecting the best path; Col. 14 Lines 7-15).***

Regarding claim 11; **Vasseur** discloses a packet forwarding node, comprising:

a communication unit to communicate with a server for receiving a plurality of identifiers ***(See Fig. 2 and 7; Router 200…and… PCC/PCE 248 with Stored Requests Table 500 (i.e. storage unit) and PCE computes the metrics (i.e. identifiers). The requesting CE (i.e. forwarding node) modifies IP/Data Packet corresponding to the CE-CE path metrics; Col. 8 Lines 42-50 and Lines 50-55, and Col. 9 Lines 58-65)***; each of which identifies a link between nodes on a packet forwarding path ***(See Figs. 2 and 4; Router (i.e., a forwarding node) with forwarding tables 246 and PCE 248 for path computation of the CE-CE paths and current metrics to the remote destination address; Col. 8 Lines 59-67 and Col. 11 Lines 54-60);*** and

a forwarding unit to forward an incoming packet based on the identifier corresponding to the packet forwarding node ***(See Fig. 2; Routing Service 247 forward the incoming data packet using the label found in the packet. PCE computes the metric to set up the routing/forwarding destination of the CE; Col. 9 Lines 55-65 and see also Fig. 7; for performing IP traffic routing and selecting the best path; Col. 14 Lines 7-15).***

Regarding claim 12; **Vasseur** discloses the packet forwarding node wherein the forwarding unit forwards the packet based on an identifier which uniquely identifies a link within a predetermined domain (See Fig. 2; Routing Service 247 forward the incoming data packet

using the label found in the packet. PCE computes the metric to set up the routing/forwarding destination of the CE; Col. 9 Lines 55-65; and see also Figs. 4 and 5; CE-PE links (i.e. PE link for predetermined domain); Col. 10 Lines 51-60 and Col. 12 Lines 40-47).

Regarding claim 13; **Vasseur** discloses the packet forwarding node, wherein the forwarding unit forwards the packet based on an identifier which uniquely identifies a link within a predetermined domain (See Figs. 4 and 5; CE-CE links (i.e. predetermined local domain); Col. 9 Lines 54-60).

Regarding claim 14; **Vasseur** discloses the packet forwarding node wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link within the packet forwarding node (See Figs. 2 and 4; Router (i.e., a forwarding node) with forwarding tables 246; Col. 8 Lines 59-67); and

Regarding claim 15; **Vasseur** discloses the packet forwarding node wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link among the packet forwarding nodes (See Figs. 2 and 4; Router (i.e., a forwarding node) with forwarding tables 246; Col. 8 Lines 59-67).

Regarding claim 16; **Vasseur** discloses a packet forwarding node, comprising:

a communication unit to communicate with a server for receiving a plurality of identifiers ***(See Fig. 2 and 7; Router 200…and… PCC/PCE 248 with Stored Requests Table 500 (i.e. storage unit) and PCE computes the metrics (i.e. identifiers); Col. 8 Lines 42-50 and Lines 50-55, and Col. 9 Lines***

58-65, each of which identifies an interface of a packet forwarding node ***(See Fig. 2; Each node includes one or more network interfaces that are coupled to a processor to execute memory that store routing forwarding tables and compute CE-CE or PE-CE path metrics to destination address to balance out the traffic load across the network links. (See Fig. 2: Col. 8 Lines 21-32 and Col. 8 Lines 37-47…and see also Fig. 4: Router (i.e., a forwarding node) with forwarding tables 246; Col. 8 Lines 59-67);*** and

a forwarding unit to receive an incoming packet including a plurality of the identifiers ***(See Figs. 2 and 4; Router performs/receives routing information database RIB and forwarding information database FIB; Col. 8 Lines 59-67),*** and to forward the incoming packet based on an identifier corresponding to the packet forwarding node ***(See Figs. 2 and 4; a forwarding selection selects a label (i.e. identifier) to route of the destination; Col. 9 Lines 15-24…and see also Fig. 7; for performing IP traffic routing and selecting the best path; Col. 14 Lines 7-15).***

Regarding claims 17-20, the claimed steps of the method correspond with the elements of the device as addressed in claims 11-15 respectively. Since the device has been anticipated, the steps of using the device in its intended manner are also anticipated.

Regarding claim 21; **Vasseur** discloses a server, comprising:

a first unit to determine a plurality of the identifiers each of which identifies a link between nodes on a packet forwarding path path ***(See Fig. 2 and 7; PCC/PCE 248 with Stored Requests Table 500 (i.e. a first unit) and PCE computes the metrics (i.e. identifiers). The requesting CE (i.e. forwarding node) modifies IP/Data Packet corresponding to the CE-CE path metrics; Col. 8 Lines 42-50 and Lines 50-55, and Col. 9 Lines 58-65)***; and

a second unit to send the information elements to a packet forwarding node ***(See Fig. 2; Routing Services 247 with Routing Tables 246 (i.e. second unit)...a forwarding selection and new substitute label are determined by using the label found in the incoming packet of the forwarding table; Col. 9 Lines 17-22)***, and to forward the incoming packet based on the identifier corresponding to the packet forwarding node ***(See Fig. 2; Routing Service 247 forward the incoming data packet using the label found in the packet. PCE computes the metric to set up the routing destination of the CE; Col. 9 Lines 55-65).***

(Note: Claim 21 recites the term "capable of" which is not positively recited claim limitations and produces unnecessary ambiguity. Therefore, any limitations beyond the term "capable of" will not be considered in the examination but the reference does teach the limitations.)

Response to Arguments

5. Applicant's arguments with respect to claims 1-21, filed on 13/16/2015 have been fully considered but they are not persuasive.

The Applicant argued that **Vasseur** fails to teach or suggest (e.g., claim 1), *"a storage unit to store a packet ,forwarding table used for forwarding a packet based on an identifier which identifies a link between nodes on a packet forwarding path."* The applicant further argued that *"a forwarding table including a set of destination IP address and a forwarding node which are not included in* ***Vasseur****..."*.

In response to the above argument, the examiner respectfully disagrees because the applicant's argument relies on the limitations (i.e. a set of destination IP address) are not recited in the rejected claims. Although the claims are interpreted in light of the specification, limitations

from the specification are not read into the claims. See In re Van Geuns, 988 F.2d 1181, 26 USPQ2d 1057 (Fed. Cir. 1993).

The cited reference (i.e. **Vasseur**) clearly, however, teaches that the routing/forwarding tables (i.e. See Fig. 2 and table 246) of the each forwarding station are used to perform IP traffic routing based on the IP forwarding entries and determine to route to the next destination address over CE-PE link according to the path metrics of the corresponding paths. **Vasseur** further explains that the forwarding node a plurality of network interfaces 210 (i.e. line card) that configured to transmit or receive data using a variety of different communication protocols. (See Fig. 2: Col. 8 Lines 37-50). One or more network interfaces are coupled to a processor to execute memory that store routing forwarding tables and compute CE-CE or PE-CE path metrics to destination address to balance out the traffic load across the network links. (See Fig. 2: Col. 8 and Lines 21-32, Col. 8 and Lines 37-47).

The applicant further argued that the forwarding table in the claimed invention and the forwarding table in **Vasseur** are not the same.

The examiner disagrees because the applicant fails to provide detail and clear information of the forwarding table that includes identifiers to identify a link in the claimed limitations. Under the broadest reasonable interpretations, therefore, the identifier could be an address label, routing tag or routing address. In **Vasseur**, the invention explains each receiving data packet contains a label. Using the label found in the incoming packet as a reference to a label forwarding table that includes this information, a forwarding selection is performed. The forwarding path and decision are made based on the incoming packet label. Path Computation Element (PCE) is further applied to compute a set of data paths and current metrics to the remote destination

address. (See Figs. 2 and 4; a forwarding selection selects a label (i.e. identifier) to route of the destination; Col. 9 Lines 15-24, Col. 9 Lines 54-64, and Col. 11 Lines 42-48).

Therefore, in response to the above arguments, the cited reference teaches each and every limitation in the claimed inventions. Thus, the Examiner believes that all the rejections shall be sustained. Thus, the Applicant's recurring argument about failing to disclose the amended claim limitations is inconsistent

The applicant is further suggested to amend the claim by adding further specific limitations in such a way that the claim could be in condition for patentability.

Conclusion

Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to SAI AUNG whose telephone number is (571)272-3507. The examiner can normally be reached on Monday-Friday, Alt Fridays, 7:30 AM- 5:00 PM (EST).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Dang Ton can be reached on 571-272-3171. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/ROBERT WILSON/

Primary Examiner, Art Unit 2475

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14244701	AWANO, JUN
	Examiner	Art Unit
	SAI AUNG	2475

CPC- SEARCHED		
Symbol	Date	Examiner
H04L45/04; H04L45/24; H04L45/66; H04L45/00;	4/13/2015	SA

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
370	370/401; 370/392; 370/231; 370/252; 370/352; 370/395.53	12/14/2014	SA

SEARCH NOTES		
Search Notes	Date	Examiner
EAST SEARCH (INCLUDING INVENTORS AND ASSIGNEE SEARCH)	12/14/2014	SA
GOOGLE PATENTS SEARCH	4/13/2015	SA
OTHER RELATED CPC SEARCH: H04L45/302; H04L45/50; H04L49/351	4/13/2015	SA

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner

/S.A./ Examiner.Art Unit 2475	

Docket No.: NEG-1440PCT-US2CT
KATO.327CONT.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Continuation patent application of 13/176,610, filed on July 5, 2011.

Jun Awano

Serial No.:	Not Yet Assigned	**Group Art Unit:**	Not Yet Assigned
Filed:	Concurrently Herewith	**Examiner:**	Not Yet Assigned

For: COMMUNICATION SYSTEM, FORWARDING NODE, PATH MANAGEMENT SERVER, COMMUNICATION METHOD, AND PROGRAM

Honorable Commissioner of Patents
Alexandria, Virginia 22313-1450

INFORMATION DISCLOSURE STATEMENT

Sir:

Under the provisions of 37 CFR §1.97 through §1.98 and pursuant to applicant's duty of disclosure under 37 CFR §1.56, applicant respectfully brings the following documents listed on the attached form PTO-1449, to the attention of the Examiner in charge of the above-identified application. These references were either cited or submitted in parent Application No. 13/176,610, and thus copies of these references are not provided in accordance with 37 C.F.R. §1.98(d).

This citation does not constitute an admission that the references are relevant or material to the claims. They are only cited as constituting related art of which applicant is aware.

It is respectfully requested that the listed references be considered by the Examiner and formally made of record in this application.

Please charge any deficiencies in fees and credit any overpayment of fees to Attorney's Deposit Account No. 50-0481.

Respectfully submitted,

Scott L. Mandir, Esq.
Registration No. 67,186
Sean M. McGinn, Esq.
Registration No. 34,386

Date: 4/03/14

MCGINN INTELLECTUAL PROPERTY LAW GROUP, PLLC
8321 Old Courthouse Road, Suite 200
Vienna, Virginia 22182-3817
(703) 761-4100, Customer No. 21254

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /S.A./

Information Disclosure Citation	Docket Number NEG-1440PCT-US2CT	Application Number Not Yet Assigned
	Applicant NEC Corporation	
	Filing Date Concurrently Herewith	Group Art Unit Not Yet Assigned

U. S. Patent Documents

Examiner Initial	Ref	Document Number	Date	Name	Class	Subclass	Filing Date (If Appropriate)	
		US 2007/0280102 A1	12-2007	Vasseur et al.				
		US 2008/0123651 A1	05-2008	Vasseur et al.				
		US 2008/0279196 A1	11-2008	Friskney et al.				
		US 7,447,151 B2	11-2008	McDysan, David E.				
		US 7,522,603 B2	04-2009	Vasseur, Jean-Philippe				
		US 2010/0165995 A1	07-2010	Mehta et al.				
		US 8,125,928 B2	02-2012	Mehta et al				
		US 7, 706,344 B2	04/27/2010	Kobayashi et al.				
		US 2003/0053427 A1	03-2003	Kanda et al				
		US 2008/0137615 A1	06-2008	Park et al				

Foreign Patent Documents

Examiner Initial	Ref	Document Number	Date	Country	Class	Sub-class	Translation	
							Yes	No
		CN 1988498 (A)	06-27-2007	China			ABS	
		CN 101047614 (A)	10-03-2007	China			ABS	
		CN 101505278 (A)	08-12-2009	China			ABS	
		JP 2002-198989 A	07-12-2002	JAPAN			ABS	
		JP 2004-80637 A	3-11-2004	JAPAN			ABS	

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /S.A./

		JP 7-336383 A	12-22-2004	JAPAN			ABS	
		JP 2004-356883 A	12-16-2004	JAPAN			ABS	
		JP 2007-235444 A	09-13-2007	JAPAN			ABS	

Other Documents (Including Author, Title, Date, Pertinent Pages, etc.)		
		Notice of Allowance for App. No. 13/176,610 dated February 1, 2014
		Final Office Action for App. No. 13/176,610 dated October 9, 2013
		Non-Final Office Action for App. No. 13/176,610 dated March 7, 2013
		Petri Jokela et al, "LIPSIN: Line Speed Publish/Subscribe Inter-Networking", SIGCOMM' 09, August 21, 2009, Barcelona, Spain, p.p. 195-206.
		Nick McKeown, et al., 'Open Flow: Enabling Innovation in Campus Networks', [online], [search conducted July 17, 2009] Internet URL: http://www.OpenFlowSwitch.org//documents/OpenFlow-wp-latest.pdf; March 14, 2008.

Examiner /Sai Aung/	**Date Considered** 04/13/2015

Examiner: Initial if citation considered, whether citation is in conformance with MPEP Section 609; Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to Applicant.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /S.A./

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14244701	AWANO, JUN
	Examiner	Art Unit
	SAI AUNG	2475

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	12/12/2014	04/13/2015							
	1	✓	✓							
	2	✓	✓							
	3	✓	✓							
	4	✓	✓							
	5	✓	✓							
	6	✓	✓							
	7	✓	✓							
	8	✓	✓							
	9	✓	✓							
	10	✓	✓							
	11	✓	✓							
	12	✓	✓							
	13	✓	✓							
	14	✓	✓							
	15	✓	✓							
	16	✓	✓							
	17	✓	✓							
	18	✓	✓							
	19	✓	✓							
	20	✓	✓							
	21	✓	✓							

Docket No. NEG-1440PCT-US2CT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: Jun Awano

Serial No.: 14/244,701 Group Art Unit: 2475

Filed: April 3, 2014 Examiner: AUNG, SAI

For: COMMUNICATION SYSTEM, FORWARDING NODE, PATH MANAGEMENT SERVER, COMMUNICATION METHOD, AND PROGRAM

Honorable Commissioner of Patents
Alexandria, VA 22313-1450

INFORMATION DISCLOSURE STATEMENT

Sir:

Under the provisions of 37 CFR §1.97 through §1.98 and pursuant to Applicant's duty of disclosure under 37 CFR §1.56, Applicant respectfully brings the following documents cited in the Japanese Office Action dated April 21, 2015, in a counterpart foreign application and listed on the attached form PTO-1449, to the attention of the Examiner in charge of the above-identified application.

It is noted that U.S. Patent No. 8,559,434 B2 is the U.S. equivalent of Japanese Patent Application Publication No. 2012-501127 A.

In compliance with the requirements of 37 CFR §1.98(a)(3), as a concise statement of relevance, as it is presently understood by the individual designated in 35 U.S.C. §1.56(c) most knowledgeable about the content of the information, the undersigned attorney of record submits a translation of an official action by a foreign examiner in which the references were cited. The relevance to the pending U.S. patent application is that the references were cited in a foreign patent application on the same subject matter. However, no independent analysis of the references, the accuracy of the statement of the foreign examiner or the claims of the foreign application under the laws of that country of the United States relative to the subject matter claimed in the present application has been made, the present understanding of the contents thereof by the undersigned being based on the translation of the foreign examiner's comments submitted herewith. Further, an English-language Abstract is attached to one of the references.

This citation does not constitute an admission that the references are relevant or material to the claims. They are only cited as constituting related art of which Applicant is aware.

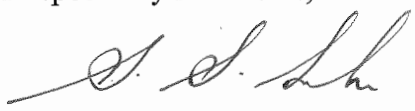
I hereby certify that each item of information contained in this Information Disclosure Statement was the first citation of that item by a foreign patent office in a counterpart foreign application, which occurred not more than three months prior to the filing of this statement.

The Commissioner is authorized to charge Attorney's Deposit Account No. 50-0481 in the amount of $180.00 to cover the IDS fee.

It is respectfully requested that the listed references be considered by the Examiner and formally made of record in this application.

Please charge any deficiencies in fees and credit any overpayment of fees to Attorney's Deposit Account No. 50-0481.

Respectfully submitted,



Sam S. Sahota, Esq.
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Sean M. McGinn, Esq.
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Date: July 20, 2015

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(703) 761-4100
Customer No. 21254

Information Disclosure Citation

Docket Number	Application Number
NEG-1440PCT-US2CT	14/244,701
Inventor: Jun Awano	
Filing Date: April 3, 2014	Group Art Unit: 2475

U. S. Patent Documents

Examiner Initial	Ref	Document Number	Date	Name	Class	Subclass	Filing Date (If Appropriate)	
		US 7,471,669 B1	12-30-2008	Sabesan et al.				
		US 8,559,434 B2	10-15-2013	Esteve Rothenberg et al.				

U. S. Patent Application Publications

Examiner Initial	Ref	Document Number	Date	Name	Class	Subclass	Filing Date (If Appropriate)	

Foreign Patent Documents

Examiner Initial	Ref	Document Number	Date	Country	Class	Subclass	Translation	
							Yes	No
		JP 2012-501127 A	01-12-2012	JAPAN			ABS	

Other Documents (Including Author, Title, Date, Pertinent Pages, etc.)

		Japanese Office Action dated April 21, 2015 with partial English Translation

Examiner	**Date Considered**

Examiner: Initial if citation considered, whether citation is in conformance with MPEP Section 609; Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to Applicant.

<Translation>

Mailing date: April 21, 2015

NOTICE OF GROUNDS FOR REJECTION

JP Patent application No. 2014-161291
Applied provision : Section 29 Para 2, Section 36

--REDACTED--

●Regarding Ground 1 (inventive step)
・ Claims 1-21
・ Reference 1
・ Remarks
"Regarding Claims 1-5"

Reference 1 (see in particular Fig. 3, Fig. 9-15 etc.) describes sending routing information included in a header, and performing routing of a packet based on a link identifier (corresponding to an identifier for identifying links between nodes of the present invention), therefore, the inventions according to Claims 1-5 of the present application can be conceived easily by a person skilled in the art on the basis of Reference 1.

"Regarding Claims 6-10"

In addition to the above, although Reference 1 is related to a link identifier, performing a source routing similarly by using an interface identifier can be conceived easily by a person skilled in the art.

"Regarding Claims 11-21"

In addition to the above, specifying a routing in a managing server is known, for example, by Open Flow etc., applying a source routing technology described in Reference 1 to the system can be conceived easily by a person skilled in the art.

--REDACTED--

DELL - Exhibit 1002 - Page 215

< List of References>

1. US-7471669-B1

<Record of search results of prior art documents>

- The investigated field IPC H04L 12 / 00
- Prior art document JP-2012-501127

This record of the search results of prior art documents does not constitute the grounds for rejection.

--REDACTED--

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整理番号　3350011447
発送番号　178720
発送日　　平成27年 4月21日

拒絶理由通知書

特許出願の番号	特願２０１４－１６１２９１
起案日	平成２７年　４月１４日
特許庁審査官	安藤　一道　　３０４８　５Ｘ００
特許出願人代理人	加藤　朝道　様
適用条文	第２９条第２項、第３６条

この出願は、次の理由によって拒絶をすべきものです。これについて意見がありましたら、この通知書の発送の日から６０日以内に意見書を提出してください。

理由

１．（進歩性）この出願の下記の請求項に係る発明は、その出願前に日本国内又は外国において、頒布された下記の刊行物に記載された発明又は電気通信回線を通じて公衆に利用可能となった発明に基いて、その出願前にその発明の属する技術の分野における通常の知識を有する者が容易に発明をすることができたものであるから、特許法第２９条第２項の規定により特許を受けることができない。

２．（明確性）この出願は、特許請求の範囲の記載が下記の点で、特許法第３６条第６項第２号に規定する要件を満たしていない。

記　　（引用文献等については引用文献等一覧参照）

●理由１（進歩性）について

・請求項　１－２１
・引用文献等　１
・備考
「請求項１－５について」
引用文献１（特に、図３、図９－１５等　参照）には、ルーティング情報をヘッダに含めて送信すること、リンク識別子（本願のノード間のリンクを識別するための識別子」に相当）に基づいてパケットのルーティングを行うことが記載されており、本願の請求項１－５に係る発明は、引用文献１に基づいて当業者が容易になし得ることである。

「請求項６－１０について」
上記に加えて、引用文献１はリンク識別子であるが、インタフェース識別子を用いて同様にソースルーティングを行うようにすることは当業者であれば容易になし得ることである。

「請求項１１－２１について」
上記に加えて、ルーティングを管理サーバにおいて指定することは、例えばOpenFlow等で知られており、該システムに対して、引用文献１に記載のソースルーティングの技術を適用することは当業者であれば容易になし得ることである。

●理由２（明確性）について

・請求項　２－５、７－１０、１２－１５、１７－２０
・備考
「請求項２－５について」
請求項２及び請求項３には、それぞれ、「所定のドメイン内」、「所定のローカルドメイン内」なる記載があるが、［発明の詳細な説明］には、「ドメイン」、「ローカルドメイン」なる記載はなく、それぞれの用語が何を意味するのか不明である。
なお、請求項２もしくは請求項３を引用する請求項も同様の理由である。

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「請求項７－１０について」
　請求項７及び請求項８には、それぞれ、「所定のドメイン内」、「所定のローカルドメイン内」なる記載があるが、［発明の詳細な説明］には、「ドメイン」、「ローカルドメイン」なる記載はなく、それぞれの用語が何を意味するのか不明である。
　なお、請求項７もしくは請求項８を引用する請求項も同様の理由である。

「請求項１２－１５について」
　請求項１２及び請求項１５には、それぞれ、「所定のドメイン内」、「所定のローカルドメイン内」なる記載があるが、［発明の詳細な説明］には、「ドメイン」、「ローカルドメイン」なる記載はなく、それぞれの用語が何を意味するのか不明である。
　なお、請求項１２もしくは請求項１５を引用する請求項も同様の理由である。

「請求項１７－２０について」
　請求項１７及び請求項１８には、それぞれ、「所定のドメイン内」、「所定のローカルドメイン内」なる記載があるが、［発明の詳細な説明］には、「ドメイン」、「ローカルドメイン」なる記載はなく、それぞれの用語が何を意味するのか不明である。
　なお、請求項１７もしくは請求項１８を引用する請求項も同様の理由である。

　拒絶の理由が新たに発見された場合には拒絶の理由が通知される。

＜引用文献等一覧＞
１．米国特許第７４７１６６９号明細書
－－－－－－－－－－－－－－－－－－－－－－－－－－－－－－－－－－－－

＜先行技術文献調査結果の記録＞

・調査した分野　　ＩＰＣ　Ｈ０４Ｌ１２／００

・先行技術文献　　特表２０１２－５０１１２７号公報

　この先行技術文献調査結果の記録は、拒絶理由を構成するものではありません。

＜補正をする際の注意＞
（１）明細書、特許請求の範囲について補正をする場合は、補正により記載を変更した個所に下線を引いてください（特許法施行規則様式第１３備考６、７）。
（２）補正は、この出願の出願当初の明細書、特許請求の範囲又は図面に記載した事項の範囲内で行わなければなりません。また、意見書で、各補正事項について補正が適法なものである理由を、根拠となる出願当初の明細書等の記載箇所を明確に示したうえで主張してください。
（３）特許請求の範囲について補正をする際には、特許法第１７条の２第４項に違反する補正とならないよう、注意してください。

　この拒絶理由通知の内容に関するお問い合わせ又は面接のご希望がありましたら次の連絡先までご連絡ください。

審査第四部　デジタル通信（データネットワーク）　安藤　一道
ＴＥＬ．０３－３５８１－１１０１　内線３５９４
ＦＡＸ．０３－３５０１－０６９９

DELL - Exhibit 1002 - Page 218

US007471669B1

(12) **United States Patent**
Sabesan et al.

(10) **Patent No.: US 7,471,669 B1**
(45) **Date of Patent: Dec. 30, 2008**

(54) **ROUTING OF PROTOCOL DATA UNITS WITHIN A COMMUNICATION NETWORK**

(75) Inventors: **Subramaniam Sabesan**, Bishops Stortford (GB); **Martin Biddiscombe**, Harlow (GB); **Glenn Denney**, Knebworth (GB)

(73) Assignee: **Nortel Networks Limited**, St. Laurent, Quebec (CA)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 852 days.

(21) Appl. No.: **10/955,496**

(22) Filed: **Sep. 30, 2004**

(51) **Int. Cl.**
H04L 12/28 (2006.01)

(52) **U.S. Cl.** **370/351**; 370/401

(58) **Field of Classification Search** 370/351, 370/400, 401, 410, 252, 253, 428, 254, 236.1, 370/236.2, 238
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,309,433	A *	5/1994	Cidon et al.	370/390
5,504,746	A *	4/1996	Meier	370/256
5,563,878	A *	10/1996	Blakeley et al.	370/392
5,917,820	A *	6/1999	Rekhter	370/392
6,084,882	A *	7/2000	Ogura et al.	370/409
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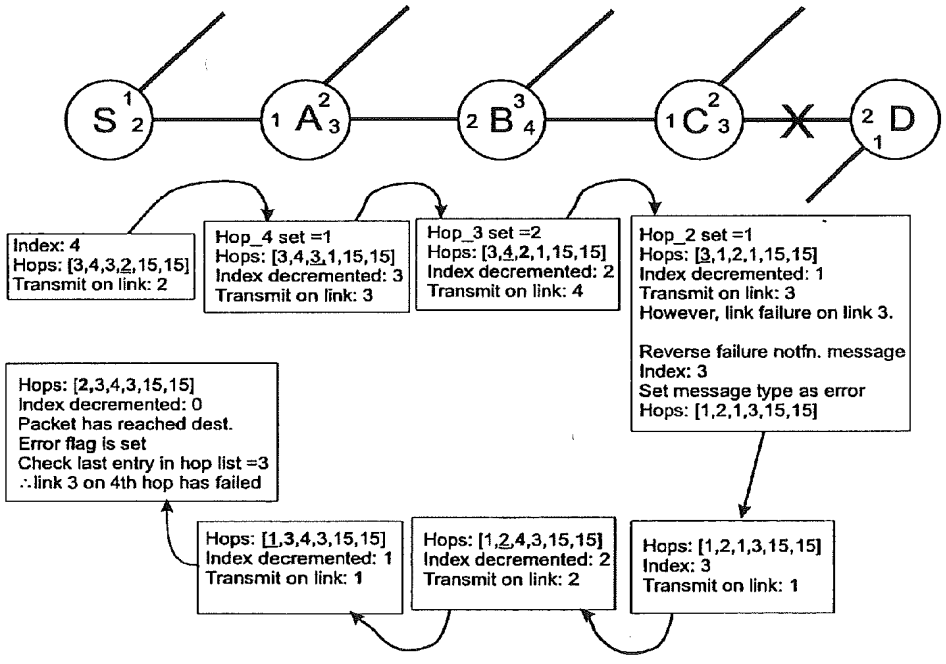
Assistant Examiner—Gary Mui
(74) *Attorney, Agent, or Firm*—Barnes & Thornburg LLP

(57) **ABSTRACT**

A protocol data unit is routed along a path between a first node and a second node within a communication network. The protocol data unit carries routing information which specifies the path in the form of a list of identifiers of the links to be followed towards the second node. At each intermediate node, the link identifier for the link just traversed with a link identifier for the corresponding link in the reverse direction towards the first node. At any point along the path the protocol data unit carries information which allows it to be carried towards the second node, or to follow a reverse path towards the first node. This reverse path can be used to report a fault to the first node.

21 Claims, 7 Drawing Sheets



US008559434B2

(12) **United States Patent**
Esteve Rothenberg et al.

(10) **Patent No.: US 8,559,434 B2**
(45) **Date of Patent: Oct. 15, 2013**

(54) **PACKET FORWARDING IN A NETWORK**

(75) Inventors: **Christian Esteve Rothenberg**, Madrid (ES); **Petri Jokela**, Espoo (FI); **Jimmy Kjällman**, Espoo (FI); **Pekka Nikander**, Jorvas (FI); **Teemu Rinta-Aho**, Espoo (FI); **Jukka Ylitalo**, Espoo (FI)

(73) Assignee: **Telefonaktiebolaget L M Ericsson (publ)**, Stockholm (SE)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 180 days.

(21) Appl. No.: **13/059,958**

(22) PCT Filed: **Oct. 10, 2008**

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(2), (4) Date: **Feb. 18, 2011**

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Related U.S. Application Data

(63) Continuation-in-part of application No. PCT/EP2008/061167, filed on Aug. 26, 2008.

(51) **Int. Cl.**
H04L 12/28 (2006.01)

(52) **U.S. Cl.**
USPC **370/392**; 709/238

(58) **Field of Classification Search**
USPC 370/392, 409; 709/238
See application file for complete search history.

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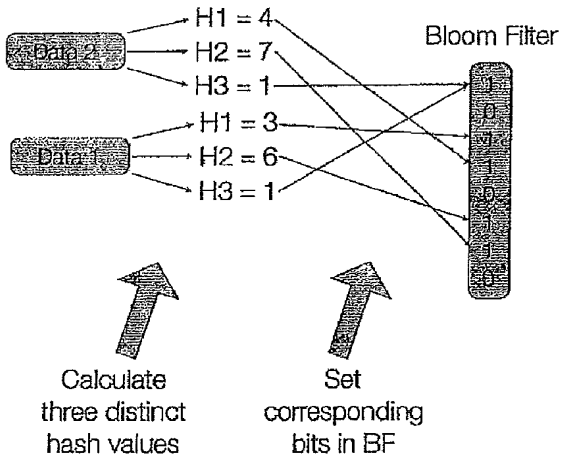
Primary Examiner — Wei Zhao
(74) *Attorney, Agent, or Firm* — Myers Bigel Sibley & Sajovec PA

(57) **ABSTRACT**

A method of providing packet routing information comprises: encoding routing information from a source node to one or more destination nodes into a compact representation of set membership; and putting the compact representation of sets into a header of a packet that is to be sent from the source node to the destination node(s). The compact representation may be obtained by: generating d representations of a set of identifiers; generating d candidate compact representations of set membership from the d representations of the identifiers; and selecting one of the candidate compact representation of set membership. The selection may be made on the basis of which of the candidate compact representations has the lowest rate of returning false positives.

17 Claims, 12 Drawing Sheets



Espacenet

Bibliographic data: JP2012501127 (A) — 2012-01-12

PACKET FORWARDING IN A NETWORK

Inventor(s):

Applicant(s):

Classification: - international: *H04L12/56*
- cooperative: H04L45/00; H04L45/16; H04L45/34; H04L45/566; H04L45/745

Application number: JP20110524204 20081010

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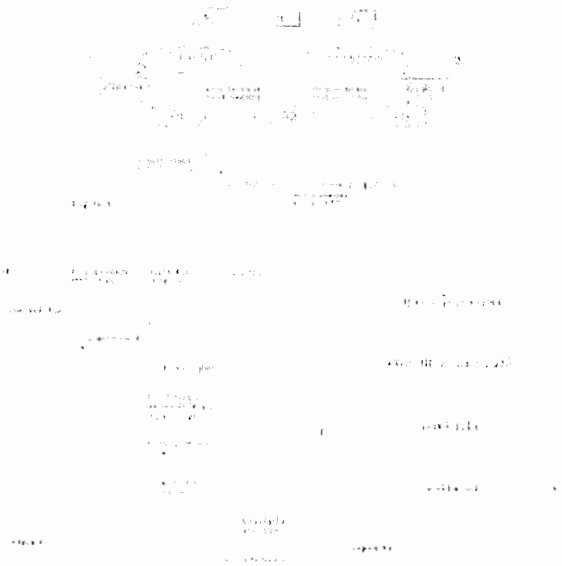
Abstract not available for JP2012501127 (A)
Abstract of corresponding document: WO2010022767 (A1)

A method of providing packet routing information comprising encoding routing information from a source node to one or more destination nodes into a compact representation of set membership such as, for example, a Bloom filter. The compact representations is put into a header of a packet that is to be sent from the source node to the destination node (s). When the packet is received at a network node, the network node interrogates the routing information contained in the header of the packet to determine one or more outgoing links from the node along which the packet is to be sent.



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(51)Int.Cl.	F I	テーマコード（参考）
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(33)優先権主張国	欧州特許庁 (EP)

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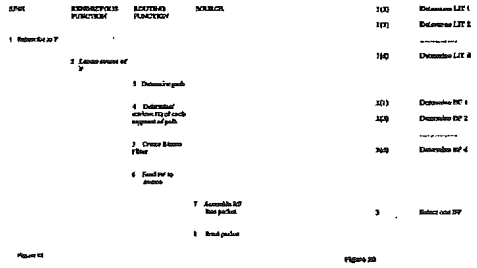
最終頁に続く

(54)【発明の名称】ネットワークにおけるパケット転送

(57)【要約】
パケットのルーティング情報を提供する方法が、ソースノードから１以上の宛先ノードへのルーティング情報を、集合メンバシップのコンパクト表現の中に符号化するステップと、前記ソースノードから前記１以上の宛先ノードへと送信すべきパケットのヘッダの中に、集合の前記コンパクト表現を入れるステップとを備える。前記コンパクト表現は、識別子のｄ個の集合の表現を生成し、前記識別子のｄ個の表現から集合メンバシップのｄ個のコンパクト表現の候補を生成し、集合メンバシップの前記コンパクト表現の候補のうちの１つを選択することにより、得ることができる。前記選択は、どのコンパクト表現の候補が偽陽性を返す確率が最も低いかに基づいて行われてもよい。



【特許請求の範囲】
【請求項１】
パケットのルーティング情報を提供する方法であって、
ソースノードから１以上の宛先ノードへのルーティング情報を、集合メンバシップのコンパクト表現の中に符号化するステップと、
前記ソースノードから前記１以上のソースノードへ送信すべきパケットのヘッダの中に、前記集合の前記コンパクト表現を入れるステップと、
を有する、方法。
【請求項２】
前記ルーティング情報は、前記ソースノード又はルーティングサーバにおいて符号化される、
請求項１に記載の方法。
【請求項３】
前記ルーティング情報は、１以上の識別子の表現を含み、
各識別子は、各ネットワークリンク、各ノード、又は、２以上のネットワークリンクを含む全体パス又は部分パスを識別する、
請求項１又は２に記載の方法。
【請求項４】
前記方法は、ネットワークを通るパスを定義するステップを更に有し、前記パスは複数の区分を含み、各区分は関連する識別子を有し、
前記方法は、前記パスに識別子を割り当てるステップを更に有し、前記パスに割り当てられる識別子は、前記パスに含まれる各区分に関連する識別子とは異なり、
前記ルーティング情報を符号化する前記ステップは、前記パスに割り当てられた識別子を符号化するステップを有する、
請求項１乃至３のいずれか１項に記載の方法。
【請求項５】
前記パスに割り当てられる識別子は、前記パスに含まれる各区分に関連する識別子とは無関係である、
請求項４に記載の方法。
【請求項６】
前記パスの少なくとも１つの区分は、２以上のリンクを含み、各リンクは、２つのネットワークノードを直接接続する、
請求項４に記載の方法。
【請求項７】
前記１以上の識別子のｄ個の表現から、集合メンバシップのｄ個のコンパクト表現の候補を生成するステップと、
集合メンバシップの前記コンパクト表現の１つを前記パケットヘッダに入れるステップと、
を有する、請求項３に記載の方法。
【請求項８】
前記パケットヘッダに含まれる集合メンバシップのコンパクト表現を識別する情報を、前記パケットヘッダの中に含めるステップ、
を更に有する、請求項７に記載の方法。
【請求項９】
ネットワークを通ってパケットをルーティングする方法であって、
ネットワークノードにおいてパケットを受信するステップと、
前記ノードから前記パケットがこれに沿って送信されるべき１以上のリンクを判定するために、又は、前記ノードから前記パケットがそこへ送信されるべき１以上の他のノードを判定するために、又は、その両方のために、前記パケットのヘッダの中に集合メンバシップのコンパクト表現として含まれるルーティング情報を問い合わせるステップと、

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前記判定された１以上のリンクに沿って、又は、前記判定された１以上の他のノードへ、又は、その両方で、前記パケットを転送するステップと、
を有する、方法。
【請求項１０】
集合メンバシップの前記コンパクト表現は、ブルームフィルタを含む、
請求項１乃至９のいずれか１項に記載の方法。
【請求項１１】
前記ルーティング情報は、複数のリンク識別子又はノード識別子を含み、
当該複数のリンク識別子又はノード識別子の各々は、各ネットワークリンク又は各ノードを識別する、
請求項１乃至１０のいずれか１項に記載の方法。
【請求項１２】
前記ルーティング情報は、２以上のネットワークリンクを含む全体パス又は部分パスを識別する識別子を含む、
請求項１乃至１０のいずれか１項に記載の方法。
【請求項１３】
前記ルーティング情報は、１以上の識別子の表現を含み、
各識別子は、各ネットワークリンク、各ノード、又は、２以上のネットワークリンクを含む全体パス又は部分パスを識別する、
請求項９に記載の方法。
【請求項１４】
前記ルーティング情報は、前記１以上の識別子の複数の表現の候補の１つを含む、
請求項１３に記載の方法。
【請求項１５】
前記ルーティングは、複数のルックアップテーブルから、前記１以上の識別子のうちの受信した表現に対応するルックアップテーブルを選択するステップを更に含む、
請求項１４に記載の方法。
【請求項１６】
ネットワークノードであって、
パケットを受信する手段と、
前記ノードから前記パケットがこれに沿って送信されるべき１以上のリンクを判定するために、又は、前記ノードから前記パケットがそこへ送信されるべき１以上の他のノードを判定するために、又は、その両方のために、前記パケットのヘッダの中に集合メンバシップのコンパクト表現として含まれるルーティング情報を問い合わせる手段と、
を有し、
前記ネットワークノードは、前記判定された１以上のリンクに沿って、又は、前記判定された１以上の他のノードへ、又は、その両方で、前記パケットを転送するように構成される、
ネットワークノード。
【請求項１７】
各々が１以上の識別子のｄ個の表現の候補の１つに対応するｄ個のルックアップテーブルから、前記１以上の識別子のうちの受信した表現に対応するルックアップテーブルを選択するように更に構成される、
請求項１６に記載のネットワークノード。
【請求項１８】
パケットのルーティング情報を提供するネットワークノードであって、
ソースノードから１以上の宛先ノードへのルーティング情報を、前記ソースノードから前記１以上のソースノードへ送信すべきパケットのヘッダの中に含めるために、集合メンバシップのコンパクト表現の中に符号化するように構成される、
ネットワークノード。

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【請求項１９】
集合メンバシップの前記コンパクト表現を前記ソースノードへ送信するように構成される、
請求項１８に記載のネットワークノード。
【請求項２０】
１以上の識別子のうちの少なくとも一部に関するｄ個の表現を生成し、
前記識別子の前記ｄ個の表現から集合メンバシップのｄ個のコンパクト表現の候補を生成し、
集合メンバシップの前記ｄ個のコンパクト表現の候補の１つを選択する
ことにより、前記１以上の識別子の表現を含むルーティング情報を符号化するように構成される、
請求項１８に記載のネットワークノード。
【請求項２１】
１以上の識別子のうちの少なくとも一部に関するｄ個の表現を生成し、
前記識別子の前記ｄ個の表現から集合メンバシップのｄ個のコンパクト表現の候補を生成し、
集合メンバシップの前記ｄ個のコンパクト表現の候補の２以上を他のノードへ送信する
ことにより、前記１以上の識別子の表現を含むルーティング情報を符号化するように構成される、
請求項１８に記載のネットワークノード。
【請求項２２】
複数の識別子の集合のコンパクト表現を生成する方法であって、
前記複数の識別子のうちの少なくとも一部に関するｄ個の表現を生成するステップと、
前記識別子の前記ｄ個の表現から集合メンバシップのｄ個のコンパクト表現の候補を生成するステップと、
集合メンバシップの前記ｄ個のコンパクト表現の候補の１つを選択するステップと、
を有する、方法。
【請求項２３】
集合メンバシップに関する誤った指示を生成する確率が最も低い、集合メンバシップのコンパクト表現の候補を選択するステップを有する、
請求項２２に記載の方法。
【請求項２４】
前記識別子の１以上を含むサブセットに関して集合メンバシップに関する誤った指示を生成する確率が最も低い、集合メンバシップのコンパクト表現の候補を選択するステップを有する、
請求項２２に記載の方法。
【発明の詳細な説明】
【技術分野】
【０００１】
本発明はネットワークにおけるパケット転送に関する。特に、本発明は、パケットがどのリンクに沿って転送されるべきかをネットワークノードがパケットヘッダの中の転送情報から判定できるようにするため、転送情報がパケットヘッダの中に含まれるような方法に関する。
【背景技術】
【０００２】
２００８年６月１１日から１３日までストックホルムで開催されたＩＣＴ Ｍｏｂｉｌｅ Ｓｕｍｍｉｔの予稿集の中で発表された「ＲＴＦＭ：Ｐｕｂｌｉｓｈ／Ｓｕｂｓｃｒｉｂｅ Ｉｎｔｅｒｗｏｒｋｉｎｇ Ａｒｃｈｉｔｅｃｔｕｒｅ」の中でＭｉｋｋｏ Ｓａｒｅｌａ、Ｔｅｅｍｕ Ｒｉｎｔａ－Ａｈｏ、およびＳａｓｕ Ｔａｒｋｏｍａによっ

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て記述されたＰｕｂｌｉｓｈ－Ｓｕｂｓｃｒｉｂｅ（「ｐｕｂｓｕｂ」）指向のネットワーキングは、第１に指定されるエンティティとしてホストとエンドポイントとに着目する元々のインターネットプロトコルとは対照的に、データに着目する。エンドポイントと、エンドポイント間のユニバーサルな接続性とを指定することに関するこの着目は、多くの良く知られた問題を引き起こす。第１に、現行のインターネットワーキングパラダイムでは、極悪な当事者もいれば利己的な当事者もいるにも関わらず、オープンなネットワーク内で当事者同士が相互に通信することができる。第２に、現代のアプリケーションの主要部分は、エンド・ツー・エンドの双方向通信の働きよりもむしろ、情報を広める働きを行っている。最後に、ハードウェアの観点からは、多くのタイプのネットワーク（例えば所定のタイプの無線、ケーブル、および光のネットワーク）では、ブロードキャスティングまたはマルチキャスティングは、単一の明確に識別された受信者にメッセージを送信することよりも、もっと自然で基本的な動作である。（「マルチキャスティング」は、指定された宛先のグループに情報を同時に配信することであり、「ブロードキャスティング」は、原理的にはネットワーク上のいかなるデバイスによっても受信できるように情報を送信することを言う。）これら３つの問題に照らして、ｐｕｂｌｉｓｈ－ｓｕｂｓｃｒｉｂｅパラダイムに基づくインターネットワーキングの方が、現行の送信者指向のものと比べて、より自然で、効率的で、実装が容易であろうということが提案されている。

【０００３】

次いで、ＨＴＴＰ、ピア・ツー・ピアのトラヒック、ＲＳＳフィード、ＰＳＩＰイベント、Ｓｅｒｖｉｃｅ　Ｏｒｉｅｎｔｅｄ　Ａｒｃｈｉｔｅｃｔｕｒｅ（ＳＯＡ）等の場合には、データをより詳しく見ると、このトラヒック（および恐らく他のトラヒックも）の大部分は、かなり単純な情報の繰り返しで構成されているように見える。例えば、動的なウェブページでさえ、典型的には、少量のクライアント固有ＨＴＭＬコードに結合された多数の静的な構成要素で構成される。多くのピア・ツー・ピアのネットワークでは、主な問題は、見込まれる消費者にできる限り近づくようにデータを最適なやり方で事前配信することである。

【０００４】

一般に、音声通話のようなリアルタイム双方向トラヒックという例外も可能性としてはあるが、現代のネットワークトラヒックの大半がデータ指向であると主張することができる。すなわち、アプリケーションは、接続を作り出すことに関心を持っているのではなく、十分に定義されたデータの断片を転送することに関心を持っているのである。一部のデータは、本質的にはトランザクションであり、すなわち、寿命が短く、かつ、通信の当事者に固有であるが、大部分のデータは、送信者および受信者には非依存であるように思える。例えば、ユーザが最新のＣＮＮニュースを知りたいと望む場合、ユーザＩＤに関係なくビットは基本的に（大体）同じであり、ユーザは、ビットが物理的にどこから来るのか気にしない。

【０００５】

比較的単純で静的ですらあるデータを配信するための技術が非常に多種多様であることから、相互接続の欠如に起因する多くの問題が生じている。将来のデータ配信標準のための競争は、もう始まっている。（現行のアーキテクチャの中での相互接続の欠如およびその他の欠陥によって生じた）動機付けが存在するのだから、データを発行して検索することについての何らかの標準的なやり方が１０年以内に提供されることが予想される。

【０００６】

Ｐｕｂｌｉｓｈ－Ｓｕｂｓｃｒｉｂｅパラダイムの背景にある１つの概念は、あるノードから別のノードへの不要なデータ配信を回避できるということである。今日のネットワークの場合のように、送信者は、グローバルに一意であるＩＰアドレスを用いて、何ら受信者からの明示的な要求がなくてもＩＰアドレスで識別されたホストにデータパケットを配信することができる。この結果、ユーザは、不要な、場合によっては悪質なデータを受信することになるため、これによって多くの問題が生じる。ＩＰアドレススキームで用いられているような、受信者に基づいたアドレス指定を廃止すれば、宛先ホストがデータを

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要求していないのに宛先ホストにデータを送信する可能性がこれによって除去されるのだから、この問題は克服することができるであろう。しかし、ＩＰアドレススキームが廃止された場合、ネットワークを通してパケットをルーティングするのに用いられうる新たなメカニズムを提供することが必要であろう。

【発明の概要】

【０００７】

本発明の第１の態様は、パケットのルーティング情報を提供する方法を提供する。当該方法において、ソースノードから１以上の宛先ノードへのルーティング情報が、集合メンバシップのコンパクト表現の中に符号化される。前記コンパクト表現は、前記ソースノードから前記１以上のソースノードへ送信すべきパケットのヘッダの中に入れられる。

【０００８】

集合メンバシップの前記コンパクト表現は、ブルームフィルタを含んでもよい。

【０００９】

前記ルーティング情報は、各々が各ネットワークリンク又は各ネットワークノードを識別する複数のリンク識別子又はノード識別子を含んでもよい。あるいは、前記ルーティング情報は、後で「仮想リンク」と呼ばれる、２以上のネットワークリンクを含む部分パスを識別する識別子を含んでもよい。（ここで使用されるように、「リンク」はネットワークの２つのノードを直接接続し、ネットワークを通る「パス」は、概して、複数の「リンク」を含む。）他のルーティング情報は、管理領域又は物理ネットワークエリアを識別する、ネットワーク領域の識別子を含んでもよい。

【００１０】

前記ルーティング情報は、前記ソースノードから前記１以上の宛先ノードへの１以上のパスを定義することができる。あるいは、前記ルーティング情報は、前記ソースノードから２以上の異なる宛先ノードへの各パスを定義してもよい。パスの一部が重複している場合、そのような重複している情報は１度だけ符号化され、これにより、パスの集合の代わりに配信ツリーを表す。

【００１１】

前記ルーティング情報は、前記ネットワークのソースノードで符号化されてもよい。あるいは、前記ルーティング情報は、ルーティングサーバで符号化されて、符号化されたルーティング情報が前記ソースノードへ転送されてもよい。

【００１２】

前記方法は、前記パケットのヘッダの中に含まれる前記ルーティング情報を問い合わせることにより、前記ソースノードから前記１以上の宛先ノードへのパスを判定するステップを含んでもよい。

【００１３】

前記方法は、識別子のｄ個の表現から、集合メンバシップのｄ個のコンパクト表現の候補を生成するステップを含んでもよい（ｄは２以上の整数である）。

【００１４】

その後、集合メンバシップの前記コンパクト表現の１つが、使用のために選択されてもよい。この選択は、ユーザが決定した基準（例えば、どの表現が擬陽性を生み出す確率が最も低いか、どの表現が複数の識別子のうちの１以上を含むサブセットに関して擬陽性を生み出す確率が最も低いか、又は、どの表現が複数の識別子のうちの１以上を含むサブセットに関して擬陽性を生み出さないか）に従って行われてもよい。

【００１５】

集合メンバシップの選択されたコンパクト表現は、例えば、ルーティング情報を提供するためにパケットヘッダに含められてもよい。

【００１６】

本発明の第２の態様は、ネットワークを通ってパケットをルーティングする方法を提供する。パケットが、ネットワークノードにおいて受信される。前記ノードから前記パケットがこれに沿って送信されるべき１以上のリンクを判定するために、又は、前記ノードか

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ら前記パケットがそこへ送信されるべき１以上の他のノードを判定するために、又は、その両方のために、前記パケットのヘッダの中に含まれるルーティング情報が問い合わせられる。前記ルーティング情報は、前記パケットのヘッダの中に集合メンバシップのコンパクト表現として含まれる。前記パケットは、前記判定された１以上のリンクに沿って、又は、前記判定された１以上の他のノードへ、又は、その両方で、前記ネットワークノードから転送される。

【００１７】

集合メンバシップの前記コンパクト表現は、ブルームフィルタを含んでもよい。

【００１８】

前記ルーティング情報は、各々が各ネットワークリンク又は各ネットワークノードを識別する複数のリンク識別子を含んでもよい。あるいは、前記ルーティング情報は、２以上のネットワークリンクを含む部分パスを各々が識別する１以上の識別子を含んでもよい。

【００１９】

前記ルーティング情報は、前記１以上の識別子の複数の表現の候補の１つを含んでもよい。

【００２０】

前記ルーティングは、複数のルックアップテーブルから、前記１以上の識別子のうちの受信した表現に対応するルックアップテーブルを選択するステップを含んでもよい。

【００２１】

本発明の第３の態様は、パケットを受信する手段を有するネットワークノードを提供する。前記ネットワークノードは更に、前記ノードから前記パケットがこれに沿って送信されるべき１以上のリンクを判定するために、又は、前記ノードから前記パケットがそこへ送信されるべき１以上の他のノードを判定するために、又は、その両方のために、前記パケットのヘッダの中に集合メンバシップのコンパクト表現として含まれるルーティング情報を問い合わせる手段を有する。前記ネットワークノードは、前記判定された１以上のリンクに沿って、又は、前記判定された１以上の他のノードへ、又は、その両方で、前記パケットを転送する。

【００２２】

前記ルーティング情報は、各々が各ネットワークリンク又は各ネットワークノードを識別する複数のリンク識別子又はノード識別子を含んでもよい。あるいは、前記ルーティング情報は、２以上のネットワークリンクを含む全体パス又は部分パスを各々が識別する１以上の識別子を含んでもよい。

【００２３】

前記ネットワークノードは、各々が前記１以上の識別子のｄ個の表現の候補の１つに対応するｄ個のルックアップテーブルから、前記１以上の識別子のうちの受信した表現に対応するルックアップテーブルを選択するように構成されてもよい。

【００２４】

集合メンバシップの前記コンパクト表現は、ブルームフィルタであってもよい。

【００２５】

前記第１の態様の方法は、ネットワークを通るパスを定義するステップを有してもよい。前記パスは複数の区分を含み、各区分は関連する識別子を有する。前記パスに含まれる各区分に関連する識別子とは異なる識別子が、前記パスに割り当てられる。前記ルーティング情報を符号化する前記ステップは、前記パスの各区分に関連する識別子を符号化するのではなく、前記パスに割り当てられた識別子を符号化するステップを有する。

【００２６】

前記パスに割り当てられる識別子は、前記パスに含まれる各区分に関連する識別子とは無関係であってもよい。

【００２７】

前記パスの少なくとも１つの区分は、２以上のリンクを含んでもよく、各リンクは、２つのネットワークノードを直接接続してもよい。

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【００２８】
本発明の第４の態様は、パケットのルーティング情報を提供するネットワークノードであって、ソースノードから１以上の宛先ノードへのルーティング情報を、前記ソースノードから前記１以上のソースノードへ送信すべきパケットのヘッダの中に含めるために、集合メンバシップのコンパクト表現の中に符号化するように構成される、ネットワークノードを提供する。
【００２９】
前記ネットワークノードは、例えば当該ネットワークノードがルーティング機能ノードである場合に、集合メンバシップの前記コンパクト表現を前記ソースノードへ送信するように構成されてもよい。
【００３０】
あるいは、前記ネットワークノードは前記ソースノードであってもよく、この場合、前記ネットワークノードは、集合メンバシップの前記コンパクト表現を、前記ソースノードから送信すべきパケットのヘッダの中に含めるように構成されてもよい。
【００３１】
集合メンバシップの前記コンパクト表現は、ブルームフィルタであってもよい。
【００３２】
前記ネットワークノードは、１以上の識別子のうちの少なくとも一部に関するｄ個の表現を生成し、前記識別子の前記ｄ個の表現から集合メンバシップのｄ個のコンパクト表現の候補を生成し、集合メンバシップの前記ｄ個のコンパクト表現の候補の１つを選択することにより、前記１以上の識別子の表現を含むルーティング情報を符号化するように構成されてもよい。
【００３３】
あるいは、前記ネットワークノードは、１以上の識別子のうちの少なくとも一部に関するｄ個の表現を生成し、前記識別子の前記ｄ個の表現から集合メンバシップのｄ個のコンパクト表現の候補を生成し、集合メンバシップの前記ｄ個のコンパクト表現の候補の２以上を他のノードへ送信することにより、前記１以上の識別子の表現を含むルーティング情報を符号化するように構成されてもよい。前記他のノードは例えば前記ソースノードであってもよく、その後、当該ソースノードは、受信したコンパクト表現の候補の１つを選択し、当該選択したコンパクト表現をパケットヘッダの中に含めることができる。あるいは、前記他のノードは、受信したコンパクト表現の候補の１つを選択してもよいが、自分自身は当該選択したコンパクト表現を使用せずに、当該選択したコンパクト表現を他のノードへ転送してもよい。
【００３４】
各識別子は、各ネットワークリンク、各ノード、又は、２以上のネットワークリンクを含む全体パス又は部分パスを識別してもよい。
【００３５】
本発明の第５の態様は、複数の識別子の集合のコンパクト表現を生成する方法を提供する。前記方法は、最初に、前記識別子に関するｄ個の表現を生成するステップを有し、集合メンバシップのｄ個のコンパクト表現の候補が、前記識別子の前記ｄ個の表現から生成される。その後、集合メンバシップの前記ｄ個のコンパクト表現の候補の１つが、使用のために選択される。
【００３６】
前記選択は、ユーザによって事前定義された基準に基づいて行われてもよい。
【００３７】
前記方法は、適当なプロセッサによって（例えば、ネットワークノードに含まれるか又はネットワークノードを構成するプロセッサにおいて）実装可能である。
【００３８】
前記識別子の前記表現は、コンパクト表現であってもよい。識別子の「コンパクト」な表現とは、それが表す識別子よりも少ない数のビット（好ましくは、大幅に少ない数のビ

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ット）が１に設定される表現を意味する。コンパクト表現の使用には、識別子自体の長さ及び形式には（あるとしても）少ない制限しか存在しないという利点がある。

【００３９】

集合メンバシップの前記コンパクト表現は、ブルームフィルタであってもよい。

【００４０】

本発明の他の態様は、命令を含んだコンピュータ読み取り可能な物を提供する。当該命令は、プロセッサ上で実行されると、当該プロセッサに、本発明の第１の態様の方法を実行させるか、又は、本発明の第２の態様の方法を実行させる。

【００４１】

本発明はまた、１以上の識別子のうちの少なくとも一部に関するｄ個の表現を生成し、前記識別子の前記ｄ個の表現から集合メンバシップのｄ個のコンパクト表現の候補を生成することにより、前記１以上の識別子の表現を含む、パケットのルーティング情報を符号化するネットワークノードを提供する。

【００４２】

本発明はまた、１以上の識別子の表現を含む、パケットのルーティング情報を提供するネットワークノードを提供する。前記ネットワークノードは、集合メンバシップの複数のコンパクト表現の候補を受信し、事前決定された基準に従って集合メンバシップの前記コンパクト表現の１つを選択するように構成される。ユーザ定義であってもよい前記基準は、例えば、どの表現が擬陽性を生み出す確率が最も低いか、どの表現が複数の識別子のうちの１以上を含むサブセットに関して擬陽性を生み出す確率が最も低いか、又は、どの表現が複数の識別子のうちの１以上を含むサブセットに関して擬陽性を生み出さないか、であってもよい。

【００４３】

本発明はまた、ソースノードを提供する。前記ソースノードは、集合メンバシップのコンパクト表現を受信し、ルーティング情報を提供するために集合メンバシップの前記コンパクト表現をパケットヘッダの中に含めるように構成される。

【００４４】

集合メンバシップの前記コンパクト表現は、ブルームフィルタであってもよい。

【図面の簡単な説明】

【００４５】

本発明の実施形態について、添付の図面を参照しながら、例証として、さらに記述しよう。

【図１】ブルームフィルタに項目を追加するプロセスを図解する略図である。

【図２】ブルームフィルタにデータ項目が追加されたかどうかを検証するプロセスを図解する略図である。

【図３】偽陽性を返すブルームフィルタ検証を図解する略図である。

【図４】本発明の一実施形態による、ネットワークを通るパケット転送を図解する図である。

【図５】本発明の一実施形態による、ネットワークを通るパケット転送を図解する図である。

【図６】本発明の別の実施形態による、ネットワークを通る仮想リンクの作成を図解する図である。

【図７】仮想リンク・セットアップ・パケットの略図である。

【図８】ネットワークを通る仮想リンクを作成する別の方法を図解する図である。

【図９】Ｍｕｌｔｉｃａｓｔツリーを作成する仮想リンクを図解する図である。

【図１０】１個のパケットについてネットワークを通る複数のパスを図解する図である。

【図１１】（ａ）及び（ｂ）は、パスの自己生成を図解する図である。

【図１２】パケットヘッダ内での転送情報の提供を図解するブロックフロー図である。

【図１３】図５の実施形態による、ネットワークを通るパケット転送を図解するブロックフロー図である。

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【図１４】識別子に対応するタグの生成を図解する図である。
【図１５】本発明の別の態様による転送ノードを図解する略図である。
【図１６】パケットヘッダの略図である。
【図１７】本発明の別の実施形態による方法を図解する図である。
【図１８】本発明の一実施形態によって得られうる偽陽性率の削減を図解する図である。
【図１９】偽陽性率を図解する図である。
【図２０】本発明の別の態様の方法のブロックフロー図である。
【発明を実施するための形態】
【００４６】
本発明について、ルーティング情報がブルームフィルタに含まれる実施形態に関して記述しよう。しかし、本発明はブルームフィルタに限定されるのではなく、ルーティング情報を、機能性ではブルームフィルタを用いるのと同様にルーティング情報を識別するために問い合わせ可能な集合メンバシップへと符号化することを含む、他のコンパクト表現が用いられてもよい。これは例えば、Ｄｉｓｃｒｅｔｅアルゴリズムに関する第１６回年次ＡＣＭ－ＳＩＡＭシンポジウム（２００５）の予稿集の８２３頁から８２９頁までに記載された「Ａｎ　Ｏｐｔｉｍａｌ　Ｂｌｏｏｍ　Ｆｉｌｔｅｒ　Ｒｅｐｌａｃｅｍｅｎｔ」の中でＡ　Ｐａｇｈ他によって記述された表現のようなものである。また、本発明は、例えばＩＥＥＥ／ＡＣＭ　Ｔｒａｎｓａｃｔｉｏｎｓ　ｏｎ　Ｎｅｔｗｏｒｋｉｎｇ、Ｖｏｌ．１０、Ｎｏ．５、ｐ６０４（２００２）の「Ｃｏｍｐｒｅｓｓｅｄ　Ｂｌｏｏｍ　Ｆｉｌｔｅｒｓ」の中でＭ．Ｍｉｔｚｅｎｍａｃｈｅｒによって開示されたもののような、修正されたブルームフィルタを使って達成されてもよい。
【００４７】
本発明は、ブルームフィルタ（ＢＦ）に基づいた新たなソースルーティングスキームを提供し、この場合、ルーティング情報はパケットヘッダの中のＢＦに含まれる。通常、「ソースルーティング」という用語は、パケットがソースノードから宛先ノードまでたどることになるパス全体をソースノードが制御する時に用いられる。用いられる他の用語として、正確なパスが既知である場合の「ストリクト・ソース・ルーティング」と、パケットが通過することになるネットワーク内の一部のポイントだけをソースノードが定義する場合の「ルーズ・ソース・ルーティング」とがある。
【００４８】
提案する解決策は、ルーティング機能性が宛先または宛先の集合までのパケットのパス全体を知っており、この情報に基づいてパケットヘッダを作成するという意味で「ソースルーティング」である。また、パス上の各ノードが知られているのだから、これはストリクト・ソース・ルーティングであると考えることもできる。（留意すべきだが、以下で説明するように、ノードは本発明では転送要素として動作するのであって、パケットがどのルートをたどるべきかについてノード自身が決定を行うことはない。）作成されたパケットヘッダは、パケットに組み込むため、ソースノードに与えられるかまたはソースノードで構築される。すべての個々の転送ステップが含まれるＢＦベースのヘッダを用いる時には、転送ノードは、いかなるノードまたはリンク情報であろうとまったくヘッダから抽出することはできない。従って、ノードは、パケットがどこへルーティングされることになるのか実際には知らない。パス上の各ノードは、自分自身のリンク情報を用いて、パケットがどこへ渡されるべきかを検証することができるだけである。
【００４９】
本発明のブルームフィルタベースの方法を用いて、ネットワークノード内で必要とされる状態情報を最小化することも可能である。
【００５０】
本発明の実施形態について記述する前に、ブルームフィルタの予備的説明をしよう。
【００５１】
ブルームフィルタ
ブルームフィルタ（ＢＦ）は、集合メンバシップのコンパクト表現の中にデータ項目を

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含める効率的なやり方を提供する。データに対して少数の別個のハッシュ値が算出され、これらのハッシュ値は、ブルームフィルタのビット列の中の所定のビットを表しており、それが項目を追加する間に１に設定される。

【００５２】

同じ方法論を用いて、集合表現の中にリンク情報を挿入することも可能であり、その場合、リンク情報は、ネットワーク内の２つのノード間のリンクに対応する。データ項目が追加されたブルームフィルタからは、追加された情報を抽出することは不可能である。可能なのは、その項目がその中に含まれているか否かを検証することだけである。偽陽性（データ項目が実際には追加されていないのに、追加されたと通知すること）の可能性は若干あるが、偽陰性の可能性はない。これをルーティングに適用する場合、パケット転送に用いられるＢＦは、偽陽性が原因でネットワーク内で追加パケットの増殖を生み出す可能性があるが、それはｐｕｂ／ｓｕｂネットワークでは、偽陽性率を制御するやり方がある限り、有害とはみなされない。ＢＦの場合、それは、追加されることになる項目の数とフィルタのサイズとを制御することが可能であることを意味する。しかし、もっと重要なことだが、少なくとも集合表現に追加されたリンクを介して、データは常にルーティングされる。

【００５３】

結果として、ＢＦ（例えば長さ１２８ビット）をパケットヘッダに追加することができ、そしてそれは、ソースノードから宛先ノードまでの全ルートを含む。これは、エンド・ツー・エンドであってもよいし、元のデータ発行者から加入者までのパスの一部だけであってもよい。ネットワークノードでは、最小限の転送情報だけを維持すればよい。例えば、各ノードは、典型的には、ルーティングテーブルを維持し、各テーブルエントリは、所与のリンクを介して送信されることになるパケットを識別するのに必要な情報を保持する。その場合、ノードは、自身が接続しているノードの各々について転送テーブルの中で１つのエントリだけを必要とするということでよい。

【００５４】

転送プロセスは効率的であり、転送テーブルエントリの中のパケット識別情報は、パケットヘッダ内のＢＦとの間でビット単位でＡＮＤ演算され（この場合、「ＡＮＤ演算される」とは、論理ＡＮＤ演算を意味する）、そして結果がパケット識別情報に等しい場合、パケットは対応する送出リンクへ転送される。結果が等しくない場合、特定のリンクの識別子がブルームフィルタに追加されなかったのだから、パケットはそのリンクへは転送されない。

【００５５】

従って本発明は、ブルームフィルタに基づいてパケットヘッダの中にコンパクトなソースルーティング情報を提供することができる。これによって、ネットワークノード内に保持されなければならない状態情報が最小化される。

【００５６】

さらに留意されることだが、ノード間のリンクに名前を付ける代替的方法がいくつかある。識別子は自由な形式でよく、その場合、それらのブルームフィルタ表現が、識別子に対してｋ個の異なるハッシュ値をとるような通常のやり方で演算される。あるいは、リンク名が、ｋ個の「１」のビットおよびｍ－ｋ個の「０」のビット、または、ｋ－ｚ．．、ｋ－１、ｋ、ｋ＋１、．．ｋ＋ｚ個の「１」のビット（ｚは非常に小さい）と対応する個数の「０」のビットとで、直接構築されてもよい。その場合、そのようなハッシングは、ブルームフィルタを構築するためには必要でない。いずれの場合にも、命名スキームは、ハッシュの衝突を避けるために、名前に対して十分なエントロピー（ランダムネス）を符号化しなければならない。自由形式のリンク識別子とブルームフィルタ対応のｋ－ｏｆ－ｍビット識別子とを区別するため、本発明では後者をリンクＩＤと呼ぶ。

【００５７】

ブルームフィルタ（ＢＦ）は、フィルタと呼ばれる集合のコンパクト表現に対してデータ要素を追加し、後でその要素が以前にそれに追加されたかどうかをテストするための、

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簡単なやり方である。ＢＦは、所定のビット数、例えば１２８ビット、を含むビット列であり、それは当初はすべて０に設定される。ＢＦのサイズは、用途によって異なりうる。一例として、図１では、ＢＦのビット数は８である。一般的には、８ビットのＢＦは非常に小さいＢＦであろうから、実際には、いかなる目的にも使用できないであろう。ＢＦにデータ項目を追加することは、１個の識別子から複数の別個のハッシュ値が演算されるプロセスである。図１の例の場合、３つの異なるハッシングアルゴリズムを識別子「データ１」に適用することによって３つの別個のハッシュ値が、これらの値の各々が１と８の間にあるように演算される。これらの値の各々は、ＢＦ内の１ビットを表す。ハッシュ値が算出された後、ＢＦ内の対応する各ビットが１に設定される。図１の例では、３つのハッシュ値は３、６、１であり、ブルームフィルタの中の第１、第３、第６ビットが「１」に設定される。これは、識別子「データ１」についてのリンクＩＤを構成する。

【００５８】

また、図１は、別の識別子「データ２」をＢＦに追加することも示す。別個のハッシュ値が同様に算出され、そして、対応するビットがＢＦにおいてすでに１に設定されている場合、ビットは１のままである。図１の例では、「データ２」から得られた３つのハッシュ値は、４、７、１であり、ブルームフィルタの中の第４および第７が「１」に設定される（第１ビットは、「データ１」がブルームフィルタに追加された時に、すでに「１」に設定されている。項目がこのように追加される場合、いずれかの項目をＢＦから削除する可能性がないのは明らかであり、値「１」を持つビットが１つ以上のデータ項目から来るかどうかは誰にも分からない。（これらの制限に対する解決策が提案されているＢＦの変形が存在し、例えば、各ビットに対してカウンタが添付されている。項目が追加されて対応するビットが１に設定される度にカウンタが増える。項目を削除すると、カウンタ値は減るであろうし、値がゼロになると、対応するビットもゼロに設定することができる。しかし、この解決策は、１ビットでもカウンタ値のオーバフローがある場合に問題をもたらす可能性があり、値を減らすことにはもはや信頼性がない。カウンタ値を含めることのもう１つのマイナス面は、ＢＦのサイズが増えることであり、もはや、含められたデータ項目のコンパクト表現とは言えなくなる。本発明はコンパクトなＢＦを必要としており、本発明の基本形としては、ＢＦから項目を削除する必要はない。ＢＦは、使用後は廃棄される。）

特定のデータ項目がＢＦに追加されたかどうか検証したい場合、データに対する必要な数の別個のハッシュ値を算出することによってプロセスを開始し、結果として、ＢＦビット列の中の所定のビットに対応する数字の集合が得られる。検証プロセスの間、ＢＦの中のこれらのビットの値がチェックされ、すべての値がＢＦの中で１に設定されている場合、検証プロセスはｔｒｕｅを返し、いずれかのビットが０である場合、検証プロセスはｆａｌｓｅを返す。これを図２に図解するが、図２は、「データ１」が図１で作成されたブルームフィルタのメンバであるかどうかチェックするプロセスを示す。ブルームフィルタを作成するために用いられたのと同じ３つのハッシュアルゴリズムを用いて、３つのハッシュ値が「データ１」について作成され、そして、これらは３、６、１である。ブルームフィルタがチェックされると、ブルームフィルタの第３、第６および第１ビットがすべて「１」に設定されていることが分かり、これは、「データ１」がブルームフィルタに含まれていることを（正確に）示す。

【００５９】

ブルームフィルタの１つの特徴は、ある項目がブルームフィルタのメンバであるかどうかを検証するプロセスが、完全には正確でなく、「偽陽性」を生じる可能性があるということである。しかし、「偽陰性」を生じる可能性はない。データ項目が実際に含まれていた場合、対応するブルームフィルタのビットはすべて「１」であろうから（算出プロセスは、ブルームフィルタに項目を追加する間と検証の間とは同じであるため）、フィルタ検証は常に「ｔｒｕｅ」を返す。こうして、正確な応答が得られる。しかし、検証プロセスでチェックされたビットのうちのいずれかがゼロであることが分かった場合、検証は、「ｆａｌｓｅ」を返し、その項目はブルームフィルタに追加されていなかったことが分かる

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【００６０】

しかし、図３に示すように、たとえばデータ項目がフィルタに追加されていなくてもフィルタ検証がｔｒｕｅを返すことがありうる。図３の例では、「データ３」から得られた３つのハッシュ値は、４、６、１であり、ブルームフィルタの第４、第６、第１ビットはすべて「１」であると分かり、従って、検証プロセスは、「データ３」がブルームフィルタに含まれているということを返す。しかし、図１でブルームフィルタが作成された時に「データ３」はブルームフィルタに追加されなかったのだから、この結果は、不正確であり、この場合、検証は「偽陽性」を返すと言える。

【００６１】

偽陽性率は、フィルタの長さと、フィルタに追加された項目の数とに依存する。

【００６２】

ブルームフィルタをルーティングに利用する

本発明によれば、ネットワークの各リンク、すなわち２つのノード間の接続は、識別子（または「名前」）を有する識別可能なデータ項目であるとみなされる。従って、本発明は、パケットが要求される場合、ネットワークを通るパスがソースノードから宛先ノードまで選択され、それがリンク識別子のシーケンスとして記述されうることを提案する。リンク識別子のシーケンスは、ＢＦへと符号化され、そして、ＢＦがパケットヘッダに入れられる。

【００６３】

あるいは、ネットワークを通るパスを構成するリンクを識別する代わりに、パス沿いのノードを識別することによってパスを定義することができるだろう。しかし、パスの２つのノード間で２つ以上の異なるリンクが存在する可能性がある場合、そのようなスキームでは、例えば、並行するリンク間でトラヒック負荷をバランスさせる必要がある場合などは、含まれる情報が減り、また、あまり適正でない動作が行われるであろう。従って、一般性を失わずに、本発明の好適実施形態は、パスを構成するリンクによってパスを識別するという点に限って記述するが、理解されるべきだが、本発明はこれに限定されない。但し、留意されるべきだが、純粋な無線ネットワークの場合、例えばＭｏｂｉｌｅ　Ａｄ　Ｈｏｃ　Ｎｅｔｗｏｒｋ（ＭＡＮＥＴ）には、識別可能なリンクは存在せず、従って、そのような環境では、本発明はリンク識別子の代わりにノード識別子を用いるであろう。さらに、留意しなければならないことだが、ノードＩＤが（一方向の）リンクＩＤの代わりに用いられる場合、過度のルーピングを避けるメカニズムが必要であり、例えば、各パケットが存続期間の指標や少数の最近訪問したノードの識別子を搬送してもよいし、あるいは各ノードが、最近出会ったパケットを十分な数だけ記憶してもよい。

【００６４】

ネットワーク内のノードは、どの送出リンクＩＤがパケットヘッダ内のブルームフィルタに追加されたのかを判定するためにパケットヘッダ内のブルームフィルタに問い合わせることによって、ノードからどの送出リンクに沿って自分がパケットを転送すべきかを判定することができ、例えば特定の送出リンク識別子がパケットヘッダ内のブルームフィルタに追加された場合、パケットはそのリンクに沿って転送される。このプロセスは、パスに沿って各ノードで繰り返される。（パスが、パスを構成するリンクの観点からではなくてパス沿いのノードの観点から定義される場合、ノードは、他のどのネットワークノードに自分がパケットを送信すべきかを判定するため、パケットヘッダ内のブルームフィルタに問い合わせるであろうし、そして、パケットは、ブルームフィルタに問い合わせることによって得られたノードに転送される。）

本発明は、ＢＦがデータ項目のコンパクト表現であり、かつ、データ項目がフィルタに追加されたかどうかについてＢＦが常に正確な応答を返すという意味で、ＢＦの利点を利用する。「ｐｕｂ／ｓｕｂ」ルーティングの場合、確率が低い限り、偽陽性は問題ではない。偽陽性は、パケットが間違った宛先に配信される原因となるが、それは、偽陽性率が制御されうる限り、有害とはみなされない。ＢＦでは、偽陽性率は、ＢＦの長さと、デー

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タ項目を表すビット数と、フィルタに追加されたデータ項目の数とに依存する。

【００６５】

本発明の一実施形態について、図４乃至図１１を参照しながら記述しよう。本実施形態は、ブルームフィルタの生成に関する。

【００６６】

図４は、ノードＲ１乃至Ｒ５を有する単純なネットワークの略図である。パケットソース１が、ノードＲ１に接続し、パケット宛先（または「シンク」）２が、ノードＲ３に接続している。ノードＲ１乃至Ｒ５のうちの２つの間の各リンクは、リンク識別子を使って提供され、図４の実施形態では、直接のブルームフィルタ対応リンクＩＤが用いられ、それらは、各リンクが、各方向に１つずつ、２つの別個のリンクＩＤを有するように、有向の識別子として生成される。これは、（以下で述べる）一部の状況でループを回避するために必要である。一例として、ノードＲ１からノードＲ２までのリンクは、リンクＩＤ　００１００１００１　を有し、ノードＲ２からノードＲ１までの逆リンクは、リンクＩＤ　１１０００１０００　を有する。例示したリンクＩＤは、例として９ビットと非常に短いものが選択されているが、実際は、これより長いであろう。

【００６７】

図４の実施形態は、ソースノードと宛先ノードとの間でデータを捜し出して配信するのに必要な機能性が、Ｒｅｎｄｅｚｖｏｕｓ（ランデブー）、Ｒｏｕｔｉｎｇ（ルーティング）、Ｆｏｒｗａｒｄｉｎｇ（転送）という３つの異なる動作で成り立つとみなすことができるようなＰｕｂ／Ｓｕｂネットワークに関する。大まかには、ランデブーメカニズムは、ネットワーク内での位置情報の発行を維持することに責任を持ち、ルーティングメカニズムは、ランデブーシステムの中に維持される情報に基づいてデータ位置から加入者ノードまでのルートを作成して構成することに責任を持ち、転送機能は、ネットワークを通る実際のデータパケットを転送することに責任を持つ。これらを図４にそれぞれ項目３、４、５として略示する。

【００６８】

ソース１は、発行Ｐを発行すると仮定する。この情報は、発行Ｐがその現在位置をマッピングするようにランデブーシステム３に格納される。シンク２でユーザが発行２を購読する場合（図１１のステップ１）、発行Ｐの位置情報は、ランデブーシステム３から見つけることができる（図１１のステップ２）。これは、データの現在位置とそれが配信される必要がある宛先とについての情報を提供する。

【００６９】

ルーティング機能４は、ソース１と宛先（シンク２）との間の転送パスを構築するためにソースノード情報および宛先ノード情報を必要とする。ルーティング機能４は、ネットワークリンクと、関連するリンクＩＤと、リンクが接続するノードとについての情報を維持するが、例えばルーティング機能の中に維持される情報は、ノードペアと、各ノードペアについての、それらの間のリンクのリンクＩＤとであってもよい。リンクＩＤと、リンクが接続するノードとについての情報がルーティングレイヤに存在した後ならば、ソースノード情報および宛先ノード情報を用いてネットワークを通るパスを構築することができる。

【００７０】

このようにして、ルーティング機能は、ネットワークトポロジについての知識を有する。ルーティング機能は、ノードＡとノードＢとの間にパスを構築するための要求を受け取ると、ＡとＣおよびＢとＣが直接接続している場合、リンクを用いて例えばＡからＣまでの、およびＣからＢまでのパスを作成することができる。従って、ルーティング機能４は、シンク２がソース１に発行Ｐを要求したことを通知される場合、ソースノード情報および宛先ノード情報に基づいて、ソース１から宛先２までのパスを作成することができる（図１１のステップ３）。図４の例では、ルーティングシステムは、ネットワークトポロジ情報を使用して、データがパスＲ１－Ｒ２－Ｒ３を移動する必要があると判定する。

【００７１】

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判定されたパスは、リンク識別子のシーケンスとして表されてもよく、この場合、リンクＲ１からＲ２までと、リンクＲ２からＲ３までとで形成されたパスを示すために｛００１００１００１，００１０１１０００｝として表されてもよい。これを行うため、ルーティング機能は、図１１のステップ３で定義したパスの中の各リンクのリンクＩＤを判定または検索する（図１１のステップ４）。

【００７２】

リンクＩＤを判定するやり方はいろいろある。それらがノードによって自動的に生成され（例えばあるノードが、自分が直接接続していると分かっているノード群に対する自分自身の送出リンクにリンクＩＤを割り当てることもできる）、その後、ルーティング機能に通信されてもよいし、あるいは、それらが他のインスタンスによって割り当てられ、ノード上で構成されてもよい。リンクＩＤが、例えば、必要数のハッシングアルゴリズムを根底にある識別子に適用して、結果として得られるハッシュ値からビットマスクを得ることによって得られてもよい。しかし、本発明において、リンクＩＤが、ＢＦの追加と検証とに直接適用されうるビットマスク以外の何かである必要はなく、適切なビットマスクが、長さｍビットのビット列のうちのｋビットを「１」に設定して残りのビットが「０」のままであるようにすることによって得られてもよい（この場合、ブルームフィルタはｍビットの長さを有し、かつｋ＜ｍである。）

【００７３】

実際には、ハードウェアの中で可変長フィールドを処理するのは非効率であるだろうから、すべてのリンクＩＤが同じビットマスク長ｍを有することが有利である。それゆえ、実際には、ｍについて無理のない最大限のサイズを決め、次いで、すべてのリンクＩＤについてのビットマスク長としてそれを使用することが、有利である。しかし、リンクＩＤを形成するビットマスク内で「１」に設定されるビット数ｋは、ネットワークによってさまざまであろうし、「１」に設定されるビット数ｋは、すべてのリンクについて同じでなくてもよい。例えば、高容量リンクについてのリンクＩＤは、長さｍビットのビット列のうちのk_0-1ビットを「１」に設定することによって形成されてもよいし、他方、通常容量リンクは、長さｍビットのビット列のうちのk_0ビットを「１」に設定することによって形成されるリンクＩＤを有してもよい。これによって、高容量リンクについての偽陽性の数が増す可能性があるが、他のリンクについての偽陽性の数は減るはずである。逆に、低容量リンクについてのリンクＩＤは、長さｍビットのビット列のうちのk_0+1ビットを、さらにはk_0+2ビットを「１」に設定することによって形成されてもよい。これによって、そのリンクについての偽陽性の数が減るはずであるが、他のリンクについての偽陽性の数は増すことがある。

【００７４】

リンクＩＤを形成するために「１」に設定されるｋビットは、無作為に選択されてもよい。ただし、ｋビットは、他のやり方で選択されてもよく、例えば、ローカルでは、あるノードからのリンクのリンクＩＤ間に重複がないようにノードからの各送出リンクについてｋビットを選択することは、意味を成すであろう。従って、あるノードからパケットが１つの送出リンクだけで送信されるべき場合に２つ以上のリンクでパケットを送信する確率は、大幅に減少するであろう（但し、他のどこかで偽陽性が増えているかもしれない）。

【００７５】

ブルームフィルタの長さｍは、下記のようにすべてのルーティング情報がブルームフィルタに書き込まれた後で、ブルームフィルタの中身が半分しかないように選ばれること、すなわち、ブルームフィルタの中身が半分を超えると偽陽性率が顕著になりうることから、「１」に設定されるのはｍ／２ビットを超えないことが望ましい。ただし、ブルームフィルタをパケットヘッダに入れることは、ブルームフィルタのビット数がかなり少ない場合に限って実行可能である。実際には多くの場合、１２８ビット前後の長さのブルームフィルタなら、偽陽性の数が適度に少ないはずである。

【００７６】

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パスが決められると、ルーティング機能４は、パスのリンクＩＤを含むＢＦを作成する（図１１のステップ５）。上記のようにリンクＩＤが構築され、かつ、そのうちのｋ（またはｋ－１、ｋ＋１等）個が「１」ビットであるような「ｍ」ビットがそこに含まれる場合、各リンクＩＤは、ＢＦへとＯＲ演算され（この場合、ＯＲ演算されるとは、論理ＯＲ演算を意味する）、従ってこの場合、ＢＦは、パス上の各リンクについての情報を含む。図４の例では、パスは、Ｒ１からＲ２まで（リンクＩＤ：００１００１００１）とＲ２からＲ３まで（リンクＩＤ：００１０１１０００）の２つのリンクを含んでおり、従って、生成されたブルームフィルタは、００１０１１００１である。

【００７７】

ルーティング機能は、作成されたソースルーティングＢＦを発行Ｐの識別子と共にデータソース１へ送信する（図１１のステップ６）。ソースノードは発行Ｐからパケットを作成して、受信したＢＦをヘッダに入れる（図１１のステップ７）。パケットはこの時点で配信される準備が整っており、データソース１によって送信されてもよい（図１１のステップ８）。

【００７８】

原理的には、ルーティング情報は、上記のようにルーティング機能４でではなくてソースノードでブルームフィルタの中に符号化されてもよい。

【００７９】

パケットの配信を図５および図１２に図解する。パケットは、ヘッダ内にブルームフィルタ（図５の例では、パケットの中のブルームフィルタは図４で生成されたブルームフィルタ００１０１１００１である）としてルーティング情報を含んでいるが、最初にＲ１へ送信される。パケットがノードＲ１で受信される（図１２のステップ１）と、Ｒ１は、パケットヘッダの中に含まれるブルームフィルタをチェックすることによって（図１２のステップ２）、パケットヘッダの中のルーティング情報を問い合わせ、そして、パケットヘッダのＢＦの中から、Ｒ１からの送出リンクのリンクＩＤ値に一致するものを探すことを試行する（図１２のステップ３）。例えば、Ｒ１における各転送テーブルエントリは、送出リンクのリンクＩＤと、対応する物理リンクのインデックスとで構成されてもよい。一致検索プロセスを、図２に例示する。

【００８０】

パケットは、ブルームフィルタに一致するリンクＩＤを有する、ノードＲ１から送出される単数または複数のリンクに沿って転送される（図１２のステップ４）。この例では、ノードＲ１は、ノードＲ２へと（リンクＩＤ：００１００１００１）、ノードＲ４への（リンクＩＤ：００１０１０００１）２つの送出リンクを有する。Ｒ１での、受信したパケットのヘッダの中のブルームフィルタ００１０１１００１を送出リンクと照合することの結果は、２つの陽性である。これは、１つの正確な陽性と１つの偽陽性とである。リンクＲ１－Ｒ２は受信したパケットの中のＢＦに実際に追加されたものであり、結果として検証からの正確な陽性応答が行われる。しかし、リンクＲ１－Ｒ４は、ＢＦに追加されたものではなく、ノードＲ４に対する受信したパケットの中のＢＦとの一致は、偽陽性である。

【００８１】

従って、パケットは（正しく）ノードＲ２へ転送され、そして、（間違って）ノードＲ４にも転送される。パケットヘッダの中のブルームフィルタに問い合わせて、ブルームフィルタに含まれる送出リンクを探すというプロセスは、パケットが受信される各ノードで繰り返される。従って、図５の例では、パケットがノードＲ２およびＲ４で受信されると、上記のプロセスは各ノードで繰り返される。ノードＲ４では、送出用の一致するリンクＩＤが存在せず、パケットは破棄される。（ＩＰの場合は同じ宛先ＩＰアドレスを用いてネットワークのどこからでもパケットを宛先に配信することができるが、それとは違って、本発明のＢＦベースのヘッダは、特定のパスに限ってルーティング用として使用することができる。一旦パケットがパスの外に出ると、パスは一致するリンクＩＤを含まないため、パケットを正確に配信することはできない。）しかし、ノードＲ２では、パケットへ

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ッダの中のＢＦは、Ｒ３に対するリンクにさらに一致するため（ステップ４）、パケットは、そのリンクを用いてノードＲ３に転送される。

【００８２】

ノードＲ３からシンク２までの最終配信は、いずれかの便利なやり方で扱われてもよく、本発明は、最終配信の特定の方法には限定されない。例えば、シンク２に向かうリンクＩＤを、ＢＦが作成される時にＢＦに追加することもできるだろうし、パケットが、ノードＲ１、Ｒ２、Ｒ３の間で転送されるのと同様にノードＲ３からシンクへ転送されてもよい。もう１つの例として、Ｒ３が、シンクからの購読情報を維持し、発行ＩＤを購読と照合し、データをシンクに転送することもできるだろう。

【００８３】

仮想リンク

ブルームフィルタに関する１つの問題は、それらが比較的早く「一杯」になりうることである。１つのフィルタに追加される要素が増えれば、偽陽性の確率が高まり、一般には、中身が半分をかなり超えることは、ブルームフィルタにとって望ましくない。さらに、上記のように、ブルームフィルタの長さを比較的短く維持することが望ましい。従って、本発明の好適な特長では、複数の単一のリンクから（この場合、単一の「リンク」は２つのネットワークノードを直接リンクする）１つの「仮想リンク」が定義されるが、それによって、ネットワークにおいて配信ツリーを記述する、より効率的なやり方が可能になると共に、ＢＦに追加されることが必要なリンクＩＤもより少なくて済む。本発明の方法によってパケットをルーティングするのに「仮想リンク」が用いられる場合、仮想リンクを用いるルーティングは、上記と同じやり方で行われる。仮想リンクのリンクＩＤは、例えばブルームフィルタの中で、符号化され、そして、パケットヘッダに入れられる。仮想リンク沿いのノードの転送テーブルは、仮想リンクのリンクＩＤと適切な転送の宛先とを含めるように構成される。仮想リンクのリンクＩＤをそのヘッダ内に有するパケットを受信すると、ノードは、転送テーブルの中の仮想リンクのリンクＩＤに関連する宛先にパケットを転送する。

【００８４】

ルーティング機能がデータをＲ１からＲ３まで配信する、図６に示す事例について考えよう。何らかの理由で、この部分的なパスは負荷が重くて、複数の異なる送信が同じパスを使用している。従って、Ｒ１とＲ３との間の「仮想リンク」を定義することは利益になりうる。図６では、ルーティング機能は、Ｒ１からＲ２を介してＲ３までのそのような仮想リンクを定義し、そして、それに仮想リンクＩＤを与えている。図６の例では、仮想リンクは、２つの単一リンクＲ１－Ｒ２とＲ２－Ｒ３とから定義されるが、仮想リンクは、３つ以上の単一リンクを含んでもよい。従って、新たな仮想リンクは、Ｒ１－Ｒ２－Ｒ３である。従って、ノードＲ１からノードＲ３までのパケットの配信を確実にするため、パケットヘッダの中のブルームフィルタの中に、リンクＲ１－Ｒ２とリンクＲ２－Ｒ３とのリンクＩＤを入力するのではなく、仮想リンクのリンクＩＤだけを入力することが必要である。

【００８５】

生成された仮想リンクは、リンクＩＤを有しているが、それは仮想リンクを作成するのに使用された根底にあるリンクのリンクＩＤに直接関連する必要はない。図６の例では、仮想リンクＲ１－Ｒ２－Ｒ３には、リンクＩＤ　１０１０００１００が与えられる。

【００８６】

仮想リンクのリンクＩＤは、リンクＩＤについて上述したように、ｋビットが「１」でｋ－ｍビットが「０」であるような、長さｍビットのビットマスクであってもよいし、リンクの根底にある識別子にハッシュ関数を適用することによって得られてもよい。リンクＩＤがビットマスクである場合、ビットマスクのうちの指定のビットを用いて、リンクが実際のリンクである場合には指定のビットを「１」に、リンクが仮想リンクである場合には「０」に（あるいはその逆に）設定することによって、あるリンクが実際のリンクであるか仮想リンクであるかを表すことが可能であろう。

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【００８７】
仮想リンクに属するノード、すなわち仮想リンクに対応する物理パス上にあるノードは、それらがパケットを転送できるように、仮想リンクについて知る必要がある。例えば、各仮想リンクについて、（リンクの最後のノードを除いて）リンクのノードには新たな転送テーブルエントリがある可能性がある。従って、図６では、ノードＲ１についての転送テーブルは、さらに、仮想リンクＲ１－Ｒ２－Ｒ３についてのエントリを含み、それは、パケットヘッダ内にリンクＩＤ　１０１０００１００を含むパケットはノードＲ２へ転送されるべきことを示す。同様に、ノードＲ２についての転送テーブルは、さらに、仮想リンクについてのエントリを含み、それは、パケットヘッダ内にリンクＩＤ　１０１０００１００を含むパケットはノードＲ３へ転送されるべきことを示す。

【００８８】
新たな仮想リンクが設定される場合、新たに作成された仮想リンクに属するノードにそれが伝達される必要がある。仮想リンクについての情報を伝達する１つのやり方は、新たなリンクＩＤをリンクの各ノードに別々に配信することであるが、代わりに、もっと簡潔な方法を用いて、各ノードが、関連ノードを通じて配信される別個の制御パケットからこの情報を入手できるようにすることも可能であろう。

【００８９】
例えば、制御パケットを用いて新たな仮想リンクについての情報を配信するため、図７に示すように、ルーティング機能が、Ｖｉｒｔｕａｌ　Ｌｉｎｋ　Ｓｅｔｕｐ　Ｐａｃｋｅｔ（ＶｉＬＳ）を用いて新たな仮想リンクＩＤについてノードに情報提供してもよい。ＶｉＬＳのパケットヘッダの中のＢＦは、通常通り算出されたＢＦを含んでいる。すなわち、それに対して、パケットがリンクＲ１－Ｒ２－Ｒ３に沿って転送されるようにするため、上記のようにＲ１－Ｒ２リンクＩＤおよびＲ２－Ｒ３リンクＩＤが追加されている。ＶｉＬＳパケットのデータフィールドには、新たな仮想リンクＩＤが含まれ、必要に応じて仮想ＩＤの存続時間も含まれる。ＶｉＬＳパケットを受信する各ノードは、ＶｉＬＳパケットからリンクＩＤを読み取って、リンクＩＤを、対応する送出リンクと共にその転送テーブルに追加することができる。発行ＩＤフィールドまたはパケットヘッダの中の何らかの他のフィールドを用いて、ＶｉＬＳパケットのタイプを示してもよいが、これについては他の方法もある。ＶｉＬＳパケットのデータフィールドの中に、ノードの中の転送テーブルエントリをセットアップすることに関する他の情報を含める必要はなく、パケットヘッダの中のＢＦをこの目的で使用することができるのだから、ノードの転送テーブルの中で定義される送出リンクは、パケット内のＢＦがパケットをノードからルーティングするであろう場合のリンク、およびＶｉＬＳパケットが次に送信される場合のリンクと同じである。

【００９０】
上記のように、通常通り算出されたＢＦに依存して仮想リンクについての情報を配信する場合、ネットワーク内の仮想リンクの表現は、通常通り算出されたＢＦが含む（もしあれば）のと同じ偽陽性を含むであろう。そのような偽陽性を避けることが望ましい場合、ＶｉＬＳパケットは、仮想リンクを形成するリンクのリンクＩＤを、例えばパケットのデータ部分の中で、明示的に符号化してもよい。リンクＩＤがＶｉＬＳパケットの中へ明示的に符号化される場合、仮想リンク沿いの各ノードは、送出リンクＩＤをパケット内の明示的に符号化されたリンクＩＤと比較して、この目的でパケットヘッダ内のＢＦを無視することによって、仮想リンクのための転送テーブルをセットアップするであろう。

【００９１】
仮想リンクをネットワークノードの転送テーブルに追加するため、ルーティング機能は、新たに構築されたＶｉＬＳをノードＲ１に入れる。ノードＲ１は、これが制御パケットであることに気付き、新たな仮想リンクを記述する新たな転送テーブルエントリに必要な情報をパケットのデータフィールドから取得し、そして、新たなエントリをその転送テーブルに入れる。このエントリについての宛先は、ＶｉＬＳパケットヘッダ内のＢＦによってかまたは、上記のように、それらを明示的にリストすることによって、判定されてもよ

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い。典型的には、通常のパケット転送メカニズムによってＶｉＬＳパケットがさらに配信される場合と同じ宛先が、転送テーブルに追加される。従って、この例ではノードＲ１が、ノードＲ２への送出リンクに対して、仮想リンクＲ１－Ｒ２－Ｒ３のリンクＩＤをその転送テーブルに追加する。次いでＶｉＬＳパケットがノードＲ２へ転送され、ノードＲ２でプロセスが繰り返され、その結果、ノードＲ”は、ノードＲ３への送出リンクに対して、仮想リンクＲ１－Ｒ２－Ｒ３のリンクＩＤをその転送テーブルに追加する。次いでＶｉＬＳパケットは、次のノードへ転送され、以下同様に行われる。

【００９２】

図６では、仮想リンクが実際のリンクを用いて構築される。また、既存の仮想リンクを結合することによって新たな仮想リンクを定義することも可能である。図８は、これがどのようにして行われるかを示す。仮想リンクＲ１－Ｒ２－Ｒ３－Ｒ４－Ｒ５が、１つの区分が仮想リンクＲ１－Ｒ２－Ｒ３であり、もう１つの区分が仮想リンクＲ３－Ｒ４－Ｒ５であるように定義される。あるいは、少なくとも１つの区分が実際のリンクであり、少なくとも１つの区分が仮想リンクであるように、仮想リンクが定義されてもよい。

【００９３】

このようにして定義される仮想リンクに、その構成区分の識別子とは異なり（かつ、それに関連する必要のない）、かつ、仮想リンクに含まれる実際のリンクの識別子とも異なる、リンクＩＤが与えられる。従って、図８の仮想リンクＲ１－Ｒ２－Ｒ３－Ｒ４－Ｒ５に対して、２つの構成仮想リンクであるＲ１－Ｒ２－Ｒ３およびＲ３－Ｒ４－Ｒ５のリンクＩＤにも、根底にあるネットワークリンクであるＲ１－Ｒ２、Ｒ２－Ｒ３、Ｒ３－Ｒ４、Ｒ４－Ｒ５のリンクＩＤにも関連する必要のない、リンクＩＤが当てられる。

【００９４】

仮想リンクＲ１－Ｒ２－Ｒ３－Ｒ４－Ｒ５のリンクＩＤが、上記のようにＶｉＬＳパケットを用いてノードＲ１－Ｒ２－Ｒ３－Ｒ４の転送テーブルに追加されてもよい。動作は、図６について記述したものと同様であり、ＢＦの中に含まれるリンクＩＤは、仮想リンクＲ１－Ｒ２－Ｒ３および仮想リンクＲ３－Ｒ４－Ｒ５のＩＤである。

【００９５】

仮想リンクは、存続時間が限定されなくてもよいし、存続時間が限定されてもよい。図７に示すように、ＶｉＬＳパケットは、もし分かっていれば、この存続時間情報も含んでもよい。そのような場合、ノードは、仮想リンクの存続時間が終了した後、転送テーブルから仮想リンクを消去する。

【００９６】

既存の仮想リンクの存続時間の修正を、ＶｉＬＳパケットを用いて、新たな存続時間を定義する新たなパケットを送信することによって、行うこともできる。同じ方法を用いて、存続時間がゼロに設定されているＶｉＬＳを送信することによって、既存の仮想リンクを手動で消去することもできる。

【００９７】

マルチパス／マルチキャスト・ステートレス転送

本発明の上記の記述は、ソースから単一の宛先ノードへ送信されるパケットに関する。しかし、本発明は、これに限定されず、パケットをソースから２つ以上の異なる宛先ノードへ配信するのに用いられてもよい。これは、２つ以上の宛先へのパスを定義するリンクＩＤを、パケットヘッダの中に含まれることになるブルームフィルタに追加することによって行われてもよい。

【００９８】

さらに、仮想リンクの上記の記述は、１つのソースから単一の宛先ノードまで送信されるパケットに関するが、マルチパスまたはマルチキャスト仮想リンクを作成することも可能である。これは、いずれも１つのノードから出るリンクを定義する２つ以上のリンクＩＤをＢＦに追加することによって行われてもよい。これを図９に示すが、ここではＲ１－Ｒ２－Ｒ３、Ｒ１－Ｒ４－Ｒ５およびＲ１－Ｒ４－Ｒ６を含む仮想リンクが（リンクＩＤ００１００１００１を使って）定義されている。完全なマルチキャストツリーは、リン

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クＲ１－Ｒ２、Ｒ２－Ｒ３、Ｒ１－Ｒ４、Ｒ４－Ｒ５およびＲ４－Ｒ６を同じＢＦにＯＲ演算することによって実装することができる。

【００９９】

ヘッダ内のこのＢＦを用いてソースから配信されるパケットは、図の中の３つのシンクノードすべて（Ｒ３、Ｒ５、Ｒ６）に配信されるであろう。図６で２つのノード間に仮想リンクがセットアップされるのと同様に、図９は、まったく同じ方法を用いて仮想マルチキャストツリーをセットアップする。この場合、２つ以上の宛先にデータを送信することになる各ノードは、仮想リンクＩＤを、（例えばノードＲ４の転送テーブルがノードＲ５へのリンクとノードＲ６へのリンクとを両方とも仮想リンクのリンクＩＤ（００１００１００１）に対してリストするように）複数の宛先リンクに関連付けることによって、転送テーブルの中でこれを判定するであろう。

【０１００】

この場合もやはり、仮想リンクの詳細は、ＶｉＬＳパケットを用いて配信することもできる。図９では、ルーティング機能は、ツリーのための仮想リンクＩＤ（００１００１００１）を作成し、ＶｉＬＳパケットを生成し、そしてそれをＲ１に入れる。ＶｉＬＳパケットがすべての宛先に渡された後、仮想マルチキャストツリーがネットワーク内でセットアップされる。データパケットが、ヘッダ内に仮想マルチキャストツリーのＩＤだけを含むＢＦ（００１００１００１）を使って送信される場合、データは、ソースからネットワーク内のすべてのシンクへルーティングされる。図９は、Ｒ２およびＲ４についての転送テーブルを示す。

【０１０１】

複数のパスを活用するもう１つのやり方は、それを冗長の目的で使用することである。同じソースと最終の宛先とを有するけれども、複数の並行パスを伴うようなパスを作成することは可能である（図１０）。すべてのパスは一方向であるが、２つのノード間でそのようなマルチパスルート（または仮想リンク）を容易に作成することができる。

【０１０２】

留意すべきだが、仮想リンクの生成は、本発明の特定のルーティングの方法を用いることに限定されない。

【０１０３】

上記の実施形態では、ネットワークを通るルートは、ノード間の単一のリンクかまたはノード間の単一のリンクから構築される仮想リンクを用いて、ルーティングレイヤで決められる。しかし、本発明は、これに限定されない。

【０１０４】

ステートフル・ルーティング

別の選択肢として、ネットワークを２つ以上のステートレス・ルーティング・エリアに分割するノードをネットワークに追加することが可能である。これらのプロキシノードは、異なるＢＦおよび発行間の状態情報を維持して、パケットが通過する際にＢＦヘッダ間のラベル切り替えを行う。これらのプロキシノードは、ブルームフィルタが一杯になるのを避けるために用いることもできるし、単にネットワークをさまざまな管理領域に分割するために用いることもできる。

【０１０５】

偽陽性率の削減

上記のように、ブルームフィルタの１つの特徴は、ＢＦ内のリンク識別子の存在をチェックする時、それが偽陽性を返す可能性がある（すなわち、ある項目がフィルタ内に存在すると報告するが、実際にはそれは存在しない）ということである。偽陽性の結果、パケットは、ＢＦの構築の間は含まれていなかった１つ以上のリンク上で転送される。ｐｕｂ／ｓｕｂパラダイムでは、偽陽性率が過大になることを制御するやり方がある限り、この影響は有害だとみなされない。偽陽性率は、フィルタ内に挿入された項目の数ｎと、フィルタのサイズｍと、フィルタ内の項目を表すビット数ｋとに依存する（この場合、リンク識別子は、ｋビットが１に設定され、残りのｍ－ｋビットが０に設定されたｍビットのベ

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クトルのかたちをとる）。

【０１０６】

ＢＦに関する問題は、それらが比較的速く「一杯」になることである。偽陽性の確率は、１つのフィルタに追加される要素が増えるにつれて高くなる。それによって、所定のＢＦサイズについては、所定の偽陽性率を超えないことが望ましい場合、ＢＦによって表されうるリンクの数は限られる。一例として、現行のＢＦの設計および約２５６ビットという典型的なパケットヘッダサイズの場合、ＢＦの偽陽性率（％）に起因して、３２個を超えるリンクＩＤをＢＦに挿入することはほぼ実行不可能となるであろうが、それは、偽陽性率が高くなる（約３％）であろうという理由による。しかし、多くの場合、３２個のリンクＩＤは、（ネットワークトポロジと、３２個のリンクによって定義されるパス上で通信するノードの数と、によっては）ルーティングの目的では不十分であろう。

【０１０７】

加えて、所定のネットワークトポロジとリンクＩＤの配信とを想定した場合に、現行のＢＦの生成には、偽陽性の影響をさらに細かく制御できるようなメカニズムが欠けている。特に、想定されるシステムにおけるルーティング機能が、ルーティングＢＦを作成するという柔軟性（ネットワーク内で特定のパスを定義するという主たる目的では同等であるが、ネットワークオペレータによって指定される何らかの条件においては偽陽性がいっそう有害であるという、リンクＩＤによって識別される特定の領域では偽陽性を回避できるような、ルーティングＢＦを作成するという柔軟性）を持てば、有益であろう。

【０１０８】

提案するＢＦを利用した手法のもう１つの問題は、セキュリティである。できれば、見込まれる悪質ソースノードに対処するメカニズムが求められる。見込まれる悪質ソースノードは、見込まれるＤｅｎｉａｌ　ｏｆ　Ｓｅｒｖｉｃｅアタックのための転送ＢＦを自分自身で生成したり、あるいは、ホストＩＤではなくトポロジ内でリンクを命名することに基づく転送システムを有するという本質的なセキュリティを迂回したりするかもしれない。

【０１０９】

従って、本発明のさらなる態様は、ＢＦベースのルーティング手法の偽陽性率を削減し、そして、ルーティングパス沿いのＢＦの影響を制御する新たなメカニズムを提供するという問題に取り組む。本発明のこの態様では、複数のブルームフィルタ候補（または、本態様もブルームフィルタに限定されないことから、他のコンパクトな集合表現）が生成され、そして、ブルームフィルタ候補（または、他のコンパクトな集合表現）の１つが、例えば、どの候補が偽陽性を返す確率が最も低いか等のような、所定の基準に基づいて選択される。この態様は、リンク識別子を含むＢＦを生成する確率的プロセスの間に利用できる選択に基づく。

【０１１０】

このさらなる態様は、一例として、複数のリンクを有するネットワークにおけるルーティングに関して記述されるであろうが、この態様はこれに限定されない。

【０１１１】

上記で説明したように、例えば図４のネットワークのようなネットワークの各リンクは、関連するリンク識別子（ＬＩＤまたはリンクＩＤ）を有する。上記の実施形態では、ＬＩＤを用いてブルームフィルタが生成され、これにより、特定のネットワーク利用についてはＢＦが１つだけ生成される。しかし、本発明の別の態様は、あるネットワークのパスを同等に表現する、２つ以上のＢＦ候補を生成する。これが行われうる１つのやり方は、各リンク識別子（ＬＩＤ）に関連する複数のリンク識別子タグ（ＬＩＴ）を生成し、ＬＩＴから複数のブルームフィルタ候補を生成することである。ソースルーティングに用いられるＢＦを選択する時に、ＢＦの中に挿入されることになるＬＩＴの最適な集合が、偽陽性の確率を最小化することができるように選択される。

【０１１２】

一般論として、本発明のこの態様が、識別子の集合に適用される場合、複数の表現（ま

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たは「タグ」）が各識別子について生成される。複数のブルームフィルタ候補（または集合メンバシップの複数の他のコンパクト表現）が、複数の識別子の表現から生成され、そして、ブルームフィルタ（または集合メンバシップの他のコンパクト表現）のうちの１つが、候補の中から選択される。

【０１１３】

一実施形態では、各ＬＩＤについて、ＬＩＤのｄ個のコンパクト表現を演算するが、ここでｄは、２以上の整数である。コンパクト表現の各々は、リンク識別子タグ（ＬＩＴ）として知られる。ＢＦの中に挿入されることになるリンクの各ＬＩＴについて、１度に各ＬＩＤの１つのＬＩＴ表現をＯＲ演算することによって、ＢＦ候補が生成される。この結果、ネットワークパスのリンク識別子を「等しく」表現する、ｄ個のＢＦ候補が生じることになり、ここで「等しく」とは、ｄ個のＢＦ候補の各々が、パケットがそれに沿ってルーティングされることが意図された（少なくとも）すべてのパスをパケットにたどらせることを意味する。

【０１１４】

原理的には、各リンクＩＤについてｄ個のＬＩＴを生成する必要はない。一例として、３２個のリンクがある場合、３２個のリンクＩＤのうちの３１個についてはｄ個のＬＩＴを生成するが、３２番目のリンクについては、このリンクがそのｄ個の表現の各々において同じＬＩＴを有するように、１個だけＬＩＴを生成することも可能であろう。この例では、ＢＦ候補を構築する際に３２番目のＬＩＴが何個のビットを１に設定するのかを選択する力はないであろうから、３２番目のＬＩＴは、ＢＦの中のそれらの数を削減することには貢献しないであろう。

【０１１５】

一部のリンクＩＤだけについてｄ個のＬＩＴを生成することは、ＢＦを解釈する一部の転送ノードがこのｄ個の拡張を有さず、従ってＬＩＴについての異なる転送テーブルを有しないようなシステムでは、有益でありうるだろう。それによって、より単純な転送ノードを供給することが可能になり、後方互換性サポートが提供される。

【０１１６】

ｄ個のＢＦ候補のうち、上記の実施形態の場合のように、ルーティング情報を提供する目的でパケットヘッダに挿入されるために１つが選択される。

【０１１７】

使用されることになるＢＦを選択するための主な基準は、ユーザが決めてもよく、例えば、偽陽性率を最小化することであってもよく、その場合、０の数が最も多いＢＦが、ＢＦ候補から選択される。例えば、１つ以上のリンクの部分集合について偽陽性率を最小化する（または、一般的な表現では、１つ以上の識別子の部分集合について偽陽性率を最小化する）ことのように、ＢＦを選択するための他の基準を適用することも可能であり、これは、例えば、パケットが所定のネットワーク領域に転送される結果となる偽陽性をもたらす所定のリンク識別子を避けるために（すなわち、偽陽性を所定のネットワークエリアに閉じ込める能力を提供するために）利用してもよい。

【０１１８】

この態様が上記の実施形態に適用される場合、パケットヘッダは、今度は、転送情報を含むＢＦに加えて、ＢＦを構築するのに用いられたＬＩＴの集合を識別するインデックスｄの２進法表現を含む。この態様のＢＦ（ｄ拡張型ＢＦと呼ぶ）を受信するルーティングノードは、ＢＦを構築するのに用いられたＬＩＴの集合に適した転送テーブルを選択することができる。

【０１１９】

提案するｄ拡張型ＢＦの手法は、それによって、ルーティングポリシーを実行するために適用されうる、偽陽性の影響に対するより精緻な制御を可能にし、そして、ＢＦを転送ヘッダとして用いる場合にセキュリティ機能を提供するように補強することができる。

【０１２０】

拡張型ブルームフィルタの詳細記述

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ランデブー、ルーティング、転送という３つの動作レイヤを持つＰｕｂ／Ｓｕｂネットワークに関して、実施形態を記述しよう。それらは一緒に、ソースノードと宛先ノードとの間でデータを発見して配信するのに必要な機能性を提供する。ネットワークの各リンクは、関連の識別子（リンクＩＤ）を有する。本発明の本態様では、各リンクＩＤのｄ個（ｄ＞１）の表現が生成され、ｄ個のＢＦ候補が、リンクＩＤのｄ個の表現から生成される。１個のリンク識別子に関連付けられたｄ個の表現の集合を有することは、偽陽性に対するより精緻な制御を提供することによって、より効率的かつ強力な転送スキームを可能にする。さらに、ＬＩＴベースのＢＦの選択力は、セキュリティまたはゾーン間のルーティング目的のためのポリシーの実行を、これらのポリシーをＢＦの選択および最適化の基準とみなすことによって、可能にする。

【０１２１】

リンクＩＤタグの構築

リンクＩＤは、ネットワークのリンクについての有向識別子として生成される。（記述を簡単にするため、すべての「リンク」は２つのネットワークノード間の実際のリンクであるが、リンクＩＤは、図６に関して記述したように「仮想リンク」の識別子でもあってもよいと仮定しよう。）本発明の本態様では、リンクＩＤ（ＬＩＤ）は、２つのネットワーク要素（例えばルータ）間のリンクを識別するため、いかなる名前の形態でもとることができる。典型的には、ＬＩＤは、無作為に生成されたビットの組み合わせ（例えば２５６ビットのハッシュ値）であろう。

【０１２２】

本発明の別の態様は、リンクＩＤのコンパクト表現として、「リンクＩＤタグ」（ＬＩＴ）という概念を導入する。加えて、すべてのリンクＩＤは、多価のマッピング関数を各ＬＩＤに適用することによって演算されるｄ個のＬＩＴの集合に関連付けられ、従ってこの場合、ＬＩＴは、各リンクＩＤについてと同じやり方で演算される。ｄは、ネットワークに依存して最適化されうるシステムパラメータである。ｄの典型的な範囲は、２から３２までであろう。（以前のリンクＩＤのように１個のＬＩＴしか見えない場合、それはｄ＝１の場合に相当するであろう。）例えば、マッピング関数は、各リンクＩＤについて、ｋビットが１に設定され、ｍ－ｋビットが０に設定されたＬＩＴビットベクトルを作成するために各リンクＩＤに適用される、ｋ個のハッシュ関数の集合であってもよい。この形態のＬＩＴをＢＦに組み込むことは、ｋ個のハッシュ関数を用いて挿入された１つの要素を持つｍビットのＢＦと同等であろう。（ＬＩＴのｄ個の集合がどうすれば得られるかという記述を以下に示す。）

以前の実施形態では、リンクＩＤは、好都合なＢＦの追加とチェック動作のため、ｋビットが１に設定されて他のｍ－ｋビットが０に設定された、サイズｍのビットマスクのかたちであってもよい。しかし、本実施形態では、ｋビットが１に設定されて他のｍ－ｋビットが０に設定された、サイズｍのビットマスクのかたちをとるのは、ＬＩＴであり、リンクＩＤのサイズと表現とは自由であって、ＬＩＴをそこから演算することができるならばいかなる適切なかたちをもとることができ、従って、本態様では、リンクＩＤ自体についてのかたちの選択の幅が拡がる。主な違いは、今度は、同じネットワークリンクを同等に表現するｄ個のＬＩＴの集合があり、偽陽性率を最小化するようなリンク識別子の組み合わせを表現するＬＩＴの集合を選択するために、ＬＩＴおよびＢＦの生成の無作為性を利用することができるということである。

【０１２３】

加えて、１個のリンクＩＤについてｄ個のＬＩＴの集合を生成するプロセスは、無作為のプロセスであってもよいし、ネットワークの実際のトポロジによりよく適合するためのもっと制御されたプロセスであってもよい。１個のリンクＩＤについてＬＩＴを生成することが、以下のようにトポロジにリンクされてもよい。（例えば転送ノードがネットワークに接続する）ブートストラッププロセスの間、リンクＩＤがＴｏｐｏｌｏｇｙ Ｍｏｄｕｌｅに登録される。ＬＩＴは、転送ノード自体によって生成されてもよいが、それは、ＬＩＴの生成に用いられるハッシュ関数を両者が分かっている場合である。あるいは、Ｔ

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ｏｐｏｌｏｇｙ　Ｍｏｄｕｌｅが、ＬＩＴを接続ノードに返すこともできる。この時点で、Ｔｏｐｏｌｏｇｙ　Ｍｏｄｕｌｅは、生成されたＬＩＴの衝突が最小限となり、それによって偽陽性率が低下するように、接続ノードの転送テーブルの中に「インストールされる」ことになるＬＩＴのリストを、アクティブなＬＩＴと一般に利用されるネットワークパスとに対してチェックする力を有する。

【０１２４】

図１４は、第１のハッシュ手順Ｈ１（ｘ）をリンクＩＤに適用することによって、１に設定されることになるとＨ１（ｘ）によって判断されるｋビットに基づいて第１のＬＩＴを生成し、第２のハッシュ手順をリンクＩＤに適用することによって第２のＬＩＴを生成し、ｄ番目のハッシュ関数Ｈｄ（ｘ）がリンクＩＤに適用されてｄ番目のＬＩＴを生成するまで以下同様に１個のリンクＩＤについてＬＩＴを生成する、１つの見込まれる方法を図解する。各ハッシュ手順は、ｋ個のハッシュ関数で構成され、その各々が、上記の図１に関して述べたように、１に設定されることになる、ビットベクトルの中の１つのビット位置を決める。

【０１２５】

各ハッシュ手順をリンクＩＤに適用することは、（偶然による場合を除いて）２つのハッシュ手順が同じ出力を生成しないように、各ハッシュ手順が新たなハッシュ関数の集合を含むことを必要とする。あるいは、その後のハッシュ手順を、以前に生成されたＬＩＴに繰り返して適用することもできるが、これなら、各ハッシュ手順が新たなハッシュ関数の集合を含むことは必要でないだろう。あるいは、ｋ個のハッシュ関数の集合が固定されたままで、最後に生成されたＬＩＴに繰り返して適用されてもよく、これなら、良好な無作為のＬＩＴを返すためのもう１つの有効な手順となり、必要なハッシュ関数の量が削減されるであろう。別の選択肢として、以下に述べるように、すべてのＬＩＴを生成するために必要なのは、２つの無作為な関数と２つのハッシングだけとなる。

【０１２６】

リンクＩＤ生成のプロセスの場合と同様に、リンクＩＤタグを決めるやり方はいろいろある。それらがルータによって自動的に生成され、その後、ルーティングレイヤに通信されてもよいし、それらが他のインスタンスによって割り当てられ、ルータ上で構成されてもよい。

【０１２７】

ルータは、自分が直接接続していると分かっているルータに対する自分自身の送出リンクにリンクＩＤを割り当てることができる（図１５のリンクＩＤ　ｘ　出力インタフェースを参照）。図１５は、リンクＩＤを使って各出力インタフェースを識別するネットワークノードの略図である（出力ポート１にはリンクＩＤａ、出力ポート２にはリンクＩＤｂ、以下同様）。ノードは、リンクＩＤタグによるインデックス付きのｄ個の転送テーブルを維持するが、それらは各ＬＩＴに関連する出力ポートを識別する。（すでに指摘したように、リンクＩＤは、仮想リンクに関係してもよいし、キャッシュシステムや他のネットワークプロセッサ／システムプロセスへのリンクに関係してもよい。）ルーティング機能の中に維持される情報は、今度は、各リンクＩＤに関連するｄ個のＬＩＴを含むように拡張される（ただし、原理的には、リンクＩＤだけがそこに格納されて、ＬＩＴ候補は常にオンデマンドで生成されてもよいだろう）。

【０１２８】

標準的なリンクＩＤの手法の場合と同様に、ネットワークノード内で維持されることになる転送状態は、非常に小さいままである。ｄの値が着信パケットの中に含まれている場合、各リンクＩＤについてのＬＩＴは、どのようにしてＬＩＴが当初生成されたかという知識からオンデマンドで演算されてもよいだろうが、性能上の理由で、（図１５に示すように）リンク識別子のｄ個の表現の各々について転送テーブルを維持することが望ましいことがあるだろう。図１６は、パケットヘッダの中の別のフィールドに含まれるブルームフィルタを生成するのに用いられるｄの値を与えるフィールドを有する、パケットヘッダの略図である。

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【０１２９】
１個のリンクＩＤからｄ個のリンクＩＤタグを算出するのに必要な異なるハッシュ関数の数を考える場合、各ＬＩＴのビット分布において最大のエントロピーを達成するには、ＬＩＴ毎にｋ個の異なるハッシュ関数が必要であろう。それは、１個のＬＩＤについてｄ個のＬＩＴを演算するのに合計でｋ＊ｄ個のハッシュ関数が必要であろうということを意味する。本発明でハッシュ関数を用いる場合、２つの態様に注目すべきである。第１に、本発明で提案するＢＦ生成と選択プロセスとの無作為性を考えると、ＬＩＴを生成するのに用いられるハッシュが真に無作為であることは重要ではない。第２に、二重のハッシング技法を用いれば、２つだけ無作為の非依存のハッシュ関数（例えばＢＯＢ、ＯＡＡＴ、ＳＢＯＸ、Ｈｓｉｅｈ、ＴＷＭＸ、ＲＳ、ＳＨＡ、ＭＤ５）を用いることによって、漸近的な偽陽性の確率を増加させることなく、ｄ個のＬＩＴを非常に効率的に生成することができる。２つのハッシュ関数ｈ１（ｘ）およびｈ２（ｘ）は、次式の形式のｉ個のハッシュ関数をシミュレートすることができる。

$$g_i(x) = h1(x) + i * h2(x) \bmod m$$

【０１３０】
さらに、この方法を用いると、いかなるＬＩＴ生成プロセスであろうと、１に設定されるＬＩＴのｋ個の位置を演算するのに用いられたｉ個のインデックスの集合によってコンパクトに表現することができる。従って、ｈ１（ｘ）とｈ２（ｘ）とがルーティング要素によって知られている場合、いずれかのＬＩＤについてＬＩＴを導出するのに必要なのは、ｄ＊ｋ個の整数ｉを共有することだけである。Ｔｏｐｏｌｏｇｙ　Ｍｏｄｕｌｅは、転送ノードにＬＩＴ全体を返信する代わりに、ＬＩＴを演算するのに用いられることになるインデックスｉを送信するだけでよいだろう。例えば、ＬＩＴ１［ｉ＝１，２，３，４，５］は、ＬＩＴ１が、ｉの値［１，２，３，４，５］とｈ１（ｘ）とｈ２（ｘ）とを用いるｇ（ｘ）によって判定されるｋ（＝５）ビットを１に設定することによって演算されることを意味するであろう。ｈ１（ｘ）とｈ２（ｘ）とはいずれも転送ノードとＴｏｐｏｌｏｇｙ　Ｍｏｄｕｌｅとによって知られているのだから、ｄ個のＬＩＴが演算されうるようにするには、ＬＩＤとインデックスｉ（合計でｄ＊ｋ個のインデックスがある）とを共有するだけで十分である。加えて、すでに述べたように、ｉは、単なる徐々に増加するシーケンスであってもよいだろうから、この場合、知られていると想定することもでき、従って、交換される必要はない。

【０１３１】
リンクＩＤタグ転送テーブル
パケットがネットワークノードに到着する時、パケットヘッダは、パケットがそれに沿って転送されるべきリンクのＬＩＴを含むかまたは符号化するＢＦを含み、かつ、ＢＦのｄの値を識別する。上記のように、パケット転送は、図１５に示すようにリンク識別子のｄ個の表現の各々について転送テーブルを維持するネットワークノードによって行われてもよい。着信リンク上でパケットが到着した時点で、ノード内の転送機能が、ｄ拡張型ＢＦ転送ヘッダに含まれる値ｄに基づいて、用いられることになる転送テーブルを選択する。ポート転送動作は簡単であって、ＢＦは、すべてのＬＩＴエントリに対して同時にＡＮＤであり、そして、この迅速な要素チェック動作の結果としてＬＩＴエントリが得られる度に、パケットは転送テーブルの中のＰｏｒｔＯｕｔ値へ転送される。

【０１３２】
転送テーブルにＬＩＴエントリを格納するための空間効率のよい複数の選択肢について述べよう。

【０１３３】
標準的な表現
標準的な表現では、見込まれるｄの値の各々について別個のルックアップテーブルが格納されるため、ｄ個のルックアップテーブルが格納される必要がある。各ルックアップテーブルは、各リンクＩＤタグについての適切な出力ポートを、例えば以下のようにリストする（テーブルは、２個のｄ値についてのみ示す）。

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リンクIDタグ(d=00)	出力インタフェース
0010100000100001	1
0001000010010100	3
256ビット	1バイト

リンクIDタグ(d=10)	リンクIDタグ(d=10)
1000010000100101	7
1000000010010100	1
256ビット	1バイト

【０１３４】
ＬＩＴベースの転送テーブルのための、ビットでの総メモリは、次式のようである。
FT_{mem}＝ｄ＊＃ＬＩＤｓ＊（ｓｉｚｅ（ＬＩＴ）＋ｓｉｚｅ（ＰｏｒｔＯｕｔ））
例：
ｄ＝８で、５１２個のリンクＩＤが存在し、各ＬＩＴは２５６ビットのサイズを有し、各出力ポート名は１ビットのサイズを有する場合には、
FT_{mem}＝８＊５１２＊（２５６＋８）＝１０８１３４４ｂｉｔ＝１０５６ｋｂｉｔ≒１Ｍｂｉｔ
である。（後で、図１８および図１９に要約したシミュレーションの結果を通じて、転送ＢＦのサイズが小さければ、ｄ＝８が良好なパラメータ選択であることを示す。）
【０１３５】
疎な表現
これは、１に設定されたｋビットの位置だけがＬＩＴエントリとして格納される、ＬＩＴの空間効率のよい表現である。表現は、ルックアップテーブルがＬＩＴ全体を格納せずに１に設定されるＬＩＴのｋビットの位置だけを格納するという点を除いて、標準的な表現の場合と同様にｄ個のルックアップテーブルを含む。ビットでのＬＩＴのサイズは、ｋにビット位置の２進法表現を乗じたものまで削減することができる（係数$\log(x)_2$／ｘでの削減）。この場合、ＬＩＴのサイズは次式で与えられる。

サイズ（ＬＩＴ）＝ｋ＊$\log_2$（ＬＩＴ）

例：ｋ＝５ならば、サイズ（ＬＩＴ）＝５＊$\log_2$（２５６）＝５＊８＝４０ビットである。
【０１３６】
今度は、ｄ個のＬＩＴ転送テーブルのための総メモリは、次式で与えられる。
FT_{mem}＝８＊５１２＊（４０＋８）＝１９６６０８＝１９２ｋｂｉｔ
【０１３７】
区分されたハッシュの疎な表現
区分されたハッシュの疎な表現は、１に設定されるＬＩＴのｋビットのビット位置だけを符号化することによるＢＦの疎な表現と同じ原理を用いる。しかし、ＢＦは、区分されたハッシングを用いて生成されると仮定されており、その場合、ハッシュ動作（ビットを１に設定すること）は、ＢＦを表すｍサイズのビットのベクトルの区分に対して排他的に行われる。各ｋビットのうちの１つだけが、サイズｍ／ｋの区分に対して設定される。この技術は、偽陽性率に重大な影響は及ぼさないと証明されている。この場合、ＬＩＴサイズは、次式で与えられる。

サイズ（ＬＩＴ）＝ｋ＊$\log_2$（ＬＩＴ／ｋ）

例：ｋ＝５ならば、サイズ（ＬＩＴ）＝５＊$\log_2$（２５６／５）＝５＊６＝３０ビ

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ットである。

【０１３８】

ここで、ｄ個のＬＩＴ転送テーブルのための総メモリは、次式で与えられる。

FT_{mem}＝８＊５１２＊（３０＋８）＝１９６６０８＝１４４ｋｂｉｔ

【０１３９】

効率的なルーティングのためのｄ最適化ブルームフィルタの構築

本セクションは、最適化されたＢＦを構築する手順がどのようにして行われるかを詳細に記述する。リンクＩＤタグがあれば、ネットワークリンクを表すｄ個のＬＩＴの間の選択力を利用することによって転送ＢＦのより柔軟な構築を可能にする識別子の基盤ができる。

【０１４０】

Ｔｏｐｏｌｏｇｙモジュールまたはルーティング機能が、通信ノード間でネットワークパスを確立するのに必要なリンクＩＤの集合を選択するという問題を解決したと仮定する（図１２のステップ３および４）。ＢＦの中で表現されることになるリンクＩＤの数をｎとしよう。偽陽性を最小化するための最適化手順は、以下のようである。上述のように、各リンクＩＤについてｄ個のＬＩＴが生成され、これらは、ＬＩＴ１、ＬＩＴ２、・・・ＬＩＴｄとラベル付けされる（図２０のステップ１（１）、１（２）、・・・１（ｄ））。

【０１４１】

ＢＦを構築するルーティング機能は、ＬＩＴ１の単純なＯＲ演算をすることによって、すべてのリンクＩＤのＬＩＴ１表現を第１のブルームフィルタ候補ＢＦ１の中に挿入する（図２０のステップ２（１））。同様に、同じ方法に従って、ＬＩＴ２の単純なＯＲ演算をすることによって、すべてのリンクＩＤのＬＩＴ２表現を第２のブルームフィルタ候補ＢＦ２の中に挿入し（図２０のステップ２（２））、以下同様に、ｄ番目のブルームフィルタ候補ＢＦｄが、すべてのリンクＩＤのＬＩＴｄ表現を挿入することによって構築され（図２のステップ２（ｄ））、結果として、同じネットワークパスを表現するｄ個のＢＦが生じるまで、挿入されることになるすべてのリンクの次のＬＩＴ表現を取り込む。（実際には、ｄ個のＢＦは、ここで述べるように次々にではなく、並行して構築される。）しかし、ｄ個のＢＦは同じネットワークパスを表現しているのだが、ＢＦを構築するためのＬＩＴとＯＲ演算の確率的性質が原因で、ＢＦは、１に設定されるビットの数（および位置）がさまざまである。

【０１４２】

パケットをルーティングするのに用いられることになるＢＦは、ｄ個のＢＦ候補から選択される（図２０のステップ３）。一実施形態では偽陽性を返す全体的な確率が最も低いＢＦが選択される。

【０１４３】

次いで、選択されたブルームフィルタが、上記の実施形態で記述したように用いられてもよく、そして、例えば、ソースノードに送信されてパケットヘッダに組み入れられてもよい（図１２のステップ６、７）。あるいは、ルーティング機能が、選択されたブルームフィルタをソースノード以外のノードに送信してもよい。

【０１４４】

図２０の方法は、ルーティング機能の中で行われると上述したけれども、その代わりにソースノードで行われてもよいだろう。

【０１４５】

一般に、図１２の方法で用いるＢＦを生成するのに図２０の方法が用いられる場合、３つの主な段階に分けることができるが、それらは、ｄ個のＢＦ候補を生成することと、使用される１つのＢＦ候補を選択することと、選択されたＢＦを使用することとである。これらの段階はすべて、同じネットワークノードで行われてもよいし、２つまたは３つもの異なるネットワークノードまたはエンドホストノードに分散されてもよい。例えば、上記のように、図２０の方法が全部ソースノードで行われ、ソースノードがパケットヘッダ内

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に選択されたブルームフィルタを含める場合、これは、生成段階と選択段階と使用段階とをすべて同じノードで実行する事例となるであろう。

【０１４６】

別の例として、図２０の方法は、ルーティング機能と別のノード（例えばソースノード）との間で分割することができるだろう。例えば、ルーティング機能がｄ個のブルームフィルタを生成するが、その後、ｄ個のブルームフィルタ全部を別のノードへ送信し、使用されることになるブルームフィルタの選択がその別のノードで行われるようにすることもできるだろう。本実施形態で望ましいならば、ルーティング機能は、ｄ個のブルームフィルタを他方のノードへ送信する時、どのブルームフィルタが選択されるべきだと自分が考えているかを示すこともできるだろうが、他方のノードは、この指示を無視することもできるだろう。他方のノードがソースノードである場合には、ソースノードは、選択されたブルームフィルタを、ソースノードから送信されることになるパケットに含めてもよい。（これは、ルーティング機能が生成段階を実行し、ソースノードが選択段階と使用段階とを実行することに相当するであろう。）しかし、他方のノードが、選択されたブルームフィルタの対象となるユーザでない場合、他方のノードは、選択されたブルームフィルタを対象となるユーザ、例えばソースノードに送信するであろう。（これは、生成段階と選択段階と使用段階とがすべて別のノードで実行される事例となるであろう。）

別の例として、ルーティング機能が、ｄ個のブルームフィルタから予備的な選択を行い、例えば、さらなる検討の結果、１つ以上の指定のリンクについて偽陽性を与える可能性のあるいずれかのブルームフィルタを廃棄することもできよう。次いでルーティング機能は、この予備的選択を通過したこれらのブルームフィルタを、（場合によっては、どのブルームフィルタが選択されるべきであるとルーティング機能が考えるかという指標と共に）別のノードに送信し、別のノードが最終選択を行うであろう。他方のノードが、選択されたブルームフィルタの対象となるユーザでなかった場合、他方のノードは、選択されたブルームフィルタを対象となるユーザに送信するであろう。

【０１４７】

ＢＦが偽陽性を返す確率は、ＢＦ内の０の１に対する割合に依存するということは重要であろうし、ＢＦの偽陽性率は、セルが空である確率の関数であることを示すことができる（例えば、Ａ．ＢｒｏｄｅｒとＭ．Ｍｉｔｚｅｎｍａｃｈｅｒとによる「Ｎｅｔｗｏｒｋ ａｐｐｌｉｃａｔｉｏｎｓ ｏｆ Ｂｌｏｏｍ ｆｉｌｔｅｒｓ： Ａ ｓｕｒｖｅｙ」、Ｉｎｔｅｒｎｅｔ Ｍａｔｈｅｍａｔｉｃｓ、ｖｏｌ．１、ｎｏ．４、２００２を参照のこと）。

$$p = Pr[\text{1個のセルが空である}] = (1 - 1/m)^{kn} \fallingdotseq e^{-kn/m}$$

$$fpb = Pr[\text{偽陽性}] = (1 - p)^{k} \fallingdotseq (1 - e^{-kn/m})^{k}$$

【０１４８】

セルが空である確率は、すでに１に設定されたセルの数に依存する。０に設定されるビット数が増加する場合、要素をチェックする時に０を見つける可能性が高まり、従って、偽陽性率は減少する。ｆｐｂで与えられる数式は、ハッシングの前の偽陽性の確率である。一旦ハッシング手順が行われ、ビットがＢＦ内で１に設定されると、フィルファクターρ（ロー）は既知であり、ハッシングの後の偽陽性の確率のより良い推定量は、次式で与えられる。

$$fpa = Pr[\text{偽陽性}] = \rho^{k}$$

【０１４９】

このように、ｄ個のＢＦ候補から偽陽性を返す確率が最小であるＢＦを選択することは簡単であり、０が最も多い（または１に設定されたビット数が最も少ない）ＢＦの方が、より良い成果が得られ、偽陽性が少なくなるであろうし、その結果、本発明のルーティング方法では、要求していないトラヒックを受信するリンクが減少する。偽陽性の確率が最小であると予測されるｄ個のＢＦ候補を選択するための選択アリゴリズムは、次式のようであろう。

$$\text{最小の } \{\rho_0^{k}, \ldots, \rho_d^{k}\} \text{ fpaを生じるdを選択する}$$

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【０１５０】
留意すべきだが、ｋは、ｄ個のＬＩＴ表現の各々について同じである必要はない。加えて、アプリケーションのシナリオによっては、ＬＩＴ表現の各々について、１に設定されるビットの量ｋが異なることも有益でありうる。例えば、ｄ＝８の場合、ｋを例えば｛３；３；４；４；５；５；６；６｝のように配分してもよいだろう。それは、８個のＬＩＴのうちの２個のＬＩＴは、３ビットだけが１に設定され、２個のＬＩＴは、４ビットが１に設定され、以下同様に設定されることを意味する。この場合、選択アルゴリズムは、一般的な事例である上述したものであって、すべてのＬＩＴを構築するのに同じｋが用いられる場合に限って当てはまる、０の数が最小の事例に留まらない。
【０１５１】
図１７は、リンクＡとリンクＢとで構成されるパスを表すためｄ＝４のＢＦ候補を生成するという単純な事例についての最適化プロセスを示す。この例では、ＢＦ２が、パケットヘッダ内でルーティングＢＦとして用いられることになる最適なＢＦであるが、それは、最大数のゼロを含んでおり、従って、偽陽性を与える全体的な可能性が最小だからである。
【０１５２】
この最適化のもう１つの解釈は、所定の最大の所望の偽陽性率について、ｄ選択型ＬＩＴ最適化によって、ＢＦにもっと多くのリンク識別子を挿入することが今では可能であり、それによって、さらなるホップへと拡大し、もっと多くの宛先ホストに到達することができるような、より大きな配信ツリーを構築することも可能であるということであろう。
【０１５３】
ＢＦの最適化は、全体的な偽陽性率に限定される必要はなく、他のポリシー、またはネットワーク最適化ポリシーを考慮に入れてもよいだろう。例えば、ｄ個のＢＦ候補を生成した後、ルーティング最適化モジュールが、転送要素の所定のリンクＩＤタグは、リンクの特定の部分集合について望まれていない偽陽性、例えば、ピアされていない領域や遅いネットワークパスや輻輳している領域への転送をもたらそうとしているかどうかチェックすることができてもよいだろう。この場合、絶対的な値としては最良の偽陽性率を有することができたとしても、このＢＦの選択肢を廃棄することを選択してもよいだろう。この一例を表１に示す。

LIT BF候補	選択基準一最適化目標				
	偽陽性率が全体的に最小	これらのリンクIDタグの集合についてBF内での偽陽性をチェックする			
		ポリシー対象領域間リンクID	高密度/低容量ゾーン内のリンクID	輻輳リンクID（動的集合）	…
BF1	++	-	+	++	
BF2	+++	---	-	-	
BF3	-	+	+++	+++	
…					
BFd	+	+	-	+	

表１
【０１５４】
表１は、各ＢＦ候補について、全体的な偽陽性率だけでなく特定のリンクの３つの部分集合（領域間リンク、低容量ゾーン内のリンク、輻輳リンク）についての偽陽性率を示す。領域間リンク、低容量ゾーン内のリンク、または輻輳リンク内の偽陽性は、その他のリンク内の偽陽性より有害であると仮定する。候補ＢＦ３は、全体的な偽陽性率は低いが、低容量ゾーン内および輻輳リンク内でのリンクについての偽陽性の確率が高い。従って、

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候補ＢＦ２は候補ＢＦ３よりも全体的な偽陽性率は高いけれども、低容量ゾーン内および輻輳リンク内でのリンクについての偽陽性の確率がより低いことから、パケットヘッダについてのＢＦとしてＢＦ２候補を選択する方が望ましいであろう。このようにして、本実施形態は、ＢＦが、偽陽性の全体的な確率に基づくのではなく、選択されたリンクにおける（本実施形態では、偽陽性がより有害であると考えられるリンクについての）偽陽性の確率に基づいて選択されることを可能にする。

【０１５５】

従って、本発明の本態様は、ＢＦが偽陽性を返すことが原因で一定のネットワークエリアにパケットが誤って進入することを回避する（または最小化する）ように、パケットヘッダ用の転送ＢＦを構築する強力な方法を提供することが分かる。ｄ個の同等のＢＦ候補を生成して、ＢＦ候補のうちの１つを選択することは、ネットワークを通るパケットの必須のパスは維持されていることを保証するが、所定のリンク上での偽陽性を最小化することや、偽陽性の影響をもっと好都合なパスに分散することもできる。

【０１５６】

本発明の利点

提案するリンクＩＤタグを使用すると、リンク情報の所与の集合がブルームフィルタのような確率的コンパクト表現に挿入される際の、偽陽性率が減少する。偽陽性率が減少すると、結果として、ＢＦベースのルーティング手法の帯域幅効率が向上した解決策が得られる。ＬＩＴを生成して最も適したＢＦを選択することについて提案する方法は、転送プロセスの簡素さを失うことなく、かつ、非常に安価な実装コストで、ＢＦベースのルーティングスキームの性能を大幅に向上させる。従って、所定の最大偽陽性値について、提案するリンクＩＤタグに基づくＢＦの構築は、ＢＦのサイズを増加させることなくＢＦに追加可能なリンク情報の容量を増加させる。

【０１５７】

リンクＩＤを表すリンクＩＤタグ候補を上手に選択することは、ＢＦによって決められるルーティングのホップの最大数を増加させるだけでなく、例えば、ＬＩＤによって識別される所定のネットワーク領域における偽陽性を回避（または最小化）することによって、または、例えば、偽陽性の影響をもっと好都合なパス全体にわたって拡散することによって、偽陽性の影響を制御することにおける柔軟性を高める。このより精緻な制御によって、ルーティングポリシーおよびセキュリティポリシーを本書で述べたＢＦベースのソースルーティング手法に適用することが可能になることが見込まれる。

【０１５８】

図１８は、ｄ選択型ＬＩＴ技法に従って構築されたＢＦの実際の偽陽性率の改善を示す。図１８は、偽陽性率を、５つの事例についてＢＦとして符号化されたリンクの数の関数として示す。

【０１５９】

１）ｋ＝５で、リンクＩＤをＢＦへと符号化した場合（＋で示す）
２）ｋ＝４、ｄ＝２で、ＬＩＴをＢＦへと符号化した場合（×で示す）
３）ｋ＝５、ｄ＝４で、ＬＩＴをＢＦへと符号化した場合（＊で示す）
４）ｋ＝６、ｄ＝８で、ＬＩＴをＢＦへと符号化した場合（白い四角で示す）
５）ｋ＝６、ｄ＝１６で、ＬＩＴをＢＦへと符号化した場合（黒い四角で示す）

【０１６０】

図は、５０回の実験に対する偽陽性率の平均と拡散(spread)とを、データポイント（フィルタ内の要素の数）毎に示す。

【０１６１】

ＬＩＴをＢＦへ符号化すると、偽陽性率が著しく減少し、減少幅は、ＢＦにおけるリンクの数が増加するにつれて拡大することが分かる。２４４ビットまでのＢＦのサイズについて、リンクＩＤがその中に符号化されている標準的なＢＦは、およそ３５個のリンクＩＤを含んでいる場合、４％の偽陽性率を呈する。ｄ＝８のＬＩＴ　ＢＦでは、同様の偽陽性率は、６０個のリンクＩＤがＢＦに挿入されている場合に限って観察される。ｄ選択型

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ＢＦは、構築された標準のＢＦより、すべての設定について勝っている。

【０１６２】

図１９は、ｄ選択型ＬＩＴ技法に従って構築されたＢＦの実際の偽陽性率の向上が、どのようにしてｄの値に依存するのかを示す。図１９は、偽陽性率を、ｋが一定である場合にｄの３つの異なる値についてＢＦとして符号化されたリンクの数の関数として示す。

【０１６３】

１）ｋ＝５、ｄ＝４で、ＬＩＴＢＦへと符号化した場合（＋で示す）

２）ｋ＝５、ｄ＝８で、ＢＦへと符号化した場合（×で示す）

３）ｋ＝５、ｄ＝１６で、ＢＦへと符号化した場合（＊で示す）

【０１６４】

図は、データポイント（フィルタ内の要素の数）毎の５０回の実験に対する偽陽性率の平均と拡散(spread)とを示す。

【０１６５】

図１９から、パラメータｄ＝８を設定することは、一方では偽陽性率の削減と、他方ではシステム内でより大きなｄの値を有すること（例えば転送テーブルのサイズとＢＦヘッダの中のビット数（$\log_2$（ｄ）ビット））に関連するコストの削減との間の良いトレードオフになりそうだと推論することができる。

【０１６６】

上記の方法では、ｄ個の「同等の」タグを一意のＩＤに関連付ける方法は、ＩＤがネットワークリンクについての何らかの識別子を参照するような利用シナリオに着目した。しかし、ＩＤからタグを生成するのに用いられるハッシング手順は、ｄ個のタグが導出されるＩＤの命名形式やサイズや意味に非依存である。従って、ｄ個のＢＦ候補を構築する上記の方法は、ネットワークリンクを符号化するＢＦに限定されるのではなく、ＩＤ（識別子）の集合が、例えばＢＦのような確率的データ構造によってコンパクトに表される、他の用途の場合にも適合する。

【０１６７】

一例をあげれば、ＩＤとしてホスト名（またはいずれかのタイプのホストＩＤ、識別子、署名、鍵、等）を考える場合にホスト名の集合のコンパクト表現を構築したい場合であろう。次いで、ｄ個のタグを各ＩＤについて同様に定義し、候補となるｄ個の表現（ブルームフィルタ）を演算し、そして、特定の利用シナリオに適した選択アルゴリズムを適用することができる。この場合もやはり、基本的な基準は、ＢＦの偽陽性確率予測を最小化することであってもよいだろうから、従って、選択アルゴリズムは、１に設定されるビット数が最も少ない候補、すなわち、何個の項目が挿入されたか、および、どのようにしてタグが構築されたかということに依存（例えば、すべてのタグで、固定数ｋビットが１に設定されているのか、あるいは、タグでのｋの濃度はさまざまであるのかに依存）して、ハッシング後の偽陽性確率が最も良い候補を選択するであろう。ＢＦに含まれる要素が少ないシナリオでは、ｋが大きい方が、ハッシング後の偽陽性推定量の結果が良いであろう。逆にＢＦがもっと詰まっている場合、要素毎のビット数（ｋ）を少なくすれば、偽陽性率が良好になるであろう。ｋの値にこのような柔軟性を持たせると、より多くの利用シナリオについて選択アルゴリズムが自然に適応する。

【０１６８】

同様に、それぞれの場合に最適化目標を達成するために、もっと緻密な選択戦略をとることもでき、例えば、ホストＩＤの試験集合を構築して、ＢＦ候補に対して偽陽性を試験し、観測された偽陽性率が最も少ないＢＦ候補が選択されてもよいだろう。その他のオフラインの選択基準には、一つでも偽陽性があればＢＦ候補を選択プロセスからすぐに排除するような試験集合が含まれてもよい（例えば、所定のリンクＩＤ（例えば或るネットワーク領域に広がるかもしくは領域間リンクに広がる使用量の多い仮想リンクＩＤ）については、ＢＦは偽陽性を一切引き起こしてはならないと指定することもできよう）。

【０１６９】

また、ｄ個のタグを有することの重要な利点も当然これに当てはまり、ポリシーの実行

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を有効にすることと、より良い成果をもたらすことと、新たなセキュリティメカニズムを有効にすることなどが、利点に含まれる。

【０１７０】

タグがそこから構築されうる、さらに想定されるＩＤには、ネットワーク領域（管理領域および物理領域）、ネットワークシステム、アプリケーションプロセス、ネットワークインタフェース、論理ポートおよび仮想ポート等が含まれる。アプリケーションによっては、複合的な最適化戦略や特定の選択基準が定義されてもよいし、他方、ｄ個のタグとｄ個のＢＦ候補を構築する基本的な方法が、単純な偽陽性率軽減アルゴリズムに加えてかまたはその代わりに、直接適用されてもよいだろう。

【図１】

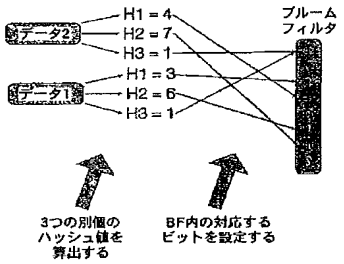

Figure 1

【図２】

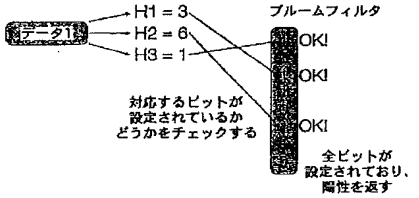

Figure 2

【図３】

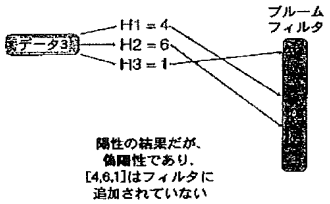

Figure 3

【図４】

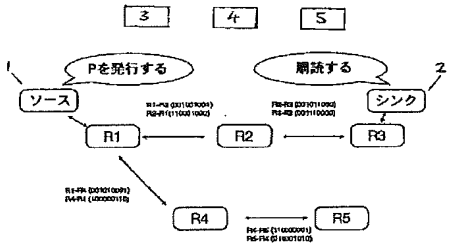

Figure 4

【図５】

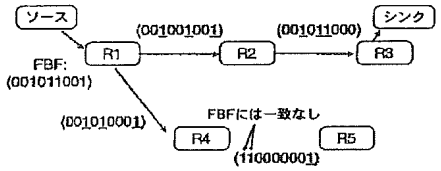

Figure 5 BFを使った転送

【図６】

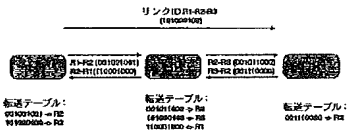

Figure 6

【図７】

転送ヘッダ BF: 001011001	発行ID VILS's ID	データ n-ID: 101000100; 存続時間

Figure 7 仮想リンクセットアップパケット

【図８】

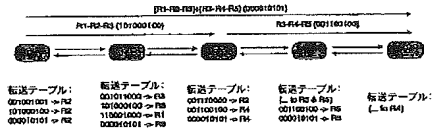

Figure 8

【図９】

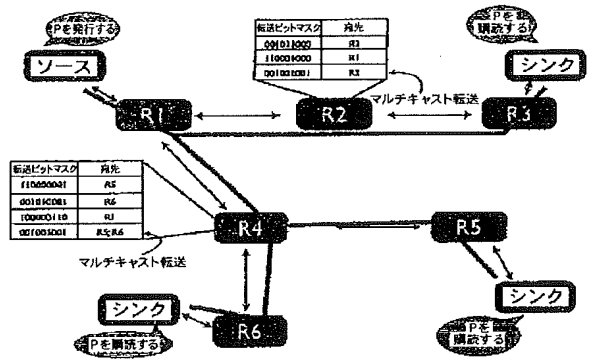

Figure 9

【図１０】

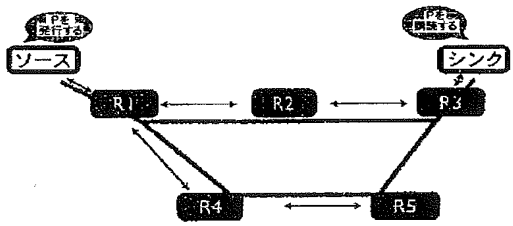

Figure 10

【図１１】

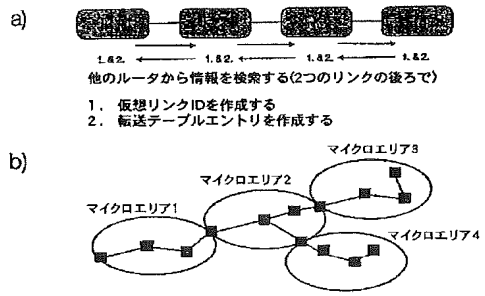

Figure 11 a）増強された自己生成 b）ステートフルルータに接続されたマイクロエリア

図b)は、その中でパスが自己生成されるマイクロエリアにネットワークを分割する可能性を図解する。ルーティング機能は、対応するマイクロエリアから受信したマイクロエリア情報を用いてパス全体を生成することに責任を持つ。

【図１２】

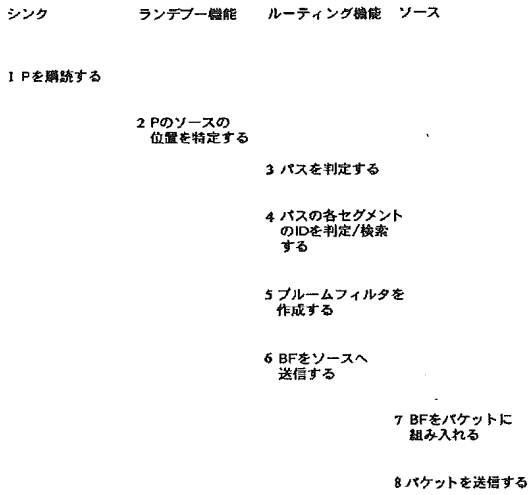

Figure 12

【図１３】

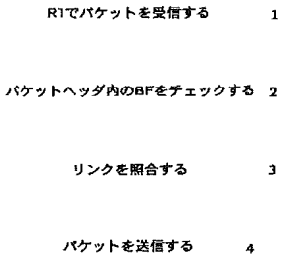

Figure 13

【図１４】

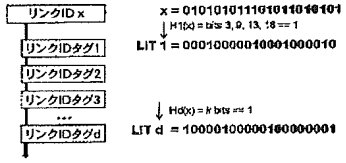

Figure 14. 1個のリンクIDとd個のリンクIDタグとの関係。
任意のk個を1に設定して残りを0のままにすることによるLIT生成の一例。

【図１５】

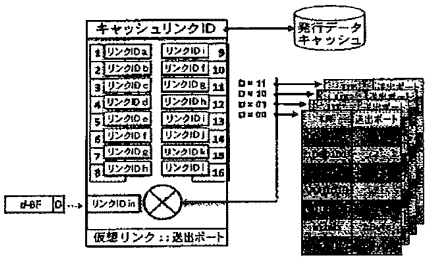

Figure 15. リンクIDを使って各出力インタフェースを識別し、かつ、
リンクIDタグによるインデックス付きのｄ個の転送テーブルを維持する、
転送エレメントの略図

【図１６】

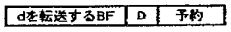

Figure 16. dを転送するBFヘッダの例

【図１７】

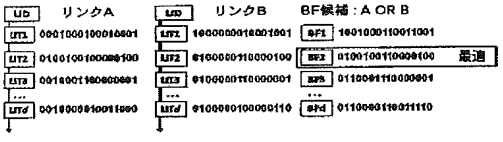

Figure 17 d個のブルームフィルタ候補の生成と、ビットベクトル内に存在する
0の数が最大であることに基づく最適なBFの選択

【図１８】

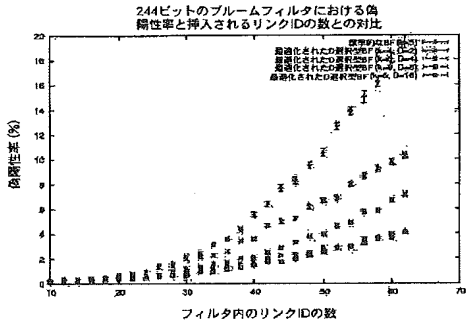

Figure 18 挿入されるリンクIDの数の関数としての実際の偽陽性率における、標準的なBF構造とd選択型LIT最適化されたBFとの対比

【図１９】

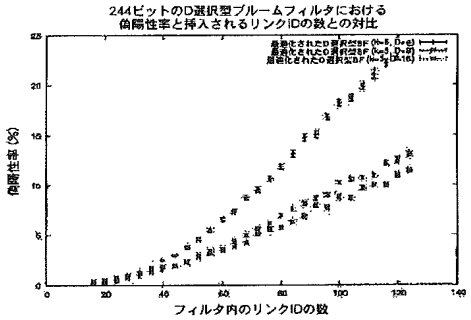

Figure 19 挿入されるリンクIDの数の関数としての、ブルームフィルタ構造のためにさまざまな程度で選択されたｄについての実際の偽陽性率、D=8が、244ビットについて推奨されるパラメータだと考えられる。

【図２０】

1(1) LIT1を判定する

1(2) LIT2を判定する

.....

1(d) LITdを判定する

2(1) BF1を判定する

2(2) BF2を判定する

.....

2(d) BFdを判定する

3 1個のBFを選択する

Figure 20

【手続補正書】
【提出日】平成22年10月18日(2010.10.18)
【手続補正１】
【補正対象書類名】特許請求の範囲
【補正対象項目名】全文
【補正方法】変更
【補正の内容】
【特許請求の範囲】
【請求項１】
パケットのルーティング情報を提供する方法であって、
ソースノードから１以上の宛先ノードへのルーティング情報を、集合メンバシップのコンパクト表現の中に符号化するステップを有し、
前記ルーティング情報は、１以上の識別子の表現を含み、
各識別子は、各ネットワークリンク、各ノード、又は、２以上のネットワークリンクを含む全体パス又は部分パスを識別し、
前記方法は、
前記１以上の識別子のｄ個（ｄは２以上の整数）の表現から、集合メンバシップのｄ個のコンパクト表現の候補を生成するステップと、
前記ソースノードから前記１以上のソースノードへ送信すべきパケットのヘッダの中に、集合メンバシップの前記コンパクト表現の１つを入れるステップと、
を有する、方法。
【請求項２】
前記ルーティング情報は、前記ソースノード又はルーティングサーバにおいて符号化される、
請求項１に記載の方法。
【請求項３】
前記パケットヘッダに含まれる集合メンバシップのコンパクト表現を識別する情報を、前記パケットヘッダの中に含めるステップ、
を更に有する、請求項１又は２に記載の方法。
【請求項４】
ネットワークを通ってパケットをルーティングする方法であって、
ネットワークノードにおいてパケットを受信するステップと、
前記ノードから前記パケットがこれに沿って送信されるべき１以上のリンクを判定するために、又は、前記ノードから前記パケットがそこへ送信されるべき１以上の他のノードを判定するために、又は、その両方のために、前記パケットのヘッダの中に集合メンバシップのコンパクト表現として含まれるルーティング情報を問い合わせるステップと、
前記判定された１以上のリンクに沿って、又は、前記判定された１以上の他のノードへ、又は、その両方で、前記パケットを転送するステップと、
を有し、
前記ルーティング情報は、１以上の識別子の複数の表現の候補の１つを含み、
各識別子は、各ネットワークリンク、各ノード、又は、２以上のネットワークリンクを含む全体パス又は部分パスを識別し、
前記ルーティングは、各々が前記１以上の識別子のｄ個（ｄは２以上の整数）の表現の候補の１つに対応するｄ個のルックアップテーブルから、前記１以上の識別子のうちの受信した表現に対応するルックアップテーブルを選択するステップを更に含む、
方法。
【請求項５】
ネットワークノードであって、
パケットを受信する手段と、
前記ノードから前記パケットがこれに沿って送信されるべき１以上のリンクを判定する

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ために、又は、前記ノードから前記パケットがそこへ送信されるべき１以上の他のノードを判定するために、又は、その両方のために、前記パケットのヘッダの中に集合メンバシップのコンパクト表現として含まれるルーティング情報を問い合わせる手段と、
を有し、
前記ネットワークノードは、前記判定された１以上のリンクに沿って、又は、前記判定された１以上の他のノードへ、又は、その両方で、前記パケットを転送するように構成され、
前記ネットワークノードは、各々が１以上の識別子のｄ個（ｄは２以上の整数）の表現の候補の１つに対応するｄ個のルックアップテーブルから、前記１以上の識別子のうちの受信した表現に対応するルックアップテーブルを選択するように更に構成される、
ネットワークノード。
【請求項６】
パケットのルーティング情報を提供するネットワークノードであって、
ソースノードから１以上の宛先ノードへのルーティング情報を、前記ソースノードから前記１以上のソースノードへ送信すべきパケットのヘッダの中に含めるために、集合メンバシップのコンパクト表現の中に符号化するように構成され、
前記ルーティング情報は、１以上の識別子の表現を含み、
前記ネットワークノードは、
前記１以上の識別子のうちの少なくとも一部に関するｄ個（ｄは２以上の整数）の表現を生成し、
前記識別子の前記ｄ個の表現から集合メンバシップのｄ個のコンパクト表現の候補を生成し、
集合メンバシップの前記ｄ個のコンパクト表現の候補の１つを選択する
ことにより、前記ルーティング情報を符号化するように構成される、
ネットワークノード。
【請求項７】
前記１以上の識別子のうちの少なくとも一部に関するｄ個（ｄは２以上の整数）の表現を生成し、
前記識別子の前記ｄ個の表現から集合メンバシップのｄ個のコンパクト表現の候補を生成し、
集合メンバシップの前記ｄ個のコンパクト表現の候補の２以上を他のノードへ送信する
ことにより、前記１以上の識別子の表現を含むルーティング情報を符号化するように構成される、
請求項６に記載のネットワークノード。

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【国際調査報告】

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2008/063647

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04L12/56

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, INSPEC, IBM-TDB, COMPENDEX, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	LICHUN BAO ED - WENJUN ZHANG ET AL: "A New Approach to Anonymous Multicast Routing in Ad Hoc Networks" COMMUNICATIONS AND NETWORKING IN CHINA, 2007. CHINACOM '07. SECOND INTERNATIONAL CONFERENCE ON, IEEE, PISCATAWAY, NJ, USA, 22 August 2007 (2007-08-22), pages 1004-1008, XP031238021 ISBN: 978-1-4244-1008-8	1-3, 9-14,16, 18,19
Y	paragraph [00II] - paragraph [0III]	4-6

-/--

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
10 August 2009	14/08/2009

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Hes, Ronald

Form PCT/ISA/210 (second sheet) (April 2005)

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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2008/063647

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CLAUDE CASTELLUCCIA ET AL: "Hash-Based Dynamic Source Routing" NETWORKING 2004, NETWORKING TECHNOLOGIES, SERVICES, AND PROTOCOLS; PERFORMANCE OF COMPUTER AND COMMUNICATION NETWORKS; MOBILE AND WIRELESS COMMUNICATIONS; [LECTURE NOTES IN COMPUTER SCIENCE;;LNCS], SPRINGER-VERLAG, BERLIN/HEIDELBERG, vol. 3042, 8 April 2004 (2004-04-08), pages 1012-1023, XP019005643 ISBN: 978-3-540-21959-0	1-3, 9-14,16, 18,19
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Form PCT/ISA/210 (continuation of second sheet) (April 2005)

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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2008/063647

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	MIGUEL JIMENO ET AL: "A Power Management Proxy with a New Best-of-N Bloom Filter Design to Reduce False Positives" PERFORMANCE, COMPUTING, AND COMMUNICATIONS CONFERENCE, 2007. IPCCC 200 7. IEEE INTERNATIONA, IEEE, PI, 1 April 2007 (2007-04-01), pages 125-133, XP031086865 ISBN: 978-1-4244-1137-5 abstract paragraph [0003] - paragraph [0005]	22-24
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A	SAILESH KUMAR ET AL: "Segmented hash" 26 October 2005 (2005-10-26), ARCHITECTURE FOR NETWORKING AND COMMUNICATIONS SYSTEMS, 2005. ANCS 2005. SYMPOSIUM ON, IEEE, PISCATAWAY, NJ, USA, PAGE(S) 91 - 103 , XP031362752 ISBN: 978-1-59593-082-8 paragraph [04.1] - paragraph [04.3]	22-24

Form PCT/ISA/210 (continuation of second sheet) (April 2005)

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/EP2008/063647

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers allsearchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search reportcovers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

Form PCT/ISA/210 (continuation of first sheet (2)) (April 2005)

International Application No. PCT/EP2008/063647

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-6, 9-13, 16,18-19

How to identify a path in a network

2. claims: 7-8, 14-15, 17, 20-24

How to generate compact set representations

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2008/063647

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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Form PCT/ISA/210 (patent family annex) (April 2005)

フロントページの続き

(81)指定国 AP(BW,GH,GM,KE,LS,MW,MZ,NA,SD,SL,SZ,TZ,UG,ZM,ZW),EA(AM,AZ,BY,KG,KZ,MD,RU,TJ,TM),EP(AT,BE,BG,CH,CY,CZ,DE,DK,EE,ES,FI,FR,GB,GR,HR,HU,IE,IS,IT,LT,LU,LV,MC,MT,NL,NO,PL,PT,RO,SE,SI,SK,TR),OA(BF,BJ,CF,CG,CI,CM,GA,GN,GQ,GW,ML,MR,NE,SN,TD,TG),AE,AG,AL,AM,AO,AT,AU,AZ,BA,BB,BG,BH,BR,BW,BY,BZ,CA,CH,CN,CO,CR,CU,CZ,DE,DK,DM,DO,DZ,EC,EE,EG,ES,FI,GB,GD,GE,GH,GM,GT,HN,HR,HU,ID,IL,IN,IS,JP,KE,KG,KM,KN,KP,KR,KZ,LA,LC,LK,LR,LS,LT,LU,LY,MA,MD,ME,MG,MK,MN,MW,MX,MY,MZ,NA,NG,NI,NO,NZ,OM,PG,PH,PL,PT,RO,RS,RU,SC,SD,SE,SG,SK,SL,SM,ST,SV,SY,TJ,TM,TN,TR,TT,TZ,UA,UG,US,UZ,VC,VN,ZA,ZM,ZW

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Fターム(参考) 5K030 GA15 HA08 HC01 HD03 LB05 LD19 LD20

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US008559434B2

(12) **United States Patent**
Esteve Rothenberg et al.

(10) **Patent No.: US 8,559,434 B2**
(45) **Date of Patent: Oct. 15, 2013**

(54) **PACKET FORWARDING IN A NETWORK**

(75) Inventors: **Christian Esteve Rothenberg**, Madrid (ES); **Petri Jokela**, Espoo (FI); **Jimmy Kjällman**, Espoo (FI); **Pekka Nikander**, Jorvas (FI); **Teemu Rinta-Aho**, Espoo (FI); **Jukka Ylitalo**, Espoo (FI)

(73) Assignee: **Telefonaktiebolaget L M Ericsson (publ)**, Stockholm (SE)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 180 days.

(21) Appl. No.: **13/059,958**

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(86) PCT No.: **PCT/EP2008/063647**

§ 371 (c)(1),
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Related U.S. Application Data

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(51) **Int. Cl.**
H04L 12/28 (2006.01)

(52) **U.S. Cl.**
USPC **370/392**; 709/238

(58) **Field of Classification Search**
USPC 370/392, 409; 709/238
See application file for complete search history.

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Primary Examiner — Wei Zhao
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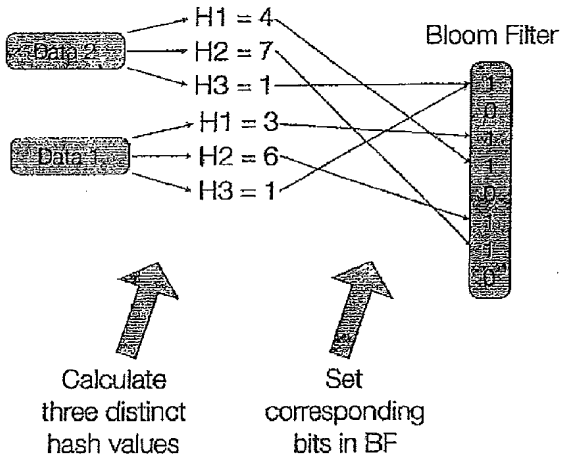
(57) **ABSTRACT**

A method of providing packet routing information comprises: encoding routing information from a source node to one or more destination nodes into a compact representation of set membership; and putting the compact representation of sets into a header of a packet that is to be sent from the source node to the destination node(s). The compact representation may be obtained by: generating d representations of a set of identifiers; generating d candidate compact representations of set membership from the d representations of the identifiers; and selecting one of the candidate compact representation of set membership. The selection may be made on the basis of which of the candidate compact representations has the lowest rate of returning false positives.

17 Claims, 12 Drawing Sheets



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(43)公表日　平成24年1月12日(2012.1.12)

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H04L 12/56 (2006.01)	H04L	12/56 100Z	5K030

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(31)優先権主張番号	PCT/EP2008/061167
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(33)優先権主張国	欧州特許庁 (EP)

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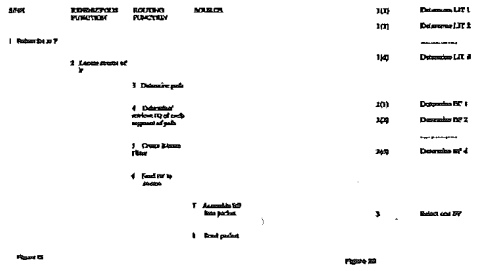
最終頁に続く

(54)【発明の名称】ネットワークにおけるパケット転送

(57)【要約】
パケットのルーティング情報を提供する方法が、ソースノードから１以上の宛先ノードへのルーティング情報を、集合メンバシップのコンパクト表現の中に符号化するステップと、前記ソースノードから前記１以上の宛先ノードへと送信すべきパケットのヘッダの中に、集合の前記コンパクト表現を入れるステップとを備える。前記コンパクト表現は、識別子のｄ個の集合の表現を生成し、前記識別子のｄ個の表現から集合メンバシップのｄ個のコンパクト表現の候補を生成し、集合メンバシップの前記コンパクト表現の候補のうちの１つを選択することにより、得ることができる。前記選択は、どのコンパクト表現の候補が偽陽性を返す確率が最も低いかに基づいて行われてもよい。



【特許請求の範囲】
【請求項１】
パケットのルーティング情報を提供する方法であって、
ソースノードから１以上の宛先ノードへのルーティング情報を、集合メンバシップのコンパクト表現の中に符号化するステップと、
前記ソースノードから前記１以上のソースノードへ送信すべきパケットのヘッダの中に、前記集合の前記コンパクト表現を入れるステップと、
を有する、方法。
【請求項２】
前記ルーティング情報は、前記ソースノード又はルーティングサーバにおいて符号化される、
請求項１に記載の方法。
【請求項３】
前記ルーティング情報は、１以上の識別子の表現を含み、
各識別子は、各ネットワークリンク、各ノード、又は、２以上のネットワークリンクを含む全体パス又は部分パスを識別する、
請求項１又は２に記載の方法。
【請求項４】
前記方法は、ネットワークを通るパスを定義するステップを更に有し、前記パスは複数の区分を含み、各区分は関連する識別子を有し、
前記方法は、前記パスに識別子を割り当てるステップを更に有し、前記パスに割り当てられる識別子は、前記パスに含まれる各区分に関連する識別子とは異なり、
前記ルーティング情報を符号化する前記ステップは、前記パスに割り当てられた識別子を符号化するステップを有する、
請求項１乃至３のいずれか１項に記載の方法。
【請求項５】
前記パスに割り当てられる識別子は、前記パスに含まれる各区分に関連する識別子とは無関係である、
請求項４に記載の方法。
【請求項６】
前記パスの少なくとも１つの区分は、２以上のリンクを含み、各リンクは、２つのネットワークノードを直接接続する、
請求項４に記載の方法。
【請求項７】
前記１以上の識別子のｄ個の表現から、集合メンバシップのｄ個のコンパクト表現の候補を生成するステップと、
集合メンバシップの前記コンパクト表現の１つを前記パケットヘッダに入れるステップと、
を有する、請求項３に記載の方法。
【請求項８】
前記パケットヘッダに含まれる集合メンバシップのコンパクト表現を識別する情報を、前記パケットヘッダの中に含めるステップ、
を更に有する、請求項７に記載の方法。
【請求項９】
ネットワークを通ってパケットをルーティングする方法であって、
ネットワークノードにおいてパケットを受信するステップと、
前記ノードから前記パケットがこれに沿って送信されるべき１以上のリンクを判定するために、又は、前記ノードから前記パケットがそこへ送信されるべき１以上の他のノードを判定するために、又は、その両方のために、前記パケットのヘッダの中に集合メンバシップのコンパクト表現として含まれるルーティング情報を問い合わせるステップと、

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前記判定された１以上のリンクに沿って、又は、前記判定された１以上の他のノードへ、又は、その両方で、前記パケットを転送するステップと、
を有する、方法。
【請求項１０】
集合メンバシップの前記コンパクト表現は、ブルームフィルタを含む、
請求項１乃至９のいずれか１項に記載の方法。
【請求項１１】
前記ルーティング情報は、複数のリンク識別子又はノード識別子を含み、
当該複数のリンク識別子又はノード識別子の各々は、各ネットワークリンク又は各ノードを識別する、
請求項１乃至１０のいずれか１項に記載の方法。
【請求項１２】
前記ルーティング情報は、２以上のネットワークリンクを含む全体パス又は部分パスを識別する識別子を含む、
請求項１乃至１０のいずれか１項に記載の方法。
【請求項１３】
前記ルーティング情報は、１以上の識別子の表現を含み、
各識別子は、各ネットワークリンク、各ノード、又は、２以上のネットワークリンクを含む全体パス又は部分パスを識別する、
請求項９に記載の方法。
【請求項１４】
前記ルーティング情報は、前記１以上の識別子の複数の表現の候補の１つを含む、
請求項１３に記載の方法。
【請求項１５】
前記ルーティングは、複数のルックアップテーブルから、前記１以上の識別子のうちの受信した表現に対応するルックアップテーブルを選択するステップを更に含む、
請求項１４に記載の方法。
【請求項１６】
ネットワークノードであって、
パケットを受信する手段と、
前記ノードから前記パケットがこれに沿って送信されるべき１以上のリンクを判定するために、又は、前記ノードから前記パケットがそこへ送信されるべき１以上の他のノードを判定するために、又は、その両方のために、前記パケットのヘッダの中に集合メンバシップのコンパクト表現として含まれるルーティング情報を問い合わせる手段と、
を有し、
前記ネットワークノードは、前記判定された１以上のリンクに沿って、又は、前記判定された１以上の他のノードへ、又は、その両方で、前記パケットを転送するように構成される、
ネットワークノード。
【請求項１７】
各々が１以上の識別子のｄ個の表現の候補の１つに対応するｄ個のルックアップテーブルから、前記１以上の識別子のうちの受信した表現に対応するルックアップテーブルを選択するように更に構成される、
請求項１６に記載のネットワークノード。
【請求項１８】
パケットのルーティング情報を提供するネットワークノードであって、
ソースノードから１以上の宛先ノードへのルーティング情報を、前記ソースノードから前記１以上のソースノードへ送信すべきパケットのヘッダの中に含めるために、集合メンバシップのコンパクト表現の中に符号化するように構成される、
ネットワークノード。

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【請求項１９】
集合メンバシップの前記コンパクト表現を前記ソースノードへ送信するように構成される、
請求項１８に記載のネットワークノード。
【請求項２０】
１以上の識別子のうちの少なくとも一部に関するｄ個の表現を生成し、
前記識別子の前記ｄ個の表現から集合メンバシップのｄ個のコンパクト表現の候補を生成し、
集合メンバシップの前記ｄ個のコンパクト表現の候補の１つを選択する
ことにより、前記１以上の識別子の表現を含むルーティング情報を符号化するように構成される、
請求項１８に記載のネットワークノード。
【請求項２１】
１以上の識別子のうちの少なくとも一部に関するｄ個の表現を生成し、
前記識別子の前記ｄ個の表現から集合メンバシップのｄ個のコンパクト表現の候補を生成し、
集合メンバシップの前記ｄ個のコンパクト表現の候補の２以上を他のノードへ送信する
ことにより、前記１以上の識別子の表現を含むルーティング情報を符号化するように構成される、
請求項１８に記載のネットワークノード。
【請求項２２】
複数の識別子の集合のコンパクト表現を生成する方法であって、
前記複数の識別子のうちの少なくとも一部に関するｄ個の表現を生成するステップと、
前記識別子の前記ｄ個の表現から集合メンバシップのｄ個のコンパクト表現の候補を生成するステップと、
集合メンバシップの前記ｄ個のコンパクト表現の候補の１つを選択するステップと、
を有する、方法。
【請求項２３】
集合メンバシップに関する誤った指示を生成する確率が最も低い、集合メンバシップのコンパクト表現の候補を選択するステップを有する、
請求項２２に記載の方法。
【請求項２４】
前記識別子の１以上を含むサブセットに関して集合メンバシップに関する誤った指示を生成する確率が最も低い、集合メンバシップのコンパクト表現の候補を選択するステップを有する、
請求項２２に記載の方法。
【発明の詳細な説明】
【技術分野】
【０００１】
本発明はネットワークにおけるパケット転送に関する。特に、本発明は、パケットがどのリンクに沿って転送されるべきかをネットワークノードがパケットヘッダの中の転送情報から判定できるようにするため、転送情報がパケットヘッダの中に含まれるような方法に関する。
【背景技術】
【０００２】
２００８年６月１１日から１３日までストックホルムで開催されたＩＣＴ Ｍｏｂｉｌｅ Ｓｕｍｍｉｔの予稿集の中で発表された「ＲＴＦＭ：Ｐｕｂｌｉｓｈ／Ｓｕｂｓｃｒｉｂｅ Ｉｎｔｅｒｗｏｒｋｉｎｇ Ａｒｃｈｉｔｅｃｔｕｒｅ」の中でＭｉｋｋｏ Ｓａｒｅｌａ、Ｔｅｅｍｕ Ｒｉｎｔａ－Ａｈｏ、およびＳａｓｕ Ｔａｒｋｏｍａによっ

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て記述されたＰｕｂｌｉｓｈ－Ｓｕｂｓｃｒｉｂｅ（「ｐｕｂｓｕｂ」）指向のネットワーキングは、第１に指定されるエンティティとしてホストとエンドポイントとに着目する元々のインターネットプロトコルとは対照的に、データに着目する。エンドポイントと、エンドポイント間のユニバーサルな接続性とを指定することに関するこの着目は、多くの良く知られた問題を引き起こす。第１に、現行のインターネットワーキングパラダイムでは、極悪な当事者もいれば利己的な当事者もいるにも関わらず、オープンなネットワーク内で当事者同士が相互に通信することができる。第２に、現代のアプリケーションの主要部分は、エンド・ツー・エンドの双方向通信の働きよりもむしろ、情報を広める働きを行っている。最後に、ハードウェアの観点からは、多くのタイプのネットワーク（例えば所定のタイプの無線、ケーブル、および光のネットワーク）では、ブロードキャスティングまたはマルチキャスティングは、単一の明確に識別された受信者にメッセージを送信することよりも、もっと自然で基本的な動作である。（「マルチキャスティング」は、指定された宛先のグループに情報を同時に配信することであり、「ブロードキャスティング」は、原理的にはネットワーク上のいかなるデバイスによっても受信できるように情報を送信することを言う。）これら３つの問題に照らして、ｐｕｂｌｉｓｈ－ｓｕｂｓｃｒｉｂｅパラダイムに基づくインターネットワーキングの方が、現行の送信者指向のものと比べて、より自然で、効率的で、実装が容易であろうということが提案されている。

【０００３】

次いで、ＨＴＴＰ、ピア・ツー・ピアのトラヒック、ＲＳＳフィード、ＰＳＩＰイベント、Ｓｅｒｖｉｃｅ　Ｏｒｉｅｎｔｅｄ　Ａｒｃｈｉｔｅｃｔｕｒｅ（ＳＯＡ）等の場合には、データをより詳しく見ると、このトラヒック（および恐らく他のトラヒックも）の大部分は、かなり単純な情報の繰り返しで構成されているように見える。例えば、動的なウェブページでさえ、典型的には、少量のクライアント固有ＨＴＭＬコードに結合された多数の静的な構成要素で構成される。多くのピア・ツー・ピアのネットワークでは、主な問題は、見込まれる消費者にできる限り近づくようにデータを最適なやり方で事前配信することである。

【０００４】

一般に、音声通話のようなリアルタイム双方向トラヒックという例外も可能性としてはあるが、現代のネットワークトラヒックの大半がデータ指向であると主張することができる。すなわち、アプリケーションは、接続を作り出すことに関心を持っているのではなく、十分に定義されたデータの断片を転送することに関心を持っているのである。一部のデータは、本質的にはトランザクションであり、すなわち、寿命が短く、かつ、通信の当事者に固有であるが、大部分のデータは、送信者および受信者には非依存であるように思える。例えば、ユーザが最新のＣＮＮニュースを知りたいと望む場合、ユーザＩＤに関係なくビットは基本的に（大体）同じであり、ユーザは、ビットが物理的にどこから来るのか気にしない。

【０００５】

比較的単純で静的ですらあるデータを配信するための技術が非常に多種多様であることから、相互接続の欠如に起因する多くの問題が生じている。将来のデータ配信標準のための競争は、もう始まっている。（現行のアーキテクチャの中での相互接続の欠如およびその他の欠陥によって生じた）動機付けが存在するのだから、データを発行して検索することについての何らかの標準的なやり方が１０年以内に提供されることが予想される。

【０００６】

Ｐｕｂｌｉｓｈ－Ｓｕｂｓｃｒｉｂｅパラダイムの背景にある１つの概念は、あるノードから別のノードへの不要なデータ配信を回避できるということである。今日のネットワークの場合のように、送信者は、グローバルに一意であるＩＰアドレスを用いて、何ら受信者からの明示的な要求がなくてもＩＰアドレスで識別されたホストにデータパケットを配信することができる。この結果、ユーザは、不要な、場合によっては悪質なデータを受信することになるため、これによって多くの問題が生じる。ＩＰアドレススキームで用いられているような、受信者に基づいたアドレス指定を廃止すれば、宛先ホストがデータを

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要求していないのに宛先ホストにデータを送信する可能性がこれによって除去されるのだから、この問題は克服することができるであろう。しかし、ＩＰアドレススキームが廃止された場合、ネットワークを通してパケットをルーティングするのに用いられうる新たなメカニズムを提供することが必要であろう。

【発明の概要】

【０００７】

本発明の第１の態様は、パケットのルーティング情報を提供する方法を提供する。当該方法において、ソースノードから１以上の宛先ノードへのルーティング情報が、集合メンバシップのコンパクト表現の中に符号化される。前記コンパクト表現は、前記ソースノードから前記１以上のソースノードへ送信すべきパケットのヘッダの中に入れられる。

【０００８】

集合メンバシップの前記コンパクト表現は、ブルームフィルタを含んでもよい。

【０００９】

前記ルーティング情報は、各々が各ネットワークリンク又は各ネットワークノードを識別する複数のリンク識別子又はノード識別子を含んでもよい。あるいは、前記ルーティング情報は、後で「仮想リンク」と呼ばれる、２以上のネットワークリンクを含む部分パスを識別する識別子を含んでもよい。（ここで使用されるように、「リンク」はネットワークの２つのノードを直接接続し、ネットワークを通る「パス」は、概して、複数の「リンク」を含む。）他のルーティング情報は、管理領域又は物理ネットワークエリアを識別する、ネットワーク領域の識別子を含んでもよい。

【００１０】

前記ルーティング情報は、前記ソースノードから前記１以上の宛先ノードへの１以上のパスを定義することができる。あるいは、前記ルーティング情報は、前記ソースノードから２以上の異なる宛先ノードへの各パスを定義してもよい。パスの一部が重複している場合、そのような重複している情報は１度だけ符号化され、これにより、パスの集合の代わりに配信ツリーを表す。

【００１１】

前記ルーティング情報は、前記ネットワークのソースノードで符号化されてもよい。あるいは、前記ルーティング情報は、ルーティングサーバで符号化されて、符号化されたルーティング情報が前記ソースノードへ転送されてもよい。

【００１２】

前記方法は、前記パケットのヘッダの中に含まれる前記ルーティング情報を問い合わせることにより、前記ソースノードから前記１以上の宛先ノードへのパスを判定するステップを含んでもよい。

【００１３】

前記方法は、識別子のｄ個の表現から、集合メンバシップのｄ個のコンパクト表現の候補を生成するステップを含んでもよい（ｄは２以上の整数である）。

【００１４】

その後、集合メンバシップの前記コンパクト表現の１つが、使用のために選択されてもよい。この選択は、ユーザが決定した基準（例えば、どの表現が擬陽性を生み出す確率が最も低いか、どの表現が複数の識別子のうちの１以上を含むサブセットに関して擬陽性を生み出す確率が最も低いか、又は、どの表現が複数の識別子のうちの１以上を含むサブセットに関して擬陽性を生み出さないか）に従って行われてもよい。

【００１５】

集合メンバシップの選択されたコンパクト表現は、例えば、ルーティング情報を提供するためにパケットヘッダに含められてもよい。

【００１６】

本発明の第２の態様は、ネットワークを通ってパケットをルーティングする方法を提供する。パケットが、ネットワークノードにおいて受信される。前記ノードから前記パケットがこれに沿って送信されるべき１以上のリンクを判定するために、又は、前記ノードか

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ら前記パケットがそこへ送信されるべき１以上の他のノードを判定するために、又は、その両方のために、前記パケットのヘッダの中に含まれるルーティング情報が問い合わせられる。前記ルーティング情報は、前記パケットのヘッダの中に集合メンバシップのコンパクト表現として含まれる。前記パケットは、前記判定された１以上のリンクに沿って、又は、前記判定された１以上の他のノードへ、又は、その両方で、前記ネットワークノードから転送される。

【００１７】

集合メンバシップの前記コンパクト表現は、ブルームフィルタを含んでもよい。

【００１８】

前記ルーティング情報は、各々が各ネットワークリンク又は各ネットワークノードを識別する複数のリンク識別子を含んでもよい。あるいは、前記ルーティング情報は、２以上のネットワークリンクを含む部分パスを各々が識別する１以上の識別子を含んでもよい。

【００１９】

前記ルーティング情報は、前記１以上の識別子の複数の表現の候補の１つを含んでもよい。

【００２０】

前記ルーティングは、複数のルックアップテーブルから、前記１以上の識別子のうちの受信した表現に対応するルックアップテーブルを選択するステップを含んでもよい。

【００２１】

本発明の第３の態様は、パケットを受信する手段を有するネットワークノードを提供する。前記ネットワークノードは更に、前記ノードから前記パケットがこれに沿って送信されるべき１以上のリンクを判定するために、又は、前記ノードから前記パケットがそこへ送信されるべき１以上の他のノードを判定するために、又は、その両方のために、前記パケットのヘッダの中に集合メンバシップのコンパクト表現として含まれるルーティング情報を問い合わせる手段を有する。前記ネットワークノードは、前記判定された１以上のリンクに沿って、又は、前記判定された１以上の他のノードへ、又は、その両方で、前記パケットを転送する。

【００２２】

前記ルーティング情報は、各々が各ネットワークリンク又は各ネットワークノードを識別する複数のリンク識別子又はノード識別子を含んでもよい。あるいは、前記ルーティング情報は、２以上のネットワークリンクを含む全体パス又は部分パスを各々が識別する１以上の識別子を含んでもよい。

【００２３】

前記ネットワークノードは、各々が前記１以上の識別子のｄ個の表現の候補の１つに対応するｄ個のルックアップテーブルから、前記１以上の識別子のうちの受信した表現に対応するルックアップテーブルを選択するように構成されてもよい。

【００２４】

集合メンバシップの前記コンパクト表現は、ブルームフィルタであってもよい。

【００２５】

前記第１の態様の方法は、ネットワークを通るパスを定義するステップを有してもよい。前記パスは複数の区分を含み、各区分は関連する識別子を有する。前記パスに含まれる各区分に関連する識別子とは異なる識別子が、前記パスに割り当てられる。前記ルーティング情報を符号化する前記ステップは、前記パスの各区分に関連する識別子を符号化するのではなく、前記パスに割り当てられた識別子を符号化するステップを有する。

【００２６】

前記パスに割り当てられる識別子は、前記パスに含まれる各区分に関連する識別子とは無関係であってもよい。

【００２７】

前記パスの少なくとも１つの区分は、２以上のリンクを含んでもよく、各リンクは、２つのネットワークノードを直接接続してもよい。

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【００２８】
本発明の第４の態様は、パケットのルーティング情報を提供するネットワークノードであって、ソースノードから１以上の宛先ノードへのルーティング情報を、前記ソースノードから前記１以上のソースノードへ送信すべきパケットのヘッダの中に含めるために、集合メンバシップのコンパクト表現の中に符号化するように構成される、ネットワークノードを提供する。
【００２９】
前記ネットワークノードは、例えば当該ネットワークノードがルーティング機能ノードである場合に、集合メンバシップの前記コンパクト表現を前記ソースノードへ送信するように構成されてもよい。
【００３０】
あるいは、前記ネットワークノードは前記ソースノードであってもよく、この場合、前記ネットワークノードは、集合メンバシップの前記コンパクト表現を、前記ソースノードから送信すべきパケットのヘッダの中に含めるように構成されてもよい。
【００３１】
集合メンバシップの前記コンパクト表現は、ブルームフィルタであってもよい。
【００３２】
前記ネットワークノードは、１以上の識別子のうちの少なくとも一部に関するｄ個の表現を生成し、前記識別子の前記ｄ個の表現から集合メンバシップのｄ個のコンパクト表現の候補を生成し、集合メンバシップの前記ｄ個のコンパクト表現の候補の１つを選択することにより、前記１以上の識別子の表現を含むルーティング情報を符号化するように構成されてもよい。
【００３３】
あるいは、前記ネットワークノードは、１以上の識別子のうちの少なくとも一部に関するｄ個の表現を生成し、前記識別子の前記ｄ個の表現から集合メンバシップのｄ個のコンパクト表現の候補を生成し、集合メンバシップの前記ｄ個のコンパクト表現の候補の２以上を他のノードへ送信することにより、前記１以上の識別子の表現を含むルーティング情報を符号化するように構成されてもよい。前記他のノードは例えば前記ソースノードであってもよく、その後、当該ソースノードは、受信したコンパクト表現の候補の１つを選択し、当該選択したコンパクト表現をパケットヘッダの中に含めることができる。あるいは、前記他のノードは、受信したコンパクト表現の候補の１つを選択してもよいが、自分自身は当該選択したコンパクト表現を使用せずに、当該選択したコンパクト表現を他のノードへ転送してもよい。
【００３４】
各識別子は、各ネットワークリンク、各ノード、又は、２以上のネットワークリンクを含む全体パス又は部分パスを識別してもよい。
【００３５】
本発明の第５の態様は、複数の識別子の集合のコンパクト表現を生成する方法を提供する。前記方法は、最初に、前記識別子に関するｄ個の表現を生成するステップを有し、集合メンバシップのｄ個のコンパクト表現の候補が、前記識別子の前記ｄ個の表現から生成される。その後、集合メンバシップの前記ｄ個のコンパクト表現の候補の１つが、使用のために選択される。
【００３６】
前記選択は、ユーザによって事前定義された基準に基づいて行われてもよい。
【００３７】
前記方法は、適当なプロセッサによって（例えば、ネットワークノードに含まれるか又はネットワークノードを構成するプロセッサにおいて）実装可能である。
【００３８】
前記識別子の前記表現は、コンパクト表現であってもよい。識別子の「コンパクト」な表現とは、それが表す識別子よりも少ない数のビット（好ましくは、大幅に少ない数のビ

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ット）が１に設定される表現を意味する。コンパクト表現の使用には、識別子自体の長さ及び形式には（あるとしても）少ない制限しか存在しないという利点がある。

【００３９】

集合メンバシップの前記コンパクト表現は、ブルームフィルタであってもよい。

【００４０】

本発明の他の態様は、命令を含んだコンピュータ読み取り可能な物を提供する。当該命令は、プロセッサ上で実行されると、当該プロセッサに、本発明の第１の態様の方法を実行させるか、又は、本発明の第２の態様の方法を実行させる。

【００４１】

本発明はまた、１以上の識別子のうちの少なくとも一部に関するｄ個の表現を生成し、前記識別子の前記ｄ個の表現から集合メンバシップのｄ個のコンパクト表現の候補を生成することにより、前記１以上の識別子の表現を含む、パケットのルーティング情報を符号化するネットワークノードを提供する。

【００４２】

本発明はまた、１以上の識別子の表現を含む、パケットのルーティング情報を提供するネットワークノードを提供する。前記ネットワークノードは、集合メンバシップの複数のコンパクト表現の候補を受信し、事前決定された基準に従って集合メンバシップの前記コンパクト表現の１つを選択するように構成される。ユーザ定義であってもよい前記基準は、例えば、どの表現が擬陽性を生み出す確率が最も低いか、どの表現が複数の識別子のうちの１以上を含むサブセットに関して擬陽性を生み出す確率が最も低いか、又は、どの表現が複数の識別子のうちの１以上を含むサブセットに関して擬陽性を生み出さないか、であってもよい。

【００４３】

本発明はまた、ソースノードを提供する。前記ソースノードは、集合メンバシップのコンパクト表現を受信し、ルーティング情報を提供するために集合メンバシップの前記コンパクト表現をパケットヘッダの中に含めるように構成される。

【００４４】

集合メンバシップの前記コンパクト表現は、ブルームフィルタであってもよい。

【図面の簡単な説明】

【００４５】

本発明の実施形態について、添付の図面を参照しながら、例証として、さらに記述しよう。

【図１】ブルームフィルタに項目を追加するプロセスを図解する略図である。

【図２】ブルームフィルタにデータ項目が追加されたかどうかを検証するプロセスを図解する略図である。

【図３】偽陽性を返すブルームフィルタ検証を図解する略図である。

【図４】本発明の一実施形態による、ネットワークを通るパケット転送を図解する図である。

【図５】本発明の一実施形態による、ネットワークを通るパケット転送を図解する図である。

【図６】本発明の別の実施形態による、ネットワークを通る仮想リンクの作成を図解する図である。

【図７】仮想リンク・セットアップ・パケットの略図である。

【図８】ネットワークを通る仮想リンクを作成する別の方法を図解する図である。

【図９】Ｍｕｌｔｉｃａｓｔツリーを作成する仮想リンクを図解する図である。

【図１０】１個のパケットについてネットワークを通る複数のパスを図解する図である。

【図１１】（ａ）及び（ｂ）は、パスの自己生成を図解する図である。

【図１２】パケットヘッダ内での転送情報の提供を図解するブロックフロー図である。

【図１３】図５の実施形態による、ネットワークを通るパケット転送を図解するブロックフロー図である。

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【図１４】識別子に対応するタグの生成を図解する図である。
【図１５】本発明の別の態様による転送ノードを図解する略図である。
【図１６】パケットヘッダの略図である。
【図１７】本発明の別の実施形態による方法を図解する図である。
【図１８】本発明の一実施形態によって得られうる偽陽性率の削減を図解する図である。
【図１９】偽陽性率を図解する図である。
【図２０】本発明の別の態様の方法のブロックフロー図である。
【発明を実施するための形態】
【００４６】
本発明について、ルーティング情報がブルームフィルタに含まれる実施形態に関して記述しよう。しかし、本発明はブルームフィルタに限定されるのではなく、ルーティング情報を、機能性ではブルームフィルタを用いるのと同様にルーティング情報を識別するために問い合わせ可能な集合メンバシップへと符号化することを含む、他のコンパクト表現が用いられてもよい。これは例えば、Ｄｉｓｃｒｅｔｅアルゴリズムに関する第１６回年次ＡＣＭ－ＳＩＡＭシンポジウム（２００５）の予稿集の８２３頁から８２９頁までに記載された「Ａｎ　Ｏｐｔｉｍａｌ　Ｂｌｏｏｍ　Ｆｉｌｔｅｒ　Ｒｅｐｌａｃｅｍｅｎｔ」の中でＡ　Ｐａｇｈ他によって記述された表現のようなものである。また、本発明は、例えばＩＥＥＥ／ＡＣＭ　Ｔｒａｎｓａｃｔｉｏｎｓ　ｏｎ　Ｎｅｔｗｏｒｋｉｎｇ、Ｖｏｌ．１０、Ｎｏ．５、ｐ６０４（２００２）の「Ｃｏｍｐｒｅｓｓｅｄ　Ｂｌｏｏｍ　Ｆｉｌｔｅｒｓ」の中でＭ．Ｍｉｔｚｅｎｍａｃｈｅｒによって開示されたもののような、修正されたブルームフィルタを使って達成されてもよい。
【００４７】
本発明は、ブルームフィルタ（ＢＦ）に基づいた新たなソースルーティングスキームを提供し、この場合、ルーティング情報はパケットヘッダの中のＢＦに含まれる。通常、「ソースルーティング」という用語は、パケットがソースノードから宛先ノードまでたどることになるパス全体をソースノードが制御する時に用いられる。用いられる他の用語として、正確なパスが既知である場合の「ストリクト・ソース・ルーティング」と、パケットが通過することになるネットワーク内の一部のポイントだけをソースノードが定義する場合の「ルーズ・ソース・ルーティング」とがある。
【００４８】
提案する解決策は、ルーティング機能性が宛先または宛先の集合までのパケットのパス全体を知っており、この情報に基づいてパケットヘッダを作成するという意味で「ソースルーティング」である。また、パス上の各ノードが知られているのだから、これはストリクト・ソース・ルーティングであると考えることもできる。（留意すべきだが、以下で説明するように、ノードは本発明では転送要素として動作するのであって、パケットがどのルートをたどるべきかについてノード自身が決定を行うことはない。）作成されたパケットヘッダは、パケットに組み込むため、ソースノードに与えられるかまたはソースノードで構築される。すべての個々の転送ステップが含まれるＢＦベースのヘッダを用いる時には、転送ノードは、いかなるノードまたはリンク情報であろうとまったくヘッダから抽出することはできない。従って、ノードは、パケットがどこへルーティングされることになるのか実際には知らない。パス上の各ノードは、自分自身のリンク情報を用いて、パケットがどこへ渡されるべきかを検証することができるだけである。
【００４９】
本発明のブルームフィルタベースの方法を用いて、ネットワークノード内で必要とされる状態情報を最小化することも可能である。
【００５０】
本発明の実施形態について記述する前に、ブルームフィルタの予備的説明をしよう。
【００５１】
ブルームフィルタ
ブルームフィルタ（ＢＦ）は、集合メンバシップのコンパクト表現の中にデータ項目を

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含める効率的なやり方を提供する。データに対して少数の別個のハッシュ値が算出され、これらのハッシュ値は、ブルームフィルタのビット列の中の所定のビットを表しており、それが項目を追加する間に１に設定される。

【００５２】

同じ方法論を用いて、集合表現の中にリンク情報を挿入することも可能であり、その場合、リンク情報は、ネットワーク内の２つのノード間のリンクに対応する。データ項目が追加されたブルームフィルタからは、追加された情報を抽出することは不可能である。可能なのは、その項目がその中に含まれているか否かを検証することだけである。偽陽性（データ項目が実際には追加されていないのに、追加されたと通知すること）の可能性は若干あるが、偽陰性の可能性はない。これをルーティングに適用する場合、パケット転送に用いられるＢＦは、偽陽性が原因でネットワーク内で追加パケットの増殖を生み出す可能性があるが、それはｐｕｂ／ｓｕｂネットワークでは、偽陽性率を制御するやり方がある限り、有害とはみなされない。ＢＦの場合、それは、追加されることになる項目の数とフィルタのサイズとを制御することが可能であることを意味する。しかし、もっと重要なことだが、少なくとも集合表現に追加されたリンクを介して、データは常にルーティングされる。

【００５３】

結果として、ＢＦ（例えば長さ１２８ビット）をパケットヘッダに追加することができ、そしてそれは、ソースノードから宛先ノードまでの全ルートを含む。これは、エンド・ツー・エンドであってもよいし、元のデータ発行者から加入者までのパスの一部だけであってもよい。ネットワークノードでは、最小限の転送情報だけを維持すればよい。例えば、各ノードは、典型的には、ルーティングテーブルを維持し、各テーブルエントリは、所与のリンクを介して送信されることになるパケットを識別するのに必要な情報を保持する。その場合、ノードは、自身が接続しているノードの各々について転送テーブルの中で１つのエントリだけを必要とするということでよい。

【００５４】

転送プロセスは効率的であり、転送テーブルエントリの中のパケット識別情報は、パケットヘッダ内のＢＦとの間でビット単位でＡＮＤ演算され（この場合、「ＡＮＤ演算される」とは、論理ＡＮＤ演算を意味する）、そして結果がパケット識別情報に等しい場合、パケットは対応する送出リンクへ転送される。結果が等しくない場合、特定のリンクの識別子がブルームフィルタに追加されなかったのだから、パケットはそのリンクへは転送されない。

【００５５】

従って本発明は、ブルームフィルタに基づいてパケットヘッダの中にコンパクトなソースルーティング情報を提供することができる。これによって、ネットワークノード内に保持されなければならない状態情報が最小化される。

【００５６】

さらに留意されることだが、ノード間のリンクに名前を付ける代替的方法がいくつかある。識別子は自由な形式でよく、その場合、それらのブルームフィルタ表現が、識別子に対してｋ個の異なるハッシュ値をとるような通常のやり方で演算される。あるいは、リンク名が、ｋ個の「１」のビットおよびｍ－ｋ個の「０」のビット、または、ｋ－ｚ．．、ｋ－１、ｋ、ｋ＋１、．．ｋ＋ｚ個の「１」のビット（ｚは非常に小さい）と対応する個数の「０」のビットとで、直接構築されてもよい。その場合、そのようなハッシングは、ブルームフィルタを構築するためには必要でない。いずれの場合にも、命名スキームは、ハッシュの衝突を避けるために、名前に対して十分なエントロピー（ランダムネス）を符号化しなければならない。自由形式のリンク識別子とブルームフィルタ対応のｋ－ｏｆ－ｍビット識別子とを区別するため、本発明では後者をリンクＩＤと呼ぶ。

【００５７】

ブルームフィルタ（ＢＦ）は、フィルタと呼ばれる集合のコンパクト表現に対してデータ要素を追加し、後でその要素が以前にそれに追加されたかどうかをテストするための、

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簡単なやり方である。ＢＦは、所定のビット数、例えば１２８ビット、を含むビット列であり、それは当初はすべて０に設定される。ＢＦのサイズは、用途によって異なりうる。一例として、図１では、ＢＦのビット数は８である。一般的には、８ビットのＢＦは非常に小さいＢＦであろうから、実際には、いかなる目的にも使用できないであろう。ＢＦにデータ項目を追加することは、１個の識別子から複数の別個のハッシュ値が演算されるプロセスである。図１の例の場合、３つの異なるハッシングアルゴリズムを識別子「データ１」に適用することによって３つの別個のハッシュ値が、これらの値の各々が１と８の間にあるように演算される。これらの値の各々は、ＢＦ内の１ビットを表す。ハッシュ値が算出された後、ＢＦ内の対応する各ビットが１に設定される。図１の例では、３つのハッシュ値は３、６、１であり、ブルームフィルタの中の第１、第３、第６ビットが「１」に設定される。これは、識別子「データ１」についてのリンクＩＤを構成する。

【００５８】

また、図１は、別の識別子「データ２」をＢＦに追加することも示す。別個のハッシュ値が同様に算出され、そして、対応するビットがＢＦにおいてすでに１に設定されている場合、ビットは１のままである。図１の例では、「データ２」から得られた３つのハッシュ値は、４、７、１であり、ブルームフィルタの中の第４および第７が「１」に設定される（第１ビットは、「データ１」がブルームフィルタに追加された時に、すでに「１」に設定されている。項目がこのように追加される場合、いずれかの項目をＢＦから削除する可能性がないのは明らかであり、値「１」を持つビットが１つ以上のデータ項目から来るかどうかは誰にも分からない。（これらの制限に対する解決策が提案されているＢＦの変形が存在し、例えば、各ビットに対してカウンタが添付されている。項目が追加されて対応するビットが１に設定される度にカウンタが増える。項目を削除すると、カウンタ値は減るであろうし、値がゼロになると、対応するビットもゼロに設定することができる。しかし、この解決策は、１ビットでもカウンタ値のオーバフローがある場合に問題をもたらす可能性があり、値を減らすことにはもはや信頼性がない。カウンタ値を含めることのもう１つのマイナス面は、ＢＦのサイズが増えることであり、もはや、含められたデータ項目のコンパクト表現とは言えなくなる。本発明はコンパクトなＢＦを必要としており、本発明の基本形としては、ＢＦから項目を削除する必要はない。ＢＦは、使用後は廃棄される。）

特定のデータ項目がＢＦに追加されたかどうか検証したい場合、データに対する必要な数の別個のハッシュ値を算出することによってプロセスを開始し、結果として、ＢＦビット列の中の所定のビットに対応する数字の集合が得られる。検証プロセスの間、ＢＦの中のこれらのビットの値がチェックされ、すべての値がＢＦの中で１に設定されている場合、検証プロセスはｔｒｕｅを返し、いずれかのビットが０である場合、検証プロセスはｆａｌｓｅを返す。これを図２に図解するが、図２は、「データ１」が図１で作成されたブルームフィルタのメンバであるかどうかチェックするプロセスを示す。ブルームフィルタを作成するために用いられたのと同じ３つのハッシュアルゴリズムを用いて、３つのハッシュ値が「データ１」について作成され、そして、これらは３、６、１である。ブルームフィルタがチェックされると、ブルームフィルタの第３、第６および第１ビットがすべて「１」に設定されていることが分かり、これは、「データ１」がブルームフィルタに含まれていることを（正確に）示す。

【００５９】

ブルームフィルタの１つの特徴は、ある項目がブルームフィルタのメンバであるかどうかを検証するプロセスが、完全には正確でなく、「偽陽性」を生じる可能性があるということである。しかし、「偽陰性」を生じる可能性はない。データ項目が実際に含まれていた場合、対応するブルームフィルタのビットはすべて「１」であろうから（算出プロセスは、ブルームフィルタに項目を追加する間と検証の間とは同じであるため）、フィルタ検証は常に「ｔｒｕｅ」を返す。こうして、正確な応答が得られる。しかし、検証プロセスでチェックされたビットのうちのいずれかがゼロであることが分かった場合、検証は、「ｆａｌｓｅ」を返し、その項目はブルームフィルタに追加されていなかったことが分かる

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【００６０】

しかし、図３に示すように、たとえばデータ項目がフィルタに追加されていなくてもフィルタ検証がｔｒｕｅを返すことがありうる。図３の例では、「データ３」から得られた３つのハッシュ値は、４、６、１であり、ブルームフィルタの第４、第６、第１ビットはすべて「１」であると分かり、従って、検証プロセスは、「データ３」がブルームフィルタに含まれているということを返す。しかし、図１でブルームフィルタが作成された時に「データ３」はブルームフィルタに追加されなかったのだから、この結果は、不正確であり、この場合、検証は「偽陽性」を返すと言える。

【００６１】

偽陽性率は、フィルタの長さと、フィルタに追加された項目の数とに依存する。

【００６２】

ブルームフィルタをルーティングに利用する

本発明によれば、ネットワークの各リンク、すなわち２つのノード間の接続は、識別子（または「名前」）を有する識別可能なデータ項目であるとみなされる。従って、本発明は、パケットが要求される場合、ネットワークを通るパスがソースノードから宛先ノードまで選択され、それがリンク識別子のシーケンスとして記述されうることを提案する。リンク識別子のシーケンスは、ＢＦへと符号化され、そして、ＢＦがパケットヘッダに入れられる。

【００６３】

あるいは、ネットワークを通るパスを構成するリンクを識別する代わりに、パス沿いのノードを識別することによってパスを定義することができるだろう。しかし、パスの２つのノード間で２つ以上の異なるリンクが存在する可能性がある場合、そのようなスキームでは、例えば、並行するリンク間でトラヒック負荷をバランスさせる必要がある場合などは、含まれる情報が減り、また、あまり適正でない動作が行われるであろう。従って、一般性を失わずに、本発明の好適実施形態は、パスを構成するリンクによってパスを識別するという点に限って記述するが、理解されるべきだが、本発明はこれに限定されない。但し、留意されるべきだが、純粋な無線ネットワークの場合、例えばＭｏｂｉｌｅ　Ａｄ　Ｈｏｃ　Ｎｅｔｗｏｒｋ（ＭＡＮＥＴ）には、識別可能なリンクは存在せず、従って、そのような環境では、本発明はリンク識別子の代わりにノード識別子を用いるであろう。さらに、留意しなければならないことだが、ノードＩＤが（一方向の）リンクＩＤの代わりに用いられる場合、過度のルーピングを避けるメカニズムが必要であり、例えば、各パケットが存続期間の指標や少数の最近訪問したノードの識別子を搬送してもよいし、あるいは各ノードが、最近出会ったパケットを十分な数だけ記憶してもよい。

【００６４】

ネットワーク内のノードは、どの送出リンクＩＤがパケットヘッダ内のブルームフィルタに追加されたのかを判定するためにパケットヘッダ内のブルームフィルタに問い合わせることによって、ノードからどの送出リンクに沿って自分がパケットを転送すべきかを判定することができ、例えば特定の送出リンク識別子がパケットヘッダ内のブルームフィルタに追加された場合、パケットはそのリンクに沿って転送される。このプロセスは、パスに沿って各ノードで繰り返される。（パスが、パスを構成するリンクの観点からではなくてパス沿いのノードの観点から定義される場合、ノードは、他のどのネットワークノードに自分がパケットを送信すべきかを判定するため、パケットヘッダ内のブルームフィルタに問い合わせるであろうし、そして、パケットは、ブルームフィルタに問い合わせることによって得られたノードに転送される。）

本発明は、ＢＦがデータ項目のコンパクト表現であり、かつ、データ項目がフィルタに追加されたかどうかについてＢＦが常に正確な応答を返すという意味で、ＢＦの利点を利用する。「ｐｕｂ／ｓｕｂ」ルーティングの場合、確率が低い限り、偽陽性は問題ではない。偽陽性は、パケットが間違った宛先に配信される原因となるが、それは、偽陽性率が制御されうる限り、有害とはみなされない。ＢＦでは、偽陽性率は、ＢＦの長さと、デー

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タ項目を表すビット数と、フィルタに追加されたデータ項目の数とに依存する。

【００６５】

本発明の一実施形態について、図４乃至図１１を参照しながら記述しよう。本実施形態は、ブルームフィルタの生成に関する。

【００６６】

図４は、ノードＲ１乃至Ｒ５を有する単純なネットワークの略図である。パケットソース１が、ノードＲ１に接続し、パケット宛先（または「シンク」）２が、ノードＲ３に接続している。ノードＲ１乃至Ｒ５のうちの２つの間の各リンクは、リンク識別子を使って提供され、図４の実施形態では、直接のブルームフィルタ対応リンクＩＤが用いられ、それらは、各リンクが、各方向に１つずつ、２つの別個のリンクＩＤを有するように、有向の識別子として生成される。これは、（以下で述べる）一部の状況でループを回避するために必要である。一例として、ノードＲ１からノードＲ２までのリンクは、リンクＩＤ　００１００１００１　を有し、ノードＲ２からノードＲ１までの逆リンクは、リンクＩＤ　１１０００１０００　を有する。例示したリンクＩＤは、例として９ビットと非常に短いものが選択されているが、実際は、これより長いであろう。

【００６７】

図４の実施形態は、ソースノードと宛先ノードとの間でデータを捜し出して配信するのに必要な機能性が、Ｒｅｎｄｅｚｖｏｕｓ（ランデブー）、Ｒｏｕｔｉｎｇ（ルーティング）、Ｆｏｒｗａｒｄｉｎｇ（転送）という３つの異なる動作で成り立つとみなすことができるようなＰｕｂ／Ｓｕｂネットワークに関する。大まかには、ランデブーメカニズムは、ネットワーク内での位置情報の発行を維持することに責任を持ち、ルーティングメカニズムは、ランデブーシステムの中に維持される情報に基づいてデータ位置から加入者ノードまでのルートを作成して構成することに責任を持ち、転送機能は、ネットワークを通る実際のデータパケットを転送することに責任を持つ。これらを図４にそれぞれ項目３、４、５として略示する。

【００６８】

ソース１は、発行Ｐを発行すると仮定する。この情報は、発行Ｐがその現在位置をマッピングするようにランデブーシステム３に格納される。シンク２でユーザが発行２を購読する場合（図１１のステップ１）、発行Ｐの位置情報は、ランデブーシステム３から見つけることができる（図１１のステップ２）。これは、データの現在位置とそれが配信される必要がある宛先とについての情報を提供する。

【００６９】

ルーティング機能４は、ソース１と宛先（シンク２）との間の転送パスを構築するためにソースノード情報および宛先ノード情報を必要とする。ルーティング機能４は、ネットワークリンクと、関連するリンクＩＤと、リンクが接続するノードとについての情報を維持するが、例えばルーティング機能の中に維持される情報は、ノードペアと、各ノードペアについての、それらの間のリンクのリンクＩＤとであってもよい。リンクＩＤと、リンクが接続するノードとについての情報がルーティングレイヤに存在した後ならば、ソースノード情報および宛先ノード情報を用いてネットワークを通るパスを構築することができる。

【００７０】

このようにして、ルーティング機能は、ネットワークトポロジについての知識を有する。ルーティング機能は、ノードＡとノードＢとの間にパスを構築するための要求を受け取ると、ＡとＣおよびＢとＣが直接接続している場合、リンクを用いて例えばＡからＣまでの、およびＣからＢまでのパスを作成することができる。従って、ルーティング機能４は、シンク２がソース１に発行Ｐを要求したことを通知される場合、ソースノード情報および宛先ノード情報に基づいて、ソース１から宛先２までのパスを作成することができる（図１１のステップ３）。図４の例では、ルーティングシステムは、ネットワークトポロジ情報を使用して、データがパスＲ１－Ｒ２－Ｒ３を移動する必要があると判定する。

【００７１】

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判定されたパスは、リンク識別子のシーケンスとして表されてもよく、この場合、リンクＲ１からＲ２までと、リンクＲ２からＲ３までとで形成されたパスを示すために｛００１００１００１，００１０１１０００｝として表されてもよい。これを行うため、ルーティング機能は、図１１のステップ３で定義したパスの中の各リンクのリンクＩＤを判定または検索する（図１１のステップ４）。

【００７２】

リンクＩＤを判定するやり方はいろいろある。それらがノードによって自動的に生成され（例えばあるノードが、自分が直接接続していると分かっているノード群に対する自分自身の送出リンクにリンクＩＤを割り当てることもできる）、その後、ルーティング機能に通信されてもよいし、あるいは、それらが他のインスタンスによって割り当てられ、ノード上で構成されてもよい。リンクＩＤが、例えば、必要数のハッシングアルゴリズムを根底にある識別子に適用して、結果として得られるハッシュ値からビットマスクを得ることによって得られてもよい。しかし、本発明において、リンクＩＤが、ＢＦの追加と検証とに直接適用されうるビットマスク以外の何かである必要はなく、適切なビットマスクが、長さｍビットのビット列のうちのｋビットを「１」に設定して残りのビットが「０」のままであるようにすることによって得られてもよい（この場合、ブルームフィルタはｍビットの長さを有し、かつｋ＜ｍである。）

【００７３】

実際には、ハードウェアの中で可変長フィールドを処理するのは非効率であるだろうから、すべてのリンクＩＤが同じビットマスク長ｍを有することが有利である。それゆえ、実際には、ｍについて無理のない最大限のサイズを決め、次いで、すべてのリンクＩＤについてのビットマスク長としてそれを使用することが、有利である。しかし、リンクＩＤを形成するビットマスク内で「１」に設定されるビット数ｋは、ネットワークによってさまざまであろうし、「１」に設定されるビット数ｋは、すべてのリンクについて同じでなくてもよい。例えば、高容量リンクについてのリンクＩＤは、長さｍビットのビット列のうちのk_0-1ビットを「１」に設定することによって形成されてもよいし、他方、通常容量リンクは、長さｍビットのビット列のうちのk_0ビットを「１」に設定することによって形成されるリンクＩＤを有してもよい。これによって、高容量リンクについての偽陽性の数が増す可能性があるが、他のリンクについての偽陽性の数は減るはずである。逆に、低容量リンクについてのリンクＩＤは、長さｍビットのビット列のうちのk_0+1ビットを、さらにはk_0+2ビットを「１」に設定することによって形成されてもよい。これによって、そのリンクについての偽陽性の数が減るはずであるが、他のリンクについての偽陽性の数は増すことがある。

【００７４】

リンクＩＤを形成するために「１」に設定されるｋビットは、無作為に選択されてもよい。ただし、ｋビットは、他のやり方で選択されてもよく、例えば、ローカルでは、あるノードからのリンクのリンクＩＤ間に重複がないようにノードからの各送出リンクについてｋビットを選択することは、意味を成すであろう。従って、あるノードからパケットが１つの送出リンクだけで送信されるべき場合に２つ以上のリンクでパケットを送信する確率は、大幅に減少するであろう（但し、他のどこかで偽陽性が増えているかもしれない）。

【００７５】

ブルームフィルタの長さｍは、下記のようにすべてのルーティング情報がブルームフィルタに書き込まれた後で、ブルームフィルタの中身が半分しかないように選ばれること、すなわち、ブルームフィルタの中身が半分を超えると偽陽性率が顕著になりうることから、「１」に設定されるのはｍ／２ビットを超えないことが望ましい。ただし、ブルームフィルタをパケットヘッダに入れることは、ブルームフィルタのビット数がかなり少ない場合に限って実行可能である。実際には多くの場合、１２８ビット前後の長さのブルームフィルタなら、偽陽性の数が適度に少ないはずである。

【００７６】

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パスが決められると、ルーティング機能４は、パスのリンクＩＤを含むＢＦを作成する（図１１のステップ５）。上記のようにリンクＩＤが構築され、かつ、そのうちのｋ（またはｋ－１、ｋ＋１等）個が「１」ビットであるような「ｍ」ビットがそこに含まれる場合、各リンクＩＤは、ＢＦへとＯＲ演算され（この場合、ＯＲ演算されるとは、論理ＯＲ演算を意味する）、従ってこの場合、ＢＦは、パス上の各リンクについての情報を含む。図４の例では、パスは、Ｒ１からＲ２まで（リンクＩＤ：００１００１００１）とＲ２からＲ３まで（リンクＩＤ：００１０１１０００）の２つのリンクを含んでおり、従って、生成されたブルームフィルタは、００１０１１００１である。

【００７７】

ルーティング機能は、作成されたソースルーティングＢＦを発行Ｐの識別子と共にデータソース１へ送信する（図１１のステップ６）。ソースノードは発行Ｐからパケットを作成して、受信したＢＦをヘッダに入れる（図１１のステップ７）。パケットはこの時点で配信される準備が整っており、データソース１によって送信されてもよい（図１１のステップ８）。

【００７８】

原理的には、ルーティング情報は、上記のようにルーティング機能４でではなくてソースノードでブルームフィルタの中に符号化されてもよい。

【００７９】

パケットの配信を図５および図１２に図解する。パケットは、ヘッダ内にブルームフィルタ（図５の例では、パケットの中のブルームフィルタは図４で生成されたブルームフィルタ００１０１１００１である）としてルーティング情報を含んでいるが、最初にＲ１へ送信される。パケットがノードＲ１で受信される（図１２のステップ１）と、Ｒ１は、パケットヘッダの中に含まれるブルームフィルタをチェックすることによって（図１２のステップ２）、パケットヘッダの中のルーティング情報を問い合わせ、そして、パケットヘッダのＢＦの中から、Ｒ１からの送出リンクのリンクＩＤ値に一致するものを探すことを試行する（図１２のステップ３）。例えば、Ｒ１における各転送テーブルエントリは、送出リンクのリンクＩＤと、対応する物理リンクのインデックスとで構成されてもよい。一致検索プロセスを、図２に例示する。

【００８０】

パケットは、ブルームフィルタに一致するリンクＩＤを有する、ノードＲ１から送出される単数または複数のリンクに沿って転送される（図１２のステップ４）。この例では、ノードＲ１は、ノードＲ２へと（リンクＩＤ：００１００１００１）、ノードＲ４への（リンクＩＤ：００１０１０００１）２つの送出リンクを有する。Ｒ１での、受信したパケットのヘッダの中のブルームフィルタ００１０１１００１を送出リンクと照合することの結果は、２つの陽性である。これは、１つの正確な陽性と１つの偽陽性とである。リンクＲ１－Ｒ２は受信したパケットの中のＢＦに実際に追加されたものであり、結果として検証からの正確な陽性応答が行われる。しかし、リンクＲ１－Ｒ４は、ＢＦに追加されたものではなく、ノードＲ４に対する受信したパケットの中のＢＦとの一致は、偽陽性である。

【００８１】

従って、パケットは（正しく）ノードＲ２へ転送され、そして、（間違って）ノードＲ４にも転送される。パケットヘッダの中のブルームフィルタに問い合わせて、ブルームフィルタに含まれる送出リンクを探すというプロセスは、パケットが受信される各ノードで繰り返される。従って、図５の例では、パケットがノードＲ２およびＲ４で受信されると、上記のプロセスは各ノードで繰り返される。ノードＲ４では、送出用の一致するリンクＩＤが存在せず、パケットは破棄される。（ＩＰの場合は同じ宛先ＩＰアドレスを用いてネットワークのどこからでもパケットを宛先に配信することができるが、それとは違って、本発明のＢＦベースのヘッダは、特定のパスに限ってルーティング用として使用することができる。一旦パケットがパスの外に出ると、パスは一致するリンクＩＤを含まないため、パケットを正確に配信することはできない。）しかし、ノードＲ２では、パケットへ

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ッダの中のＢＦは、Ｒ３に対するリンクにさらに一致するため（ステップ４）、パケットは、そのリンクを用いてノードＲ３に転送される。

【００８２】

ノードＲ３からシンク２までの最終配信は、いずれかの便利なやり方で扱われてもよく、本発明は、最終配信の特定の方法には限定されない。例えば、シンク２に向かうリンクＩＤを、ＢＦが作成される時にＢＦに追加することもできるだろうし、パケットが、ノードＲ１、Ｒ２、Ｒ３の間で転送されるのと同様にノードＲ３からシンクへ転送されてもよい。もう１つの例として、Ｒ３が、シンクからの購読情報を維持し、発行ＩＤを購読と照合し、データをシンクに転送することもできるだろう。

【００８３】

仮想リンク

ブルームフィルタに関する１つの問題は、それらが比較的早く「一杯」になりうることである。１つのフィルタに追加される要素が増えれば、偽陽性の確率が高まり、一般には、中身が半分をかなり超えることは、ブルームフィルタにとって望ましくない。さらに、上記のように、ブルームフィルタの長さを比較的短く維持することが望ましい。従って、本発明の好適な特長では、複数の単一のリンクから（この場合、単一の「リンク」は２つのネットワークノードを直接リンクする）１つの「仮想リンク」が定義されるが、それによって、ネットワークにおいて配信ツリーを記述する、より効率的なやり方が可能になると共に、ＢＦに追加されることが必要なリンクＩＤもより少なくて済む。本発明の方法によってパケットをルーティングするのに「仮想リンク」が用いられる場合、仮想リンクを用いるルーティングは、上記と同じやり方で行われる。仮想リンクのリンクＩＤは、例えばブルームフィルタの中で、符号化され、そして、パケットヘッダに入れられる。仮想リンク沿いのノードの転送テーブルは、仮想リンクのリンクＩＤと適切な転送の宛先とを含めるように構成される。仮想リンクのリンクＩＤをそのヘッダ内に有するパケットを受信すると、ノードは、転送テーブルの中の仮想リンクのリンクＩＤに関連する宛先にパケットを転送する。

【００８４】

ルーティング機能がデータをＲ１からＲ３まで配信する、図６に示す事例について考えよう。何らかの理由で、この部分的なパスは負荷が重くて、複数の異なる送信が同じパスを使用している。従って、Ｒ１とＲ３との間の「仮想リンク」を定義することは利益になりうる。図６では、ルーティング機能は、Ｒ１からＲ２を介してＲ３までのそのような仮想リンクを定義し、そして、それに仮想リンクＩＤを与えている。図６の例では、仮想リンクは、２つの単一リンクＲ１－Ｒ２とＲ２－Ｒ３とから定義されるが、仮想リンクは、３つ以上の単一リンクを含んでもよい。従って、新たな仮想リンクは、Ｒ１－Ｒ２－Ｒ３である。従って、ノードＲ１からノードＲ３までのパケットの配信を確実にするため、パケットヘッダの中のブルームフィルタの中に、リンクＲ１－Ｒ２とリンクＲ２－Ｒ３とのリンクＩＤを入力するのではなく、仮想リンクのリンクＩＤだけを入力することが必要である。

【００８５】

生成された仮想リンクは、リンクＩＤを有しているが、それは仮想リンクを作成するのに使用された根底にあるリンクのリンクＩＤに直接関連する必要はない。図６の例では、仮想リンクＲ１－Ｒ２－Ｒ３には、リンクＩＤ　１０１０００１００が与えられる。

【００８６】

仮想リンクのリンクＩＤは、リンクＩＤについて上述したように、ｋビットが「１」でｋ－ｍビットが「０」であるような、長さｍビットのビットマスクであってもよいし、リンクの根底にある識別子にハッシュ関数を適用することによって得られてもよい。リンクＩＤがビットマスクである場合、ビットマスクのうちの指定のビットを用いて、リンクが実際のリンクである場合には指定のビットを「１」に、リンクが仮想リンクである場合には「０」に（あるいはその逆に）設定することによって、あるリンクが実際のリンクであるか仮想リンクであるかを表すことが可能であろう。

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【００８７】
仮想リンクに属するノード、すなわち仮想リンクに対応する物理パス上にあるノードは、それらがパケットを転送できるように、仮想リンクについて知る必要がある。例えば、各仮想リンクについて、（リンクの最後のノードを除いて）リンクのノードには新たな転送テーブルエントリがある可能性がある。従って、図６では、ノードＲ１についての転送テーブルは、さらに、仮想リンクＲ１－Ｒ２－Ｒ３についてのエントリを含み、それは、パケットヘッダ内にリンクＩＤ　１０１０００１００を含むパケットはノードＲ２へ転送されるべきことを示す。同様に、ノードＲ２についての転送テーブルは、さらに、仮想リンクについてのエントリを含み、それは、パケットヘッダ内にリンクＩＤ　１０１０００１００を含むパケットはノードＲ３へ転送されるべきことを示す。

【００８８】
新たな仮想リンクが設定される場合、新たに作成された仮想リンクに属するノードにそれが伝達される必要がある。仮想リンクについての情報を伝達する１つのやり方は、新たなリンクＩＤをリンクの各ノードに別々に配信することであるが、代わりに、もっと簡潔な方法を用いて、各ノードが、関連ノードを通じて配信される別個の制御パケットからこの情報を入手できるようにすることも可能であろう。

【００８９】
例えば、制御パケットを用いて新たな仮想リンクについての情報を配信するため、図７に示すように、ルーティング機能が、Ｖｉｒｔｕａｌ　Ｌｉｎｋ　Ｓｅｔｕｐ　Ｐａｃｋｅｔ（ＶｉＬＳ）を用いて新たな仮想リンクＩＤについてノードに情報提供してもよい。ＶｉＬＳのパケットヘッダの中のＢＦは、通常通り算出されたＢＦを含んでいる。すなわち、それに対して、パケットがリンクＲ１－Ｒ２－Ｒ３に沿って転送されるようにするため、上記のようにＲ１－Ｒ２リンクＩＤおよびＲ２－Ｒ３リンクＩＤが追加されている。ＶｉＬＳパケットのデータフィールドには、新たな仮想リンクＩＤが含まれ、必要に応じて仮想ＩＤの存続時間も含まれる。ＶｉＬＳパケットを受信する各ノードは、ＶｉＬＳパケットからリンクＩＤを読み取って、リンクＩＤを、対応する送出リンクと共にその転送テーブルに追加することができる。発行ＩＤフィールドまたはパケットヘッダの中の何らかの他のフィールドを用いて、ＶｉＬＳパケットのタイプを示してもよいが、これについては他の方法もある。ＶｉＬＳパケットのデータフィールドの中に、ノードの中の転送テーブルエントリをセットアップすることに関する他の情報を含める必要はなく、パケットヘッダの中のＢＦをこの目的で使用することができるのだから、ノードの転送テーブルの中で定義される送出リンクは、パケット内のＢＦがパケットをノードからルーティングするであろう場合のリンク、およびＶｉＬＳパケットが次に送信される場合のリンクと同じである。

【００９０】
上記のように、通常通り算出されたＢＦに依存して仮想リンクについての情報を配信する場合、ネットワーク内の仮想リンクの表現は、通常通り算出されたＢＦが含む（もしあれば）のと同じ偽陽性を含むであろう。そのような偽陽性を避けることが望ましい場合、ＶｉＬＳパケットは、仮想リンクを形成するリンクのリンクＩＤを、例えばパケットのデータ部分の中で、明示的に符号化してもよい。リンクＩＤがＶｉＬＳパケットの中へ明示的に符号化される場合、仮想リンク沿いの各ノードは、送出リンクＩＤをパケット内の明示的に符号化されたリンクＩＤと比較して、この目的でパケットヘッダ内のＢＦを無視することによって、仮想リンクのための転送テーブルをセットアップするであろう。

【００９１】
仮想リンクをネットワークノードの転送テーブルに追加するため、ルーティング機能は、新たに構築されたＶｉＬＳをノードＲ１に入れる。ノードＲ１は、これが制御パケットであることに気付き、新たな仮想リンクを記述する新たな転送テーブルエントリに必要な情報をパケットのデータフィールドから取得し、そして、新たなエントリをその転送テーブルに入れる。このエントリについての宛先は、ＶｉＬＳパケットヘッダ内のＢＦによってかまたは、上記のように、それらを明示的にリストすることによって、判定されてもよ

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い。典型的には、通常のパケット転送メカニズムによってＶｉＬＳパケットがさらに配信される場合と同じ宛先が、転送テーブルに追加される。従って、この例ではノードＲ１が、ノードＲ２への送出リンクに対して、仮想リンクＲ１－Ｒ２－Ｒ３のリンクＩＤをその転送テーブルに追加する。次いでＶｉＬＳパケットがノードＲ２へ転送され、ノードＲ２でプロセスが繰り返され、その結果、ノードＲ”は、ノードＲ３への送出リンクに対して、仮想リンクＲ１－Ｒ２－Ｒ３のリンクＩＤをその転送テーブルに追加する。次いでＶｉＬＳパケットは、次のノードへ転送され、以下同様に行われる。

【００９２】

図６では、仮想リンクが実際のリンクを用いて構築される。また、既存の仮想リンクを結合することによって新たな仮想リンクを定義することも可能である。図８は、これがどのようにして行われるかを示す。仮想リンクＲ１－Ｒ２－Ｒ３－Ｒ４－Ｒ５が、１つの区分が仮想リンクＲ１－Ｒ２－Ｒ３であり、もう１つの区分が仮想リンクＲ３－Ｒ４－Ｒ５であるように定義される。あるいは、少なくとも１つの区分が実際のリンクであり、少なくとも１つの区分が仮想リンクであるように、仮想リンクが定義されてもよい。

【００９３】

このようにして定義される仮想リンクに、その構成区分の識別子とは異なり（かつ、それに関連する必要のない）、かつ、仮想リンクに含まれる実際のリンクの識別子とも異なる、リンクＩＤが与えられる。従って、図８の仮想リンクＲ１－Ｒ２－Ｒ３－Ｒ４－Ｒ５に対して、２つの構成仮想リンクであるＲ１－Ｒ２－Ｒ３およびＲ３－Ｒ４－Ｒ５のリンクＩＤにも、根底にあるネットワークリンクであるＲ１－Ｒ２、Ｒ２－Ｒ３、Ｒ３－Ｒ４、Ｒ４－Ｒ５のリンクＩＤにも関連する必要のない、リンクＩＤが当てられる。

【００９４】

仮想リンクＲ１－Ｒ２－Ｒ３－Ｒ４－Ｒ５のリンクＩＤが、上記のようにＶｉＬＳパケットを用いてノードＲ１－Ｒ２－Ｒ３－Ｒ４の転送テーブルに追加されてもよい。動作は、図６について記述したものと同様であり、ＢＦの中に含まれるリンクＩＤは、仮想リンクＲ１－Ｒ２－Ｒ３および仮想リンクＲ３－Ｒ４－Ｒ５のＩＤである。

【００９５】

仮想リンクは、存続時間が限定されなくてもよいし、存続時間が限定されてもよい。図７に示すように、ＶｉＬＳパケットは、もし分かっていれば、この存続時間情報も含んでもよい。そのような場合、ノードは、仮想リンクの存続時間が終了した後、転送テーブルから仮想リンクを消去する。

【００９６】

既存の仮想リンクの存続時間の修正を、ＶｉＬＳパケットを用いて、新たな存続時間を定義する新たなパケットを送信することによって、行うこともできる。同じ方法を用いて、存続時間がゼロに設定されているＶｉＬＳを送信することによって、既存の仮想リンクを手動で消去することもできる。

【００９７】

マルチパス／マルチキャスト・ステートレス転送

本発明の上記の記述は、ソースから単一の宛先ノードへ送信されるパケットに関する。しかし、本発明は、これに限定されず、パケットをソースから２つ以上の異なる宛先ノードへ配信するのに用いられてもよい。これは、２つ以上の宛先へのパスを定義するリンクＩＤを、パケットヘッダの中に含まれることになるブルームフィルタに追加することによって行われてもよい。

【００９８】

さらに、仮想リンクの上記の記述は、１つのソースから単一の宛先ノードまで送信されるパケットに関するが、マルチパスまたはマルチキャスト仮想リンクを作成することも可能である。これは、いずれも１つのノードから出るリンクを定義する２つ以上のリンクＩＤをＢＦに追加することによって行われてもよい。これを図９に示すが、ここではＲ１－Ｒ２－Ｒ３、Ｒ１－Ｒ４－Ｒ５およびＲ１－Ｒ４－Ｒ６を含む仮想リンクが（リンクＩＤ００１００１００１を使って）定義されている。完全なマルチキャストツリーは、リン

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クＲ１－Ｒ２、Ｒ２－Ｒ３、Ｒ１－Ｒ４、Ｒ４－Ｒ５およびＲ４－Ｒ６を同じＢＦにＯＲ演算することによって実装することができる。

【００９９】

ヘッダ内のこのＢＦを用いてソースから配信されるパケットは、図の中の３つのシンクノードすべて（Ｒ３、Ｒ５、Ｒ６）に配信されるであろう。図６で２つのノード間に仮想リンクがセットアップされるのと同様に、図９は、まったく同じ方法を用いて仮想マルチキャストツリーをセットアップする。この場合、２つ以上の宛先にデータを送信することになる各ノードは、仮想リンクＩＤを、（例えばノードＲ４の転送テーブルがノードＲ５へのリンクとノードＲ６へのリンクとを両方とも仮想リンクのリンクＩＤ（００１００１００１）に対してリストするように）複数の宛先リンクに関連付けることによって、転送テーブルの中でこれを判定するであろう。

【０１００】

この場合もやはり、仮想リンクの詳細は、ＶｉＬＳパケットを用いて配信することもできる。図９では、ルーティング機能は、ツリーのための仮想リンクＩＤ（００１００１００１）を作成し、ＶｉＬＳパケットを生成し、そしてそれをＲ１に入れる。ＶｉＬＳパケットがすべての宛先に渡された後、仮想マルチキャストツリーがネットワーク内でセットアップされる。データパケットが、ヘッダ内に仮想マルチキャストツリーのＩＤだけを含むＢＦ（００１００１００１）を使って送信される場合、データは、ソースからネットワーク内のすべてのシンクへルーティングされる。図９は、Ｒ２およびＲ４についての転送テーブルを示す。

【０１０１】

複数のパスを活用するもう１つのやり方は、それを冗長の目的で使用することである。同じソースと最終の宛先とを有するけれども、複数の並行パスを伴うようなパスを作成することは可能である（図１０）。すべてのパスは一方向であるが、２つのノード間でそのようなマルチパスルート（または仮想リンク）を容易に作成することができる。

【０１０２】

留意すべきだが、仮想リンクの生成は、本発明の特定のルーティングの方法を用いることに限定されない。

【０１０３】

上記の実施形態では、ネットワークを通るルートは、ノード間の単一のリンクかまたはノード間の単一のリンクから構築される仮想リンクを用いて、ルーティングレイヤで決められる。しかし、本発明は、これに限定されない。

【０１０４】

ステートフル・ルーティング

別の選択肢として、ネットワークを２つ以上のステートレス・ルーティング・エリアに分割するノードをネットワークに追加することが可能である。これらのプロキシノードは、異なるＢＦおよび発行間の状態情報を維持して、パケットが通過する際にＢＦヘッダ間のラベル切り替えを行う。これらのプロキシノードは、ブルームフィルタが一杯になるのを避けるために用いることもできるし、単にネットワークをさまざまな管理領域に分割するために用いることもできる。

【０１０５】

偽陽性率の削減

上記のように、ブルームフィルタの１つの特徴は、ＢＦ内のリンク識別子の存在をチェックする時、それが偽陽性を返す可能性がある（すなわち、ある項目がフィルタ内に存在すると報告するが、実際にはそれは存在しない）ということである。偽陽性の結果、パケットは、ＢＦの構築の間は含まれていなかった１つ以上のリンク上で転送される。ｐｕｂ／ｓｕｂパラダイムでは、偽陽性率が過大になることを制御するやり方がある限り、この影響は有害だとみなされない。偽陽性率は、フィルタ内に挿入された項目の数ｎと、フィルタのサイズｍと、フィルタ内の項目を表すビット数ｋとに依存する（この場合、リンク識別子は、ｋビットが１に設定され、残りのｍ－ｋビットが０に設定されたｍビットのベ

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クトルのかたちをとる）。

【０１０６】

ＢＦに関する問題は、それらが比較的速く「一杯」になることである。偽陽性の確率は、１つのフィルタに追加される要素が増えるにつれて高くなる。それによって、所定のＢＦサイズについては、所定の偽陽性率を超えないことが望ましい場合、ＢＦによって表されうるリンクの数は限られる。一例として、現行のＢＦの設計および約２５６ビットという典型的なパケットヘッダサイズの場合、ＢＦの偽陽性率（％）に起因して、３２個を超えるリンクＩＤをＢＦに挿入することはほぼ実行不可能となるであろうが、それは、偽陽性率が高くなる（約３％）であろうという理由による。しかし、多くの場合、３２個のリンクＩＤは、（ネットワークトポロジと、３２個のリンクによって定義されるパス上で通信するノードの数と、によっては）ルーティングの目的では不十分であろう。

【０１０７】

加えて、所定のネットワークトポロジとリンクＩＤの配信とを想定した場合に、現行のＢＦの生成には、偽陽性の影響をさらに細かく制御できるようなメカニズムが欠けている。特に、想定されるシステムにおけるルーティング機能が、ルーティングＢＦを作成するという柔軟性（ネットワーク内で特定のパスを定義するという主たる目的では同等であるが、ネットワークオペレータによって指定される何らかの条件においては偽陽性がいっそう有害であるという、リンクＩＤによって識別される特定の領域では偽陽性を回避できるような、ルーティングＢＦを作成するという柔軟性）を持てば、有益であろう。

【０１０８】

提案するＢＦを利用した手法のもう１つの問題は、セキュリティである。できれば、見込まれる悪質ソースノードに対処するメカニズムが求められる。見込まれる悪質ソースノードは、見込まれるＤｅｎｉａｌ　ｏｆ　Ｓｅｒｖｉｃｅアタックのための転送ＢＦを自分自身で生成したり、あるいは、ホストＩＤではなくトポロジ内でリンクを命名することに基づく転送システムを有するという本質的なセキュリティを迂回したりするかもしれない。

【０１０９】

従って、本発明のさらなる態様は、ＢＦベースのルーティング手法の偽陽性率を削減し、そして、ルーティングパス沿いのＢＦの影響を制御する新たなメカニズムを提供するという問題に取り組む。本発明のこの態様では、複数のブルームフィルタ候補（または、本態様もブルームフィルタに限定されないことから、他のコンパクトな集合表現）が生成され、そして、ブルームフィルタ候補（または、他のコンパクトな集合表現）の１つが、例えば、どの候補が偽陽性を返す確率が最も低いか等のような、所定の基準に基づいて選択される。この態様は、リンク識別子を含むＢＦを生成する確率的プロセスの間に利用できる選択に基づく。

【０１１０】

このさらなる態様は、一例として、複数のリンクを有するネットワークにおけるルーティングに関して記述されるであろうが、この態様はこれに限定されない。

【０１１１】

上記で説明したように、例えば図４のネットワークのようなネットワークの各リンクは、関連するリンク識別子（ＬＩＤまたはリンクＩＤ）を有する。上記の実施形態では、ＬＩＤを用いてブルームフィルタが生成され、これにより、特定のネットワーク利用についてはＢＦが１つだけ生成される。しかし、本発明の別の態様は、あるネットワークのパスを同等に表現する、２つ以上のＢＦ候補を生成する。これが行われうる１つのやり方は、各リンク識別子（ＬＩＤ）に関連する複数のリンク識別子タグ（ＬＩＴ）を生成し、ＬＩＴから複数のブルームフィルタ候補を生成することである。ソースルーティングに用いられるＢＦを選択する時に、ＢＦの中に挿入されることになるＬＩＴの最適な集合が、偽陽性の確率を最小化することができるように選択される。

【０１１２】

一般論として、本発明のこの態様が、識別子の集合に適用される場合、複数の表現（ま

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たは「タグ」）が各識別子について生成される。複数のブルームフィルタ候補（または集合メンバシップの複数の他のコンパクト表現）が、複数の識別子の表現から生成され、そして、ブルームフィルタ（または集合メンバシップの他のコンパクト表現）のうちの１つが、候補の中から選択される。

【０１１３】

一実施形態では、各ＬＩＤについて、ＬＩＤのｄ個のコンパクト表現を演算するが、ここでｄは、２以上の整数である。コンパクト表現の各々は、リンク識別子タグ（ＬＩＴ）として知られる。ＢＦの中に挿入されることになるリンクの各ＬＩＴについて、１度に各ＬＩＤの１つのＬＩＴ表現をＯＲ演算することによって、ＢＦ候補が生成される。この結果、ネットワークパスのリンク識別子を「等しく」表現する、ｄ個のＢＦ候補が生じることになり、ここで「等しく」とは、ｄ個のＢＦ候補の各々が、パケットがそれに沿ってルーティングされることが意図された（少なくとも）すべてのパスをパケットにたどらせることを意味する。

【０１１４】

原理的には、各リンクＩＤについてｄ個のＬＩＴを生成する必要はない。一例として、３２個のリンクがある場合、３２個のリンクＩＤのうちの３１個についてはｄ個のＬＩＴを生成するが、３２番目のリンクについては、このリンクがそのｄ個の表現の各々において同じＬＩＴを有するように、１個だけＬＩＴを生成することも可能であろう。この例では、ＢＦ候補を構築する際に３２番目のＬＩＴが何個のビットを１に設定するのかを選択する力はないであろうから、３２番目のＬＩＴは、ＢＦの中のそれらの数を削減することには貢献しないであろう。

【０１１５】

一部のリンクＩＤだけについてｄ個のＬＩＴを生成することは、ＢＦを解釈する一部の転送ノードがこのｄ個の拡張を有さず、従ってＬＩＴについての異なる転送テーブルを有しないようなシステムでは、有益でありうるだろう。それによって、より単純な転送ノードを供給することが可能になり、後方互換性サポートが提供される。

【０１１６】

ｄ個のＢＦ候補のうち、上記の実施形態の場合のように、ルーティング情報を提供する目的でパケットヘッダに挿入されるために１つが選択される。

【０１１７】

使用されることになるＢＦを選択するための主な基準は、ユーザが決めてもよく、例えば、偽陽性率を最小化することであってもよく、その場合、０の数が最も多いＢＦが、ＢＦ候補から選択される。例えば、１つ以上のリンクの部分集合について偽陽性率を最小化する（または、一般的な表現では、１つ以上の識別子の部分集合について偽陽性率を最小化する）ことのように、ＢＦを選択するための他の基準を適用することも可能であり、これは、例えば、パケットが所定のネットワーク領域に転送される結果となる偽陽性をもたらす所定のリンク識別子を避けるために（すなわち、偽陽性を所定のネットワークエリアに閉じ込める能力を提供するために）利用してもよい。

【０１１８】

この態様が上記の実施形態に適用される場合、パケットヘッダは、今度は、転送情報を含むＢＦに加えて、ＢＦを構築するのに用いられたＬＩＴの集合を識別するインデックスｄの２進法表現を含む。この態様のＢＦ（ｄ拡張型ＢＦと呼ぶ）を受信するルーティングノードは、ＢＦを構築するのに用いられたＬＩＴの集合に適した転送テーブルを選択することができる。

【０１１９】

提案するｄ拡張型ＢＦの手法は、それによって、ルーティングポリシーを実行するために適用されうる、偽陽性の影響に対するより精緻な制御を可能にし、そして、ＢＦを転送ヘッダとして用いる場合にセキュリティ機能を提供するように補強することができる。

【０１２０】

拡張型ブルームフィルタの詳細記述

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ランデブー、ルーティング、転送という３つの動作レイヤを持つＰｕｂ／Ｓｕｂネットワークに関して、実施形態を記述しよう。それらは一緒に、ソースノードと宛先ノードとの間でデータを発見して配信するのに必要な機能性を提供する。ネットワークの各リンクは、関連の識別子（リンクＩＤ）を有する。本発明の本態様では、各リンクＩＤのｄ個（ｄ＞１）の表現が生成され、ｄ個のＢＦ候補が、リンクＩＤのｄ個の表現から生成される。１個のリンク識別子に関連付けられたｄ個の表現の集合を有することは、偽陽性に対するより精緻な制御を提供することによって、より効率的かつ強力な転送スキームを可能にする。さらに、ＬＩＴベースのＢＦの選択力は、セキュリティまたはゾーン間のルーティング目的のためのポリシーの実行を、これらのポリシーをＢＦの選択および最適化の基準とみなすことによって、可能にする。

【０１２１】

リンクＩＤタグの構築

リンクＩＤは、ネットワークのリンクについての有向識別子として生成される。（記述を簡単にするため、すべての「リンク」は２つのネットワークノード間の実際のリンクであるが、リンクＩＤは、図６に関して記述したように「仮想リンク」の識別子でもあってもよいと仮定しよう。）本発明の本態様では、リンクＩＤ（ＬＩＤ）は、２つのネットワーク要素（例えばルータ）間のリンクを識別するため、いかなる名前の形態でもとることができる。典型的には、ＬＩＤは、無作為に生成されたビットの組み合わせ（例えば２５６ビットのハッシュ値）であろう。

【０１２２】

本発明の別の態様は、リンクＩＤのコンパクト表現として、「リンクＩＤタグ」（ＬＩＴ）という概念を導入する。加えて、すべてのリンクＩＤは、多価のマッピング関数を各ＬＩＤに適用することによって演算されるｄ個のＬＩＴの集合に関連付けられ、従ってこの場合、ＬＩＴは、各リンクＩＤについてと同じやり方で演算される。ｄは、ネットワークに依存して最適化されうるシステムパラメータである。ｄの典型的な範囲は、２から３２までであろう。（以前のリンクＩＤのように１個のＬＩＴしか見えない場合、それはｄ＝１の場合に相当するであろう。）例えば、マッピング関数は、各リンクＩＤについて、ｋビットが１に設定され、ｍ－ｋビットが０に設定されたＬＩＴビットベクトルを作成するために各リンクＩＤに適用される、ｋ個のハッシュ関数の集合であってもよい。この形態のＬＩＴをＢＦに組み込むことは、ｋ個のハッシュ関数を用いて挿入された１つの要素を持つｍビットのＢＦと同等であろう。（ＬＩＴのｄ個の集合がどうすれば得られるかという記述を以下に示す。）

以前の実施形態では、リンクＩＤは、好都合なＢＦの追加とチェック動作のため、ｋビットが１に設定されて他のｍ－ｋビットが０に設定された、サイズｍのビットマスクのかたちであってもよい。しかし、本実施形態では、ｋビットが１に設定されて他のｍ－ｋビットが０に設定された、サイズｍのビットマスクのかたちをとるのは、ＬＩＴであり、リンクＩＤのサイズと表現とは自由であって、ＬＩＴをそこから演算することができるならばいかなる適切なかたちをもとることができ、従って、本態様では、リンクＩＤ自体についてのかたちの選択の幅が拡がる。主な違いは、今度は、同じネットワークリンクを同等に表現するｄ個のＬＩＴの集合があり、偽陽性率を最小化するようなリンク識別子の組み合わせを表現するＬＩＴの集合を選択するために、ＬＩＴおよびＢＦの生成の無作為性を利用することができるということである。

【０１２３】

加えて、１個のリンクＩＤについてｄ個のＬＩＴの集合を生成するプロセスは、無作為のプロセスであってもよいし、ネットワークの実際のトポロジによりよく適合するためのもっと制御されたプロセスであってもよい。１個のリンクＩＤについてＬＩＴを生成することが、以下のようにトポロジにリンクされてもよい。（例えば転送ノードがネットワークに接続する）ブートストラッププロセスの間、リンクＩＤがＴｏｐｏｌｏｇｙ Ｍｏｄｕｌｅに登録される。ＬＩＴは、転送ノード自体によって生成されてもよいが、それは、ＬＩＴの生成に用いられるハッシュ関数を両者が分かっている場合である。あるいは、Ｔ

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ｏｐｏｌｏｇｙ　Ｍｏｄｕｌｅが、ＬＩＴを接続ノードに返すこともできる。この時点で、Ｔｏｐｏｌｏｇｙ　Ｍｏｄｕｌｅは、生成されたＬＩＴの衝突が最小限となり、それによって偽陽性率が低下するように、接続ノードの転送テーブルの中に「インストールされる」ことになるＬＩＴのリストを、アクティブなＬＩＴと一般に利用されるネットワークパスとに対してチェックする力を有する。

【０１２４】

図１４は、第１のハッシュ手順Ｈ１（ｘ）をリンクＩＤに適用することによって、１に設定されることになるとＨ１（ｘ）によって判断されるｋビットに基づいて第１のＬＩＴを生成し、第２のハッシュ手順をリンクＩＤに適用することによって第２のＬＩＴを生成し、ｄ番目のハッシュ関数Ｈｄ（ｘ）がリンクＩＤに適用されてｄ番目のＬＩＴを生成するまで以下同様に１個のリンクＩＤについてＬＩＴを生成する、１つの見込まれる方法を図解する。各ハッシュ手順は、ｋ個のハッシュ関数で構成され、その各々が、上記の図１に関して述べたように、１に設定されることになる、ビットベクトルの中の１つのビット位置を決める。

【０１２５】

各ハッシュ手順をリンクＩＤに適用することは、（偶然による場合を除いて）２つのハッシュ手順が同じ出力を生成しないように、各ハッシュ手順が新たなハッシュ関数の集合を含むことを必要とする。あるいは、その後のハッシュ手順を、以前に生成されたＬＩＴに繰り返して適用することもできるが、これなら、各ハッシュ手順が新たなハッシュ関数の集合を含むことは必要でないだろう。あるいは、ｋ個のハッシュ関数の集合が固定されたままで、最後に生成されたＬＩＴに繰り返して適用されてもよく、これなら、良好な無作為のＬＩＴを返すためのもう１つの有効な手順となり、必要なハッシュ関数の量が削減されるであろう。別の選択肢として、以下に述べるように、すべてのＬＩＴを生成するために必要なのは、２つの無作為な関数と２つのハッシングだけとなる。

【０１２６】

リンクＩＤ生成のプロセスの場合と同様に、リンクＩＤタグを決めるやり方はいろいろある。それらがルータによって自動的に生成され、その後、ルーティングレイヤに通信されてもよいし、それらが他のインスタンスによって割り当てられ、ルータ上で構成されてもよい。

【０１２７】

ルータは、自分が直接接続していると分かっているルータに対する自分自身の送出リンクにリンクＩＤを割り当てることができる（図１５のリンクＩＤ　ｘ　出力インタフェースを参照）。図１５は、リンクＩＤを使って各出力インタフェースを識別するネットワークノードの略図である（出力ポート１にはリンクＩＤａ、出力ポート２にはリンクＩＤｂ、以下同様）。ノードは、リンクＩＤタグによるインデックス付きのｄ個の転送テーブルを維持するが、それらは各ＬＩＴに関連する出力ポートを識別する。（すでに指摘したように、リンクＩＤは、仮想リンクに関係してもよいし、キャッシュシステムや他のネットワークプロセッサ／システムプロセスへのリンクに関係してもよい。）ルーティング機能の中に維持される情報は、今度は、各リンクＩＤに関連するｄ個のＬＩＴを含むように拡張される（ただし、原理的には、リンクＩＤだけがそこに格納されて、ＬＩＴ候補は常にオンデマンドで生成されてもよいだろう）。

【０１２８】

標準的なリンクＩＤの手法の場合と同様に、ネットワークノード内で維持されることになる転送状態は、非常に小さいままである。ｄの値が着信パケットの中に含まれている場合、各リンクＩＤについてのＬＩＴは、どのようにしてＬＩＴが当初生成されたかという知識からオンデマンドで演算されてもよいだろうが、性能上の理由で、（図１５に示すように）リンク識別子のｄ個の表現の各々について転送テーブルを維持することが望ましいことがあるだろう。図１６は、パケットヘッダの中の別のフィールドに含まれるブルームフィルタを生成するのに用いられるｄの値を与えるフィールドを有する、パケットヘッダの略図である。

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【０１２９】
１個のリンクＩＤからｄ個のリンクＩＤタグを算出するのに必要な異なるハッシュ関数の数を考える場合、各ＬＩＴのビット分布において最大のエントロピーを達成するには、ＬＩＴ毎にｋ個の異なるハッシュ関数が必要であろう。それは、１個のＬＩＤについてｄ個のＬＩＴを演算するのに合計でｋ＊ｄ個のハッシュ関数が必要であろうということを意味する。本発明でハッシュ関数を用いる場合、２つの態様に注目すべきである。第１に、本発明で提案するＢＦ生成と選択プロセスとの無作為性を考えると、ＬＩＴを生成するのに用いられるハッシュが真に無作為であることは重要ではない。第２に、二重のハッシング技法を用いれば、２つだけ無作為の非依存のハッシュ関数（例えばＢＯＢ、ＯＡＡＴ、ＳＢＯＸ、Ｈｓｉｅｈ、ＴＷＭＸ、ＲＳ、ＳＨＡ、ＭＤ５）を用いることによって、漸近的な偽陽性の確率を増加させることなく、ｄ個のＬＩＴを非常に効率的に生成することができる。２つのハッシュ関数ｈ１（ｘ）およびｈ２（ｘ）は、次式の形式のｉ個のハッシュ関数をシミュレートすることができる。

$$g_i(x) = h1(x) + i * h2(x) \bmod m$$

【０１３０】
さらに、この方法を用いると、いかなるＬＩＴ生成プロセスであろうと、１に設定されるＬＩＴのｋ個の位置を演算するのに用いられたｉ個のインデックスの集合によってコンパクトに表現することができる。従って、ｈ１（ｘ）とｈ２（ｘ）とがルーティング要素によって知られている場合、いずれかのＬＩＤについてＬＩＴを導出するのに必要なのは、ｄ＊ｋ個の整数ｉを共有することだけである。Ｔｏｐｏｌｏｇｙ　Ｍｏｄｕｌｅは、転送ノードにＬＩＴ全体を返信する代わりに、ＬＩＴを演算するのに用いられることになるインデックスｉを送信するだけでよいだろう。例えば、ＬＩＴ１［ｉ＝１，２，３，４，５］は、ＬＩＴ１が、ｉの値［１，２，３，４，５］とｈ１（ｘ）とｈ２（ｘ）とを用いるｇ（ｘ）によって判定されるｋ（＝５）ビットを１に設定することによって演算されることを意味するであろう。ｈ１（ｘ）とｈ２（ｘ）とはいずれも転送ノードとＴｏｐｏｌｏｇｙ　Ｍｏｄｕｌｅとによって知られているのだから、ｄ個のＬＩＴが演算されうるようにするには、ＬＩＤとインデックスｉ（合計でｄ＊ｋ個のインデックスがある）とを共有するだけで十分である。加えて、すでに述べたように、ｉは、単なる徐々に増加するシーケンスであってもよいだろうから、この場合、知られていると想定することもでき、従って、交換される必要はない。

【０１３１】
リンクＩＤタグ転送テーブル
パケットがネットワークノードに到着する時、パケットヘッダは、パケットがそれに沿って転送されるべきリンクのＬＩＴを含むかまたは符号化するＢＦを含み、かつ、ＢＦのｄの値を識別する。上記のように、パケット転送は、図１５に示すようにリンク識別子のｄ個の表現の各々について転送テーブルを維持するネットワークノードによって行われてもよい。着信リンク上でパケットが到着した時点で、ノード内の転送機能が、ｄ拡張型ＢＦ転送ヘッダに含まれる値ｄに基づいて、用いられることになる転送テーブルを選択する。ポート転送動作は簡単であって、ＢＦは、すべてのＬＩＴエントリに対して同時にＡＮＤであり、そして、この迅速な要素チェック動作の結果としてＬＩＴエントリが得られる度に、パケットは転送テーブルの中のＰｏｒｔＯｕｔ値へ転送される。

【０１３２】
転送テーブルにＬＩＴエントリを格納するための空間効率のよい複数の選択肢について述べよう。

【０１３３】
標準的な表現
標準的な表現では、見込まれるｄの値の各々について別個のルックアップテーブルが格納されるため、ｄ個のルックアップテーブルが格納される必要がある。各ルックアップテーブルは、各リンクＩＤタグについての適切な出力ポートを、例えば以下のようにリストする（テーブルは、２個のｄ値についてのみ示す）。

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リンクIDタグ(d=00)	出力インタフェース
0010100000100001	1
0001000010010100	3
256ビット	1バイト

リンクIDタグ(d=10)	リンクIDタグ(d=10)
1000010000100101	7
1000000010010100	1
256ビット	1バイト

【０１３４】
ＬＩＴベースの転送テーブルのための、ビットでの総メモリは、次式のようである。
FT_{mem}＝ｄ＊＃ＬＩＤｓ＊（ｓｉｚｅ（ＬＩＴ）＋ｓｉｚｅ（ＰｏｒｔＯｕｔ））
例：
ｄ＝８で、５１２個のリンクＩＤが存在し、各ＬＩＴは２５６ビットのサイズを有し、各出力ポート名は１ビットのサイズを有する場合には、
FT_{mem}＝８＊５１２＊（２５６＋８）＝１０８１３４４ｂｉｔ＝１０５６ｋｂｉｔ≒１Ｍｂｉｔ
である。（後で、図１８および図１９に要約したシミュレーションの結果を通じて、転送ＢＦのサイズが小さければ、ｄ＝８が良好なパラメータ選択であることを示す。）
【０１３５】
疎な表現
これは、１に設定されたｋビットの位置だけがＬＩＴエントリとして格納される、ＬＩＴの空間効率のよい表現である。表現は、ルックアップテーブルがＬＩＴ全体を格納せずに１に設定されるＬＩＴのｋビットの位置だけを格納するという点を除いて、標準的な表現の場合と同様にｄ個のルックアップテーブルを含む。ビットでのＬＩＴのサイズは、ｋにビット位置の２進法表現を乗じたものまで削減することができる（係数$\log(x)_2/x$での削減）。この場合、ＬＩＴのサイズは次式で与えられる。

$$サイズ(LIT)=k*\log_2(LIT)$$

例：ｋ＝５ならば、サイズ（ＬＩＴ）＝５＊$\log_2$（２５６）＝５＊８＝４０ビットである。
【０１３６】
今度は、ｄ個のＬＩＴ転送テーブルのための総メモリは、次式で与えられる。
FT_{mem}＝８＊５１２＊（４０＋８）＝１９６６０８＝１９２ｋｂｉｔ
【０１３７】
区分されたハッシュの疎な表現
区分されたハッシュの疎な表現は、１に設定されるＬＩＴのｋビットのビット位置だけを符号化することによるＢＦの疎な表現と同じ原理を用いる。しかし、ＢＦは、区分されたハッシングを用いて生成されると仮定されており、その場合、ハッシュ動作（ビットを１に設定すること）は、ＢＦを表すｍサイズのビットのベクトルの区分に対して排他的に行われる。各ｋビットのうちの１つだけが、サイズｍ／ｋの区分に対して設定される。この技術は、偽陽性率に重大な影響は及ぼさないと証明されている。この場合、ＬＩＴサイズは、次式で与えられる。

$$サイズ(LIT)=k*\log_2(LIT/k)$$

例：ｋ＝５ならば、サイズ（ＬＩＴ）＝５＊$\log_2$（２５６／５）＝５＊６＝３０ビ

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ットである。

【０１３８】

ここで、ｄ個のＬＩＴ転送テーブルのための総メモリは、次式で与えられる。

FT_{mem}＝８＊５１２＊（３０＋８）＝１９６６０８＝１４４ｋｂｉｔ

【０１３９】

効率的なルーティングのためのｄ最適化ブルームフィルタの構築

本セクションは、最適化されたＢＦを構築する手順がどのようにして行われるかを詳細に記述する。リンクＩＤタグがあれば、ネットワークリンクを表すｄ個のＬＩＴの間の選択力を利用することによって転送ＢＦのより柔軟な構築を可能にする識別子の基盤ができる。

【０１４０】

Ｔｏｐｏｌｏｇｙモジュールまたはルーティング機能が、通信ノード間でネットワークパスを確立するのに必要なリンクＩＤの集合を選択するという問題を解決したと仮定する（図１２のステップ３および４）。ＢＦの中で表現されることになるリンクＩＤの数をｎとしよう。偽陽性を最小化するための最適化手順は、以下のようである。上述のように、各リンクＩＤについてｄ個のＬＩＴが生成され、これらは、ＬＩＴ１、ＬＩＴ２、・・・ＬＩＴｄとラベル付けされる（図２０のステップ１（１）、１（２）、・・・１（ｄ））。

【０１４１】

ＢＦを構築するルーティング機能は、ＬＩＴ１の単純なＯＲ演算をすることによって、すべてのリンクＩＤのＬＩＴ１表現を第１のブルームフィルタ候補ＢＦ１の中に挿入する（図２０のステップ２（１））。同様に、同じ方法に従って、ＬＩＴ２の単純なＯＲ演算をすることによって、すべてのリンクＩＤのＬＩＴ２表現を第２のブルームフィルタ候補ＢＦ２の中に挿入し（図２０のステップ２（２））、以下同様に、ｄ番目のブルームフィルタ候補ＢＦｄが、すべてのリンクＩＤのＬＩＴｄ表現を挿入することによって構築され（図２のステップ２（ｄ））、結果として、同じネットワークパスを表現するｄ個のＢＦが生じるまで、挿入されることになるすべてのリンクの次のＬＩＴ表現を取り込む。（実際には、ｄ個のＢＦは、ここで述べるように次々にではなく、並行して構築される。）しかし、ｄ個のＢＦは同じネットワークパスを表現しているのだが、ＢＦを構築するためのＬＩＴとＯＲ演算の確率的性質が原因で、ＢＦは、１に設定されるビットの数（および位置）がさまざまである。

【０１４２】

パケットをルーティングするのに用いられることになるＢＦは、ｄ個のＢＦ候補から選択される（図２０のステップ３）。一実施形態では偽陽性を返す全体的な確率が最も低いＢＦが選択される。

【０１４３】

次いで、選択されたブルームフィルタが、上記の実施形態で記述したように用いられてもよく、そして、例えば、ソースノードに送信されてパケットヘッダに組み入れられてもよい（図１２のステップ６、７）。あるいは、ルーティング機能が、選択されたブルームフィルタをソースノード以外のノードに送信してもよい。

【０１４４】

図２０の方法は、ルーティング機能の中で行われると上述したけれども、その代わりにソースノードで行われてもよいだろう。

【０１４５】

一般に、図１２の方法で用いるＢＦを生成するのに図２０の方法が用いられる場合、３つの主な段階に分けることができるが、それらは、ｄ個のＢＦ候補を生成することと、使用される１つのＢＦ候補を選択することと、選択されたＢＦを使用することとである。これらの段階はすべて、同じネットワークノードで行われてもよいし、２つまたは３つもの異なるネットワークノードまたはエンドホストノードに分散されてもよい。例えば、上記のように、図２０の方法が全部ソースノードで行われ、ソースノードがパケットヘッダ内

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に選択されたブルームフィルタを含める場合、これは、生成段階と選択段階と使用段階とをすべて同じノードで実行する事例となるであろう。

【０１４６】

別の例として、図２０の方法は、ルーティング機能と別のノード（例えばソースノード）との間で分割することができるだろう。例えば、ルーティング機能がｄ個のブルームフィルタを生成するが、その後、ｄ個のブルームフィルタ全部を別のノードへ送信し、使用されることになるブルームフィルタの選択がその別のノードで行われるようにすることもできるだろう。本実施形態で望ましいならば、ルーティング機能は、ｄ個のブルームフィルタを他方のノードへ送信する時、どのブルームフィルタが選択されるべきだと自分が考えているかを示すこともできるだろうが、他方のノードは、この指示を無視することもできるだろう。他方のノードがソースノードである場合には、ソースノードは、選択されたブルームフィルタを、ソースノードから送信されることになるパケットに含めてもよい。（これは、ルーティング機能が生成段階を実行し、ソースノードが選択段階と使用段階とを実行することに相当するであろう。）しかし、他方のノードが、選択されたブルームフィルタの対象となるユーザでない場合、他方のノードは、選択されたブルームフィルタを対象となるユーザ、例えばソースノードに送信するであろう。（これは、生成段階と選択段階と使用段階とがすべて別のノードで実行される事例となるであろう。）

別の例として、ルーティング機能が、ｄ個のブルームフィルタから予備的な選択を行い、例えば、さらなる検討の結果、１つ以上の指定のリンクについて偽陽性を与える可能性のあるいずれかのブルームフィルタを廃棄することもできよう。次いでルーティング機能は、この予備的選択を通過したこれらのブルームフィルタを、（場合によっては、どのブルームフィルタが選択されるべきであるとルーティング機能が考えるかという指標と共に）別のノードに送信し、別のノードが最終選択を行うであろう。他方のノードが、選択されたブルームフィルタの対象となるユーザでなかった場合、他方のノードは、選択されたブルームフィルタを対象となるユーザに送信するであろう。

【０１４７】

ＢＦが偽陽性を返す確率は、ＢＦ内の０の１に対する割合に依存するということは重要であろうし、ＢＦの偽陽性率は、セルが空である確率の関数であることを示すことができる（例えば、Ａ．ＢｒｏｄｅｒとＭ．Ｍｉｔｚｅｎｍａｃｈｅｒとによる「Ｎｅｔｗｏｒｋ ａｐｐｌｉｃａｔｉｏｎｓ ｏｆ Ｂｌｏｏｍ ｆｉｌｔｅｒｓ： Ａ ｓｕｒｖｅｙ」、Ｉｎｔｅｒｎｅｔ Ｍａｔｈｅｍａｔｉｃｓ、ｖｏｌ．１、ｎｏ．４、２００２を参照のこと）。

$$p = Pr[\text{1個のセルが空である}] = (1 - 1/m)^{kn} \fallingdotseq e^{-kn/m}$$

$$fpb = Pr[\text{偽陽性}] = (1 - p)^{k} \fallingdotseq (1 - e^{-kn/m})^{k}$$

【０１４８】

セルが空である確率は、すでに１に設定されたセルの数に依存する。０に設定されるビット数が増加する場合、要素をチェックする時に０を見つける可能性が高まり、従って、偽陽性率は減少する。ｆｐｂで与えられる数式は、ハッシングの前の偽陽性の確率である。一旦ハッシング手順が行われ、ビットがＢＦ内で１に設定されると、フィルファクターρ（ロー）は既知であり、ハッシングの後の偽陽性の確率のより良い推定量は、次式で与えられる。

$$fpa = Pr[\text{偽陽性}] = \rho^{k}$$

【０１４９】

このように、ｄ個のＢＦ候補から偽陽性を返す確率が最小であるＢＦを選択することは簡単であり、０が最も多い（または１に設定されたビット数が最も少ない）ＢＦの方が、より良い成果が得られ、偽陽性が少なくなるであろうし、その結果、本発明のルーティング方法では、要求していないトラヒックを受信するリンクが減少する。偽陽性の確率が最小であると予測されるｄ個のＢＦ候補を選択するための選択アリゴリズムは、次式のようであろう。

$$\text{最小の} \{\rho_0^{k}, \ldots, \rho_d^{k}\} \ fpa\text{を生じるｄを選択する}$$

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【０１５０】
留意すべきだが、ｋは、ｄ個のＬＩＴ表現の各々について同じである必要はない。加えて、アプリケーションのシナリオによっては、ＬＩＴ表現の各々について、１に設定されるビットの量ｋが異なることも有益でありうる。例えば、ｄ＝８の場合、ｋを例えば｛３；３；４；４；５；５；６；６｝のように配分してもよいだろう。それは、８個のＬＩＴのうちの２個のＬＩＴは、３ビットだけが１に設定され、２個のＬＩＴは、４ビットが１に設定され、以下同様に設定されることを意味する。この場合、選択アルゴリズムは、一般的な事例である上述したものであって、すべてのＬＩＴを構築するのに同じｋが用いられる場合に限って当てはまる、０の数が最小の事例に留まらない。

【０１５１】
図１７は、リンクＡとリンクＢとで構成されるパスを表すためｄ＝４のＢＦ候補を生成するという単純な事例についての最適化プロセスを示す。この例では、ＢＦ２が、パケットヘッダ内でルーティングＢＦとして用いられることになる最適なＢＦであるが、それは、最大数のゼロを含んでおり、従って、偽陽性を与える全体的な可能性が最小だからである。

【０１５２】
この最適化のもう１つの解釈は、所定の最大の所望の偽陽性率について、ｄ選択型ＬＩＴ最適化によって、ＢＦにもっと多くのリンク識別子を挿入することが今では可能であり、それによって、さらなるホップへと拡大し、もっと多くの宛先ホストに到達することができるような、より大きな配信ツリーを構築することも可能であるということであろう。

【０１５３】
ＢＦの最適化は、全体的な偽陽性率に限定される必要はなく、他のポリシー、またはネットワーク最適化ポリシーを考慮に入れてもよいだろう。例えば、ｄ個のＢＦ候補を生成した後、ルーティング最適化モジュールが、転送要素の所定のリンクＩＤタグは、リンクの特定の部分集合について望まれていない偽陽性、例えば、ピアされていない領域や遅いネットワークパスや輻輳している領域への転送をもたらそうとしているかどうかチェックすることができてもよいだろう。この場合、絶対的な値としては最良の偽陽性率を有することができたとしても、このＢＦの選択肢を廃棄することを選択してもよいだろう。この一例を表１に示す。

LIT BF候補	選択基準一最適化目標				
	偽陽性率が全体的に最小	これらのリンクIDタグの集合についてBF内での偽陽性をチェックする			
		ポリシー対象領域間リンクID	高密度/低容量ゾーン内のリンクID	輻輳リンクID（動的集合）	…
BF1	++	-	+	++	
BF2	+++	---	-	-	
BF3	-	+	+++	+++	
…					
BFd	+	+	-	+	

表１

【０１５４】
表１は、各ＢＦ候補について、全体的な偽陽性率だけでなく特定のリンクの３つの部分集合（領域間リンク、低容量ゾーン内のリンク、輻輳リンク）についての偽陽性率を示す。領域間リンク、低容量ゾーン内のリンク、または輻輳リンク内の偽陽性は、その他のリンク内の偽陽性より有害であると仮定する。候補ＢＦ３は、全体的な偽陽性率は低いが、低容量ゾーン内および輻輳リンク内でのリンクについての偽陽性の確率が高い。従って、

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候補ＢＦ２は候補ＢＦ３よりも全体的な偽陽性率は高いけれども、低容量ゾーン内および輻輳リンク内でのリンクについての偽陽性の確率がより低いことから、パケットヘッダについてのＢＦとしてＢＦ２候補を選択する方が望ましいであろう。このようにして、本実施形態は、ＢＦが、偽陽性の全体的な確率に基づくのではなく、選択されたリンクにおける（本実施形態では、偽陽性がより有害であると考えられるリンクについての）偽陽性の確率に基づいて選択されることを可能にする。

【０１５５】

従って、本発明の本態様は、ＢＦが偽陽性を返すことが原因で一定のネットワークエリアにパケットが誤って進入することを回避する（または最小化する）ように、パケットヘッダ用の転送ＢＦを構築する強力な方法を提供することが分かる。ｄ個の同等のＢＦ候補を生成して、ＢＦ候補のうちの１つを選択することは、ネットワークを通るパケットの必須のパスは維持されていることを保証するが、所定のリンク上での偽陽性を最小化することや、偽陽性の影響をもっと好都合なパスに分散することもできる。

【０１５６】

本発明の利点

提案するリンクＩＤタグを使用すると、リンク情報の所与の集合がブルームフィルタのような確率的コンパクト表現に挿入される際の、偽陽性率が減少する。偽陽性率が減少すると、結果として、ＢＦベースのルーティング手法の帯域幅効率が向上した解決策が得られる。ＬＩＴを生成して最も適したＢＦを選択することについて提案する方法は、転送プロセスの簡素さを失うことなく、かつ、非常に安価な実装コストで、ＢＦベースのルーティングスキームの性能を大幅に向上させる。従って、所定の最大偽陽性値について、提案するリンクＩＤタグに基づくＢＦの構築は、ＢＦのサイズを増加させることなくＢＦに追加可能なリンク情報の容量を増加させる。

【０１５７】

リンクＩＤを表すリンクＩＤタグ候補を上手に選択することは、ＢＦによって決められるルーティングのホップの最大数を増加させるだけでなく、例えば、ＬＩＤによって識別される所定のネットワーク領域における偽陽性を回避（または最小化）することによって、または、例えば、偽陽性の影響をもっと好都合なパス全体にわたって拡散することによって、偽陽性の影響を制御することにおける柔軟性を高める。このより精緻な制御によって、ルーティングポリシーおよびセキュリティポリシーを本書で述べたＢＦベースのソースルーティング手法に適用することが可能になることが見込まれる。

【０１５８】

図１８は、ｄ選択型ＬＩＴ技法に従って構築されたＢＦの実際の偽陽性率の改善を示す。図１８は、偽陽性率を、５つの事例についてＢＦとして符号化されたリンクの数の関数として示す。

【０１５９】

１）ｋ＝５で、リンクＩＤをＢＦへと符号化した場合（＋で示す）
２）ｋ＝４、ｄ＝２で、ＬＩＴをＢＦへと符号化した場合（×で示す）
３）ｋ＝５、ｄ＝４で、ＬＩＴをＢＦへと符号化した場合（＊で示す）
４）ｋ＝６、ｄ＝８で、ＬＩＴをＢＦへと符号化した場合（白い四角で示す）
５）ｋ＝６、ｄ＝１６で、ＬＩＴをＢＦへと符号化した場合（黒い四角で示す）

【０１６０】

図は、５０回の実験に対する偽陽性率の平均と拡散(spread)とを、データポイント（フィルタ内の要素の数）毎に示す。

【０１６１】

ＬＩＴをＢＦへ符号化すると、偽陽性率が著しく減少し、減少幅は、ＢＦにおけるリンクの数が増加するにつれて拡大することが分かる。２４４ビットまでのＢＦのサイズについて、リンクＩＤがその中に符号化されている標準的なＢＦは、およそ３５個のリンクＩＤを含んでいる場合、４％の偽陽性率を呈する。ｄ＝８のＬＩＴ　ＢＦでは、同様の偽陽性率は、６０個のリンクＩＤがＢＦに挿入されている場合に限って観察される。ｄ選択型

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ＢＦは、構築された標準のＢＦより、すべての設定について勝っている。

【０１６２】

図１９は、ｄ選択型ＬＩＴ技法に従って構築されたＢＦの実際の偽陽性率の向上が、どのようにしてｄの値に依存するのかを示す。図１９は、偽陽性率を、ｋが一定である場合にｄの３つの異なる値についてＢＦとして符号化されたリンクの数の関数として示す。

【０１６３】

１）ｋ＝５、ｄ＝４で、ＬＩＴＢＦへと符号化した場合（＋で示す）

２）ｋ＝５、ｄ＝８で、ＢＦへと符号化した場合（×で示す）

３）ｋ＝５、ｄ＝１６で、ＢＦへと符号化した場合（＊で示す）

【０１６４】

図は、データポイント（フィルタ内の要素の数）毎の５０回の実験に対する偽陽性率の平均と拡散(spread)とを示す。

【０１６５】

図１９から、パラメータｄ＝８を設定することは、一方では偽陽性率の削減と、他方ではシステム内でより大きなｄの値を有すること（例えば転送テーブルのサイズとＢＦヘッダの中のビット数（$\log_2$（ｄ）ビット））に関連するコストの削減との間の良いトレードオフになりそうだと推論することができる。

【０１６６】

上記の方法では、ｄ個の「同等の」タグを一意のＩＤに関連付ける方法は、ＩＤがネットワークリンクについての何らかの識別子を参照するような利用シナリオに着目した。しかし、ＩＤからタグを生成するのに用いられるハッシング手順は、ｄ個のタグが導出されるＩＤの命名形式やサイズや意味に非依存である。従って、ｄ個のＢＦ候補を構築する上記の方法は、ネットワークリンクを符号化するＢＦに限定されるのではなく、ＩＤ（識別子）の集合が、例えばＢＦのような確率的データ構造によってコンパクトに表される、他の用途の場合にも適合する。

【０１６７】

一例をあげれば、ＩＤとしてホスト名（またはいずれかのタイプのホストＩＤ、識別子、署名、鍵、等）を考える場合にホスト名の集合のコンパクト表現を構築したい場合であろう。次いで、ｄ個のタグを各ＩＤについて同様に定義し、候補となるｄ個の表現（ブルームフィルタ）を演算し、そして、特定の利用シナリオに適した選択アルゴリズムを適用することができる。この場合もやはり、基本的な基準は、ＢＦの偽陽性確率予測を最小化することであってもよいだろうから、従って、選択アルゴリズムは、１に設定されるビット数が最も少ない候補、すなわち、何個の項目が挿入されたか、および、どのようにしてタグが構築されたかということに依存（例えば、すべてのタグで、固定数ｋビットが１に設定されているのか、あるいは、タグでのｋの濃度はさまざまであるのかに依存）して、ハッシング後の偽陽性確率が最も良い候補を選択するであろう。ＢＦに含まれる要素が少ないシナリオでは、ｋが大きい方が、ハッシング後の偽陽性推定量の結果が良いであろう。逆にＢＦがもっと詰まっている場合、要素毎のビット数（ｋ）を少なくすれば、偽陽性率が良好になるであろう。ｋの値にこのような柔軟性を持たせると、より多くの利用シナリオについて選択アルゴリズムが自然に適応する。

【０１６８】

同様に、それぞれの場合に最適化目標を達成するために、もっと緻密な選択戦略をとることもでき、例えば、ホストＩＤの試験集合を構築して、ＢＦ候補に対して偽陽性を試験し、観測された偽陽性率が最も少ないＢＦ候補が選択されてもよいだろう。その他のオフラインの選択基準には、一つでも偽陽性があればＢＦ候補を選択プロセスからすぐに排除するような試験集合が含まれてもよい（例えば、所定のリンクＩＤ（例えば或るネットワーク領域に広がるかもしくは領域間リンクに広がる使用量の多い仮想リンクＩＤ）については、ＢＦは偽陽性を一切引き起こしてはならないと指定することもできよう）。

【０１６９】

また、ｄ個のタグを有することの重要な利点も当然これに当てはまり、ポリシーの実行

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を有効にすることと、より良い成果をもたらすことと、新たなセキュリティメカニズムを有効にすることなどが、利点に含まれる。

【０１７０】

タグがそこから構築されうる、さらに想定されるＩＤには、ネットワーク領域（管理領域および物理領域）、ネットワークシステム、アプリケーションプロセス、ネットワークインタフェース、論理ポートおよび仮想ポート等が含まれる。アプリケーションによっては、複合的な最適化戦略や特定の選択基準が定義されてもよいし、他方、ｄ個のタグとｄ個のＢＦ候補を構築する基本的な方法が、単純な偽陽性率軽減アルゴリズムに加えてかまたはその代わりに、直接適用されてもよいだろう。

【図１】

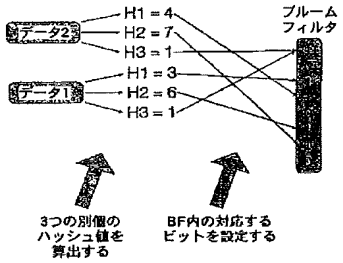

Figure 1

【図２】

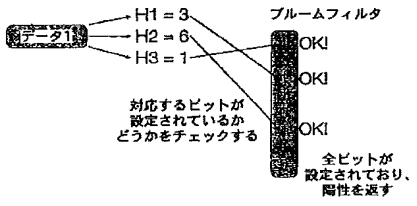

Figure 2

【図３】

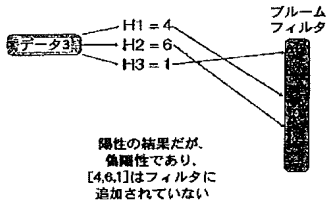

Figure 3

【図４】

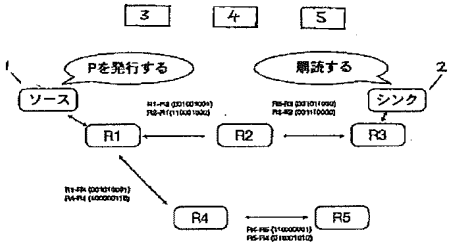

Figure 4

【図５】

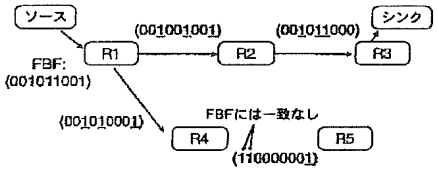

Figure 5 BFを使った転送

【図６】

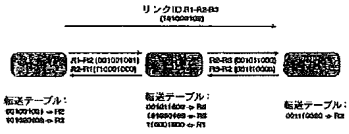

Figure 6

【図７】

転送ヘッダ BF: 001011001	発行ID VILS's ID	データ n-ID; 101000100; 存続時間

Figure 7 仮想リンクセットアップパケット

【図８】

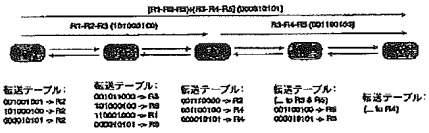

Figure 8

【図９】

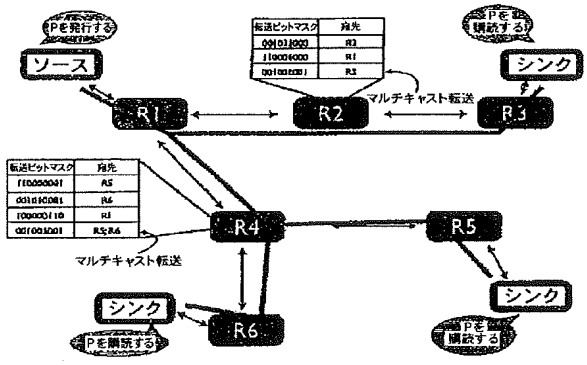

Figure 9

【図１０】

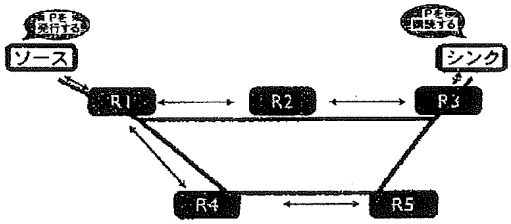

Figure 10

【図１１】

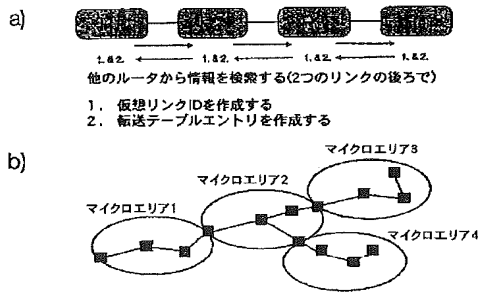

Figure 11 a）増強された自己生成 b）ステートフルルータに接続されたマイクロエリア

図b)は、その中でパスが自己生成されるマイクロエリアにネットワークを分割する可能性を図解する。ルーティング機能は、対応するマイクロエリアから受信したマイクロエリア情報を用いてパス全体を生成することに責任を持つ。

【図１２】

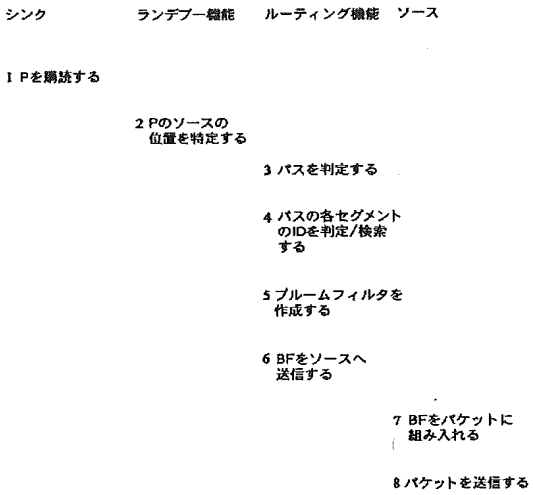

Figure 12

【図１３】

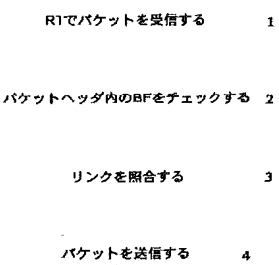

Figure 13

【図１４】

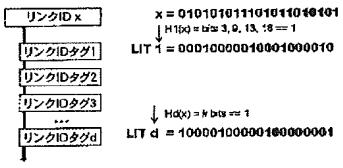

Figure 14. 1個のリンクIDとd個のリンクIDタグとの関係。
任意のk個を1に設定して残りを0のままにすることによるLIT生成の一例。

【図１５】

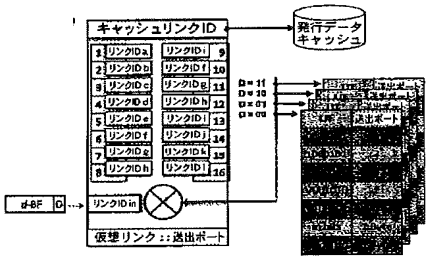

Figure 15. リンクIDを使って各出力インタフェースを識別し、かつ、
リンクIDタグによるインデックス付きのｄ個の転送テーブルを維持する、
転送エレメントの略図

【図１６】

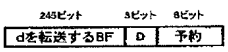

Figure 16. dを転送するBFヘッダの例

【図１７】

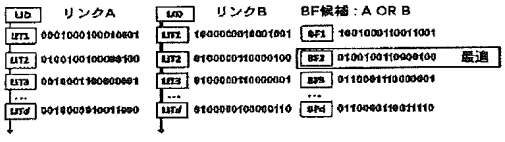

Figure 17 d個のブルームフィルタ候補の生成と、ビットベクトル内に存在する
0の数が最大であることに基づく最適なBFの選択

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【図１８】

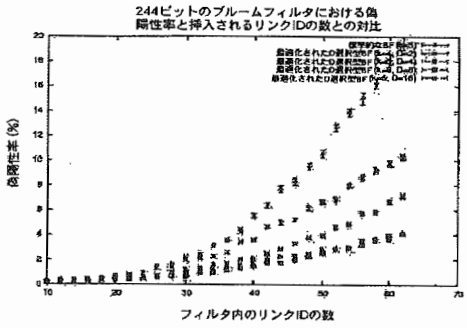

Figure 18 挿入されるリンクIDの数の関数としての実際の偽陽性率における、標準的なBF構造とd選択型LIT最適化されたBFとの対比

【図１９】

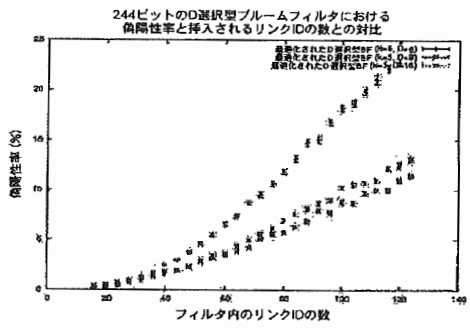

Figure 19 挿入されるリンクIDの数の関数としての、ブルームフィルタ構造のためにさまざまな程度で選択されたdについての実際の偽陽性率。D=8が、244ビットについて推奨されるパラメータだと考えられる。

【図２０】

Figure 20

【手続補正書】
【提出日】平成22年10月18日(2010.10.18)
【手続補正１】
【補正対象書類名】特許請求の範囲
【補正対象項目名】全文
【補正方法】変更
【補正の内容】
【特許請求の範囲】
【請求項１】
パケットのルーティング情報を提供する方法であって、
ソースノードから１以上の宛先ノードへのルーティング情報を、集合メンバシップのコンパクト表現の中に符号化するステップを有し、
前記ルーティング情報は、１以上の識別子の表現を含み、
各識別子は、各ネットワークリンク、各ノード、又は、２以上のネットワークリンクを含む全体パス又は部分パスを識別し、
前記方法は、
前記１以上の識別子のｄ個（ｄは２以上の整数）の表現から、集合メンバシップのｄ個のコンパクト表現の候補を生成するステップと、
前記ソースノードから前記１以上のソースノードへ送信すべきパケットのヘッダの中に、集合メンバシップの前記コンパクト表現の１つを入れるステップと、
を有する、方法。
【請求項２】
前記ルーティング情報は、前記ソースノード又はルーティングサーバにおいて符号化される、
請求項１に記載の方法。
【請求項３】
前記パケットヘッダに含まれる集合メンバシップのコンパクト表現を識別する情報を、前記パケットヘッダの中に含めるステップ、
を更に有する、請求項１又は２に記載の方法。
【請求項４】
ネットワークを通ってパケットをルーティングする方法であって、
ネットワークノードにおいてパケットを受信するステップと、
前記ノードから前記パケットがこれに沿って送信されるべき１以上のリンクを判定するために、又は、前記ノードから前記パケットがそこへ送信されるべき１以上の他のノードを判定するために、又は、その両方のために、前記パケットのヘッダの中に集合メンバシップのコンパクト表現として含まれるルーティング情報を問い合わせるステップと、
前記判定された１以上のリンクに沿って、又は、前記判定された１以上の他のノードへ、又は、その両方で、前記パケットを転送するステップと、
を有し、
前記ルーティング情報は、１以上の識別子の複数の表現の候補の１つを含み、
各識別子は、各ネットワークリンク、各ノード、又は、２以上のネットワークリンクを含む全体パス又は部分パスを識別し、
前記ルーティングは、各々が前記１以上の識別子のｄ個（ｄは２以上の整数）の表現の候補の１つに対応するｄ個のルックアップテーブルから、前記１以上の識別子のうちの受信した表現に対応するルックアップテーブルを選択するステップを更に含む、
方法。
【請求項５】
ネットワークノードであって、
パケットを受信する手段と、
前記ノードから前記パケットがこれに沿って送信されるべき１以上のリンクを判定する

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ために、又は、前記ノードから前記パケットがそこへ送信されるべき１以上の他のノードを判定するために、又は、その両方のために、前記パケットのヘッダの中に集合メンバシップのコンパクト表現として含まれるルーティング情報を問い合わせる手段と、
を有し、
前記ネットワークノードは、前記判定された１以上のリンクに沿って、又は、前記判定された１以上の他のノードへ、又は、その両方で、前記パケットを転送するように構成され、
前記ネットワークノードは、各々が１以上の識別子のｄ個（ｄは２以上の整数）の表現の候補の１つに対応するｄ個のルックアップテーブルから、前記１以上の識別子のうちの受信した表現に対応するルックアップテーブルを選択するように更に構成される、
ネットワークノード。
【請求項６】
パケットのルーティング情報を提供するネットワークノードであって、
ソースノードから１以上の宛先ノードへのルーティング情報を、前記ソースノードから前記１以上のソースノードへ送信すべきパケットのヘッダの中に含めるために、集合メンバシップのコンパクト表現の中に符号化するように構成され、
前記ルーティング情報は、１以上の識別子の表現を含み、
前記ネットワークノードは、
前記１以上の識別子のうちの少なくとも一部に関するｄ個（ｄは２以上の整数）の表現を生成し、
前記識別子の前記ｄ個の表現から集合メンバシップのｄ個のコンパクト表現の候補を生成し、
集合メンバシップの前記ｄ個のコンパクト表現の候補の１つを選択する
ことにより、前記ルーティング情報を符号化するように構成される、
ネットワークノード。
【請求項７】
前記１以上の識別子のうちの少なくとも一部に関するｄ個（ｄは２以上の整数）の表現を生成し、
前記識別子の前記ｄ個の表現から集合メンバシップのｄ個のコンパクト表現の候補を生成し、
集合メンバシップの前記ｄ個のコンパクト表現の候補の２以上を他のノードへ送信する
ことにより、前記１以上の識別子の表現を含むルーティング情報を符号化するように構成される、
請求項６に記載のネットワークノード。

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【国際調査報告】

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2008/063647

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04L12/56

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, INSPEC, IBM-TDB, COMPENDEX, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	LICHUN BAO ED - WENJUN ZHANG ET AL: "A New Approach to Anonymous Multicast Routing in Ad Hoc Networks" COMMUNICATIONS AND NETWORKING IN CHINA, 2007. CHINACOM '07. SECOND INTERNATIONAL CONFERENCE ON, IEEE, PISCATAWAY, NJ, USA, 22 August 2007 (2007-08-22), pages 1004-1008, XP031238021 ISBN: 978-1-4244-1008-8	1-3, 9-14,16, 18,19
Y	paragraph [00II] - paragraph [0III]	4-6

-/--

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
10 August 2009	14/08/2009

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Hes, Ronald

Form PCT/ISA/210 (second sheet) (April 2005)

DELL - Exhibit 1002 - Page 304

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2008/063647

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CLAUDE CASTELLUCCIA ET AL: "Hash-Based Dynamic Source Routing" NETWORKING 2004, NETWORKING TECHNOLOGIES, SERVICES, AND PROTOCOLS; PERFORMANCE OF COMPUTER AND COMMUNICATION NETWORKS; MOBILE AND WIRELESS COMMUNICATIONS; [LECTURE NOTES IN COMPUTER SCIENCE;;LNCS], SPRINGER-VERLAG, BERLIN/HEIDELBERG, vol. 3042, 8 April 2004 (2004-04-08), pages 1012-1023, XP019005643 ISBN:. 978-3-540-21959-0	1-3, 9-14,16, 18,19
Y	paragraph [0001] - paragraph [02.3]	4-6
X	WO 2006/020658 A (YAU JOHNNY [US]; NGAN CHRISTOPHER J [US]) 23 February 2006 (2006-02-23) paragraph [0023] - paragraph [0026] paragraph [0037] - paragraph [0038] paragraph [0042] paragraph [0051] paragraph [0065] - paragraph [0070]	1-3, 9-14,16, 18,19
X	DENH SY ET AL: "ODAR: On-Demand Anonymous Routing in Ad Hoc Networks" MOBILE ADHOC AND SENSOR SYSETEMS (MASS), 2006 IEEE INTERNATIONAL CONFE RENCE ON, IEEE, PI, 1 October 2006 (2006-10-01), pages 267-276, XP031003841 ISBN: 978-1-4244-0506-0 paragraph II B- paragraph III A	1-3,18, 19
X	IMAD AAD ET AL: "Packet Coding for Strong Anonymity in Ad Hoc Networks" SECURECOMM AND WORKSHOPS, 2006, IEEE, PI, 1 August 2006 (2006-08-01), pages 1-10, XP031087503 ISBN: 978-1-4244-0422-3 paragraph [00IV]	1-3,18, 19
Y	US 2002/131418 A1 (RAFTELIS MICHAEL [US] ET AL) 19 September 2002 (2002-09-19) paragraph [0177] - paragraph [0178] figures 31,32	4-6

-/--

Form PCT/ISA/210 (continuation of second sheet) (April 2005)

DELL - Exhibit 1002 - Page 305

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2008/063647

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	MIGUEL JIMENO ET AL: "A Power Management Proxy with a New Best-of-N Bloom Filter Design to Reduce False Positives" PERFORMANCE, COMPUTING, AND COMMUNICATIONS CONFERENCE, 2007. IPCCC 200 7. IEEE INTERNATIONA, IEEE, PI, 1 April 2007 (2007-04-01), pages 125-133, XP031086865 ISBN: 978-1-4244-1137-5 abstract paragraph [0003] - paragraph [0005]	22-24
X	US 6 341 311 B1 (SMITH BRIAN J [US] ET AL) 22 January 2002 (2002-01-22) column 5, line 19 - line 28 column 12, line 19 - line 34	22-24
A	SAILESH KUMAR ET AL: "Segmented hash" 26 October 2005 (2005-10-26), ARCHITECTURE FOR NETWORKING AND COMMUNICATIONS SYSTEMS, 2005. ANCS 2005. SYMPOSIUM ON, IEEE, PISCATAWAY, NJ, USA, PAGE(S) 91 - 103 , XP031362752 ISBN: 978-1-59593-082-8 paragraph [04.1] - paragraph [04.3]	22-24

Form PCT/ISA/210 (continuation of second sheet) (April 2005)

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/EP2008/063647

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. [x] As all required additional search fees were timely paid by the applicant, this international search report covers allsearchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search reportcovers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

Form PCT/ISA/210 (continuation of first sheet (2)) (April 2005)

International Application No. PCT/EP2008/063647

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-6, 9-13, 16,18-19

How to identify a path in a network

2. claims: 7-8, 14-15, 17, 20-24

How to generate compact set representations

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2008/063647

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2006020658 A	23-02-2006	US 2008002599 A1	03-01-2008
US 2002131418 A1	19-09-2002	NONE	
US 6341311 B1	22-01-2002	NONE	

Form PCT/ISA/210 (patent family annex) (April 2005)

フロントページの続き

(81)指定国 AP(BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), EA(AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), EP(AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, NO, PL, PT, RO, SE, SI, SK, TR), OA(BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG), AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW

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Fターム(参考) 5K030 GA15 HA08 HC01 HD03 LB05 LD19 LD20

DELL - Exhibit 1002 - Page 310

Electronic Patent Application Fee Transmittal

Application Number:	14244701
Filing Date:	03-Apr-2014
Title of Invention:	Communication system, forwarding node, path management server, communication method, and program
First Named Inventor/Applicant Name:	JUN AWANO
Filer:	Saryadvinder S. Sahota/Erica Butkiewicz
Attorney Docket Number:	NEG-1440PCT-US2CT

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
Submission- Information Disclosure Stmt	1806	1	180	180
		Total in USD ($)		**180**

Electronic Acknowledgement Receipt

EFS ID:	22960793
Application Number:	14244701
International Application Number:	
Confirmation Number:	2010
Title of Invention:	Communication system, forwarding node, path management server, communication method, and program
First Named Inventor/Applicant Name:	JUN AWANO
Customer Number:	21254
Filer:	Saryadvinder S. Sahota/Erica Butkiewicz
Filer Authorized By:	Saryadvinder S. Sahota
Attorney Docket Number:	NEG-1440PCT-US2CT
Receipt Date:	20-JUL-2015
Filing Date:	03-APR-2014
Time Stamp:	13:03:04
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$180
RAM confirmation Number	9913
Deposit Account	500481
Authorized User	SAHOTA, SARVADVINDER SAM

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

Charge any Additional Fees required under 37 C.F.R. Section 1.16 (National application filing, search, and examination fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.17 (Patent application and reexamination processing fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.19 (Document supply fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.20 (Post Issuance fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Form (SB08)	201507201247.pdf	287832 16f360e411d537ffb60bf6eebca554e29615c877	no	3
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
2	Other Reference-Patent/App/Search documents	201507201247-1.pdf	328239 c809289cf34cda50e30e641b943b21bd2d8137c2	no	4
Warnings:					
Information:					
3	Other Reference-Patent/App/Search documents	201507201247-2.pdf	119401 78811a0a01b48c4c78ab0779aa9aeaf4106114a4	no	1
Warnings:					
Information:					
4	Other Reference-Patent/App/Search documents	201507201248.pdf	116244 acdaf0d065617af4af20a236088962a000fe2cfe	no	1
Warnings:					
Information:					
5	Foreign Reference	201507201249.pdf	10025911 fcb583ea8dac2f3671a9edefbce625063a820af1	no	90
Warnings:					
Information:					
6	Fee Worksheet (SB06)	fee-info.pdf	30794 a2e2c099887b998f5075371b61359947a18ebaa3	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	10908421		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/244,701	04/03/2014	JUN AWANO	NEG-1440PCT-US2CT	2010

21254 7590 08/10/2015

MCGINN INTELLECTUAL PROPERTY LAW GROUP, PLLC
8321 OLD COURTHOUSE ROAD
SUITE 200
VIENNA, VA 22182-3817

EXAMINER
AUNG, SAI

ART UNIT	PAPER NUMBER
2475	

MAIL DATE	DELIVERY MODE
08/10/2015	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Applicant-Initiated Interview Summary	Application No.	Applicant(s)	
	14/244,701	AWANO, JUN	
	Examiner	Art Unit	
	SAI AUNG	2475	

All participants (applicant, applicant's representative, PTO personnel):

(1) *SAI AUNG*. (3)_____.

(2) *Sam Sahota (Reg. 47,051)*. (4)_____.

Date of Interview: *06 August 2015*.

Type: ☒ Telephonic ☐ Video Conference
☐ Personal [copy given to: ☐ applicant ☐ applicant's representative]

Exhibit shown or demonstration conducted: ☐ Yes ☐ No.
If Yes, brief description: _____.

Issues Discussed ☐101 ☐112 ☒102 ☐103 ☐Others
(For each of the checked box(es) above, please describe below the issue and detailed description of the discussion)

Claim(s) discussed: *1 and 6*.

Identification of prior art discussed: *Vasseur (US 7522603 B2)*.

Substance of Interview
(For each issue discussed, provide a detailed description and indicate if agreement was reached. Some topics may include: identification or clarification of a reference or a portion thereof, claim interpretation, proposed amendments, arguments of any applied references etc...)

*During the interview, the applicant's representative argued that the ref Vasseur fails to disclose a packet includes a plurality of identifiers. The examiner explained that the identifiers could be interpreted as addresses, labels, or service requests. The claim fails to provide further limitations of identifiers. The examiner suggested that further specific limitatios to clarify the identifier shall be required in order to overcome current prior rejections. No agreement was reached afterall.*_____.

Applicant recordation instructions: The formal written reply to the last Office action must include the substance of the interview. (See MPEP section 713.04). If a reply to the last Office action has already been filed, applicant is given a non-extendable period of the longer of one month or thirty days from this interview date, or the mailing date of this interview summary form, whichever is later, to file a statement of the substance of the interview

Examiner recordation instructions: Examiners must summarize the substance of any interview of record. A complete and proper recordation of the substance of an interview should include the items listed in MPEP 713.04 for complete and proper recordation including the identification of the general thrust of each argument or issue discussed, a general indication of any other pertinent matters discussed regarding patentability and the general results or outcome of the interview, to include an indication as to whether or not agreement was reached on the issues raised.

☐ Attachment

/S. A./ Examiner, Art Unit 2475	/DANG TON/ Supervisory Patent Examiner, Art Unit 2475

Summary of Record of Interview Requirements

Manual of Patent Examining Procedure (MPEP), Section 713.04, Substance of Interview Must be Made of Record
A complete written statement as to the substance of any face-to-face, video conference, or telephone interview with regard to an application must be made of record in the application whether or not an agreement with the examiner was reached at the interview.

Title 37 Code of Federal Regulations (CFR) § 1.133 Interviews
Paragraph (b)

In every instance where reconsideration is requested in view of an interview with an examiner, a complete written statement of the reasons presented at the interview as warranting favorable action must be filed by the applicant. An interview does not remove the necessity for reply to Office action as specified in §§ 1.111, 1.135. (35 U.S.C. 132)

37 CFR §1.2 Business to be transacted in writing.
All business with the Patent or Trademark Office should be transacted in writing. The personal attendance of applicants or their attorneys or agents at the Patent and Trademark Office is unnecessary. The action of the Patent and Trademark Office will be based exclusively on the written record in the Office. No attention will be paid to any alleged oral promise, stipulation, or understanding in relation to which there is disagreement or doubt.

The action of the Patent and Trademark Office cannot be based exclusively on the written record in the Office if that record is itself incomplete through the failure to record the substance of interviews.

It is the responsibility of the applicant or the attorney or agent to make the substance of an interview of record in the application file, unless the examiner indicates he or she will do so. It is the examiner's responsibility to see that such a record is made and to correct material inaccuracies which bear directly on the question of patentability.

Examiners must complete an Interview Summary Form for each interview held where a matter of substance has been discussed during the interview by checking the appropriate boxes and filling in the blanks. Discussions regarding only procedural matters, directed solely to restriction requirements for which interview recordation is otherwise provided for in Section 812.01 of the Manual of Patent Examining Procedure, or pointing out typographical errors or unreadable script in Office actions or the like, are excluded from the interview recordation procedures below. Where the substance of an interview is completely recorded in an Examiners Amendment, no separate Interview Summary Record is required.

The Interview Summary Form shall be given an appropriate Paper No., placed in the right hand portion of the file, and listed on the "Contents" section of the file wrapper. In a personal interview, a duplicate of the Form is given to the applicant (or attorney or agent) at the conclusion of the interview. In the case of a telephone or video-conference interview, the copy is mailed to the applicant's correspondence address either with or prior to the next official communication. If additional correspondence from the examiner is not likely before an allowance or if other circumstances dictate, the Form should be mailed promptly after the interview rather than with the next official communication.

The Form provides for recordation of the following information:
- Application Number (Series Code and Serial Number)
- Name of applicant
- Name of examiner
- Date of interview
- Type of interview (telephonic, video-conference, or personal)
- Name of participant(s) (applicant, attorney or agent, examiner, other PTO personnel, etc.)
- An indication whether or not an exhibit was shown or a demonstration conducted
- An identification of the specific prior art discussed
- An indication whether an agreement was reached and if so, a description of the general nature of the agreement (may be by attachment of a copy of amendments or claims agreed as being allowable). Note: Agreement as to allowability is tentative and does not restrict further action by the examiner to the contrary.
- The signature of the examiner who conducted the interview (if Form is not an attachment to a signed Office action)

It is desirable that the examiner orally remind the applicant of his or her obligation to record the substance of the interview of each case. It should be noted, however, that the Interview Summary Form will not normally be considered a complete and proper recordation of the interview unless it includes, or is supplemented by the applicant or the examiner to include, all of the applicable items required below concerning the substance of the interview.

A complete and proper recordation of the substance of any interview should include at least the following applicable items:

1) A brief description of the nature of any exhibit shown or any demonstration conducted,
2) an identification of the claims discussed,
3) an identification of the specific prior art discussed,
4) an identification of the principal proposed amendments of a substantive nature discussed, unless these are already described on the Interview Summary Form completed by the Examiner,
5) a brief identification of the general thrust of the principal arguments presented to the examiner,
   (The identification of arguments need not be lengthy or elaborate. A verbatim or highly detailed description of the arguments is not required. The identification of the arguments is sufficient if the general nature or thrust of the principal arguments made to the examiner can be understood in the context of the application file. Of course, the applicant may desire to emphasize and fully describe those arguments which he or she feels were or might be persuasive to the examiner.)
6) a general indication of any other pertinent matters discussed, and
7) if appropriate, the general results or outcome of the interview unless already described in the Interview Summary Form completed by the examiner.

Examiners are expected to carefully review the applicant's record of the substance of an interview. If the record is not complete and accurate, the examiner will give the applicant an extendable one month time period to correct the record.

Examiner to Check for Accuracy

If the claims are allowable for other reasons of record, the examiner should send a letter setting forth the examiner's version of the statement attributed to him or her. If the record is complete and accurate, the examiner should place the indication, "Interview Record OK" on the paper recording the substance of the interview along with the date and the examiner's initials.

PTO/SB/30 (07-09)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Request for Continued Examination (RCE) Transmittal

Address to:
Mail Stop RCE
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Application Number	14/244,701
Filing Date	April 3, 2014
First Named Inventor	JUN AWANO
Art Unit	2475
Examiner Name	AUNG, SAI
Attorney Docket Number	NEG-1440PCTUSCONT

This is a Request for Continued Examination (RCE) under 37 CFR 1.114 of the above-identified application.
Request for Continued Examination (RCE) practice under 37 CFR 1.114 does not apply to any utility or plant application filed prior to June 8, 1995, or to any design application. See Instruction Sheet for RCEs (not to be submitted to the USPTO) on page 2.

1. Submission required under 37 CFR 1.114 Note: If the RCE is proper, any previously filed unentered amendments and amendments enclosed with the RCE will be entered in the order in which they were filed unless applicant instructs otherwise. If applicant does not wish to have any previously filed unentered amendment(s) entered, applicant must request non-entry of such amendment(s).

   a. ☐ Previously submitted. If a final Office action is outstanding, any amendments filed after the final Office action may be considered as a submission even if this box is not checked.

      i. ☐ Consider the arguments in the Appeal Brief or Reply Brief previously filed on _____

      ii. ☐ Other _____

   b. ☑ Enclosed

      i. ☑ Amendment/Reply

      ii. ☐ Affidavit(s)/ Declaration(s)

      iii. ☐ Information Disclosure Statement (IDS)

      iv. ☐ Other _____

2. Miscellaneous

   a. ☐ Suspension of action on the above-identified application is requested under 37 CFR 1.103(c) for a period of _____ months. (Period of suspension shall not exceed 3 months; Fee under 37 CFR 1.17(i) required)

   b. ☐ Other _____

3. Fees The RCE fee under 37 CFR 1.17(e) is required by 37 CFR 1.114 when the RCE is filed.

   a. ☑ The Director is hereby authorized to charge the following fees, any underpayment of fees, or credit any overpayments, to Deposit Account No. 50-0481.

      i. ☑ RCE fee required under 37 CFR 1.17(e)

      ii. ☑ Extension of time fee (37 CFR 1.136 and 1.17)

      iii. ☐ Other _____

   b. ☐ Check in the amount of $ _____ enclosed

   c. ☐ Payment by credit card (Form PTO-2038 enclosed)

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT REQUIRED

Signature		Date	September 15, 2015
Name (Print/Type)	Sam S. Sahota	Registration No.	47,051

CERTIFICATE OF MAILING OR TRANSMISSION

I hereby certify that this correspondence is being deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to: Mail Stop RCE, Commissioner for Patents, P. O. Box 1450, Alexandria, VA 22313-1450 or facsimile transmitted to the U.S. Patent and Trademark Office on the date shown below.

Signature			
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This collection of information is required by 37 CFR 1.114. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Mail Stop RCE, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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Electronic Patent Application Fee Transmittal

Application Number:	14244701
Filing Date:	03-Apr-2014
Title of Invention:	Communication system, forwarding node, path management server, communication method, and program
First Named Inventor/Applicant Name:	JUN AWANO
Filer:	Saryadvinder S. Sahota/Amber Carroll
Attorney Docket Number:	NEG-1440PCT-US2CT

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Claims in Excess of 20	1202	5	80	400
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Extension - 2 months with $0 paid	1252	1	600	600
Miscellaneous:				
Request for Continued Examination	1801	1	1200	1200
		Total in USD ($)		**2200**

Electronic Acknowledgement Receipt

EFS ID:	23501140
Application Number:	14244701
International Application Number:	
Confirmation Number:	2010
Title of Invention:	Communication system, forwarding node, path management server, communication method, and program
First Named Inventor/Applicant Name:	JUN AWANO
Customer Number:	21254
Filer:	Saryadvinder S. Sahota/Amber Carroll
Filer Authorized By:	Saryadvinder S. Sahota
Attorney Docket Number:	NEG-1440PCT-US2CT
Receipt Date:	15-SEP-2015
Filing Date:	03-APR-2014
Time Stamp:	17:29:49
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$2200
RAM confirmation Number	4410
Deposit Account	500481
Authorized User	SAHOTA, SARVADVINDER SAM

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

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Charge any Additional Fees required under 37 C.F.R. Section 1.17 (Patent application and reexamination processing fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.19 (Document supply fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.20 (Post Issuance fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Amendment Submitted/Entered with Filing of CPA/RCE	Amendment.pdf	862943 8b91724b4aae1e179fb56922d9f9784df1dbcda7	no	11
Warnings:					
Information:					
2	Extension of Time	EOT.pdf	145652 b7b6a6d24e334a2a98885245143dd3e89eddb667	no	1
Warnings:					
Information:					
3	Request for Continued Examination (RCE)	RCE.pdf	175240 31c1986ba1652d165092c062d3dc4ab693d444f6	no	1
Warnings:					
This is not a USPTO supplied RCE SB30 form.					
Information:					
4	Fee Worksheet (SB06)	fee-info.pdf	33983 9e3edfdad9e731a5fc425180af82dc21f69a8da9	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	1217818		

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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

14/244,701
NEG-1440PCT-US2CT
KATO.327CONT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of Jun Awano

Serial No.: 14/244,701 Group Art Unit: 2475

Filed: April 3, 2014 Examiner: AUNG, SAI

For: COMMUNICATION SYSTEM, FORWARDING NODE, PATH MANAGEMENT SERVER, COMMUNICATION METHOD, AND PROGRAM

Honorable Commissioner of Patents
Alexandria, VA 22313-1450
Mail Stop RCE

AMENDMENT UNDER 37 C.F.R. §1.114

Sir:

In response to Office Action dated **April 15, 2015**, with a request for continued examination (RCE), and a petition for two (2) month extension of time, please amend the above identified application as follows:

INTRODUCTORY COMMENTS

Amendments to the Claims begin on page 2 of this paper. The amendments to the claims do not add new matter.

Remarks begin on page 7 of this paper.

AMENDMENTS TO THE CLAIMS

Please add new claims 22-26, and amend the claims as follows:

1. (Previously Presented) A packet forwarding node, comprising:

a storage unit to store a packet forwarding table used for forwarding a packet based on an identifier which identifies a link between nodes on a packet forwarding path; and

a forwarding unit to receive an incoming packet including a plurality of the identifiers, and to forward the incoming packet based on the identifier corresponding to the packet forwarding node.

2. (Original) The packet forwarding node according to claim 1, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link within a predetermined domain.

3. (Original) The packet forwarding node according to claim 1, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link within a predetermined local domain.

4. (Original) The packet forwarding node according to claim 1, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link within the packet forwarding node.

5. (Original) The packet forwarding node according to claim 1, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link among the packet forwarding nodes.

6. (Previously Presented) A packet forwarding node, comprising:

a storage unit to store a packet forwarding table used for forwarding a packet based on an identifier which identifies an interface of a packet forwarding node; and

a forwarding unit to receive an incoming packet including a plurality of identifiers, and to forward the incoming packet based on the identifier corresponding to the packet forwarding node.

7. (Original) The packet forwarding node according to claim 6, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies a link within a predetermined domain.

8. (Previously Presented) The packet forwarding node according to claim 6, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies a link within a predetermined local domain.

9. (Previously Presented) The packet forwarding node according to claim 6, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies a link within the packet forwarding node.

10. (Previously Presented) The packet forwarding node according to claim 6, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies a link among the packet forwarding nodes.

11. (Original) A packet forwarding node, comprising:

a communication unit to communicate with a server for receiving a plurality of

identifiers, each of which identifies a link between nodes on a packet forwarding path; and

a forwarding unit to forward an incoming packet based on an identifier corresponding to a packet forwarding node.

12. (Previously Presented) The packet forwarding node according to claim 11, wherein the forwarding unit forwards the packet based on the identifier which uniquely identifies a link within a predetermined domain.

13. (Previously Presented) The packet forwarding node according to claim 11, wherein the forwarding unit forwards the packet based on the identifier which uniquely identifies the link within a predetermined local domain.

14. (Previously Presented) The packet forwarding node according to claim 11, wherein the forwarding unit forwards the packet based on the identifier which uniquely identifies the link within the packet forwarding node.

15. (Previously Presented) The packet forwarding node according to claim 11, wherein the forwarding unit forwards the packet based on the identifier which uniquely identifies the link among the packet forwarding nodes.

16. (Original) A packet forwarding node, comprising:

a communication unit to communicate with a server for receiving a plurality of identifiers, each of which identifies an interface of a packet forwarding node; and

a forwarding unit to forward an incoming packet based on an identifier corresponding to the packet forwarding node.

17. (Previously Presented) The packet forwarding node according to claim 16, wherein the forwarding unit forwards the packet based on the identifier which uniquely identifies a link within a predetermined domain.

18. (Previously Presented) The packet forwarding node according to claim 16, wherein the forwarding unit forwards the packet based on the identifier which uniquely identifies a link within a predetermined local domain.

19. (Previously Presented) The packet forwarding node according to claim 16, wherein the forwarding unit forwards the packet based on the identifier which uniquely identifies a link within the packet forwarding node.

20. (Previously Presented) The packet forwarding node according to claim 16, wherein the forwarding unit forwards the packet based on the identifier which uniquely identifies a link among the packet forwarding nodes.

21. (Original) A server, comprising:

a first unit to determine a plurality of identifiers, each of which identifies a link between nodes on a packet forwarding path; and

a second unit to send information elements to a packet forwarding node which is capable of forwarding an incoming packet based on an identifier corresponding to the packet forwarding node.

22. (New) The packet forwarding node according to claim 1, wherein the storage unit stores the table used for forwarding the packet based on the identifier which indentifies a link

between adjacent nodes on a packet forwarding path.

23. (New) The packet forwarding node according to claim 6, wherein the storage unit stores the packet forwarding table used for forwarding the packet based on the identifier which indentifies a link between adjacent nodes on a packet forwarding path.

24. (New) The packet forwarding node according to claim 11, further comprising a storage unit that stores a table used for forwarding the packet based on an identifier which indentifies a link between adjacent nodes on a packet forwarding path.

25. (New) The packet forwarding node according to claim 16, further comprising a storage unit that stores a table used for forwarding the packet based on an identifier which indentifies a link between adjacent nodes on a packet forwarding path.

26. (New) The server according to claim 21, further comprising a storage unit to store a packet forwarding table used for forwarding the incoming packet based on the identifier which identifies the link between nodes on the packet forwarding path,

wherein the storage unit stores the table used for forwarding the packet based on the identifier which indentifies a link between adjacent nodes on a packet forwarding path.

REMARKS

Claims 1-26 are all of the claims presently pending in the application. Applicant has amended various claims to more particularly define the claimed invention and/or for editorial purposes. Applicant has added claims 22-26 to provide more varied protection for the claimed invention.

Further, Applicant specifically states that no amendment to any claim herein should be construed as a disclaimer of any interest in or right to an equivalent of any element or feature of the amended claim.

The amendments are supported by, for example, paragraphs [0081] to [0082], Figs. 7 and 8 of the present application. Therefore, no new matter is added.

Claims 1-4, 8-9, 11-15, and 19-21 stand rejected under 35 U.S.C. 102 (b) as being anticipated by Vasseur (U.S. Patent No. 7,522,603 B2) as indicated on page 3 of the Office Action.

This rejection is respectfully traversed in the following discussion.

In the office action, the Examiner also addresses claim 5 regarding Vasseur, but does not address claims 7-10 specifically or in general. Therefore, it is assumed that claim 7-10 are allowable.

I. INTERVIEW SUMMARY

An interview was conducted with Examiner on August 6, 2015, and claims 1, 6 and the Vasseur reference were discussed. During the interview, Applicant's representative, S. Sahota argued that the Vasseur does not disclose the claimed invention. No agreement was reached. The Examiner suggested further limitations to clarify the identifier. Applicant is very grateful for Examiner taking the time to help expedite prosecution.

II. THE CLAIMED INVENTION

The claimed invention (e.g., as defined by exemplary claim 1) is directed to a packet forwarding node, including a storage unit to store a packet forwarding table used for forwarding a packet based on an identifier which identifies a link between nodes on a packet forwarding path, and a forwarding unit to receive an incoming packet including a plurality of the identifiers, and to forward the incoming packet based on the identifier corresponding to the packet forwarding node.

III. THE ALLEGED PRIOR ART REFERENCE

The Vasseur Reference

Claims 1-4, 8-9, 11-15, and 19-21 stand rejected under 35 U.S.C. 102 (b) as being anticipated by Vasseur (U.S. Patent No. 7,522,603 B2).

Vasseur fails to teach or suggest (e.g., claim 1), "*storage unit to store a packet forwarding table used for forwarding a packet based on an identifier which identifies a link between nodes on a packet forwarding path; and a forwarding unit to receive an incoming packet including a plurality of the identifiers, and to forward the incoming packet based on the identifier corresponding to the packet forwarding node*".

The Examiner asserts that the identifier of the present application which identifies the "link" of the claimed invention and "label" disclosed in Vasseur are the same. Applicant respectfully does not agree.

In Vasseur, a packet, being used in MPLS (Multi-Protocol Label Switching), includes **a single label**. On the other hand, in the present application, a packet includes **a plurality of identifiers**. Thus, there is a difference between Vassuer and the claimed invention as the identifier of the claimed invention and label of Vasseur are not the same.

Therefore, in MPLS of Vasseur, merely one identifier (label of MPLS) is included in

one packet and so a plurality of identifiers are not included in one packet as in the claimed invention showing also that the forwarding table in Vasseur and the forwarding table in the claimed invention are not the same.

For example, Vasseur recites that "[i]n one simple MPLS scenario, at an ingress to a network, a label is assigned to each incoming packet based on its forwarding equivalence class before forwarding the packet to a next-hop router. At each router, a forwarding selection and a new substitute label are determined by using the label found in the incoming packet as a reference to a label forwarding table that includes this information." See col. 9, lines 15-21, emphasis added. Therefore, the "label" is assigned to each packet based on its class, but is not a link per se. Moreover, the packet has a single label.

Additionally, The Examiner's rejection of anticipation is also improper because the identical invention is not provided in the following. Please note that according to MPEP §2131, the following applies in a 35 U.S.C. §102 rejection:

> "A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." Verdegaal Bros. v. Union Oil Co. of California, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987).."The identical invention must be shown in as complete detail as is contained in the ... claim." Richardson v. Suzuki Motor Co., 868 F.2d 1226, 1236, 9 USPQ2d 1913, 1920 (Fed. Cir. 1989). The elements must be arranged as required by the claim, but this is not an ipsissimis verbis test, i.e., identity of terminology is not required. In re Bond, 910 F.2d 831, 15 USPQ2d 1566 (Fed. Cir. 1990).

Therefore, as shown above, that since the identical invention is not provided in as complete details as the arranged in the claims from Vasseur, the claims are clearly not anticipated.

Therefore, Applicant submits that, even if combined, the alleged combination of references would not teach or suggest each and every feature of the claimed invention. Therefore, Applicant respectfully requests the Examiner to withdraw this rejection.

IV. NEW CLAIMS

Applicant has added new claims 22-26 to claim additional features of the invention and to provide more varied protection for the claimed invention. These claims are independently patentable because of the novel and nonobvious features recited therein.

Applicant submits that new claims are patentable over the cited prior art references at least for analogous reasons to those set forth above with respect to the above mentioned claims.

V. FORMAL MATTERS AND CONCLUSION

In view of the foregoing, Applicant submits that claims 1-26, all of the claims presently pending in the application, are patentably distinct over the prior art of record and are in condition for allowance. Applicant respectfully requests the Examiner to pass the above application to issue at the earliest possible time.

Should the Examiner find the application to be other than in condition for allowance, Applicant requests the Examiner to contact the undersigned at the local telephone number listed below to discuss any other changes deemed necessary in a telephonic or personal interview.

The undersigned authorizes the Commissioner to charge any deficiency in fees or to credit any overpayment in fees to Attorney's Deposit Account No. 50-0481.

Respectfully Submitted,

Date: September 15, 2015

S. S. Sahota, Esq.
Registration No. 47,051

Sean M. McGinn, Esq.
Registration No. 34,386

MCGINN INTELLECTUAL PROPERTY LAW GROUP, PLLC
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(703) 761-4100
Customer No. 21254

PTO/AIA/22 (03-13)
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PETITION FOR EXTENSION OF TIME UNDER 37 CFR 1.136(a)

Docket Number (Optional): NEG-1440PCTUSCONT

Application Number: 14/244,701

Filed: April 3, 2014

For: Communication system, forwarding node, path management server, communication method, and program

Art Unit: 2475

Examiner: AUNG, SAI

This is a request under the provisions of 37 CFR 1.136(a) to extend the period for filing a reply in the above-identified application.

The requested extension and fee are as follows (check time period desired and enter the appropriate fee below):

		Fee	Small Entity Fee	Micro Entity Fee	
☐	One month (37 CFR 1.17(a)(1))	$200	$100	$50	$
☑	Two months (37 CFR 1.17(a)(2))	$600	$300	$150	$ 600
☐	Three months (37 CFR 1.17(a)(3))	$1,400	$700	$350	$
☐	Four months (37 CFR 1.17(a)(4))	$2,200	$1,100	$550	$
☐	Five months (37 CFR 1.17(a)(5))	$3,000	$1,500	$750	$

☐ Applicant asserts small entity status. See 37 CFR 1.27.

☐ Applicant certifies micro entity status. See 37 CFR 1.29.
Form PTO/SB/15A or B or equivalent must either be enclosed or have been submitted previously.

☐ A check in the amount of the fee is enclosed.

☐ Payment by credit card. Form PTO-2038 is attached.

☐ The Director has already been authorized to charge fees in this application to a Deposit Account.

☑ The Director is hereby authorized to charge any fees which may be required, or credit any overpayment, to Deposit Account Number 50-0481.

☐ Payment made via EFS-Web.

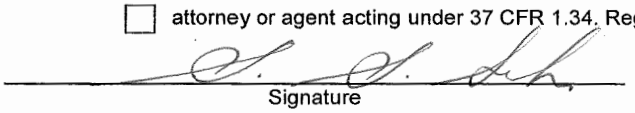
WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

I am the

☐ applicant.

☑ attorney or agent of record. Registration number 47,051.

☐ attorney or agent acting under 37 CFR 1.34. Registration number _____.



Signature

September 15, 2015
Date

Sam S. Sahota
Typed or printed name

703-761-4100
Telephone Number

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. Submit multiple forms if more than one signature is required, see below*.

☐ * Total of _____ forms are submitted.

This collection of information is required by 37 CFR 1.136(a). The information is required to obtain or retain a benefit by the public, which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 6 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Mail Stop PCT, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

PTO/SB/06 (09-11)
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 14/244,701	Filing Date 04/03/2014	☐ To be Mailed

ENTITY: ☒ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED – PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	

APPLICATION AS AMENDED – PART II

AMENDMENT	09/15/2015	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 26	Minus	** 21	= 5	X $80 =	400
	Independent (37 CFR 1.16(h))	* 5	Minus	***5	= 0	X $420 =	0
	☐ Application Size Fee (37 CFR 1.16(s))						
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
						TOTAL ADD'L FEE	**400**

AMENDMENT		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=	X $ =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	X $ =	
	☐ Application Size Fee (37 CFR 1.16(s))						
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
						TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".

The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

LIE
/EVELYN NIMMONS/

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/244,701	04/03/2014	JUN AWANO	NEG-1440PCT-US2CT	2010

21254 7590 10/06/2015

MCGINN INTELLECTUAL PROPERTY LAW GROUP, PLLC
8321 OLD COURTHOUSE ROAD
SUITE 200
VIENNA, VA 22182-3817

EXAMINER
AUNG, SAI

ART UNIT	PAPER NUMBER
2475	

MAIL DATE	DELIVERY MODE
10/06/2015	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No. 14/244,701	Applicant(s) AWANO, JUN	
	Examiner SAI AUNG	Art Unit 2475	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *09/15/2015*.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5)☒ Claim(s) *1-26* is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6)☐ Claim(s) _____ is/are allowed.

7)☒ Claim(s) *1-26* is/are rejected.

8)☐ Claim(s) _____ is/are objected to.

9)☐ Claim(s) _____ are subject to restriction and/or election requirement.

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☒ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date _____.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

4) ☐ Other: _____.

DETAILED ACTION

Claims status

1. In the amended application filed on 03/16/2015, claims 1-21 are currently pending for the examination. The present application is being examined under the pre-AIA first to invent provisions.

Examiner Notes

2. The Examiner cites particular columns and line numbers in the references as applied to the claims below for the convenience of the Applicants(s). Although the specified citations are representative of the disclosings in the art and are applied to the specific limitations within the individual claim, other passages and figures may apply as well. It is respectfully requested that, in preparing response, the Applicant fully consider the references in their entirety as potentially disclosing all or part of the claimed invention, as well as the context of the passage as taught by the prior art or disclosed by the Examiner.

Claim Objections

3. Claims 16-20 are objected to because of the following informalities:

Claim 16 recites "*a packet forwarding node*" in line 3. It is recommended amend the claim limitation to ---the packet forwarding node---, if it is referring back to a packet forwarding node in line 1.

Claims 17-20 are also objected to as being dependent upon an objected base claim.

Claims 22-26 are further objected to because it recites "identifies", and should be corrected to --- identifies---.

35 U.S.C. 112(f): Claim Interpretations

4. The following is a quotation of 35 U.S.C. 112(f):

> *(f) Element in Claim for a Combination. – An element in a claim for a combination may be expressed as a means or step for performing a specified function without the recital of structure, material, or acts in support thereof, and such claim shall be construed to cover the corresponding structure, material, or acts described in the specification and equivalents thereof.*

5. The following is a quotation of pre-AIA 35 U.S.C. 112, sixth paragraph:

> *An element in a claim for a combination may be expressed as a means or step for performing a specified function without the recital of structure, material, or acts in support thereof, and such claim shall be construed to cover the corresponding structure, material, or acts described in the specification and equivalents thereof.*

6. Claim 6 recites "*A packet forwarding node, comprising: a storage unit to store a packet forwarding table..., and a forwarding unit to receive in incoming packet...*", and thus the claim has been interpreted under 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph, because it uses a generic placeholder "a storage unit" coupled with functional language "to store" without reciting sufficient structure to achieve the function. Furthermore, the generic placeholder is not preceded by a structural modifier.

Since the claim limitation(s) invokes 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph, claims 6-10 have been interpreted to cover the corresponding structure described in the specification that achieves the claimed function, and equivalents thereof.

A review of the specification shows that the following appears to be the corresponding structure described in the specification for the 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph limitation:

Figure 3 and Para. 0072 in the Specification provides the recording unit 370 holds a forwarding table shown in FIG. 3, and this is referred to by the packet forwarding unit 320, the local ID determination unit 340, and the neighbor information notification unit 350.

If applicant wishes to provide further explanation or dispute the examiner's interpretation of the corresponding structure, applicant must identify the corresponding structure with reference to the specification by page and line number, and to the drawing, if any, by reference characters in response to this Office action.

If applicant does not intend to have the claim limitation(s) treated under 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112 , sixth paragraph, applicant may amend the claim(s) so that it/they will clearly not invoke 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph, or present a sufficient showing that the claim recites/recite sufficient structure, material, or acts for performing the claimed function to preclude application of 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph.

For more information, see MPEP § 2173 et seq. and Supplementary Examination Guidelines for Determining Compliance With 35 U.S.C. 112 and for Treatment of Related Issues in Patent Applications, 76 FR 7162, 7167 (Feb. 9, 2011).

7. Claim 11 recites "*A packet forwarding node, comprising: a communication unit to communicate with a server for receiving..., and a forwarding unit to forward in incoming*

packet...", and thus the claim has been interpreted under 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph, because it uses a generic placeholder "a communication unit" coupled with functional language "to communicate" without reciting sufficient structure to achieve the function. Furthermore, the generic placeholder is not preceded by a structural modifier.

Since the claim limitation(s) invokes 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph, claims 11-15 have been interpreted to cover the corresponding structure described in the specification that achieves the claimed function, and equivalents thereof.

A review of the specification shows that the following appears to be the corresponding structure described in the specification for the 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph limitation:

Figure 3 and Para. 0072 in the Specification provides the recording unit 370 holds a forwarding table shown in FIG. 3, and this is referred to by the packet forwarding unit 320, the local ID determination unit 340, and the neighbor information notification unit 350.

If applicant wishes to provide further explanation or dispute the examiner's interpretation of the corresponding structure, applicant must identify the corresponding structure with reference to the specification by page and line number, and to the drawing, if any, by reference characters in response to this Office action.

If applicant does not intend to have the claim limitation(s) treated under 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112 , sixth paragraph, applicant may amend the claim(s) so that it/they will clearly not invoke 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph, or present a sufficient showing that the claim recites/recite sufficient structure, material, or acts for

performing the claimed function to preclude application of 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph.

For more information, see MPEP § 2173 et seq. and Supplementary Examination Guidelines for Determining Compliance With 35 U.S.C. 112 and for Treatment of Related Issues in Patent Applications, 76 FR 7162, 7167 (Feb. 9, 2011).

8. Claim 16 recites "*A packet forwarding node, comprising: a communication unit to communicate with a server for receiving..., and a forwarding unit to forward in incoming packet...*", and thus the claim has been interpreted under 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph, because it uses a generic placeholder "a communication unit" coupled with functional language "to communicate" without reciting sufficient structure to achieve the function. Furthermore, the generic placeholder is not preceded by a structural modifier.

Since the claim limitation(s) invokes 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph, claims 16-20 have been interpreted to cover the corresponding structure described in the specification that achieves the claimed function, and equivalents thereof.

A review of the specification shows that the following appears to be the corresponding structure described in the specification for the 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph limitation:

Figure 3 and Para. 0072 and 0075 in the Specification provides the recording unit 370 holds a forwarding table shown in FIG. 3, and this is referred to by the packet forwarding unit 320, the local ID determination unit 340, and the neighbor information notification unit 350.

If applicant wishes to provide further explanation or dispute the examiner's interpretation of the corresponding structure, applicant must identify the corresponding structure with reference to the specification by page and line number, and to the drawing, if any, by reference characters in response to this Office action.

If applicant does not intend to have the claim limitation(s) treated under 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112 , sixth paragraph, applicant may amend the claim(s) so that it/they will clearly not invoke 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph, or present a sufficient showing that the claim recites/recite sufficient structure, material, or acts for performing the claimed function to preclude application of 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph.

For more information, see MPEP § 2173 et seq. and Supplementary Examination Guidelines for Determining Compliance With 35 U.S.C. 112 and for Treatment of Related Issues in Patent Applications, 76 FR 7162, 7167 (Feb. 9, 2011).

9. Claim 21 recites "*A server comprising: a first unit to determine a plurality of identifiers..., and a second unit to send information elements...*", and thus the claim has been interpreted under 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph, because it uses a generic placeholder "a communication unit" coupled with functional language "to communicate" without reciting sufficient structure to achieve the function. Furthermore, the generic placeholder is not preceded by a structural modifier.

Since the claim limitation(s) invokes 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph, claims 11-15 have been interpreted to cover the corresponding structure described in the specification that achieves the claimed function, and equivalents thereof.

A review of the specification shows that the following appears to be the corresponding structure described in the specification for the 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph limitation:

Figure 6 and Para. 0077 in the Specification provides The path management server 500 collects neighbor information notified from boundary forwarding nodes 300 and internal forwarding nodes 400, and configures network topology information describing connection relationships of the internal forwarding nodes 400 and the boundary forwarding nodes 300 inside the data transfer network 600. The network topology information also includes connection information for the communication nodes 100 a and 100 b connected to the boundary forwarding nodes 300.

If applicant wishes to provide further explanation or dispute the examiner's interpretation of the corresponding structure, applicant must identify the corresponding structure with reference to the specification by page and line number, and to the drawing, if any, by reference characters in response to this Office action.

If applicant does not intend to have the claim limitation(s) treated under 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112 , sixth paragraph, applicant may amend the claim(s) so that it/they will clearly not invoke 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph, or present a sufficient showing that the claim recites/recite sufficient structure, material, or acts for

performing the claimed function to preclude application of 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph.

For more information, see MPEP § 2173 et seq. and Supplementary Examination Guidelines for Determining Compliance With 35 U.S.C. 112 and for Treatment of Related Issues in Patent Applications, 76 FR 7162, 7167 (Feb. 9, 2011).

Claim Rejections: 35 USC 112(b) after invoking 35 USC 112(f)

10. The following is a quotation of 35 U.S.C. 112(f):

> *(f) Element in Claim for a Combination. – An element in a claim for a combination may be expressed as a means or step for performing a specified function without the recital of structure, material, or acts in support thereof, and such claim shall be construed to cover the corresponding structure, material, or acts described in the specification and equivalents thereof.*

11. The following is a quotation of pre-AIA 35 U.S.C. 112, sixth paragraph:

> *An element in a claim for a combination may be expressed as a means or step for performing a specified function without the recital of structure, material, or acts in support thereof, and such claim shall be construed to cover the corresponding structure, material, or acts described in the specification and equivalents thereof.*

12. The following is a quotation of 35 U.S.C. 112(b):

> *(b) CONCLUSION.—The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the inventor or a joint inventor regards as the invention.*
> The following is a quotation of 35 U.S.C. 112 (pre-AIA), second paragraph:
>
> *The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.*

13. Claims 1-5 are rejected under 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the inventor or a joint inventor, or for pre-AIA the applicant regards as the invention.

Claim 1 recites "*A packet forwarding node, comprising: a storage unit to store..., and a forwarding unit to receive...*", and thus the claim has been interpreted under 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph, because it uses a generic placeholder "a storage unit" coupled with functional language "to store" without reciting sufficient structure to achieve the function. Furthermore, the generic placeholder is not preceded by a structural modifier.

Since the claim limitation(s) invokes 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph, claims 1-5 have been interpreted to cover the corresponding structure described in the specification that achieves the claimed function, and equivalents thereof.

A review of the specification, i.e. figure 2 and paragraphs 0067 and 0068, seems to provide that the following appears to be the corresponding structure described in the specification for the 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph limitation.

However, **the written description provided in the specification does not clearly link to the structure to perform the steps of the function listed on the claim**. Moreover, the disclosed structure shown in the figures **is not sufficient to perform** the claimed function [emphasis added]. See MPEP 2181 under Section II.

Therefore, the claim is indefinite. Thus, the claim must be rejected under 112(b), second paragraph. Claims 2-5 are also rejected because of being dependent upon the rejected based claims. It is recommended that the claim language be amended such that the exact meaning of

the above quoted limitation is clear. For the purpose of the examination, the Examiner will interpret the claim as best understood.

Double Patenting

14. The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the "right to exclude" granted by a patent and to prevent possible harassment by multiple assignees. A nonstatutory obviousness-type double patenting rejection is appropriate where the conflicting claims are not identical, but at least one examined application claim is not patentably distinct from the reference claim(s) because the examined application claim is either anticipated by, or would have been obvious over, the reference claim(s). See, e.g., *In re Berg*, 140 F.3d 1428, 46 USPQ2d 1226 (Fed. Cir. 1998); *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); and *In re Thorington*, 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) or 1.321(d) may be used to overcome an actual or provisional rejection based on a nonstatutory double patenting ground provided the conflicting application or patent either is shown to be commonly owned with this application, or claims an invention made as a result of activities undertaken within the scope of a joint research agreement. Effective January 1, 1994, a registered attorney or agent of

record may sign a terminal disclaimer. A terminal disclaimer signed by the assignee must fully comply with 37 CFR 3.73(b).

15. **Claims 1-21 are** rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claims 1 and 8 of the U.S. application number **13/137,237**. Although the conflicting claims are not identical, they are not patentably distinct from each other. This is an **obviousness-type double patenting rejection** because the conflicting claims have not in fact been patented.

Regarding pending claims 1, 6 and 21; the claims recite limitations substantially the same as in the US application number **13/137,237**. These limitations are fully covered by the claims of the US application number **13/137,237.**

The compared table below (i.e. underlined claim elements) shows only Example (sample) of how each of these claims are anticipated and mapped by claims such as claims 1-7, 11, and 18, respectively of the US application number **13/137,237.**

Instant Application: 14244701	**U.S. Patent#: 13/137,237**
1. A packet forwarding node, comprising: a storage unit to store a packet forwarding table used for forwarding a packet based on an identifier which identifies a link between nodes on a packet forwarding path; and a forwarding unit to receive an incoming packet including a plurality of the identifiers, and to forward the incoming packet based on an identifier corresponding to the packet forwarding node.	8. A forwarding node, connected to a path management server that generates a plurality of forwarding path information items each includes a sequence of identifiers, each of which identifies a communication interface provided in each of a plurality of forwarding nodes on a forwarding path in a data forwarding network or a link established between the

	forwarding node and a neighboring node thereof, wherein the forwarding node, in accordance with at least one of the plurality of forwarding path information items, executes a packet forwarding processing of a packet with a header including the plurality of forwarding path information items.
21. A server, comprising: a first unit to determine a plurality of identifiers, each of which identifies a link between nodes on a packet forwarding path; and a second unit to send information elements to a packet forwarding node which is capable of forwarding an incoming packet based on an identifier corresponding to the packet forwarding node.	1. A communication system comprising: a path management server that generates a plurality of forwarding path information items each includes a sequence of identifiers, each of which identifies a communication interface provided in each of a plurality of forwarding nodes on a forwarding path in a data forwarding network or a link established between the forwarding node and a neighboring node thereof; and a forwarding node that, in accordance with at least one of the plurality of forwarding path information items, executes a packet forwarding processing of a packet with a header including the plurality of forwarding path information items.

Claim Rejections - 35 USC § 102

16. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

17. Claims 1-4, 8-9, 11-15 and 19-28 are rejected under 35 U.S.C. 102(b) as being anticipated by **Vasseur (US 7,522,603 B2).**

Regarding claim 1; **Vasseur** discloses a packet forwarding node, comprising:

a storage unit to store a packet forwarding table used for forwarding a packet based on an identifier which identifies a link between nodes on a packet forwarding path ***(See Figs. 2 and 4; Router (i.e., a forwarding node) with forwarding tables 246 and PCE 248 for path computation of the CE-CE paths and current metrics to the remote destination address; Col. 8 Lines 59-67 and Col. 11 Lines 54-60);*** and

a forwarding unit to receive an incoming packet including a plurality of the identifiers ***(See Figs. 2 and 4; Router performs/receives routing information database RIB and forwarding information database FIB; Col. 8 Lines 59-67),*** and to forward the incoming packet based on an identifier corresponding to the packet forwarding node ***(See Figs. 2 and 4; a forwarding selection selects a label (i.e. identifier) to route of the destination; Col. 9 Lines 15-24...and see also Fig. 7; for performing IP traffic routing and selecting the best path; Col. 14 Lines 7-15).***

Regarding claim 2; **Vasseur** discloses the packet forwarding node wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link within a predetermined domain ***(See Figs. 4 and 5; CE-PE links (i.e. PE link for predetermined domain); Col. 10 Lines 51-60 and Col. 12 Lines 40-47).***

Regarding claim 3; **Vasseur** discloses the packet forwarding node, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link within a predetermined local domain ***(See Figs. 4 and 5; CE-CE links (i.e. predetermined local domain); Col. 9 Lines 54-60).***

Regarding claim 4; **Vasseur** discloses the packet forwarding node wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link within the packet forwarding node ***(See Figs. 2 and 4; Router (i.e., a forwarding node) with forwarding tables 246; Col. 8 l 59-67).***

Regarding claim 5; **Vasseur** discloses the packet forwarding node wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link among the packet forwarding nodes ***(See Figs. 2 and 4; Router (i.e., a forwarding node) with forwarding tables 246; Col. 8 l 59-67).***

Regarding claim 6; **Vasseur** discloses a packet forwarding node, comprising:

a storage unit to store a packet forwarding table used for forwarding a packet based on an identifier which identifies an interface of a packet forwarding node ***(See Fig. 2; Each node includes one or more network interfaces that are coupled to a processor to execute memory that store routing forwarding tables and compute CE-CE or PE-CE path metrics to destination address to balance out the traffic load across the network links. (See Fig. 2: Col. 8 Lines 21-32 and Col. 8 Lines 37-47...and see also Fig. 4: Router (i.e., a forwarding node) with forwarding tables 246; Col. 8 Lines 59-67);*** and

a forwarding unit to receive an incoming packet including a plurality of the identifiers ***(See Figs. 2 and 4; Router performs/receives routing information database RIB and forwarding information database FIB; Col. 8 Lines 59-67),*** and to forward the incoming packet based on an identifier corresponding to the packet forwarding node ***(See Figs. 2 and 4; a forwarding selection selects a label (i.e. identifier) to route of the destination; Col. 9 Lines 15-24...and see also Fig. 7; for performing IP traffic routing and selecting the best path; Col. 14 Lines 7-15).***

Regarding claim 11; **Vasseur** discloses a packet forwarding node, comprising:

a communication unit to communicate with a server for receiving a plurality of identifiers ***(See Fig. 2 and 7; Router 200...and... PCC/PCE 248 with Stored Requests Table 500 (i.e. storage unit) and PCE computes the metrics (i.e. identifiers). The requesting CE (i.e. forwarding node) modifies IP/Data Packet corresponding to the CE-CE path metrics; Col. 8 Lines 42-50 and Lines 50-55, and Col. 9 Lines 58-65)***; each of which identifies a link between nodes on a packet forwarding path ***(See Figs. 2 and 4; Router (i.e., a forwarding node) with forwarding tables 246 and PCE 248 for path computation of the CE-CE paths and current metrics to the remote destination address; Col. 8 Lines 59-67 and Col. 11 Lines 54-60);*** and

a forwarding unit to forward an incoming packet based on the identifier corresponding to the packet forwarding node ***(See Fig. 2; Routing Service 247 forward the incoming data packet using the label found in the packet. PCE computes the metric to set up the routing/forwarding destination of the CE; Col. 9 Lines 55-65 and see also Fig. 7; for performing IP traffic routing and selecting the best path; Col. 14 Lines 7-15).***

Regarding claim 12; **Vasseur** discloses the packet forwarding node wherein the forwarding unit forwards the packet based on an identifier which uniquely identifies a link within

a predetermined domain (See Fig. 2; Routing Service 247 forward the incoming data packet using the label found in the packet. PCE computes the metric to set up the routing/forwarding destination of the CE; Col. 9 Lines 55-65; and see also Figs. 4 and 5; CE-PE links (i.e. PE link for predetermined domain); Col. 10 Lines 51-60 and Col. 12 Lines 40-47).

Regarding claim 13; **Vasseur** discloses the packet forwarding node, wherein the forwarding unit forwards the packet based on an identifier which uniquely identifies a link within a predetermined domain (See Figs. 4 and 5; CE-CE links (i.e. predetermined local domain); Col. 9 Lines 54-60).

Regarding claim 14; **Vasseur** discloses the packet forwarding node wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link within the packet forwarding node (See Figs. 2 and 4; Router (i.e., a forwarding node) with forwarding tables 246; Col. 8 Lines 59-67); and

Regarding claim 15; **Vasseur** discloses the packet forwarding node wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link among the packet forwarding nodes (See Figs. 2 and 4; Router (i.e., a forwarding node) with forwarding tables 246; Col. 8 Lines 59-67).

Regarding claim 16; **Vasseur** discloses a packet forwarding node, comprising:

a communication unit to communicate with a server for receiving a plurality of identifiers ***(See Fig. 2 and 7; Router 200...and... PCC/PCE 248 with Stored Requests Table 500 (i.e. storage unit) and PCE computes the metrics (i.e. identifiers); Col. 8 Lines 42-50 and Lines 50-55, and Col. 9 Lines 58-65)***, each of which identifies an interface of a packet forwarding node ***(See Fig. 2; Each node includes one or more network interfaces that are coupled to a processor to execute memory that store routing forwarding tables and compute CE-CE or PE-CE path metrics to destination address to balance out the traffic load across the network links. See also Col. 8 Lines 21-32 and Col. 8 Lines 37-47...and see also Fig. 4: Router (i.e., a forwarding node) with forwarding tables 246; Col. 8 Lines 59-67);*** and

a forwarding unit to receive an incoming packet including a plurality of the identifiers ***(See Figs. 2 and 4; Router performs/receives routing information database RIB and forwarding information database FIB; Col. 8 Lines 59-67),*** and to forward the incoming packet based on an identifier corresponding to the packet forwarding node ***(See Figs. 2 and 4; a forwarding selection selects a label (i.e. identifier) to route of the destination; Col. 9 Lines 15-24...and see also Fig. 7; for performing IP traffic routing and selecting the best path; Col. 14 Lines 7-15).***

Regarding claims 17-20, the claimed steps of the method correspond with the elements of the device as addressed in claims 11-15 respectively. Since the device has been anticipated, the steps of using the device in its intended manner are also anticipated.

Regarding claim 21; **Vasseur** discloses a server, comprising:

a first unit to determine a plurality of the identifiers each of which identifies a link between nodes on a packet forwarding path ***(See Fig. 2 and 7; PCC/PCE 248 with Stored Requests Table 500 (i.e. a first unit) and PCE computes the metrics (i.e. identifiers). The requesting CE (i.e. forwarding node)***

modifies IP/Data Packet corresponding to the CE-CE path metrics; Col. 8 Lines 42-50 and Lines 50-55, and Col. 9 Lines 58-65); and

a second unit to send the information elements to a packet forwarding node ***(See Fig. 2; Routing Services 247 with Routing Tables 246 (i.e. second unit)...a forwarding selection and new substitute label are determined by using the label found in the incoming packet of the forwarding table; Col. 9 Lines 17-22)***, and to forward the incoming packet based on the identifier corresponding to the packet forwarding node ***(See Fig. 2; Routing Service 247 forward the incoming data packet using the label found in the packet. PCE computes the metric to set up the routing destination of the CE; Col. 9 Lines 55-65).***

(Note: Claim 21 recites the term "capable of" which is not positively recited claim limitations and produces unnecessary ambiguity. Therefore, any limitations beyond the term "capable of" will not be considered in the examination but the reference does teach the limitations.)

Claim Rejections - 35 USC § 103

18. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> *(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.*

19. The factual inquiries set forth in Graham v. John Deere Co., 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows: (See MPEP Ch. 2141)

a) Determining the scope and contents of the prior art;

b) Ascertaining the differences between the prior art and the claims in issue;

c) Resolving the level of ordinary skill in the pertinent art; and

d) Evaluating evidence of secondary considerations for indicating obviousness or nonobviousness.

20. Claims 22-26 are rejected under 35 U.S.C. 103(a) as being unpatentable over **Vasseur-1 (US 7,522,603 B2)** in view of **Vasseur-2 (US 2007/0280102 A1)**.

Regarding claims 22, 23, 24, and 25; **Vasseur-1** discloses a packet forwarding node, comprising:

a storage unit to store a packet forwarding table used for forwarding a packet based on an identifier which identifies a link between nodes on a packet forwarding path ***(See Figs. 2 and 4; Router (i.e., a forwarding node) with forwarding tables 246 and PCE 248 for path computation of the CE-CE paths and current metrics to the remote destination address; Col. 8 Lines 59-67 and Col. 11 Lines 54-60);*** and

a forwarding unit to receive an incoming packet including a plurality of the identifiers ***(See Figs. 2 and 4; Router performs/receives routing information database RIB and forwarding information database FIB; Col. 8 Lines 59-67),*** and to forward the incoming packet based on an identifier corresponding to the packet forwarding node ***(See Figs. 2 and 4; a forwarding selection selects a label (i.e. identifier) to route of***

the destination; Col. 9 Lines 15-24...and see also Fig. 7; for performing IP traffic routing and selecting the best path; Col. 14 Lines 7-15

Vasseur-1 doesn't explicitly disclose the method to identify a link between adjacent nodes on a packet forwarding path.

However, **Vasseur**-2 discloses the method to identify a link between adjacent nodes on a packet forwarding path (***See Fig. 1 and 6; identifying routing information/link with neighboring node; Para. [0010] and [0072]***).

Therefore, it would have been obvious to one having ordinary skill in the art at the time of the invention was made to provide the method to identify a link between adjacent nodes on a packet forwarding path as taught by **Vasseur**-2 to have incorporated in the system of **Vasseur**-1, so that it would provide that For instance, the cost value may be measured in terms of the number of hops required to reach the neighboring node, the average time for a packet to reach the neighboring node, the amount of network traffic or available bandwidth over a communication link coupled to the neighboring node, etc. (**Vasseur**-1: Para. [0010]).

Regarding claim 26; **Vasseur-1** discloses a server, comprising:

a first unit to determine a plurality of the identifiers each of which identifies a link between nodes on a packet forwarding path ***(See Fig. 2 and 7; PCC/PCE 248 with Stored Requests Table 500 (i.e. a first unit) and PCE computes the metrics (i.e. identifiers). The requesting CE (i.e. forwarding node) modifies IP/Data Packet corresponding to the CE-CE path metrics; Col. 8 Lines 42-50 and Lines 50-55, and Col. 9 Lines 58-65)***; and

a second unit to send the information elements to a packet forwarding node ***(See Fig. 2; Routing Services 247 with Routing Tables 246 (i.e. second unit)...a forwarding selection and new substitute***

label are determined by using the label found in the incoming packet of the forwarding table; Col. 9 Lines 17-22), and to forward the incoming packet based on the identifier corresponding to the packet forwarding node ***(See Fig. 2; Routing Service 247 forward the incoming data packet using the label found in the packet. PCE computes the metric to set up the routing destination of the CE; Col. 9 Lines 55-65).***

Vasseur-1 further discloses a storage unit to store a packet forwarding table used for forwarding a packet based on an identifier which identifies a link between nodes on a packet forwarding path ***(See Figs. 2 and 4; Router (i.e., a forwarding node) with forwarding tables 246 and PCE 248 for path computation of the CE-CE paths and current metrics to the remote destination address; Col. 8 Lines 59-67 and Col. 11 Lines 54-60).***

Vasseur-1 doesn't explicitly disclose the method to identify a link between adjacent nodes on a packet forwarding path.

However, **Vasseur**-2 discloses the method to identify a link between adjacent nodes on a packet forwarding path (***See Fig. 1 and 6; identifying routing information/link with neighboring node; Para. [0010] and [0072]***).

Therefore, it would have been obvious to one having ordinary skill in the art at the time of the invention was made to provide the method to identify a link between adjacent nodes on a packet forwarding path as taught by **Vasseur**-2 to have incorporated in the system of **Vasseur**-1, so that it would provide that For instance, the cost value may be measured in terms of the number of hops required to reach the neighboring node, the average time for a packet to reach the neighboring node, the amount of network traffic or available bandwidth over a communication link coupled to the neighboring node, etc. (**Vasseur**-1: Para. [0010]).

(Note: Claim 21 recites the term "capable of" which is not positively recited claim limitations and produces unnecessary ambiguity. Therefore, any limitations beyond the term

"capable of" will not be considered in the examination but the reference does teach the limitations.)

Conclusion

21. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

a. Friskney et al. (US 2008/0279196 A1)

b. **Vasseur** et al. (US 2007/0280102 A1)

c. **Vasseur** et al. (US 2008/0123651 A1)

d. McDysan et al. (US 7447 151 B2).

Contact Information

22. Any inquiry concerning this communication or earlier communications from the examiner should be directed to SAI AUNG whose telephone number is (571)272-3507. The examiner can normally be reached on Monday-Friday, Alt Fridays, 7:30 AM- 5:00 PM (EST).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Dang Ton can be reached on 571-272-3171. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300. Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-

direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/S. A./

Examiner, Art Unit 2475

/DANG TON/

Supervisory Patent Examiner, Art Unit 2475/D. T./

Supervisory Patent Examiner, Art Unit 2475

Notice of References Cited	Application/Control No. 14/244,701	Applicant(s)/Patent Under Reexamination AWANO, JUN	
	Examiner SAI AUNG	Art Unit 2475	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-2003/0053427 A1	03-2003	Kanda, Mitsuru	H04W8/14	370/328
*	B	US-2007/0280102 A1	12-2007	Vasseur; Jean-Philippe	H04J3/14	370/225
*	C	US-2008/0123651 A1	05-2008	Vasseur; Jean-Philippe	H04L12/4633	370/392
*	D	US-2008/0137615 A1	06-2008	PARK; Chang Min	H04L45/302	370/332
*	E	US-2008/0279196 A1	11-2008	Friskney; Robert	H04L12/4645	370/395.53
*	F	US-7,447,151 B2	11-2008	McDysan; David E.	H04L12/24	370/231
*	G	US-7,522,603 B2	04-2009	Vasseur; Jean-Philippe	H04L12/66	370/238.1
*	H	US-2010/0165995 A1	07-2010	Mehta; Apurva	H04L12/462	370/400
*	I	US-8,125,928 B2	02-2012	Mehta; Apurva	H04L12/4625	370/254
	J	US-				
	K	US-				
	L	US-				
	M	US-				

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*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14244701	AWANO, JUN
	Examiner	Art Unit
	SAI AUNG	2475

CPC- SEARCHED		
Symbol	Date	Examiner
H04L45/04; H04L45/24; H04L45/66; H04L45/00;	9/29/2015	SA

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
370	370/401; 370/392; 370/231; 370/252; 370/352; 370/395.53	9/29/2015	SA

SEARCH NOTES		
Search Notes	Date	Examiner
EAST SEARCH (INCLUDING INVENTORS AND ASSIGNEE SEARCH)	12/14/2014	SA
GOOGLE PATENTS SEARCH	4/13/2015	SA
OTHER RELATED CPC SEARCH: H04L45/302; H04L45/50; H04L49/351	4/13/2015	SA

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner

/S.A./ Examiner.Art Unit 2475	

Information Disclosure Citation

Docket Number	Application Number
NEG-1440PCT-US2CT	14/244,701
Inventor: Jun Awano	
Filing Date: April 3, 2014	Group Art Unit: 2475

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Examiner Initial	Ref	Document Number	Date	Name	Class	Subclass	Filing Date (If Appropriate)	
/S.A./		US 7,471,669 B1	12-30-2008	Sabesan et al.				
/S.A./		US 8,559,434 B2	10-15-2013	Esteve Rothenberg et al.				

U. S. Patent Application Publications

Examiner Initial	Ref	Document Number	Date	Name	Class	Subclass	Filing Date (If Appropriate)	

Foreign Patent Documents

Examiner Initial	Ref	Document Number	Date	Country	Class	Subclass	Translation Yes	Translation No
/S.A./		JP 2012-501127 A	01-12-2012	JAPAN			ABS	

Other Documents (Including Author, Title, Date, Pertinent Pages, etc.)

/S.A./		Japanese Office Action dated April 21, 2015 with partial English Translation

Examiner /Sai Aung/	**Date Considered** 09/29/2015

Examiner: Initial if citation considered, whether citation is in conformance with MPEP Section 609; Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to Applicant.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /S.A./

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L9	84	(Jun near2 Awano).in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/30 00:32
L10	4	(packet and forward$4 and node and path and identif$6).clm. and 9	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/30 00:33
L11	9	(US-20100165995-$ or US-20080279196-$ or US-20070280102-$ or US-20080123651-$ or US-20080137615-$ or US-20030053427-$).did. or (US-8125928-$ or US-7522603-$ or US-7447151-$).did.	US-PGPUB; USPAT	OR	ON	2015/09/30 00:36
L12	5	11 and (adjacent and node)	US-PGPUB; USPAT	OR	ON	2015/09/30 00:36
S1	46007	370/389,473,474,352-356,349,310.2,328,338,312.ccls.	US-PGPUB; USPAT	OR	ON	2012/06/19 19:15
S2	17081	370/218-225,401,237,238.ccls.	US-PGPUB; USPAT	OR	ON	2012/06/19 19:15
S3	21369	avaya.as. or (bank new york mellon trust).as.	US-PGPUB; USPAT	OR	ON	2012/06/19 19:15
S4	717668	(switch$4 or rout$4 or gate$4) and (encapsulat$4 or authenticat$4 or encod$4) and (packe$2 or data$1)	US-PGPUB; USPAT	OR	ON	2012/06/19 19:16
S5	400097	(virtu$4 or tunne$3) same (media or access$3 or control$3 or MAC)	US-PGPUB; USPAT	OR	ON	2012/06/19 19:17
S6	364	(source$1 or origi$3) and ((dual or multi$3) adj3 hom$3 adj3 (connect$3 or host$1))	US-PGPUB; USPAT	OR	ON	2012/06/19 19:18
S7	215	(source$3 or origi$4) and ((dual or multi$3) adj3 hom$3 adj3 connect$3)	US-PGPUB; USPAT	OR	ON	2012/06/19 19:18
S9	282	((dual or multi$3) adj3 hom$3 adj3 connect$3)	US-PGPUB; USPAT	OR	ON	2012/06/19 19:19
S10	6566	((dual or multi$3) adj3 hom$3)	US-PGPUB; USPAT	OR	ON	2012/06/19 19:19
S11	124	S10 and S1 and S2	US-PGPUB; USPAT	OR	ON	2012/06/19 19:19
S12	80	S11 and S4	US-PGPUB; USPAT	OR	ON	2012/06/19 19:20
S17	80	S11 and S4 and (media or access$3 or control$3 or MAC)	US-PGPUB; USPAT	OR	ON	2012/06/19 19:34
S19	398071	(switch$4 or rout$4 or gate$4) and (encapsulat$4 or authenticat$4 or encod$4) same (packe$2 or data$1)	US-PGPUB; USPAT	OR	ON	2012/06/19 19:35
S26	400097	(virtu$4 or tunne$3) same (media or access$3 or control$3 or MAC)	US-PGPUB; USPAT	OR	ON	2012/06/20 16:30
S27	6566	((dual or multi$3) adj3 hom$3)	US-PGPUB; USPAT	OR	ON	2012/06/20 16:30
S28	398071	(switch$4 or rout$4 or gate$4) and (encapsulat$4 or authenticat$4 or encod$4) same (packe$2 or data$1)	US-PGPUB; USPAT	OR	ON	2012/06/20 16:30
S29	46007	370/389,473,474,352-356,349,310.2,328,338,312.ccls.	US-PGPUB; USPAT	OR	ON	2012/06/20 16:32
S32	124	S27 and S29 and S31	US-PGPUB; USPAT	OR	ON	2012/06/20 18:44
S33	717668	(switch$4 or rout$4 or gate$4) and (encapsulat$4	US-PGPUB;	OR	ON	2012/06/20

		or authenticat$4 or encod$4) and (packe$2 or data$1)	USPAT			18:45
S34	80	S32 and S33	US-PGPUB; USPAT	OR	ON	2012/06/20 18:45
S35	38	S34 and S26	US-PGPUB; USPAT	OR	ON	2012/06/20 18:45
S36	468	((dual or multi$3) adj3 hom$3) and S31	US-PGPUB; USPAT	OR	ON	2012/06/20 18:57
S37	8447	(virtu$4 or tunne$3) same (media or access$3 or control$3 or MAC) and "L3"	US-PGPUB; USPAT	OR	ON	2012/06/20 18:58
S38	230	(virtu$4 or tunne$3) same (media or access$3 or control$3 or MAC) and S36	US-PGPUB; USPAT	OR	ON	2012/06/20 18:58
S42	105	(virtu$4 or tunne$3) near10 ((media and access$3) or control$3 or MAC) and S36 not S30	US-PGPUB; USPAT	OR	ON	2012/06/20 19:01
S43	65	(switch$4 or rout$4 or gate$4) and (encapsulat$4 or authenticat$4 or encod$4) same (packe$2 or data$1) and S42	US-PGPUB; USPAT	OR	ON	2012/06/20 19:06
S65	21392	avaya.as. or (bank new york mellon trust).as.	US-PGPUB; USPAT	OR	ON	2012/06/25 18:18
S66	17095	370/218-225,401,237,238.ccls.	US-PGPUB; USPAT	OR	ON	2012/06/25 18:18
S67	468	((dual or multi$3) adj3 hom$3) and S66	US-PGPUB; USPAT	OR	ON	2012/06/25 18:18
S68	105	(virtu$4 or tunne$3) near10 ((media and access$3) or control$3 or MAC) and S67 not S65	US-PGPUB; USPAT	OR	ON	2012/06/25 18:18
S95	6042098	Encapsulation Method for Transport	US-PGPUB; USPAT	OR	ON	2012/06/27 13:02
S96	1734704	S95 and ethernet frames	US-PGPUB; USPAT	OR	ON	2012/06/27 13:03
S117	48595	370/389,473,474,352-356,349,310.2,328,338,312.ccls.	US-PGPUB; USPAT	OR	ON	2012/10/30 17:56
S118	17789	370/218-225,401,237,238.ccls.	US-PGPUB; USPAT	OR	ON	2012/10/30 17:56
S121	2	("20070195700").PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/02/07 17:42
S125	7644	(rout$5) near4 (setup)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:12
S127	1553238	(flow) with (manage$5 control$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:13
S128	2159	S125 and S127	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:14
S129	1788	@ad<="20090326" and S128	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:15
S130	8916	370/218-225,254.ccls.	US-PGPUB; USPAT	OR	ON	2013/02/07 18:16
S131	42	S130 and S129	US-PGPUB; USPAT	OR	ON	2013/02/07 18:16
S132	5262	370/254.ccls.	US-PGPUB; USPAT	OR	ON	2013/02/07 18:16
S134	42078	(IP near3 rout$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:18

S135	363	S129 and S134	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:18
S136	301	(data with packet) and S135	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:19
S137	284	(request$4) and S136	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:20
S138	271283	(source destination) near5 (node address MAC)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:21
S140	244	S137 and S138	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:21
S141	242	(pre$determin$3 determin$3 reserv$3) and S140	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:22
S142	219	(pre$determin$3 pre$defin$3 reserv$3) and S140	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:22
S143	6	S132 and S142	US-PGPUB; USPAT	OR	ON	2013/02/07 18:23
S144	46911	370/389,352-356,349,310.2,328,338,312.ccls.	US-PGPUB; USPAT	OR	ON	2013/02/07 18:23
S145	71	S142 and S144	US-PGPUB; USPAT	OR	ON	2013/02/07 18:23
S146	26048	370/389,352-356,349.ccls.	US-PGPUB; USPAT	OR	ON	2013/02/07 18:24
S147	64	S142 and S146	US-PGPUB; USPAT	OR	ON	2013/02/07 18:24
S148	7644	(rout$5) near4 (setup)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:33
S149	1553238	(flow) with (manage$5 control$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:33
S150	2159	S148 and S149	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:33
S151	1788	@ad<="20090326" and S150	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:33
S152	42078	(IP near3 rout$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:33
S153	363	S151 and S152	US-PGPUB; USPAT; USOCR;	OR	ON	2013/02/07 18:33

			FPRS; EPO; JPO; DERWENT; IBM_TDB			
S154	301	(data with packet) and S153	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:33
S155	284	(request$4) and S154	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:33
S156	271283	(source destination) near5 (node address MAC)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:33
S157	244	S155 and S156	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:33
S158	219	(pre$determin$3 pre$defin$3 reserv$3) and S157	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:33
S159	26048	370/389,352-356,349.ccls.	US-PGPUB; USPAT	OR	ON	2013/02/07 18:33
S160	64	S158 and S159	US-PGPUB; USPAT	OR	ON	2013/02/07 18:33
S161	64	S160	US-PGPUB; USPAT	OR	ON	2013/02/07 18:33
S175	31571	370/229-235,251-254,230-236.ccls.	US-PGPUB; USPAT	OR	ON	2013/02/07 22:44
S176	29	S158 and S175	US-PGPUB; USPAT	OR	ON	2013/02/07 22:44
S177	58	(look$up LUT map$4 hash$4) and S161	US-PGPUB; USPAT	OR	ON	2013/02/07 22:55
S178	24	(rout$5 near3 server) and S177	US-PGPUB; USPAT	OR	ON	2013/02/07 22:55
S181	108	S150 and ((server gatewy) near3 (set$up (set$4 adj up)))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 23:47
S183	2837	S175 and S159	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 23:48
S184	28	S181 and S159	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 23:48
S186	135	jean near3 vasseur.in.	USPAT	OR	ON	2013/02/07 23:56
S187	103	(pre$determin$3 pre$defin$3 reserv$3 predict$3) and S186	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 23:57
S188	827364	(switch$4 or rout$4 or gate$4) with (IP or packet or data)	US-PGPUB; USPAT	OR	ON	2013/02/07 23:58
S189	168189	S188 and S149	US-PGPUB; USPAT	OR	ON	2013/02/07 23:58
S190	40	S187 and S189	US-PGPUB; USPAT	OR	ON	2013/02/07 23:58

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S191	22	(look$up LUT map$4 hash$4) and S190	US-PGPUB; USPAT	OR	ON	2013/02/07 23:58

9/30/2015 1:02:06 AM
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DELL - Exhibit 1002 - Page 370

Docket No.: NEG-1440PCT-US2CT
KATO.327CONT.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Continuation patent application of 13/176,610, filed on July 5, 2011.

Jun Awano

Serial No.:	Not Yet Assigned	**Group Art Unit:**	Not Yet Assigned
Filed:	Concurrently Herewith	**Examiner:**	Not Yet Assigned

For: COMMUNICATION SYSTEM, FORWARDING NODE, PATH MANAGEMENT SERVER, COMMUNICATION METHOD, AND PROGRAM

Honorable Commissioner of Patents
Alexandria, Virginia 22313-1450

INFORMATION DISCLOSURE STATEMENT

Sir:

Under the provisions of 37 CFR §1.97 through §1.98 and pursuant to applicant's duty of disclosure under 37 CFR §1.56, applicant respectfully brings the following documents listed on the attached form PTO-1449, to the attention of the Examiner in charge of the above-identified application. These references were either cited or submitted in parent Application No. 13/176,610, and thus copies of these references are not provided in accordance with 37 C.F.R. §1.98(d).

This citation does not constitute an admission that the references are relevant or material to the claims. They are only cited as constituting related art of which applicant is aware.

It is respectfully requested that the listed references be considered by the Examiner and formally made of record in this application.

Please charge any deficiencies in fees and credit any overpayment of fees to Attorney's Deposit Account No. 50-0481.

Respectfully submitted,

Scott L. Mandir, Esq.
Registration No. 67,186
Sean M. McGinn, Esq.
Registration No. 34,386

Date: 4/03/14

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Vienna, Virginia 22182-3817
(703) 761-4100, Customer No. 21254

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /S.A./

Information Disclosure Citation	Docket Number NEG-1440PCT-US2CT	Application Number Not Yet Assigned
	Applicant NEC Corporation	
	Filing Date Concurrently Herewith	Group Art Unit Not Yet Assigned

U. S. Patent Documents

Examiner Initial	Ref	Document Number	Date	Name	Class	Subclass	Filing Date (If Appropriate)	
/S.A./		US 2007/0280102 A1	12-2007	Vasseur et al.				
/S.A./		US 2008/0123651 A1	05-2008	Vasseur et al.				
/S.A./		US 2008/0279196 A1	11-2008	Friskney et al.				
/S.A./		US 7,447,151 B2	11-2008	McDysan, David E.				
/S.A./		US 7,522,603 B2	04-2009	Vasseur, Jean-Philippe				
/S.A./		US 2010/0165995 A1	07-2010	Mehta et al.				
/S.A./		US 8,125,928 B2	02-2012	Mehta et al				
/S.A./		US 7, 706,344 B2	04/27/2010	Kobayashi et al.				
/S.A./		US 2003/0053427 A1	03-2003	Kanda et al				
/S.A./		US 2008/0137615 A1	06-2008	Park et al				

Foreign Patent Documents

Examiner Initial	Ref	Document Number	Date	Country	Class	Sub-class	Translation	
							Yes	No
/S.A./		CN 1988498 (A)	06-27-2007	China			ABS	
/S.A./		CN 101047614 (A)	10-03-2007	China			ABS	
/S.A./		CN 101505278 (A)	08-12-2009	China			ABS	
/S.A./		JP 2002-198989 A	07-12-2002	JAPAN			ABS	
/S.A./		JP 2004-80637 A	3-11-2004	JAPAN			ABS	

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /S.A./

/S.A./		JP 7-336383 A	12-22-2004	JAPAN			ABS	
/S.A./		JP 2004-356883 A	12-16-2004	JAPAN			ABS	
/S.A./		JP 2007-235444 A	09-13-2007	JAPAN			ABS	

Other Documents (Including Author, Title, Date, Pertinent Pages, etc.)		
/S.A./		Notice of Allowance for App. No. 13/176,610 dated February 1, 2014
/S.A./		Final Office Action for App. No. 13/176,610 dated October 9, 2013
/S.A./		Non-Final Office Action for App. No. 13/176,610 dated March 7, 2013
/S.A./		Petri Jokela et al, "LIPSIN: Line Speed Publish/Subscribe Inter-Networking", SIGCOMM' 09, August 21, 2009, Barcelona, Spain, p.p. 195-206.
/S.A./		Nick McKeown, et al., 'Open Flow: Enabling Innovation in Campus Networks', [online], [search conducted July 17, 2009] Internet URL: http://www.OpenFlowSwitch.org//documents/OpenFlow-wp-latest.pdf; March 14, 2008.

Examiner /Sai Aung/	**Date Considered** 09/29/2015

Examiner: Initial if citation considered, whether citation is in conformance with MPEP Section 609; Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to Applicant.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /S.A./

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14244701	AWANO, JUN
	Examiner	Art Unit
	SAI AUNG	2475

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	12/12/2014	04/13/2015	09/30/2015						
	1	✓	✓	✓						
	2	✓	✓	✓						
	3	✓	✓	✓						
	4	✓	✓	✓						
	5	✓	✓	✓						
	6	✓	✓	✓						
	7	✓	✓	✓						
	8	✓	✓	✓						
	9	✓	✓	✓						
	10	✓	✓	✓						
	11	✓	✓	✓						
	12	✓	✓	✓						
	13	✓	✓	✓						
	14	✓	✓	✓						
	15	✓	✓	✓						
	16	✓	✓	✓						
	17	✓	✓	✓						
	18	✓	✓	✓						
	19	✓	✓	✓						
	20	✓	✓	✓						
	21	✓	✓	✓						
	22			✓						
	23			✓						
	24			✓						
	25			✓						
	26			✓						

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/244,701	04/03/2014	JUN AWANO	NEG-1440PCT-US2CT	2010

21254 7590 10/30/2015

MCGINN INTELLECTUAL PROPERTY LAW GROUP, PLLC
8321 OLD COURTHOUSE ROAD
SUITE 200
VIENNA, VA 22182-3817

EXAMINER
AUNG, SAI

ART UNIT	PAPER NUMBER
2475	

MAIL DATE	DELIVERY MODE
10/30/2015	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Applicant-Initiated Interview Summary	Application No.	Applicant(s)	
	14/244,701	AWANO, JUN	
	Examiner	Art Unit	
	SAI AUNG	2475	

All participants (applicant, applicant's representative, PTO personnel):

(1) *SAI AUNG*. (3)_____.

(2) *S. Sahota (Reg., 47,051)*. (4)_____.

Date of Interview: *20 October 2015*.

Type: ☒ Telephonic ☐ Video Conference
☐ Personal [copy given to: ☐ applicant ☐ applicant's representative]

Exhibit shown or demonstration conducted: ☐ Yes ☐ No.
If Yes, brief description: _____.

Issues Discussed ☐101 ☐112 ☐102 ☐103 ☐Others
(For each of the checked box(es) above, please describe below the issue and detailed description of the discussion)

Claim(s) discussed: *7-10*.

Identification of prior art discussed: _____.

Substance of Interview
(For each issue discussed, provide a detailed description and indicate if agreement was reached. Some topics may include: identification or clarification of a reference or a portion thereof, claim interpretation, proposed amendments, arguments of any applied references etc...)

The applicant initiated the interview and indicated that the office action doesn't have any reasoning for claims 7-10. The examiner agreed to send out the corrected version of office Acton to correctly address claims 7-10..

Applicant recordation instructions: The formal written reply to the last Office action must include the substance of the interview. (See MPEP section 713.04). If a reply to the last Office action has already been filed, applicant is given a non-extendable period of the longer of one month or thirty days from this interview date, or the mailing date of this interview summary form, whichever is later, to file a statement of the substance of the interview

Examiner recordation instructions: Examiners must summarize the substance of any interview of record. A complete and proper recordation of the substance of an interview should include the items listed in MPEP 713.04 for complete and proper recordation including the identification of the general thrust of each argument or issue discussed, a general indication of any other pertinent matters discussed regarding patentability and the general results or outcome of the interview, to include an indication as to whether or not agreement was reached on the issues raised.

☐ Attachment

/S. A./ Examiner, Art Unit 2475	

Summary of Record of Interview Requirements

Manual of Patent Examining Procedure (MPEP), Section 713.04, Substance of Interview Must be Made of Record
A complete written statement as to the substance of any face-to-face, video conference, or telephone interview with regard to an application must be made of record in the application whether or not an agreement with the examiner was reached at the interview.

Title 37 Code of Federal Regulations (CFR) § 1.133 Interviews
Paragraph (b)

In every instance where reconsideration is requested in view of an interview with an examiner, a complete written statement of the reasons presented at the interview as warranting favorable action must be filed by the applicant. An interview does not remove the necessity for reply to Office action as specified in §§ 1.111, 1.135. (35 U.S.C. 132)

37 CFR §1.2 Business to be transacted in writing.
All business with the Patent or Trademark Office should be transacted in writing. The personal attendance of applicants or their attorneys or agents at the Patent and Trademark Office is unnecessary. The action of the Patent and Trademark Office will be based exclusively on the written record in the Office. No attention will be paid to any alleged oral promise, stipulation, or understanding in relation to which there is disagreement or doubt.

The action of the Patent and Trademark Office cannot be based exclusively on the written record in the Office if that record is itself incomplete through the failure to record the substance of interviews.

It is the responsibility of the applicant or the attorney or agent to make the substance of an interview of record in the application file, unless the examiner indicates he or she will do so. It is the examiner's responsibility to see that such a record is made and to correct material inaccuracies which bear directly on the question of patentability.

Examiners must complete an Interview Summary Form for each interview held where a matter of substance has been discussed during the interview by checking the appropriate boxes and filling in the blanks. Discussions regarding only procedural matters, directed solely to restriction requirements for which interview recordation is otherwise provided for in Section 812.01 of the Manual of Patent Examining Procedure, or pointing out typographical errors or unreadable script in Office actions or the like, are excluded from the interview recordation procedures below. Where the substance of an interview is completely recorded in an Examiners Amendment, no separate Interview Summary Record is required.

The Interview Summary Form shall be given an appropriate Paper No., placed in the right hand portion of the file, and listed on the "Contents" section of the file wrapper. In a personal interview, a duplicate of the Form is given to the applicant (or attorney or agent) at the conclusion of the interview. In the case of a telephone or video-conference interview, the copy is mailed to the applicant's correspondence address either with or prior to the next official communication. If additional correspondence from the examiner is not likely before an allowance or if other circumstances dictate, the Form should be mailed promptly after the interview rather than with the next official communication.

The Form provides for recordation of the following information:
- Application Number (Series Code and Serial Number)
- Name of applicant
- Name of examiner
- Date of interview
- Type of interview (telephonic, video-conference, or personal)
- Name of participant(s) (applicant, attorney or agent, examiner, other PTO personnel, etc.)
- An indication whether or not an exhibit was shown or a demonstration conducted
- An identification of the specific prior art discussed
- An indication whether an agreement was reached and if so, a description of the general nature of the agreement (may be by attachment of a copy of amendments or claims agreed as being allowable). Note: Agreement as to allowability is tentative and does not restrict further action by the examiner to the contrary.
- The signature of the examiner who conducted the interview (if Form is not an attachment to a signed Office action)

It is desirable that the examiner orally remind the applicant of his or her obligation to record the substance of the interview of each case. It should be noted, however, that the Interview Summary Form will not normally be considered a complete and proper recordation of the interview unless it includes, or is supplemented by the applicant or the examiner to include, all of the applicable items required below concerning the substance of the interview.

A complete and proper recordation of the substance of any interview should include at least the following applicable items:
1) A brief description of the nature of any exhibit shown or any demonstration conducted,
2) an identification of the claims discussed,
3) an identification of the specific prior art discussed,
4) an identification of the principal proposed amendments of a substantive nature discussed, unless these are already described on the Interview Summary Form completed by the Examiner,
5) a brief identification of the general thrust of the principal arguments presented to the examiner,
   (The identification of arguments need not be lengthy or elaborate. A verbatim or highly detailed description of the arguments is not required. The identification of the arguments is sufficient if the general nature or thrust of the principal arguments made to the examiner can be understood in the context of the application file. Of course, the applicant may desire to emphasize and fully describe those arguments which he or she feels were or might be persuasive to the examiner.)
6) a general indication of any other pertinent matters discussed, and
7) if appropriate, the general results or outcome of the interview unless already described in the Interview Summary Form completed by the examiner.

Examiners are expected to carefully review the applicant's record of the substance of an interview. If the record is not complete and accurate, the examiner will give the applicant an extendable one month time period to correct the record.

Examiner to Check for Accuracy

If the claims are allowable for other reasons of record, the examiner should send a letter setting forth the examiner's version of the statement attributed to him or her. If the record is complete and accurate, the examiner should place the indication, "Interview Record OK" on the paper recording the substance of the interview along with the date and the examiner's initials.

Office Action Summary	Application No. 14/244,701	Applicant(s) AWANO, JUN	
	Examiner SAI AUNG	Art Unit 2475	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *09/15/2015*.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5)☒ Claim(s) *1-26* is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6)☐ Claim(s) _____ is/are allowed.

7)☒ Claim(s) *1-26* is/are rejected.

8)☐ Claim(s) _____ is/are objected to.

9)☐ Claim(s) _____ are subject to restriction and/or election requirement.

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☐ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date _____.

3) ☒ Interview Summary (PTO-413) Paper No(s)/Mail Date. *10/20/2015* .

4) ☒ Other: *PTO 90C*.

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APPLICATION NO./ CONTROL NO.	FILING DATE	FIRST NAMED INVENTOR / PATENT IN REEXAMINATION	ATTORNEY DOCKET NO.
14/244,701	03 April, 2014	AWANO, JUN	NEG-1440PCT-US2CT

MCGINN INTELLECTUAL PROPERTY LAW GROUP, PLLC
8321 OLD COURTHOUSE ROAD
SUITE 200
VIENNA, VA 22182-3817

EXAMINER	
SAI AUNG	
ART UNIT	PAPER
2475	20151028

DATE MAILED:

Please find below and/or attached an Office communication concerning this application or proceeding.

Commissioner for Patents

It has been noted by the Applicant that typographical errors have been occurred on the office action dated on 10/06/2015. The office action lacks reasoning for claims 7-10. Claims 7-10 are corrected in a corrected offic action. The corrected office action is being provided and the time period is being reset to THREE MONTHS from the mailing of this letter.

/DANG TON/ Supervisory Patent Examiner, Art Unit 2475	/S. A./ Examiner, Art Unit 2475

PTO-90C (Rev.04-03)

DETAILED ACTION

Claims status

1. In the amended application filed on 09/15/2015, claims 1-26 are currently pending for the examination. The present application is being examined under the pre-AIA first to invent provisions. The corrected office action is being provided and the time period is being reset to THREE MONTHS from the mailing of this letter.

Examiner Notes

2. The Examiner cites particular columns and line numbers in the references as applied to the claims below for the convenience of the Applicants(s). Although the specified citations are representative of the disclosings in the art and are applied to the specific limitations within the individual claim, other passages and figures may apply as well. It is respectfully requested that, in preparing response, the Applicant fully consider the references in their entirety as potentially disclosing all or part of the claimed invention, as well as the context of the passage as taught by the prior art or disclosed by the Examiner.

Claim Objections

3. Claims 16-20 are objected to because of the following informalities:

Claim 16 recites "*a packet forwarding node*" in line 3. It is recommended amend the claim limitation to ---the packet forwarding node---, if it is referring back to a packet forwarding node in line 1.

Claims 17-20 are also objected to as being dependent upon an objected base claim.

Claims 22-26 are further objected to because it recites "identifies", and should be corrected to --- identifies---.

35 U.S.C. 112(f): Claim Interpretations

4. The following is a quotation of 35 U.S.C. 112(f):

> *(f) Element in Claim for a Combination. – An element in a claim for a combination may be expressed as a means or step for performing a specified function without the recital of structure, material, or acts in support thereof, and such claim shall be construed to cover the corresponding structure, material, or acts described in the specification and equivalents thereof.*

5. The following is a quotation of pre-AIA 35 U.S.C. 112, sixth paragraph:

> *An element in a claim for a combination may be expressed as a means or step for performing a specified function without the recital of structure, material, or acts in support thereof, and such claim shall be construed to cover the corresponding structure, material, or acts described in the specification and equivalents thereof.*

6. Claim 6 recites "*A packet forwarding node, comprising: a storage unit to store a packet forwarding table..., and a forwarding unit to receive in incoming packet...*", and thus the claim has been interpreted under 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph, because it uses a generic placeholder "a storage unit" coupled with functional language "to store" without reciting sufficient structure to achieve the function. Furthermore, the generic placeholder is not preceded by a structural modifier.

Since the claim limitation(s) invokes 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph, claims 6-10 have been interpreted to cover the corresponding structure described in the specification that achieves the claimed function, and equivalents thereof.

A review of the specification shows that the following appears to be the corresponding structure described in the specification for the 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph limitation:

Figure 3 and Para. 0072 in the Specification provides the recording unit 370 holds a forwarding table shown in FIG. 3, and this is referred to by the packet forwarding unit 320, the local ID determination unit 340, and the neighbor information notification unit 350.

If applicant wishes to provide further explanation or dispute the examiner's interpretation of the corresponding structure, applicant must identify the corresponding structure with reference to the specification by page and line number, and to the drawing, if any, by reference characters in response to this Office action.

If applicant does not intend to have the claim limitation(s) treated under 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112 , sixth paragraph, applicant may amend the claim(s) so that it/they will clearly not invoke 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph, or present a sufficient showing that the claim recites/recite sufficient structure, material, or acts for performing the claimed function to preclude application of 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph.

For more information, see MPEP § 2173 et seq. and Supplementary Examination Guidelines for Determining Compliance With 35 U.S.C. 112 and for Treatment of Related Issues in Patent Applications, 76 FR 7162, 7167 (Feb. 9, 2011).

7. Claim 11 recites "*A packet forwarding node, comprising: a communication unit to communicate with a server for receiving..., and a forwarding unit to forward in incoming*

packet...", and thus the claim has been interpreted under 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph, because it uses a generic placeholder "a communication unit" coupled with functional language "to communicate" without reciting sufficient structure to achieve the function. Furthermore, the generic placeholder is not preceded by a structural modifier.

Since the claim limitation(s) invokes 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph, claims 11-15 have been interpreted to cover the corresponding structure described in the specification that achieves the claimed function, and equivalents thereof.

A review of the specification shows that the following appears to be the corresponding structure described in the specification for the 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph limitation:

Figure 3 and Para. 0072 in the Specification provides the recording unit 370 holds a forwarding table shown in FIG. 3, and this is referred to by the packet forwarding unit 320, the local ID determination unit 340, and the neighbor information notification unit 350.

If applicant wishes to provide further explanation or dispute the examiner's interpretation of the corresponding structure, applicant must identify the corresponding structure with reference to the specification by page and line number, and to the drawing, if any, by reference characters in response to this Office action.

If applicant does not intend to have the claim limitation(s) treated under 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112 , sixth paragraph, applicant may amend the claim(s) so that it/they will clearly not invoke 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph, or present a sufficient showing that the claim recites/recite sufficient structure, material, or acts for

performing the claimed function to preclude application of 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph.

For more information, see MPEP § 2173 et seq. and Supplementary Examination Guidelines for Determining Compliance With 35 U.S.C. 112 and for Treatment of Related Issues in Patent Applications, 76 FR 7162, 7167 (Feb. 9, 2011).

8. Claim 16 recites "*A packet forwarding node, comprising: a communication unit to communicate with a server for receiving..., and a forwarding unit to forward in incoming packet...*", and thus the claim has been interpreted under 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph, because it uses a generic placeholder "a communication unit" coupled with functional language "to communicate" without reciting sufficient structure to achieve the function. Furthermore, the generic placeholder is not preceded by a structural modifier.

Since the claim limitation(s) invokes 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph, claims 16-20 have been interpreted to cover the corresponding structure described in the specification that achieves the claimed function, and equivalents thereof.

A review of the specification shows that the following appears to be the corresponding structure described in the specification for the 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph limitation:

Figure 3 and Para. 0072 and 0075 in the Specification provides the recording unit 370 holds a forwarding table shown in FIG. 3, and this is referred to by the packet forwarding unit 320, the local ID determination unit 340, and the neighbor information notification unit 350.

If applicant wishes to provide further explanation or dispute the examiner's interpretation of the corresponding structure, applicant must identify the corresponding structure with reference to the specification by page and line number, and to the drawing, if any, by reference characters in response to this Office action.

If applicant does not intend to have the claim limitation(s) treated under 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112 , sixth paragraph, applicant may amend the claim(s) so that it/they will clearly not invoke 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph, or present a sufficient showing that the claim recites/recite sufficient structure, material, or acts for performing the claimed function to preclude application of 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph.

For more information, see MPEP § 2173 et seq. and Supplementary Examination Guidelines for Determining Compliance With 35 U.S.C. 112 and for Treatment of Related Issues in Patent Applications, 76 FR 7162, 7167 (Feb. 9, 2011).

9. Claim 21 recites "*A server comprising: a first unit to determine a plurality of identifiers..., and a second unit to send information elements...*", and thus the claim has been interpreted under 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph, because it uses a generic placeholder "a communication unit" coupled with functional language "to communicate" without reciting sufficient structure to achieve the function. Furthermore, the generic placeholder is not preceded by a structural modifier.

Since the claim limitation(s) invokes 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph, claims 11-15 have been interpreted to cover the corresponding structure described in the specification that achieves the claimed function, and equivalents thereof.

A review of the specification shows that the following appears to be the corresponding structure described in the specification for the 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph limitation:

Figure 6 and Para. 0077 in the Specification provides The path management server 500 collects neighbor information notified from boundary forwarding nodes 300 and internal forwarding nodes 400, and configures network topology information describing connection relationships of the internal forwarding nodes 400 and the boundary forwarding nodes 300 inside the data transfer network 600. The network topology information also includes connection information for the communication nodes 100 a and 100 b connected to the boundary forwarding nodes 300.

If applicant wishes to provide further explanation or dispute the examiner's interpretation of the corresponding structure, applicant must identify the corresponding structure with reference to the specification by page and line number, and to the drawing, if any, by reference characters in response to this Office action.

If applicant does not intend to have the claim limitation(s) treated under 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112 , sixth paragraph, applicant may amend the claim(s) so that it/they will clearly not invoke 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph, or present a sufficient showing that the claim recites/recite sufficient structure, material, or acts for

performing the claimed function to preclude application of 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph.

For more information, see MPEP § 2173 et seq. and Supplementary Examination Guidelines for Determining Compliance With 35 U.S.C. 112 and for Treatment of Related Issues in Patent Applications, 76 FR 7162, 7167 (Feb. 9, 2011).

Claim Rejections: 35 USC 112(b) after invoking 35 USC 112(f)

10. The following is a quotation of 35 U.S.C. 112(f):

> *(f) Element in Claim for a Combination. – An element in a claim for a combination may be expressed as a means or step for performing a specified function without the recital of structure, material, or acts in support thereof, and such claim shall be construed to cover the corresponding structure, material, or acts described in the specification and equivalents thereof.*

11. The following is a quotation of pre-AIA 35 U.S.C. 112, sixth paragraph:

> *An element in a claim for a combination may be expressed as a means or step for performing a specified function without the recital of structure, material, or acts in support thereof, and such claim shall be construed to cover the corresponding structure, material, or acts described in the specification and equivalents thereof.*

12. The following is a quotation of 35 U.S.C. 112(b):

> *(b) CONCLUSION.—The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the inventor or a joint inventor regards as the invention.*
> The following is a quotation of 35 U.S.C. 112 (pre-AIA), second paragraph:
>
> *The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.*

13. Claims 1-5 are rejected under 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the inventor or a joint inventor, or for pre-AIA the applicant regards as the invention.

Claim 1 recites "*A packet forwarding node, comprising: a storage unit to store..., and a forwarding unit to receive...*", and thus the claim has been interpreted under 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph, because it uses a generic placeholder "a storage unit" coupled with functional language "to store" without reciting sufficient structure to achieve the function. Furthermore, the generic placeholder is not preceded by a structural modifier.

Since the claim limitation(s) invokes 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph, claims 1-5 have been interpreted to cover the corresponding structure described in the specification that achieves the claimed function, and equivalents thereof.

A review of the specification, i.e. figure 2 and paragraphs 0067 and 0068, seems to provide that the following appears to be the corresponding structure described in the specification for the 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph limitation.

However, **the written description provided in the specification does not clearly link to the structure to perform the steps of the function listed on the claim**. Moreover, the disclosed structure shown in the figures **is not sufficient to perform** the claimed function [emphasis added]. See MPEP 2181 under Section II.

Therefore, the claim is indefinite. Thus, the claim must be rejected under 112(b), second paragraph. Claims 2-5 are also rejected because of being dependent upon the rejected based claims. It is recommended that the claim language be amended such that the exact meaning of

the above quoted limitation is clear. For the purpose of the examination, the Examiner will interpret the claim as best understood.

Double Patenting

14. The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the "right to exclude" granted by a patent and to prevent possible harassment by multiple assignees. A nonstatutory obviousness-type double patenting rejection is appropriate where the conflicting claims are not identical, but at least one examined application claim is not patentably distinct from the reference claim(s) because the examined application claim is either anticipated by, or would have been obvious over, the reference claim(s). See, e.g., *In re Berg*, 140 F.3d 1428, 46 USPQ2d 1226 (Fed. Cir. 1998); *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); and *In re Thorington*, 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) or 1.321(d) may be used to overcome an actual or provisional rejection based on a nonstatutory double patenting ground provided the conflicting application or patent either is shown to be commonly owned with this application, or claims an invention made as a result of activities undertaken within the scope of a joint research agreement. Effective January 1, 1994, a registered attorney or agent of

record may sign a terminal disclaimer. A terminal disclaimer signed by the assignee must fully comply with 37 CFR 3.73(b).

15. **Claims 1-26 are** rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claims 1 and 8 of the U.S. application number **13/137,237**. Although the conflicting claims are not identical, they are not patentably distinct from each other. This is an **obviousness-type double patenting rejection** because the conflicting claims have not in fact been patented.

Regarding pending claims 1, 6 and 21; the claims recite limitations substantially the same as in the US application number **13/137,237**. These limitations are fully covered by the claims of the US application number **13/137,237.**

The compared table below (i.e. underlined claim elements) shows only Example (sample) of how each of these claims are anticipated and mapped by claims such as claims 1-7, 11, and 18, respectively of the US application number **13/137,237.**

Instant Application: 14244701	**Application #: 13/137,237**
1. A packet forwarding node, comprising: a storage unit to store a packet forwarding table used for forwarding a packet based on an identifier which identifies a link between nodes on a packet forwarding path; and a forwarding unit to receive an incoming packet including a plurality of the identifiers, and to forward the incoming packet based on an identifier corresponding to the packet forwarding node.	8. A forwarding node, connected to a path management server that generates a plurality of forwarding path information items each includes a sequence of identifiers, each of which identifies a communication interface provided in each of a plurality of forwarding nodes on a forwarding path in a data forwarding network or a link established between the forwarding node and a neighboring node thereof, wherein the forwarding node, in accordance with at least one of the

6. (Previously Presented) A packet forwarding node, comprising: a storage unit to store a packet forwarding table used for forwarding a packet based on an identifier which identifies an interface of a packet forwarding node; and a forwarding unit to receive an incoming packet including a plurality of identifiers, and to forward the incoming packet based on the identifier corresponding to the packet forwarding node. 11. (Original) A packet forwarding node, comprising: a communication unit to communicate with a server for receiving a plurality of identifiers, each of which identifies a link between nodes on a packet forwarding path; and a forwarding unit to forward an incoming packet based on an identifier corresponding to a packet forwarding node. 16. (Original) A packet forwarding node, comprising: a communication unit to communicate with a server for receiving a plurality of identifiers, each of which identifies an interface of a packet forwarding node; and a forwarding unit to forward an incoming packet based on an identifier corresponding to the packet forwarding node. 21. A server, comprising: a first unit to determine a plurality of identifiers, each of which identifies a link between nodes on a packet forwarding path; and a second unit to send information	plurality of forwarding path information items, executes a packet forwarding processing of a packet with a header including the plurality of forwarding path information items. 1. A communication system comprising: a path management server that generates a plurality of forwarding path information items each includes a sequence of identifiers, each of which identifies a communication interface provided in each of a plurality of forwarding nodes on a forwarding path in a data forwarding network or a link established between the forwarding node and a neighboring node thereof; and a forwarding node that, in accordance with at least one of the plurality of forwarding path information items, executes a packet forwarding processing of a packet with a header including the plurality of forwarding path information items. 8. A forwarding node, connected to a path management server that generates a plurality of forwarding path information items each includes a sequence of identifiers, each of which identifies a communication interface provided in each of a plurality of forwarding nodes on a forwarding path in a data forwarding network or a link established between the forwarding node and a neighboring node thereof, wherein the forwarding node, in accordance with at least one of the plurality of forwarding path information items, executes a packet forwarding processing of a packet with a header including the plurality of forwarding path information items. 1. A communication system comprising: a path management server that generates a plurality of

elements to a packet forwarding node which is capable of forwarding an incoming packet based on an identifier corresponding to the packet forwarding node.	forwarding path information items each includes a sequence of identifiers, each of which identifies a communication interface provided in each of a plurality of forwarding nodes on a forwarding path in a data forwarding network or a link established between the forwarding node and a neighboring node thereof; and a forwarding node that, in accordance with at least one of the plurality of forwarding path information items, executes a packet forwarding processing of a packet with a header including the plurality of forwarding path information items.

Claim Rejections - 35 USC § 102

16. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

17. Claims 1-21 are rejected under 35 U.S.C. 102(b) as being anticipated by **Vasseur (US 7,522,603 B2).**

Regarding claim 1; **Vasseur** discloses a packet forwarding node, comprising:

a storage unit to store a packet forwarding table used for forwarding a packet based on an identifier which identifies a link between nodes on a packet forwarding path ***(See Figs. 2 and 4; Router (i.e., a forwarding node) with forwarding tables 246 and PCE 248 for path computation of the CE-CE***

paths and current metrics to the remote destination address; Col. 8 Lines 59-67 and Col. 11 Lines 54-60); and

a forwarding unit to receive an incoming packet including a plurality of the identifiers ***(See Figs. 2 and 4; Router performs/receives routing information database RIB and forwarding information database FIB; Col. 8 Lines 59-67),*** and to forward the incoming packet based on an identifier corresponding to the packet forwarding node ***(See Figs. 2 and 4; a forwarding selection selects a label (i.e. identifier) to route of the destination; Col. 9 Lines 15-24...and see also Fig. 7; for performing IP traffic routing and selecting the best path; Col. 14 Lines 7-15).***

Regarding claim 2; **Vasseur** discloses the packet forwarding node wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link within a predetermined domain ***(See Figs. 4 and 5; CE-PE links (i.e. PE link for predetermined domain); Col. 10 Lines 51-60 and Col. 12 Lines 40-47).***

Regarding claim 3; **Vasseur** discloses the packet forwarding node, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link within a predetermined local domain ***(See Figs. 4 and 5; CE-CE links (i.e. predetermined local domain); Col. 9 Lines 54-60).***

Regarding claim 4; **Vasseur** discloses the packet forwarding node wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link within the packet forwarding node ***(See Figs. 2 and 4; Router (i.e., a forwarding node) with forwarding tables 246; Col. 8 l 59-67).***

Regarding claim 5; **Vasseur** discloses the packet forwarding node wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link among the packet forwarding nodes ***(See Figs. 2 and 4; Router (i.e., a forwarding node) with forwarding tables 246; Col. 8 l 59-67).***

Regarding claim 6; **Vasseur** discloses a packet forwarding node, comprising:

a storage unit to store a packet forwarding table used for forwarding a packet based on an identifier which identifies an interface of a packet forwarding node ***(See Fig. 2; Each node includes one or more network interfaces that are coupled to a processor to execute memory that store routing forwarding tables and compute CE-CE or PE-CE path metrics to destination address to balance out the traffic load across the network links. (See Fig. 2: Col. 8 Lines 21-32 and Col. 8 Lines 37-47...and see also Fig. 4: Router (i.e., a forwarding node) with forwarding tables 246; Col. 8 Lines 59-67);*** and

a forwarding unit to receive an incoming packet including a plurality of the identifiers ***(See Figs. 2 and 4; Router performs/receives routing information database RIB and forwarding information database FIB; Col. 8 Lines 59-67),*** and to forward the incoming packet based on an identifier corresponding to the packet forwarding node ***(See Figs. 2 and 4; a forwarding selection selects a label (i.e. identifier) to route of the destination; Col. 9 Lines 15-24...and see also Fig. 7; for performing IP traffic routing and selecting the best path; Col. 14 Lines 7-15).***

Regarding claim 7; **Vasseur** discloses the packet forwarding node wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely

identifies the link within a predetermined domain ***(See Figs. 4 and 5; CE-PE links (i.e. PE link for predetermined domain); Col. 10 Lines 51-60 and Col. 12 Lines 40-47).***

Regarding claim 8; **Vasseur** discloses the packet forwarding node, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link within a predetermined local domain ***(See Figs. 4 and 5; CE-CE links (i.e. predetermined local domain); Col. 9 Lines 54-60).***

Regarding claim 9; **Vasseur** discloses the packet forwarding node wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link within the packet forwarding node ***(See Figs. 2 and 4; Router (i.e., a forwarding node) with forwarding tables 246; Col. 8 l 59-67).***

Regarding claim 10; **Vasseur** discloses the packet forwarding node wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link among the packet forwarding nodes ***(See Figs. 2 and 4; Router (i.e., a forwarding node) with forwarding tables 246; Col. 8 l 59-67).***

Regarding claim 11; **Vasseur** discloses a packet forwarding node, comprising:

a communication unit to communicate with a server for receiving a plurality of identifiers ***(See Fig. 2 and 7; Router 200...and... PCC/PCE 248 with Stored Requests Table 500 (i.e. storage unit) and PCE computes the metrics (i.e. identifiers). The requesting CE (i.e. forwarding node) modifies IP/Data Packet corresponding to the CE-CE path metrics; Col. 8 Lines 42-50 and Lines 50-55, and Col. 9 Lines 58-65)***; each

of which identifies a link between nodes on a packet forwarding path ***(See Figs. 2 and 4; Router (i.e., a forwarding node) with forwarding tables 246 and PCE 248 for path computation of the CE-CE paths and current metrics to the remote destination address; Col. 8 Lines 59-67 and Col. 11 Lines 54-60);*** and

a forwarding unit to forward an incoming packet based on the identifier corresponding to the packet forwarding node ***(See Fig. 2; Routing Service 247 forward the incoming data packet using the label found in the packet. PCE computes the metric to set up the routing/forwarding destination of the CE; Col. 9 Lines 55-65 and see also Fig. 7; for performing IP traffic routing and selecting the best path; Col. 14 Lines 7-15).***

Regarding claim 12; **Vasseur** discloses the packet forwarding node wherein the forwarding unit forwards the packet based on an identifier which uniquely identifies a link within a predetermined domain (See Fig. 2; Routing Service 247 forward the incoming data packet using the label found in the packet. PCE computes the metric to set up the routing/forwarding destination of the CE; Col. 9 Lines 55-65; and see also Figs. 4 and 5; CE-PE links (i.e. PE link for predetermined domain); Col. 10 Lines 51-60 and Col. 12 Lines 40-47).

Regarding claim 13; **Vasseur** discloses the packet forwarding node, wherein the forwarding unit forwards the packet based on an identifier which uniquely identifies a link within a predetermined domain (See Figs. 4 and 5; CE-CE links (i.e. predetermined local domain); Col. 9 Lines 54-60).

Regarding claim 14; **Vasseur** discloses the packet forwarding node wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely

identifies the link within the packet forwarding node (See Figs. 2 and 4; Router (i.e., a forwarding node) with forwarding tables 246; Col. 8 Lines 59-67); and

Regarding claim 15; **Vasseur** discloses the packet forwarding node wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link among the packet forwarding nodes (See Figs. 2 and 4; Router (i.e., a forwarding node) with forwarding tables 246; Col. 8 Lines 59-67).

Regarding claim 16; **Vasseur** discloses a packet forwarding node, comprising:

a communication unit to communicate with a server for receiving a plurality of identifiers ***(See Fig. 2 and 7; Router 200...and... PCC/PCE 248 with Stored Requests Table 500 (i.e. storage unit) and PCE computes the metrics (i.e. identifiers); Col. 8 Lines 42-50 and Lines 50-55, and Col. 9 Lines 58-65)***, each of which identifies an interface of a packet forwarding node ***(See Fig. 2; Each node includes one or more network interfaces that are coupled to a processor to execute memory that store routing forwarding tables and compute CE-CE or PE-CE path metrics to destination address to balance out the traffic load across the network links. See also Col. 8 Lines 21-32 and Col. 8 Lines 37-47...and see also Fig. 4: Router (i.e., a forwarding node) with forwarding tables 246; Col. 8 Lines 59-67);*** and

a forwarding unit to receive an incoming packet including a plurality of the identifiers ***(See Figs. 2 and 4; Router performs/receives routing information database RIB and forwarding information database FIB; Col. 8 Lines 59-67),*** and to forward the incoming packet based on an identifier corresponding to the packet forwarding node ***(See Figs. 2 and 4; a forwarding selection selects a label (i.e. identifier) to route of the destination; Col. 9 Lines 15-24...and see also Fig. 7; for performing IP traffic routing and selecting the best path; Col. 14 Lines 7-15).***

Regarding claim 17; **Vasseur** discloses the packet forwarding node wherein the forwarding unit forwards the packet based on the identifier which uniquely identifies a link within a predetermined domain ***(See Figs. 4 and 5; CE-PE links (i.e. PE link for predetermined domain); Col. 10 Lines 51-60 and Col. 12 Lines 40-47).***

Regarding claim 18; **Vasseur** discloses the packet forwarding node wherein the forwarding unit forwards the packet based on the identifier which uniquely identifies a link within a predetermined local domain ***(See Figs. 4 and 5; CE-CE links (i.e. predetermined local domain); Col. 9 Lines 54-60).***

Regarding claim 19; **Vasseur** discloses the packet forwarding node wherein the forwarding unit forwards the packet based on the identifier which uniquely identifies a link within the packet forwarding node ***(See Figs. 2 and 4; Router (i.e., a forwarding node) with forwarding tables 246; Col. 8 l 59-67).***

Regarding claim 20; **Vasseur** discloses the packet forwarding node wherein the forwarding unit forwards the packet based on the identifier which uniquely identifies the link among the packet forwarding nodes ***(See Figs. 2 and 4; Router (i.e., a forwarding node) with forwarding tables 246; Col. 8 l 59-67).***

Regarding claim 21; **Vasseur** discloses a server, comprising:

a first unit to determine a plurality of the identifiers each of which identifies a link between nodes on a packet forwarding path ***(See Fig. 2 and 7; PCC/PCE 248 with Stored Requests Table 500 (i.e. a first unit) and PCE computes the metrics (i.e. identifiers). The requesting CE (i.e. forwarding node) modifies IP/Data Packet corresponding to the CE-CE path metrics; Col. 8 Lines 42-50 and Lines 50-55, and Col. 9 Lines 58-65)***; and

a second unit to send the information elements to a packet forwarding node ***(See Fig. 2; Routing Services 247 with Routing Tables 246 (i.e. second unit)...a forwarding selection and new substitute label are determined by using the label found in the incoming packet of the forwarding table; Col. 9 Lines 17-22)*** which is capable of forwarding an incoming packet based on the identifier corresponding to the packet forwarding node ***(See Fig. 2; Routing Service 247 forward the incoming data packet using the label found in the packet. PCE computes the metric to set up the routing destination of the CE; Col. 9 Lines 55-65).***

Note: The term "capable of" is not a positively cited claim language, and the term may raise a question as to the limiting effect of the language in a claim. An alternative term is "configured to" or a positive action verb to perform the function without any unnecessary ambiguity. See MPEP 2111.04.

Claim Rejections - 35 USC § 103

18. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> *(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole*

would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

19. The factual inquiries set forth in Graham v. John Deere Co., 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows: (See MPEP Ch. 2141)

a) Determining the scope and contents of the prior art;

b) Ascertaining the differences between the prior art and the claims in issue;

c) Resolving the level of ordinary skill in the pertinent art; and

d) Evaluating evidence of secondary considerations for indicating obviousness or nonobviousness.

20. Claims 22-26 are rejected under 35 U.S.C. 103(a) as being unpatentable over **Vasseur-1 (US 7,522,603 B2)** in view of **Vasseur-2 (US 2007/0280102 A1)**.

Regarding claim 22; **Vasseur-1** discloses a packet forwarding node, comprising:

a storage unit to store a packet forwarding table used for forwarding a packet based on an identifier which identifies a link between nodes on a packet forwarding path ***(See Figs. 2 and 4; Router (i.e., a forwarding node) with forwarding tables 246 and PCE 248 for path computation of the CE-CE paths and current metrics to the remote destination address; Col. 8 Lines 59-67 and Col. 11 Lines 54-60);*** and

a forwarding unit to receive an incoming packet including a plurality of the identifiers ***(See Figs. 2 and 4; Router performs/receives routing information database RIB and forwarding information database FIB; Col. 8 Lines 59-67),*** and to forward the incoming packet based on an identifier corresponding to the

packet forwarding node ***(See Figs. 2 and 4; a forwarding selection selects a label (i.e. identifier) to route of the destination; Col. 9 Lines 15-24...and see also Fig. 7; for performing IP traffic routing and selecting the best path; Col. 14 Lines 7-15***

Vasseur-1 doesn't explicitly disclose identifying a link between adjacent nodes on a packet forwarding path.

However, **Vasseur**-2 discloses the method to identify a link between adjacent nodes on a packet forwarding path (***See Fig. 1 and 6; identifying routing information/link with neighboring node; Para. [0010] and [0072]***).

Therefore, it would have been obvious to one having ordinary skill in the art at the time of the invention was made to provide the method to identify a link between adjacent nodes on a packet forwarding path as taught by **Vasseur**-2 to have incorporated in the system of **Vasseur**-1, so that it would provide that For instance, the cost value may be measured in terms of the number of hops required to reach the neighboring node, the average time for a packet to reach the neighboring node, the amount of network traffic or available bandwidth over a communication link coupled to the neighboring node, etc. (**Vasseur**-1: Para. [0010]).

Regarding claim 23; **Vasseur-1** discloses a packet forwarding node, comprising:

a storage unit to store a packet forwarding table used for forwarding a packet based on an identifier which identifies a link between nodes on a packet forwarding path ***(See Figs. 2 and 4; Router (i.e., a forwarding node) with forwarding tables 246 and PCE 248 for path computation of the CE-CE paths and current metrics to the remote destination address; Col. 8 Lines 59-67 and Col. 11 Lines 54-60);*** and

a forwarding unit to receive an incoming packet including a plurality of the identifiers ***(See Figs. 2 and 4; Router performs/receives routing information database RIB and forwarding information database FIB; Col. 8 Lines 59-67),*** and to forward the incoming packet based on an identifier corresponding to the packet forwarding node ***(See Figs. 2 and 4; a forwarding selection selects a label (i.e. identifier) to route of the destination; Col. 9 Lines 15-24...and see also Fig. 7; for performing IP traffic routing and selecting the best path; Col. 14 Lines 7-15***

Vasseur-1 doesn't explicitly disclose identifying a link between adjacent nodes on a packet forwarding path.

However, **Vasseur**-2 discloses the method to identify a link between adjacent nodes on a packet forwarding path (***See Fig. 1 and 6; identifying routing information/link with neighboring node; Para. [0010] and [0072]***).

Therefore, it would have been obvious to one having ordinary skill in the art at the time of the invention was made to provide the method to identify a link between adjacent nodes on a packet forwarding path as taught by **Vasseur**-2 to have incorporated in the system of **Vasseur**-1, so that it would provide that For instance, the cost value may be measured in terms of the number of hops required to reach the neighboring node, the average time for a packet to reach the neighboring node, the amount of network traffic or available bandwidth over a communication link coupled to the neighboring node, etc. (**Vasseur**-1: Para. [0010]).

Regarding claim 24; **Vasseur-1** discloses a packet forwarding node, comprising:

a storage unit to store a packet forwarding table used for forwarding a packet based on an identifier which identifies a link between nodes on a packet forwarding path ***(See Figs. 2 and 4; Router (i.e., a forwarding node) with forwarding tables 246 and PCE 248 for path computation of the CE-CE***

paths and current metrics to the remote destination address; Col. 8 Lines 59-67 and Col. 11 Lines 54-60);

and

a forwarding unit to receive an incoming packet including a plurality of the identifiers ***(See Figs. 2 and 4; Router performs/receives routing information database RIB and forwarding information database FIB; Col. 8 Lines 59-67),*** and to forward the incoming packet based on an identifier corresponding to the packet forwarding node ***(See Figs. 2 and 4; a forwarding selection selects a label (i.e. identifier) to route of the destination; Col. 9 Lines 15-24...and see also Fig. 7; for performing IP traffic routing and selecting the best path; Col. 14 Lines 7-15***

Vasseur-1 doesn't explicitly disclose identifying a link between adjacent nodes on a packet forwarding path.However, **Vasseur**-2 discloses the method to identify a link between adjacent nodes on a packet forwarding path (***See Fig. 1 and 6; identifying routing information/link with neighboring node; Para. [0010] and [0072]***).

Therefore, it would have been obvious to one having ordinary skill in the art at the time of the invention was made to provide the method to identify a link between adjacent nodes on a packet forwarding path as taught by **Vasseur**-2 to have incorporated in the system of **Vasseur**-1, so that it would provide that For instance, the cost value may be measured in terms of the number of hops required to reach the neighboring node, the average time for a packet to reach the neighboring node, the amount of network traffic or available bandwidth over a communication link coupled to the neighboring node, etc. (**Vasseur**-1: Para. [0010]).

Regarding claim 25; **Vasseur-1** discloses a packet forwarding node, comprising:

a storage unit to store a packet forwarding table used for forwarding a packet based on an identifier which identifies a link between nodes on a packet forwarding path ***(See Figs. 2 and 4;***

Router (i.e., a forwarding node) with forwarding tables 246 and PCE 248 for path computation of the CE-CE paths and current metrics to the remote destination address; Col. 8 Lines 59-67 and Col. 11 Lines 54-60);

and

a forwarding unit to receive an incoming packet including a plurality of the identifiers ***(See Figs. 2 and 4; Router performs/receives routing information database RIB and forwarding information database FIB; Col. 8 Lines 59-67),*** and to forward the incoming packet based on an identifier corresponding to the packet forwarding node ***(See Figs. 2 and 4; a forwarding selection selects a label (i.e. identifier) to route of the destination; Col. 9 Lines 15-24...and see also Fig. 7; for performing IP traffic routing and selecting the best path; Col. 14 Lines 7-15***

Vasseur-1 doesn't explicitly disclose identifying a link between adjacent nodes on a packet forwarding path.However, **Vasseur**-2 discloses the method to identify a link between adjacent nodes on a packet forwarding path (***See Fig. 1 and 6; identifying routing information/link with neighboring node; Para. [0010] and [0072]***).

Therefore, it would have been obvious to one having ordinary skill in the art at the time of the invention was made to provide the method to identify a link between adjacent nodes on a packet forwarding path as taught by **Vasseur**-2 to have incorporated in the system of **Vasseur**-1, so that it would provide that For instance, the cost value may be measured in terms of the number of hops required to reach the neighboring node, the average time for a packet to reach the neighboring node, the amount of network traffic or available bandwidth over a communication link coupled to the neighboring node, etc. (**Vasseur**-1: Para. [0010]).

Regarding claim 26; **Vasseur-1** discloses a server, comprising:

a first unit to determine a plurality of the identifiers each of which identifies a link between nodes on a packet forwarding path ***(See Fig. 2 and 7; PCC/PCE 248 with Stored Requests Table 500 (i.e. a first unit) and PCE computes the metrics (i.e. identifiers). The requesting CE (i.e. forwarding node) modifies IP/Data Packet corresponding to the CE-CE path metrics; Col. 8 Lines 42-50 and Lines 50-55, and Col. 9 Lines 58-65)***; and

a second unit to send the information elements to a packet forwarding node ***(See Fig. 2; Routing Services 247 with Routing Tables 246 (i.e. second unit)...a forwarding selection and new substitute label are determined by using the label found in the incoming packet of the forwarding table; Col. 9 Lines 17-22)***, and to forward the incoming packet based on the identifier corresponding to the packet forwarding node ***(See Fig. 2; Routing Service 247 forward the incoming data packet using the label found in the packet. PCE computes the metric to set up the routing destination of the CE; Col. 9 Lines 55-65).***

Vasseur-1 further discloses a storage unit to store a packet forwarding table used for forwarding a packet based on an identifier which identifies a link between nodes on a packet forwarding path ***(See Figs. 2 and 4; Router (i.e., a forwarding node) with forwarding tables 246 and PCE 248 for path computation of the CE-CE paths and current metrics to the remote destination address; Col. 8 Lines 59-67 and Col. 11 Lines 54-60).***

Vasseur-1 doesn't explicitly disclose the method to identify a link between adjacent nodes on a packet forwarding path.

However, **Vasseur**-2 discloses the method to identify a link between adjacent nodes on a packet forwarding path (***See Fig. 1 and 6; identifying routing information/link with neighboring node; Para. [0010] and [0072]***).

Therefore, it would have been obvious to one having ordinary skill in the art at the time of the invention was made to provide the method to identify a link between adjacent nodes on a

packet forwarding path as taught by **Vasseur**-2 to have incorporated in the system of **Vasseur**-1, so that it would provide that For instance, the cost value may be measured in terms of the number of hops required to reach the neighboring node, the average time for a packet to reach the neighboring node, the amount of network traffic or available bandwidth over a communication link coupled to the neighboring node, etc. (**Vasseur**-1: Para. [0010]).

Note: The term "capable of" is not a positively cited claim language, and the term may raise a question as to the limiting effect of the language in a claim. An alternative term is "configured to" or a positive action verb to perform the function without any unnecessary ambiguity. See MPEP 2111.04.

Conclusion

21. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

a. Friskney et al. (US 2008/0279196 A1)

b. **Vasseur** et al. (US 2007/0280102 A1)

c. **Vasseur** et al. (US 2008/0123651 A1)

d. McDysan et al. (US 7447 151 B2).

Contact Information

22. Any inquiry concerning this communication or earlier communications from the examiner should be directed to SAI AUNG whose telephone number is (571)272-3507. The examiner can normally be reached on Monday-Friday, Alt Fridays, 7:30 AM- 5:00 PM (EST).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Dang Ton can be reached on 571-272-3171. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300. Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/S. A./

Examiner, Art Unit 2475

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Supervisory Patent Examiner, Art Unit 2475/D. T./

Supervisory Patent Examiner, Art Unit 2475

Applicant-Initiated Interview Summary	Application No.	Applicant(s)	
	14/244,701	AWANO, JUN	
	Examiner	Art Unit	
	SAI AUNG	2475	

All participants (applicant, applicant's representative, PTO personnel):

(1) *SAI AUNG*. (3)_____.

(2) *S. Sahota (Reg., 47,051)*. (4)_____.

Date of Interview: *20 October 2015*.

Type: ☒ Telephonic ☐ Video Conference
☐ Personal [copy given to: ☐ applicant ☐ applicant's representative]

Exhibit shown or demonstration conducted: ☐ Yes ☐ No.
If Yes, brief description: _____.

Issues Discussed ☐101 ☐112 ☐102 ☐103 ☐Others
(For each of the checked box(es) above, please describe below the issue and detailed description of the discussion)

Claim(s) discussed: *7-10*.

Identification of prior art discussed: _____.

Substance of Interview
(For each issue discussed, provide a detailed description and indicate if agreement was reached. Some topics may include: identification or clarification of a reference or a portion thereof, claim interpretation, proposed amendments, arguments of any applied references etc...)

The applicant initiated the interview and indicated that the office action doesn't have any reasoning for claims 7-10. The examiner agreed to send out the corrected version of office Acton to correctly address claims 7-10..

Applicant recordation instructions: The formal written reply to the last Office action must include the substance of the interview. (See MPEP section 713.04). If a reply to the last Office action has already been filed, applicant is given a non-extendable period of the longer of one month or thirty days from this interview date, or the mailing date of this interview summary form, whichever is later, to file a statement of the substance of the interview

Examiner recordation instructions: Examiners must summarize the substance of any interview of record. A complete and proper recordation of the substance of an interview should include the items listed in MPEP 713.04 for complete and proper recordation including the identification of the general thrust of each argument or issue discussed, a general indication of any other pertinent matters discussed regarding patentability and the general results or outcome of the interview, to include an indication as to whether or not agreement was reached on the issues raised.

☐ Attachment

/S. A./ Examiner, Art Unit 2475	

Summary of Record of Interview Requirements

Manual of Patent Examining Procedure (MPEP), Section 713.04, Substance of Interview Must be Made of Record
A complete written statement as to the substance of any face-to-face, video conference, or telephone interview with regard to an application must be made of record in the application whether or not an agreement with the examiner was reached at the interview.

Title 37 Code of Federal Regulations (CFR) § 1.133 Interviews
Paragraph (b)

In every instance where reconsideration is requested in view of an interview with an examiner, a complete written statement of the reasons presented at the interview as warranting favorable action must be filed by the applicant. An interview does not remove the necessity for reply to Office action as specified in §§ 1.111, 1.135. (35 U.S.C. 132)

37 CFR §1.2 Business to be transacted in writing.
All business with the Patent or Trademark Office should be transacted in writing. The personal attendance of applicants or their attorneys or agents at the Patent and Trademark Office is unnecessary. The action of the Patent and Trademark Office will be based exclusively on the written record in the Office. No attention will be paid to any alleged oral promise, stipulation, or understanding in relation to which there is disagreement or doubt.

The action of the Patent and Trademark Office cannot be based exclusively on the written record in the Office if that record is itself incomplete through the failure to record the substance of interviews.

It is the responsibility of the applicant or the attorney or agent to make the substance of an interview of record in the application file, unless the examiner indicates he or she will do so. It is the examiner's responsibility to see that such a record is made and to correct material inaccuracies which bear directly on the question of patentability.

Examiners must complete an Interview Summary Form for each interview held where a matter of substance has been discussed during the interview by checking the appropriate boxes and filling in the blanks. Discussions regarding only procedural matters, directed solely to restriction requirements for which interview recordation is otherwise provided for in Section 812.01 of the Manual of Patent Examining Procedure, or pointing out typographical errors or unreadable script in Office actions or the like, are excluded from the interview recordation procedures below. Where the substance of an interview is completely recorded in an Examiners Amendment, no separate Interview Summary Record is required.

The Interview Summary Form shall be given an appropriate Paper No., placed in the right hand portion of the file, and listed on the "Contents" section of the file wrapper. In a personal interview, a duplicate of the Form is given to the applicant (or attorney or agent) at the conclusion of the interview. In the case of a telephone or video-conference interview, the copy is mailed to the applicant's correspondence address either with or prior to the next official communication. If additional correspondence from the examiner is not likely before an allowance or if other circumstances dictate, the Form should be mailed promptly after the interview rather than with the next official communication.

The Form provides for recordation of the following information:
- Application Number (Series Code and Serial Number)
- Name of applicant
- Name of examiner
- Date of interview
- Type of interview (telephonic, video-conference, or personal)
- Name of participant(s) (applicant, attorney or agent, examiner, other PTO personnel, etc.)
- An indication whether or not an exhibit was shown or a demonstration conducted
- An identification of the specific prior art discussed
- An indication whether an agreement was reached and if so, a description of the general nature of the agreement (may be by attachment of a copy of amendments or claims agreed as being allowable). Note: Agreement as to allowability is tentative and does not restrict further action by the examiner to the contrary.
- The signature of the examiner who conducted the interview (if Form is not an attachment to a signed Office action)

It is desirable that the examiner orally remind the applicant of his or her obligation to record the substance of the interview of each case. It should be noted, however, that the Interview Summary Form will not normally be considered a complete and proper recordation of the interview unless it includes, or is supplemented by the applicant or the examiner to include, all of the applicable items required below concerning the substance of the interview.

A complete and proper recordation of the substance of any interview should include at least the following applicable items:
1) A brief description of the nature of any exhibit shown or any demonstration conducted,
2) an identification of the claims discussed,
3) an identification of the specific prior art discussed,
4) an identification of the principal proposed amendments of a substantive nature discussed, unless these are already described on the Interview Summary Form completed by the Examiner,
5) a brief identification of the general thrust of the principal arguments presented to the examiner,
   (The identification of arguments need not be lengthy or elaborate. A verbatim or highly detailed description of the arguments is not required. The identification of the arguments is sufficient if the general nature or thrust of the principal arguments made to the examiner can be understood in the context of the application file. Of course, the applicant may desire to emphasize and fully describe those arguments which he or she feels were or might be persuasive to the examiner.)
6) a general indication of any other pertinent matters discussed, and
7) if appropriate, the general results or outcome of the interview unless already described in the Interview Summary Form completed by the examiner.

Examiners are expected to carefully review the applicant's record of the substance of an interview. If the record is not complete and accurate, the examiner will give the applicant an extendable one month time period to correct the record.

Examiner to Check for Accuracy

If the claims are allowable for other reasons of record, the examiner should send a letter setting forth the examiner's version of the statement attributed to him or her. If the record is complete and accurate, the examiner should place the indication, "Interview Record OK" on the paper recording the substance of the interview along with the date and the examiner's initials.

Notice of References Cited	Application/Control No. 14/244,701	Applicant(s)/Patent Under Reexamination AWANO, JUN	
	Examiner SAI AUNG	Art Unit 2475	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-2003/0053427 A1	03-2003	Kanda, Mitsuru	H04W8/14	370/328
*	B	US-2007/0280102 A1	12-2007	Vasseur; Jean-Philippe	H04J3/14	370/225
*	C	US-2008/0123651 A1	05-2008	Vasseur; Jean-Philippe	H04L12/4633	370/392
*	D	US-2008/0137615 A1	06-2008	PARK; Chang Min	H04L45/302	370/332
*	E	US-2008/0279196 A1	11-2008	Friskney; Robert	H04L12/4645	370/395.53
*	F	US-7,447,151 B2	11-2008	McDysan; David E.	H04L12/24	370/231
*	G	US-7,522,603 B2	04-2009	Vasseur; Jean-Philippe	H04L12/66	370/238.1
*	H	US-2010/0165995 A1	07-2010	Mehta; Apurva	H04L12/462	370/400
*	I	US-8,125,928 B2	02-2012	Mehta; Apurva	H04L12/4625	370/254
	J	US-				
	K	US-				
	L	US-				
	M	US-				

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14244701	AWANO, JUN
	Examiner	Art Unit
	SAI AUNG	2475

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	12/12/2014	04/13/2015	10/28/2015						
	1	✓	✓	✓						
	2	✓	✓	✓						
	3	✓	✓	✓						
	4	✓	✓	✓						
	5	✓	✓	✓						
	6	✓	✓	✓						
	7	✓	✓	✓						
	8	✓	✓	✓						
	9	✓	✓	✓						
	10	✓	✓	✓						
	11	✓	✓	✓						
	12	✓	✓	✓						
	13	✓	✓	✓						
	14	✓	✓	✓						
	15	✓	✓	✓						
	16	✓	✓	✓						
	17	✓	✓	✓						
	18	✓	✓	✓						
	19	✓	✓	✓						
	20	✓	✓	✓						
	21	✓	✓	✓						
	22			✓						
	23			✓						
	24			✓						
	25			✓						
	26			✓						

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14244701	AWANO, JUN
	Examiner	Art Unit
	SAI AUNG	2475

CPC- SEARCHED		
Symbol	Date	Examiner
H04L45/04; H04L45/24; H04L45/66; H04L45/00;	9/29/2015	SA

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
370	370/401; 370/392; 370/231; 370/252; 370/352; 370/395.53	9/29/2015	SA

SEARCH NOTES		
Search Notes	Date	Examiner
EAST SEARCH (INCLUDING INVENTORS AND ASSIGNEE SEARCH)	12/14/2014	SA
GOOGLE PATENTS SEARCH	4/13/2015	SA
OTHER RELATED CPC SEARCH: H04L45/302; H04L45/50; H04L49/351	4/13/2015	SA

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner

14/244,701
NEG-1440PCT-US2CT
KATO.327CONT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of Jun Awano

Serial No.: 14/244,701 Group Art Unit: 2475

Filed: April 3, 2014 Examiner: AUNG, SAI

For: COMMUNICATION SYSTEM, FORWARDING NODE, PATH MANAGEMENT SERVER, COMMUNICATION METHOD, AND PROGRAM

Honorable Commissioner of Patents
Alexandria, VA 22313-1450

AMENDMENT UNDER 37 C.F.R. §1.111

Sir:

In response to Office Action dated **October 30, 2015**, please amend the above identified application as follows:

INTRODUCTORY COMMENTS

Amendments to the Claims begin on page 2 of this paper. The amendments to the claims do not add new matter.

Remarks begin on page 8 of this paper.

AMENDMENTS TO THE CLAIMS

Please add new claims 27-28, and amend the claims as follows:

1. (Currently Amended) A packet forwarding node, comprising:

a storage unit including a non-transitory computer readable medium configured to store a packet forwarding table used for forwarding a packet based on an identifier which identifies a link between nodes on a packet forwarding path; and

a forwarding unit configured to receive an incoming packet including a plurality of the identifiers, and to forward the incoming packet based on the identifier corresponding to the packet forwarding node.

2. (Original) The packet forwarding node according to claim 1, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link within a predetermined domain.

3. (Original) The packet forwarding node according to claim 1, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link within a predetermined local domain.

4. (Original) The packet forwarding node according to claim 1, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link within the packet forwarding node.

5. (Original) The packet forwarding node according to claim 1, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link among the packet forwarding nodes.

6. (Currently Amended) A packet forwarding node, comprising:

a storage unit including a non-transitory computer readable medium configured to store a packet forwarding table used for forwarding a packet based on an identifier which identifies an interface of a packet forwarding node; and

a forwarding unit configured to receive an incoming packet including a plurality of identifiers, and to forward the incoming packet based on the identifier corresponding to the packet forwarding node.

7. (Original) The packet forwarding node according to claim 6, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies a link within a predetermined domain.

8. (Previously Presented) The packet forwarding node according to claim 6, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies a link within a predetermined local domain.

9. (Previously Presented) The packet forwarding node according to claim 6, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies a link within the packet forwarding node.

10. (Previously Presented) The packet forwarding node according to claim 6, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies a link among the packet forwarding nodes.

11. (Currently Amended) A packet forwarding node, comprising:

a communication unit configured to communicate with a server for receiving a plurality of identifiers, each of which identifies a link between nodes on a packet forwarding path; and

a forwarding unit configured to forward an incoming packet based on an identifier corresponding to a packet forwarding node.

12. (Previously Presented) The packet forwarding node according to claim 11, wherein the forwarding unit forwards the packet based on the identifier which uniquely identifies a link within a predetermined domain.

13. (Previously Presented) The packet forwarding node according to claim 11, wherein the forwarding unit forwards the packet based on the identifier which uniquely identifies the link within a predetermined local domain.

14. (Previously Presented) The packet forwarding node according to claim 11, wherein the forwarding unit forwards the packet based on the identifier which uniquely identifies the link within the packet forwarding node.

15. (Previously Presented) The packet forwarding node according to claim 11, wherein the forwarding unit forwards the packet based on the identifier which uniquely identifies the link among the packet forwarding nodes.

16. (Currently Amended) A packet forwarding node, comprising:

a communication unit configured to communicate with a server for receiving a plurality of identifiers, each of which identifies an interface of [[a]] the packet forwarding

node; and

a forwarding unit configured to forward an incoming packet based on an identifier corresponding to the packet forwarding node.

17. (Previously Presented) The packet forwarding node according to claim 16, wherein the forwarding unit forwards the packet based on the identifier which uniquely identifies a link within a predetermined domain.

18. (Previously Presented) The packet forwarding node according to claim 16, wherein the forwarding unit forwards the packet based on the identifier which uniquely identifies a link within a predetermined local domain.

19. (Previously Presented) The packet forwarding node according to claim 16, wherein the forwarding unit forwards the packet based on the identifier which uniquely identifies a link within the packet forwarding node.

20. (Previously Presented) The packet forwarding node according to claim 16, wherein the forwarding unit forwards the packet based on the identifier which uniquely identifies a link among the packet forwarding nodes.

21. (Currently Amended) A server, comprising:

a first unit configured to determine a plurality of identifiers, each of which identifies a link between nodes on a packet forwarding path; and

a second unit configured to send information elements to a packet forwarding node which is capable of forwarding an incoming packet based on an identifier corresponding to

the packet forwarding node.

22. (Currently Amended) The packet forwarding node according to claim 1, wherein the storage unit stores the table used for forwarding the packet based on the identifier which ~~indentifies~~ identifies a link between adjacent nodes on a packet forwarding path.

23. (Currently Amended) The packet forwarding node according to claim 6, wherein the storage unit stores the packet forwarding table used for forwarding the packet based on the identifier which ~~indentifies~~ identifies a link between adjacent nodes on a packet forwarding path.

24. (Currently Amended) The packet forwarding node according to claim 11, further comprising a storage unit that stores a table used for forwarding the packet based on an identifier which ~~indentifies~~ identifies a link between adjacent nodes on a packet forwarding path.

25. (Currently Amended) The packet forwarding node according to claim 16, further comprising a storage unit that stores a table used for forwarding the packet based on an identifier which ~~indentifies~~ identifies a link between adjacent nodes on a packet forwarding path.

26. (Currently Amended) The server according to claim 21, further comprising a storage unit to store a packet forwarding table used for forwarding the incoming packet based on the identifier which identifies the link between nodes on the packet forwarding path,

wherein the storage unit stores the table used for forwarding the packet based on the identifier which ~~indentifies~~ identifies a link between adjacent nodes on a packet forwarding

path.

27. (New) The packet forwarding node according to claim 1, wherein the forwarding unit comprises a forwarding device.

28. (New) The packet forwarding node according to claim 11, wherein:

the communication unit comprises a communication device, and

the forwarding unit comprises a forwarding device.

REMARKS

Claims 1-28 are all of the claims presently pending in the application. Applicant has amended various claims to more particularly define the claimed invention and/or for editorial purposes. Claims 27-28 are added to provide further clarification.

Further, Applicant specifically states that no amendment to any claim herein should be construed as a disclaimer of any interest in or right to an equivalent of any element or feature of the amended claim.

Claims 1-5 are rejected under 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the inventor or a joint inventor, or for pre-AlA the applicant regards as the invention. Claims 1-26 are rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claims 1 and 8 of the U.S. application number 131137,237. Claims 1-21 stand rejected under 35 U.S.C. 102 (b) as being anticipated by Vasseur (U.S. Patent No. 7,522,603 B2). Claims 22-26 are rejected under 35 U.S.C. 103(a) as being unpatentable over Vasseur-l (US 7,522,603 B2) in view of Vasseur-2 (US 2007/0280102 AI).

These rejections are respectfully traversed in the following discussion.

I. INTERVIEW SUMMARY

Applicant greatly appreciates the Examiner sending out a new non-final office action addressing claims 7-10 as indicated in the Examiner's interview summary of October 30, 2016 (attached to Office Action) for the interview of October 20, 2016.

II. THE CLAIMED INVENTION

The claimed invention (e.g., as defined by exemplary claim 1) is directed to a packet

forwarding node, including a storage unit to store a packet forwarding table used for forwarding a packet based on an identifier which identifies a link between nodes on a packet forwarding path, and a forwarding unit to receive an incoming packet including a plurality of the identifiers, and to forward the incoming packet based on the identifier corresponding to the packet forwarding node.

III. THE 35 USC 112 (f) CLAIM INTERPRETATION

MPEP § 2181(I) states that a claim feature will be presumed to invoke the sixth paragraph of 35 U.S.C. § 112 if the feature meets the following 3-prong analysis:

(A) the claim limitations must use the phrase "means for" or "step for";

(B) the "means for" or "step for" must be modified by functional language; and

(C) the phrase "means for" or "step for" must not be modified by sufficient structure, material, or acts for achieving the specified function.

In this case, none of the above mentioned language is mentioned in the claims and so the claims do not invoke the sixth or "f' paragraph 35 USC 112.

MPEP § 2181(I) also recites that "By contrast, a claim limitation that does not use the term “means” or “step” will trigger the rebuttable presumption that 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph does not apply. See, e.g., Phillips v. AWH Corp., 415 F.3d 1303, 1310, 75 USPQ2d 1321, 1324 (Fed. Cir. 2005) (en banc); CCS Fitness, Inc. v. Brunswick Corp., 288 F.3d 1359, 1369, 62 USPQ2d 1658, 1664 (Fed. Cir. 2002); Personalized Media Commc’ns, LLC v. ITC, 161 F.3d 696, 703-04, 48 USPQ2d 1880, 1886–87 (Fed. Cir. 1998). This presumption is a strong one that is not readily overcome". (emphasis added). No rebuttal has been provided by the Examiner.

Moreover, concerning claims 1 and 6, while Applicant does not agree with the Examiner, the storage unit was further clarified to include "a non-transitory computer readable medium".

Concerning the "forwarding unit", the term was further clarified as a "forwarding device" in new dependent claims 27 and 28. Additionally, the "communication unit" was further clarified as a "communication device" in dependent claim 28. Additionally, to expedite prosecution, the claims were further amended as the units being "configured to".

Therefore, the 35 USC 112(f) invocation should be removed.

IV. THE 35 USC 112 (b) INDEFINITESS REJECTION

Claims 1-5 are rejected under 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the inventor or a joint inventor, or for pre-AIA the applicant regards as the invention.

The Examiner rejected claims 1-5 as indefinite based on the 35 USC 112(f) interpretation. Claims 1-5 claim interpretation was traversed above under section I, and amended as noted above. Therefore, as indicated above in section I, since the 35 USC 112(f) interpretation is no longer valid, the rejection should be removed.

V. DOUBLE PATENTING

Claims 1-26 are rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claims 1 and 8 of the U.S. application number 13/137,237.

The Applicant respectfully requests that the Examiner hold the obviousness double patenting rejection in view of U.S. application number 13/137,237 in abeyance until a time when the claims are indicated as allowable.

VI. THE ALLEGED PRIOR ART REFERENCE

1. The Vasseur Reference

Claims 1-21 stand rejected under 35 U.S.C. 102 (b) as being anticipated by Vasseur (U.S. Patent No. 7,522,603 B2).

Vasseur fails to teach or suggest (e.g., claim 1), "*storage unit to store a packet forwarding table used for forwarding a packet based on an identifier which identifies a link between nodes on a packet forwarding path; and a forwarding unit to receive an incoming packet including a plurality of the identifiers, and to forward the incoming packet based on the identifier corresponding to the packet forwarding node*".

Referring to Figs. 2 and 4, the Examiner alleges that the Router performs/receives routing information database RIB and forwarding information database FIB. However, as seen in Col. 8 Lines 59-67 and col. 9, lines 1-2, Vasseur recites that (emphasis added):

> Routing services 247 contain computer executable instruc tions executed by processor 220 to perform functions pro vided by one or more routing protocols, such as OSPF, IS-IS, IP, BGP, etc. These functions may be configured to manage a routing information database (RIB) and/or a forwarding information database (FIB) containing, e.g., data used to make routing and forwarding decisions, such as in routing/ forwarding tables 246. Routing services 247 may also per form functions related to virtual routing protocols, such as maintaining VRF instances (not shown), as will be under stood by those skilled in the art.

However, this is merely reciting that the functions maybe configured to manage a database. There is not teaching or suggestion that the incoming packet actually includes a plurality of the identifiers.

Moreover, the Examiner asserts that the identifier of the present application which identifies the "link" of the claimed invention and "label" disclosed in Vasseur are the same. Applicant respectfully does not agree.

In Vasseur, a packet, being used in MPLS (Multi-Protocol Label Switching), includes **a single label**. On the other hand, in the present application, a packet includes **a plurality of identifiers**. Thus, there is a difference between Vassuer and the claimed invention as the identifier of the claimed invention and label of Vasseur are not the same.

Therefore, in MPLS of Vasseur, merely one identifier (label of MPLS) is included in one packet and so a plurality of identifiers are not included in one packet as in the claimed invention showing also that the forwarding table in Vasseur and the forwarding table in the claimed invention are not the same.

For example, Vasseur recites that "[i]n one simple MPLS scenario, at an ingress to a network, a label is assigned to each incoming packet based on its forwarding equivalence class before forwarding the packet to a next-hop router. At each router, a forwarding selection and a new substitute label are determined by using the label found in the incoming packet as a reference to a label forwarding table that includes this information." See col. 9, lines 15-21, emphasis added. Therefore, the "label" is assigned to each packet based on its class, but is not a link per se. Moreover, the packet has a single label.

Additionally, The Examiner's rejection of anticipation is also improper because the identical invention is not provided in the following. Please note that according to MPEP §2131, the following applies in a 35 U.S.C. §102 rejection:

> "A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." Verdegaal Bros. v. Union Oil Co. of California, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987).."The identical invention must be shown in as complete detail as is contained in the ... claim." Richardson v. Suzuki Motor Co., 868 F.2d 1226, 1236, 9 USPQ2d 1913, 1920 (Fed. Cir. 1989). The elements must be arranged as required by the claim, but this is not an ipsissimis verbis test, i.e., identity of terminology is not required. In re Bond, 910 F.2d 831, 15 USPQ2d 1566

(Fed. Cir. 1990).

Therefore, as shown above, that since the identical invention is not provided in as complete details as the arranged in the claims from Vasseur, the claims are clearly not anticipated.

Therefore, Applicant submits that, even if combined, the alleged combination of references would not teach or suggest each and every feature of the claimed invention. Therefore, Applicant respectfully requests the Examiner to withdraw this rejection.

B. The Vasseur-1 and Vasseur-2 References

Claims 22-26 are rejected under 35 U.S.C. 103(a) as being unpatentable over Vasseur-l (US 7,522,603 B2) in view of Vasseur-2 (US 2007/0280102 A). Applicant respectfully traverses because of the above. Therefore, Applicant respectfully requests the Examiner to withdraw this rejection.

VII. NEW CLAIMS

Applicant has added new claims 27-28 to claim additional features of the invention and to provide more varied protection for the claimed invention. These claims are independently patentable because of the novel and nonobvious features recited therein.

Applicant submits that new claims are patentable over the cited prior art references at least for analogous reasons to those set forth above with respect to the above mentioned claims.

VIII. FORMAL MATTERS AND CONCLUSION

Concerning the claim objections, the claims were amended as suggested by the Examiner. Therefore, the claim objections should now be removed.

In view of the foregoing, Applicant submits that claims 1-28, all of the claims presently pending in the application, are patentably distinct over the prior art of record and are in condition for allowance. Applicant respectfully requests the Examiner to pass the above application to issue at the earliest possible time.

Should the Examiner find the application to be other than in condition for allowance, Applicant requests the Examiner to contact the undersigned at the local telephone number listed below to discuss any other changes deemed necessary in a telephonic or personal interview.

The undersigned authorizes the Commissioner to charge any deficiency in fees or to credit any overpayment in fees to Attorney's Deposit Account No. 50-0481.

Respectfully Submitted,

Date: February 1, 2016

S. S. Sahota, Esq.
Registration No. 47,051
Sean M. McGinn, Esq.
Registration No. 34,386

MCGINN INTELLECTUAL PROPERTY LAW GROUP, PLLC
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Vienna, VA 22182-3817
(703) 761-4100
Customer No. 21254

Electronic Patent Application Fee Transmittal

Application Number:	14244701
Filing Date:	03-Apr-2014
Title of Invention:	Communication system, forwarding node, path management server, communication method, and program
First Named Inventor/Applicant Name:	JUN AWANO
Filer:	Saryadvinder S. Sahota/Amber Carroll
Attorney Docket Number:	NEG-1440PCT-US2CT

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Claims in Excess of 20	1202	2	80	160
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**160**

Electronic Acknowledgement Receipt

EFS ID:	24786178
Application Number:	14244701
International Application Number:	
Confirmation Number:	2010
Title of Invention:	Communication system, forwarding node, path management server, communication method, and program
First Named Inventor/Applicant Name:	JUN AWANO
Customer Number:	21254
Filer:	Saryadvinder S. Sahota/Amber Carroll
Filer Authorized By:	Saryadvinder S. Sahota
Attorney Docket Number:	NEG-1440PCT-US2CT
Receipt Date:	01-FEB-2016
Filing Date:	03-APR-2014
Time Stamp:	17:50:19
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$160
RAM confirmation Number	4962
Deposit Account	500481
Authorized User	SAHOTA, SARVADVINDER SAM

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

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Charge any Additional Fees required under 37 CFR 1.17 (Patent application and reexamination processing fees)

Charge any Additional Fees required under 37 CFR 1.19 (Document supply fees)

Charge any Additional Fees required under 37 CFR 1.20 (Post Issuance fees)

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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Amendment/Req. Reconsideration-After Non-Final Reject	Amendment.pdf	1138230 735bd8a195b4a1c9b36ea8da1b48fb5332539ca5	no	14
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30509 6b33ca7f9e28296d2bcf3adaf87e7bda045dbe2e	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	1168739		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

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If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

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New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/SB/06 (09-11)
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 14/244,701	Filing Date 04/03/2014	☐ To be Mailed

ENTITY: ☒ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED – PART I

	(Column 1)	(Column 2)		
FOR	NUMBER FILED	NUMBER EXTRA	RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	

APPLICATION AS AMENDED – PART II

		(Column 1)		(Column 2)	(Column 3)		
	02/01/2016	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
AMENDMENT	Total (37 CFR 1.16(i))	* 28	Minus	** 26	= 2	X $80 =	160
	Independent (37 CFR 1.16(h))	* 4	Minus	***5	= 0	X $420 =	0
	☐ Application Size Fee (37 CFR 1.16(s))						
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
						TOTAL ADD'L FEE	**160**

		(Column 1)		(Column 2)	(Column 3)		
		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
AMENDMENT	Total (37 CFR 1.16(i))	*	Minus	**	=	X $ =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	X $ =	
	☐ Application Size Fee (37 CFR 1.16(s))						
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
						TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".

The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

LIE
/PAUL STANBACK/

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/244,701	04/03/2014	JUN AWANO	NEG-1440PCT-US2CT	2010

21254 7590 03/03/2016

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VIENNA, VA 22182-3817

EXAMINER	
AUNG, SAI	

ART UNIT	PAPER NUMBER
2475	

MAIL DATE	DELIVERY MODE
03/03/2016	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No. 14/244,701	Applicant(s) AWANO, JUN	
	Examiner SAI AUNG	Art Unit 2475	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *02/01/2016*.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5)☒ Claim(s) *1-28* is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6)☐ Claim(s) _____ is/are allowed.

7)☒ Claim(s) *1-28* is/are rejected.

8)☐ Claim(s) _____ is/are objected to.

9)☐ Claim(s) _____ are subject to restriction and/or election requirement.

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)

2) ☐ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date _____.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

4) ☐ Other: _____.

DETAILED ACTION

Claims status

1. In the amended application filed on 02/01/2016, claims 27-28 have been added. Claims 1-28 are currently pending for the examination. The present application is being examined under the pre-AIA first to invent provisions.

Examiner Notes

2. The Examiner has pointed out particular references contained in the prior art of record within the body of this action for the convenience of the Applicant. Although the specified citations are representative of the teachings in the art and are applied to the specific limitations within the individual claim, other passages and figures may apply. "The use of patents as references is not limited to what the patentees describe as their own inventions or to the problems with which they are concerned. They are part of the literature of the art, relevant for all they contain." In re Heck, 699 F.2d 1331, 1332-33,216 USPQ 1038, 1039 (Fed. Cir. 1983) (quoting In re Lemelson, 397 F.2d 1006, 1009, 158 USPQ 275,277 (CCPA 1968)). A reference may be relied upon for all that it would have reasonably suggested to one having ordinary skill the art, including non-preferred embodiments (see MPEP 2123). Therefore, Applicant, in preparing the response, must fully consider the entire disclosure of the cited references as potentially teaching all or part of the claimed invention, including the context of the cited passages as taught by the prior art disclosed by the Examiner. The Examiner has noted several intended use recitations in the claims (i.e. configured to). Language that suggests or makes optional but does not require steps to be performed or does not limit a claim to a particular structure does not limit the scope

of a claim or claim limitation. Such clauses may render parts of the claims optional (see MPEP 2106 and 2111.04).

35 U.S.C. 112(f): Claim Interpretations

3. The following is a quotation of 35 U.S.C. 112(f):

> *(f) Element in Claim for a Combination. – An element in a claim for a combination may be expressed as a means or step for performing a specified function without the recital of structure, material, or acts in support thereof, and such claim shall be construed to cover the corresponding structure, material, or acts described in the specification and equivalents thereof.*

4. The following is a quotation of pre-AIA 35 U.S.C. 112, sixth paragraph:

> *An element in a claim for a combination may be expressed as a means or step for performing a specified function without the recital of structure, material, or acts in support thereof, and such claim shall be construed to cover the corresponding structure, material, or acts described in the specification and equivalents thereof.*

5. Claim 6 recites "*A packet forwarding node, comprising: a storage unit to store a packet forwarding table..., and a forwarding unit to receive in incoming packet...*", and thus **the claim hasn't been interpreted** under 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph, because it uses a structural specific term "a storage unit" coupled with functional language "to store" with reciting sufficient structure to achieve the function. Therefore, **112(f) is not invoked** because it includes a sufficient structure term called "storage" or "forwarding".

If applicant wishes to provide further explanation or dispute the examiner's interpretation of the corresponding structure, applicant must identify the corresponding structure with reference to the specification by page and line number, and to the drawing, if any, by reference characters in response to this Office action.

If applicant does not intend to have the claim limitation(s) treated under 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112 , sixth paragraph, applicant may amend the claim(s) so that it/they will clearly not invoke 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph, or present a sufficient showing that the claim recites/recite sufficient structure, material, or acts for performing the claimed function to preclude application of 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph.

For more information, see MPEP § 2173 et seq. and Supplementary Examination Guidelines for Determining Compliance With 35 U.S.C. 112 and for Treatment of Related Issues in Patent Applications, 76 FR 7162, 7167 (Feb. 9, 2011).

6. Claim 11 recites "*A packet forwarding node, comprising: a communication unit to communicate with a server for receiving..., and a forwarding unit to forward in incoming packet...*", and thus **the claim hasn't been interpreted** under 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph, because it uses a structural specific term "a communication unit" coupled with functional language "to communicate" with reciting sufficient structure to achieve the function. Therefore, **112(f) is not invoked** because it includes a sufficient structural term called "communication" or "forwarding".

If applicant wishes to provide further explanation or dispute the examiner's interpretation of the corresponding structure, applicant must identify the corresponding structure with reference to the specification by page and line number, and to the drawing, if any, by reference characters in response to this Office action.

If applicant does not intend to have the claim limitation(s) treated under 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112 , sixth paragraph, applicant may amend the claim(s) so that it/they will clearly not invoke 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph, or present a sufficient showing that the claim recites/recite sufficient structure, material, or acts for performing the claimed function to preclude application of 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph.

For more information, see MPEP § 2173 et seq. and Supplementary Examination Guidelines for Determining Compliance With 35 U.S.C. 112 and for Treatment of Related Issues in Patent Applications, 76 FR 7162, 7167 (Feb. 9, 2011).

7. Claim 16 recites "*A packet forwarding node, comprising: a communication unit to communicate with a server for receiving..., and a forwarding unit to forward in incoming packet...*", and thus **the claim hasn't been interpreted** under 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph, because it uses a structural specific term "a communication unit" coupled with functional language "to communicate" with reciting sufficient structure to achieve the function. Therefore, **112(f) is not invoked** because it includes a sufficient structural specific term called "communication" or "forwarding".

If applicant wishes to provide further explanation or dispute the examiner's interpretation of the corresponding structure, applicant must identify the corresponding structure with reference to the specification by page and line number, and to the drawing, if any, by reference characters in response to this Office action.

If applicant does not intend to have the claim limitation(s) treated under 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112 , sixth paragraph, applicant may amend the claim(s) so that it/they will clearly not invoke 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph, or present a sufficient showing that the claim recites/recite sufficient structure, material, or acts for performing the claimed function to preclude application of 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph.

For more information, see MPEP § 2173 et seq. and Supplementary Examination Guidelines for Determining Compliance With 35 U.S.C. 112 and for Treatment of Related Issues in Patent Applications, 76 FR 7162, 7167 (Feb. 9, 2011).

Regarding claim 21, the Applicant asserts that the claim element "*a first unit and second unit*" is a limitation that does not invoke 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, 6th paragraph. However, it is unclear whether the claim element invokes 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, 6th paragraph because the term "unit" as simply a substitute for the term "means for' because "unit" would not be recognized by one of ordinary skill in the art as being sufficiently definite structure for performing the claimed function (see MPEP 2181(I.)). If applicant does not wish to have the claim limitation treated under 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, 6th Paragraph applicant may:

(a) Amend the claim to add structure, material or acts that are sufficient to perform the claimed function; or

(b) Present a sufficient showing that the claim limitation recites sufficient structure, material, or acts for performing the claimed function to preclude application of 35

U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph. For more information, see MPEP § 2181.

Double Patenting

8. The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the "right to exclude" granted by a patent and to prevent possible harassment by multiple assignees. A nonstatutory obviousness-type double patenting rejection is appropriate where the conflicting claims are not identical, but at least one examined application claim is not patentably distinct from the reference claim(s) because the examined application claim is either anticipated by, or would have been obvious over, the reference claim(s). See, e.g., *In re Berg*, 140 F.3d 1428, 46 USPQ2d 1226 (Fed. Cir. 1998); *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); and *In re Thorington*, 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) or 1.321(d) may be used to overcome an actual or provisional rejection based on a nonstatutory double patenting ground provided the conflicting application or patent either is shown to be commonly owned with this application, or claims an invention made as a result of activities undertaken within the scope of a joint research agreement. Effective January 1, 1994, a registered attorney or agent of

record may sign a terminal disclaimer. A terminal disclaimer signed by the assignee must fully comply with 37 CFR 3.73(b).

9. **Claims 1-28 are** rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claims 1 and 8 of the U.S. application number **13/137,237**. Although the conflicting claims are not identical, they are not patentably distinct from each other. This is an **obviousness-type double patenting rejection** because the conflicting claims have not in fact been patented.

Regarding pending claims 1, 6 and 21; the claims recite limitations substantially the same as in the US application number **13/137,237**. These limitations are fully covered by the claims of the US application number **13/137,237.**

The compared table below (i.e. underlined claim elements) shows only Example (sample) of how each of these claims are anticipated and mapped by claims such as claims 1-7, 11, and 18, respectively of the US application number **13/137,237.**

Instant Application: 14244701	**Application #: 13/137,237**
1. A packet forwarding node, comprising: a storage unit to store a packet forwarding table used for forwarding a packet based on an identifier which identifies a link between nodes on a packet forwarding path; and a forwarding unit to receive an incoming packet including a plurality of the identifiers, and to forward the incoming packet based on an identifier corresponding to the packet forwarding node.	8. A forwarding node, connected to a path management server that generates a plurality of forwarding path information items each includes a sequence of identifiers, each of which identifies a communication interface provided in each of a plurality of forwarding nodes on a forwarding path in a data forwarding network or a link established between the forwarding node and a neighboring node thereof, wherein the forwarding node, in accordance with at least one of the

6. (Previously Presented) A packet forwarding node, comprising: a storage unit to store a packet forwarding table used for forwarding a packet based on an identifier which identifies an interface of a packet forwarding node; and a forwarding unit to receive an incoming packet including a plurality of identifiers, and to forward the incoming packet based on the identifier corresponding to the packet forwarding node.	plurality of forwarding path information items, executes a packet forwarding processing of a packet with a header including the plurality of forwarding path information items.
11. (Original) A packet forwarding node, comprising: a communication unit to communicate with a server for receiving a plurality of identifiers, each of which identifies a link between nodes on a packet forwarding path; and a forwarding unit to forward an incoming packet based on an identifier corresponding to a packet forwarding node.	1. A communication system comprising: a path management server that generates a plurality of forwarding path information items each includes a sequence of identifiers, each of which identifies a communication interface provided in each of a plurality of forwarding nodes on a forwarding path in a data forwarding network or a link established between the forwarding node and a neighboring node thereof; and a forwarding node that, in accordance with at least one of the plurality of forwarding path information items, executes a packet forwarding processing of a packet with a header including the plurality of forwarding path information items.
16. (Original) A packet forwarding node, comprising: a communication unit to communicate with a server for receiving a plurality of identifiers, each of which identifies an interface of a packet forwarding node; and a forwarding unit to forward an incoming packet based on an identifier corresponding to the packet forwarding node.	8. A forwarding node, connected to a path management server that generates a plurality of forwarding path information items each includes a sequence of identifiers, each of which identifies a communication interface provided in each of a plurality of forwarding nodes on a forwarding path in a data forwarding network or a link established between the forwarding node and a neighboring node thereof, wherein the forwarding node, in accordance with at least one of the plurality of forwarding path information items, executes a packet forwarding processing of a packet with a header including the plurality of forwarding path information items.
21. A server, comprising: a first unit to determine a plurality of identifiers, each of which identifies a link between nodes on a packet forwarding path; and a second unit to send information elements to a packet forwarding node which is capable of forwarding an incoming packet based on an identifier	1. A communication system comprising: a path management server that generates a plurality of

corresponding to the packet forwarding node.	forwarding path information items each includes a sequence of identifiers, each of which identifies a communication interface provided in each of a plurality of forwarding nodes on a forwarding path in a data forwarding network or a link established between the forwarding node and a neighboring node thereof; and a forwarding node that, in accordance with at least one of the plurality of forwarding path information items, executes a packet forwarding processing of a packet with a header including the plurality of forwarding path information items.

Vasseur (US 7,522,603 B2) further discloses a packet forwarding node, comprising:

a storage unit (***See Fig. 2: Memory 240***) to store a packet forwarding table (***See Fig. 2: Memory 240 for storing software programs and data structures including forwarding tables; Col. 8, Lines 37-45***) used for forwarding a packet based on an identifier (***See Fig. 3 and 4: label address (i.e. identifier) to route for the destination; Col. 9, Lines 15-24***) which identifies a link between nodes on a packet forwarding path ***(See Figs. 2 and 4; Router (i.e., a forwarding node) with forwarding tables 246 and PCE 248 for path computation of the CE-CE paths and current Metrics with destination addresses; Col. 8 Lines 59-67 and Col. 11 Lines 54-60);*** and a forwarding unit (***See Fig. 2: Processor 220 for routing and forwarding; Col. 8, Lines 42-48***) configured to receive an incoming packet including a plurality of the identifiers ***(See Figs. 2-4; receiving routing information database RIB that includes the Path Computation Request Message comprising multiple identifiers, such as a header, a source and destination address of the request, the Metrics with Address Prefixes/identifiers to set up the routing/forwarding destination of the CE and so on; Col. 8 Lines 59-67 and Col. 11, Lines 41-48),*** and to forward the incoming packet based on an identifier corresponding to the packet forwarding node ***(See Figs. 2 and 4; a forwarding selection selects a label (i.e. identifier) to route of the destination; Col. 9 Lines 15-24...and see also Fig. 7; for performing IP traffic routing and selecting the best path; Col. 14 Lines 7-15).***

The motivation is to provide a novel technique efficiently routes IP traffic on CE-CE paths in a computer network. By utilizing PCEs with knowledge of dynamic link attribute information of CE-CE path links, the novel technique allows for a multi-homed CE to efficiently route, e.g., load balance, IP traffic across its multi-homed CE-PE links accordingly. In particular, the novel technique advantageously utilizes PCEs for IP traffic. Further, the dynamic nature of the novel technique alleviates the need for cumbersome manual configuration. (*See Col. 6, Lines 51-60*).

Claim Rejections - 35 USC § 102

10. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

> *(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.*

11. Claims 1-21 and 27-28 are rejected under 35 U.S.C. 102(b) as being anticipated by **Vasseur (US 7,522,603 B2).**

Regarding claim 1; **Vasseur** discloses a packet forwarding node, comprising:

a storage unit (***See Fig. 2: Memory 240***) including a non-transitory computer readable medium configured to store a packet forwarding table (***See Fig. 2: Memory 240 for storing software programs and data structures including forwarding tables; Col. 8, Lines 37-45***) used for forwarding a

packet based on an identifier (***See Fig. 3 and 4: label address (i.e. identifier) to route for the destination; Col. 9, Lines 15-24***) which identifies a link between nodes on a packet forwarding path ***(See Figs. 2 and 4; Router (i.e., a forwarding node) with forwarding tables 246 and PCE 248 for path computation of the CE-CE paths and current Metrics with destination addresses; Col. 8 Lines 59-67 and Col. 11 Lines 54-60);*** and

a forwarding unit (***See Fig. 2: Processor 220 for routing and forwarding; Col. 8, Lines 42-48***) configured to receive an incoming packet including a plurality of the identifiers ***(See Figs. 2-4; receiving routing information database RIB that includes the Path Computation Request Message comprising multiple identifiers, such as a header, a source and destination address of the request, the Metrics with Address Prefixes/identifiers to set up the routing/forwarding destination of the CE and so on; Col. 8 Lines 59-67 and Col. 11, Lines 41-48),*** and to forward the incoming packet based on an identifier corresponding to the packet forwarding node ***(See Figs. 2 and 4; a forwarding selection selects a label (i.e. identifier) to route of the destination; Col. 9 Lines 15-24...and see also Fig. 7; for performing IP traffic routing and selecting the best path; Col. 14 Lines 7-15).***

Regarding claim 2; **Vasseur** discloses the packet forwarding node wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link within a predetermined domain ***(See Figs. 4 and 5; CE-PE links (i.e. PE link for predetermined domain); Col. 10 Lines 51-60 and Col. 12 Lines 40-47).***

Regarding claim 3; **Vasseur** discloses the packet forwarding node, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely

identifies the link within a predetermined local domain ***(See Figs. 4 and 5; CE-CE links (i.e. predetermined local domain); Col. 9 Lines 54-60).***

Regarding claim 4; **Vasseur** discloses the packet forwarding node wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link within the packet forwarding node ***(See Figs. 2 and 4; Router (i.e., a forwarding node) with forwarding tables 246; Col. 8 l 59-67).***

Regarding claim 5; **Vasseur** discloses the packet forwarding node wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link among the packet forwarding nodes ***(See Figs. 2 and 4; Router (i.e., a forwarding node) with forwarding tables 246; Col. 8 l 59-67).***

Regarding claim 6; **Vasseur** discloses a packet forwarding node, comprising:

a storage unit (***See Fig. 2: Memory 240***) including a non-transitory computer readable medium configured to store a packet forwarding table ***See Fig. 2: Memory 240 for storing software programs and data structures including forwarding tables; Col. 8, Lines 37-45***) used for forwarding a packet based on an identifier (***See Fig. 3 and 4: label address (i.e. identifier) to route for the destination; Col. 9, Lines 15-24***)which identifies an interface of a packet forwarding node ***(See Fig. 2; Each node includes one or more network interfaces that are coupled to a processor to execute memory that store routing forwarding tables and compute CE-CE or PE-CE path Metrics to destination address to balance out the traffic load across the network links; Col. 8 Lines 21-32 and Col. 8 Lines 37-47...and see also Fig. 4: Router (i.e., a forwarding node) with forwarding tables 246; Col. 8 Lines 59-67);*** and

a forwarding unit (***See Fig. 2: Processor 220 for routing and forwarding; Col. 8, Lines 42-48***) to receive an incoming packet including a plurality of the identifiers ***(See Figs. 2-4; receiving routing information database RIB that includes the Path Computation Request Message comprising multiple identifiers, such as a header, a source and destination address of the request, the Metrics with Address Prefixes/identifiers to set up the routing/forwarding destination of the CE and so on; Col. 8 Lines 59-67 and Col. 11, Lines 41-48),*** and to forward the incoming packet based on an identifier corresponding to the packet forwarding node ***(See Figs. 2 and 4; a forwarding selection selects a label address (i.e. identifier) to route of the destination; Col. 9 Lines 15-24...and see also Fig. 7; for performing IP traffic routing and selecting the best path; Col. 14 Lines 7-15).***

Regarding claim 7; **Vasseur** discloses the packet forwarding node wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link within a predetermined domain ***(See Figs. 4 and 5; CE-PE links (i.e. PE link for predetermined domain); Col. 10 Lines 51-60 and Col. 12 Lines 40-47).***

Regarding claim 8; **Vasseur** discloses the packet forwarding node, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link within a predetermined local domain ***(See Figs. 4 and 5; CE-CE links (i.e. predetermined local domain); Col. 9 Lines 54-60).***

Regarding claim 9; **Vasseur** discloses the packet forwarding node wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely

identifies the link within the packet forwarding node ***(See Figs. 2 and 4; Router (i.e., a forwarding node) with forwarding tables 246; Col. 8 l 59-67).***

Regarding claim 10; **Vasseur** discloses the packet forwarding node wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link among the packet forwarding nodes ***(See Figs. 2 and 4; Router (i.e., a forwarding node) with forwarding tables 246; Col. 8 l 59-67).***

Regarding claim 11; **Vasseur** discloses a packet forwarding node, comprising:

a communication unit (***See Fig. 2: Communication Router 200***) to communicate with a server (***See Abstract for CE-PE communication***) for receiving a plurality of identifiers ***(See Figs. 2-4; receiving routing information database RIB that includes the Path Computation Request Message comprising multiple identifiers, such as a header, a source and destination address of the request, the Metrics with Address Prefixes/identifiers to set up the routing/forwarding destination of the CE and so on; Col. 8 Lines 59-67 and Col. 11, Lines 41-48)***; each of which identifies a link between nodes on a packet forwarding path ***(See Figs. 2 and 4; Router (i.e., a forwarding node) with forwarding tables 246 and PCE 248 for path computation of the CE-CE paths and current Metrics to the remote destination address; Col. 8 Lines 59-67 and Col. 11 Lines 54-60);*** and

a forwarding unit (***See Fig. 2: Processor 220 for routing and forwarding; Col. 8, Lines 42-48***) to forward an incoming packet based on the identifier corresponding to the packet forwarding node ***(See Fig. 2; Routing Service 247 forward the incoming data packet using the label address found in the packet. PCE computes the Metrics with Address Prefixes/identifiers to set up the routing/forwarding***

destination of the CE; Col. 9 Lines 55-65 and see also Fig. 7; for performing IP traffic routing and selecting the best path; Col. 14 Lines 7-15).

Regarding claim 12; **Vasseur** discloses the packet forwarding node wherein the forwarding unit forwards the packet based on an identifier which uniquely identifies a link within a predetermined domain (See Fig. 2; Routing Service 247 forward the incoming data packet using the label found in the packet. PCE computes **the Metrics with Address Prefixes/identifiers** to set up the routing/forwarding destination of the CE; Col. 9 Lines 55-65; and see also Figs. 4 and 5; CE-PE links (i.e. PE link for predetermined domain); Col. 10 Lines 51-60 and Col. 12 Lines 40-47).

Regarding claim 13; **Vasseur** discloses the packet forwarding node, wherein the forwarding unit forwards the packet based on an identifier which uniquely identifies a link within a predetermined domain (See Figs. 4 and 5; CE-CE links (i.e. predetermined local domain); Col. 9 Lines 54-60).

Regarding claim 14; **Vasseur** discloses the packet forwarding node wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link within the packet forwarding node (See Figs. 2 and 4; Router (i.e., a forwarding node) with forwarding tables 246; Col. 8 Lines 59-67); and

Regarding claim 15; **Vasseur** discloses the packet forwarding node wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely

identifies the link among the packet forwarding nodes (See Figs. 2 and 4; Router (i.e., a forwarding node) with forwarding tables 246; Col. 8 Lines 59-67).

Regarding claim 16; **Vasseur** discloses a packet forwarding node, comprising:

a communication unit (***See Fig. 2: Communication Router 200***) to communicate with a server for receiving a plurality of identifiers ***(See Fig. 2 and 7; Router 200...and... PCC/PCE 248 with Stored Requests Table 500 (i.e. storage unit) and PCE computes the Metrics with Address Prefixes/identifierss (i.e. identifiers); Col. 8 Lines 42-50 and Lines 50-55, and Col. 9 Lines 58-65)***, each of which identifies an interface of a packet forwarding node ***(See Fig. 2; Each node includes one or more network interfaces that are coupled to a processor to execute memory that store routing forwarding tables and compute CE-CE or PE-CE path Metrics to destination address to balance out the traffic load across the network links. See also Col. 8 Lines 21-32 and Col. 8 Lines 37-47...and see also Fig. 4: Router (i.e., a forwarding node) with forwarding tables 246; Col. 8 Lines 59-67);*** and

a forwarding unit (***See Fig. 2: Processor 220 for routing and forwarding; Col. 8, Lines 42-48***) to receive an incoming packet including a plurality of the identifiers ***(See Figs. 2 and 4; Router performs/receives routing information database RIB and forwarding information database FIB; Col. 8 Lines 59-67),*** and to forward the incoming packet based on an identifier corresponding to the packet forwarding node ***(See Figs. 2 and 4; a forwarding selection selects a label address (i.e. identifier) to route of the destination; Col. 9 Lines 15-24...and see also Fig. 7; for performing IP traffic routing and selecting the best path; Col. 14 Lines 7-15).***

Regarding claim 17; **Vasseur** discloses the packet forwarding node wherein the forwarding unit forwards the packet based on the identifier which uniquely identifies a link

within a predetermined domain ***(See Figs. 4 and 5; CE-PE links (i.e. PE link for predetermined domain); Col. 10 Lines 51-60 and Col. 12 Lines 40-47).***

Regarding claim 18; **Vasseur** discloses the packet forwarding node wherein the forwarding unit forwards the packet based on the identifier which uniquely identifies a link within a predetermined local domain ***(See Figs. 4 and 5; CE-CE links (i.e. predetermined local domain); Col. 9 Lines 54-60).***

Regarding claim 19; **Vasseur** discloses the packet forwarding node wherein the forwarding unit forwards the packet based on the identifier which uniquely identifies a link within the packet forwarding node ***(See Figs. 2 and 4; Router (i.e., a forwarding node) with forwarding tables 246; Col. 8 l 59-67).***

Regarding claim 20; **Vasseur** discloses the packet forwarding node wherein the forwarding unit forwards the packet based on the identifier which uniquely identifies the link among the packet forwarding nodes ***(See Figs. 2 and 4; Router (i.e., a forwarding node) with forwarding tables 246; Col. 8 l 59-67).***

Regarding claim 21; **Vasseur** discloses a server, comprising:

a first unit to determine a plurality of the identifiers each of which identifies a link between nodes on a packet forwarding path ***(See Fig. 2 and 7; PCC/PCE 248 with Stored Requests Table 500 (i.e. a first unit) and PCE computes the Metrics with Address Prefixes/identifierss (i.e. identifiers). The***

requesting CE (i.e. forwarding node) modifies IP/Data Packet corresponding to the CE-CE path Metrics; Col. 8 Lines 42-50 and Lines 50-55, and Col. 9 Lines 58-65); and

a second unit to send the information elements to a packet forwarding node ***(See Fig. 2; Routing Services 247 with Routing Tables 246 (i.e. second unit)...a forwarding selection and new substitute label address are determined by using the label address found in the incoming packet of the forwarding table; Col. 9 Lines 17-22)*** which is capable of forwarding an incoming packet based on the identifier corresponding to the packet forwarding node ***(See Fig. 2; Routing Service 247 forward the incoming data packet using the label address found in the packet. PCE computes the Metrics with Address Prefixes/identifiers to set up the routing destination of the CE; Col. 9 Lines 55-65).***

Note: The term "capable of" is not a positively cited claim language, and the term may raise a question as to the limiting effect of the language in a claim. An alternative term is "configured to" or a positive action verb to perform the function without any unnecessary ambiguity. See MPEP 2111.04.

Regarding claims 27 and 28; **Vasseur** discloses the forwarding comprises a forwarding device and the communication unit comprises a communication device.

Claim Rejections - 35 USC § 103

12. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole

would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

13. The factual inquiries set forth in Graham v. John Deere Co., 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows: (See MPEP Ch. 2141)

a) Determining the scope and contents of the prior art;

b) Ascertaining the differences between the prior art and the claims in issue;

c) Resolving the level of ordinary skill in the pertinent art; and

d) Evaluating evidence of secondary considerations for indicating obviousness or nonobviousness.

14. Claims 22-26 are rejected under 35 U.S.C. 103(a) as being unpatentable over **Vasseur-1 (US 7,522,603 B2)** in view of **Vasseur-2 (US 2007/0280102 A1)**.

Regarding claim 22; **Vasseur-1** discloses the packet forwarding node, comprising:

a storage unit including a non-transitory computer readable medium configured to store a packet forwarding table used for forwarding a packet based on an identifier which identifies a link between nodes on a packet forwarding path ***(See Figs. 2 and 4; Router (i.e., a forwarding node) with forwarding tables 246 and PCE 248 for path computation of the CE-CE paths and current Metrics to the remote destination address; Col. 8 Lines 59-67 and Col. 11 Lines 54-60);*** and

a forwarding unit to receive an incoming packet including a plurality of the identifiers ***(See Figs. 2 and 4; Router performs/receives routing information database RIB and forwarding information database FIB; Col. 8 Lines 59-67),*** and to forward the incoming packet based on an identifier corresponding to the

packet forwarding node ***(See Figs. 2 and 4; a forwarding selection selects a label address (i.e. identifier) to route of the destination; Col. 9 Lines 15-24...and see also Fig. 7; for performing IP traffic routing and selecting the best path; Col. 14 Lines 7-15***

Vasseur-1 doesn't explicitly disclose identifying a link between adjacent nodes on a packet forwarding path.

However, **Vasseur**-2 discloses the method to identify a link between adjacent nodes on a packet forwarding path (***See Fig. 1 and 6; identifying routing information/link with neighboring node; Para. [0010] and [0072]***).

Therefore, it would have been obvious to one having ordinary skill in the art at the time of the invention was made to provide the method to identify a link between adjacent nodes on a packet forwarding path as taught by **Vasseur**-2 to have incorporated in the system of **Vasseur**-1, so that it would provide that For instance, the cost value may be measured in terms of the number of hops required to reach the neighboring node, the average time for a packet to reach the neighboring node, the amount of network traffic or available bandwidth over a communication link coupled to the neighboring node, etc. (**Vasseur**-1: Para. [0010]).

Regarding claim 23; **Vasseur-1** discloses a packet forwarding node, comprising:

a storage unit including a non-transitory computer readable medium configured to store a packet forwarding table used for forwarding a packet based on an identifier which identifies a link between nodes on a packet forwarding path ***(See Figs. 2 and 4; Router (i.e., a forwarding node) with forwarding tables 246 and PCE 248 for path computation of the CE-CE paths and current Metrics to the remote destination address; Col. 8 Lines 59-67 and Col. 11 Lines 54-60);*** and

a forwarding unit to receive an incoming packet including a plurality of the identifiers ***(See Figs. 2 and 4; Router performs/receives routing information database RIB and forwarding information database FIB; Col. 8 Lines 59-67),*** and to forward the incoming packet based on an identifier corresponding to the packet forwarding node ***(See Figs. 2 and 4; a forwarding selection selects a label address (i.e. identifier) to route of the destination; Col. 9 Lines 15-24...and see also Fig. 7; for performing IP traffic routing and selecting the best path; Col. 14 Lines 7-15***

Vasseur-1 doesn't explicitly disclose identifying a link between adjacent nodes on a packet forwarding path.

However, **Vasseur**-2 discloses the method to identify a link between adjacent nodes on a packet forwarding path (***See Fig. 1 and 6; identifying routing information/link with neighboring node; Para. [0010] and [0072]***).

Therefore, it would have been obvious to one having ordinary skill in the art at the time of the invention was made to provide the method to identify a link between adjacent nodes on a packet forwarding path as taught by **Vasseur**-2 to have incorporated in the system of **Vasseur**-1, so that it would provide that For instance, the cost value may be measured in terms of the number of hops required to reach the neighboring node, the average time for a packet to reach the neighboring node, the amount of network traffic or available bandwidth over a communication link coupled to the neighboring node, etc. (**Vasseur**-1: Para. [0010]).

Regarding claim 24; **Vasseur-1** discloses a packet forwarding node, comprising:

a storage unit including a non-transitory computer readable medium configured to store a packet forwarding table used for forwarding a packet based on an identifier which identifies a link between nodes on a packet forwarding path ***(See Figs. 2 and 4; Router (i.e., a forwarding node)***

with forwarding tables 246 and PCE 248 for path computation of the CE-CE paths and current Metrics to the remote destination address; Col. 8 Lines 59-67 and Col. 11 Lines 54-60); and

a forwarding unit to receive an incoming packet including a plurality of the identifiers ***(See Figs. 2 and 4; Router performs/receives routing information database RIB and forwarding information database FIB; Col. 8 Lines 59-67),*** and to forward the incoming packet based on an identifier corresponding to the packet forwarding node ***(See Figs. 2 and 4; a forwarding selection selects a label address (i.e. identifier) to route of the destination; Col. 9 Lines 15-24...and see also Fig. 7; for performing IP traffic routing and selecting the best path; Col. 14 Lines 7-15***

Vasseur-1 doesn't explicitly disclose identifying a link between adjacent nodes on a packet forwarding path. However, **Vasseur**-2 discloses the method to identify a link between adjacent nodes on a packet forwarding path (***See Fig. 1 and 6; identifying routing information/link with neighboring node; Para. [0010] and [0072]***).

Therefore, it would have been obvious to one having ordinary skill in the art at the time of the invention was made to provide the method to identify a link between adjacent nodes on a packet forwarding path as taught by **Vasseur**-2 to have incorporated in the system of **Vasseur**-1, so that it would provide that For instance, the cost value may be measured in terms of the number of hops required to reach the neighboring node, the average time for a packet to reach the neighboring node, the amount of network traffic or available bandwidth over a communication link coupled to the neighboring node, etc. (**Vasseur**-1: Para. [0010]).

Regarding claim 25; **Vasseur-1** discloses a packet forwarding node, comprising:

a storage unit including a non-transitory computer readable medium configured to store a packet forwarding table used for forwarding a packet based on an identifier which identifies a

link between nodes on a packet forwarding path ***(See Figs. 2 and 4; Router (i.e., a forwarding node) with forwarding tables 246 and PCE 248 for path computation of the CE-CE paths and current Metrics to the remote destination address; Col. 8 Lines 59-67 and Col. 11 Lines 54-60);*** and

a forwarding unit to receive an incoming packet including a plurality of the identifiers ***(See Figs. 2 and 4; Router performs/receives routing information database RIB and forwarding information database FIB; Col. 8 Lines 59-67),*** and to forward the incoming packet based on an identifier corresponding to the packet forwarding node ***(See Figs. 2 and 4; a forwarding selection selects a label address (i.e. identifier) to route of the destination; Col. 9 Lines 15-24...and see also Fig. 7; for performing IP traffic routing and selecting the best path; Col. 14 Lines 7-15***

Vasseur-1 doesn't explicitly disclose identifying a link between adjacent nodes on a packet forwarding path. However, **Vasseur**-2 discloses the method to identify a link between adjacent nodes on a packet forwarding path (***See Fig. 1 and 6; identifying routing information/link with neighboring node; Para. [0010] and [0072]***).

Therefore, it would have been obvious to one having ordinary skill in the art at the time of the invention was made to provide the method to identify a link between adjacent nodes on a packet forwarding path as taught by **Vasseur**-2 to have incorporated in the system of **Vasseur**-1, so that it would provide that For instance, the cost value may be measured in terms of the number of hops required to reach the neighboring node, the average time for a packet to reach the neighboring node, the amount of network traffic or available bandwidth over a communication link coupled to the neighboring node, etc. (**Vasseur**-1: Para. [0010]).

Regarding claim 26; **Vasseur-1** discloses a server, comprising:

a first unit to determine a plurality of the identifiers each of which identifies a link between nodes on a packet forwarding path ***(See Fig. 2 and 7; PCC/PCE 248 with Stored Requests Table 500 (i.e. a first unit) and PCE computes the Metrics with Address Prefixes/identifierss (i.e. identifiers). The requesting CE (i.e. forwarding node) modifies IP/Data Packet corresponding to the CE-CE path Metrics; Col. 8 Lines 42-50 and Lines 50-55, and Col. 9 Lines 58-65)***; and

a second unit to send the information elements to a packet forwarding node ***(See Fig. 2; Routing Services 247 with Routing Tables 246 (i.e. second unit)...a forwarding selection and new substitute label address are determined by using the label address found in the incoming packet of the forwarding table; Col. 9 Lines 17-22)***, and to forward the incoming packet based on the identifier corresponding to the packet forwarding node ***(See Fig. 2; Routing Service 247 forward the incoming data packet using the label address found in the packet. PCE computes the Metrics with Address Prefixes/identifiers to set up the routing destination of the CE; Col. 9 Lines 55-65).***

Vasseur-1 further discloses a storage unit to store a packet forwarding table used for forwarding a packet based on an identifier which identifies a link between nodes on a packet forwarding path ***(See Figs. 2 and 4; Router (i.e., a forwarding node) with forwarding tables 246 and PCE 248 for path computation of the CE-CE paths and current Metrics to the remote destination address; Col. 8 Lines 59-67 and Col. 11 Lines 54-60).***

Vasseur-1 doesn't explicitly disclose the method to identify a link between adjacent nodes on a packet forwarding path.

However, **Vasseur**-2 discloses the method to identify a link between adjacent nodes on a packet forwarding path (***See Fig. 1 and 6; identifying routing information/link with neighboring node; Para. [0010] and [0072]***).

Therefore, it would have been obvious to one having ordinary skill in the art at the time of the invention was made to provide the method to identify a link between adjacent nodes on a packet forwarding path as taught by **Vasseur**-2 to have incorporated in the system of **Vasseur**-1, so that it would provide that For instance, the cost value may be measured in terms of the number of hops required to reach the neighboring node, the average time for a packet to reach the neighboring node, the amount of network traffic or available bandwidth over a communication link coupled to the neighboring node, etc. (**Vasseur**-1: Para. [0010]).

Note: The term "capable of" is not a positively cited claim language, and the term may raise a question as to the limiting effect of the language in a claim. An alternative term is "configured to" or a positive action verb to perform the function without any unnecessary ambiguity. See MPEP 2111.04.

Response to Arguments

16. In terms of the 112 (f) Claim Interpretation, the applicant argued that 35 U.S.C 112(f) only apply for the phase, such as the "means for" or "step for". The examiner disagrees. According to MPEP 2181(A), there is a list of non-structural generic placeholders ,that could be a substitute for the term "means", such as "mechanism for," "module for," "device for," "unit for," "component for," "element for," "member for," "apparatus for," "machine for," or "system for." The applicant is further requested to review the following link for 112(f) or Pre AIA 112 Sixth Paragraph Analysis Modules: http://www.uspto.gov/patent/35-usc-112-f-means-plus-function-limitations

17. The obviousness double patenting is still sustained because the Applicant requested to hold for it in abeyance until a time when the claims are indicated as allowable.

18. Applicant's arguments, with regards to claims 1-28, filed on 02/01/2016 have been fully considered but they are not persuasive.

In view of the applicant's argument under Remarks on page 11, the applicant argued that **Vasseur** fails to teach "*a storage unit including a non-transitory computer readable medium configured to store a packet forwarding table used for forwarding a packet based on an identifier which identifies a link between nodes on a packet forwarding path; and a forwarding unit configured to receive an incoming packet including a plurality of the identifiers, and to forward the incoming packet based on the identifier corresponding to the packet forwarding node.*"

In response to the above argument, the applicant's arguments fail to comply with 37 CFR 1.111(b) because they amount to a general allegation that the claims define a patentable invention without specifically pointing out how the language of the claims patentably distinguishes them from the references.

The applicant further argued that **Vasseur** fails to teach a packet with a plurality of the identifiers.

In response to the above argument, the examiner disagrees. The examiner disagrees because the applicant fails to provide a clear and distinct explanation of the type of the identifier. Moreover, the applicant never mentions that all the identifiers are the same or different ones.

Under the broadest reasonable interpretations, the identifier could be any type of identifier or ID, such as label, address, ID, parameter, header, Metric Prefix and so on.

However, the cited reference, i.e. **Vasseur**, still teaches an identifier which identifies a link between nodes. **Vasseur** explains a label address (i.e. identifier) is assigned to teach incoming packet based on the label forwarding table that includes multiple labels/addresses (i.e. identifiers) to identify the next-hop router/node before forwarding the packet. (See Col. 9, Lines 14-22). **Vasseur** further teaches the method of receiving and transmitting the path computation request message or routing information database between the CEs and PCE in accordance with a MPLS protocol. Inside the path computation message 300, it includes multiple identifiers, such as a header, a source and destination address of the request, the set of data path request parameters, flag, a request identification and so on. (**Vasseur**: Col. 11, Lines 1-5 and Lines 10-17).

In view of the above reasoning, the examiner believes that the rejections should be sustained because **Vasseur** teaches each and every limitations as set forth in the claims 1, 6, 11, 16 and 21. Thus, the Applicant's recurring argument about failing to disclose the amended claim limitations is inconsistent and erratic.

Conclusion

19. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO

MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to SAI AUNG whose telephone number is (571)272-3507. The examiner can normally be reached on Monday-Friday, Alt Fridays, 7:30 AM- 5:00 PM (EST).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Dang Ton can be reached on 571-272-3171. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/S. A./

Examiner, Art Unit 2475

/DANG TON/

Supervisory Patent Examiner, Art Unit 2475/D. T./

Supervisory Patent Examiner, Art Unit 2475

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14244701	AWANO, JUN
	Examiner	Art Unit
	SAI AUNG	2475

CPC- SEARCHED		
Symbol	Date	Examiner
H04L45/04; H04L45/24; H04L45/66; H04L45/00;	3/1/2016	SA

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
370	370/401; 370/392; 370/231; 370/252; 370/352; 370/395.53	3/1/2016	SA

SEARCH NOTES		
Search Notes	Date	Examiner
EAST SEARCH (INCLUDING INVENTORS AND ASSIGNEE SEARCH)	3/1/2016	SA
GOOGLE PATENTS SEARCH	4/13/2015	SA
OTHER RELATED CPC SEARCH: H04L45/302; H04L45/50; H04L49/351	4/13/2015	SA

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner

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Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14244701	AWANO, JUN
	Examiner	Art Unit
	SAI AUNG	2475

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	12/12/2014	04/13/2015	10/28/2015	03/01/2016					
	1	✓	✓	✓	✓					
	2	✓	✓	✓	✓					
	3	✓	✓	✓	✓					
	4	✓	✓	✓	✓					
	5	✓	✓	✓	✓					
	6	✓	✓	✓	✓					
	7	✓	✓	✓	✓					
	8	✓	✓	✓	✓					
	9	✓	✓	✓	✓					
	10	✓	✓	✓	✓					
	11	✓	✓	✓	✓					
	12	✓	✓	✓	✓					
	13	✓	✓	✓	✓					
	14	✓	✓	✓	✓					
	15	✓	✓	✓	✓					
	16	✓	✓	✓	✓					
	17	✓	✓	✓	✓					
	18	✓	✓	✓	✓					
	19	✓	✓	✓	✓					
	20	✓	✓	✓	✓					
	21	✓	✓	✓	✓					
	22			✓	✓					
	23			✓	✓					
	24			✓	✓					
	25			✓	✓					
	26			✓	✓					
	27				✓					
	28				✓					

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re patent application of

JUN AWANO

Serial No.: 14/244,701 Group Art Unit: 2475

Filed: April 3, 2014 Examiner: AUNG, SAI

For: COMMUNICATION SYSTEM, FORWARDING NODE, PATH MANAGEMENT SERVER, COMMUNICATION METHOD, AND PROGRAM

Honorable Commissioner of Patents
Alexandria, VA 22313-1450

INFORMATION DISCLOSURE STATEMENT

Sir:

Under the provisions of 37 CFR §1.97 through §1.98 and pursuant to applicant's duty of disclosure under 37 CFR §1.56, applicant respectfully brings the following documents listed on the attached from PTO-1449, to the attention of the Examiner in charge of the above-identified application. This reference was cited in an Office Action dated January 12, 2016, issued by the Examiner in the co-pending Application No. 13/137,237. Copies of the listed documents are provided herewith for the convenience of the Examiner.

This citation does not constitute an admission that the references are relevant or material to the claim. It is only cited as constituting related art of which the applicant is aware.

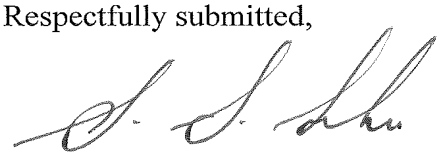
I hereby certify that no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in §1.56(c) more than three months prior to the filing of the information disclosure statement.

The Commissioner is authorized to charge Attorney's Deposit Account No. 50-0481 in the amount of $180.00 to cover the IDS fee.

It is respectfully requested that the listed references be considered by the Examiner and formally made of record in this application.

Please charge any deficiencies in fees and credit any overpayment of fees to Attorney's Deposit Account No. 50-0481.

Respectfully submitted,



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Date: April 8, 2016

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Information Disclosure Citation

Docket Number	Application Number
NEG-1440PCTUSCONT	14/244,701
Inventor	
NEC CORPORATION	
Filing Date	**Group Art Unit**
April 3, 2014	2475

U. S. Patent Documents

Examiner Initial	Ref	Document Number	Date	Name	Class	Subclass	Filing Date (If Appropriate)	

U. S. Patent Application Publications

Examiner Initial	Ref	Document Number	Date	Name	Class	Subclass	Filing Date (If Appropriate)	
		US 2002/0150041 A1	10/17/2002	Reinshmidt, et al.				

Foreign Patent Documents

Examiner Initial	Ref	Document Number	Date	Country	Class	Subclass	Translation	
							Yes	No

Other Documents (Including Author, Title, Date, Pertinent Pages, etc.)

		United States Office Action dated January 12, 2016 in co-pending Application No. 13/137,237.

Examiner	**Date Considered**

Examiner: Initial if citation considered, whether citation is in conformance with MPEP Section 609; Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to Applicant.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/137,237	07/29/2011	Jun Awano	NEG-1493PCT-US	3475

21254 7590 01/12/2016

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EXAMINER
CHOUDHRY, SAMINA F

ART UNIT	PAPER NUMBER
2462	

MAIL DATE	DELIVERY MODE
01/12/2016	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No. 13/137,237	Applicant(s) AWANO, JUN	
	Examiner SAMINA CHOUDHRY	Art Unit 2462	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *12/31/2015*.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5)☒ Claim(s) *1,2,4-13,16-18 and 21-23* is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6)☐ Claim(s) _____ is/are allowed.

7)☒ Claim(s) *1,2,4-13,16-18 and 21-23* is/are rejected.

8)☐ Claim(s) _____ is/are objected to.

9)☐ Claim(s) _____ are subject to restriction and/or election requirement.

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☒ The drawing(s) filed on *07/29/2011* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☒ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date _____.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

4) ☐ Other: _____.

DETAILED ACTION

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on Dec. 31, 2015 has been entered.

Response to Arguments

2. This action is response to the communication filed on 12/31/2015.

Claims 1, 2, 4-13, 16-18 and 21-22 are pending. Based on new ground of rejection, applicant's arguments are moot.

Claim Rejections - 35 USC § 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

4. Claims 1, 8, 9, 10, 11 and 23 are rejected under 35 U.S.C. 103(a) as being unpatentable over Vasseur et al. (US 2007/0217419) in view of Ashwood-Smith et al. (US 2012/0147752), hereinafter Smith and further in view of Reinshmidt et al. (US 2002/0150041).

Regarding claim 1, Vasseur discloses:

a path management server (¶ 25; a path computation element PCE) that generates a plurality of identifiers (¶ 25; 46; 47; and 70; PCE generates path metrics and link attribute information);

Vasseur does not explicitly disclose that each of the identifier identifies a link established between a forwarding node from among a plurality of forwarding nodes and a neighboring node thereof, wherein the link is uniquely identified by one of the plurality of identifiers within a network domain comprising a plurality of nodes; and the forwarding node forwards a packet in accordance with at least one of the plurality of identifiers arranged in forwarding order in a header of the packet.

In an analogous art, Smith discloses that each of the identifier identifies a link established between a forwarding node from among a plurality of forwarding nodes and a neighboring node thereof (para 25; Referring now to FIG. 1A, an exemplary network 10 in which source routing may be used is shown. A source device 12 that seeks to communicate with a destination device 38 executes a transport layer routing protocol, such as Open Shortest Path First (OSPF) routing protocol, IS-IS, or the like to select the desired `hops` in the path from source to destination. For the purpose of this application, a `hop` may be defined to be an address of a node, a link associated with a node or a label identifying a link or a node), wherein the link is uniquely identified by one of the plurality of identifiers within a network domain comprising a plurality of nodes (para 28; fig. 2A and 2B, a source routing network wherein links rather than nodal addresses, are used to identify the next `hop` in the network is shown. For the purpose of this application, a link identifies an interface of a network device which may be used to transmit data. Thus, in the network 5, device 14 has multiple output interface link (L1, L2, L6 and L7), any of which can be selected to as a path for the next `hop` out of the device. The path from source node 12 to destination node 38 is thus indicated

as link `hops` L1, L2, L3, L4 and L5 as illustrated in FIG. 2B); and the forwarding node forwards a packet in accordance with at least one of the plurality of identifiers (para 29; according to one aspect of the invention, the header of a packet can be modified to include, with each hop identifier (whether it be a node address, link address, label or some other indicator), one or more bits comprising a congestion field, such as congestion fields 40, 41, 42, 43 and 44. The congestion field is associated with each `hop`, and indicates a relative congestion on the `hop.` The existence of congestion at the `hop` can be determined using any one of a variety of known congestion detection techniques, and the present invention is not limited to the use of any particular mechanism or threshold for congestion detection. Exemplary methods that are used in the art include monitoring transmit and receive buffer fullness at the device, measuring a number of dropped packets, measurement of a delay in response by the device, and may other methods. In one sense,`Congestion` means resource conflicts with regard to the transport medium and buffers associated with packet traffic. However, the system and method of the present invention can also used to indicate other resource conflicts; such as power, error rates, etc., and thus the terms `congestion` and `resource conflicts` can be used interchangeably below). It would have been obvious to one of ordinary skill in the art at the time of invention was made to modify Vasseur's system by adding the limitation of Smith in order to minimize congestion and improving routing in a communication system.

Vasseur does not explicitly disclose that the forwarding node refers to a current offset in the packet to determine an identifier for forwarding the packet from the plurality of identifiers.

In an analogous art, Reinshmidt discloses that the forwarding node refers to a current offset in the packet to determine an identifier for forwarding the packet from the plurality of identifiers

(para 79 and 82; If IP packet 46 is forwarded via a BBQ-based path (e.g., BBQ 51), it includes a header that is associated only with UDP process (56a and 56b). If the incoming packet arrives from a RQnode, its header is associated with ICMP protocol (56a). If the next hop type is RQnode, the ICMP header is added to the packet (56b). The Camod driver recognizes that packet 46 arrived from originator source (not shown) in a way described above. If packet 46 is identified, by the Camod driver, as a `UDP` packet (i.e., by utilizing 56a), the Camod driver forwards packet 46 to the IP level, wherein the IP address (52) of the current node is extracted, and the next consecutive

IP address (53) is `revealed`, to which the packet is forwarded (i.e., to the next consecutive node, being a BBQ node). However, if packet 46 is identified, by the Camod driver, as an `ICMP` packet, the Camod driver forwards packet 46 directly to the Qflow application (58, 51) (i.e., bypassing the IP and TCP levels). Being an intermediate BBQ node, Qflow application 51 further forwards packet 46 to the Camod driver (54), from which the packet is forwarded to the next consecutive node, being an RQnode node. Referring also to FIG. 13, the Qflow application (FIG. 6) compares the hops offset number to the current hop number. The two latter numbers do not match, a fact which indicates that the current BBQ (51) is only an intermediate node. Therefore, the Qflow application updates the current hop number and inserts the next BBQ's IP address (53) into the packet's header if it is intended for a BBQ node, or adds ICMP header, if it is intended for a RQnode node. The modified packet (55) is then forwarded to the local ISP default router (54), and from there to the next node (not shown), along the selected path in the VPN). It would have been obvious to one of ordinary skill in the art at the time of invention was made to modify Vasseur's system by adding the limitation of Reinshmidt in order to improve Quality of Service (QoS) for the transportation of data packets over network infrastructure).

Regarding claim 8, Vasseur discloses a forwarding node (¶ 25; CE1 of Fig. 4), connected to a path management server (¶ 25; Fig. 4; a path computation element PCE inside PE1, wherein PE1 is connected with CE1) that generates a plurality of forwarding path information items (¶ 25; In response to the request, the PCE computes the set of available CE-CE paths and current metrics to the remote destination address prefixes and returns the corresponding CE-CE path metrics to the requesting CE. The requesting CE modifies its IP forwarding entries accordingly in order to perform IP traffic routing corresponding to the CE-CE path metrics);
the forwarding node (¶ 25; CE1 of Fig. 4) that, in accordance with at least one of the plurality of forwarding path information items (¶ 25; In response to the request, the PCE computes the set of available CE-CE paths and current metrics to the remote destination address prefixes and returns the corresponding CE-CE path metrics to the requesting CE. The requesting CE modifies its IP forwarding entries accordingly in order to perform IP traffic routing corresponding to the CE-CE path metrics), executes a packet forwarding processing of a packet (¶ 25; The requesting CE modifies its IP forwarding entries accordingly in order to perform IP traffic routing corresponding to the CE-CE path metrics) with a header including the plurality of forwarding path information items (¶ 51; The header 310 may be used to indicate a source and destination address of the request).

Vasseur does not explicitly disclose that each of the identifier identifies a link established between a forwarding node from among a plurality of forwarding nodes and a neighboring node thereof, wherein the link is uniquely identified by one of the plurality of identifiers within a network domain comprising a plurality of nodes; and a forwarding unit forwards a packet in accordance with at least one of the plurality of identifiers.

In an analogous art, Smith discloses that each of the identifier identifies a link established between a forwarding node from among a plurality of forwarding nodes and a neighboring node thereof (para 25; Referring now to FIG. 1A, an exemplary network 10 in which source routing may be used is shown. A source device 12 that seeks to communicate with a destination device 38 executes a transport layer routing protocol, such as Open Shortest Path First (OSPF) routing protocol, IS-IS, or the like to select the desired `hops` in the path from source to destination. For the purpose of this application, a `hop` may be defined to be an address of a node, a link associated with a node or a label identifying a link or a node), wherein the link is uniquely identified by one of the plurality of identifiers within a network domain comprising a plurality of nodes (para 28; fig. 2A and 2B, a source routing network wherein links rather than nodal addresses, are used to identify the next `hop` in the network is shown. For the purpose of this application, a link identifies an interface of a network device which may be used to transmit data. Thus, in the network 5, device 14 has multiple output interface link (L1, L2, L6 and L7), any of which can be selected to as a path for the next `hop` out of the device. The path from source node 12 to destination node 38 is thus indicated as link `hops` L1, L2, L3, L4 and L5 as illustrated in FIG. 2B); and a forwarding unit forwards a packet in accordance with at least one of the plurality of identifiers (para 29; according to one aspect of the invention, the header of a packet can be modified to include, with each hop identifier (whether it be a node address, link address, label or some other indicator), one or more bits comprising a congestion field, such as congestion fields 40, 41, 42, 43 and 44. The congestion field is associated with each `hop`, and indicates a relative congestion on the `hop.` The existence of congestion at the `hop` can be determined using any one of a variety of known congestion detection techniques, and the present invention is not limited to the use of any particular mechanism or threshold for congestion detection. Exemplary methods that are used in the art include monitoring

transmit and receive buffer fullness at the device, measuring a number of dropped packets, measurement of a delay in response by the device, and may other methods. In one sense,`Congestion` means resource conflicts with regard to the transport medium and buffers associated with packet traffic. However, the system and method of the present invention can also used to indicate other resource conflicts; such as power, error rates, etc., and thus the terms `congestion` and `resource conflicts` can be used interchangeably below). It would have been obvious to one of ordinary skill in the art at the time of invention was made to modify Vasseur's system by adding the limitation of Smith in order to minimize congestion and improving routing in a communication system.

Vasseur does not explicitly disclose that the forwarding node refers to a current offset in the packet to determine an identifier for forwarding the packet from the plurality of identifiers.

In an analogous art, Reinshmidt discloses that the forwarding node refers to a current offset in the packet to determine an identifier for forwarding the packet from the plurality of identifiers (para 79 and 82; If IP packet 46 is forwarded via a BBQ-based path (e.g., BBQ 51), it includes a header that is associated only with UDP process (56a and 56b). If the incoming packet arrives from a RQnode, its header is associated with ICMP protocol (56a). If the next hop type is RQnode, the ICMP header is added to the packet (56b). The Camod driver recognizes that packet 46 arrived from originator source (not shown) in a way described above. If packet 46 is identified, by the Camod driver, as a `UDP` packet (i.e., by utilizing 56a), the Camod driver forwards packet 46 to the IP level, wherein the IP address (52) of the current node is extracted, and the next consecutive

IP address (53) is `revealed`, to which the packet is forwarded (i.e., to the next consecutive node, being a BBQ node). However, if packet 46 is identified, by the Camod driver, as an `ICMP` packet, the Camod driver forwards packet 46 directly to the Qflow application (58, 51) (i.e., bypassing the IP and TCP levels). Being an intermediate BBQ node, Qflow application 51 further forwards packet 46 to the Camod driver (54), from which the packet is forwarded to the next consecutive node, being an RQnode node. Referring also to FIG. 13, the Qflow application (FIG. 6) compares the hops offset number to the current hop number. The two latter numbers do not match, a fact which indicates that the current BBQ (51) is only an intermediate node. Therefore, the Qflow application updates the current hop number and inserts the next BBQ's IP address (53) into the packet's header if it is intended for a BBQ node, or adds ICMP header, if it is intended for a RQnode node. The modified packet (55) is then forwarded to the local ISP default router (54), and from there to the next node (not shown), along the selected path in the VPN). It would have been obvious to one of ordinary skill in the art at the time of invention was made to modify Vasseur's system by adding the limitation of Reinshmidt in order to improve Quality of Service (QoS) for the transportation of data packets over network infrastructure).

Regarding claim 9, Vasseur further discloses a path management server (¶ 25; Fig. 4; a path computation element PCE inside PE1) that, upon receiving a path request from the forwarding node (¶ 25 and 46; Fig. 4; PE1 receives request from CE), replies (¶ 25; Fig. 4; In response to the request, the PCE computes the set of available CE-CE paths and current metrics to the remote destination address prefixes and returns the corresponding CE-CE path metrics to the requesting CE), based on information included in the path request (¶ 25 and 46; the request indicate one or more requested path attributes. In response to the request, the PCE computes the set of available

CE-CE paths based on the information in the request), with a plurality of forwarding path identifiers by which the packet is made to reach a communication partner (¶ 63; path metrics used for a packet to reach to the destination).

Regarding claim 10, Vasseur discloses:

by a path management server (¶ 25; a path computation element PCE inside PE1) in a data forwarding network (100 of Fig. 4), upon receiving a path request from a forwarding node (Fig. 4; PE1 receives request from CE1), replying (Fig. 4; In response to the request, the PCE computes the set of available CE-CE paths and current metrics to the remote destination address prefixes and returns the corresponding CE-CE path metrics to the requesting CE.), based on information included in the path request (¶ 25; the request may indicate one or more requested path attributes) with a plurality of forwarding path information items (¶ 25; In response to the request, the PCE computes the set of available CE-CE paths and current metrics to the remote destination address prefixes and returns the corresponding CE-CE path metrics to the requesting CE. The requesting CE modifies its IP forwarding entries accordingly in order to perform IP traffic routing corresponding to the CE-CE path metrics);

by a forwarding node group (¶ 23 and 25; Fig. 4; CEs) that is on a forwarding path selected from among the plurality of forwarding path information items (¶ 25; CE-CE paths" metrics/information) and includes the forwarding node (Fig. 4; CE1of Fig, 4), sequentially forwarding a packet in accordance with the selected forwarding path information (¶ 25 and 26; The requesting CE modifies its IP forwarding entries accordingly in order to perform IP traffic routing corresponding to the CE-CE path metrics across its multi-homed CE-PE links).

Vasseur does not explicitly disclose that each of the identifier identifies a link established between a forwarding node from among a plurality of forwarding nodes and a neighboring node thereof, wherein the link is uniquely identified by one of the plurality of identifiers within a network domain comprising a plurality of nodes; and a forwarding unit forwards a packet in accordance with at least one of the plurality of identifiers.

In an analogous art, Smith discloses that each of the identifier identifies a link established between a forwarding node from among a plurality of forwarding nodes and a neighboring node thereof (para 25; Referring now to FIG. 1A, an exemplary network 10 in which source routing may be used is shown. A source device 12 that seeks to communicate with a destination device 38 executes a transport layer routing protocol, such as Open Shortest Path First (OSPF) routing protocol, IS-IS, or the like to select the desired `hops` in the path from source to destination. For the purpose of this application, a `hop` may be defined to be an address of a node, a link associated with a node or a label identifying a link or a node), wherein the link is uniquely identified by one of the plurality of identifiers within a network domain comprising a plurality of nodes (para 28; fig. 2A and 2B, a source routing network wherein links rather than nodal addresses, are used to identify the next `hop` in the network is shown. For the purpose of this application, a link identifies an interface of a network device which may be used to transmit data. Thus, in the network 5, device 14 has multiple output interface link (L1, L2, L6 and L7), any of which can be selected to as a path for the next `hop` out of the device. The path from source node 12 to destination node 38 is thus indicated as link `hops` L1, L2, L3, L4 and L5 as illustrated in FIG. 2B); and a forwarding unit forwards a packet in accordance with at least one of the plurality of identifiers (para 29; according to one aspect of the invention, the header of a packet can be modified to include, with each hop identifier

(whether it be a node address, link address, label or some other indicator), one or more bits comprising a congestion field, such as congestion fields 40, 41, 42, 43 and 44. The congestion field is associated with each `hop`, and indicates a relative congestion on the `hop.` The existence of congestion at the `hop` can be determined using any one of a variety of known congestion detection techniques, and the present invention is not limited to the use of any particular mechanism or threshold for congestion detection. Exemplary methods that are used in the art include monitoring transmit and receive buffer fullness at the device, measuring a number of dropped packets, measurement of a delay in response by the device, and may other methods. In one sense,`Congestion` means resource conflicts with regard to the transport medium and buffers associated with packet traffic. However, the system and method of the present invention can also used to indicate other resource conflicts; such as power, error rates, etc., and thus the terms `congestion` and `resource conflicts` can be used interchangeably below). It would have been obvious to one of ordinary skill in the art at the time of invention was made to modify Vasseur's system by adding the limitation of Smith in order to minimize congestion and improving routing in a communication system.

Vasseur does not explicitly disclose that the forwarding node refers to a current offset in the packet to determine an identifier for forwarding the packet from the plurality of identifiers.

In an analogous art, Reinshmidt discloses that the forwarding node refers to a current offset in the packet to determine an identifier for forwarding the packet from the plurality of identifiers (para 79 and 82; If IP packet 46 is forwarded via a BBQ-based path (e.g., BBQ 51), it includes a header that is associated only with UDP process (56a and 56b). If the incoming packet arrives from a RQnode, its header is associated with ICMP protocol (56a). If the next hop type is RQnode, the

ICMP header is added to the packet (56b). The Camod driver recognizes that packet 46 arrived from originator source (not shown) in a way described above. If packet 46 is identified, by the Camod driver, as a `UDP` packet (i.e., by utilizing 56a), the Camod driver forwards packet 46 to the IP level, wherein the IP address (52) of the current node is extracted, and the next consecutive

IP address (53) is `revealed`, to which the packet is forwarded (i.e., to the next consecutive node, being a BBQ node). However, if packet 46 is identified, by the Camod driver, as an `ICMP` packet, the Camod driver forwards packet 46 directly to the Qflow application (58, 51) (i.e., bypassing the IP and TCP levels). Being an intermediate BBQ node, Qflow application 51 further forwards packet 46 to the Camod driver (54), from which the packet is forwarded to the next consecutive node, being an RQnode node. Referring also to FIG. 13, the Qflow application (FIG. 6) compares the hops offset number to the current hop number. The two latter numbers do not match, a fact which indicates that the current BBQ (51) is only an intermediate node. Therefore, the Qflow application updates the current hop number and inserts the next BBQ's IP address (53) into the packet's header if it is intended for a BBQ node, or adds ICMP header, if it is intended for a RQnode node. The modified packet (55) is then forwarded to the local ISP default router (54), and from there to the next node (not shown), along the selected path in the VPN). It would have been obvious to one of ordinary skill in the art at the time of invention was made to modify Vasseur's system by adding the limitation of Reinshmidt in order to improve Quality of Service (QoS) for the transportation of data packets over network infrastructure).

Regarding claim 11, Vasseur discloses a storage unit to store a packet forwarding table (¶ 41, 60 and 61; The memory stores forwarding table) used for forwarding a packet (¶ 44; At each

router, a forwarding selection and a new substitute label are determined by using the label found in the incoming packet as a reference to a label forwarding table that includes this information).

Vasseur does not explicitly disclose that a forwarding node from among a plurality of forwarding nodes forwards a packet in accordance with an identifier included in a header of the packet; and the forwarding is based on an identifier which identifies a link between the packet forwarding node and an adjacent node thereof on a packet forwarding path; and the link is uniquely identified by the identifier within a network domain comprising a plurality of nodes.

In an analogous art, Smith discloses that a forwarding node from among a plurality of forwarding nodes forwards a packet in accordance with an identifier included in a header of the packet (para 25); and the forwarding is based on an identifier which identifies a link between the packet forwarding node and an adjacent node thereof on a packet forwarding path; and the link is uniquely identified by the identifier within a network domain comprising a plurality of nodes (para 28). It would have been obvious to one of ordinary skill in the art at the time of invention was made to modify Vasseur's system by adding the limitation of Smith in order to minimize congestion and improving routing in a communication system.

Vasseur does not explicitly disclose that the forwarding node refers to a current offset in the packet to determine an identifier for forwarding the packet from the plurality of identifiers.

In an analogous art, Reinshmidt discloses that the forwarding node refers to a current offset in the packet to determine an identifier for forwarding the packet from the plurality of identifiers (para 79 and 82; If IP packet 46 is forwarded via a BBQ-based path (e.g., BBQ 51), it includes a header that is associated only with UDP process (56a and 56b). If the incoming packet arrives from

a RQnode, its header is associated with ICMP protocol (56a). If the next hop type is RQnode, the ICMP header is added to the packet (56b). The Camod driver recognizes that packet 46 arrived from originator source (not shown) in a way described above. If packet 46 is identified, by the Camod driver, as a `UDP` packet (i.e., by utilizing 56a), the Camod driver forwards packet 46 to the IP level, wherein the IP address (52) of the current node is extracted, and the next consecutive

IP address (53) is `revealed`, to which the packet is forwarded (i.e., to the next consecutive node, being a BBQ node). However, if packet 46 is identified, by the Camod driver, as an `ICMP` packet, the Camod driver forwards packet 46 directly to the Qflow application (58, 51) (i.e., bypassing the IP and TCP levels). Being an intermediate BBQ node, Qflow application 51 further forwards packet 46 to the Camod driver (54), from which the packet is forwarded to the next consecutive node, being an RQnode node. Referring also to FIG. 13, the Qflow application (FIG. 6) compares the hops offset number to the current hop number. The two latter numbers do not match, a fact which indicates that the current BBQ (51) is only an intermediate node. Therefore, the Qflow application updates the current hop number and inserts the next BBQ's IP address (53) into the packet's header if it is intended for a BBQ node, or adds ICMP header, if it is intended for a RQnode node. The modified packet (55) is then forwarded to the local ISP default router (54), and from there to the next node (not shown), along the selected path in the VPN). It would have been obvious to one of ordinary skill in the art at the time of invention was made to modify Vasseur's system by adding the limitation of Reinshmidt in order to improve Quality of Service (QoS) for the transportation of data packets over network infrastructure).

Regarding claim 23, Vasseur does not explicitly disclose that the unique link identifier permits a packet to be transmitted along the link in either one of a forward direction or a reverse

direction, thereby permitting the forwarding nodes to backtrack the packet routing to attempt to find another forwarding node with a branching point that provides an alternate routing for the packet.

In an analogous art, Smith discloses that the unique link identifier permits a packet to be transmitted along the link in either one of a forward direction or a reverse direction (para 25), thereby permitting the forwarding nodes to backtrack the packet routing to attempt to find another forwarding node with a branching point that provides an alternate routing for the packet (para 28).It would have been obvious to one of ordinary skill in the art at the time of invention was made to modify Vasseur's system by adding the limitation of Smith in order to minimize congestion and improving routing in a communication system.

4. Claims 6, and 21 are rejected under 35 U.S.C. 103(a) as being unpatentable over Vasseur et al. (US 2007/0217419) in view of Ashwood-Smith et al. (US 2012/0147752), hereinafter Smith, further in view of Reinshmidt et al. (US 2002/0150041) and further in view of Srivastava et al. (US 2006/0130064).

Regarding claim 6, Vasseur does not explicitly disclose that upon changing a forwarding path, the packet stores information that identifies forwarding path information before the change; and the forwarding node uses the forwarding path information before the change included in the packet to perform a return processing to a forwarding path before the change, and to search for a further branch destination.

In an analogous art, Srivastava discloses that upon changing a forwarding path, the packet stores information that identifies forwarding path information before the change (¶ 28; packet stores

forwarding path information before changing the path); and the forwarding node uses the forwarding path information before the change included in the packet to perform a return processing to a forwarding path before the change (¶ 31; forwarding node uses the return path information stored in the packet before changing the path), and to search for a further branch destination (¶ 87 and 88; searching and identifying a branch). Therefore, it would have been obvious to one of ordinary skill in the art at the time of invention was made to modify Vasseur's system by adding the limitation of Srivastava in order to improve the performance of a communication system by finding alternate paths while using the existing paths.

Regarding claim 21, Vasseur does not explicitly disclose the storage unit stores the packet forwarding table used for forwarding the packet based on an identifier which identifies a link between a pair of interfaces of respective nodes.

In an analogous art, Srivastava discloses that the storage unit stores the packet forwarding table used for forwarding the packet based on an identifier which identifies a link between a pair of interfaces of respective nodes (¶ 33 and 173; an identifier that identifies the path between two interfaces). It would have been obvious to one of ordinary skill in the art at the time of invention was made to modify Vasseur's system by adding the limitation of Srivastava in order to improve the efficiency of a data forwarding network.

5. Claims 12, and 13 are rejected under 35 U.S.C. 103(a) as being unpatentable over Vasseur et al. (US 2007/0217419) in view of Ashwood-Smith et al. (US 2012/0147752), hereinafter Smith, further in view of Reinshmidt et al. (US 2002/0150041) and further in view of Kusama et al. (US 2006/0256711).

Regarding claim 12, Vasseur does not explicitly disclose that the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link within a predetermined domain.

In an analogous art, Kusama discloses that the storage unit stores the table used for forwarding the packet based on the identifier (¶ 104; 174 and 188; link identifier is stored in the table and the table is stored in the device information holding module) which uniquely identifies the link within a predetermined domain ((¶ 77; Fig. 1; Each link is uniquely identified by a link identifier throughout the communication network 2. A link identifier is a combination of the router's identifier and interface identifier of an interface to which a link in question is connected. For example, a link 51, which in FIG. 1 connect [192.168.100.1, 1002] and [192.168.100.2, 1001] to each other, has a link identifier [192.168.100.1, 1002, 192.168.100.2, 1001]). It would have been obvious to one of ordinary skill in the art at the time of invention was made to modify Vasseur's system by adding the limitation of Kusama in order to manage communication path configurations to provide efficient routing in a communication network.

Regarding claim 13, Vasseur does not explicitly disclose that the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link within a predetermined local domain.

In an analogous art, Kusama discloses that the storage unit stores the table used for forwarding the packet based on the identifier (¶ 104; 174 and 188; link identifier is stored in the table and the table is stored in the device information holding module) which uniquely identifies the link within a predetermined local domain (¶ 77; Fig. 1; Each link is uniquely identified by a link

identifier throughout the communication network 2. A link identifier is a combination of the router's identifier and interface identifier of an interface to which a link in question is connected. For example, a link 51, which in FIG. 1 connect [192.168.100.1, 1002] and [192.168.100.2, 1001] to each other, has a link identifier [192.168.100.1, 1002, 192.168.100.2, 1001]). It would have been obvious to one of ordinary skill in the art at the time of invention was made to modify Vasseur's system by adding the limitation of Kusama in order to manage communication path configurations to provide efficient routing in a communication network.

4. Claims 2, 4 and 7 are rejected under 35 U.S.C. 103(a) as being unpatentable over Vasseur et al. (US 2007/0217419) in view of Ashwood-Smith et al. (US 2012/0147752), hereinafter Smith further in view of Reinshmidt et al. (US 2002/0150041) and further in view of Chiabaut et al. (US 2009/0168768).

Regarding claim 2, Vasseur in view of Srivastava does not explicitly disclose that the plurality of identifiers include information for determining a forwarding node at which branching is possible from one forwarding path to another forwarding path; and a forwarding node at a position at which the branching is possible selects at least one of the plurality of forwarding path information items.

In an analogous art, Chiabaut discloses that the plurality of identifiers include information for determining a forwarding node at which branching is possible from one forwarding path to another forwarding path (¶ 61 and 64; the node identifier in the diverging branch of the first path which meets a first selection criterion. This can be considered a branch identifier for the first path); and a forwarding node at a position at which the branching is possible selects at least one of the

plurality of forwarding path information items (¶ 70 and 80; selecting information regarding selected branch). Therefore, it would have been obvious to one of ordinary skill in the art at the time of invention was made to modify Vasseur/Srivastava's system by adding the limitation of Chiabaut in order to improve routing in a network by selecting a path among multiple possibilities.

Regarding claim 4, Vasseur further discloses that the packet stores forwarding result information indicative of a forwarding result when a forwarding node performs a forwarding processing based on forwarding path information determined by the path selection information (¶ 6; packet header stores forwarding information); and the forwarding node refers to the forwarding result information updated according to a result of forwarding processing to select forwarding path information in which there is no failure in forwarding (¶ 12 and 53; forwarding path information without failure).

Regarding claim 7, Vassuer does not explicitly disclose that the forwarding node further comprises a forwarding result recording unit that records forwarding path information where a forwarding failure has occurred ; and upon receiving a packet, the forwarding node compares the forwarding path information contained in the packet and the recorded forwarding path information where a forwarding failure has occurred, and when a forwarding failure is expected, switches from a present forwarding path to another forwarding path.

In an analogous art, Chiabaut discloses that the forwarding node further comprises a forwarding result recording unit that records forwarding path information where a forwarding failure has occurred (¶ 86 and 91); and upon receiving a packet, the forwarding node compares the forwarding path information contained in the packet and the recorded forwarding path information where a forwarding failure has occurred (¶ 15 and 50; comparing path information in the packet

with the stored path information), and when a forwarding failure is expected, switches from a present forwarding path to another forwarding path (¶ 91; the branch with a failure is not selected for the incoming packet). Therefore, it would have been obvious to one of ordinary skill in the art at the time of invention was made to modify Vasseur/ Srivastava's system by adding the limitation of Chiabaut in order to improve network performance by minimizing loops in case of a failure in a network path.

5. Claims 5 is rejected under 35 U.S.C. 103(a) as being unpatentable over Vasseur et al. (US 2007/0217419) in view of Ashwood-Smith et al. (US 2012/0147752), hereinafter Smith further in view of Reinshmidt et al. (US 2002/0150041) and further in view of Curtis et al. (US 2008/0285560).

Regarding claim 5, Vassuer in view of Srivastava does not explicitly disclose that the packet can store branch point information indicative of a member of forwarding nodes branch able from a present forwarding path to a different forwarding path(s), on a forwarding path that extends up to a forwarding node that has received the packet; and the forwarding node reduces the branch point information when a forwarding processing is failed and determines whether or not to drop the packet using the branch point information.

In an analogous art, Chiabaut discloses that the packet can store branch point information indicative of a member of forwarding nodes branch able from a present forwarding path to a different forwarding path(s) (¶ 11 and 12; packet contains the information about forwarding path information that includes branch node identifier with different branches), on a forwarding path that extends up to a forwarding node that has received the packet (¶ 12 and 65). Therefore, it would have

been obvious to one of ordinary skill in the art at the time of invention was made to modify Vasseur/Srivastava's system by adding the limitation of Chiabaut in order to improve routing in a network by selecting paths among multiple possibilities.

Vassuer does not explicitly disclose that the forwarding node reduces the branch point information when a forwarding processing is failed and determines whether or not to drop the packet using the branch point information.

In an analogous art, Curtis discloses that the forwarding node reduces the branch point information when a forwarding processing is failed and determines whether or not to drop the packet using the branch point information (¶ 25; if forwarding unsuccessful (no branch) then drops the packet, otherwise forward the packet). Therefore, it would have been obvious to one of ordinary skill in the art at the time of invention was made to modify Vasseur/ Srivastava/Chiabaut's system by adding the limitation of Curtis in order to improve the utilization of network resources by determining proper routing path for a message.

6. Claim 16, 17, 18 and 22 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kusama et al. (US 2006/0256711) in view of Ashwood-Smith et al. (US 2012/0147752), hereinafter Smith and further in view of Reinshmidt et al. (US 2002/0150041).

Regarding claim 16, Kusama discloses a communication unit to communicate with a server for receiving a plurality of information identifiers (¶ 102; the path establishment control protocol message receiving module 301 then derives the link identifiers of links controlled by those message . For instance, in the case where RSVP_HOP is [192.168.100.1, 1002], which represents the interface 31b of the GMPLS switch A, [192.168.100.1, 1002, 192.168.100.2, 1001] is derived as the link

identifier of the link that is controlled by this RSVP-TE message by obtaining 192.168.100.2, 1001], which represents the interface 32a of the GMPLS switch B, namely, the opposing interface of the interface 31b) each of which identifies a link between the packet forwarding node and an adjacent node thereof on a packet forwarding path (¶ 146; 174; link_ID to identify a link); and the link is uniquely identified by the identifier within a network domain comprising a plurality of nodes (¶ 77; Fig. 1; Each link is uniquely identified by a link identifier throughout the communication network 2. A link identifier is a combination of the router's identifier and interface identifier of an interface to which a link in question is connected. For example, a link 51, which in FIG. 1 connect [192.168.100.1, 1002] and [192.168.100.2, 1001] to each other, has a link identifier [192.168.100.1, 1002, 192.168.100.2, 1001]).

Kusama does not explicitly disclose that each of the identifier identifies a link established between a forwarding node from among a plurality of forwarding nodes and a neighboring node thereof, wherein the link is uniquely identified by one of the plurality of identifiers within a network domain comprising a plurality of nodes; and the forwarding node forwards a packet in accordance with at least one of the plurality of identifiers.

In an analogous art, Smith discloses that each of the identifier identifies a link established between a forwarding node from among a plurality of forwarding nodes and a neighboring node thereof (para 25; Referring now to FIG. 1A, an exemplary network 10 in which source routing may be used is shown. A source device 12 that seeks to communicate with a destination device 38 executes a transport layer routing protocol, such as Open Shortest Path First (OSPF) routing protocol, IS-IS, or the like to select the desired `hops` in the path from source to destination. For the purpose of this application, a `hop` may be defined to be an address of a node, a link associated

with a node or a label identifying a link or a node), wherein the link is uniquely identified by one of the plurality of identifiers within a network domain comprising a plurality of nodes (para 28; fig. 2A and 2B, a source routing network wherein links rather than nodal addresses, are used to identify the next `hop` in the network is shown. For the purpose of this application, a link identifies an interface of a network device which may be used to transmit data. Thus, in the network 5, device 14 has multiple output interface link (L1, L2, L6 and L7), any of which can be selected to as a path for the next `hop` out of the device. The path from source node 12 to destination node 38 is thus indicated as link `hops` L1, L2, L3, L4 and L5 as illustrated in FIG. 2B); and the forwarding node forwards a packet in accordance with at least one of the plurality of identifiers (para 29; according to one aspect of the invention, the header of a packet can be modified to include, with each hop identifier (whether it be a node address, link address, label or some other indicator), one or more bits comprising a congestion field, such as congestion fields 40, 41, 42, 43 and 44. The congestion field is associated with each `hop`, and indicates a relative congestion on the `hop.` The existence of congestion at the `hop` can be determined using any one of a variety of known congestion detection techniques, and the present invention is not limited to the use of any particular mechanism or threshold for congestion detection. Exemplary methods that are used in the art include monitoring transmit and receive buffer fullness at the device, measuring a number of dropped packets, measurement of a delay in response by the device, and may other methods. In one sense,`Congestion` means resource conflicts with regard to the transport medium and buffers associated with packet traffic. However, the system and method of the present invention can also used to indicate other resource conflicts; such as power, error rates, etc., and thus the terms `congestion` and `resource conflicts` can be used interchangeably below). It would have been obvious to one of ordinary skill in the art at the time of invention was made to modify Kusama's

system by adding the limitation of Smith in order to minimize congestion and improving routing in a communication system.

Vasseur does not explicitly disclose that the forwarding node refers to a current offset in the packet to determine an identifier for forwarding the packet from the plurality of identifiers.

In an analogous art, Reinshmidt discloses that the forwarding node refers to a current offset in the packet to determine an identifier for forwarding the packet from the plurality of identifiers (para 79 and 82; If IP packet 46 is forwarded via a BBQ-based path (e.g., BBQ 51), it includes a header that is associated only with UDP process (56a and 56b). If the incoming packet arrives from a RQnode, its header is associated with ICMP protocol (56a). If the next hop type is RQnode, the ICMP header is added to the packet (56b). The Camod driver recognizes that packet 46 arrived from originator source (not shown) in a way described above. If packet 46 is identified, by the Camod driver, as a `UDP` packet (i.e., by utilizing 56a), the Camod driver forwards packet 46 to the IP level, wherein the IP address (52) of the current node is extracted, and the next consecutive

IP address (53) is `revealed`, to which the packet is forwarded (i.e., to the next consecutive node, being a BBQ node). However, if packet 46 is identified, by the Camod driver, as an `ICMP` packet, the Camod driver forwards packet 46 directly to the Qflow application (58, 51) (i.e., bypassing the IP and TCP levels). Being an intermediate BBQ node, Qflow application 51 further forwards packet 46 to the Camod driver (54), from which the packet is forwarded to the next consecutive node, being an RQnode node. Referring also to FIG. 13, the Qflow application (FIG. 6) compares the hops offset number to the current hop number. The two latter numbers do not match, a fact which indicates that the current BBQ (51) is only an intermediate node.

Therefore, the Qflow application updates the current hop number and inserts the next BBQ's IP address (53) into the packet's header if it is intended for a BBQ node, or adds ICMP header, if it is intended for a RQnode node. The modified packet (55) is then forwarded to the local ISP default router (54), and from there to the next node (not shown), along the selected path in the VPN). It would have been obvious to one of ordinary skill in the art at the time of invention was made to modify Vasseur's system by adding the limitation of Reinshmidt in order to improve Quality of Service (QoS) for the transportation of data packets over network infrastructure).

Regarding claim 17, Kusama discloses that the storage unit stores the table used for forwarding the packet based on the identifier (¶ 104; 174 and 188; link identifier is stored in the table and the table is stored in the device information holding module) which uniquely identifies the link within a predetermined domain (¶ 77; Fig. 1; Each link is uniquely identified by a link identifier throughout the communication network 2. A link identifier is a combination of the router's identifier and interface identifier of an interface to which a link in question is connected. For example, a link 51, which in FIG. 1 connect [192.168.100.1, 1002] and [192.168.100.2, 1001] to each other, has a link identifier [192.168.100.1, 1002, 192.168.100.2, 1001]).

Regarding claim 18, Kusama discloses that the storage unit stores the table used for forwarding the packet based on the identifier (¶ 104; 174 and 188; link identifier is stored in the table and the table is stored in the device information holding module) which uniquely identifies the link within a predetermined local domain (¶ 77; Fig. 1; Each link is uniquely identified by a link identifier throughout the communication network 2. A link identifier is a combination of the router's identifier and interface identifier of an interface to which a link in question is connected. For

example, a link 51, which in FIG. 1 connect [192.168.100.1, 1002] and [192.168.100.2, 1001] to each other, has a link identifier [192.168.100.1, 1002, 192.168.100.2, 1001]).

Regarding claim 22, Kusama does not explicitly disclose the storage unit stores the packet forwarding table used for forwarding the packet based on an identifier which identifies a link between a pair of interfaces of respective nodes.

In an analogous art, Smith discloses that the storage unit stores the packet forwarding table used for forwarding the packet based on an identifier which identifies a link between a pair of interfaces of respective nodes (¶ 22 and 29). It would have been obvious to one of ordinary skill in the art at the time of invention was made to modify Kusama's system by adding the limitation of Smith in order to minimize congestion and improving routing in a communication system.

Conclusion

7. Any inquiry concerning this communication or earlier communications from the examiner should be directed to SAMINA CHOUDHRY whose telephone number is (571)270-7102. The examiner can normally be reached on Monday to Thursday (7:30 a.m. to 5.00p.m.).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Yemane Mesfin can be reached on (571)272-3927. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications

may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/SAMINA CHOUDHRY/

Primary Examiner, Art Unit 2462

Notice of References Cited	Application/Control No. 13/137,237	Applicant(s)/Patent Under Reexamination AWANO, JUN	
	Examiner SAMINA CHOUDHRY	Art Unit 2462	Page 1 of 1

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*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-2002/0150041 A1	10-2002	Reinshmidt, Mendel Menachem	H04L12/2697	370/216
	B	US-				
	C	US-				
	D	US-				
	E	US-				
	F	US-				
	G	US-				
	H	US-				
	I	US-				
	J	US-				
	K	US-				
	L	US-				
	M	US-				

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
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	O					
	P					
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NON-PATENT DOCUMENTS

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(54) **METHOD AND SYSTEM FOR PROVIDING AN IMPROVED QUALITY OF SERVICE FOR DATA TRANSPORTATION OVER THE INTERNET**

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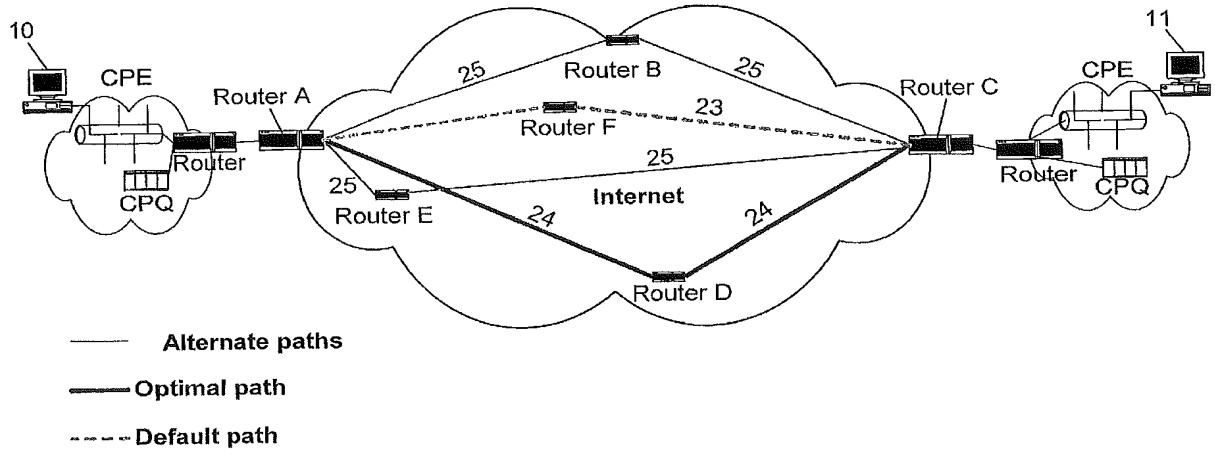
(57) **ABSTRACT**

Method and system for improving the quality of transportation of selected data packets over a data network. Selected nodes are determined as access points to the data network, such that each node may be a source node from which the selected data packets can be transmitted, or a destination node to which the selected data packets can be intended. One or more intermediate nodes are selected, for generating a plurality of alternative paths between the source node and the destination node. Each of the alternative paths consists of segments and includes one or more intermediate nodes for routing the selected data packets. The packet transportation parameters are periodically tested in the segments of each preselected path, each time by sending a plurality of test packets from the source node to the destination node, along the preselected paths defined by different intermediate nodes, the addresses of which are known to the source node. One or more optimal paths, being selected from the alternative paths are defined, for delivering the selected data packets from the source node to the destination node according to the tested transportation parameters. Optimal paths may also be defined according to predefined parameters characterizing the segments by selecting a combination of segments, connected to nodes, and having the optimal tested transportation parameters and/or predefined parameters, that connects the source node to the destination node. A modified header containing a single address or sequence of consecutive addresses that correspond to consecutive nodes along an optimal path, is generated for each selected data packet, and attached to the selected data packet. Each selected test/data packet is forwarded from the source node to the destination node along the optimal path(s), while at each intermediate node, along the optimal path, starting from the source, the modified header is processed and the address that corresponds to the next consecutive intermediate node is extracted. The selected data packet is forwarded from the intermediate node to its consecutive intermediate node using the extracted address. This process is repeated for all intermediate nodes until the destination node, at which the modified header is removing from the selected data packet and, whenever desired, its original header is used.



Electronic Patent Application Fee Transmittal

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Title of Invention:	Communication system, forwarding node, path management server, communication method, and program
First Named Inventor/Applicant Name:	JUN AWANO
Filer:	Sean Michael McGinn/Amber Carroll
Attorney Docket Number:	NEG-1440PCT-US2CT

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Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
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Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

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Miscellaneous:				
Submission- Information Disclosure Stmt	1806	1	180	180
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Payment was successfully received in RAM	$180
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Deposit Account	500481
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Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
2	Other Reference-Patent/App/Search documents	201604081651-1.pdf	2453868 3010e1724033162aa03a9e729c515e837db38042	no	30
Warnings:					
Information:					
3	Other Reference-Patent/App/Search documents	201604081651-2.pdf	146440 b612df52bab4e5da274e3163e8d482ce19f1ce85	no	1
Warnings:					
Information:					
4	Fee Worksheet (SB06)	fee-info.pdf	30636 c9f20a838f5b04eb2e913f065c224038662e3d73	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	2890441		

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If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

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PTO/AIA/31 (03-14)
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NOTICE OF APPEAL FROM THE EXAMINER TO THE PATENT TRIAL AND APPEAL BOARD

Docket Number (Optional): NEG-1440PCT-US2CT

I hereby certify that this correspondence is being facsimile transmitted to the USPTO, EFS-Web transmitted to the USPTO, or deposited with the United States Postal Service with sufficient postage in an envelope addressed to "Commissioner for Patents, P.O. Box 1450, Alexandria, on Alexandria, VA 22313-1450" [37 CFR 1.8(a)]

on _____.

Signature _____

Typed or printed name _____

In re Application of: JUN AWANO

Application Number	Filed
14/244,701	April 3, 2014

For: Communication system, forwarding node, path management server, communication method, and program

Art Unit	Examiner
2475	AUNG, SAI

Applicant hereby **appeals** to the Patent Trial and Appeal Board from the last decision of the examiner.

The fee for this Notice of Appeal is (37 CFR 41.20(b)(1)) $ 800.00

☐ Applicant asserts small entity status. See 37 CFR 1.27. Therefore, the fee shown above is reduced by 50%, and the resulting fee is: $ _____

☐ Applicant certifies micro entity status. See 37 CFR 1.29. Therefore, the fee shown above is reduced by 75%, and the resulting fee is: $ _____
Form PTO/SB/15A or B or equivalent must either be enclosed or have been submitted previously.

☐ A check in the amount of the fee is enclosed.

☐ Payment by credit card. Form PTO-2038 is attached.

☑ The Director is hereby authorized to charge any fees which may be required, or credit any overpayment to Deposit Account No. 50-0481.

☑ Payment made via EFS-Web.

☐ A petition for an extension of time under 37 CFR 1.136(a) (PTO/AIA/22 or equivalent) is enclosed.
For extensions of time in reexamination proceedings, see 37 CFR 1.550.

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

I am the

☐ applicant

☑ attorney or agent of record
Registration number 47,051

☐ attorney or agent acting under 37 CFR 1.34
Registration number _____

Signature S. S. Sahota

Typed or printed name Sam S. Sahota

Telephone Number (703) 761-4100

Date June 3, 2016

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. Submit multiple forms if more than one signature is required, see below*.

☐ * Total of _____ forms are submitted.

This collection of information is required by 37 CFR 41.20(b)(1) and 41.31. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11, 1.14 and 41.6. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Electronic Patent Application Fee Transmittal

Application Number:	14244701
Filing Date:	03-Apr-2014
Title of Invention:	Communication system, forwarding node, path management server, communication method, and program
First Named Inventor/Applicant Name:	JUN AWANO
Filer:	Saryadvinder S. Sahota/Amber Carroll
Attorney Docket Number:	NEG-1440PCT-US2CT

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Notice of Appeal	1401	1	800	800
Post-Allowance-and-Post-Issuance:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**800**

Electronic Acknowledgement Receipt

EFS ID:	25967463
Application Number:	14244701
International Application Number:	
Confirmation Number:	2010
Title of Invention:	Communication system, forwarding node, path management server, communication method, and program
First Named Inventor/Applicant Name:	JUN AWANO
Customer Number:	21254
Filer:	Saryadvinder S. Sahota/Amber Carroll
Filer Authorized By:	Saryadvinder S. Sahota
Attorney Docket Number:	NEG-1440PCT-US2CT
Receipt Date:	03-JUN-2016
Filing Date:	03-APR-2014
Time Stamp:	16:37:47
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$800
RAM confirmation Number	3482
Deposit Account	500481
Authorized User	SAHOTA, SARVADVINDER SAM

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

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Charge any Additional Fees required under 37 CFR 1.17 (Patent application and reexamination processing fees)

Charge any Additional Fees required under 37 CFR 1.19 (Document supply fees)

Charge any Additional Fees required under 37 CFR 1.20 (Post Issuance fees)

Charge any Additional Fees required under 37 CFR 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Notice of Appeal Filed	KATO_Appeal.pdf	109765 40500bfde5cce5d755d9689afa2554cae7177d09	no	1
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30343 2f87de936676be4808cae9525b3a522bd0647f50	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	140108		

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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of Jun Awano

Serial No.: 14/244,701 Group Art Unit: 2475

Filed: April 3, 2014 Examiner: AUNG, SAI

For: COMMUNICATION SYSTEM, FORWARDING NODE, PATH MANAGEMENT SERVER, COMMUNICATION METHOD, AND PROGRAM

Honorable Commissioner of Patents
Alexandria, VA 22313-1450

APPELLANT'S BRIEF ON APPEAL

Sir:

Appellant respectfully appeals the rejection of claims 1-28 in the Office Action dated March 3, 2016. A Notice of Appeal was timely filed on June 3, 2016 and the present Brief on Appeal is being filed.

I. REAL PARTY IN INTEREST

The real party in interest is NEC Corporation, assignee of 100% interest of the above-referenced patent application. An assignment to NEC Corporation of the parent application 13/176,610 (now U.S. Patent 8,750,163) , for which this application 14/244,701 is a continuation of, was signed by all inventors and recorded with the USPTO at Reel/Frame 26619/499 on July 6, 2011.

II. RELATED APPEALS AND INTERFERENCES

There are no other appeals or interferences known to Appellant, Appellant's legal representative or Assignee which would directly affect or be directly affected by or have a bearing on the Board's decision in this Appeal.

III. STATUS OF CLAIMS

Claims 1-28 are rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claims 1 and 8 of the U.S. application number 13/137,237. Claims 1-21 and 27-28 are rejected under 35 U.S.C. 102(b) as being anticipated by Vasseur '603 (US 7,522,603 B2). Claims 22-26 are rejected under 35 U.S.C. l03(a) as being unpatentable over Vasseur '603 (US 7,522,603 B2) in view of Vasseur '102 (US 2007/0280102 A1).

IV. STATUS OF AMENDMENTS (SUBSEQUENT TO FINAL REJECTION)

No amendment was filed subsequent to the final rejection of March 3, 2016. A notice of appeal was filed on June 3, 2016. .

Therefore, the attached claims reflect the version of the claims in the amendment under 37 CFR §1.111 filed on February 1, 2016.

V. SUMMARY OF CLAIMED SUBJECT MATTER

Referring to FIGS. 1 through 9, and paragraphs [0038]-[0141] of the original

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Specification, and using the references numbers of the disclosed embodiment by way of example and not to limit the claims, independent claim 1 is drawn to a packet forwarding node (*e.g.*, 300), comprising:

a storage unit (*e.g.*, 370) including a non-transitory computer readable medium configured to store a packet forwarding table used for forwarding a packet based on an identifier which identifies a link (e.g., link ID) between nodes on a packet forwarding path (See, *e.g.*, [0049]-[0051], Figs. 2-3); and

a forwarding unit (*e.g.*, 320) configured to receive an incoming packet including a plurality of the identifiers, and to forward the incoming packet based on the identifier corresponding to the packet forwarding node (See, *e.g.*, [0049]-[0072]).

Independent claim 6 is drawn to a packet forwarding node (*e.g.*, 300), comprising:

a storage unit (*e.g.*, 370) including a non-transitory computer readable medium configured to store a packet forwarding table used for forwarding a packet based on an identifier (e.g., field 'interface') which identifies an interface (e.g., 310) of a packet forwarding node (See, *e.g.*, [0049]-[0051], Figs. 2-3); and

a forwarding unit (*e.g.*, 320) configured to receive an incoming packet including a plurality of identifiers, and to forward the incoming packet based on the identifier corresponding to the packet forwarding node (See, *e.g.*, [0049]-[0072]).

Independent claim 11 is drawn to a packet forwarding node (*e.g.*, 300), comprising:

a communication unit (e.g., 310) configured to communicate with a server (e.g., 500) for receiving a plurality of identifiers, each of which identifies a link (e.g., link ID) between

nodes on a packet forwarding path (See, *e.g.*, [0046]-[0051], Figs. 1-3); and

a forwarding unit (*e.g.*, 320) configured to forward an incoming packet based on an identifier corresponding to a packet forwarding node (See, *e.g.*, [0049]-[0072]).

Independent claim 16 is drawn to a packet forwarding node (e.g., 300), comprising:

a communication unit (e.g., 310) configured to communicate with a server (e.g., 500) for receiving a plurality of identifiers, each of which identifies an interface of the packet forwarding node (See, *e.g.*, [0046]-[0051], Figs. 1-3); and

a forwarding unit (*e.g.*, 320) configured to forward an incoming packet based on an identifier corresponding to the packet forwarding node (See, *e.g.*, [0049]-[0072]).

Independent claim 21 is drawn to a server (e.g., 500, Fig. 6), comprising:

a first unit (e.g., 530) configured to determine a plurality of identifiers, each of which identifies a link (link ID) between nodes on a packet forwarding path (See, *e.g.*, [0078]-[0091]); and

a second unit (e.g., 510) configured to send information elements to a packet forwarding node which is capable of forwarding an incoming packet based on an identifier corresponding to the packet forwarding node (See, *e.g.*, [0078]-[0091]).

VI. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

The following grounds of rejection to be reviewed by the Board in this Appeal are as follows:

A. Claims 1-21 and 27-28 are rejected under 35 U.S.C. 102(b) as being

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anticipated by Vasseur '603 (US 7,522,603 B2).

B. Claims 22-26 are rejected under 35 U.S.C. l03(a) as being unpatentable over Vasseur '603 (US 7,522,603 B2) in view of Vasseur '102 (US 2007/0280102 A1).

VII. ARGUMENTS

A. Claims 1-21 and 27-28 are rejected under 35 U.S.C. 102(b) as being anticipated by Vasseur (US 7,522,603 B2, hereinafter Vasseur '603).

1. Appellant's arguments with respect to Independent Claims 1, 6, 11, 16 and 21.

Vasseur '603 fails to teach (e.g., claim 1), "*storage unit to store a packet forwarding table used for forwarding a packet based on an identifier which identifies a link between nodes on a packet forwarding path; and a forwarding unit to receive an incoming packet including a plurality of the identifiers, and to forward the incoming packet based on the identifier corresponding to the packet forwarding node*". (emphasis added by Appellant)

Referring to Figs. 2 and 4, the Examiner alleges that the Router performs/receives routing information database RIB and forwarding information database FIB. However, as seen in Col. 8 Lines 59-67 and col. 9, lines 1-2, Vasseur '603 recites that (emphasis added):

Routing services 247 contain computer executable instruc

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> tions executed by processor 220 to perform functions pro vided by one or more routing protocols, such as OSPF, IS-IS, IP, BGP, etc. These functions may be configured to manage a routing information database (RIB) and/or a forwarding information database (FIB) containing, e.g., data used to make routing and forwarding decisions, such as in routing/ forwarding tables 246. Routing services 247 may also per form functions related to virtual routing protocols, such as maintaining VRF instances (not shown), as will be under stood by those skilled in the art.

This is merely reciting that the functions maybe configured to manage a database. There is no teaching that the incoming packet actually includes a plurality of the identifiers.

Moreover, the Examiner asserts that the identifier of the present application which identifies the "link" of the claimed invention and "label" disclosed in Vasseur '603 are the same. Appellant respectfully does not agree.

In Vasseur '603, a packet, being used in MPLS (Multi-Protocol Label Switching), includes a **single label**. On the other hand, in the present application, a packet includes **a plurality of identifiers**. Thus, there is a difference between Vasseur '603 and the claimed invention as the identifier of the claimed invention and label of Vasseur '603 are not the same.

Therefore, in MPLS of Vasseur '603, merely one identifier (label of MPLS) is included in one packet and so a plurality of identifiers are not included in one packet as in the claimed invention showing also that the forwarding table in Vasseur '603 and the forwarding table in the claimed invention are not the same.

For example, Vasseur '603 recites that "[i]n one simple MPLS scenario, at an ingress to a network, a label is assigned to each incoming packet based on its forwarding equivalence class before forwarding the packet to a next-hop router. At each router, a forwarding selection and a new substitute label are determined by using the label found in the incoming

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packet as a reference to a label forwarding table that includes this information." See col. 9, lines 15-21, emphasis added. Therefore, the "label" is assigned to each packet based on its class, but is not a link per se. Moreover, the packet has a single label.

Additionally, The Examiner's rejection of anticipation is also improper because the identical invention is not provided in the following. Please note that according to MPEP §2131, the following applies in a 35 U.S.C. §102 rejection:

> "A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." Verdegaal Bros. v. Union Oil Co. of California, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987).."The identical invention must be shown in as complete detail as is contained in the ... claim." Richardson v. Suzuki Motor Co., 868 F.2d 1226, 1236, 9 USPQ2d 1913, 1920 (Fed. Cir. 1989). The elements must be arranged as required by the claim, but this is not an ipsissimis verbis test, i.e., identity of terminology is not required. In re Bond, 910 F.2d 831, 15 USPQ2d 1566 (Fed. Cir. 1990).

Therefore, as shown above, that since the identical invention is not provided in as complete details as the arranged in the claims from Vasseur '603, the claims are clearly not anticipated.

Independent claims 6, 11, 16, and 21 are similarly not taught by Vasseur '603.

Therefore, Appellant submits that there are elements of the claimed invention that are not taught by Vasseur '603.

Accordingly, Appellant respectfully requests the Board to reconsider and withdraw this rejection of independent claims 1, 6, 11, 16, 21 and claims dependent thereof.

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2. Appellant's arguments with respect to Independent Claims 11, 16 and 21.

Vasseur '603 fails to teach or suggest (e.g., claim 11), "*a communication unit configured to communicate with a server for receiving a plurality of identifiers, each of which identifies a link between nodes on a packet forwarding path; and*

a forwarding unit configured to forward an incoming packet based on an identifier corresponding to a packet forwarding node". (emphasis added by Appellant).

In addition to the arguments stated above, the following also applies.

On pages 28-29 of the last office action (dated March 3, 2016), the Examiner disagrees with the Appellants arguments, "because the applicant fails to provide a clear and distinct explanation of the type of the identifier. Moreover, the applicant never mentions that all the identifiers are the same or different ones. Under the broadest reasonable interpretations, the identifier could be any type of identifier or ID, such as label, address, ID, parameter, header, Metric Prefix and so on."

On page 14 of the last office action, the Examiner alleged that " Figs. 2-4; receiving routing information database RIB that includes the Path Computation Request Message comprising multiple identifiers, such as a header, a source and destination address of the request, the Metrics with Address Prefixes/identifiers to set up the routing/forwarding destination of the CE and so on; Col. 8 Lines 59-67 and Col. 11, Lines 41-48".

However, as seen in claims 11, 16 and 21, the claims do clarify that the communication unit communicates with a server for receiving a plurality of identifiers, each of which identifies a link between nodes on a packet forwarding path. Therefore, each of the plurality of identifiers indentifies a link between the nodes and is communicated from the server. Therefore, the identifier is not any type of ID or label or header. The claims clearly

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clarify the type of identifier as each of the plurality of identifiers indentifies a link between the nodes. No such disclosure is identically made in Vasseur '603, since as shown above, Vasseur '603 relates to MPLS which includes a single label.

Claims 16 and 21 are similarly not taught by Vasseur '603.

Accordingly, Appellant respectfully requests the Board to reconsider and withdraw this rejection for claims 11, 16, 21 and claims dependent thereof.

B. Claims 22-26 are rejected under 35 U.S.C. l03(a) as being unpatentable over Vasseur (US 7,522,603 B2, hereinafter Vasseur '603) in view of Vasseur (US 2007/0280102 A1, hereinafter Vasseur '102).

Claims 22-26 are also not taught or suggested because of the dependency on claims 1, 6, 11, 16 and 21, respectively. Accordingly, Appellant respectfully requests the Board to reconsider and withdraw this rejection.

VIII. CONCLUSION

In view of the foregoing, Appellant submits that claims 1-28, all of the claims presently pending in the application, are patentably distinct over the prior art of record. Thus, the Board is respectfully requested to remove the rejections of claims 1-28. Once allowable subject matter is noted, a terminal disclaimer may be filed to overcome the non-statutory obviousness type double patenting rejection over application US 13/137,237.

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The Commissioner is hereby authorized to charge any deficiency in fees or to credit any overpayment in fees to Attorney's Deposit Account No. 50-0481.

Respectfully Submitted,

Date: August 3, 2016

S. S. Sahota, Esq.
Registration No. 47,051

Sean M. McGinn, Esq.
Registration No. 34,386

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IX. CLAIMS APPENDIX

Claims, as reflected upon entry of the Amendment under 37 CFR §1.111 filed on February 1, 2016:

1. (Previously Presented) A packet forwarding node, comprising:

a storage unit including a non-transitory computer readable medium configured to store a packet forwarding table used for forwarding a packet based on an identifier which identifies a link between nodes on a packet forwarding path; and

a forwarding unit configured to receive an incoming packet including a plurality of the identifiers, and to forward the incoming packet based on the identifier corresponding to the packet forwarding node.

2. (Original) The packet forwarding node according to claim 1, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link within a predetermined domain.

3. (Original) The packet forwarding node according to claim 1, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link within a predetermined local domain.

4. (Original) The packet forwarding node according to claim 1, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link within the packet forwarding node.

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5. (Original) The packet forwarding node according to claim 1, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link among the packet forwarding nodes.

6. (Previously Presented) A packet forwarding node, comprising:

a storage unit including a non-transitory computer readable medium configured to store a packet forwarding table used for forwarding a packet based on an identifier which identifies an interface of a packet forwarding node; and

a forwarding unit configured to receive an incoming packet including a plurality of identifiers, and to forward the incoming packet based on the identifier corresponding to the packet forwarding node.

7. (Original) The packet forwarding node according to claim 6, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies a link within a predetermined domain.

8. (Previously Presented) The packet forwarding node according to claim 6, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies a link within a predetermined local domain.

9. (Previously Presented) The packet forwarding node according to claim 6, wherein the

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storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies a link within the packet forwarding node.

10. (Previously Presented) The packet forwarding node according to claim 6, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies a link among the packet forwarding nodes.

11. (Previously Presented) A packet forwarding node, comprising:

a communication unit configured to communicate with a server for receiving a plurality of identifiers, each of which identifies a link between nodes on a packet forwarding path; and

a forwarding unit configured to forward an incoming packet based on an identifier corresponding to a packet forwarding node.

12. (Previously Presented) The packet forwarding node according to claim 11, wherein the forwarding unit forwards the packet based on the identifier which uniquely identifies a link within a predetermined domain.

13. (Previously Presented) The packet forwarding node according to claim 11, wherein the forwarding unit forwards the packet based on the identifier which uniquely identifies the link within a predetermined local domain.

14. (Previously Presented) The packet forwarding node according to claim 11, wherein the

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forwarding unit forwards the packet based on the identifier which uniquely identifies the link within the packet forwarding node.

15. (Previously Presented) The packet forwarding node according to claim 11, wherein the forwarding unit forwards the packet based on the identifier which uniquely identifies the link among the packet forwarding nodes.

16. (Previously Presented) A packet forwarding node, comprising:

a communication unit configured to communicate with a server for receiving a plurality of identifiers, each of which identifies an interface of the packet forwarding node; and

a forwarding unit configured to forward an incoming packet based on an identifier corresponding to the packet forwarding node.

17. (Previously Presented) The packet forwarding node according to claim 16, wherein the forwarding unit forwards the packet based on the identifier which uniquely identifies a link within a predetermined domain.

18. (Previously Presented) The packet forwarding node according to claim 16, wherein the forwarding unit forwards the packet based on the identifier which uniquely identifies a link within a predetermined local domain.

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19. (Previously Presented) The packet forwarding node according to claim 16, wherein the forwarding unit forwards the packet based on the identifier which uniquely identifies a link within the packet forwarding node.

20. (Previously Presented) The packet forwarding node according to claim 16, wherein the forwarding unit forwards the packet based on the identifier which uniquely identifies a link among the packet forwarding nodes.

21. (Previously Presented) A server, comprising:

a first unit configured to determine a plurality of identifiers, each of which identifies a link between nodes on a packet forwarding path; and

a second unit configured to send information elements to a packet forwarding node which is capable of forwarding an incoming packet based on an identifier corresponding to the packet forwarding node.

22. (Previously Presented) The packet forwarding node according to claim 1, wherein the storage unit stores the table used for forwarding the packet based on the identifier which identifies a link between adjacent nodes on a packet forwarding path.

23. (Previously Presented) The packet forwarding node according to claim 6, wherein the storage unit stores the packet forwarding table used for forwarding the packet based on the identifier which identifies a link between adjacent nodes on a packet forwarding path.

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24. (Previously Presented) The packet forwarding node according to claim 11, further comprising a storage unit that stores a table used for forwarding the packet based on an identifier which identifies a link between adjacent nodes on a packet forwarding path.

25. (Previously Presented) The packet forwarding node according to claim 16, further comprising a storage unit that stores a table used for forwarding the packet based on an identifier which identifies a link between adjacent nodes on a packet forwarding path.

26. (Previously Presented) The server according to claim 21, further comprising a storage unit to store a packet forwarding table used for forwarding the incoming packet based on the identifier which identifies the link between nodes on the packet forwarding path,

wherein the storage unit stores the table used for forwarding the packet based on the identifier which identifies a link between adjacent nodes on a packet forwarding path.

27. (Previously Presented) The packet forwarding node according to claim 1, wherein the forwarding unit comprises a forwarding device.

28. (Previously Presented) The packet forwarding node according to claim 11, wherein:

the communication unit comprises a communication device, and

the forwarding unit comprises a forwarding device.

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Electronic Acknowledgement Receipt

EFS ID:	26541301
Application Number:	14244701
International Application Number:	
Confirmation Number:	2010
Title of Invention:	Communication system, forwarding node, path management server, communication method, and program
First Named Inventor/Applicant Name:	JUN AWANO
Customer Number:	21254
Filer:	Sean Michael McGinn/Amber Carroll
Filer Authorized By:	Sean Michael McGinn
Attorney Docket Number:	NEG-1440PCT-US2CT
Receipt Date:	03-AUG-2016
Filing Date:	03-APR-2014
Time Stamp:	19:30:34
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Appeal Brief Filed	Appeal.pdf	1235641 1513bb2930d2d622c8ff600b7541a94dc9a51a50	no	16

Warnings:

Information:	
Total Files Size (in bytes):	1235641

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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

OPAP AKIMA-3
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PATENT & TRADEMARK OFFICE

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re patent application of

JUN AWANO

Serial No.: 14/244,701 Group Art Unit: 2475

Filed: April 3, 2014 Examiner: AUNG, SAI

For: COMMUNICATION SYSTEM, FORWARDING NODE, PATH MANAGEMENT SERVER, COMMUNICATION METHOD, AND PROGRAM

Honorable Commissioner of Patents
Alexandria, VA 22313-1450

INFORMATION DISCLOSURE STATEMENT

Sir:

Under the provisions of 37 CFR §1.97 through §1.98 and pursuant to applicant's duty of disclosure under 37 CFR §1.56, applicant respectfully brings the following documents listed on the attached from PTO-1449, to the attention of the Examiner in charge of the above-identified application. This reference was cited in an Office Action dated July 27, 2016, issued by the Examiner in the co-pending Application No. 13/137,237. Copies of the listed documents are provided herewith for the convenience of the Examiner.

This citation does not constitute an admission that the references are relevant or material to the claim. It is only cited as constituting related art of which the applicant is aware.

I hereby certify that no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in §1.56(c) more than three months prior to the filing of the information disclosure statement.

Submitted herewith is the Information Disclosure Statement fee of $180.00.

09/02/2016 SMOHAMME 00000005 14244701
01 FC:1806 180.00 OP

It is respectfully requested that the listed references be considered by the Examiner and formally made of record in this application.

Please charge any deficiencies in fees and credit any overpayment of fees to Attorney's Deposit Account No. 50-0481.

Respectfully submitted,

Sam S. Sahota, Esq.
Registration No. 47,051
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Registration No. 34,386

Date: September 1, 2016

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OPAP
SEP 01 2016
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Information Disclosure Citation

Docket Number	Application Number
NEG-1440PCTUSCONT	14/244,701
Inventor	
NEC CORPORATION	
Filing Date	**Group Art Unit**
April 3, 2014	2475

U. S. Patent Documents

Examiner Initial	Ref	Document Number	Date	Name	Class	Subclass	Filing Date (If Appropriate)	
		US 6,788,689 B1	09/07/2004	Turner, et al.				

U. S. Patent Application Publications

Examiner Initial	Ref	Document Number	Date	Name	Class	Subclass	Filing Date (If Appropriate)	

Foreign Patent Documents

Examiner Initial	Ref	Document Number	Date	Country	Class	Subclass	Translation	
							Yes	No

Other Documents (Including Author, Title, Date, Pertinent Pages, etc.)

		United States Office Action dated July 27, 2016 in co-pending Application No. 13/137,237.

Examiner	**Date Considered**

Examiner: Initial if citation considered, whether citation is in conformance with MPEP Section 609; Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to Applicant.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/137,237	07/29/2011	Jun Awano	NEG-1493PCT-US	3475

21254 7590 07/27/2016

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JUL 29 2016

EXAMINER	
CHOUDHRY, SAMINA F	

ART UNIT	PAPER NUMBER
2462	

MAIL DATE	DELIVERY MODE
07/27/2016	PAPER

McGINN IP LAW, PLLC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

9-27-16
10-27-16
11-27-16
12-27-16
1-27-17

Office Action Summary	Application No. 13/137,237	Applicant(s) AWANO, JUN	
	Examiner SAMINA CHOUDHRY	Art Unit 2462	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *04/08/2016*.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5)☒ Claim(s) *1,2,4-13,16-18 and 21-23* is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6)☐ Claim(s) _____ is/are allowed.

7)☐ Claim(s) *1-2, 4-13 and 16-18 and 21-23* is/are rejected.

8)☐ Claim(s) _____ is/are objected to.

9)☐ Claim(s) _____ are subject to restriction and/or election requirement.

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☒ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date _____.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.

4) ☐ Other: _____.

DETAILED ACTION

Response to Arguments

1. This action is response to the communication filed on 04/08/2016.

Claims 1, 2, 4-13, 16-18 and 21-23 are pending. Based on new ground of rejection, applicant's arguments are moot.

Claim Rejections - 35 USC § 103

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

3. Claims 1, 8, 9, 10, 11 and 23 are rejected under 35 U.S.C. 103(a) as being unpatentable over Vasseur et al. (US 2007/0217419) in view of Ashwood-Smith et al. (US 2012/0147752), hereinafter Smith and further in view of Turner et al. (US 6,788,689).

Regarding claim 1, Vasseur discloses:

a path management server (¶ 25; a path computation element PCE) that generates a plurality of identifiers (¶ 25; 46; 47; and 70; PCE generates path metrics and link attribute information);

Vasseur does not explicitly disclose that each of the identifier identifies a link established between a forwarding node from among a plurality of forwarding nodes and a neighboring node thereof, wherein the link is uniquely identified by one of the plurality of identifiers within a network

domain comprising a plurality of nodes; and the forwarding node forwards a packet in accordance with at least one of the plurality of identifiers arranged in forwarding order in a header of the packet.

In an analogous art, Smith discloses that each of the identifier identifies a link established between a forwarding node from among a plurality of forwarding nodes and a neighboring node thereof (para 25; Referring now to FIG. 1A, an exemplary network 10 in which source routing may be used is shown. A source device 12 that seeks to communicate with a destination device 38 executes a transport layer routing protocol, such as Open Shortest Path First (OSPF) routing protocol, IS-IS, or the like to select the desired `hops` in the path from source to destination. For the purpose of this application, a `hop` may be defined to be an address of a node, a link associated with a node or a label identifying a link or a node), wherein the link is uniquely identified by one of the plurality of identifiers within a network domain comprising a plurality of nodes (para 28; fig. 2A and 2B, a source routing network wherein links rather than nodal addresses, are used to identify the next `hop` in the network is shown. For the purpose of this application, a link identifies an interface of a network device which may be used to transmit data. Thus, in the network 5, device 14 has multiple output interface link (L1, L2, L6 and L7), any of which can be selected to as a path for the next `hop` out of the device. The path from source node 12 to destination node 38 is thus indicated as link `hops` L1, L2, L3, L4 and L5 as illustrated in FIG. 2B); and the forwarding node forwards a packet in accordance with at least one of the plurality of identifiers (para 29; according to one aspect of the invention, the header of a packet can be modified to include, with each hop identifier (whether it be a node address, link address, label or some other indicator), one or more bits comprising a congestion field, such as congestion fields 40, 41, 42, 43 and 44. The congestion field is associated with each `hop`, and indicates a relative congestion on the `hop.` The existence of

congestion at the `hop` can be determined using any one of a variety of known congestion detection techniques, and the present invention is not limited to the use of any particular mechanism or threshold for congestion detection. Exemplary methods that are used in the art include monitoring transmit and receive buffer fullness at the device, measuring a number of dropped packets, measurement of a delay in response by the device, and may other methods. In one sense,`Congestion` means resource conflicts with regard to the transport medium and buffers associated with packet traffic. However, the system and method of the present invention can also used to indicate other resource conflicts; such as power, error rates, etc., and thus the terms `congestion` and `resource conflicts` can be used interchangeably below). It would have been obvious to one of ordinary skill in the art at the time of invention was made to modify Vasseur's system by adding the limitation of Smith in order to minimize congestion and improving routing in a communication system.

Vasseur does not explicitly disclose that the forwarding node refers to a current offset in the packet to determine an identifier that identifies a link for forwarding the packet from the plurality of identifiers.

In an analogous art, Turner discloses that the forwarding node refers to a current offset in the packet to determine an identifier that identifies a link for forwarding the packet from the plurality of identifiers (Col. 8; lines 62-67; The operation of the route assignment mechanism in the SE I is similar to that for the input interfaces. In an SE1, the offset identifies one of the links from that SE1 to an SE2, and the bandwidth value for a particular output interface Y represents the total bandwidth used by packets passing through that SE1 and going to output interface Y. If the (offset, bandwidth) pair for output Y is (f, b), then packets to output Y are routed through the links

numbered f, f+1, . . . , f+b-1 connecting that SE1 to SE2s). It would have been obvious to one of ordinary skill in the art at the time of invention was made to modify Vasseur's system by adding the limitation of Turner in order to provide method and system for routing traffic to achieve bounded delay in a communication system.

Regarding claim 8, Vasseur discloses a forwarding node (¶ 25; CE1 of Fig. 4), connected to a path management server (¶ 25; Fig. 4; a path computation element PCE inside PE1, wherein PE1 is connected with CE1) that generates a plurality of forwarding path information items (¶ 25; In response to the request, the PCE computes the set of available CE-CE paths and current metrics to the remote destination address prefixes and returns the corresponding CE-CE path metrics to the requesting CE. The requesting CE modifies its IP forwarding entries accordingly in order to perform IP traffic routing corresponding to the CE-CE path metrics);
the forwarding node (¶ 25; CE1 of Fig. 4) that, in accordance with at least one of the plurality of forwarding path information items (¶ 25; In response to the request, the PCE computes the set of available CE-CE paths and current metrics to the remote destination address prefixes and returns the corresponding CE-CE path metrics to the requesting CE. The requesting CE modifies its IP forwarding entries accordingly in order to perform IP traffic routing corresponding to the CE-CE path metrics), executes a packet forwarding processing of a packet (¶ 25; The requesting CE modifies its IP forwarding entries accordingly in order to perform IP traffic routing corresponding to the CE-CE path metrics) with a header including the plurality of forwarding path information items (¶ 51; The header 310 may be used to indicate a source and destination address of the request).

Vasseur does not explicitly disclose that each of the identifier identifies a link established between a forwarding node from among a plurality of forwarding nodes and a neighboring node

thereof, wherein the link is uniquely identified by one of the plurality of identifiers within a network domain comprising a plurality of nodes; and a forwarding unit forwards a packet in accordance with at least one of the plurality of identifiers.

In an analogous art, Smith discloses that each of the identifier identifies a link established between a forwarding node from among a plurality of forwarding nodes and a neighboring node thereof (para 25; Referring now to FIG. 1A, an exemplary network 10 in which source routing may be used is shown. A source device 12 that seeks to communicate with a destination device 38 executes a transport layer routing protocol, such as Open Shortest Path First (OSPF) routing protocol, IS-IS, or the like to select the desired `hops` in the path from source to destination. For the purpose of this application, a `hop` may be defined to be an address of a node, a link associated with a node or a label identifying a link or a node), wherein the link is uniquely identified by one of the plurality of identifiers within a network domain comprising a plurality of nodes (para 28; fig. 2A and 2B, a source routing network wherein links rather than nodal addresses, are used to identify the next `hop` in the network is shown. For the purpose of this application, a link identifies an interface of a network device which may be used to transmit data. Thus, in the network 5, device 14 has multiple output interface link (L1, L2, L6 and L7), any of which can be selected to as a path for the next `hop` out of the device. The path from source node 12 to destination node 38 is thus indicated as link `hops` L1, L2, L3, L4 and L5 as illustrated in FIG. 2B); and a forwarding unit forwards a packet in accordance with at least one of the plurality of identifiers (para 29; according to one aspect of the invention, the header of a packet can be modified to include, with each hop identifier (whether it be a node address, link address, label or some other indicator), one or more bits comprising a congestion field, such as congestion fields 40, 41, 42, 43 and 44. The congestion field

is associated with each `hop`, and indicates a relative congestion on the `hop.` The existence of congestion at the `hop` can be determined using any one of a variety of known congestion detection techniques, and the present invention is not limited to the use of any particular mechanism or threshold for congestion detection. Exemplary methods that are used in the art include monitoring transmit and receive buffer fullness at the device, measuring a number of dropped packets, measurement of a delay in response by the device, and may other methods. In one sense,`Congestion` means resource conflicts with regard to the transport medium and buffers associated with packet traffic. However, the system and method of the present invention can also used to indicate other resource conflicts; such as power, error rates, etc., and thus the terms `congestion` and `resource conflicts` can be used interchangeably below). It would have been obvious to one of ordinary skill in the art at the time of invention was made to modify Vasseur's system by adding the limitation of Smith in order to minimize congestion and improving routing in a communication system.

Vasseur does not explicitly disclose that the forwarding node refers to a current offset in the packet to determine an identifier that identifies a link for forwarding the packet from the plurality of identifiers.

In an analogous art, Turner discloses that the forwarding node refers to a current offset in the packet to determine an identifier that identifies a link for forwarding the packet from the plurality of identifiers (Col. 8; lines 62-67; The operation of the route assignment mechanism in the SE I is similar to that for the input interfaces. In an SE1, the offset identifies one of the links from that SE1 to an SE2, and the bandwidth value for a particular output interface Y represents the total bandwidth used by packets passing through that SE1 and going to output interface Y. If the (offset,

bandwidth) pair for output Y is (f, b), then packets to output Y are routed through the links numbered f, f+1, . . . , f+b-1 connecting that SE1 to SE2s). It would have been obvious to one of ordinary skill in the art at the time of invention was made to modify Vasseur's system by adding the limitation of Turner in order to provide method and system for routing traffic to achieve bounded delay in a communication system.

Regarding claim 9, Vasseur further discloses a path management server (¶ 25; Fig. 4; a path computation element PCE inside PE1) that, upon receiving a path request from the forwarding node (¶ 25 and 46; Fig. 4; PE1 receives request from CE), replies (¶ 25; Fig. 4; In response to the request, the PCE computes the set of available CE-CE paths and current metrics to the remote destination address prefixes and returns the corresponding CE-CE path metrics to the requesting CE), based on information included in the path request (¶ 25 and 46; the request indicate one or more requested path attributes. In response to the request, the PCE computes the set of available CE-CE paths based on the information in the request), with a plurality of forwarding path identifiers by which the packet is made to reach a communication partner (¶ 63; path metrics used for a packet to reach to the destination).

Regarding claim 10, Vasseur discloses:

by a path management server (¶ 25; a path computation element PCE inside PE1) in a data forwarding network (100 of Fig. 4), upon receiving a path request from a forwarding node (Fig. 4; PE1 receives request from CE1), replying (Fig. 4; In response to the request, the PCE computes the set of available CE-CE paths and current metrics to the remote destination address prefixes and returns the corresponding CE-CE path metrics to the requesting CE.), based on information included in the path request (¶ 25; the request may indicate one or more requested path attributes)

with a plurality of forwarding path information items (¶ 25; In response to the request, the PCE computes the set of available CE-CE paths and current metrics to the remote destination address prefixes and returns the corresponding CE-CE path metrics to the requesting CE. The requesting CE modifies its IP forwarding entries accordingly in order to perform IP traffic routing corresponding to the CE-CE path metrics);

by a forwarding node group (¶ 23 and 25; Fig. 4; CEs) that is on a forwarding path selected from among the plurality of forwarding path information items (¶ 25; CE-CE paths" metrics/information) and includes the forwarding node (Fig. 4; CE1of Fig, 4), sequentially forwarding a packet in accordance with the selected forwarding path information (¶ 25 and 26; The requesting CE modifies its IP forwarding entries accordingly in order to perform IP traffic routing corresponding to the CE-CE path metrics across its multi-homed CE-PE links).

Vasseur does not explicitly disclose that each of the identifier identifies a link established between a forwarding node from among a plurality of forwarding nodes and a neighboring node thereof, wherein the link is uniquely identified by one of the plurality of identifiers within a network domain comprising a plurality of nodes; and a forwarding unit forwards a packet in accordance with at least one of the plurality of identifiers.

In an analogous art, Smith discloses that each of the identifier identifies a link established between a forwarding node from among a plurality of forwarding nodes and a neighboring node thereof (para 25; Referring now to FIG. 1A, an exemplary network 10 in which source routing may be used is shown. A source device 12 that seeks to communicate with a destination device 38 executes a transport layer routing protocol, such as Open Shortest Path First (OSPF) routing

protocol, IS-IS, or the like to select the desired `hops` in the path from source to destination. For the purpose of this application, a `hop` may be defined to be an address of a node, a link associated with a node or a label identifying a link or a node), wherein the link is uniquely identified by one of the plurality of identifiers within a network domain comprising a plurality of nodes (para 28; fig. 2A and 2B, a source routing network wherein links rather than nodal addresses, are used to identify the next `hop` in the network is shown. For the purpose of this application, a link identifies an interface of a network device which may be used to transmit data. Thus, in the network 5, device 14 has multiple output interface link (L1, L2, L6 and L7), any of which can be selected to as a path for the next `hop` out of the device. The path from source node 12 to destination node 38 is thus indicated as link `hops` L1, L2, L3, L4 and L5 as illustrated in FIG. 2B); and a forwarding unit forwards a packet in accordance with at least one of the plurality of identifiers (para 29; according to one aspect of the invention, the header of a packet can be modified to include, with each hop identifier (whether it be a node address, link address, label or some other indicator), one or more bits comprising a congestion field, such as congestion fields 40, 41, 42, 43 and 44. The congestion field is associated with each `hop`, and indicates a relative congestion on the `hop.` The existence of congestion at the `hop` can be determined using any one of a variety of known congestion detection techniques, and the present invention is not limited to the use of any particular mechanism or threshold for congestion detection. Exemplary methods that are used in the art include monitoring transmit and receive buffer fullness at the device, measuring a number of dropped packets, measurement of a delay in response by the device, and may other methods. In one sense,`Congestion` means resource conflicts with regard to the transport medium and buffers associated with packet traffic. However, the system and method of the present invention can also used to indicate other resource conflicts; such as power, error rates, etc., and thus the terms

`congestion` and `resource conflicts` can be used interchangeably below). It would have been obvious to one of ordinary skill in the art at the time of invention was made to modify Vasseur's system by adding the limitation of Smith in order to minimize congestion and improving routing in a communication system.

Vasseur does not explicitly disclose that the forwarding node refers to a current offset in the packet to determine an identifier that identifies a link for forwarding the packet from the plurality of identifiers.

In an analogous art, Turner discloses that the forwarding node refers to a current offset in the packet to determine an identifier that identifies a link for forwarding the packet from the plurality of identifiers (Col. 8; lines 62-67; The operation of the route assignment mechanism in the SE I is similar to that for the input interfaces. In an SE1, the offset identifies one of the links from that SE1 to an SE2, and the bandwidth value for a particular output interface Y represents the total bandwidth used by packets passing through that SE1 and going to output interface Y. If the (offset, bandwidth) pair for output Y is (f, b), then packets to output Y are routed through the links numbered f, f+1, . . . , f+b-1 connecting that SE1 to SE2s). It would have been obvious to one of ordinary skill in the art at the time of invention was made to modify Vasseur's system by adding the limitation of Turner in order to provide method and system for routing traffic to achieve bounded delay in a communication system.

Regarding claim 11, Vasseur discloses a storage unit to store a packet forwarding table (¶ 41, 60 and 61; The memory stores forwarding table) used for forwarding a packet (¶ 44; At each router, a forwarding selection and a new substitute label are determined by using the label found in the incoming packet as a reference to a label forwarding table that includes this information).

Vasseur does not explicitly disclose that a forwarding node from among a plurality of forwarding nodes forwards a packet in accordance with an identifier included in a header of the packet; and the forwarding is based on an identifier which identifies a link between the packet forwarding node and an adjacent node thereof on a packet forwarding path; and the link is uniquely identified by the identifier within a network domain comprising a plurality of nodes.

In an analogous art, Smith discloses that a forwarding node from among a plurality of forwarding nodes forwards a packet in accordance with an identifier included in a header of the packet (para 25); and the forwarding is based on an identifier which identifies a link between the packet forwarding node and an adjacent node thereof on a packet forwarding path; and the link is uniquely identified by the identifier within a network domain comprising a plurality of nodes (para 28). It would have been obvious to one of ordinary skill in the art at the time of invention was made to modify Vasseur's system by adding the limitation of Smith in order to minimize congestion and improving routing in a communication system.

Vasseur does not explicitly disclose that the forwarding node refers to a current offset in the packet to determine an identifier that identifies a link for forwarding the packet from the plurality of identifiers.

In an analogous art, Turner discloses that the forwarding node refers to a current offset in the packet to determine an identifier that identifies a link for forwarding the packet from the plurality of identifiers (Col. 8; lines 62-67; The operation of the route assignment mechanism in the SE I is similar to that for the input interfaces. In an SE1, the offset identifies one of the links from that SE1 to an SE2, and the bandwidth value for a particular output interface Y represents the total bandwidth used by packets passing through that SE1 and going to output interface Y. If the (offset, bandwidth) pair for output Y is (f, b), then packets to output Y are routed through the links numbered f, f+1, . . . , f+b-1 connecting that SE1 to SE2s). It would have been obvious to one of ordinary skill in the art at the time of invention was made to modify Vasseur's system by adding the limitation of Turner in order to provide method and system for routing traffic to achieve bounded delay in a communication system.

Regarding claim 23, Vasseur does not explicitly disclose that the unique link identifier permits a packet to be transmitted along the link in either one of a forward direction or a reverse direction, thereby permitting the forwarding nodes to backtrack the packet routing to attempt to find another forwarding node with a branching point that provides an alternate routing for the packet.

In an analogous art, Smith discloses that the unique link identifier permits a packet to be transmitted along the link in either one of a forward direction or a reverse direction (para 25), thereby permitting the forwarding nodes to backtrack the packet routing to attempt to find another forwarding node with a branching point that provides an alternate routing for the packet (para 28).It would have been obvious to one of ordinary skill in the art at the time of invention was made to

modify Vasseur's system by adding the limitation of Smith in order to minimize congestion and improving routing in a communication system.

4. Claims 6, and 21 are rejected under 35 U.S.C. 103(a) as being unpatentable over Vasseur et al. (US 2007/0217419) in view of Ashwood-Smith et al. (US 2012/0147752), hereinafter Smith, further in view of Turner et al. (US 6,788,689) and further in view of Srivastava et al. (US 2006/0130064).

Regarding claim 6, Vasseur does not explicitly disclose that upon changing a forwarding path, the packet stores information that identifies forwarding path information before the change; and the forwarding node uses the forwarding path information before the change included in the packet to perform a return processing to a forwarding path before the change, and to search for a further branch destination.

In an analogous art, Srivastava discloses that upon changing a forwarding path, the packet stores information that identifies forwarding path information before the change (¶ 28; packet stores forwarding path information before changing the path); and the forwarding node uses the forwarding path information before the change included in the packet to perform a return processing to a forwarding path before the change (¶ 31; forwarding node uses the return path information stored in the packet before changing the path), and to search for a further branch destination (¶ 87 and 88; searching and identifying a branch). Therefore, it would have been obvious to one of ordinary skill in the art at the time of invention was made to modify Vasseur's system by adding the limitation of Srivastava in order to improve the performance of a communication system by finding alternate paths while using the existing paths.

Regarding claim 21, Vasseur does not explicitly disclose the storage unit stores the packet forwarding table used for forwarding the packet based on an identifier which identifies a link between a pair of interfaces of respective nodes.

In an analogous art, Srivastava discloses that the storage unit stores the packet forwarding table used for forwarding the packet based on an identifier which identifies a link between a pair of interfaces of respective nodes (¶ 33 and 173; an identifier that identifies the path between two interfaces). It would have been obvious to one of ordinary skill in the art at the time of invention was made to modify Vasseur's system by adding the limitation of Srivastava in order to improve the efficiency of a data forwarding network.

5. Claims 12, and 13 are rejected under 35 U.S.C. 103(a) as being unpatentable over Vasseur et al. (US 2007/0217419) in view of Ashwood-Smith et al. (US 2012/0147752), hereinafter Smith, further in view of Turner et al. (US 6,788,689), and further in view of Kusama et al. (US 2006/0256711).

Regarding claim 12, Vasseur does not explicitly disclose that the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link within a predetermined domain.

In an analogous art, Kusama discloses that the storage unit stores the table used for forwarding the packet based on the identifier (¶ 104; 174 and 188; link identifier is stored in the table and the table is stored in the device information holding module) which uniquely identifies the link within a predetermined domain ((¶ 77; Fig. 1; Each link is uniquely identified by a link identifier throughout the communication network 2. A link identifier is a combination of the

router's identifier and interface identifier of an interface to which a link in question is connected. For example, a link 51, which in FIG. 1 connect [192.168.100.1, 1002] and [192.168.100.2, 1001] to each other, has a link identifier [192.168.100.1, 1002, 192.168.100.2, 1001]). It would have been obvious to one of ordinary skill in the art at the time of invention was made to modify Vasseur's system by adding the limitation of Kusama in order to manage communication path configurations to provide efficient routing in a communication network.

Regarding claim 13, Vasseur does not explicitly disclose that the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link within a predetermined local domain.

In an analogous art, Kusama discloses that the storage unit stores the table used for forwarding the packet based on the identifier (¶ 104; 174 and 188; link identifier is stored in the table and the table is stored in the device information holding module) which uniquely identifies the link within a predetermined local domain (¶ 77; Fig. 1; Each link is uniquely identified by a link identifier throughout the communication network 2. A link identifier is a combination of the router's identifier and interface identifier of an interface to which a link in question is connected. For example, a link 51, which in FIG. 1 connect [192.168.100.1, 1002] and [192.168.100.2, 1001] to each other, has a link identifier [192.168.100.1, 1002, 192.168.100.2, 1001]). It would have been obvious to one of ordinary skill in the art at the time of invention was made to modify Vasseur's system by adding the limitation of Kusama in order to manage communication path configurations to provide efficient routing in a communication network.

4. Claims 2, 4 and 7 are rejected under 35 U.S.C. 103(a) as being unpatentable over Vasseur et al. (US 2007/0217419) in view of Ashwood-Smith et al. (US 2012/0147752), hereinafter Smith further in view of Turner et al. (US 6,788,689), and further in view of Chiabaut et al. (US 2009/0168768).

Regarding claim 2, Vasseur in view of Srivastava does not explicitly disclose that the plurality of identifiers include information for determining a forwarding node at which branching is possible from one forwarding path to another forwarding path; and a forwarding node at a position at which the branching is possible selects at least one of the plurality of forwarding path information items.

In an analogous art, Chiabaut discloses that the plurality of identifiers include information for determining a forwarding node at which branching is possible from one forwarding path to another forwarding path (¶ 61 and 64; the node identifier in the diverging branch of the first path which meets a first selection criterion. This can be considered a branch identifier for the first path); and a forwarding node at a position at which the branching is possible selects at least one of the plurality of forwarding path information items (¶ 70 and 80; selecting information regarding selected branch). Therefore, it would have been obvious to one of ordinary skill in the art at the time of invention was made to modify Vasseur/Srivastava's system by adding the limitation of Chiabaut in order to improve routing in a network by selecting a path among multiple possibilities.

Regarding claim 4, Vasseur further discloses that the packet stores forwarding result information indicative of a forwarding result when a forwarding node performs a forwarding processing based on forwarding path information determined by the path selection information (¶ 6;

packet header stores forwarding information); and the forwarding node refers to the forwarding result information updated according to a result of forwarding processing to select forwarding path information in which there is no failure in forwarding (¶ 12 and 53; forwarding path information without failure).

Regarding claim 7, Vassuer does not explicitly disclose that the forwarding node further comprises a forwarding result recording unit that records forwarding path information where a forwarding failure has occurred ; and upon receiving a packet, the forwarding node compares the forwarding path information contained in the packet and the recorded forwarding path information where a forwarding failure has occurred, and when a forwarding failure is expected, switches from a present forwarding path to another forwarding path.

In an analogous art, Chiabaut discloses that the forwarding node further comprises a forwarding result recording unit that records forwarding path information where a forwarding failure has occurred (¶ 86 and 91); and upon receiving a packet, the forwarding node compares the forwarding path information contained in the packet and the recorded forwarding path information where a forwarding failure has occurred (¶ 15 and 50; comparing path information in the packet with the stored path information), and when a forwarding failure is expected, switches from a present forwarding path to another forwarding path (¶ 91; the branch with a failure is not selected for the incoming packet). Therefore, it would have been obvious to one of ordinary skill in the art at the time of invention was made to modify Vasseur/ Srivastava's system by adding the limitation of Chiabaut in order to improve network performance by minimizing loops in case of a failure in a network path.

5. Claims 5 is rejected under 35 U.S.C. 103(a) as being unpatentable over Vasseur et al. (US 2007/0217419) in view of Ashwood-Smith et al. (US 2012/0147752), hereinafter Smith further in view of Turner et al. (US 6,788,689), and further in view of Curtis et al. (US 2008/0285560).

Regarding claim 5, Vassuer in view of Srivastava does not explicitly disclose that the packet can store branch point information indicative of a member of forwarding nodes branch able from a present forwarding path to a different forwarding path(s), on a forwarding path that extends up to a forwarding node that has received the packet; and the forwarding node reduces the branch point information when a forwarding processing is failed and determines whether or not to drop the packet using the branch point information.

In an analogous art, Chiabaut discloses that the packet can store branch point information indicative of a member of forwarding nodes branch able from a present forwarding path to a different forwarding path(s) (¶ 11 and 12; packet contains the information about forwarding path information that includes branch node identifier with different branches), on a forwarding path that extends up to a forwarding node that has received the packet (¶ 12 and 65). Therefore, it would have been obvious to one of ordinary skill in the art at the time of invention was made to modify Vasseur/Srivastava's system by adding the limitation of Chiabaut in order to improve routing in a network by selecting paths among multiple possibilities.

Vassuer does not explicitly disclose that the forwarding node reduces the branch point information when a forwarding processing is failed and determines whether or not to drop the packet using the branch point information.

In an analogous art, Curtis discloses that the forwarding node reduces the branch point information when a forwarding processing is failed and determines whether or not to drop the packet using the branch point information (¶ 25; if forwarding unsuccessful (no branch) then drops the packet, otherwise forward the packet). Therefore, it would have been obvious to one of ordinary skill in the art at the time of invention was made to modify Vasseur/ Srivastava/Chiabaut's system by adding the limitation of Curtis in order to improve the utilization of network resources by determining proper routing path for a message.

6. Claim 16, 17, 18 and 22 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kusama et al. (US 2006/0256711) in view of Ashwood-Smith et al. (US 2012/0147752), hereinafter Smith and further in view of Turner et al. (US 6,788,689).

Regarding claim 16, Kusama discloses a communication unit to communicate with a server for receiving a plurality of information identifiers (¶ 102; the path establishment control protocol message receiving module 301 then derives the link identifiers of links controlled by those message . For instance, in the case where RSVP_HOP is [192.168.100.1, 1002], which represents the interface 31b of the GMPLS switch A, [192.168.100.1, 1002, 192.168.100.2, 1001] is derived as the link identifier of the link that is controlled by this RSVP-TE message by obtaining 192.168.100.2, 1001], which represents the interface 32a of the GMPLS switch B, namely, the opposing interface of the interface 31b) each of which identifies a link between the packet forwarding node and an adjacent node thereof on a packet forwarding path (¶ 146; 174; link_ID to identify a link); and the link is uniquely identified by the identifier within a network domain comprising a plurality of nodes (¶ 77; Fig. 1; Each link is uniquely identified by a link identifier throughout the communication network 2. A link identifier is a combination of the router's identifier and interface identifier of an

interface to which a link in question is connected. For example, a link 51, which in FIG. 1 connect [192.168.100.1, 1002] and [192.168.100.2, 1001] to each other, has a link identifier [192.168.100.1, 1002, 192.168.100.2, 1001]).

Kusama does not explicitly disclose that each of the identifier identifies a link established between a forwarding node from among a plurality of forwarding nodes and a neighboring node thereof, wherein the link is uniquely identified by one of the plurality of identifiers within a network domain comprising a plurality of nodes; and the forwarding node forwards a packet in accordance with at least one of the plurality of identifiers.

In an analogous art, Smith discloses that each of the identifier identifies a link established between a forwarding node from among a plurality of forwarding nodes and a neighboring node thereof (para 25; Referring now to FIG. 1A, an exemplary network 10 in which source routing may be used is shown. A source device 12 that seeks to communicate with a destination device 38 executes a transport layer routing protocol, such as Open Shortest Path First (OSPF) routing protocol, IS-IS, or the like to select the desired `hops` in the path from source to destination. For the purpose of this application, a `hop` may be defined to be an address of a node, a link associated with a node or a label identifying a link or a node), wherein the link is uniquely identified by one of the plurality of identifiers within a network domain comprising a plurality of nodes (para 28; fig. 2A and 2B, a source routing network wherein links rather than nodal addresses, are used to identify the next `hop` in the network is shown. For the purpose of this application, a link identifies an interface of a network device which may be used to transmit data. Thus, in the network 5, device 14 has multiple output interface link (L1, L2, L6 and L7), any of which can be selected to as a path for the next `hop` out of the device. The path from source node 12 to destination node 38 is thus indicated

as link `hops` L1, L2, L3, L4 and L5 as illustrated in FIG. 2B); and the forwarding node forwards a packet in accordance with at least one of the plurality of identifiers (para 29; according to one aspect of the invention, the header of a packet can be modified to include, with each hop identifier (whether it be a node address, link address, label or some other indicator), one or more bits comprising a congestion field, such as congestion fields 40, 41, 42, 43 and 44. The congestion field is associated with each `hop`, and indicates a relative congestion on the `hop.` The existence of congestion at the `hop` can be determined using any one of a variety of known congestion detection techniques, and the present invention is not limited to the use of any particular mechanism or threshold for congestion detection. Exemplary methods that are used in the art include monitoring transmit and receive buffer fullness at the device, measuring a number of dropped packets, measurement of a delay in response by the device, and may other methods. In one sense,`Congestion` means resource conflicts with regard to the transport medium and buffers associated with packet traffic. However, the system and method of the present invention can also used to indicate other resource conflicts; such as power, error rates, etc., and thus the terms `congestion` and `resource conflicts` can be used interchangeably below). It would have been obvious to one of ordinary skill in the art at the time of invention was made to modify Kusama's system by adding the limitation of Smith in order to minimize congestion and improving routing in a communication system.

Vasseur does not explicitly disclose that the forwarding node refers to a current offset in the packet to determine an identifier for forwarding the packet from the plurality of identifiers.

In an analogous art, Turner discloses that the forwarding node refers to a current offset in the packet to determine an identifier that identifies a link for forwarding the packet from the

plurality of identifiers (Col. 8; lines 62-67; The operation of the route assignment mechanism in the SE I is similar to that for the input interfaces. In an SE1, the offset identifies one of the links from that SE1 to an SE2, and the bandwidth value for a particular output interface Y represents the total bandwidth used by packets passing through that SE1 and going to output interface Y. If the (offset, bandwidth) pair for output Y is (f, b), then packets to output Y are routed through the links numbered f, f+1, . . . , f+b-1 connecting that SE1 to SE2s). It would have been obvious to one of ordinary skill in the art at the time of invention was made to modify Vasseur's system by adding the limitation of Turner in order to provide method and system for routing traffic to achieve bounded delay in a communication system.

Regarding claim 17, Kusama discloses that the storage unit stores the table used for forwarding the packet based on the identifier (¶ 104; 174 and 188; link identifier is stored in the table and the table is stored in the device information holding module) which uniquely identifies the link within a predetermined domain (¶ 77; Fig. 1; Each link is uniquely identified by a link identifier throughout the communication network 2. A link identifier is a combination of the router's identifier and interface identifier of an interface to which a link in question is connected. For example, a link 51, which in FIG. 1 connect [192.168.100.1, 1002] and [192.168.100.2, 1001] to each other, has a link identifier [192.168.100.1, 1002, 192.168.100.2, 1001]).

Regarding claim 18, Kusama discloses that the storage unit stores the table used for forwarding the packet based on the identifier (¶ 104; 174 and 188; link identifier is stored in the table and the table is stored in the device information holding module) which uniquely identifies the link within a predetermined local domain (¶ 77; Fig. 1; Each link is uniquely identified by a link identifier throughout the communication network 2. A link identifier is a combination of the router's

identifier and interface identifier of an interface to which a link in question is connected. For example, a link 51, which in FIG. 1 connect [192.168.100.1, 1002] and [192.168.100.2, 1001] to each other, has a link identifier [192.168.100.1, 1002, 192.168.100.2, 1001]).

Regarding claim 22, Kusama does not explicitly disclose the storage unit stores the packet forwarding table used for forwarding the packet based on an identifier which identifies a link between a pair of interfaces of respective nodes.

In an analogous art, Smith discloses that the storage unit stores the packet forwarding table used for forwarding the packet based on an identifier which identifies a link between a pair of interfaces of respective nodes (¶ 22 and 29). It would have been obvious to one of ordinary skill in the art at the time of invention was made to modify Kusama's system by adding the limitation of Smith in order to minimize congestion and improving routing in a communication system.

Conclusion

7. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, THIS ACTION IS MADE FINAL. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

Any inquiry concerning this communication or earlier communications from the examiner should be directed to SAMINA CHOUDHRY whose telephone number is (571)270-7102. The examiner can normally be reached on Monday to Thursday (7:30 a.m. to 5.00p.m.).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Yemane Mesfin can be reached on (571)272-3927. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/SAMINA CHOUDHRY/

Primary Examiner, Art Unit 2462

Notice of References Cited	Application/Control No. 13/137,237	Applicant(s)/Patent Under Reexamination AWANO, JUN	
	Examiner SAMINA CHOUDHRY	Art Unit 2462	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-6,788,689 B1	09-2004	Turner; Jonathan S.	H04L45/00	370/357
	B	US-				
	C	US-				
	D	US-				
	E	US-				
	F	US-				
	G	US-				
	H	US-				
	I	US-				
	J	US-				
	K	US-				
	L	US-				
	M	US-				

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
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*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Jun Awano

Serial No.: 14/244,701 Group Art Unit: 2475

Filed: April 3, 2014 Examiner: AUNG, SAI

For: COMMUNICATION SYSTEM, FORWARDING NODE, PATH MANAGEMENT SERVER, COMMUNICATION METHOD, AND PROGRAM

Honorable Commissioner of Patents
Alexandria, VA 22313-1450

INFORMATION DISCLOSURE STATEMENT

Sir:

Under the provisions of 37 CFR §1.97 through §1.98 and pursuant to applicant's duty of disclosure under 37 CFR §1.56, applicant respectfully brings the following documents, cited in the Extended European Search Report and listed on the attached form PTO-1449, to the attention of the Examiner in charge of the above-identified application. Copies of the listed documents are provided herewith for the convenience of the Examiner. This citation does not constitute an admission that the references are relevant or material to the claims. They are only cited as constituting related art of which the applicant is aware.

I hereby certify that each item of information contained in this Information Disclosure Statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of this Information Disclosure Statement.

09/02/2016 SMOHAMME 00000006 14244701
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Each item of information contained in this Information Disclosure Statement was first cited in a communication from a foreign patent office in a counterpart foreign application and this communication was not received by any individual designated in §1.56(c) more than thirty days prior to the filing of this Information Disclosure Statement (37 C.F.R. §1.704(d)).

Submitted herewith is the Information Disclosure Statement fee of $180.00.

It is respectfully requested that the listed references be considered by the Examiner and formally made of record in this application.

Please charge any deficiencies in fees and credit any overpayment of fees to Attorney's Deposit Account No. 50-0481.

Respectfully submitted,

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Date: September 1, 2016

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NEC CORPORATION	
Filing Date	**Group Art Unit**
April 3, 2014	2475

U. S. Patent Documents

Examiner Initial	Ref	Document Number	Date	Name	Class	Subclass	Filing Date (If Appropriate)	

U. S. Patent Application Publications

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		US 2009/046732 A1	02/19/2009	Pratt, Jr., et al.				

Foreign Patent Documents

Examiner Initial	Ref	Document Number	Date	Country	Class	Subclass	Translation	
							Yes	No
		EP 1 320 224 A1	06/18/2003	Europe				

Other Documents (Including Author, Title, Date, Pertinent Pages, etc.)

		Extended European Search Report dated August 10, 2016.
		Jokela Petri, et al.: Lipsin: "Line Speed Publish/Subscribe Inter-Networking. TR09-0001, version 1.0" PSIRP, PUBLISH-SUBSCRIBE INTERNET ROUTING PARADIGM (9 Jan. 2009) pp.1-39, XP002566408, Retrieved from the Internet: URL:http://www.psirp.org/files/Deliverables/PSIRP-TR09-0001 LIPSIN.pdf [retrieved on 2010-02-02].

Examiner	**Date Considered**

Examiner: Initial if citation considered, whether citation is in conformance with MPEP Section 609; Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to Applicant.

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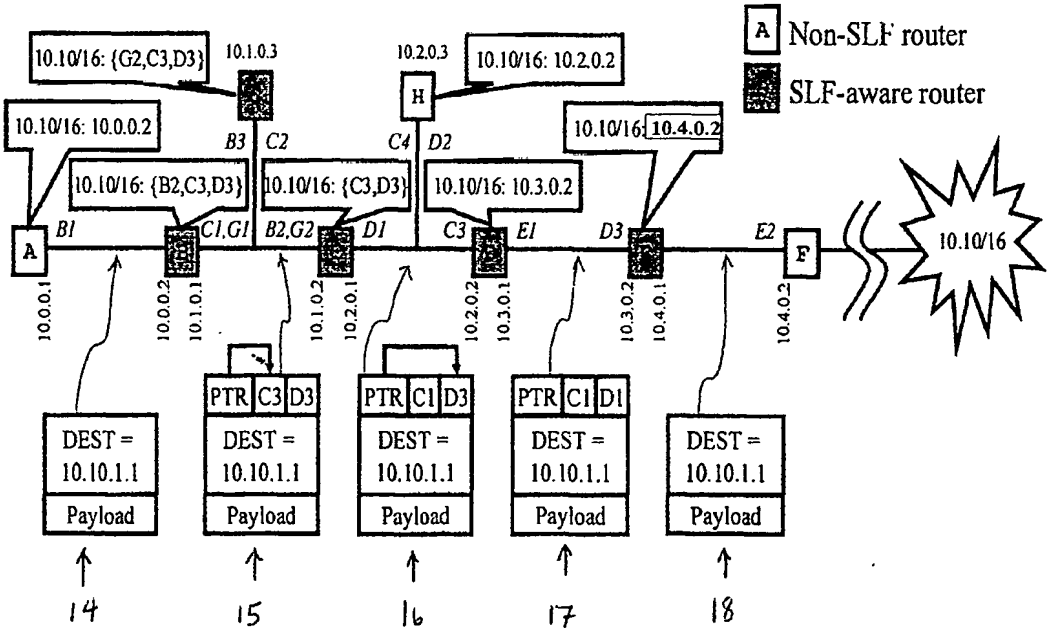
(54) Telecommunications network and a packet header therefor

(57) The invention relates to a packet header for a data packet (14) to be transported via at least one node of a network wherein the packet header includes a routing information field for containing data associated with the at least one node. The data associated with the at least one node is local node identifier data which identifies a neighbouring node of the at least one node through which the data packet is intended to be transported. Furthermore, the packet header may contain the routing information field data associated with a plurality of nodes, wherein the data associated with the plurality of nodes is local node identifier data, which identifies a neighbouring node of each node through which the data packet is intended to be transported. The packet header contains a pointer field for containing a pointer (PTR), which pointer is operable to indicate the position of individual local node identifier data in the routing information field. The pointer is operable to be incremented at each node so as to indicate the position of data, which identifies the node to which the data packet is to be subsequently transported.

FIG. 4



EP 1 320 224 A1

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Description

[0001] The present invention relates to a packet header for a data packet, and more particularly to a packet header associated with the forwarding of a data packet through a telecommunications network. It also relates to a telecommunications network and to a node comprised in the telecommunication network.

[0002] Since a given two computer networks may typically possess quite different architectures, and therefore different data transmission and communication protocols, it is generally not possible to transmit/communicate data directly between those networks. Such networks are known as heterogeneous networks. An aim of inter-networking is to provide a method of packet communication that permits an application running on a first computer on one network to send information to or generally to communicate with a second computer on a different heterogeneous network.

[0003] These aims are typically achieved by use of Internet Protocol (IP) software which provides a uniform addressing scheme between heterogeneous networks so as to permit packet communication therebetween. Data packets transported across networks using IP are often referred to as IP datagrams, and these typically consist of a header followed by a data area or 'payload'. The header contains information pertaining to the route to be taken across the inter-network, such as the IP address of the node (computer) that originated the message and the IP address of the destination node (computor). The data area contains the data to be transported.

[0004] As is well known in the art, Internet nodes called 'routers' or 'gateways' implement internet protocol to forward datagrams/packets between networks and are arranged to physically interconnect heterogeneous networks.

[0005] Two basic forms of communication protocol are in wide use in today's communication networks for transporting data packets. These are known generally as Connection-Oriented (CO) and Connection-Less (CL) transport protocols. The former uses a connection identifier in the packet header while the later uses a destination address in the packet header.

[0006] In both CL and CO networks a 'forwarder' in a given node (including a router) serves to forward that packet, incoming to that node on an 'input port', to an output port of that node from which the packet may be output. The forwarder forwards the packet from the input port typically, in the case of CO, by obtaining network connection information from the packet header in order to determine the appropriate output port to output the packet on.

[0007] In CO transport, nodes (e.g. the source and destination) must first establish a connection before sending data across that connection. A network operating under such protocol is characterized in that a connection table must be kept in the network nodes. The connection table translates some connection identifier together with the input port into a new connection identifier and the output port and as such determines the path to be taken by the packet through the network (or networks). Each data packet transported across the network(s) must contain a Connection Identifier (CID) in its header. The CID is used by a given network node, as the packet is transported through the network, to index the connection table so as to determine the address of the subsequent node to which the packet should be transported or to determine the appropriate output port from which to output the packet. ATM and MPLS are examples of CO networks.

[0008] In practice the size of a CID is limited by the computational power or memory of the forwarder in a node. As a result available CID space is often too limited to build a full mesh of network connections for example. Furthermore, when processing a CID a node must generally process all the data bits within the CID when forwarding.

[0009] In a CL network, instead of using a CID, only a destination address is looked-up (by a node forwarder) in a routing table using a longest-prefix match operation. However, although CIDs are not required, this look-up operation is generally more complex than that required in CO networks.

[0010] It has to be remarked here that with a CL network according to a predefined destination address in a routing table the output port is selected independent of the source of the packet. This means an intermediate node for a packet originating at a first source or at a second source will always select according to this routing table, an identical output port. In this way a CL network is limited. It does not allow having independent paths for each source-destination pair.

[0011] Still another method is the well-known method of IP Strict Source Routing (SSR) in IP protocols. In this method, a packet header is attached to a data packet. This header provides, amongst other things, a pointer field and a list of IP addresses that are called routing information field. The routing information field comprises a series of IP addresses, each 4 octets (32 bits) in length, which each correspond to an address of a node (e.g. router) on a network (or inter-network). The pointer field contains a pointer that points in to the route data indicating the position of the next IP address to which the packet is to be sent on its route to the destination address (also provided in the header). A given node reading this information will act accordingly, thus, strict source routing provides a means for the source of an IP packet to supply routing information to be used by relevant nodes in the network in forwarding a packet to its destination.

[0012] The method is known as strict source routing since the router or host internet protocol must send the packet directly to the next address in the route data field, and must do so only through the directly connected network indicated by the pointer. A drawback of SSR is that

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it requires the use of globally unique IP addresses in the routing data field of the header. These addresses are costly of header space (high header overhead) and processing resources of a forwarder. This is generally undesirable.

[0013] US 5,721,820 discloses a method for adaptive routing of messages in a computer network. Each message packet comprises a packet header that contains routing information, followed by the packet data. A source processor places route words in the packet header which route words identify the path which the message packet will follow. As the message packet traverses the network it is passed between switches and each switch receiving the packet examines the first route word to determine which output port of the switch the packet is to be routed to. The switch then deletes the first route word before forwarding the packet to the next network element. Therefore the next route word becomes the first route word and the switch receiving the packet will use that route word. Thus a packet has no route words left upon arriving at the destination processor. in an alternative the route words are proceeded by a route word identifier that points to the current route word, and instead of removing the first route word in each packet, each switch which the message packet passes through increments this identifier.

[0014] A disadvantage of the system described in US 5,721, 820 is that it is not suitable for use with networks having multi-access links, such as Ethernet, since they allow different nodes or switches to be reached via the same output port. It will be appreciated that specifying the output port to be used by a multi-access link node will be of no use in directing a message packet as that output port leads to several different nodes.

[0015] It is an object of the present invention to overcome at least some of the deficiencies of prior art transport protocols. The present invention aims to do so by providing a transport protocol that, for example, may provide a look-up operation less complex than that of CO protocols and obviously also less complex than that of CL. The present invention may also allow to have independent paths for each source-destination pair. Furthermore, the present invention requires less header overhead and less processing power as strict source routing. The present invention can also be used with multi-access links, such as Ethernet or Wireless LAN (IEEE 802.11), which allow more than one node to be reached from a given output port.

[0016] According to a first aspect of the present invention, there is provided a packet header for a data packet to be transported via at least one node of a network wherein the packet header includes;

a routing information field for containing data associated with the at least one node, characterised in that;

the data associated with the at least one node is local node identifier data which identifies a neighbouring node of the at least one node through which the data packet is intended to be transported.

[0017] It is to be understood that the term network is intended to cover both local networks and inter-connected (e.g. heterogeneous) networks, and the term node may be applied to any node of either type of network and also to a node in a multi-access link.

[0018] Thus, it will be understood that, according to the first of its aspects, the present invention employs local node identifier (LNI) data of a given node (or nodes) of a network for the purposes of providing routing information for a data packet. Note that no IP addresses are used as in the CL, CO and SSR prior art discussed above. Neither are port identifiers used as they are not suitable for multi-access links. Instead the invention employs local node identifiers which are only locally valid.

[0019] In some embodiments, the local node identifier (s) (LNI) is/are assigned to the neighbouring node(s) by the at least one node. For example, referring to a router operable to implement the present invention as an "SLF router" (StateLess Forwarding (SLF)), when a given SLF router boots it identifies, via a "hello" mechanism (e.g. an OSPF Hello message), all of the neighbouring routers connected to it. The given SLF router will then assign a number or symbol to each of the neighbours so identified, and each such number or symbol serves as the local node identifier (LNI) for the neighbouring router to which such number has been assigned. Typically, the given SLF router will merely assign the number 1 (one) to the first identified neighbour, the number 2 (two) to the next identified neighbour, and so on. These numbers or symbols are 'local' identifiers in the sense that they are assigned to a node by a neighbouring node and only have semantics (i.e. are meaningful) for the neighbouring node that assigned the identifier.

[0020] It is to be noted that a local node identifier may be used to identify a neighbouring node, which comprises a plurality of, or group of, sub-nodes, or may be assigned by a node comprising a plurality of sub-nodes to identify a node which neighbours the assigning node. Furthermore, a 'neighbouring node' of a given node is preferably a node connected to the given node by a network/inter-network connection within which there are no intermediate nodes present.

[0021] it is to be noted that it is well known in the art to exchange information between routers/nodes of a network which indicates the link states between those routers/nodes. The method by which this is achieved is known as LSA (Link State Advertising) whereby each router originates one LSA message that describes the list of its own interfaces with other nodes in the network. According to the present invention, LSA may be extended so as to exchange not only link states between routers/nodes, but also to exchange local node identifiers (LNI) and information indicating which routers/nodes are SLF-aware.

[0022] Since the local node identifiers, which are only locally valid, typically require less space than full IP addresses, the packet header overhead is reduced com-

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pared to previous technologies, which used full IP addresses in the packet header. Furthermore as the local node identifiers do not specify a particular output port of a given node, but may merely specify the next node to which the packet is intended to be forwarded from the given node (the "next-hop"), a packet header according to the present invention is suitable for use in networks including multiple-access links.

[0023] Typically, the LNI will be distributed together with routing information such that they may be used as far as the routing protocol is distributing them over the network. The distribution with routing information works particularly well with link-state routing protocols (e.g. OSPF). Since link-state protocols are typically used intra-domain, the most probable usage of LNI will be within one network.

[0024] An example of the distribution of LNI "next-hop" identifiers together with routing information could be: an OSPF router receives link-state information from other routers in the network and subsequently builds a spanning tree (or "shortest-path tree") which contains the shortest path to all other routers. If the LNI "next-hop" identifiers are distributed together with the link-state information, this permits a node to read from the spanning tree which LNI "next-hop" identifiers to use to define a path to a particular destination node.

[0025] Preferably, the packet header according to the first aspect of the invention provides local node identifier data wherein the node identified by the local node identifier data is the node to which the data packet is to be transported to after reaching said at least one node of the network which the data packet is to be transported through.

[0026] Thus, the forwarder in the node(s) of a given network is able to forward the headed data packet to a neighbouring node appropriate to the route intended to be taken by the packet.

[0027] The neighbouring node may be a node reached via a multi-access link such as Ethernet.

[0028] More preferably, the packet header for a data packet, according to the first aspect of the present invention, provides a routing information field containing data associated with a plurality of nodes of the network, and wherein;

the data associated with the plurality of nodes is a list of local node identifiers each local node identifier identifying a node through which the data packet is intended to be transported, and wherein;

the packet header contains a pointer field for containing a pointer, which pointer is operable to indicate the position of an individual local node identifier in the routing information field;

the pointer being operable to be incremented at each node so as to indicate the position of a local node identifier which identifies a node to which the data packet is to be subsequently transported.

[0029] In other words the packet header contains a list of local node identifiers, each specifying the next-hop in a specific node along the path. This list is used as routing/forwarding data and on receipt of the data packet by a given node, that node determines from the local node identifier list in the packet header, the appropriate neighbouring node to which it is intended to forward the packet. The packet can thus be transported through the network by each consecutive receiving node.

[0030] Accordingly, it will be understood that the routing information field provides routing information through a plurality of the nodes of a given network by listing the nodes through which the data packet should be transported in order to follow the route towards the destination node. In order that any one node may determine the relevant neighbouring node to which the packet is to be forwarded, a pointer is provided in the packet header to point to the relevant local node identifier (associated with the relevant neighbouring node) in the routing information field when the packet is received at the given node. Thus, the node is able to determine which neighbouring node to send the packet to. Once this has been ascertained, the pointer may then be incremented by the node, prior to outputting, so as to point to the relevant neighbouring (or next-hop) node identifier associated with the next node to which the packet is to be subsequently sent. Clearly, when the next and further subsequent node repeat this operation, the packet will traverse the path contained in the routing information field of the header.

[0031] This is based on the premise that the pointer is incremented just prior to outputting the data packet to the next node. However, it would be possible to increment the pointer just after reception of the data packet by a node. For example, a data packet is transported via nodes A, B and C. When the data packet is received by node A the pointer in its packet header points to node B, accordingly node A prepares the packet for output to node B, but just prior to output the pointer is incremented so that it points to node C. However, it would be possible to use the following alternative technique: when the data packet is received by node A the pointer in its data packet points towards node A, shortly after reception by node A the pointer is incremented so that it points to node B, the packet is then output to node B, shortly after reception by node B the pointer is incremented so that it points to node C etc.

[0032] Also, it would be possible to delete individual local node identifiers from the front of the header when the relevant node has been reached rather than using a pointer.

[0033] Ideally the packet header for a data packet includes a length field for containing a quantity representing the number of local node identifier data items contained within the routing information field.

[0034] Preferably, in the packet header according to the first aspect of the present invention, the routing information field may be modified (at a current node and prior to transmission therefrom) by replacing the local

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node identifier data ('local' with respect to the current node) associated with the next-hop node with local node identifier data ('local' with respect to the next-hop node) which identifies the current node. (Note: a node X may be aware of the local node identifiers used by its neighbours to identify the node X).

[0035] Thus it will be understood that a record of the reverse path for the route may be recorded in the routing information field as the packet progresses along its route through the network. Clearly, this reverse route may be used by the packet to subsequently retrace its route (in reverse) through the network to the source (originating) node.

[0036] According to a second of its aspects, the present invention provides method of transporting a data packet via at least one node of a network wherein the method includes the steps of;

providing a packet header for the data packet;

providing routing information in the header which routing information contains port identifier data which identifies a port of the at least one node through which the data packet is intended to be transported;

transporting the headed data packet via the at least one node of a network in accordance with the routing information such that the at least one node of the network transports the data packet through the port identified by the port identifier data.

[0037] Thus it will be understood that the neighbouring node identified by the local node identifier data is the "next-hop" node to which the data packet is intended to be transported after passing through said at least one node of the network which the data packet is to be transported via.

[0038] The neighbouring node may be a node reached via a multi-access link such as Ethernet.

[0039] Ideally, this method further includes the step of;

providing routing information containing data associated with a plurality of nodes of the network, wherein the data associated with the plurality of nodes is a list of local node identifiers, each local node identifier identifying a neighbouring node for a node through which the data packet is intended to be transported, and;

providing the packet header with a pointer;

indicating with the pointer the position of an individual local node identifier in the routing information;

incrementing the pointer at each node so as to indicate the position of a local node identifier which identifies a node to which the data packet is to be subsequently transported.

[0040] The invention, according to the second of its aspects, may further provide a method of transporting a data packet wherein, at a current node and prior to transmission therefrom, the method further includes the step of;

modifying the routing information by replacing the local node identifier data associated with the current node with local node identifier data identifying the previous node from which the data packet was received at the current node.

[0041] It has to be explained that different ways are possible to obtain the routing information by a node. A possible way is making use of the method known as Link State Protocol. Indeed, by extending the Link State Protocol with local node identifier information and thereby determining which nodes a given node is coupled, a node according to the invention is able to construct the routing information field.

[0042] Another way is making use of a scout packet. Indeed, in the method of transporting a data packet, according to the second aspect of the present invention, the routing information is obtained by;

providing a scout packet at a given node which packet is operable to record the route it takes through a network and information relating to the topology of the network;

transmitting such a scout packet in to the network from the given node of that network;

receiving the scout packet at a second node after the packet has been transmitted through the network;

retrieving the route and network topology information recorded by the scout packet and using that information in the compilation of routing information.

[0043] Thus it will be appreciated that such a scout packet may provide information enabling an appropriate or optimal route from packet source to destination. For example, changes in network topology (e.g. network connections) may be monitored and the routing information in subsequent packet headers may be modified accordingly. Ideally, the said given node and the said second node may be the same node such that a scout packet is both transmitted and received by the same node.

[0044] Preferably, when a node is unable to transport a data packet directly from a first node, to a second node (the first node being the current node and the second node being the intended next node);

the routing information in the header is modified by replacing the local node identifier data which identifies the intended next node as a neighbouring node of said first node, with additional routing information;

which additional routing information routes the data packet to the intended next node via an alternative route e.g. via at least one additional node or via a parallel link.

[0045] Thus, should the link associated with the intended output port of a given node be un-usable (e.g. a link failure occurs), the second aspect of the invention may provide a method whereby a data packet may be transported from the given node to the intended subsequent node (which would otherwise have received the packet via the un-usable link). It will be understood that this is achieved by re-routing the data packet around a failed link in the network. That is to say, the given node chooses the route to be taken around the un-usable link, using the network topology information available to it, and compiles the routing information to be placed in the

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header accordingly.

[0046] Preferably, in accordance with the second aspect of the present invention, the packet header may be removed from the data packet at a node in a network. Ideally, subsequent to removal of the packet header, the data packet may be further transported through the network in accordance with another packet transport protocol.

[0047] Thus, the packet may be stripped of the header (of the present invention) at a given node and subsequently transported across the network using, for example, a standard IP protocol. This ensures that, should the routing information in the packet header provide only a partial route or a segment of an intended route, the data packet may still be transported through the parts of the network not included in that partial route (i.e. the rest of the full route) once that partial route has been traversed. Clearly, this represents a form of mixed routing.

[0048] Furthermore, in accordance with any of its aspects, the present invention provides a telecommunications network including at least one node operable to receive and process data packets possessing a header according to any aspect of the present invention. Preferably, this header is compiled by a node containing port identifier data for a number of the at least one nodes of the network.

[0049] Thus, it will be understood that a node originating a data packet, headed in accordance with any aspect of the present invention, compiles the route to be taken by the packet in accordance with a set of local node identifier data items (associated with nodes of the network) known to that originating node. That is to say, the originating node chooses the route to be taken, using the information available to it, and compiles the routing information to be placed in the header accordingly.

[0050] The present invention will now be further illustrated by way of nonlimiting examples and embodiments, with reference to the following drawings:

Figure 1 illustrates an example of a header according to the present invention;
Figure 2 illustrates a system by which local node identification data items may be encoded in the header;
Figure 3 illustrates a network of nodes and the transportation of a headed packet there through;
Figure 4 illustrates an example of reverse routing;
Figure 5 illustrates a table of typical LNIs assigned by a given node to identify neighbouring nodes;
Figure 6 illustrates an OSPF shortest-path tree containing the SLF information;
Figure 7 illustrates two bordering OSPF areas;
Figure 8 illustrates a shortest-path free for one of the routers illustrated in Figure 7;
Figure 9 illustrates an example of re-routing around a link failure in a network.

[0051] Referring to figure 1, there is illustrated an example of an encoding format for a header according to the present invention. Hereafter, such a header shall be referred to as a 'SLF-header' for the purposes of clarity.

[0052] The SLF-header, according to the present embodiment, consists of an array of lines, each 4 octets (32 bits) in length, with three distinct fields, the 'LEN' field, the 'PTR' field and the 'LNI' field.

[0053] The first field in this header is denoted 'LEN' in figure 1. This field, occupying one octet of the header, contains the length (in octets) of the whole SLF-header. Thus, the value LEN+1 refers to ('points' to) the position, in the packet, at which the payload of the packet begins (i.e. immediately after the header ends). For example, the payload may begin with a further header (e.g an IP header).

[0054] The second field in the header, denoted 'PTR' in figure 1, contains a pointer. This pointer field is also 1 byte in length and contains a pointer which points to a given 1-byte word in the LNI field. The LNI field contains a sequential array of local node identifier (LNI) data items, each one byte in length, which each identify a neighbouring node of a given node in the network. The local identifiers used to identify these nodes are not full IP address headers, but rather only locally valid node identifiers each assigned by a neighbour of a given node to identify that given node to the neighbour.

[0055] These LNI define the intended route to be taken by the SLF-headed packet when being transported through the nodes of a network. That is to say, the LNI field is equivalent to a packet routing information field. The pointer therefore points to a given item (i.e. a LNI) in a routing information field and identifies a particular neighbouring node of a given node on that route. Note that the SLF-header may terminate with a number of bytes of padding so as to ensure that the header length is an integer multiple of 32 byte words.

[0056] Indeed, according to the present embodiment, when the pointer field is first read by the forwarder of a particular node, that pointer will point to the LNI of the node to which the packet is intended to be subsequently output. Prior to such output, the pointer 'PTR' is incremented so as to point to the next LNI in the LNI field.

[0057] By providing LNIs of length 1-byte, each such LNI may uniquely identify up to 256 output ports for a given node. Of course, a larger or smaller LNI size could be used according to the present invention, however, a larger LNI size would undesirably increase the header size (i.e. the LNI field) for a given number of LNIs. Conversely, a smaller LNI size would typically be harder to process. In order to be more flexible in the encoding of LNIs in an SLF-header, and to reduce the header overhead thereof, the present embodiment also provides a method of variable-length encoding of LNIs as follows.

[0058] Each item of local node identifier data is stored in the LNI field (i.e. the routing information field) with a binary prefix attached thereto such that;

if the prefix is binary value 0, then the local node

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identifying data is contained in the subsequent 3 bits of that item;

if the prefix is binary value 10, then the local node identifying data is contained in the subsequent 6 bits of that item;

if the prefix is binary value 110, then the local node identifying data is contained in the subsequent 9 bits of that item, etc.

[0059] Each additional binary digit of 1 which is added to the prefix binary value introduces an extension of 3 additional bits for the LNI data as can be seen from the three examples above. Figure 2 illustrates these three examples.

[0060] Thus, the encoding 'class' of an encoded LNI is indicated by the first one or more bits thereof, and the LNI field may contain LNIs of variable length, e.g. half a byte, one byte, 1.5 byte or two bytes etc. Clearly, the pointer 'PTR' is to be incremented according to the class of the LNIs, so as to ensure that LNIs are pointed to sequentially.

[0061] It is to be understood that the SLF-header is intended to be attached as a header to any type of payload. Such a payload might be, for example, an IP datagram such that the payload also includes a header (i.e. the IP header) encapsulating another payload. Accordingly, to further illustrate the invention according to any of its aspects, there follows an embodiment wherein the payload of the SLF-header is just such an IP datagram wherein the SLF-header is implemented as a layer below IP. The header may contain a field (not shown) which contains data identifying the next (i.e. higher) layer protocol, such as IP. In addition, a reserve field could also be inserted between the "LEN" field and the "PTR" field to allow either the room to expand as and when required.

[0062] Referring to figure 3, there is illustrated a network of consecutive IP routers denoted A, B, C, D and E. Routers B, C and D are said hereafter to be 'SLF-aware'. That is to say, while all of the routers are IP routers, only the routers B, C and D are capable of compiling and meaningfully processing SLF-headers and, hereafter, shall be referred to as 'SLF routers'.

[0063] To be a SLF router, a given router (or more generally a given node) must have available to it, or be capable of receiving, a number of LNI associated with other SLF-aware nodes in the network with which it can construct a LNI list (to put in the LNI field of the SLF-header). Put another way, a SLF router/node is a router/node able to so define a valid route intended to be taken by the SLF-headed packet when being transported through the nodes of the network.

[0064] Returning to figure 3, a source IP router A possesses a port which is connected to an input port of SLF router B. Router A transmits an IP datagram 6 to SLF router B with a forwarding entry (destination IP address) in the IP header denoted 'IP_dest=192.168.x.x'. The IP datagram 6 is received by an input port of SLF router B, the router reads the IP destination address for that datagram and then proceeds to calculate a valid route towards that destination in terms of LNI of other connected SLF-aware nodes in the network. Typically, the path so constructed would be a shortest-path route via those nodes (e.g. the routers occupy an OSPF Open Shortest Path First area), however, the present invention is not intended to be limited to such routes. In the present example, the route is denoted {3, 4} and indicates that nodes C and D (having LNIs 3 and 4 respectively) are to be used when transporting the SLF-headed packet ('SLF packet') through the network.

[0065] It has to be remarked that according to another implementation and since node B has to execute some routing processing anyway, LNI=3 relating to the 'next-hop' (router C) is not necessarily required in the routing information field.

[0066] The route so calculated is placed in the LNI field of a SLF-header and the SLF header, complete with LEN and PTR fields, is used to encapsulate the IP datagram. Router B then determines, with the pointer in the SLF-header, which neighbouring node to transmit the SLF packet to. This may entail determining which of the router's output ports to transmit the SLF packet through. The router then increments the pointer (so as to point to LNI= 4) before outputting the SLF packet 4. Thus, having been output of router B through an appropriate port, the SLF packet is subsequently received at an input port of router C.

[0067] Router C reads the SLF header of the SLF packet. The pointer PTR having been previously incremented now points to LNI=4. Accordingly, the router determines that the SLF packet is to be output to router D and towards router D. Were the LNI field to contain more than two LNIs (or were there to be more than three linked SLF routers), the router C would then increment the pointer PTR so as to point to the next LNI in that list before outputting the SLF packet to the next SLF router. However, in the present example, the pointer in the SLF header received by router C already points to the terminal LNI in the LNI field. This implies that the router to which the SLF packet is to be sent, from router C, is the terminal SLF-aware router in the local route (i.e. router D).

[0068] Thus, it will be understood that in such a case it is not necessary to increment the pointer PTR prior to output to such a terminal SLF router, since there will be no LNI in the LNI field associated with that router. Furthermore, SLF-headed packets will not be output from a terminal SLF router to a non-SLF router since, clearly, the latter type are not SLF-aware and thus are incapable of processing SLF headers.

[0069] It has to be remarked that according to another example the LNI field could include a LNI for router E and that the SLF packet output from router C could then point to that LNI. When the SLF packet is received router D could then read that LNI before stripping the SLF header off of the SLF packet. The router would then know which node to output the IP packet to and would

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still only have used the SLF protocol.

[0070] Consequently, the pointer PTR is set to 0 (zero), or some other predefined symbol, so as to indicate this condition to router D (i.e. that it is the terminal SLF router). As a result, on receipt of SLF packet 5 the router D strips that packet of its SLF header thereby revealing the original IP datagram. Subsequent packet transportation, from router D to router E takes place according to IP protocol. Of course, should that IP datagram encounter a further one or more SLF-aware routers before reaching destination address 'IP_dest=192.168.x.x', then the process of SLF header encapsulation and transmission, as discussed above, would be initiated once more.

[0071] In a further embodiment of the present invention, according to any of its aspects, there is provided a technique of 'Reverse Path Recording' (RPR) an SLF packet as shall be described below.

[0072] In general terms, this technique involves modifying the routing information at each SLF router/node, prior to transmitting the SLF packet from that node, so as to contain the route travelled by the packet in reaching the current node. This must be done without corrupting the routing information corresponding to the remaining un-travelled route.

[0073] Figure 4 illustrates an example of how this may be done. Referring to figure 4, there is illustrated a network of IP routers including routers A, B, C, D, E, F, G and H. The routers B, C, D, E and G are SLF-aware, while routers A, H and F are not SLF aware. The links between B, C and G and between C, D and H are multi-access links and the symbols 'Xi' (where X=B, C, D, E or G, and i=1, 2, 3 or 4) are the local node identifiers (LNI) assigned by the SLF router 'X'.

[0074] Each router transmits an OSPF "Hello" message in order to enable LNIs to be formed. When an SLF router receives an OSPF message from a neighbouring node/router it is able to construct a table of local node identifiers in which each next-hop interface with another node is assigned an LNI. Note that LNIs are assigned to neighbours that are not SLF-aware (SLF capabilities are not announced via OSPF "Hello" messages). Each such SLF router assigns a locally valid identifier to each of the neighbouring routers connected to it (whether or not they are SLF aware) using a semantic valid only to the assigning router. For example, router C assigns LNI=C1 to identify neighbouring router B, LNI=C2 to identify neighbouring router G, LNI=C3 to identify neighbouring router D and LNI=C4 to identify neighbouring router H.

[0075] The table illustrated in Figure 5 shows an example of a table of local node identifiers constructed by router C. An alternative way of obtaining such a table is via the router-LSAs. Each router originates one router-LSA that describes the list of its own interfaces (e.g. IP address). This has the advantage of yielding immediately the relation between the IP address of the interface (contained in each router-LSA) and the LNI (see fourth column in figure 5). All nodes of the network must learn that node C identifies interface 10.1.0.1 by LNI=C1, interface 10.1.0.3 by C2, interface 10.2.0.2 by C3 and interface 10.2.0.3 by C4, otherwise they (e.g. router E) will not be able to build an SLF path through router C.

[0076] The LNI information constructed by the various SLF routers in the network is communicated to other SLF routers in the network by 'flooding' the network with the information. The flooding of the LNI information is done via Opaque-LSA type 10 (area flooding-scope). Thus, each SLF router must be Opaque-LSA capable in this embodiment. Each router creates an Opaque-LSA to advertise its SLF information by forming an LSA packet the header of which identifies the originating router (e.g. router C) and the payload of which includes a list of the pairs:

<IP address, LNI>

for each neighbour interface (see second and fourth column of Figure 5). Accordingly, by flooding this information through the network, each Opaque-LSA capable router is able to know the IP address and LNI of each next-hop interface of all SLF routers in the flooded network. Each Opaque-LSA capable router may then map the SLF information on to a "shortest-path tree" and retrieve from this tree the explicit SLF path.

[0077] Figure 6 illustrates the mapping of SLF information pertaining to router C's shortest-path tree. The directional nature of the tree means that, for example, the LNI=G2 does not appear in the tree since it is only related to forwarding done by router G towards router C. Note that routers A and F are not SLF capable, this is known to router C because router C will never have received an Opaque-LSA from either of routers A and F. Thus, as long an a node/router does not receive Opaque-LSAs from another node/router, the former node/router will not use the LNIs leading to that latter node/router (e.g. LNI=B1 and LNI=E2). Each SLF-aware router finally builds the SLF routing table from the information it has received.

[0078] Figure 7 illustrates two bordering OSPF areas each configured as described above (i.e. LNIs have been flooded through respective areas). The router D is an Area Border Router (ABR) which serves to summarise reachability information concerning Area 1 and floods that information into Area 0. The shortest path tree for router C will then be as illustrated in Figure 8. Opaque-LSAs (type 10) are not flooded beyond the borders of the Area 1. Thus, no Area 1 SLF information is flooded into Area 0. For the inter-area routing case one can take two approaches:

1. SLF paths are not advertised outside their area. In this case SLF packets are terminated at the IP layer in the ABR and a partial SLF path can be used for the next part of the route.
2. It is allowed to advertise SLF paths outside their area. For this case an extension to OSPF can be

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defined. Normally inter-area OSPF advertises which network is reachable via which ABR, this information can be extended with the SLF path from the ABR towards the network.

[0079] Turning to Figure 4, consider an IP datagram 14 output from router A to router B and destined for a particular IP destination address (denoted 'DEST=10.10.1.1'). Upon receipt by router B the datagram is encapsulated by a SLF header, thus producing a SLF packet 15. The header of this packet includes pointer PTR and LNI field {B2, C3, D3} and, prior to incrementation, PTR points to LNI=B2 identifying (in the semantic of router B2) the node (i.e. router C) to which the SLF packet 15 is to be forwarded. Thus router B directs the packet for output towards router C and, prior to output increments PTR, then outputs packet 15 accordingly.

[0080] This packet is received by router C on an input port of the latter. Once received, router C then replaces the LNI previously pointed to i.e. LNI=C3, for router D, with LNI=C1 for router B), thus yielding SLF packet 16 with a modified LNI field containing elements {C1, D3}. Subsequently, PTR is incremented and the SLF packet transmitted to router D whereupon it is received at the latter via an input port thereof. Router D then replaces the LNI last pointed to (i.e. LNI=D3, for router E) with that for router C (i.e. LNI=D1), thus yielding SLF packet 17 with a modified LNI field containing elements {C1, D1}.

[0081] Thus, it can be seen that both SLF packets 16 and 17 contain a route (in terms of LNI) to both the originating SLF node B and the destination node E. For either packet, the forward route may then be read (by e. g. a router) by incrementing the pointer PTR, while the reverse route may be read by decrementing PTR. Either packet may be forward routed or reverse routed by incrementing or decrementing PTR respectively.

[0082] Prior to transmission each of the routers C and D may store the respective forward and reverse routes. These routes may then be used in future SLF packet routing.

[0083] It is to be noted that it is well known in the art to exchange information between routers/nodes of a network which indicates the link states between those routers/nodes. The method by which this is achieved is known as LSA (Link State Advertising). According to the present invention, LSA may be extended so as to exchange not only link states between routers/nodes, but also to exchange LNI and information indicating which routers/nodes are SLF-aware.

[0084] Alternatively, the provision of link-state information for and in respect of SLF nodes, according to the present invention, may be achieved by employing a method hereafter referred to as 'packet scouting'. Packet scouting may be initiated by any one node of a network (a SLF node or otherwise) and involves the transmission of a 'scout request' from that node, i.e. the originating node, to some destination node of the network (a SLF node or otherwise). This scout request may be transmitted from the former to the latter by any transmission or communication means as would be known to a person skilled in the art but, typically, would be effected by transmission of a data packet (a SLF packet or otherwise).

[0085] The request includes the address of the originating node and, of course, the destination node.

[0086] Once the destination node receives the scout request it accordingly transmits a 'scout packet' back to the originating node. In the course of transportation across the network, the scout packet, so transmitted, may encounter a group of interconnected SLF nodes. These interconnected nodes may form part of the route followed by the scout packet, or may comprise the whole route. At each such SLF node the scout packet is recognised as being such and, accordingly, each SLF node in the group thereafter processes the SLF header of the packet (after encapsulation thereby) using the method of reverse routing, as described above, when transporting the scout packet through the group. Each SLF node in the group which is intermediate the first and the last nodes of the group, records the reverse-routing information of the SLF header attached to the SLF packet received by it. Thus, it will be understood that the reverse route so recorded corresponds to the reverse of the route taken in a direction from the node originating the scout packet to the node originating the scout request. Clearly, this route is equivalent to a forward route from the latter to the former. Thus, each SLF node having recorded the reverse rout information is thereby able to update its route information relating to that group.

[0087] Any subsequent groups so encountered by the scout packet would, obviously, be able to operate in the same fashion.

[0088] Note that, should all the nodes encountered by the scout packet be SLF nodes then the complete route taken by that packet would be available to the node originating the scout request. Furthermore, it is to be understood that the node originating the scout request could also be the node that launches the scout packet. That is to say, a given originating node may launch a scout packet in to the network, which scout packet is destined for that same node. This would, for example, allow an originating SLF node to determine the route information and network topology of the network local to it. This is particularly useful in re-routing SLF packets around failed links between SLF nodes as will now be discussed.

[0089] An SLF node can obtain the SLF path to a certain destination without the direct co-operation of a routing protocol. First, the SLF node sends a Scout Request towards a destination address (e.g. triggered by an IP packet to this destination). The Scout Request records the SLF path and the last network prefix towards the destination until it reaches the last SLF node (not necessarily the destination). The last SLF node sends a

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Scout Reply back to the first SLF node. The Scout Reply contains the SLF path and the network prefix, which was set by the last-but-one SLF node in the Scout Request. If an intermediate SLF node receives an SLF packet with a LNI that became invalid (due to e.g. a link failure), this can be signaled to the originating node with a Path Failure message. Several cases can occur:

1. RPR (Reverse Path Recording) disabled: the intermediate node sends a Path Failure towards the originating node containing the invalid SLF sub-path
2. RPR enabled and symmetrical paths: the intermediate node sends a Path Failure using the reverse path of the invalid SLF packet. When the Path Failure arrives at the originating node, it contains the invalid SLF sub-path.
3. RPR enabled and asymmetrical paths (in fact the following method is applicable to all cases): in this case the intermediate node does not know the invalid SLF sub-path, but it can send a Path Failure containing the final destination and the hop number where the SLF path became invalid. The originating node can then derive the invalid SLF sub-path by consulting its forwarding table.

When the originating node receives a Path Failure message it can invalidate all SLF paths that contain the invalid SLF sub-path. It can then trigger new Scout Requests.

[0090] If a network topology change occurs inside a group of interconnected SLF nodes, e.g. due to link failure, the routing information contained in those nodes may be rendered invalid. There may be a significant amount of time during which a node originating an SLF packet is left unaware of this topology change and, during this time, would consequently launch SLF packets containing invalid routing information. To overcome this problem the present invention, according to any of its aspects, provides a technique by which such an originating node may be informed of such a topology change, and by which link failures may be overcome.

[0091] Accordingly, Figure 9 illustrates a group of interconnected SLF nodes, denoted A, B, C, E and F. An SLF packet is launched on to the network from node A to node B and destined for a further node (not illustrated) situated beyond node F. The pointer in the SLF header of the SLF packet so launched points to LNI=B1 of the LNI field (underlined in item 30 Figure 9), thus the SLF packet is intended, on receipt by node B, to be transported therefrom to node C. However, should the link between nodes B and C have failed (as in Figure 9) such transportation would not be possible. In such a case, node B modifies the LNI field of the SLF packet received by it by replacing the LNI of the 'next hop' node to which the packet is to be next transported with two LNIs which define an alternative route to node C, via node E, which avoids the failed link. As can be seen in the present example, LNI=B1 for the originally intended direct route is replaced by LNI=B2 and LNI=E2 so that the packet can be indirectly routed to the node C.

[0092] Clearly, the packet could be re-routed via any number of suitable SLF nodes and the present invention is not intended to be limited to re-routing only via one additional SLF node as illustrated in figure 5.

[0093] The node B may obtain the necessary route information relating to node E by e.g. employing the method of packet scouting as discussed above. Furthermore, by employing reverse routing in SLF headers, node B is able to determine the reverse route of the packet arriving from node A (i.e. determine the route from B to A) and thereby signal to node A that the originally intended link between nodes B and C has failed. This signal may also include the re-routing information used by node B such that node A may update its routing information. The signal may be sent using a packet (SLF packet or otherwise).

[0094] It has to be remarked that a possible distribution of the SLF functionality in a telecommunication network could be as follows: comprising in routers at the edge of the network i.e. edge routers, extended route information and network topology information and comprising in routers in the core of the network i.e. core routers, only a limited route and network topology information of the network e.g. only related to its neighboring nodes.

[0095] The embodiments described herein merely provide examples of the inventive concept of the present invention and are not intended to be limiting. Variations and alterations to those embodiments, such as have been identified in the above description, may be made without departing from the scope of the invention.

Claims

1. A packet header for a data packet to be transported via at least one node of a network wherein the packet header includes;

   a routing information field for containing data associated with the at least one node, **characterised in that**;

   the data associated with the at least one node is local node identifier data which identifies a neighbouring node of the at least one node through which the data packet is intended to be transported.

2. A packet header for a data packet according to claim 1 wherein the neighbouring node identified by the local node identifier data is the node to which the data packet is to be transported after reaching said at least one node.

3. A packet header for a data packet according to claim 2 wherein the routing information field contains data associated with a plurality of nodes, and

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wherein;

the data associated with the plurality of nodes is a list of local node identifiers each local node identifier identifying a node through which the data packet is intended to be transported, and wherein;

the packet header contains a pointer field for containing a pointer, which pointer is operable to indicate the position of an individual local node identifier in the routing information field;

the pointer being operable to be Incremented at each node so as to indicate the position of a local node identifier which identifies a node to which the data packet is to be subsequently transported.

4. A packet header for a data packet according to any preceding claim wherein the header includes a length field for containing a quantity representing the number of local node identifiers contained within the routing information field.

5. A packet header for a data packet according to claim 3 or 4
wherein, at a current node and prior to transmission therefrom;

the routing information field is modifiable by replacing the local node identifier data associated with the current node with local node identifier data identifying the previous node from which the data packet was received at the current node.

6. A packet header for a data packet according to any preceding claim wherein each item of local node identifier data is stored in the routing information field with additional data attached thereto to indicate the length of the local node identifying data item.

7. A method of transporting a data packet via at least one node of a network wherein the method includes the steps of;

providing a packet header for the data packet;

providing routing information in the header which routing information contains local node identifier data which identifies a neighbouring node of the at least one node through which the data packet is intended to be transported;

transporting the headed data packet via the at least one node of a network in accordance with the routing information such that the at least one node of the network transports the data packet to the neighbouring node identified by the local node identifier data.

8. A method of transporting a data packet according to claim 7 wherein the method further includes the steps of:-

providing routing information containing data associated with a plurality of nodes of the network, wherein the data associated with the plurality of nodes is a list of local node identifiers, each local node identifier identifying a neighbouring node for a node through which the data packet is intended to be transported, and;

providing the packet header with a pointer;

indicating with the pointer the position of an individual local node identifier in the routing information;

incrementing the pointer at each node so as to indicate the position of a local node identifier which identifies a node to which the data packet is to be subsequently transported.

9. A method of transporting a data packet according to claim 9
wherein, at a current node and prior to transmission therefrom, the method further includes the step of;

modifying the routing information by replacing the local node identifier data associated with the current node with local node identifier data identifying the previous node from which the data packet was received at the current node.

10. A method of transporting a data packet according to any of claims 7 to 9 wherein the routing information is obtained by;

providing a scout packet at a given node which packet is operable to record the route it takes through a network and information relating to the topology of the network;

transmitting such a scout packet in to the network from the given node of that network;

receiving the scout packet at a second node after the packet has been transmitted through the network;

retrieving the route and network topology information recorded by the scout packet and using that information in the compilation of routing information.

11. A method of transporting a data packet according to claim 10
wherein at least the second node transports data packets according to the method of claim 7.

12. A method of transporting a data packet to claim 10 or 11
wherein the said given node and the said second node are the same node.

13. A method of transporting a data packet according to any of claims 7 to 9 wherein, when a node is unable to transport a data packet directly to the intended next node;

the routing information in the header is modified by replacing the local node which identified the intended next node as a neighbouring node, with

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additional routing information;

which additional routing information routes the data packet to the intended next node via an alternative route.

14. A method of transporting a data packet according to claim 13
wherein, routing information modification occurs in the event of a link failure between nodes.

15. A method of transporting a data packet according to any of claims 7 to 14 wherein, the packet header is removed from the data packet at a node in a network.

16. A method of transporting a data packet according to claim 15
wherein, subsequent to removal of the packet header, the data packet is transported through the network in accordance with another packet transport protocol.

17. A telecommunications network including at least one node operable to receive and process data packets possessing a header according to any of claims 1 to 6.

18. A telecommunications network according to claim 17 wherein said at least one node is a multi-access link connected to several other nodes via a single output port.

19. A telecommunications network according to claim 17 or 18
wherein, the header is compiled by a node containing local node identifier data for a number of the at least one nodes of the network.

20. A telecommunications network including at least one node operable to receive and process data packets possessing a header according to any of claims 13 to 16.

21. A telecommunication network according to claim 20 wherein said at least one node is a multi-access link connected to several other nodes via a single output port.

22. A node in a telecommunication network **characterized in that** it includes at least one node operable to receive and process data packets possessing a header according to any of claims 1 to 6.

23. A node according to claim 22 **characterized in that** the header that is compiled by said node is containing local node identifier data for a number of the at least one nodes of the network.

24. A node in a telecommunication network **characterized in that** said node is operable to receive and process data packets according to the method steps of any of claims 13 to 16.

25. A node according to any one of claims 22-24 wherein the node is a multi-access link connected to several other nodes via a single output port.

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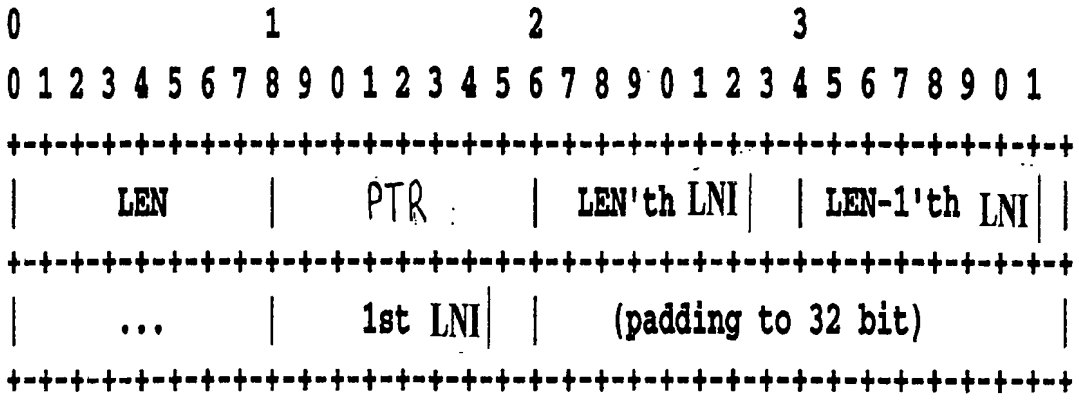

FIG. 1

0xxx

10xx xxxx

110x xxxx xxxx

FIG. 2

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FIG. 3

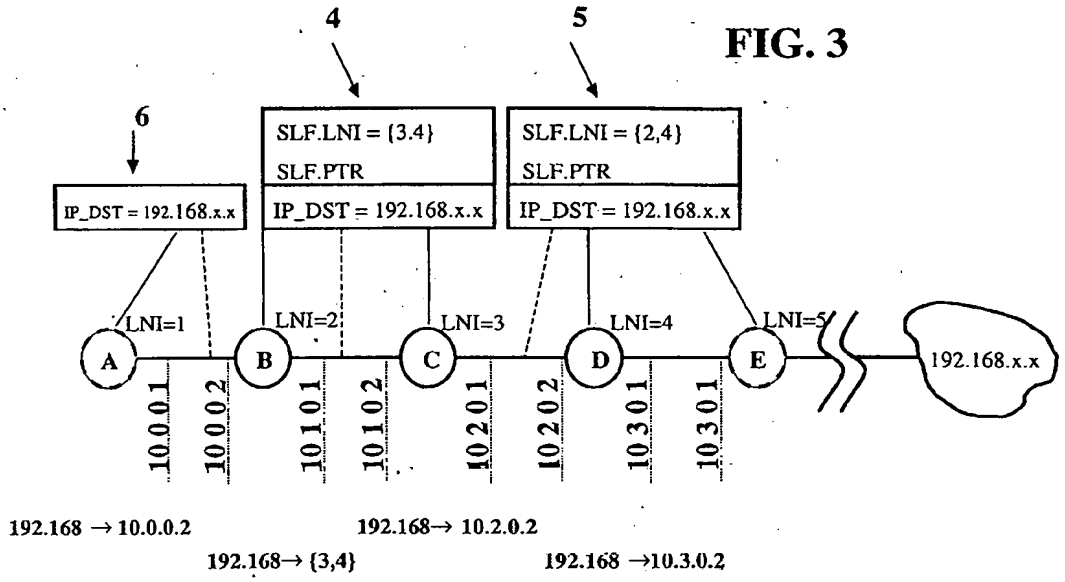

FIG. 4

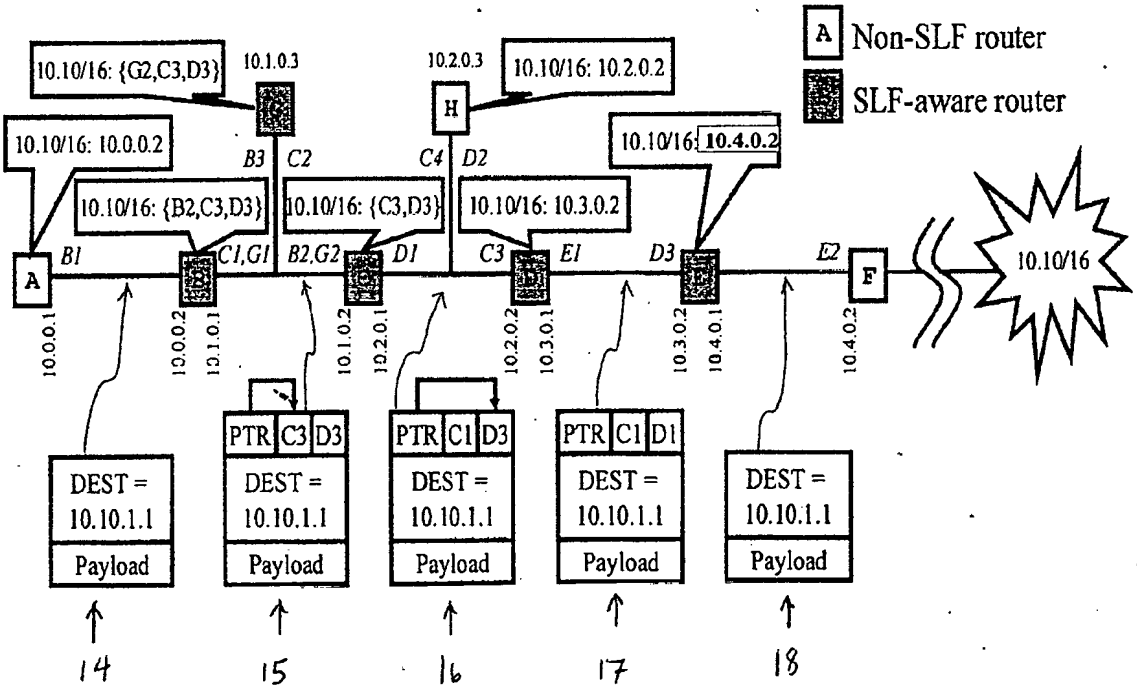

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FIG. 5

B	C1	10.1.0.2	10.1.0.1
G	C2	10.1.0.2	10.1.0.3
D	C3	10.2.0.1	10.2.0.2
H	C4	10.2.0.1	10.2.0.3

FIG. 6

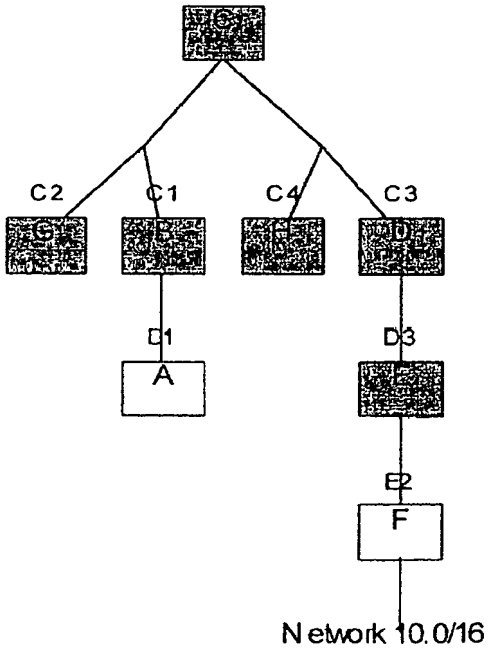

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FIG. 7

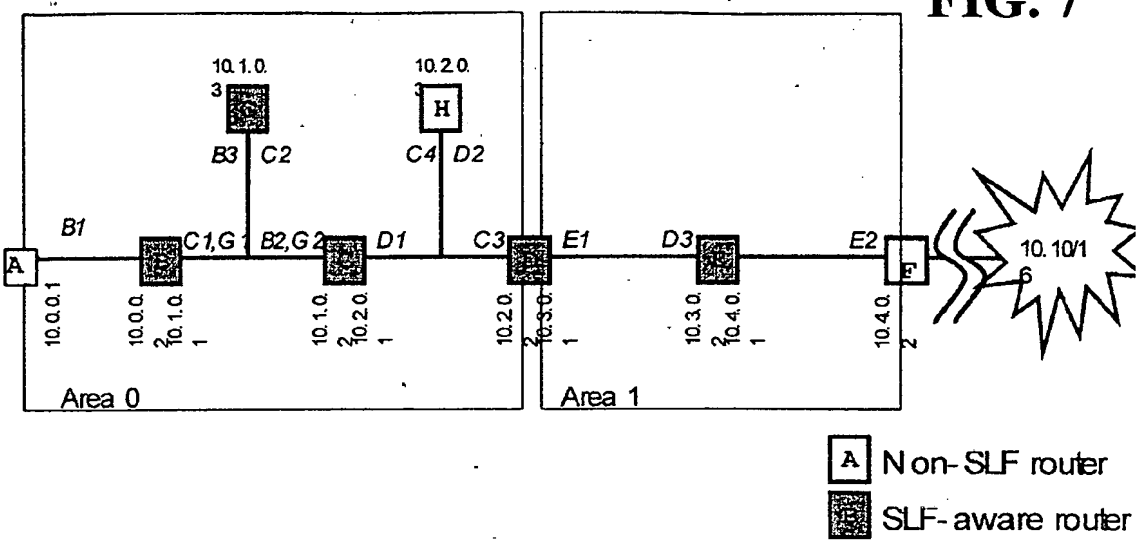

FIG. 8

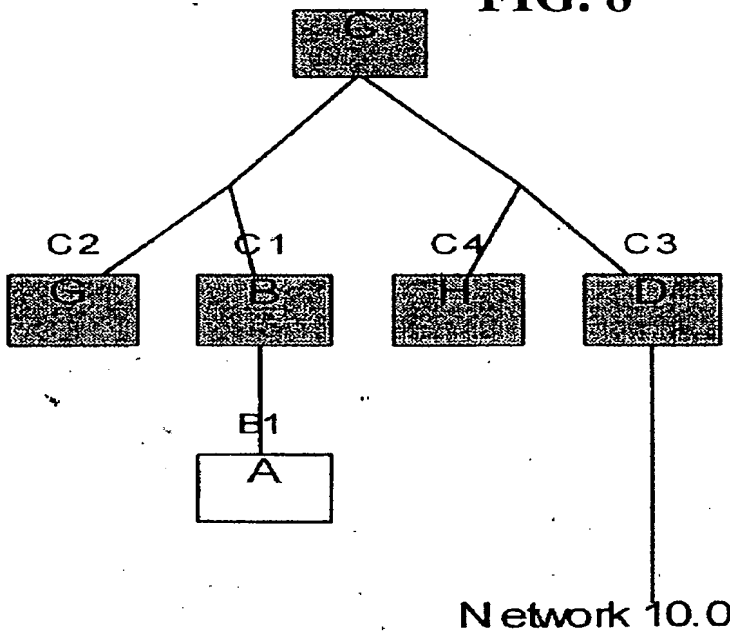

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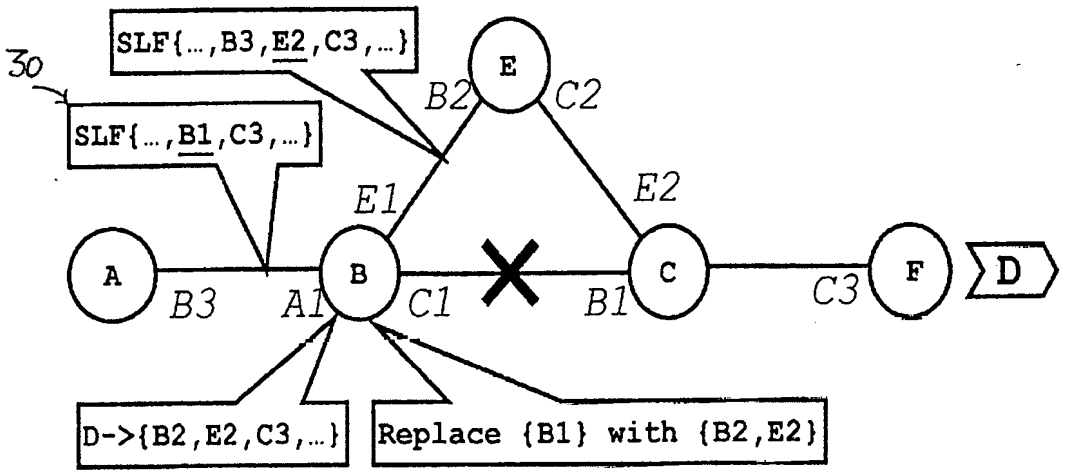
FIG. 9



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European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 01 40 3222

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	WO 01 30034 A (BEYER DAVID A ;FRIVOLD THANE J (US); GARCIA LUNA ACEVES J JOAQUIN) 26 April 2001 (2001-04-26) * abstract * * page 5, line 21 - page 7, line 12 * * page 10, line 30 - page 11, line 3 * * page 12, line 28 - line 32 * * page 15, line 16 - page 16, line 2 * * page 17, line 3 - line 26 * * page 23, line 10 - line 29 * * figure 2 * ---	1-25	H04L12/56
E	EP 1 164 754 A (ERICSSON TELEFON AB L M) 19 December 2001 (2001-12-19) * paragraph '0020! - paragraph '0022! * * paragraph '0046! - paragraph '0050! * * figure 3 * -----	1-9, 17-19, 22,23	
			TECHNICAL FIELDS SEARCHED (Int.Cl.7) H04L

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	15 May 2002	Poggio, F

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 01 40 3222

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

15-05-2002

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 0130034 A	26-04-2001	AU 1821401 A	30-04-2001
		WO 0130034 A2	26-04-2001
EP 1164754 A	19-12-2001	EP 1164754 A1	19-12-2001
		AU 6745101 A	24-12-2001
		WO 0197462 A1	20-12-2001

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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ROYAUME UNI

NC

Date
10.08.16

Reference	Application No./Patent No.
P/68061.EP01	10815479.0 - 1862 / 2479938 PCT/JP2010065712
Applicant/Proprietor	
NEC Corporation	

Communication

The extended European search report is enclosed.

The extended European search report includes, pursuant to Rule 62 EPC, the supplementary European search report (Art. 153(7) EPC) and the European search opinion.

Copies of documents cited in the European search report are attached.

☑ 0 additional set(s) of copies of such documents is (are) enclosed as well.

Refund of the search fee
If applicable under Article 9 Rules relating to fees, a separate communication from the Receiving Section on the refund of the search fee will be sent later.

Should you wish to further prosecute this application in the examination phase, your attention is drawn to the provisions of Rule 70a EPC. An invitation to respond to the extended European search report will be issued shortly (R. 70(2) EPC).

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SUPPLEMENTARY EUROPEAN SEARCH REPORT

Application Number
EP 10 81 5479

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	JOKELA PETRI ET AL: "Publish- Subscribe Internet Routing Paradigm. LIPSIN: Line Speed Publish /subscribe inter-networking. TR09-0001, version 1.0", PSIRP, PUBLISH-SUBSCRIBE INTERNET ROUTING PARADIGM , 9 January 2009 (2009-01-09), pages 1-2,1, XP002566408, Retrieved from the Internet: URL:http://www.psirp.org/files/Deliverables/PSIRP-TR09-0001_LIPSIN.pdf [retrieved on 2010-02-02] * sections "Introduction", 2.3, 2.5, 3.4 *	1-28	INV. H04L12/721 ADD. H04L12/717
X	US 2009/046732 A1 (PRATT JR WALLACE A [US] ET AL) 19 February 2009 (2009-02-19) * paragraphs [0012] - [0014], [0016], [0083] - [0091], [0101] *	1,12,16, 19,25-28	
X	EP 1 320 224 A1 (CIT ALCATEL [FR]) 18 June 2003 (2003-06-18)	12,16, 26,27	TECHNICAL FIELDS SEARCHED (IPC)
A	* paragraphs [0011] - [0013], [0028] - [0030], [0039] - [0041], [0058] *	1-11,14, 15, 17-25,28	H04L

The supplementary search report has been based on the last set of claims valid and available at the start of the search.

Place of search	Date of completion of the search	Examiner
Munich	2 August 2016	Ramenzoni, Stefano

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

1

EPO FORM 1503 03.82 (P04C04)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 10 81 5479

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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02-08-2016

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2009046732 A1	19-02-2009	CN 101682541 A	24-03-2010
		EP 2140617 A2	06-01-2010
		US 2009046732 A1	19-02-2009
		US 2011216656 A1	08-09-2011
		WO 2009008934 A2	15-01-2009
EP 1320224 A1	18-06-2003	DE 60131551 T2	23-10-2008
		EP 1320224 A1	18-06-2003
		US 2003118051 A1	26-06-2003

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

Information on Search Strategy - Pilot phase (see OJ 2015, A86)
The type of information contained in this sheet may change during the pilot for improving the usefulness of this new service.

Application Number
EP 10 81 5479

TITLE: COMMUNICATION SYSTEM, FORWARDING NODE, PATH MANAGEMENT SERVER, COMMUNICATION METHOD, AND PROGRAM

APPLICANT: NEC Corporation

IPC CLASSIFICATION: H04L12/721, H04L12/717

EXAMINER: Ramenzoni, Stefano

CONSULTED DATABASES: DOSYS, EPODOC, INET, NPL, TXT+, WPI, XPIETF

CLASSIFICATION SYMBOLS DEFINING EXTENT OF THE SEARCH:

IPC:

CPC: H04L45/34, H04L45/64, H04L45/42

FI/F-TERMS:

KEYWORDS OR OTHER ELEMENTS FEATURING THE INVENTION:
A communication system comprising:
a path management server that configures forwarding path information by arranging identifiers for identifying communication interfaces provided in respective forwarding nodes in a forwarding path of a data transfer network or links extending between said respective forwarding nodes and neighboring nodes thereof; and
a forwarding node that performs packet forwarding processing in accordance with said forwarding path information, with regard to a packet to which is added a header containing said forwarding path information;
wherein, among said forwarding nodes, a forwarding node (boundary forwarding node) positioned at a boundary with an external network comprises a header operation unit that performs addition of a header containing said forwarding path information to a packet received from said external network, or performs removal of a header containing said forwarding path information from a packet transmitted to said external network.

EPO FORM P04A42

The examination is being carried out on the **following application documents**

Description, Pages

1-48 filed with entry into the regional phase before the EPO

Claims, Numbers

1-28 filed with entry into the regional phase before the EPO

Drawings, Sheets

1/20-20/20 filed with entry into the regional phase before the EPO

1 Reference is made to the following documents; the numbering will be adhered to in the rest of the procedure:

D1 JOKELA PETRI ET AL: "Publish- Subscribe Internet Routing Paradigm. LIPSIN: Line Speed Publish /subscribe inter-networking. TR09-0001, version 1.0", PSIRP, PUBLISH-SUBSCRIBE INTERNET ROUTING PARADIGM, pages 1-2,1, XP002566408, Retrieved from the Internet: URL:http://www.psirp.org/files/Deliverables/PSIRP-TR09-0001_LIPSIN.pdf [retrieved on 2010-02-02]

D2 US 2009/046732 A1 (PRATT JR WALLACE A [US] ET AL) 19 February 2009 (2009-02-19)

2 The application does not meet the requirements of Article 84 EPC, because **claims 1, 5, 6, 12, 16 to 19 and 25 to 28** are not clear.

2.1 **Independent claims 1, 12, 16, 19 and 25 to 28** do not meet the requirements of Article 84 EPC in that the matter for which protection is sought is not clearly defined. The functional statement "*... **or** links extending...*" does not enable the skilled person to determine which words said "*or*" actually connect.

A reformulation clearly expressing that the *identifiers* are for identifying communication interfaces or links, as derivable from the description, in particular paragraph 31, would overcome this objection.

2.2 The expression "a ***header***" repeatedly used in **claims 5, 6, 16, 17, 18, 25 and 27** is unclear and leaves the reader in doubt as to the relation between all said defined "*headers*", thereby rendering the definition of the subject-matter of said claims unclear (Article 84 EPC).

3 The present application does not meet the requirements of Article 52(1) EPC because the subject-matter of **claim 1** is not new within the meaning of Article 54(1) and (2) EPC.

Document **D1** discloses, according to **all** the features of **claim 1**, a communication system comprising:

a path management server (see the "topology management system" in section 2.3) that configures forwarding path information by arranging identifiers for identifying communication interfaces provided in respective forwarding nodes in a forwarding path of a data transfer network or links extending between said respective forwarding nodes and neighboring nodes thereof (see in particular the introduction, referring to "source routing" and section 2.5); and

a forwarding node that performs packet forwarding processing in accordance with said forwarding path information, with regard to a packet to which is added a header containing said forwarding path information (see sections 2.5, 3.4).

The subject-matter of claim 1 is therefore **not new**, Articles 52(1) and 54 EPC.

It should furthermore be noted that **even if** the Applicant intended to argue novelty of claim1, based on a slightly different interpretation of its features and those disclosed in document **D1**, the subject-matter of this claim would **not involve an inventive step**, Articles 52(1) and 56 EPC, having regard to the disclosure of document **D1** and the normal knowledge of a person skilled in the art of routing protocols, specifically applied by centralized systems, as PCEs or OpenFlow controllers, and source routing techniques).

4 The same objections as made in above paragraph 3 can be based also on the disclosure of document **D2** (see in particular paragraphs 12 to 14, 16, 83 to 91, 101), which describes a method for routing packets, where a network manager applies source routing and communicates to the network nodes the list of the nodes to be traversed in a selected path.

5 The same considerations as made in above paragraphs 3 and 4 regarding claim 1 are also valid for **independent claims 12, 16, 19 and 25 to 28** since these claims include the same or a corresponding feature combination as claim 1 in terms of claims respectively relating to a forwarding node (not new also just considering the "forwarding nodes" in the Software Defined Networks), a boundary forwarding node, a path management server (not new also considering the OpenFlow controller in the Software Defined Networks), a communication method and corresponding programs.

The subject-matter of claims 12, 16, 19 and 25 to 28 therefore is **neither new**, Articles 52(1) and 54(1),(2) EPC, **nor** does it **involve an inventive step**, Articles 52(1) and 56 EPC, and hence claims 12, 16, 19 and 25 to 28 are **not** allowable.

6 **Dependent claims 2 to 11, 13 to 15, 17, 18 and 20 to 24** do not contain any additional features which, in combination with the features of any claim to which they refer, involve an inventive step for the reason that the subject-matter of these claims is **either in principle** directly derivable from the disclosure of the cited documents (see in particular in **D1** section 2.5, where the information about a "direction" of the path is disclosed, and where it is described that the "links" are stored with their IDs in a "forwarding table"; see **D2**, paragraph 83, where it is stated that the source node, i.e. a "boundary node", includes in the header of the packet the list of devices through which the packet must travel) **or** represents simple design details which are generally known to the person skilled in the field of routing protocols and related source routing techniques.

Due to the above reasons, dependent claims 2 to 11, 13 to 15, 17, 18 and 20 to 24 are **not** allowable, Articles 52(1) and 56 EPC.

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7 It is not at present apparent which part of the application could serve as a basis for new, allowable claims. Should the Applicant nevertheless regard some particular matter as patentable, an independent claim including such particular matter should be filed taking account of Rule 43 (1) EPC.

The Applicant should also indicate in the letter of reply the difference vis-à-vis the state of the art and the significance thereof (i.e. particular advantages).

8 Should the Applicant intend to file a new set of claims, the following requirements should also be taken into consideration:

8.1 To meet the requirements of Rule 43 (1) EPC any new independent claim should be properly cast in the **two-part form**, with those features which in combination are part of the nearest prior art being placed in the preamble.

8.2 To meet the requirements of Rule 42(1)(b) EPC, the cited document **D1** should be acknowledged and briefly discussed in the opening part of the description.

8.3 The features of the claims should be provided with reference signs placed in parentheses to increase the intelligibility of the claims (Rule 43(7) EPC). This applies to both the preamble and characterising portion (see Guidelines F-IV, 4.19).

8.4 The opening part of the description should be modified to bring it into agreement with any new independent claim, Rule 42 (1) (c) EPC.

8.5 References in European patent applications to other documents may relate either to the background art, or to part of the disclosure of the invention (e.g. details of one of the components of a claimed apparatus). Because the document referenced on page 1, paragraph 1, is not essential for carrying out the invention as meant by Art. 83, this reference should be deleted from the description.

8.6 The "**incorporated by reference**" statement on page 5, lines 7 and 8, should be deleted, since the application should be self-contained (see EPO Guidelines, F-III, 8).

9 Care should be taken during revision not to add subject-matter which extends beyond the content of the application as originally filed, Article 123 (2) EPC.

In his letter of reply, the Applicant should indicate the parts of the originally filed application serving as a basis for subject-matter newly introduced into the claims.

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PUBLISH-SUBSCRIBE
INTERNET ROUTING
PARADIGM

LIPSIN: Line Speed Publish/Subscribe Inter-Networking

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Summary

In an attempt to solve many of the problems in the current Internet, a number of so-called clean slate approaches have been proposed. Common to many of them is to focus on data, rather than nodes, and to use some sort of publish/subscribe, instead of send/receive, as the main API abstraction. In this paper, we explore further the space where the pub/sub paradigm replaces send / receive completely, throughout the stack. In particular, we introduce a new efficient forwarding architecture that naturally supports multicast and may be relatively easily extended to support networking functions beyond forwarding, including network coding and caching. The novelty of our approach consists of compacting source route link identifiers in small Bloom-filter-based packet headers. The suggested method is simple and can be readily implemented in hardware for fast forwarding. Although we focus on a pub/sub-based architecture in this paper, our forwarding method is not limited to pub/sub. It can be used in any network setting with known link identifiers and sufficient topology information allowing larger than hop-by-hop forwarding decisions.

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Chapter 1

Introduction

The present host-oriented way of inter-networking [19] is based on routing packets using the destination host IP address. The network was designed to serve the packet sender; it delivers the packet to the receiver the best it can. However, this scheme does not consider the possibility that the receiver may not be willing to receive that particular piece of data; the assumption was that the sender will honour the recipient's consent. Hence, the original design of the Internet has led to an imbalance of powers, in which the sender has too much control over the network, compared to the receiver. This is a root cause for a number of well-known problems, such as unwanted traffic.

A number of mechanisms have been developed and turned out to be useful to fight against problems caused by the present design. For example, firewalls are used to protect hosts by aiming to block all unwanted traffic, and NAT boxes provide partial protection by simply fracturing connectivity [38, 39]. However, from a larger perspective, such mechanisms only lead to an armament competition between those wanting protection and those wanting connectivity, for legitimate or illegitimate reasons, thereby further reducing the potential utility of the Internet.

In contrast to this background, information-centric inter-networking provides a new model for communication [19]. In an information-centric model, the focus is on data, not nodes. The underlying nodes and hosts become more-or-less impartial, possibly to an extent where they no longer have persistent, IP-address-like names (cf. with [4]). We are not interested in the name of the host that has converted the original information into the form and delivered it to us, as long as the data is timely and correct.

In this paper, we focus on how to implement topic-based publish/subscribe [15], or pub/sub for short, directly on the top of raw hardware, in a scalable manner. To our knowledge, the proposed scheme is the first one that has the potential of supporting pub/sub in Internet-like scales, allowing one to realistically consider pub/sub, instead of IP-like approaches, as an inter-networking paradigm. Furthermore, our scheme is not limited to publish/subscribe networks; instead, it can be used in any network that has a rich-enough topology layer so that

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our combination of source routing and stateful routing can be implemented; see Section 3. Hence, it is plausible that the method could be used, for example, to implement efficient IP multicast.

When designing a routing and forwarding system, one has to consider the balance between the information stored in the forwarding nodes and the present in the packet headers. In the basic IP design, the packet header contains the destination address and all the forwarding nodes know their best next hop towards all destinations. The only known way to make that design to scale is to aggregate the address space so that state is needed only for each aggregate [14].

At the opposite end from the present Internet design lies strict source routing [36], with its well-known problems related to packet sizes and security [5]. In strict source routing, the packet's path is described, hop by hop, in the packet header. A single forwarding node does not have to know anything else than its neighbors; it just picks the next hop node from the packet header and delivers the packet.

Our approach is based on an assumption that there are no stable end-to-end *addresses* for the network nodes, for three reasons. First, such addresses might foil most of our envisioned benefits in fighting unwanted traffic. Second, in an information-centric architecture long-lived node addresses should not be needed. Third, any such addresses used as identifiers are detrimental to the ability of supporting mobility and multi-homing.

Such node-address-less design generates new kind of problems, especially for routing and forwarding. Our Bloom-filter-based mechanism solves the forwarding problem without end-to-end addressing, using a link-identifier-based approach that combines elements from source routing and stateful routing, in a flexible way. In particular, we show that our approach leads to fast hardware-implementable forwarding decisions at the forwarding nodes, reduces the possibilities for malicious nodes for sending unwanted traffic, and at the same time could be scaled to Internet-wide scales.

Hence, the main contribution of this paper is showing that it is feasible to build a scalable and secure multicast forwarding layer, allowing one to explore the space of source-addressable inter-networking instead of the present destination-addressable internetworking schemes. In particular, our results indicate that it should be possible to build flat content-based name spaces in a scalable manner, contrary to previous results [8].

The rest of this paper is organised as follows. First, in Section 2, we motivate our work and give an outline of our proposed methods. In Section 3, we go into details of the design. Next, in Section 4, we provide extensive evaluation and analysis, in the form of simulation results, to support the validity of the scalability claims and accuracy of the results reported. In Section 5, we briefly describe our early FreeBSD-based end-node implementation, provide some initial performance measurements from our NetFPGA-based forwarding-node implementation, and discuss our plans for continuing with the implementation. Section 6 contrasts our work with related work, and Sec. 7 concludes the paper.

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Chapter 2

Towards scalable pub/sub

2.1 Background

In the current frenzy of the so called clean slate network designs, different sorts of publish/subscribe have become one of the more promising approaches [11, 24, 32, 37]. While the term "publish/subscribe" covers a wide variety of networking approaches [15], the so-called topic-based publish/subscribe seems to offer the best scalability. In our envisioned world, internet-networking is based on topic-based publish/subscribe rather than the present send / receive paradigm [12, 32, 37]. In topic-based publish/subscribe, the basic unit of publication and subscription is a topic, identified by a unique identifier.

From an architectural point of view, in a topic-based pub/sub a topic can be thought as an identifier of a channel. Whenever there are events related to the topic, information is delivered over the channel from the event source to the subscribers. For example, if the topic refers to a document, whenever a publisher publishes a new version of the document, the new version (or metadata describing it) is sent.

An important feature of pub/sub inter-networking is that would allow us to protect the hosts against most types of unwanted traffic. Basically, pub/sub requires a subscription by the subscriber before any data moves. The architecture becomes more balanced in power than the current Internet, allowing both the sender and the receiver to exert a roughly equal amount of control over the network.

The pub/sub abstraction allows the sender and the receivers to be separated by time. For example, a subscriber may indicate its interest a long time before a publisher has anything to publish, while another subscribe may come along only later, once the publisher has already published some data, and get the latest version of the data from a cache.

Overall, our aim is an information-centric inter-networking system that scales to tens of billions of nodes and some 10^{15} active pub/sub topics, at the same time reducing the relative amount of unwanted traffic by at least an order of

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magnitude from its present level.

2.2 A straw-man design

Now, while almost all of the so-called *clean slate* designs are somehow based on the assumption of an underlying network that forwards packets more-or-less similar to the current Internet, we have envisioned a "post IP" world where the inter-networking layer is based on topic-based pub/sub [12, 32, 37]. Hence, instead of routing and forwarding packets based on a destination address, in our architecture packets are ultimately routed based on a topic identifier. Furthermore, we want to build a network where the receiver has a great deal of control of what to receive, without the network being able to exert its power in the form of content-based price discrimination [41].

Using these assumptions, it becomes natural to leave any solutions based global end-to-end addressing behind, and move to the unmapped territory. A straightforward way of implementing information-centric data delivery, where the pieces of data have an identity of their own, is to set up a time-dependent delivery-path or tree from the publisher to the subscribing nodes, based on the topic identity. In such a solution, the routers along the path or tree are explicitly configured to forward data based on the particular topic.

It is obvious that such a simple solution does not scale. First, the number of potential topics and transmission events in the network is huge. The size of the forwarding table in a single router would grow extremely large, as each new subscription generates a separate piece of state at all routers residing on the transmission path between the existing tree and the new subscriber. Second, updating the forwarding tables due to subscribers' churn would generate a large amount of control traffic and take too long to process.

The straw-man design can be contrasted with IP multicast. In IP multicast, the data source defines a group ID for the delivered data. The group ID is announced to the potential receivers, who need to set up a connection towards the source node. In practise, a receiver "joins" the multicast group, and the network forms a multicast tree based on the "join" messages. As it is well known, the approach has both scalability and deployability problems, as it, too, involves adding state to all of the intermediate routers.

Our approach provides a flexible design where the network control functions can vary the amount of routing information placed in the packet header vs. installed at the network nodes.

In the following, we first briefly describe our overall pub/sub based inter-networking architecture, and then present a forwarding solution that resembles strict source routing but uses a *fixed-sized*, compact header, using Bloom filters, suitable for fast hardware implementation. Furthermore, our solution *hides the network structure* so that it is difficult, using only the forwarding information from the packet headers, to figure out the path that any given packet will take.

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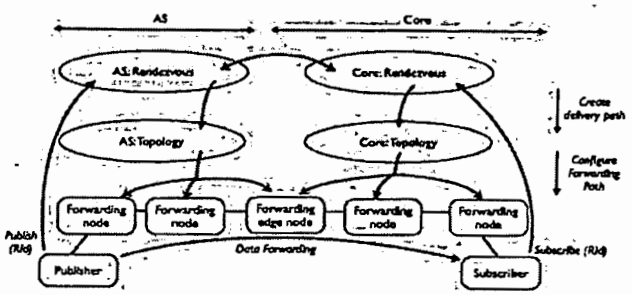

Figure 2.1: Rendezvous, Topology, and Forwarding in pub/sub architecture

2.3 The Network Architecture

In our topic-based pub/sub architecture, the topics do appear at various layers in the architecture, at the lowest layers representing single packets, higher up channels, and still higher up documents. The applications can request publish or subscribe access to these entities, typically asking existing entities in their virtual memory to be published in the network, or network-based entities to be subscribed and mapped to their virtual memory space.

While the overall architecture of the system is still work in progress (cf. [12]), the approach can be described through a recursive approach [32], depicted in Figure 2.1. At the bottom of the architecture lies the forwarding layer, the main focus of this paper. Its main responsibility is to forward packets from their sources to their sinks in an efficient, best-effort manner. The structure above the forwarding layer can be divided into a data and control plane. At the *control plane*, the topology management system creates a distributed awareness of the structure of the network, similar to what today's routing protocols do. On the top of the topology management system lies the rendezvous system, which is responsible for matching the interests of the publishers and subscribers.

At the *data plane*, at the top of the forwarding layer, in addition to the traditional transport functions, such as error detection and traffic scheduling, we envision a number of new network functions, such as opportunistic caching and lateral error correction. The transport functions will work in concert, utilising each other in a *component wheel* [12], similar to the way Haggle managers are organised [33].

As in most pub/sub schemes, communication is based on multicast. In our design, the basic communication scheme is functionally similar to IP-based source specific multicast (SSM), with the IP multicast groups having been replaced by the topic identifiers[1]. Hence, in our architecture multicast is used as the basic transmission method, and unicast is a special case of multicasting

[1] For multi-sender single-receiver situations, some sort of concast will be supported; see Section 6.3.1 of [12].

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with only one receiver.

Each publication is identified with a Rendezvous Identifier (RId). For the purposes of this paper, it is sufficient to consider each RId to be unique, acting as a handle to the publication[2]. When a publisher wants to publish a new piece of information, it acquires a new RId from the system and instructs the system where in its virtual memory space the publication data can be found. Correspondingly, when a subscriber wants to get access to a piece of information, it acquires the RId through an application specific means, e.g. from a well-known directory, and asks the system to arrange the data to appear at its virtual memory. It is the responsibility of the node-local part of the network to actually announce each new publication to the rendezvous system, and correspondingly, to request the rendezvous system to (eventually) arrange the data delivery to take place.

Once the rendezvous system has identified a publication that has both a publisher (or an up-to-date cache) and one or more subscribers, the network requests the topology system to build a forwarding tree from the present location of the data to the subscribers. While sounding trivial, the actual implementation of the functionality in a scalable manner turns out to be quite complex.

In this paper, we concentrate mostly on channel-granularity publications and only on the forwarding layer, including the way the topology system controls the forwarding layer. We do not describe any particular solution for the rendezvous mechanism or for the topology collection phase of the topology system, and we do not discuss the transport functions at the data plane. Furthermore, we mostly focus on intra-domain forwarding, i.e. forwarding inside a single autonomous system (AS). As our architecture is recursive, the method can be applied also on inter-AS routing.

2.4 Recursive bootstrapping

As mentioned above, we are creating a new network architecture on the assumption that there is no end-to-end addressing scheme deployed. The only initial way of communication is link-local broadcasting, used to bootstrap the topology mapping and rendezvous systems [30]. As a part of the bootstrapping process, we expect the topology system to create local static forwarding paths for the purposes of the rendezvous system, thereby allowing publication announcements and subscription requests to be forwarded between any nodes and the rendezvous system.

This approach is applied in a recursive manner. That is, while at the local links the rendezvous system runs directly on the top of the local broadcasting function, without any topology management at all, at the higher layers the rendezvous system relies on the static forwarding paths, created during the bootstrap and provided by the lower layers.

[2]More precisely, each publication is identified with a $< ScopeID, RendezvousID >$ pair. The scopes both help the rendezvous system to scale and to organise the publications.

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We bootstrap the system bottom-up, assuming recursively that the layer below offers (static) connectivity between any node and the rendezvous system. At the lowest layer, this assumption is trivially true since any two nodes connected by a shared link (wireline or wireless) can, by default, send packets that the other node(s) can receive.

During the bootstrap process, the topology management functions on each node learn their local connectivity, by probing or relying on the underlying layer to provide the information. Then, in a manner similar to the current routing protocols, they exchange information about their perceived local connectivity, creating a map of the network graph structure. The same messages are simultaneously used to bootstrap the rendezvous system.

2.5 Forwarding on Bloomed link identifiers

In order to forward packets through the network, we use a hybrid approach where the topology system both constructs Bloom-filters-based forwarding identifiers, used in a source-routing manner, and on demand installs new state at the forwarding nodes. For both of these functions, we use an approch where the links, not the nodes, have names.

For each point-to-point link, we assign two identifiers, called Link IDs, one in each direction. For example, a link between the nodes A and B has two identifiers, $\overrightarrow{AB}$ and $\overleftarrow{AB}$. In the case of a multipoint link, such as a wireless link, we consider each pair of nodes as a separate link. With this setup, we don't need any common agreement between the nodes on the link identities – each link identity may be locally assigned, as long as the probability of duplicates is low enough[3].

Basically, a Link ID is an m-bit Bloom filter whith just k bits set to one. In Sec. 4 we will discuss the proper values for m and k, and what are the concequences if we change the values; however, for now it is sufficient to note that typically $k \ll m$ and m is relatively large, making the Link IDs statistically unique (e.g., m=256, k=5, Link IDs $\approx m!/(m-k)!$). As briefly explained above, the topology management system creates a graph of the network using the Link IDs and connectivity information (creating the "topology map" or "routing table"). Using the network graph, the topology system can determine a forwarding tree for any publication, considering the locations of the publisher and subscribers.

Now, when the topology management system gets a request to determine a forwarding tree for a certain publication, it first creates a conceptual delivery tree for the publication using the network graph. Once it has such an internal representation of the tree, it knows which links the packets need to pass during delivery, and it can determine when to use Bloom filters and when to create state.

[3] As we will see later, under certain settings it is beneficial to coordinate the link identifiers in a centralised manner, reducing the amount of forwarding loops and false positives.

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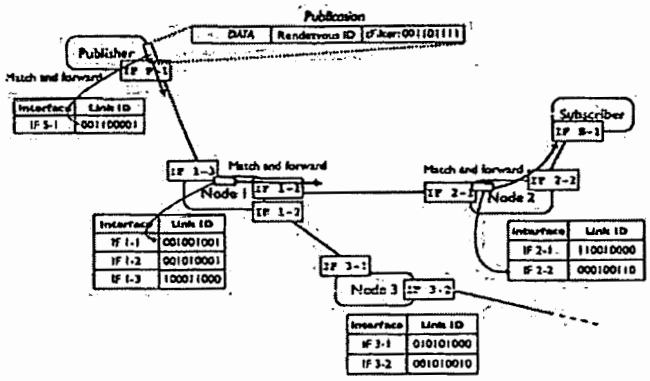

Figure 2.2: Example of Link IDs assigned for links, as well as a publication with a zFilter, built for forwarding the packet from the Publisher to the Subscriber.

In the default case, we use the source-routing-based approach. Basically, we encode the all Link IDs of the tree into Bloom filter, placed in the packet header. By having Link IDs taking the form of a BF-compatible bit vector structure (m-bit long with k one bits), the topology module can create a usable in-packet representation of the tree by simply ORing the Link IDs. Once all link IDs have been added to the filter, a mapping from the rendezvous identifier (RId) to the BF is given to the node acting as the data source, which can now create packets that will be delivered along the tree. To distinguish the BFs in the actual packet headers from other BFs, the in-packet Bloom filters (together with an addional byte) are referred as zFilters[4].

Each forwarding node acts on incoming packets roughly as follows. For each link in its forwarding table, the outgoing Link ID is ANDed with the zFilter. If the result matches with the Link ID, it is assumed that the Link ID has been added to the zFilter and that the packet needs to be forwarded along that link.

With Bloom filters, matching may result with some false positives. In such a case, the packet is forwarded along a link that was not added to the zFilter. However, we do not consider this a problem as long as the rate of false positives remains sufficiently low; see Section 4.1. Indeed, it is even possible to take advantage of some packets being transmitted unnecessarily: the packets can be opportunistically cached and used to fulfill possible future subscriptions.

Fixed-sized Bloom filters have a finite capacity; when the number of links exceeds this capacity, the rate of false positives would raise to an unbearable level. While we are able to increase the capacity somewhat through using some clever coding choices, our fundamental approach in solving the capacity problem is twofold: Firstly, we use recursive layering [10] to divide the network into

[4]The name is not due to `zfilter.com` nor the e-mail filter, but due to one of the authors reading Franquin's Zorglub for the Nth time during the early days of the presented work.

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suitably-sized components; see Section 3.4. Secondly, and perhaps more importantly, the topology system may dynamically add *virtual links* to the system[5].

A virtual link is, roughly speaking, an unidirecitional delivery tree that consists of a number of links. It has its own Link ID, similar to the real links. Furthermore, the functionality in the forwarding nodes is identical: the Link ID is compared with the zFilter in the incoming packets, and the packet is forwarded with a match. The difference is that a virtual Link ID is associated with several outgoing links at several routers, causing matches over the whole path.

In this section, we have outlined our architecture and especially the forwarding system. As the astute reader has realised, the basic solution has some shortages, e.g., how to deal with broken links or the (rare) loops that the system inherently imposes due to the false positives. In the next sections, we describe a number of enhancements to this basic forwarding solution, dealing with these shortcomings.

[5]The virtual links may also be used to implement the aformentioned static forwarding paths, needed by the rendezvous system.

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Chapter 3

Design

In the previous section, we described our basic Bloom-filter-based forwarding mechanism using Link IDs. In this section, we first consider the overall design of the system. The rendezvous and topology functions are described without going into too much details, on a level that is needed for understanding the underlying forwarding layer operations. The forwarding layer itself is described in detail, including *Link ID Tags* generation, creation and selection of the forwarding Bloom filters, loop prevention, virtual links, fast recovery, and stateful operations.

3.1 Rendezvous and Topology

The main purpose of the *rendezvous* system is to keep track of offered publications and to find publications matching with subscriptions. The *topology* system has two main functions: to autonomously collect and maintain a representation of the network graph (i.e. the "routing table"), and to create zFilters and virtual links in response to requests from the rendezvous system. That is, the topology system determines the most suitable delivery trees that are then implemented at the forwarding layer in some combination of zFilters and virtual links.

An important aspect of the topology system is to optimize the trees, both in the terms of latency as well as on, e.g., the amount of traffic and network usage. For the purposes of this paper, we assume that for each request the topology module initially selects a (semi)optimal delivery tree, to be implemented by the forwarding layer.

3.2 Link IDs and LITs

We now introduce the concept of *Link ID Tags* (LITs) as an addition to the plain Bloom-filter compatible Link IDs. That is, instead of each link being identified with a single Link ID, every unidirectional link is associated with a set of d LITs, uniformly computed by applying some mapping function (see Fig. 3.1).

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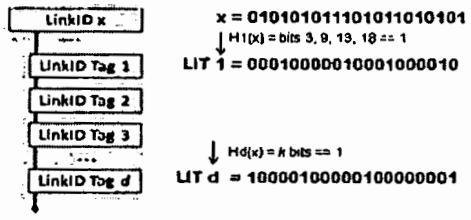

Figure 3.1: Relation of one link identifier (link ID) to d Link ID Tags (LIT). Example of $d - LIT$ generation by using k hashes the Link ID.

That allows us to construct zFilters that can be optimized in terms of the false positive rate and/or compliance with network policies. By introducing the LITs, the actual Link IDs no longer need to be BF compatible but are free to take any form (e.g., our baseline implementation uses 256-bit random bit vectors).

Hence, for each link, there are d LITs, where d is a system parameter that can vary depending on the network. As we explore later, a practical value of d is in the range of multiples of 2 between 2 to 32. The key idea is that we have a set of LITs that each equivalently represents a given link. That allows us to take advantage of the random distribution of the LITs, selecting them in a way that leads to better performing BFs.

In the default configuration, each node assigns a random Link ID and computes the corresponding d LITs for each of its outgoing links that it knows of. This information is locally maintained in the topology system with d forwarding tables containing the LIT entries of the active Link IDs.

Upon packet arrival, the zFilter and the corresponding LIT entries in the forwarding table are ANDed in parallel. The packet is then forwarded on all matching outgoing links (other than the link where the packet arrived from). Fig. 3.2 provides a conceptional view of a forwarding element. The operation is so fast that a long packet packet can be on its way out before the tail of the packet has been received.

To achieve the maximal entropy in the bit distribution of each LIT, it would be required to have k different hash functions per LIT[1]. However, we use the *double hashing* technique to generate the d LITs efficiently, using only two random independent hash functions, without any increase of the asymptotic false positive probability. That is, we rely on the result of Kirsch and Mitzenmacher [23] on linear combination of hash functions, concluding that in practice *double hashing* matches the performance of random hashing. Two independent hash functions $h_1(x)$ and $h_2(x)$ are used simulate i hash functions of the form:

$$g_i(x) = h_1(x) + i * h_2(x) + i^2 mod\ m \tag{3.1}$$

Moreover, simple hash functions have been shown [23] to perform well enough

[1]The number k can be different for each LIT, which allows us to adapt to the different fill factors of the BF, thereby yielding lower false positive rates.

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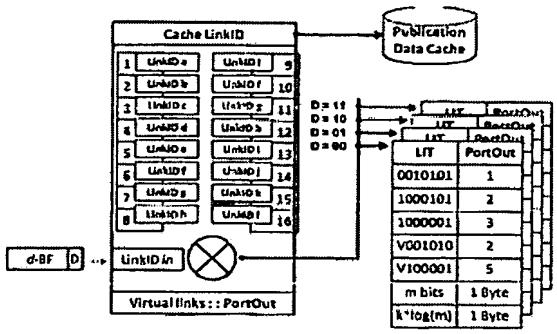

Figure 3.2: Outgoing interfaces are identified by a Link IDs and d forwarding tables indexed by Link ID Tags are maintained.

when the entropy of the elements to be hashed is sufficiently large, which is the case of our pseudo-randomly generated link identifiers.

Furthermore, using the double hashing method, any LIT generation process can be compactly represented by the set of indices i that were used to compute the k positions of the LIT set to 1 (see forwarding table discussion in Sec. 4.4). Therefore, as $h_1(x)$ and $h_2(x)$ are system wide parameters, only sharing $d * k$ integers i is required to derive the LITs for any Link ID.

3.2.1 zFilter construction using LIT's

The Link ID Tags enable a more flexible BF construction scheme by taking advantage of the power of choice [26] during the probabilistic process of generating the zFilters. For each of the d LITs of every link to be inserted in the BF, a candidate BF is generated by ORing one LIT representation at a time of each link[2] (see formal example algorithm 1). This results in having d candidate BFs that are "equivalent" representations of a certain delivery tree, meaning that the packet using any of the candidates will follow, at minimum, all the network links inserted into the BF.

[2]In the case we allow different links having a different number of LITs, we simply reuse the LITs in a modular fashion. For example, if a link as $d = 4$ and we are constructing the 7th candidate, we use the 3rd LIT.

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Algorithm 1: Construction of d candidate BFs and selection based on expected false positives.

Input: Link IDs of the delivery tree
Output: zFilter to be used as forwarding identifier

```
foreach Link ID in Delivery Tree do
    foreach Link ID Tag LIT_i / i ∈ [1 : d] do
        Candidate BF_i ← BF_i OR LIT_i;
    end
end
// Procedure to apply the filter selection criteria (e.g., BF with the best
fill factor)
Return zFilter ← SelectBest(BF_i);
```

Due to the probabilistic nature of the LITs, each candidate BF constructed by ORing the LITs will look different regarding the number and position of the bits set to 1. The fill factor ρ (or the ratio of 1's to 0's) in the candidate BFs will be key when counting for false positives. It can be shown that the false positive rate of a BF is a function of the probability that a bit cell is empty (see analysis in Sec. 4.1).

In addition to the actual BF, the packet header must now include the LIT set index d of the selected BF. At packet forwarding time, the nodes receiving the d-enhanced BF can pick the dth[3] forwarding table entry that includes the correct LIT, i.e. the same one that was used during the construction time. Our approach thereby enables finer control over the effects of false positives while keeping the appealing properties of the Bloom filters.

3.2.2 Selecting the optimal filter

When optimizing forwarding, for better performance in terms of lower false positive probability we first consider two different, relatively simple strategies:

Lowest false positive after hashing (fpa): When every LIT contributes with k bit positions set to one, selecting the best candidate BF implies simply choosing the candidate BF with the lowest amount of 1's. If different number k of bits were used for the LIT representations, the selected BF should be the one with the lowest false probability estimate after hashing: $min\{{\rho_0}^{k_0}, \ldots, {\rho_d}^{k_d}\}$. See details in Sec. 4.1.

Lowest observed false positive rate (fpr): Given a test set T_{set} of link IDs, the candidate BF can be chosen after counting for false positives against T_{set}. The objective is to minimize the observed false positives when querying against a known set of Link IDs active in the routing elements along the delivery path.

The *fpa* strategy is simple and aims at lower false positives rates for any set of link IDs under membership test. On the other hand, the *fpr* yields the

[3] $d$kth entry in the case there are only k LITs associated with the link

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best performance of false positives for a specific test set at the expense of higher complexity.

Going further, the BF selection criteria can also take other network policies into consideration beyond false positives. For instance, we can check for false positives of specific link IDs that may be troublesome, such as forwarding packets towards non-peered domains, resource constrained regions, or potential loops. Any such candidate BF would then be disregarded, even though it might offer better false positive estimates in absolute terms. We call such selection criteria as *link avoidance*, since it is based in penalizing those candidate BFs that yield false positives when tested against sets of LITs to be avoided. Such link test sets (T_{set}), for a specific criterion, can be weighted against each other when choosing the final BF. For example, the following kinds of criteria could be considered:

Routing policies: T_{set} of links to be preferably avoided due to inter/intra-domain routing policies.

Congestion mitigation: *Static* T_{set} of links to be avoided due to traffic engineering (e.g., low capacity links) and *dynamic* T_{set} containing links suffering from congestion.

Subscribers density: T_{set} of links that lead to a dense area of subscribers where false positives are expected to cause more cascaded false positives and undesired traffic.

Security policies: T_{set} containing links to be avoided due to security concerns.

With the d-choice LIT BF construction scheme, we have a powerful method to construct a compact forwarding identifier that can reduce the effects of packets by reducing and confining false positives to certain network areas. Increasing the power of choices (larger d values) leads to more possible combinations of hash functions, and hence better chance of having optimal fill factors of the BFs. However, a larger d implies larger forwarding tables that may not pay off the gains in false positive rates. Section 4.3 provides more experimental insights on these trade-offs.

3.2.3 Loop prevention

In some cases false positives can result in loops; for instance, consider the case where a zFilter encodes a forwarding path $A \rightarrow B \rightarrow C$, but, due to a false positive, the zFilter also matches with a separate link $C \rightarrow A$, which is used to forward packets from C to A. Without loop prevention, this will cause an endless loop of $A \rightarrow B \rightarrow C \rightarrow A$. Obviously, we can construct a set of links that may cause a loop and use the *pfr* method above to select only loopless candidate BFs. However, this may not guarantee loop free trees; for example, the network graph presentation may not have all links in it, e.g. due to slow reaction to network changes.

As an alternative solution, we start with each node knowing the neighboring nodes' *outgoing* Link ID and LITs towards the node itself. We call these as the *incoming* Link ID and LITs. Now, for each incoming packet, the node checks the

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incoming LITs of its interfaces, except the one from where the packet arrives, and matches them to the zFilter in the packet. A match means that there is a possibility for a loop, and the node caches the packet's zFilter and the incoming Link ID for a short period of time. In case of a loop, the packet will return to this node over a different link than the cached one and the packet is simply dropped.

3.3 Stateful functionality

3.3.1 Virtual Links

So far, a number of LITs have been inserted into a zFilter, each LIT representing an individual physical link. However, in case of dense multicast trees, heavy traffic, and long-lived connections, it becomes more efficient to identify sets of individual links with a separate Link ID and a set of associated LITs. We call such sets of links for *virtual links*. A single virtual link can define an end-to-end path partly or completely. They are always unidirectional, but they may also encode multicast trees instead of simple paths.

A virtual link may be generated by the topology layer whenever it sees the need for such a link. The creation process consists of selecting the individual links over which the virtual link is created, assigning the link a new Link ID, and computing the LITs. Once the virtual link has been generated, the topology layer needs to communicate the Link ID, together with the LITs (or their hash indices) to the nodes residing on the virtual link.

Once the virtual link creation process is finished, we can use a LIT of this virtual link in any zFilter instead of including all the individual LITs into it. This reduces the probability of false positives when matching the zFilter on the path. On the other hand, adding forwarding table entries into nodes increases the sizes of the forwarding tables, but compared to the current situation with IP routers, the sizes of the forwarding tables still remain relatively small, unless a huge amount of virtual links needs to be added.

3.3.2 Fast recovery

Whenever a link or a node fails, all delivery trees flowing through the failed component break. In this section, we consider two approaches for fast re-routing; in particular, we examine the simple case where there is only one failed node(link) on any given path.

Our first approach is to replace a failed link with a functionally equivalent, preconfigured virtual link. We call this the *VLId-based recovery* approach. The idea is to have a separate virtual backup path built for each physical link ID, to be dynamically used in case of failure of a node determining that it no longer can send packets out through one of its interfaces. This virtual backup path has the same Link ID as the physical link it replaces, but is not active by default to avoid false forwarding.

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The main advantage of this approach is that there is no need to change the zFilter in the packets; basically, it is enough that the node detecting a failure sends an activation message over the replacement route, activating the backup route for both the failed physical link and any virtual links flowing over the physical link, and then starts to forward the packets normally. When receiving the activation message, the nodes along the backup path reconfigure their forwarding tables, starting to forward packets along the replacement path. As a result, the packets flow, unmodified, over the replacement path.

Another approach is to have a separate Link ID (and LITs) for the replacement route. In this method, when a node detects a failure, it adds the appropriate LIT representing the replacement route into the zFilter in the packet. This method does not add any additional signaling or state to the forwarding nodes, but it increases the probability of false positives.

3.4 Edge or border filtering

Let us reconsider Fig. 2.1 on page 3. In the figure, the AS on the left and the core on the right each form separate subnetworks, using zFilters internally. As a result of the rendezvous systems asking the topology system to create a forwarding path, each of the topology modules compute a suitable zFilter, to be used internally. We present two alternative operations at the edge nodes, depending if we use label switching or recursive stacking for the zFilters.

In the case of *label switching*, as the AS topology module realises that the packets must continue to the core, it instructs the edge forwarding node to record a mapping from the zFilter to the RId. Correspondingly, the core topology module instructs the edge node to form a mapping from the RId to its zFilter. Note, that a single zFilter may be used to carry packets from multiple publications, each of having different RId and potentially a different set of subscribers. Thus, each of the zFilters may be mapped to multiple RIds on both directions.

Using the mappings, the edge node can now inspect incoming packets, filter out false positives, replace the incoming zFilter in the packet with an outgoing one, and pass the packet to the other network for delivery. In the case of connecting multiple domains, the edge network may forward multiple copies the packet, each having a different zFilter.

The main drawback is the huge amount of state required. Basically, there needs to be a table entry for each active RId, which becomes impractical towards the core. This method is mainly suitable for use at the edges of the network, where the order of active RIds is likely to be millions.

In the case of *recursive stacking*, the packet carries two zFilters, one for the inter-domain layer and the other one for intra-domain use.

The inter-domain zFilter contains only two links: one from the node closest to the publisher to the border node, and another from the border node to the node closest to the subscriber. These links are *virtual* in the sense that they cannot be used for forwarding through the networks but for mapping purposes.

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The edge node removes the intra-domain zFilter from the packet and determines from the inter-domain zFilter the possible other edge nodes as well as candidate internal subscriber virtual links. In our example , no edge nodes exist in the zFilter and there would be only one entry for the local subscriber. The edge node conceptually contacts the local topology layer, which determines the proper intra-domain zFilter to be used for delivering the packet to the subscriber. In practice, the local zFilter can usually be pre-determined and simply looked up from a cache, or formed from a few cache entries by ORing together the corresponding zFilters.

Even in this case the border router needs quite a lot of state, as it needs to have a separate virtual link for each separate *subscriber set*. However, for typical unicast and sparse multicast cases it suffices to have a separate entry for each local edge node, which will can be scaled up to a few millions without compromising the performance.

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Chapter 4

Evaluation

The main objective of this section is to explore the scalability limits of the zFilter forwarding approach. First, we study the false positive probability of the proposed Bloom filters for different design parameters and optimizations. Second, we estimate the amount of link IDs required to establish delivery trees in typical intra-domain AS topologies for different subscribers' density. Establishing a maximum false positive probability to achieve reasonable performance levels (e.g., 5% false positives), we will be able to draw some conclusions on the scalability of the zFilters without further extensions. Third, packet-level ns-3 simulations demonstrate the feasibility of LIPSIN and complement the previous analysis with actual false positives measurements and insights on the forwarding efficiency. Finally, we conclude the evaluation section with considerations on forwarding table sizes, security, and some final remarks.

4.1 False positive probability

As already described in Sec. 3.2, Link ID Tags are already in the form of m-bit bit vectors with k bits set to one and are added to a candidate BF_i through a simple OR operation of the LIT_i. Assuming that the hash functions to compute the LITs are uniform, it is easy to show [26, 17] that the *a priori false positive estimate* fpb is the expected false positive probability for the given set of parameters (m, n, k) *before* adding the set of elements:

$$fpb = \left[1 - \left(1 - \frac{1}{m}\right)^{k \cdot n}\right]^k \tag{4.1}$$

Setting the partial derivative of fpb with respect to k to zero, gives the number k that minimizes the false positive probability. This is attained when $k = log_2 \cdot \frac{m}{n}$, and is rounded to an integer that determines the optimal number of ones in the LIT representation.

Note that the definition of fpb does not involve knowing exactly how many bits are finally set to one in the BF. Therefore, a more accurate estimate can be

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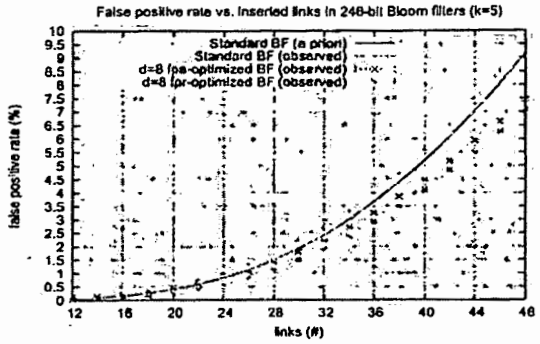

Figure 4.1: Having more choices when constructing BFs leads to improved BFs: $\approx$ 1% better fpr in our region of interest (30-40 links or below 5% fpr).

given once the *fill factor* ρ of the filter is known; that is the factor of bits that are set to one after all the keys are hashed. We can define the *posterior false positive estimate* fpa as the expected false positive estimate *after* hashing the elements:

$$fpa = \rho^k \tag{4.2}$$

In practice, the prior and the posterior estimates are usually very close due to their concentration around the mean. In our small size bit vector scenario, every bit counts and fewer false positives will be key to the performance of our system. The *fpa optimized* BF selection introduced in Sec. 3.2.2, is based on finding the set of LITs with the smallest predicted fpa.

Finally, the *observed false positive probability* is the actual *false positive rate* (fpr) that is observed when a set of queries are made on the BF:

$$fpr - \frac{\text{Observed false positives}}{\text{Tested elements}} \tag{4.3}$$

Note that the fpr is an experimental quantity computed via simulation or actual measurements and not a theoretical estimate. The minimum observed fpr of the d candidate BFs provides a reference lower bound on the actual false positive rate that we can achieve for a specific BF design (e.g., $m = 248bits, k_{opt}$).

Recall that a *fpr optimized* selection of the LIT-based zFilters can be done when the topology module bases the selection of the zFilter on the lowest observed fpr after checking for false positives against a set of LITs expected in the network path. Alternatively the sending node is provided with all candidate zFilters and is able to use the one that shows the actual best fpr based on some type of network feedback.

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4.1.1 System parameters and experiment setup

We carry a set of simulations to get practical knowledge on the actual performance and the design space of a the BF-based data structure for compact representation of Link IDs. In order to have a small overhead in the packet headers we set the size of the zFilter to 256 bits(248-bit BF + 8 reserved bits), which is also a fair comparison value to the source and destination to pair of IPv6 address fields ($2 \cdot 128bits$).

Our goal is to evaluate how many links can be inserted in the zFilter for a certain upper bound false positive probability $P_{max} = 5\%$. Recall that false positives are traduced in data packets delivered over neighbouring link IDs not included in the zFilter. However, the probability that a false positive propagates over further links is multiplicative at each hop by P_{max}, given the large space of link IDs ($m!/(m-k)!$). Recall that in our data-centric inter-networking scenario with massive *opportunistic caching*, such false positives are even less harmful; if there is space available the data may be cached at these false locations thus making the network usage more efficient.

We simulated many system parameters ($k \in [4,5,6]$,$d \in [2,4,8,16,32]$,) and for pairwise combinations we run 500 tests counting for false positives by querying for the presence of 1000 link IDs of a randomly generated disjoint T_{set}. Figure 4.1 shows the false positive ratio results for $d = 8$ degrees of choice, $k = 5$ for the standard BF and a $k_{dist} = \{3,3,4,4,5,5,6,6\}$ to build the 8 candidate BFs. The points in the graph are the mean values of the experiments and the error bars denote the standard error deviation. As expected, the best performing BF (*fpr optimization*) is the one we can select when T_{set} is known. The BF selected after observing its fill factor (*fpa optimization*) shows also better performance than a standard BF with no choice (d=1). After inserting 32 elements, a *fpa-optimized* BF reduces on average the *fpr* in around 0.5% (from 2.75% to 2.25%) and the best performing candidate brings the fpr another 0.5% down to under 1.8%. The performance gains increase with number of elements inserted in the filter. The best BF candidate supports up to 43 elements before reaching the 5% false positive rate. In comparison, the standard BF already shows this *fpr* after having inserted around 38 links. These extra 5 links means that more subscribers can be reached without loosing forwarding efficiency.

Figure 4.2 illustrates the performance gains of having 8 choices when constructing BFs. The percentage boxes illustrate the distribution of k among the experiments when the BF is selected following the lower fpa criteria (see eq. 4.2) and when the actual best performing BFs are considered. The percentage curve highlights how often the used BF performed the best among the 8 candidates in the standard BF scenario (figure 4.2(b)) and when the candidate BF was selected after computing the lowest *fpa* (figure 4.2(a)). One can also appreciate the adaptive selection characteristic of the k_{opt} depending on the *fill factor*. With ≈ 32 inserted elements, almost every second time the best performing BF was selected just looking at the *fill factor*.

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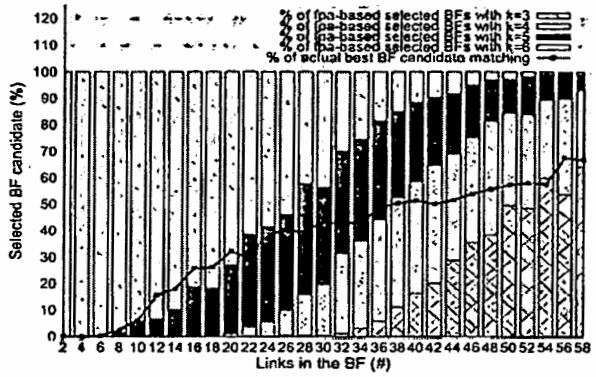
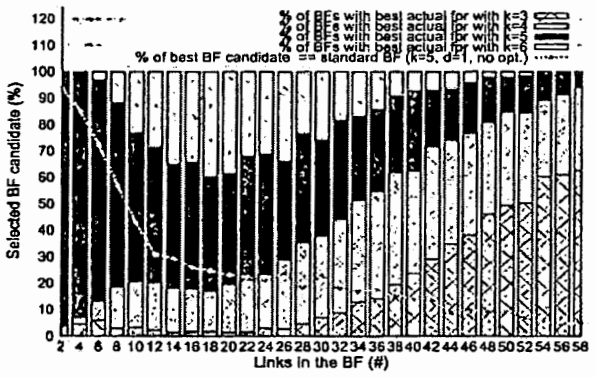


(a) *fpa*-based Bloom filter selection



(b) *fpr*-based Bloom filter selection

Figure 4.2: Performance gains of d-LIT constructed BFs and the distribution of k_{opt} .

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Table 4.1: Graph characterization of a subset of router-level AS topologies used in the experiments.

AS	1221	1755	3257	3967	6461	*TA2*	*Cost*
Nodes (#)	104	87	161	79	138	65	37
Links (#)	151	161	328	147	372	108	57
Diameter	8	11	10	10	8	8	8
Radius	4	6	5	6	4	5	5
Max. degr.	18	11	29	12	20	10	5
Avg. degr.	2	4	3	3	5	3	3

4.2 Data set

Choosing realistic AS topologies to validate new forwarding algorithms is a challenging task, mainly due to the inaccuracies of the available data sets. One set of data we used are 6 intra-domain AS topologies from Rocketfuel [2]. Though not completely accurate, they are a common (best) practice to approximate new forwarding schemes to real world scenarios. A second useful data set of "realistic" router-level topologies is SNDlib [28], where contributors worldwide have published their network maps to the research community. Recent studies [34] have pointed out the limitations of the Rocketfuel data, suggesting that the number of actual physical routing elements is less than the inferred one by their measurement technique. We observed that Rocketfuel graphs are more complex than the largest topologies in SNDlib. Four our purposes this fact (potential inaccuracy) is actually good to stress our forwarding mechanisms.

We are also aware that switching elements are not present in topology maps and could have an impact on the number of link IDs required as the number of network element hops increase. However, we believe that routers should be regarded as the significant networking units on which link IDs are defined, letting layer 2 elements hidden from the topology function.

4.2.1 User density and number of links

We carried a series of experiment to estimate the number of links required to establish delivery trees for different user densities. The experimental results for the number of links required averaged over 6 different topologies are given in Fig. 4.3. In the center figure, we show the case when one additional link ID is required for the hop between the user and the first forwarding node. The figure on the right presents the case where the leaf nodes represent rendezvous points of the subscribers and therefore maintainance of forwarding state for their attached users can be assumed. Finally, the left figure shows the experiment snapshot from the largest router-level topology (AS 1239 - Sprint).

In the previous false positive probability analysis, we observed that 40 link IDs is the maximum capacity of the zFilters to maintain the bandwidth waste

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under control. For 40 link IDs, we can conclude that up to 10 users can be reached over typical AS intra-domain topologies, or up to 20 users when some state is maintained in the forwarding node where the users are attached.

4.3 Packet-level Simulation

Another important part of our evaluation studies was to implement our line speed forwarding scheme in ns-3 [18]. First, it serves as a quick proof-of-concept implementation of the LIPSIN idea. Second, it investigates its behaviour on different topologies and gives a detailed picture about the effect of the different parameters.

We implemented a zFilter-based forwarding layer over an existing Layer2 implementation[1]. Over the forwarding layer, we implemented a simplified pub/sub-based internetworking-layer to send publication data to a given rendezvous identifier. A separate topology module has all the information about the network topology (user locations, Link IDs and LITs) and can thereby construct the zFilter by defining a tree using the shortest paths between the publisher and each subscriber. We also implemented a rough loop prevention method that solves the problem of infinite loops by caching packet headers in the forwarding elements that may potentially cause loops if a forwarded packet is received again over another input interface.

In our experiments we investigated the different settings of the number of forwarding tables (d), as well as the number of users interested in a publication (n). Furthermore, we investigated the effect of different LIT-sets for the nodes(constant k, variable k distribution), and used different BF selection algorithms (fpr/fpa optimization). We carried out our tests on the well-referenced topologies (data set from Sec. 4.2) and performed 500 runs for each parameter setting.

We can define the *forwarding efficiency* as the ratio of *inserted links* (programmed links in the zFilter) to *forwarded links* (actual links the packet traversed through). This metric gives a notion of the bandwidth overhead due to false-positive-based forwarding decisions.

We present the essence of our simulation results on Tables 4.2 and 4.3. Table 4.2 contains results using the *fpa* selection criteria with the above mentioned distribution of k around 5. Besides the mean values, we also counted the 95% percentiles to observe the sensibility of the results. We found that we have adequate performance in all of the topologies, if we consider one publisher and 23 subscribers ($\approx$ 32 links). When increasing the number of subscribers the results tend to be more topology-dependent. AS3257 presents the poorest performance, which can be expected due to its graph characteristics (many nodes, high diameter and radius).

Table 4.3 sheds light on the fpa/fpr-based BF selection algorithms. From the results we discovered an interesting relation between the distribution of k

[1]This was purely an early implementation choice. Ethernet or other Layer 2 MAC is not required.

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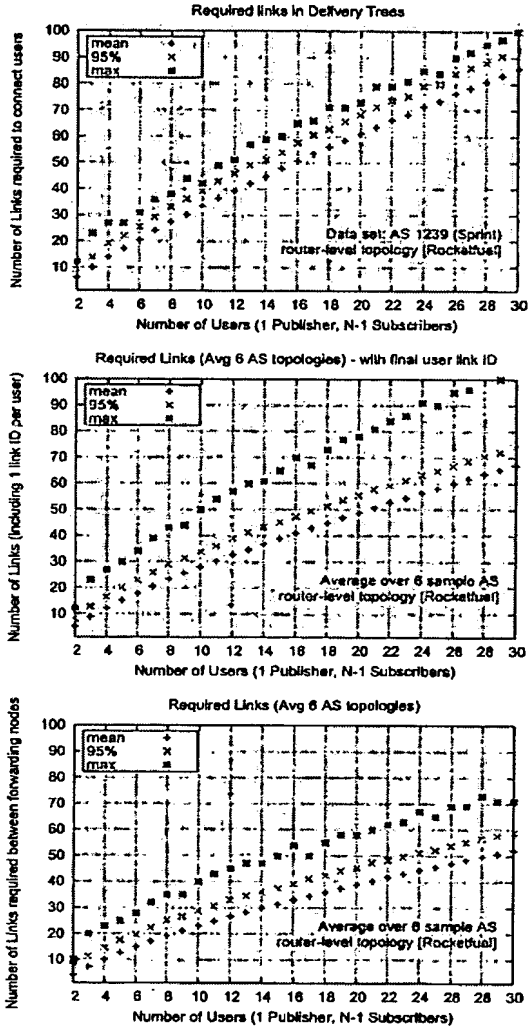

Figure 4.3: Simulation results on the number of links required to establish delivery paths for different user densities over Rocketfuel topologies.

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Table 4.2: ns-3 simulation results (d=8, multi-k=5).

Users	AS	Links (#)		Efic. (%)		fpr (%)	
		mean	95%	mean	5%	mean	95%
4	TA2	8.6	12.7	99.92	100	0.02	0
	1221	9.7	13.6	98.08	88.89	0.37	2.13
	3257	9.6	13.5	99.83	100	0.02	0
8	TA2	15.6	20.0	99.6	94.12	0.2	1.59
	1221	16.8	21.3	97.78	90.89	0.54	2.02
	3257	17.9	22.9	98.95	91.3	0.28	1.25
16	TA2	25.7	30.9	97.92	91.67	0.83	2.67
	1221	27.4	31.0	95.51	88.22	1.28	3.17
	3257	31.3	36.7	92.37	79.58	1.76	3.86
24	TA2	34.1	38.8	95.2	87.18	1.95	4.63
	1221	36.1	41.0	92.06	83.33	2.65	5.19
	3257	42.2	48.1	82.27	67.69	4.17	6.96
32	TA2	41.4	46.0	92.04	84.31	3.46	6.46
	1221	44.0	48.3	88.22	78.95	4.32	7.45
	3257	52.2	57.9	71.47	59.34	7.3	10.41

and the optimization strategies. We observed that in our region of interest the $k_{const} = 5$ performs better than the variable k distribution. As expected, *fpr-optimization* successfully reduces the false positive ratio, and outperforms the standard approach 2 or 3 times in the scenarios with 16 users. The gain of using *fpa-optimization* instead of the standard algorithm is clear, although not as significant as in the previous case. These improvements can be also observed in the sample results of AS6161 on Fig. 4.4.

4.4 Forwarding table sizes

Each forwarding node maintains d forwarding tables with one entry for every active Link ID and one associated outport value. In the basic system design, the memory requirements for the LIT-based forwarding tables are:

$$FTmem = d \cdot \#Links \cdot [size(LIT) + size(PortOut)] \tag{4.4}$$

Considering $d = 8$, 128 link IDs (physical & virtual), 248-bit LITs and 8 bits for the outport, the total memory required for the forwarding table would be $\approx 256Kbit$.

The d-LIT enhancement comes at a price of factor d in fast memory sizes. Although this memory size is small due to the source-based routing approach, there is room to design a more efficient forwarding table. Since LIT entries will only contain k bits set to one, a *sparse representation* would only require to store the k positions of the bits to be ANDed in the test membership on

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Table 4.3: ns-3 simulation results comparing mean fpr values for different configurations.

Users	AS	links	fpa-opt. (fpr %)		fpr-opt. (fpr %)		Stdrd.
		mean	k_{const}	k_{distr}	k_{const}	k_{distr}	$k = 5$
8	*TA2*	15.6	0.12	0.2	0	0	0.18
	1221	16.83	0.44	0.54	0.26	0.26	0.55
	3967	17.72	0.28	0.33	0.03	0.03	0.48
	6461	17.18	0.32	0.39	0.06	0.07	0.36
16	*TA2*	25.7	0.54	0.83	0.01	0.03	0.8
	1221	27.37	1.17	1.28	0.36	0.45	1.57
	3967	29.04	1.13	1.29	0.24	0.34	1.48
	6461	29.31	1.55	1.57	0.71	0.83	1.89
24	*TA2*	34.1	1.65	1.95	0.38	0.58	2.03
	1221	36.14	2.48	2.65	1.21	1.33	3.55
	3967	37.65	2.55	2.78	1.31	1.48	3.22
	6461	39.60	3.72	3.79	2.81	2.86	4.86

packet arrival. Thereby, the size of each LIT entry is nor to only $k \cdot log_2(LIT)$, the total forwarding table size is thereby reduced to $48Kbit$. Furthermore, if we used a *segmented hash* approach where each hash to generate the LIT is limited to a region of $\frac{m}{k}$ bits, each LIT entry would require just $k \cdot log_2(\frac{LIT}{k})$ bits, which in our example is traduced to a total forwarding table size of $36Kbit$. Our first evaluations on a FPGA implementation suggest that the forwarding performance is not penalized when adopting the sparse representation of the LIT entries.

4.5 Security

The probabilistic nature of Bloom filters inherently provides the basis for most of our security features. Furthermore, due to their construction, zFilters are location specific, making it unlikely that any given zFilter could induce any usable traffic if used outside of its intended links. Without knowledge of the actual network graph, including the active Link IDs and LITs, it is unpractical trying to guess a zFilter that would reach any set of host(s).

Consider a simple *zFilter contamination attack*, where a sending node can try to use a BF with a large amount of 1's (or even containing only 1's) that would result in the packet being broadcasted at every forwarding hop due to matches over every link. A simple countermeasure, also observed in [40], is to limit the amount of 1's in a BF, e.g., to 50–70% of the bits. This can be easily implemented in hardware without causing any additional delay. As a result, on the average any randomly generated zFilter will match outgoing links only at the false positive rate, which could be tuned in our system, e.g. to the level of 5%.

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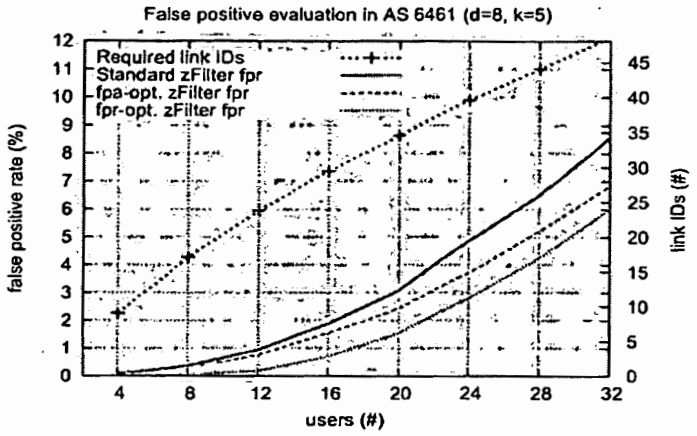

Figure 4.4: ns-3 simulation results for AS 6461.

In a more advanced attack, basically combining a *LIT learning attack* and a *zFilter re-use attack*, an attacker may first attempt to figure out the LITs of the links nearby it. For example, an attacker may attempt to lure lots of subscribers from different parts of the network, thereby allowing it to learn a number of valid zFilters originating at it and learning probable local LIT or combination of LITs for the next few links by using AND for the received LITs.

The presented attack requires quite a lot of work and there are few direct countermeasures. First, using more parallel LITs on links close to the data sources makes collection more expensive. Second, uplink Link IDs can be changed relatively often, forcing the attacker to restart. Third, varying the selection of the Bloom filter (as described in Section 3.2.2), and using those that have more ones, increases the probability that the attacker gets a too full zFilter.

More generally, we can avoid many of the known, and probably a number of still unknown attacks, by slowly changing the Link IDs over time. Thus, there would not exist fixed zFilters that can be used for data between two points at any time. The caveat would be that the connection between the hosts has to be re-calculated once in a while. For actual data delivery, we expect higher level virtual trees to be used deeper in the network which can be easily made short-lived and thereby become unusable after the timer expires.

Finally, consider the situation where an attacker has succesfully launched a *DDoS attack*. That is, there are lots of packets that do not belong to any active subscription arriving at a victim. Initially, the victim can easily quench the packet stream by changing its downlink LITs. After that, any upstream node close to the victim can AND together the zFilters from the unwanted packets, thereby determining if there are any LIT or combination LITs indicating a com-

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mon data path. If there are any such links, the traffic can be further quenched by requesting LIT changes also on those links. The above mentioned periodic Link ID changes can then be used to extinguish the attack.

Looking at our system from a higher perspective, forwarding on a hash-based data structure, such as proposed in our system, complies with several of the steps recommended by Handley and Greenhalgh [16]. By separating the roles of publishers and subscribers, basically any addressing scheme can be used in the domain where the communicating entities reside. The use of periodically changing link IDs avoids requiring global client identifiers.

In other words, the pub/sub paradigm inherently builds a powerful defense architecture empowering the receivers. In our design, no forwarding state is created if there aren't a sufficient number of subscribers that have explicitly indicated their interest in data delivery. We thereby avoid the typical problems of multicast routers maintaining state of unnecessary multicast groups, e.g., an attacker joining many low-rate multicast groups.

Our architecture has the potential to drastically reduce the amount of packet-level or DDoS-like unwanted traffic by making it more costly for the sender. Additionally, we are also considering other security mechanisms, such as using cryptographic rendezvous identifiers or using hash chains or trees to verify the integrity of packet sequences. However, the details fall beyond the scope of this paper.

4.6 Final remarks

The results of our evaluation work suggest that we can make 40 Link IDs easily available for stateless unicast traffic, covering sparse multicast, too, in small world topologies. However, dense multicast still requires explicit state.

The small memory requirements of the forwarding tables and the line speed matching of the outport LITs indicate that we could easily have a few hundreds of Link IDs defined per physical interface. We believe that with such an amount of Link IDs we can establish even more stable and larger (multi-hop) network paths via virtual links, reaching thereby larger groups of users, perhaps up to a few tens, without compromising the fast forwarding efficiency. The exact trade-offs of leveraging the (physical) Link ID based forwarding with a certain amount of virtual links has been left for future work.

Another direction towards scalability is to use a second BF, when higher capacity zFilters are required. LITs are inserted into either one of the BF. The forwarding nodes need to check for the presence of LinkIDs in both BFs. This "double query" comes at the cost of increased zFilter construction time and false positives rate.

With the diameter[2] of the Internet appearing to be established around 4 [3] and the assumption that the current Internet hass small world topology [21], on

[2] `http://thyme.apnic.net/current/data-summary` accessed in Nov. 2008: BGP routing report *average AS path length visible in the Internet* = 3.6

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average just 4 domain level hops are involved and less than 10 routers in typical end-to-end connections.

We believe that our design, with the briefly sketched edge and border operations involving zFilter swapping and stacking, should easily scale to an Internet-wide system. However, exact estimates for the memory requirements at the edge routers is left for future work.

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Chapter 5

Implementation and future work

We have implemented two partial prototypes of the system, a FreeBSD-based end-node prototype and a Stanford NetFPGA based forwarding node prototype. The structure of the end-node prototype is depicted in Fig. 5.1. Each publication is represented as a virtual memory area, depicted with a "P". The PSIRP I/O implements the needed system calls for creating new publications (reserving memory areas), publishing, and subscribing. When allocating memory for a publication, the pager is set to be a vnode pager, and the backing file to be in the Filesystem in Userspace (FUSE)[1]. Hence, each publication is backed up by a virtual file, located in a separate virtual file system running under FUSE.

In the current implementation, the actual contents of the file are kept only in the memory. The physical memory pages are mapped onto the virtual memory of the `psirpd` daemon, the publisher (if any), and the subscribers (if any). The mapping is copy-on-write, causing the kernel to allocate new pages if the publisher or any subscriber modify pages that contain published data. Whenever the publisher wants to publish a new version, the system creates a new snapshot, basically marking any changed pages again as copy-on-write. In this way, there is never need to copy data during the publication time and the system can easily keep track of changed pages, eventually leading to more efficient communications.

On a parallel track, we have implemented an early prototype of the forwarding node using Stanford NetFPGA [25]. Starting from the reference switch implementation, we removed most of the unnecessary code in the reference pipeline and replaced it with a simple zFilter switch. At this point, we have a hand coded forwarding table, with eight parallel entries and support for only one LIT ($d = 1$). The present implementation takes less than 100 lines of Verilog code.

In order to estimate the packet handling delay, we implemented a simple measurement tool on FreeBSD, using a PC with two separate gigabit Ethernet NICs. The tool sends a timestamped packet out through one NIC and waits

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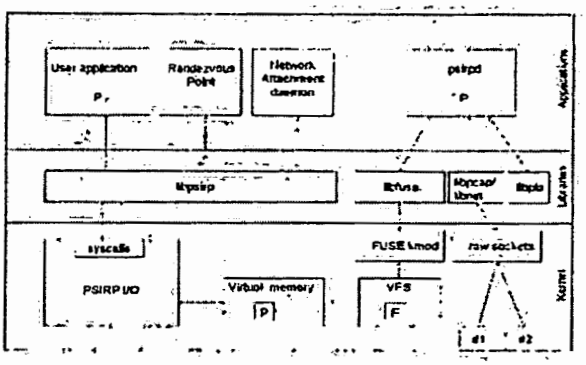

Figure 5.1: Overall view of the FreeBSD Prototype

for the packet to be returned through the other one. We measured the average packet delay over 10000 packets, once with the NetFPGA on the path and another time using a loopback cable. The results are given in Table 5.1 and indicate that the switching delay on the NetFPGA is negligible. We are 95% confident that adding the NetFPGA implementation increases the latency only by 1.01-3.95 μs.

As the next steps, we will enhance the implementation to support dynamic and larger forwarding tables, virtual links, and parallel LITs. Once done, we will measure the performance in a three NetFPGA network, and compare that with the NetFPGA reference Ethernet switch implementation.

We will integrate our end-node implementation with the rendezvous system prototype, build by another group within our project. The resulting system, while still lacking a proper topology system, will be functionally complete and allow us to test pub/sub based applications in small network settings. We have started to implement a proper topology management module, and we will also enhance the system otherwise.

On a wider scope, we will continue with the evaluation when using vir-

Table 5.1: Preliminary NetFPGA implementation performance results. Processing time in μs

	NetFPGA	loopback
Avg.	91.54	89.06
Samples	9969	9969
SD	37.46	37.27
SE	0.38	0.37
95% CI	(90.8, 92.27)	(88.33, 89.79)

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tual Link ID to explore the signaling and state trade-offs of this enhancements towards global scalability. Simulation work is going in the field of state-full operations between network domains to implement the edge or border filtering approaches. Moreover, we have not exhausted all dimensions of the zFilter design parameters.

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Chapter 6

Related Work

Related work falls into various categories, which we briefly discuss in the following paragraphs.

Pub/sub and multicast: To improve the network layer performance in topic-based pub/sub systems, one approach is mapping pub/sub topics to IP multicast groups, so data can be directly sent to subscribers with a single message on the wire. However, this method, though network efficient, does not help to solve the scalability issues of IP multicast. In case of many concurrent active receiver groups, the routers are forced to maintain huge forwarding states due to the lack of aggregation.

The authors of [31] revisit the case of IP multicast and propose Bloom filters to aggregate active multicast groups inside a domain, piggybacking this information in BGP updates. Their IP multicast design also includes a Bloom-filter-based shim header in packets to represent AS-level paths of multicast packets. Our work handles links as more general destination information than IP prefixes and explores more dimensions of the pub/sub forwarding/routing space [42].

Fast forwarding: GMPLS[27] is being extensively used to provide fast forwarding. By separating control and forwarding plane, it introduces more flexibility and important performance gains with the pure hardware fast label switching. However, it does not suit topic-based pub/sub because of the limited label space and no label aggregation capabilities. Some approaches have tried to address this problem by the help of tunneling and group aggregation. Our approach also benefits from the separation of these different planes and is extremely hardware-friendly promising a line speed forwarding layer.

Source routing: The simplest form of source routing [36], is concatenating the forwarding nodes' network identifiers on the path between senders and receivers. Our zFilters address one of the main caveats of source routing, namely the overhead of having to carry all the routing information in the packet. Moreover, our approach does not reveal these identifiers to the sending nodes, nor the sequence or amount of hops involved.

In the PoMo architecture [29], the authors suggest a routing/forwarding solution that trades overdeliveries for reduced state and reduced dependence of

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node network locators. In [9], they propose a networking approach with link identities having a pivotal role.

In line with our LIPSIN forwarding scheme, the BANANAS framework [22] for explicit and multipath routing in the Internet is based on the observation that a path can be encoded as a short hash (PathID) of a sequence of globally known identifiers. While the focus of BANANAS relies on host-centric multipath communications, our design is centered around non-global, opaque Link IDs and its compact representation for efficient information-oriented multicast communication. Many of the schemes developed in [22] for route computation and deployability over existing connectionless routing protocols (e.g., OSPF and BGP extensions) may be borrowed to be used for LIPSIN over legacy networks.

Networking applications of Bloom filters: Bloom filters [6] have attracted considerable attention from a networking application perspective. Today BFs are one of the most popular data structures, spanning their application domain [7] from distributed environments (e.g., distributed caching) to hardware implementations, becoming a daily aid for network processing applications (e.g., IP forwarding, security, etc.).

In Icarus [35], a method to detect possible loops in the routing by using in-packet BF is presented. The security model proposed in [40] shares also the principle of carrying a small BF in packets to provide data path authentication.

In resource location applications [7], BFs have been used to bias random walks in P2P networks. In content-based pub/sub systems [20], summarized subscriptions are created using BFs and used for event routing purposes and general.

We can expect more and more applications Bloom filters and its derivatives in future internetworking proposals relying in hash-based flat identifiers [13].

Improved Bloom filters: Prior work include the Power of Two Choices filter [26] and the Partitioned Hashing [17], which combine the power of choices at hashing time to improve the performance of BFs. Besides sharing the same motivation, our fast forwarding application posses some extra challenges and opportunities for optimization.

False positives are reduced in [17] by a careful choice of the group of hash functions that are well-matched to the input elements. However, this scheme is not practical in a distributed highly dynamic environments. The main idea of [26], is also to choose one of c sets of hash functions so that the number of ones in the filter is reduced. In our system we have the information of which group of hash functions was used (d value) transmitted to the test-membership issuer (forwarding nodes), avoiding thereby the caveat of checking multiple sets. On the other hand, we need to stick to one set of hash functions for all elements in the BF, whereas in [26] the optimal group of hash functions can be chosen on an element base. However, in our small BF scenario we are able to select an optimal BF after evaluating all d candidates. We recognize that there is still room for optimization and other probabilistic compact representations and design parameters could be used as long as simplicity is not sacrificed.

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Chapter 7

Conclusions

In this paper, we presented the design, analysis, and partial implementations for a recursive multicast-based forwarding layer, suitable for implementing very large topic-based publish/subscribe networks. In a two-layer model, similar to the present Internet inter-domain and intra-domain routing model, we are using a slightly larger packet header (64 bytes) than the current Internet (IPv4's 20 bytes and IPv6's 40 bytes). While the intra-domain forwarding is straightforward with our design, in inter-domain case we need to maintain some additional information about neighbour edge nodes at each of the domain's edge nodes.

Our analysis and simulations indicate that we can easily support sparse multicast trees up to approximately 20 receivers per domain. For denser multicast trees, one can either install a separate forwarding table entry for each group, or implement partial trees that can be easily shared between groups. By installing state in the network as and where required depending on the usage dynamics, we expect that applying the recursive operations it should be possible to scale our design into Internet-wide scales.

As our solution is based on partial source routing, it is potentially vulnerable to the well-known problems known from IP source routing. While the actual discussions are lengthy, we can summarise the security discussion by noting that the Bloom filters are opaque and location dependent, making it hard to construct targeted packets. We deal with the looping and packet amplification problems by using preventive actions as well as detection in the network. Link and node failures are handled using preconfigured hot spares.

While we only briefly defined the requirements for the control plane, in the companion paper [42] we discuss the problems of multicast tree construction and maintenance in more detail, and and show how the problem can be divided into a number of subproblems, each separately solvable.

We have implemented two early prototypes of our system, one running on FreeBSD (end node) and another based on the Stanford NetFPGA (forwarding node). In the FreeBSD implementation, we have implemented an publish/subscribe API using the virtual memory, resulting in zero-copy operations. With the present early NetFPGA-based implementation, forwarding

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single packets takes only about 2.5 microseconds compared to a plain loopback cable, suggesting a very fast packet forwarding plane.

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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No. 14/244,701	Applicant(s) AWANO, JUN	
	Examiner SAI AUNG	Art Unit 2475	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *08/03/2016*.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5)☒ Claim(s) *1-28* is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6)☐ Claim(s) _____ is/are allowed.

7)☒ Claim(s) *1-28* is/are rejected.

8)☐ Claim(s) _____ is/are objected to.

9)☐ Claim(s) _____ are subject to restriction and/or election requirement.

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☒ The drawing(s) filed on *04/03/2014* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☒ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date _____.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

4) ☐ Other: _____.

DETAILED ACTION

Claims status

1. In the application filed on 08/03/2016, claims 1-28 are currently pending for the examination. The present application is being examined under the pre-AIA first to invent provisions.

Information Disclosure Statement

2. The information disclosure statements (IDS) submitted on 04/08/2016 and 09/01/2016 have been placed in the application file, and the information referred therein has been considered as to the merits.

Claim Objections

3. Claims 1-28 are objected to because of the following informalities:

As per claim 1, in response to the applicant's Remarks dated on 02/01/2016, the applicant conceded that the term “forwarding unit” has been clarified as “forwarding device”, similarly the term “storage unit” is “storage device, and the term “communication unit” has been defined as “communication device”. See applicant’s remarks on Page. 10 submitted on 02/01/2016. The applicant requested that 35 U.S.C. 112 (f) invocation shall be removed because the terms "units" stand for hardware devices. However, in order to remove from 112(f) invocation, the applicant is required to amend the claims using the term “device(s)”. According to **MPEP Section § 2173**, it states that if applicant does not intend to have the claim limitation(s) treated under 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112 , sixth paragraph, applicant may amend the claim(s) so that

it/they will clearly not invoke 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph, or present a sufficient showing that the claim recites/recite sufficient structure, material, or acts for performing the claimed function to preclude application of 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph. Therefore, claim 1 must be objected. Claims 6, 11, 16, and 21 are further objected to because of the same issue exits with the term "unit(s)". Dependent claims 2-26 are also objected to since they are being dependent upon the objected base claims. Appropriate corrections are required. For the purpose of examinations, the examiner will interpret the claim(s) as best understood.

Claim Rejections - 35 USC § 112

4. The following is a quotation of 35 U.S.C. 112(b):

(b) CONCLUSION.—*The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the inventor or a joint inventor regards as the invention.*

The following is a quotation of 35 U.S.C. 112 (pre-AIA), second paragraph:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

5. Claims 1-28 are rejected under 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject

matter which the inventor or a joint inventor, or for pre-AIA the applicant regards as the invention.

Claim 1 is indefinite because of the following reasons:

a. The claim recites "*to store a packet forwarding table used for forwarding a packet based on an identifier*..." in line 3; [Emphasis Added]

b. The claim also recites "*to receive an incoming packet including a plurality of the identifiers*..." in line 5; and

c. The claim further recites "*to forward the incoming packet based on the identifier*..." in line 6.

One in the skilled in the art would have analyzed that the term "the identifier" in line 6 could also be one of the plurality of the identifiers as recited in line 5. Thus, it is difficult to determine that whether "the identifier" in line 6 intends to refer back to "an identifier" in line 3 or "one of the plurality of identifiers" in line 5. Thus, the claim is indefinite. Claim 6 is further rejected because the similar issue, as discussed in above, exits with the term "the identifier" in line 6. Claims 1-5 and 7-10 are also rejected as being dependent upon rejected base claims. It is recommended that the claim language be amended such that the exact meaning of the above quoted limitation is clear. For the purpose of examinations, the examiner will interpret the claims as best understood.

Claim 1 is further rejected under 35 U.S.C. 112(b) as being indefinite based on the following reasons:

The claim recites "*A packet forwarding node comprising a forwarding unit to receive an incoming packet..., and to forward the incoming packet based on the identifier corresponding to the packet forwarding node.*".

a. First: The packet forwarding node to receive the packet via the forwarding unit.

b. Second: The forwarding node to transmit the packet to the packet forwarding node based on the identifier. [Emphasis added].

One in the ordinary skilled in the art would not able to determine how the packet forwarding node receives and forwards itself based on the identifier. Therefore, the claim is indefinite.

Claims 12-15, 24 and 28 are further rejected under 35 U.S.C. 112(b) as being indefinite based on the following reasons:

a. Claim 11 originally recites "a packing forwarding node" in line 1 and another "a packet forwarding node" in line 6.

b. Claims 12-15, 24 and 28 further recites "the packet forwarding node" referring back to the claim 11.

c. It is difficult to determine whether "the packet forwarding node" intends to refer back to "a packing forwarding node" as recited in line 1 or another "a packet forwarding node" as recited in line 6 stated in claim 11.

Therefore, the claim is indefinite. It is recommended that the claim language be amended such that the exact meaning of the above quoted limitation is clear. For the purpose of examinations, the examiner will interpret the claims as best understood.

Claim Rejections - 35 USC § 112

6. The following is a quotation of 35 U.S.C. 112(f):

(f) Element in Claim for a Combination. – An element in a claim for a combination may be expressed as a means or step for performing a specified function without the recital of structure, material, or acts in support thereof, and such claim shall be construed to cover the corresponding structure, material, or acts described in the specification and equivalents thereof.

7. The following is a quotation of pre-AIA 35 U.S.C. 112, sixth paragraph:

An element in a claim for a combination may be expressed as a means or step for performing a specified function without the recital of structure, material, or acts in support thereof, and such claim shall be construed to cover the corresponding structure, material, or acts described in the specification and equivalents thereof.

8. The following is a quotation of 35 U.S.C. 112(b):

(b) CONCLUSION.—*The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the inventor or a joint inventor regards as the invention.*

9. The following is a quotation of 35 U.S.C. 112 (pre-AIA), second paragraph:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

10. Claim 21 recites "*a first unit configured to determine a plurality of identifiers...; and a second unit configured to send information elements to a packet forwarding node...*", and thus the claim has been interpreted under 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph, because it uses a generic placeholder "*unit*" coupled with functional language "*to determine a plurality of identifiers*" without reciting sufficient structure to achieve the function.

Furthermore, the generic placeholder is not preceded by a structural modifier. Similarly, the second unit uses a generic placeholder "*unit*" coupled with functional language "*to send information*" without reciting sufficient structure to achieve the function. Further, one of ordinary skill in the art would understand the term "*Unit*" as simply a substitute for the term "*means for*" because "*Unit*" would not be recognized by one of ordinary skill in the art as being sufficiently definite structure for performing the claimed function (see MPEP 2181(I.)). Since the claim limitation(s) invokes 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph, claims 21 and 22 have been interpreted to cover the corresponding structure described in the specification that achieves the claimed function, and equivalents thereof. However, claim 21 is rejected under 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the inventor or a joint inventor, or for pre-AIA the applicant regards as the invention.

The claim is rejected because the written description provided in the specification does not clearly link to the structure to perform the steps of the function listed on the claim. For example, the specification only provides for the Unit(s) as shown in below:

a) "*The local ID determination unit 340 is provided with a function that performs information exchange between the boundary forwarding node 300 in question and a neighboring node, and determines a non-duplicating link ID. For example, in the following method, it is possible to avoid a duplicated setting of a link ID with a neighboring node.*" See Para. [0062]

b) "*Referring to Fig. 12, first, the local ID determination unit 340 (430) determines the local ID (step S400). In a case of using a link ID as the local ID, the link ID is*

determined by implementing negotiation between neighboring nodes and the link ID". See Para. [0119].

Nowhere does in the specification further define or explain how the "first unit" and "second unit" functions or performs. Particularly, the specification fails to provide whether the first and second unit are either a software, hardware or firmware component(s). If it is a software, it is also required to be stored in the memory and executed by the processor. Since the applicant's disclosure fails to provide a sufficient structure to perform the steps of the function listed on the claim, the claim is indefinite. Claim 22 is also rejected as being dependent upon the rejected base claim.

If applicant wishes to provide further explanation or dispute the examiner's interpretation of the corresponding structure, applicant **must identify the corresponding structure with reference to the specification by page and line number, and to the drawing**, if any, by reference characters in response to this Office action. If applicant does not intend to have the claim limitation(s) treated under 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112 , sixth paragraph, applicant may amend the claim(s) so that it/they will clearly not invoke 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph, or present a sufficient showing that the claim recites/recite sufficient structure, material, or acts for performing the claimed function to preclude application of 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph. For more information, see MPEP § 2173 et seq. and Supplementary Examination Guidelines for Determining Compliance With 35 U.S.C. 112 and for Treatment of Related Issues in Patent Applications, 76 FR 7162, 7167 (Feb. 9, 2011).

Claim Rejections - 35 USC § 101

11. 35 U.S.C. 101 reads as follows:

Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title.

12. Claims 1-28 are rejected under 35 U.S.C. 101 because the claimed invention is directed to a judicial exception (i.e., a law of nature, a natural phenomenon, or an abstract idea) without significantly more.

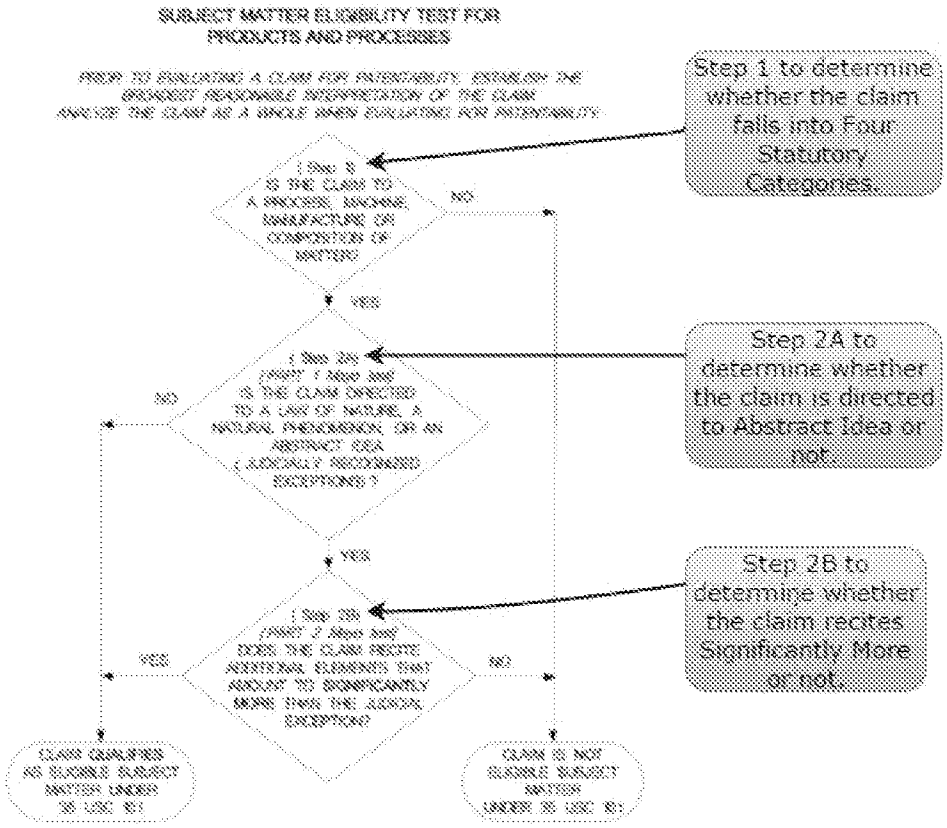
Claimed:

"*1. A packet forwarding node, comprising:*

a storage unit including a non-transitory computer readable medium configured to store a packet forwarding table used for forwarding a packet based on an identifier which identifies a link between nodes on a packet forwarding path; and

a forwarding unit configured to receive an incoming packet including a plurality of the identifiers, and to forward the incoming packet based on the identifier corresponding to the packet forwarding node."

Analysis:



I. Thus, the claimed invention directs to a Machine statutory category [Step 1: YES].

II.

A. The concept of the claimed invention is receiving an incoming data packet that includes identifier(s), and comparing or identifying the identifier based upon the storage unit that stores packet forwarding table before forwarding to the packet forwarding node. In other words, the claimed limitation directs to comparing a new identifier and selecting the identifier from the storage that previously stored data in records. The main concept is similar to the others types of basic concepts that have been ruled as "Abstract Idea" by the Courts. For instance, according to

the similar court case "*SmartGene V. Advanced Biological*", the court found that the steps of comparing new and stored information involve a mental process or abstract idea, as in *Bilski*. A similar case of comparing a new and stored data message can also be found in the relevant court case *Cybersource Corp. V. Retail Decisions, Inc.* [Step 2A: YES].

B. Upon considering the claimed elements individually, *receiving incoming packet including and forwarding the incoming packet based on the identifier*, the intended concept doesn't impose a sufficiently meaningful limit on the claim's scope because those steps could be routinely performed by a generic-purpose computer. Upon reviewing all the claim identified elements in combination and as a whole, *the storage unit to store data along with receiving incoming packet including and forwarding the incoming packet based on the identifier*, the identified limitations do not amount to significantly more than the Abstract Idea. Further, *In re Abele* made clear that the basic character of a process claim drawn to an abstract idea is not changed by claiming only its performance by computers, or by claiming the process embodied in program instructions on a computer readable medium. Therefore, the additional elements/steps have not appended any meaningful limitations to the abstract idea itself. When viewed either individually, or as an ordered combination, the additional limitations do not amount to the claim as a whole that is significantly more than the abstract idea [Step 2B: NO].

In view of the above analysis, **claim 1 is held to be patent ineligible under 35 U.S.C. 101**.

Dependent Claims 2-5 and 22 when analyzed as a whole are held to be patent ineligible under 35 U.S.C. § 101 because the additional recited limitations fail to establish that the claims are directed to an abstract idea, and none of the additionally recited limitations amount to significantly more than the abstract idea.

As per the claim 6, upon reviewing under similar analysis, the claim is also found to be patent ineligible under 35 U.S.C. 101 the claim do not amount to significantly more than the abstract idea. Dependent Claims 7-10 and 23 when analyzed as a whole are held to be patent ineligible under 35 U.S.C. § 101 because the additional recited limitations fail to establish that the claims are directed to an abstract idea, and none of the additionally recited limitations amount to significantly more than the abstract idea.

As per the claim 11, upon reviewing under similar analysis, the claim is also found to be patent ineligible under 35 U.S.C. 101 the claim do not amount to significantly more than the abstract idea. Dependent claims 12-15, 24 and 28 when analyzed as a whole are held to be patent ineligible under 35 U.S.C. § 101 because the additional recited limitations fail to establish that the claims are directed to an abstract idea, and none of the additionally recited limitations amount to significantly more than the abstract idea.

As per the claim 16, upon reviewing under similar analysis, the claim is also found to be patent ineligible under 35 U.S.C. 101 the claim do not amount to significantly more than the abstract idea. Dependent claims 17-20 and 25 when analyzed as a whole are held to be patent

ineligible under 35 U.S.C. § 101 because the additional recited limitations fail to establish that the claims are directed to an abstract idea, and none of the additionally recited limitations amount to significantly more than the abstract idea.

As per the claim 21, upon reviewing under similar analysis, the claim is also found to be patent ineligible under 35 U.S.C. 101 the claim do not amount to significantly more than the abstract idea. Dependent claim 26 when analyzed as a whole are held to be patent ineligible under 35 U.S.C. § 101 because the additional recited limitations fail to establish that the claims are directed to an abstract idea, and none of the additionally recited limitations amount to significantly more than the abstract idea. See also 101 Publicly Accessible Link for more information: http://www.uspto.gov/patent/laws-and-regulations/examination-policy/2014-interim-guidance-subject-matter-eligibility-0

Claim Rejections - 35 USC § 103

13. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> *(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time of the claimed invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.*

14. The factual inquiries set forth in Graham v. John Deere Co., 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows: (See MPEP Ch. 2141)

a) Determining the scope and contents of the prior art;

b) Ascertaining the differences between the prior art and the claims in issue;

c) Resolving the level of ordinary skill in the pertinent art; and

d) Evaluating evidence of secondary considerations for indicating obviousness or nonobviousness.

15. Claims 1-28 are rejected under 35 U.S.C. 103(a) as being unpatentable over **Dong et al. (US 7,496,096 B1)** in view of **EstevE. Rothenberg et al. (US 2011/0149973 A1).**

Regarding claim 1; **Dong** discloses a packet forwarding node (***See Fig. 1; Router(s) 38-42***), comprising:

a storage unit including a non-transitory computer readable medium (***See Fig. 2: the Memory 22 for storing the path IDs; Col. 2, Lines 40-43***) configured to store a packet forwarding table (***See Fig. 3 and 4: the memory to store Path ID's tables; Col. 5, Lines 55-65***) used for forwarding a packet (***See Fig. 1; the router decides the next hop to forward passed upon the path ID received in the IP packet; Col. 1, Lines 64-67, and Col. 2, Lines 40-47***) based on an identifier which identifies a link (***See Figs. 1 and 3; See Figs. 1 and 3; determining the IP path or link ID; Col. 5, Lines 26-30***) between nodes on a packet forwarding path (***See Fig. 1; routing between Edge Routers, such as 38, 40 and 42, using IP path or IP address; Col. 5, Lines 26-32***) ; and

a forwarding unit (***See Fig. 2: the hardware forwarding engine 29; Col. 4, Lines 30-34***) for configured to receive an incoming packet (***See Fig. 6; at step 80, receiving the path information or***

packet; Col. 6, Lines 18-24) including in a path identifier (***See Fig. 6; steps 80-90, the received path information to assign a path ID for the next-hop IP address; Col. 6, Lines 18-25***), and to forward the incoming packet based on the identifier (***See Fig. 6; steps 82-90, assigning the path ID for each path in the path groups and using the path ID for the next hop IP address; Col. 6, Lines 21-26***) corresponding to the packet forwarding node (***See Fig. 6; steps 84-86, the path ID is assigned to the next hop IP address; Col. 6, Lines 21-26, and see also Col. 5, Lines 26-35***).

Even though, **Dong** discloses receiving the path information to assign the path ID for the path group and next hop IP address for forwarding, **Dong** doesn't explicitly discuss the receiving path information/packet includes multiple path identifiers.

However, **E. Rothenberg** from the same field of endeavor teaches the path or routing information includes a plurality of link identifiers (***See Fig. 5 and 6; the routing information comprises a plurality of identifiers, each identifying a respective network link or node; Para. [0018]***).

[***For example, E. Rothenberg's is invention is from the same field of endeavor because it originally discusses routing and forwarding the data packet based upon identifying network link and link identifier in a label switching network. The invention further discusses identifying and encoding the link identifiers and putting into the packet header, and then the identified path is chosen through the network from a source node to a destination node. Para. 0018 and 0083-0084***].

In the manner of combining is that **E. Rothenberg**'s routing information that includes multiple link identifiers (IDs) could apparently be implemented into **Dong**'s conventional the path/link information that only a path ID for the next hop IP address for forwarding.

Therefore, it would have been obvious to one having ordinary skill in the art at the time of the claimed invention was made to provide that the path or routing information includes a plurality of link identifiers as taught by **Dong** to have incorporated in the system of **E.**

Rothenberg, so that it would not only provide a virtual link or physical link to be defined from multiple single links (where a single "link" directly links two network nodes), allowing a more efficient way of describing delivery trees in the network but also support more efficient and powerful forwarding schemes by providing finer control over false positives. ***E. Rothenberg: Para. [0107] and [0144].***

Regarding claim 2; **Dong** discloses the packet forwarding node wherein the storage unit stores the table (***See Figs. 3 and 4; the routing tables with stored path IDs; Col. 5, Lines 55-60***) used for forwarding the packet based on the identifier (***See Fig. 6; steps 82-90, assigning the path ID for each path in the path groups and using the path ID for the next hop IP address; Col. 6, Lines 21-26***) which uniquely identifies the link (***See Fig. 6: at step 82 to assign or identify the path ID; Col. 6, Lines 18-25***) within a predetermined domain (***See Figs. 2 and 4; Col. 1, Lines 50-54***).

Regarding claim 3; **Dong** in view of **E. Rothenberg** discloses the packet forwarding node wherein the storage unit stores the table (**Dong**: ***See Figs. 2 and 3: the Memory 22 for storing the path IDs and the memory to store Path ID's tables; Col. 2, Lines 40-43*** and ***Col. 5, Lines 55-65***) used for forwarding the packet based on the identifier (**Dong**: ***See Fig. 6; steps 82-90, assigning the path ID for each path in the path groups and using the path ID for the next hop IP address; Col. 6, Lines 21-26***) which uniquely identifies the link (**Dong**: ***See Fig. 6: at step 82 to assign or identify the path ID; Col. 6, Lines 18-25***) within a predetermined local domain (***See Figs. 2 and 4; Col. 1, Lines 50-54 and see also Fig. 1 for internally/locally managed IP identifiers***) and (***E. Rothenberg: See Fig. 9; for inter-domain links; Para. [0185]***)

Regarding claim 4; **Dong** discloses the packet forwarding node wherein the storage unit stores the table (***See Figs. 2 and 3: the Memory 22 for storing the path IDs and the memory to store Path ID's tables; Col. 2, Lines 40-43*** and ***Col. 5, Lines 55-65***) used for forwarding the packet based on the identifier (***See Fig. 6; steps 82-90, assigning the path ID for each path in the path groups and using the path ID for the next hop IP address; Col. 6, Lines 21-26***) which uniquely identifies the link (***See Fig. 6: at step 82 to assign or identify the path ID; Col. 6, Lines 18-25***) within the packet forwarding node (***See Fig. 6; at step 90; assigning the path ID within the path group of the router and see also Fig. 1 for internally/locally managed IP identifiers within a router***).

Regarding claim 5; **Dong** in view of **E. Rothenberg** discloses the packet forwarding node wherein the storage unit stores the table (**Dong**: ***See Figs. 2 and 3: the Memory 22 for storing the path IDs and the memory to store Path ID's tables; Col. 2, Lines 40-43*** and ***Col. 5, Lines 55-65***) used for forwarding the packet based on the identifier (**Dong**: ***See Fig. 6; steps 82-90, assigning the path ID for each path in the path groups and using the path ID for the next hop IP address; Col. 6, Lines 21-26***) which uniquely identifies the link (**Dong**: ***See Fig. 6: at step 82 to assign or identify the path ID; Col. 6, Lines 18-25***) among the packet forwarding nodes (***E. Rothenberg: See Fig. 9: among the source and destination nodes; Para. [0084]***).

Regarding claim 6; **Dong** discloses a packet forwarding node (***See Fig. 1; Router(s) 38-42***), comprising:

a storage unit including a non-transitory computer readable medium (***See Fig. 2: the Memory 22 for storing the path IDs; Col. 2, Lines 40-43***) configured to store a packet forwarding table

(***See Fig. 3 and 4: the memory to store Path ID's tables; Col. 5, Lines 55-65***) used for forwarding a packet (***See Fig. 1; the router decides the next hop to forward passed upon the path ID received in the IP packet; Col. 1, Lines 64-67, and Col. 2, Lines 40-47***) based on an identifier which identifies IP path link (***See Figs. 1 and 3; See Figs. 1 and 3; determining the IP path or link ID; Col. 5, Lines 26-30***) of a packet forwarding path (***See Fig. 1; routing between Edge Routers, such as 38, 40 and 42, using IP path or IP address; Col. 5, Lines 26-32***) ; and

a forwarding unit (***See Fig. 2: the hardware forwarding engine 29; Col. 4, Lines 30-34***) for configured to receive an incoming packet (***See Fig. 6; at step 80, receiving the path information or packet; Col. 6, Lines 18-24***) including in a path identifier (***See Fig. 6; steps 80-90, the received path information to assign a path ID for the next-hop IP address; Col. 6, Lines 18-25***), and to forward the incoming packet based on the identifier (***See Fig. 6; steps 82-90, assigning the path ID for each path in the path groups and using the path ID for the next hop IP address; Col. 6, Lines 21-26***) corresponding to the packet forwarding node (***See Fig. 6; steps 84-86, the path ID is assigned to the next hop IP address; Col. 6, Lines 21-26, and see also Col. 5, Lines 26-35***).

Even though, **Dong** discloses receiving the path information to assign the path ID for the path group and next hop IP address for forwarding, **Dong** doesn't explicitly discuss identifying an interface and the receiving path information/packet includes multiple path identifiers.

However, **E. Rothenberg** from the same field of endeavor teaches identifying the interface (***See Fig. 15; the router to assign the link ID of the next router and identify each output interface with a link ID; Para. [0152]***) and the path or routing information includes a plurality of link identifiers (***See Fig. 5 and 6; the routing information comprises a plurality of identifiers, each identifying a respective network link or node; Para. [0018]***).

[***For example, E. Rothenberg's is invention is from the same field of endeavor because it originally discusses routing and forwarding the data packet based upon identifying network link and link identifier in a label switching network. The invention further discusses identifying and encoding the link identifiers and putting into the packet header, and then the identified path is chosen through the network from a source node to a destination node. Para. 0018 and 0083-0084***].

In the manner of combining is that **E. Rothenberg**'s routing information that includes multiple link identifiers (IDs) could apparently be implemented into **Dong**'s conventional the path/link information that only a path ID for the next hop IP address for forwarding.

Therefore, it would have been obvious to one having ordinary skill in the art at the time of the claimed invention was made to provide that the path or routing information includes a plurality of link identifiers and identifying the output interface using the link ID as taught by **Dong** to have incorporated in the system of **E. Rothenberg**, so that it would not only provide a virtual link or physical link to be defined from multiple single links allowing a more efficient way of describing delivery trees in the network but also support more efficient and powerful forwarding schemes by providing finer control over false positives. ***E. Rothenberg: Para. [0107] and [0144].***

Regarding claim 7; **Dong** discloses the packet forwarding node wherein the storage unit stores the table (***See Figs. 3 and 4; the routing tables with stored path IDs; Col. 5, Lines 55-60***) used for forwarding the packet based on the identifier (***See Fig. 6; steps 82-90, assigning the path ID for each path in the path groups and using the path ID for the next hop IP address; Col. 6, Lines 21-26***) which uniquely identifies the link (***See Fig. 6: at step 82 to assign or identify the path ID; Col. 6, Lines 18-25***) within a predetermined domain (***See Figs. 2 and 4; Col. 1, Lines 50-54***).

Regarding claim 8; **Dong** in view of **E. Rothenberg** discloses the packet forwarding node wherein the storage unit stores the table (**Dong**: ***See Figs. 2 and 3: the Memory 22 for storing the path IDs and the memory to store Path ID's tables; Col. 2, Lines 40-43*** and ***Col. 5, Lines 55-65***) used for forwarding the packet based on the identifier (**Dong**: ***See Fig. 6; steps 82-90, assigning the path ID for each path in the path groups and using the path ID for the next hop IP address; Col. 6, Lines 21-26***) which uniquely identifies the link (**Dong**: ***See Fig. 6: at step 82 to assign or identify the path ID; Col. 6, Lines 18-25***) within a predetermined local domain (***See Figs. 2 and 4; Col. 1, Lines 50-54 and see also Fig. 1 for internally/locally managed IP identifiers***) and (***E. Rothenberg: See Fig. 9; for inter-domain links; Para. [0185]***)

Regarding claim 9; **Dong** discloses the packet forwarding node wherein the storage unit stores the table (***See Figs. 2 and 3: the Memory 22 for storing the path IDs and the memory to store Path ID's tables; Col. 2, Lines 40-43*** and ***Col. 5, Lines 55-65***) used for forwarding the packet based on the identifier (***See Fig. 6; steps 82-90, assigning the path ID for each path in the path groups and using the path ID for the next hop IP address; Col. 6, Lines 21-26***) which uniquely identifies the link (***See Fig. 6: at step 82 to assign or identify the path ID; Col. 6, Lines 18-25***) within the packet forwarding node (***See Fig. 6; at step 90; assigning the path ID within the path group of the router and see also Fig. 1 for internally/locally managed IP identifiers within a router***).

Regarding claim 10; **Dong** in view of **E. Rothenberg** discloses the packet forwarding node wherein the storage unit stores the table (**Dong**: ***See Figs. 2 and 3: the Memory 22 for storing***

the path IDs and the memory to store Path ID's tables; Col. 2, Lines 40-43 and ***Col. 5, Lines 55-65***) used for forwarding the packet based on the identifier (**Dong**: ***See Fig. 6; steps 82-90, assigning the path ID for each path in the path groups and using the path ID for the next hop IP address; Col. 6, Lines 21-26***) which uniquely identifies the link (**Dong**: ***See Fig. 6: at step 82 to assign or identify the path ID; Col. 6, Lines 18-25***) among the packet forwarding nodes (***E. Rothenberg: See Fig. 9: among the source and destination nodes; Para. [0084]***).

Regarding claim 11; **Dong** discloses a packet forwarding node (***See Fig. 1; Router(s) 38-42***), comprising:

a communication unit (***See Fig. 2: processor 20***) configured to communicate with a source node for receiving an identifier (***See Fig. 6; at step 80, receiving the path information or packet to assign the Path ID; Col. 6, Lines 18-24***), each of which identifies a link (***See Figs. 1 and 3; See Figs. 1 and 3; determining the IP path or link ID; Col. 5, Lines 26-30***) between nodes on a packet forwarding path (***See Fig. 1; routing between Edge Routers, such as 38, 40 and 42, using IP path or IP address; Col. 5, Lines 26-32***); and

a forwarding unit (***See Fig. 2: the hardware forwarding engine 29; Col. 4, Lines 30-34***) for configured to forward an incoming packet (***See Fig. 6; at step 80, receiving the path information or packet; Col. 6, Lines 18-24***) based on an identifier (***See Fig. 6; steps 80-90, the received path information to assign a path ID for the next-hop IP address; Col. 6, Lines 18-25***) corresponding to a packet forwarding nod (***See Fig. 6; steps 82-90, assigning the path ID for each path in the path groups and using the path ID for the next hop IP address; Col. 6, Lines 21-26, and see also Col. 5, Lines 26-35***).

Even though, **Dong** discloses receiving the path information to assign the path ID for the path group and next hop IP address for forwarding, **Dong** doesn't explicitly discuss the receiving path information/packet includes multiple path identifiers.

However, **E. Rothenberg** from the same field of endeavor teaches the path or routing information includes a plurality of link identifiers (***See Fig. 5 and 6; the routing information comprises a plurality of identifiers, each identifying a respective network link or node; Para. [0018]***).

[***For example, E. Rothenberg's is invention is from the same field of endeavor because it originally discusses routing and forwarding the data packet based upon identifying network link and link identifier in a label switching network. The invention further discusses identifying and encoding the link identifiers and putting into the packet header, and then the identified path is chosen through the network from a source node to a destination node. Para. 0018 and 0083-0084***].

Therefore, it would have been obvious to one having ordinary skill in the art at the time of the claimed invention was made to provide that the path or routing information includes a plurality of link identifiers as taught by **Dong** to have incorporated in the system of **E. Rothenberg**, so that it would not only provide a virtual link or physical link to be defined from multiple single links (where a single "link" directly links two network nodes), allowing a more efficient way of describing delivery trees in the network but also support more efficient and powerful forwarding schemes by providing finer control over false positives. ***E. Rothenberg: Para. [0107] and [0144].***

Regarding claim 12; **Dong** discloses the packet forwarding node wherein the storage unit stores the table (***See Figs. 3 and 4; the routing tables with stored path IDs; Col. 5, Lines 55-60***) used for forwarding the packet based on the identifier (***See Fig. 6; steps 82-90, assigning the path ID for each***

path in the path groups and using the path ID for the next hop IP address; Col. 6, Lines 21-26) which uniquely identifies the link (***See Fig. 6: at step 82 to assign or identify the path ID; Col. 6, Lines 18-25***) within a predetermined domain (***See Figs. 2 and 4; Col. 1, Lines 50-54***).

Regarding claim 13; **Dong** in view of **E. Rothenberg** discloses the packet forwarding node wherein the storage unit stores the table (**Dong**: ***See Figs. 2 and 3: the Memory 22 for storing the path IDs and the memory to store Path ID's tables; Col. 2, Lines 40-43*** and ***Col. 5, Lines 55-65***) used for forwarding the packet based on the identifier (**Dong**: ***See Fig. 6; steps 82-90, assigning the path ID for each path in the path groups and using the path ID for the next hop IP address; Col. 6, Lines 21-26***) which uniquely identifies the link (**Dong**: ***See Fig. 6: at step 82 to assign or identify the path ID; Col. 6, Lines 18-25***) within a predetermined local domain (***See Figs. 2 and 4; Col. 1, Lines 50-54 and see also Fig. 1 for internally/locally managed IP identifiers***) and (***E. Rothenberg: See Fig. 9; for inter-domain links; Para. [0185]***)

Regarding claim 14; **Dong** discloses the packet forwarding node wherein the storage unit stores the table (***See Figs. 2 and 3: the Memory 22 for storing the path IDs and the memory to store Path ID's tables; Col. 2, Lines 40-43*** and ***Col. 5, Lines 55-65***) used for forwarding the packet based on the identifier (***See Fig. 6; steps 82-90, assigning the path ID for each path in the path groups and using the path ID for the next hop IP address; Col. 6, Lines 21-26***) which uniquely identifies the link (***See Fig. 6: at step 82 to assign or identify the path ID; Col. 6, Lines 18-25***) within the packet forwarding node (***See Fig. 6; at step 90; assigning the path ID within the path group of the router and see also Fig. 1 for internally/locally managed IP identifiers within a router***).

Regarding claim 15; **Dong** in view of **E. Rothenberg** discloses the packet forwarding node wherein the storage unit stores the table (**Dong**: ***See Figs. 2 and 3: the Memory 22 for storing the path IDs and the memory to store Path ID's tables; Col. 2, Lines 40-43*** and ***Col. 5, Lines 55-65***) used for forwarding the packet based on the identifier (**Dong**: ***See Fig. 6; steps 82-90, assigning the path ID for each path in the path groups and using the path ID for the next hop IP address; Col. 6, Lines 21-26***) which uniquely identifies the link (**Dong**: ***See Fig. 6: at step 82 to assign or identify the path ID; Col. 6, Lines 18-25***) among the packet forwarding nodes (***E. Rothenberg: See Fig. 9: among the source and destination nodes; Para. [0084]***).

Regarding claim 16; **Dong** discloses a packet forwarding node (***See Fig. 1; Router(s) 38-42***), comprising:

a communication unit (***See Fig. 2: processor 20***) configured to communicate with a source node for receiving an identifier (***See Fig. 6; at step 80, receiving the path information or packet to assign the Path ID; Col. 6, Lines 18-24***), each of which identifies a path link (***See Figs. 1 and 3; See Figs. 1 and 3; determining the IP path or link ID; Col. 5, Lines 26-30***) of the packet forwarding node (***See Fig. 6; steps 84-86, the path ID is assigned to the next hop IP address; Col. 6, Lines 21-26, and see also Col. 5, Lines 26-35***); and

a forwarding unit (***See Fig. 2: the hardware forwarding engine 29; Col. 4, Lines 30-34***) for configured to forward an incoming packet (***See Fig. 6; at step 80, receiving the path information or packet; Col. 6, Lines 18-24***) based on an identifier (***See Fig. 6; steps 80-90, the received path information to assign a path ID for the next-hop IP address; Col. 6, Lines 18-25***) corresponding to the

packet forwarding node (***See Fig. 6; steps 82-90, assigning the path ID for each path in the path groups and using the path ID for the next hop IP address; Col. 6, Lines 21-26, and see also Col. 5, Lines 26-35***).

Even though, **Dong** discloses receiving the path information to assign the path ID for the path group and next hop IP address for forwarding, **Dong** doesn't explicitly discuss identifying an interface and the receiving path information/packet includes multiple path identifiers.

However, **E. Rothenberg** from the same field of endeavor teaches identifying the interface (***See Fig. 15; the router to assign the link ID of the next router and identify each output interface with a link ID; Para. [0152]***) and the path or routing information includes a plurality of link identifiers (***See Fig. 5 and 6; the routing information comprises a plurality of identifiers, each identifying a respective network link or node; Para. [0018]***). **E. Rothenberg** further discuses a method to communicate with a server (***See Fig. 9; Para. [0011]***).

[***For example, E. Rothenberg's is invention is from the same field of endeavor because it originally discusses routing and forwarding the data packet based upon identifying network link and link identifier in a label switching network. The invention further discusses identifying and encoding the link identifiers and putting into the packet header, and then the identified path is chosen through the network from a source node to a destination node. Para. 0018 and 0083-0084***].

In the manner of combining is that **E. Rothenberg**'s routing information that includes multiple link identifiers (IDs) could apparently be implemented into **Dong**'s conventional the path/link information that only a path ID for the next hop IP address for forwarding.

Therefore, it would have been obvious to one having ordinary skill in the art at the time of the claimed invention was made to provide that the path or routing information includes a plurality of link identifiers and identifying the output interface using the link ID as taught by

Dong to have incorporated in the system of **E. Rothenberg**, so that it would not only provide a virtual link or physical link to be defined from multiple single links allowing a more efficient way of describing delivery trees in the network but also support more efficient and powerful forwarding schemes by providing finer control over false positives. ***E. Rothenberg: Para. [0107] and [0144].***

Regarding claim 17; **Dong** discloses the packet forwarding node wherein the storage unit stores the table (***See Figs. 3 and 4; the routing tables with stored path IDs; Col. 5, Lines 55-60***) used for forwarding the packet based on the identifier (***See Fig. 6; steps 82-90, assigning the path ID for each path in the path groups and using the path ID for the next hop IP address; Col. 6, Lines 21-26***) which uniquely identifies the link (***See Fig. 6: at step 82 to assign or identify the path ID; Col. 6, Lines 18-25***) within a predetermined domain (***See Figs. 2 and 4; Col. 1, Lines 50-54***).

Regarding claim 18; **Dong** in view of **E. Rothenberg** discloses the packet forwarding node wherein the storage unit stores the table (**Dong**: ***See Figs. 2 and 3: the Memory 22 for storing the path IDs and the memory to store Path ID's tables; Col. 2, Lines 40-43*** and ***Col. 5, Lines 55-65***) used for forwarding the packet based on the identifier (**Dong**: ***See Fig. 6; steps 82-90, assigning the path ID for each path in the path groups and using the path ID for the next hop IP address; Col. 6, Lines 21-26***) which uniquely identifies the link (**Dong**: ***See Fig. 6: at step 82 to assign or identify the path ID; Col. 6, Lines 18-25***) within a predetermined local domain (***See Figs. 2 and 4; Col. 1, Lines 50-54 and see also Fig. 1 for internally/locally managed IP identifiers***) and (***E. Rothenberg: See Fig. 9; for inter-domain links; Para. [0185]***)

Regarding claim 19; **Dong** discloses the packet forwarding node wherein the storage unit stores the table (***See Figs. 2 and 3: the Memory 22 for storing the path IDs and the memory to store Path ID's tables; Col. 2, Lines 40-43*** and ***Col. 5, Lines 55-65***) used for forwarding the packet based on the identifier (***See Fig. 6; steps 82-90, assigning the path ID for each path in the path groups and using the path ID for the next hop IP address; Col. 6, Lines 21-26***) which uniquely identifies the link (***See Fig. 6: at step 82 to assign or identify the path ID; Col. 6, Lines 18-25***) within the packet forwarding node (***See Fig. 6; at step 90; assigning the path ID within the path group of the router and see also Fig. 1 for internally/locally managed IP identifiers within a router***).

Regarding claim 20; **Dong** in view of **E. Rothenberg** discloses the packet forwarding node wherein the storage unit stores the table (**Dong**: ***See Figs. 2 and 3: the Memory 22 for storing the path IDs and the memory to store Path ID's tables; Col. 2, Lines 40-43*** and ***Col. 5, Lines 55-65***) used for forwarding the packet based on the identifier (**Dong**: ***See Fig. 6; steps 82-90, assigning the path ID for each path in the path groups and using the path ID for the next hop IP address; Col. 6, Lines 21-26***) which uniquely identifies the link (**Dong**: ***See Fig. 6: at step 82 to assign or identify the path ID; Col. 6, Lines 18-25***) among the packet forwarding nodes (***E. Rothenberg: See Fig. 9: among the source and destination nodes; Para. [0084]***).

Regarding claim 21; **Dong** discloses a packet forwarding node (***See Fig. 1; Router(s) 38-42***), comprising:

a first unit (***See Fig. 2: the processing unit 20***) configured to determine an identifier (***See Fig. 6; steps 82-90, assigning the path ID for each path in the path groups and using the path ID for the next hop IP address; Col. 6, Lines 21-26***), each of which identifies a link (***See Figs. 1 and 3; See Figs. 1 and 3; determining the IP path or link ID; Col. 5, Lines 26-30***) between nodes on a packet forwarding path (***See Fig. 1; routing between Edge Routers, such as 38, 40 and 42, using IP path or IP address; Col. 5, Lines 26-32***) ; and

a second unit (***See Fig. 2: the hardware forwarding engine 29; Col. 4, Lines 30-34***) for configured to send information elements to a packet forwarding node (***See Figs. 1 and 2: a router with a hardware forwarding engine 29; Col. 4, Lines 30-34***) which is capable of forwarding an incoming packet (***See Fig. 6; at step 80, receiving the path information or packet; Col. 6, Lines 18-24***) based on an identifier (***See Fig. 6; steps 80-90, the received path information to assign a path ID for the next-hop IP address; Col. 6, Lines 18-25***) corresponding to the packet forwarding node (***See Fig. 6; steps 82-90, assigning the path ID for each path in the path groups and using the path ID for the next hop IP address; Col. 6, Lines 21-26, and see also Col. 5, Lines 26-35***).

Even though, **Dong** discloses receiving the path information to assign the path ID for the path group and next hop IP address for forwarding, **Dong** doesn't explicitly discuss the receiving path information/packet includes multiple path identifiers.

However, **E. Rothenberg** from the same field of endeavor teaches the path or routing information includes a plurality of link identifiers (***See Fig. 5 and 6; the routing information comprises a plurality of identifiers, each identifying a respective network link or node; Para. [0018]***).

[***For example, E. Rothenberg's is invention is from the same field of endeavor because it originally discusses routing and forwarding the data packet based upon identifying network link and link identifier in a label switching network. The invention further discusses identifying and encoding the***

link identifiers and putting into the packet header, and then the identified path is chosen through the network from a source node to a destination node. Para. 0018 and 0083-0084].

In the manner of combining is that **E. Rothenberg**'s routing information that includes multiple link identifiers (IDs) could apparently be implemented into **Dong**'s conventional the path/link information that only a path ID for the next hop IP address for forwarding.

Therefore, it would have been obvious to one having ordinary skill in the art at the time of the claimed invention was made to provide that the path or routing information includes a plurality of link identifiers as taught by **Dong** to have incorporated in the system of **E. Rothenberg**, so that it would not only provide a virtual link or physical link to be defined from multiple single links (where a single "link" directly links two network nodes), allowing a more efficient way of describing delivery trees in the network but also support more efficient and powerful forwarding schemes by providing finer control over false positives. ***E. Rothenberg: Para. [0107] and [0144].***

Regarding claim 22; **Dong** in view of **E. Rothenberg** discloses the packet forwarding node wherein the storage unit stores the table used for forwarding the packet based on the identifier which identifies a link between adjacent nodes on a packet forwarding path.

Regarding claim 18; **Dong** in view of **E. Rothenberg** discloses the packet forwarding node wherein the storage unit stores the table (**Dong**: ***See Figs. 2 and 3: the Memory 22 for storing the path IDs and the memory to store Path ID's tables; Col. 2, Lines 40-43*** and ***Col. 5, Lines 55-65***) used for forwarding the packet based on the identifier (**Dong**: ***See Fig. 6; steps 82-90, assigning the path ID for each path in the path groups and using the path ID for the next hop IP address; Col. 6, Lines 21-***

26) which uniquely identifies the link (**Dong**: ***See Fig. 6: at step 82 to assign or identify the path ID; Col. 6, Lines 18-25***) within a predetermined local domain (***See Figs. 2 and 4; Col. 1, Lines 50-54 and see also Fig. 1 for internally/locally managed IP identifiers***) and (***E. Rothenberg: See Fig. 9; for inter-domain links; Para. [0185]***)

Regarding claim 23; **Dong** in view of **E. Rothenberg** discloses the packet forwarding node, wherein the storage unit stores the packet forwarding table (**Dong**: ***See Figs. 2 and 3: the Memory 22 for storing the path IDs and the memory to store Path ID's tables; Col. 2, Lines 40-43*** and ***Col. 5, Lines 55-65***) used for forwarding the packet based on the identifier (**Dong**: ***See Fig. 6; steps 82-90, assigning the path ID for each path in the path groups and using the path ID for the next hop IP address; Col. 6, Lines 21-26***) which identifies a link (**Dong**: ***See Fig. 6: at step 82 to assign or identify the path ID; Col. 6, Lines 18-25***) between adjacent nodes on a packet forwarding path (***See Fig. 1: between the adjacent nodes 38 and 40 using the Path ID 1; Col. 5, Lines 18-25***) and (***E. Rothenberg: See Fig. 5: between adjacent nodes R1 and R2 using the path ID; Para. [0100]***).

Regarding claim 24; **Dong** in view of **E. Rothenberg** discloses the packet forwarding node further comprising a storage unit that stores the packet forwarding table (**Dong**: ***See Figs. 2 and 3: the Memory 22 for storing the path IDs and the memory to store Path ID's tables; Col. 2, Lines 40-43*** and ***Col. 5, Lines 55-65***) used for forwarding the packet based on the identifier (**Dong**: ***See Fig. 6; steps 82-90, assigning the path ID for each path in the path groups and using the path ID for the next hop IP address; Col. 6, Lines 21-26***) which identifies a link (**Dong**: ***See Fig. 6: at step 82 to assign or identify the path ID; Col. 6, Lines 18-25***) between adjacent nodes on a packet forwarding path (***See***

Fig. 1: between the adjacent nodes 38 and 40 using the Path ID 1; Col. 5, Lines 18-25) and (***E. Rothenberg: See Fig. 5: between adjacent nodes R1 and R2 using the path ID; Para. [0100]***).

Regarding claim 25; **Dong** in view of **E. Rothenberg** discloses the packet forwarding node further comprising a storage unit that stores the packet forwarding table (**Dong**: ***See Figs. 2 and 3: the Memory 22 for storing the path IDs and the memory to store Path ID's tables; Col. 2, Lines 40-43*** and ***Col. 5, Lines 55-65***) used for forwarding the packet based on the identifier (**Dong**: ***See Fig. 6; steps 82-90, assigning the path ID for each path in the path groups and using the path ID for the next hop IP address; Col. 6, Lines 21-26***) which identifies a link (**Dong**: ***See Fig. 6: at step 82 to assign or identify the path ID; Col. 6, Lines 18-25***) between adjacent nodes on a packet forwarding path (***See Fig. 1: between the adjacent nodes 38 and 40 using the Path ID 1; Col. 5, Lines 18-25***) and (***E. Rothenberg: See Fig. 5: between adjacent nodes R1 and R2 using the path ID; Para. [0100]***).

Regarding claim 26; **Dong** in view of **E. Rothenberg** discloses the server further comprising a storage unit to store a packet forwarding table (**Dong**: ***See Figs. 2 and 3: the Memory 22 for storing the path IDs and the memory to store Path ID's tables; Col. 2, Lines 40-43*** and ***Col. 5, Lines 55-65***) used for forwarding the incoming packet based on the identifier (**Dong**: ***See Fig. 6; steps 82-90, assigning the path ID for each path in the path groups and using the path ID for the next hop IP address; Col. 6, Lines 21-26***) which identifies the link (**Dong**: ***See Fig. 6: at step 82 to assign or identify the path ID; Col. 6, Lines 18-25***) between nodes on the packet forwarding path (***See Fig. 1; routing between Edge Routers, such as 38, 40 and 42, using IP path or IP address; Col. 5, Lines 26-32***), wherein the storage unit stores the table used for forwarding the packet (***See Fig. 2: the Memory 22 for storing the path IDs; Col. 2, Lines 40-43***) based on the identifier which identifies a link (**Dong**:

See Fig. 6: at step 82 to assign or identify the path ID; Col. 6, Lines 18-25) between adjacent nodes on a packet forwarding path (***See Fig. 1: between the adjacent nodes 38 and 40 using the Path ID 1; Col. 5, Lines 18-25***) and (***E. Rothenberg: See Fig. 5: between adjacent nodes R1 and R2 using the path ID; Para. [0100]***).

Regarding claim 27; **Dong** in view of **E. Rothenberg** discloses the packet forwarding node wherein the forwarding unit comprises a forwarding device (***Dong: See Fig. 1 and 2; The router to forward the data packets; Col. 4, Lines 38-45***) and (***E Rothenberg: See Fig. 5; Para. [0111]***).

Regarding claim 28; **Dong** in view of **E. Rothenberg** discloses the packet forwarding node wherein: the communication unit comprises a communication device, and the forwarding unit comprises a forwarding device (***Dong: See Fig. 1 and 2; The router to forward the data packets; Col. 4, Lines 38-45***) and (***E Rothenberg: See Fig. 5; Para. [0111]***).

Response to Arguments

16. As per Applicant's Appeal Brief, filed on 07/25/2016, with regards to claims 1-28, have been fully considered, but the Examiner found that the Applicant's arguments are persuasive. Therefore, the rejection has been withdrawn. However, upon further consideration, a new ground of rejection has been made, and claims 1-28 are rejected under 35 U.S.C. 103(a) as being unpatentable over **Dong et al. (US 7,496,096 B1)** in view of **EstevE. Rothenberg et al. (US 2011/0149973 A1).** In response to the applicant's Brief, the applicant argued that the cited prior art fails to teach an identifier which identifies a link and an incoming packet including a plurality

of the identifiers. The examiner disagrees because Dong teaches the method to receive path information which identifies a path ID to assign for each path in the path groups. **Dong** discloses receiving the path information to assign the path ID for the path group and next hop IP address for forwarding but **Dong** doesn't explicitly discuss the receiving path information/packet includes multiple path identifiers. **E. Rothenberg** from the same field of endeavor teaches the path or routing information includes a plurality of link identifiers. The motivation is to provide a virtual link or physical link to be defined from multiple single links (where a single "link" directly links two network nodes), allowing a more efficient way of describing delivery trees in the network but also support more efficient and powerful forwarding schemes by providing finer control over false positives. See Dong: See Figs. 2-6: Col. 4, Lines 30-34; Col. 6, Lines 18-24, Col. 6, Lines 21-26, and see also Col. 5, Lines 26-35). See E Rothenberg: See Fig. 5 and 6; the routing information comprises a plurality of identifiers, each identifying a respective network link or node; Para. [0018]).

Conclusion

17. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

A. Durinovic-Johri et al. (US 2002/0176363 A1) to discuss Load Balancing in Routers of a Network using overflows Paths; and

B. Ohba et al. (US 2002/0176370 A1) Scheme for Label Switched Path Loop Detection at node device.

Contact Information

18. Any inquiry concerning this communication or earlier communications from the examiner should be directed to SAI AUNG whose telephone number is (571)272-3507. The examiner can normally be reached on Monday-Friday, Alt Fridays, 7:30 AM- 5:00 PM (EST).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, PHAM CHI can be reached on 571-272-3179. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300. Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/SAI AUNG/

Examiner, Art Unit 2475

Notice of References Cited	Application/Control No. 14/244,701	Applicant(s)/Patent Under Reexamination AWANO, JUN	
	Examiner SAI AUNG	Art Unit 2475	Page 1 of 1

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*	B	US-2002/0176370 A1	11-2002	Ohba, Yoshihiro	H04L49/309	370/252
*	C	US-2002/0176363 A1	11-2002	Durinovic-Johri, Sanja	H04L45/00	370/237
*	D	US-7,496,096 B1	02-2009	Dong; Liqin	H04L45/00	370/392
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NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
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*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14244701	AWANO, JUN
	Examiner	Art Unit
	SAI AUNG	2475

CPC- SEARCHED		
Symbol	Date	Examiner
H04L45/04; H04L45/24; H04L45/66; H04L45/00;	11/16/2016	SA

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
370	370/401; 370/392; 370/231; 370/252; 370/352; 370/395.53	3/1/2016	SA

SEARCH NOTES		
Search Notes	Date	Examiner
EAST SEARCH (INCLUDING INVENTORS AND ASSIGNEE SEARCH)	11/16/2016	SA
GOOGLE PATENTS SEARCH	11/16/2016	SA
OTHER RELATED CPC SEARCH: H04L45/302; H04L45/50; H04L49/351	11/16/2016	SA

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner

/S.A./ Examiner.Art Unit 2475	

Receipt date: 09/01/2016 14244701 - GAU: 2475

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Jun Awano

Serial No.:	14/244,701	Group Art Unit:	2475
Filed:	April 3, 2014	Examiner:	AUNG, SAI

For: COMMUNICATION SYSTEM, FORWARDING NODE, PATH MANAGEMENT SERVER, COMMUNICATION METHOD, AND PROGRAM

Honorable Commissioner of Patents
Alexandria, VA 22313-1450

INFORMATION DISCLOSURE STATEMENT

Sir:

Under the provisions of 37 CFR §1.97 through §1.98 and pursuant to applicant's duty of disclosure under 37 CFR §1.56, applicant respectfully brings the following documents, cited in the Extended European Search Report and listed on the attached form PTO-1449, to the attention of the Examiner in charge of the above-identified application. Copies of the listed documents are provided herewith for the convenience of the Examiner. This citation does not constitute an admission that the references are relevant or material to the claims. They are only cited as constituting related art of which the applicant is aware.

I hereby certify that each item of information contained in this Information Disclosure Statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of this Information Disclosure Statement.

09/02/2016 SMOHAMME 00000006 14244701
01 FC:1806 180.00 OP

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /S.A./

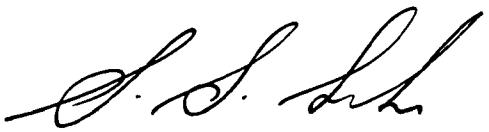
Each item of information contained in this Information Disclosure Statement was first cited in a communication from a foreign patent office in a counterpart foreign application and this communication was not received by any individual designated in §1.56(c) more than thirty days prior to the filing of this Information Disclosure Statement (37 C.F.R. §1.704(d)).

Submitted herewith is the Information Disclosure Statement fee of $180.00.

It is respectfully requested that the listed references be considered by the Examiner and formally made of record in this application.

Please charge any deficiencies in fees and credit any overpayment of fees to Attorney's Deposit Account No. 50-0481.

Respectfully submitted,



Sam S. Sahota, Esq.
Registration No. 47,051
Sean M. McGinn, Esq.
Registration No. 34,386

Date: September 1, 2016

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(703) 761-4100
Customer No. 21254

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /S.A./

Receipt date: 09/01/2016 OPAP AKIMA-3 SEP 01 2016 PATENT & TRADEMARK OFFICE

Information Disclosure Citation

Docket Number	Application Number
NEG-1440PCT-US-2CT	14/244,701
Applicant: NEC CORPORATION	
Filing Date: April 3, 2014	Group Art Unit: 2475

U. S. Patent Documents

Examiner Initial	Ref	Document Number	Date	Name	Class	Subclass	Filing Date (If Appropriate)

U. S. Patent Application Publications

Examiner Initial	Ref	Document Number	Date	Name	Class	Subclass	Filing Date (If Appropriate)
/S.A./		US 2009/046732 A1	02/19/2009	Pratt, Jr., et al.			

Foreign Patent Documents

Examiner Initial	Ref	Document Number	Date	Country	Class	Subclass	Translation Yes	Translation No
/S.A./		EP 1 320 224 A1	06/18/2003	Europe				

Other Documents (Including Author, Title, Date, Pertinent Pages, etc.)

/S.A./		Extended European Search Report dated August 10, 2016.
/S.A./		Jokela Petri, et al.: Lipsin: "Line Speed Publish/Subscribe Inter-Networking. TR09-0001, version 1.0" PSIRP, PUBLISH-SUBSCRIBE INTERNET ROUTING PARADIGM (9 Jan. 2009) pp.1-39, XP002566408, Retrieved from the Internet: URL:http://www.psirp.org/files/Deliverables/PSIRP-TR09-0001 LIPSIN.pdf [retrieved on 2010-02-02].

Examiner /Sai Aung/	**Date Considered** 11/21/2016

Examiner: Initial if citation considered, whether citation is in conformance with MPEP Section 609; Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to Applicant.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /S.A./

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S318	10	(link and mpls and rout$4 and forward$4 and table) and S317	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/16 17:48
S317	41	(liqin near2 dong, Milton near2 xu).in.	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/16 17:48
S319	22	(link and rout$4 and forward$4 and table) and S317	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/16 17:49
S320	6	@ad<="20090914" and S319	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/11/16 17:50
S321	2702	(path link channel) same (ID identif$4) same (rout$4 forward$4) same (mpls)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/11/16 18:14
S323	1547	(@ad<="20090914" or @pd<="20080914") and S321	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/11/16 18:16
S322	6	(@ad<="20090914" or @pd<="20080914") and S319	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/11/16 18:16
S325	58985	(virtu$4 or logical or physical) same (link path channel) same (ID identifier)	US-PGPUB; USPAT	OR	ON	2016/11/16 18:17
S324	1005	((source destination) with address) and S323	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/16 18:17
S330	218	(stor$4 storage) with (table) and S329	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/16 18:18
S329	399	S324 and S327	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/16 18:18
S328	399	S324 and S327	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/16 18:18
S327	74355	(virtu$4 or logical or physical) same (link path channel) same (ID identifier)	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/16 18:18
S326	397	S324 and S325	US-PGPUB; USPAT	OR	ON	2016/11/16 18:18
S331	162	(path with information) and S330	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/16 18:20
L1	3	("7496096").PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/11/21 11:03
L10	131	(path link) near10 (ID identifier Identify$4) and L9	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/21 11:04
L9	162	(path with information) and L8	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/21 11:04
L8	218	(stor$4 storage) with (table) and L7	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/21 11:04
L7	399	L5 and L6	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/21 11:04
L6	74449	(virtu$4 or logical or physical) same (link path channel) same (ID identifier)	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/21 11:04
L5	1005	((source destination) with address) and L4	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/21 11:04
L4	1547	(@ad<="20090914" or @pd<="20080914") and L3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/11/21 11:04
L3	2703	(path link channel) same (ID identif$4) same (rout$4 forward$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	OR	ON	2016/11/21 11:04

		same (mpls)	IBM_TDB			
L2	2	("20110149973").PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/11/21 11:04
L12	131	(path link) near10 (ID identifier Identify$4) and L9	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/21 11:06
L11	2	("20020176363").PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/11/21 11:06

11/ 21/ 2016 11:19:49 AM
C:\ Users\ saung1\ Documents\ EAST\ Workspaces\ 14244701\ 14244701-A.wsp

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re patent application of

JUN AWANO

Serial No.: 14/244,701 Group Art Unit: 2475

Filed: April 3, 2014 Examiner: AUNG, SAI

For: COMMUNICATION SYSTEM, FORWARDING NODE, PATH MANAGEMENT SERVER, COMMUNICATION METHOD, AND PROGRAM

Honorable Commissioner of Patents
Alexandria, VA 22313-1450

INFORMATION DISCLOSURE STATEMENT

Sir:

Under the provisions of 37 CFR §1.97 through §1.98 and pursuant to applicant's duty of disclosure under 37 CFR §1.56, applicant respectfully brings the following documents listed on the attached from PTO-1449, to the attention of the Examiner in charge of the above-identified application. This reference was cited in an Office Action dated January 12, 2016, issued by the Examiner in the co-pending Application No. 13/137,237. Copies of the listed documents are provided herewith for the convenience of the Examiner.

This citation does not constitute an admission that the references are relevant or material to the claim. It is only cited as constituting related art of which the applicant is aware.

I hereby certify that no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in §1.56(c) more than three months prior to the filing of the information disclosure statement.

The Commissioner is authorized to charge Attorney's Deposit Account No. 50-0481 in the amount of $180.00 to cover the IDS fee.

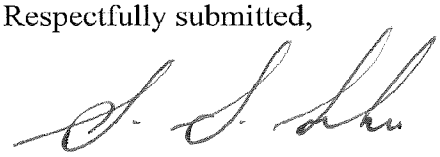
ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /S.A./

Receipt date: 04/08/2016 14244701 - GAU: 2475

It is respectfully requested that the listed references be considered by the Examiner and formally made of record in this application.

Please charge any deficiencies in fees and credit any overpayment of fees to Attorney's Deposit Account No. 50-0481.

Respectfully submitted,



Sam S. Sahota, Esq.
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Sean M. McGinn, Esq.
Registration No. 34,386

Date: April 8, 2016
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(703) 761-4100
Customer No. 21254

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /S.A./

Information Disclosure Citation

Docket Number	Application Number
NEG-1440PCTUSCONT	14/244,701
Inventor: NEC CORPORATION	
Filing Date: April 3, 2014	Group Art Unit: 2475

U. S. Patent Documents

Examiner Initial	Ref	Document Number	Date	Name	Class	Subclass	Filing Date (If Appropriate)	

U. S. Patent Application Publications

Examiner Initial	Ref	Document Number	Date	Name	Class	Subclass	Filing Date (If Appropriate)	
/S.A./		US 2002/0150041 A1	10/17/2002	Reinshmidt, et al.				

Foreign Patent Documents

Examiner Initial	Ref	Document Number	Date	Country	Class	Subclass	Translation Yes	Translation No

Other Documents (Including Author, Title, Date, Pertinent Pages, etc.)

/S.A./		United States Office Action dated January 12, 2016 in co-pending Application No. 13/137,237.

Examiner /Sai Aung/	**Date Considered** 11/21/2016

Examiner: Initial if citation considered, whether citation is in conformance with MPEP Section 609; Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to Applicant.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /S.A./

Receipt date: 09/01/2016 14244701 - GAU: 2475

OPAP AKIMA-3 SEP 01 2016 PATENT & TRADEMARK OFFICE

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re patent application of

JUN AWANO

Serial No.: 14/244,701 Group Art Unit: 2475

Filed: April 3, 2014 Examiner: AUNG, SAI

For: COMMUNICATION SYSTEM, FORWARDING NODE, PATH MANAGEMENT SERVER, COMMUNICATION METHOD, AND PROGRAM

Honorable Commissioner of Patents
Alexandria, VA 22313-1450

INFORMATION DISCLOSURE STATEMENT

Sir:

Under the provisions of 37 CFR §1.97 through §1.98 and pursuant to applicant's duty of disclosure under 37 CFR §1.56, applicant respectfully brings the following documents listed on the attached from PTO-1449, to the attention of the Examiner in charge of the above-identified application. This reference was cited in an Office Action dated July 27, 2016, issued by the Examiner in the co-pending Application No. 13/137,237. Copies of the listed documents are provided herewith for the convenience of the Examiner.

This citation does not constitute an admission that the references are relevant or material to the claim. It is only cited as constituting related art of which the applicant is aware.

I hereby certify that no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in §1.56(c) more than three months prior to the filing of the information disclosure statement.

Submitted herewith is the Information Disclosure Statement fee of $180.00.

09/02/2016 SMOHAMME 00000005 14244701
01 FC:1806 180.00 OP

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /S.A./

It is respectfully requested that the listed references be considered by the Examiner and formally made of record in this application.

Please charge any deficiencies in fees and credit any overpayment of fees to Attorney's Deposit Account No. 50-0481.

Respectfully submitted,

Sam S. Sahota, Esq.
Registration No. 47,051
Sean M. McGinn, Esq.
Registration No. 34,386

Date: September 1, 2016
McGinn Intellectual Property Law Group, PLLC
8321 Old Courthouse Road, Suite 200
Vienna, VA 22182-3817
(703) 761-4100
Customer No. 21254

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /S.A./

OPAP SEP 01 2016 PATENT & TRADEMARK OFFICE

Information Disclosure Citation

Docket Number	Application Number
NEG-1440PCTUSCONT	14/244,701
Inventor	
NEC CORPORATION	
Filing Date	**Group Art Unit**
April 3, 2014	2475

U. S. Patent Documents

Examiner Initial	Ref	Document Number	Date	Name	Class	Subclass	Filing Date (If Appropriate)	
/S.A./		US 6,788,689 B1	09/07/2004	Turner, et al.				

U. S. Patent Application Publications

Examiner Initial	Ref	Document Number	Date	Name	Class	Subclass	Filing Date (If Appropriate)	

Foreign Patent Documents

Examiner Initial	Ref	Document Number	Date	Country	Class	Subclass	Translation	
							Yes	No

Other Documents (Including Author, Title, Date, Pertinent Pages, etc.)

/S.A./		United States Office Action dated July 27, 2016 in co-pending Application No. 13/137,237.

Examiner /Sai Aung/	**Date Considered** 11/21/2016

Examiner: Initial if citation considered, whether citation is in conformance with MPEP Section 609; Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to Applicant.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /S.A./

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14244701	AWANO, JUN
	Examiner	Art Unit
	SAI AUNG	2475

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	12/12/2014	04/13/2015	10/28/2015	03/01/2016	11/18/2016				
	1	✓	✓	✓	✓	✓				
	2	✓	✓	✓	✓	✓				
	3	✓	✓	✓	✓	✓				
	4	✓	✓	✓	✓	✓				
	5	✓	✓	✓	✓	✓				
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	27				✓	✓				
	28				✓	✓				

14/244,701
NEG-1440PCT-US2CT
KATO.327CONT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of Jun Awano

Serial No.: 14/244,701 Group Art Unit: 2475

Filed: April 3, 2014 Examiner: AUNG, SAI

For: COMMUNICATION SYSTEM, FORWARDING NODE, PATH MANAGEMENT SERVER, COMMUNICATION METHOD, AND PROGRAM

Honorable Commissioner of Patents
Alexandria, VA 22313-1450

AMENDMENT UNDER 37 C.F.R. §1.111

Sir:

In response to Office Action dated **November 22, 2016**, please amend the above identified application as follows:

INTRODUCTORY COMMENTS

Amendments to the Claims begin on page 2 of this paper. The amendments to the claims do not add new matter.

Remarks begin on page 8 of this paper.

AMENDMENTS TO THE CLAIMS

Please add new claim 29, cancel claims 27-28 without prejudice or disclaimer, and amend the claims as follows:

1. (Currently Amended) A packet forwarding node, comprising:

a storage unit including a non-transitory computer readable medium configured to store a packet forwarding table used for forwarding a packet based on an identifier which identifies a link between nodes on a packet forwarding path; and

at least one processor configured to execute program instructions to provide a forwarding unit configured to receive an incoming packet including a plurality of the identifiers, and to forward the incoming packet ~~based on the identifier corresponding to the packet forwarding node~~ by using a link that corresponds to the identifier from among the plurality of the identifiers.

2. (Original) The packet forwarding node according to claim 1, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link within a predetermined domain.

3. (Original) The packet forwarding node according to claim 1, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link within a predetermined local domain.

4. (Original) The packet forwarding node according to claim 1, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link within the packet forwarding node.

5. (Original) The packet forwarding node according to claim 1, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link among the packet forwarding nodes.

6. (Currently Amended) A packet forwarding node, comprising:

a storage unit including a non-transitory computer readable medium configured to store a packet forwarding table used for forwarding a packet based on an identifier which identifies an interface of a packet forwarding node; and

at least one processor configured to execute program instructions to provide a forwarding unit configured to receive an incoming packet including a plurality of identifiers, and to forward the incoming packet ~~based on the identifier corresponding to the packet forwarding node~~ by using a link that corresponds to the identifier from among the plurality of identifiers.

7. (Original) The packet forwarding node according to claim 6, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies a link within a predetermined domain.

8. (Previously Presented) The packet forwarding node according to claim 6, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies a link within a predetermined local domain.

9. (Previously Presented) The packet forwarding node according to claim 6, wherein the storage unit stores the table used for forwarding the packet based on the identifier which

uniquely identifies a link within the packet forwarding node.

10. (Previously Presented) The packet forwarding node according to claim 6, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies a link among the packet forwarding nodes.

11. (Currently Amended) A packet forwarding node, comprising:

a memory storing a program;

at least one processor configured to execute the program to provide:

a communication unit configured to communicate with a server for receiving a plurality of identifiers, each of which identifies a link between nodes on a packet forwarding path; and

a forwarding unit configured to forward an incoming packet ~~based on an identifier corresponding to a packet forwarding node~~ by using a link that corresponds to an identifier from among the plurality of identifiers.

12. (Previously Presented) The packet forwarding node according to claim 11, wherein the forwarding unit forwards the packet based on the identifier which uniquely identifies a link within a predetermined domain.

13. (Previously Presented) The packet forwarding node according to claim 11, wherein the forwarding unit forwards the packet based on the identifier which uniquely identifies the link within a predetermined local domain.

14. (Previously Presented) The packet forwarding node according to claim 11, wherein the

forwarding unit forwards the packet based on the identifier which uniquely identifies the link within the packet forwarding node.

15. (Previously Presented) The packet forwarding node according to claim 11, wherein the forwarding unit forwards the packet based on the identifier which uniquely identifies the link among the packet forwarding nodes.

16. (Currently Amended) A packet forwarding node, comprising:

a communication unit configured to communicate with a server for receiving a plurality of identifiers, each of which identifies an interface of the packet forwarding node; and

at least one processor configured to execute program instructions to provide a forwarding unit configured to forward an incoming packet ~~based on an identifier corresponding to the packet forwarding node~~ by using a link that corresponds to an identifier from among the plurality of identifiers.

17. (Previously Presented) The packet forwarding node according to claim 16, wherein the forwarding unit forwards the packet based on the identifier which uniquely identifies a link within a predetermined domain.

18. (Previously Presented) The packet forwarding node according to claim 16, wherein the forwarding unit forwards the packet based on the identifier which uniquely identifies a link within a predetermined local domain.

19. (Previously Presented) The packet forwarding node according to claim 16, wherein the

forwarding unit forwards the packet based on the identifier which uniquely identifies a link within the packet forwarding node.

20. (Previously Presented) The packet forwarding node according to claim 16, wherein the forwarding unit forwards the packet based on the identifier which uniquely identifies a link among the packet forwarding nodes.

21. (Currently Amended) A server, comprising:

a memory storing a computer program;

at least one processor configured to execute the computer program to provide:

a first unit configured to determine a plurality of identifiers, each of which identifies a link between nodes on a packet forwarding path; and

a second unit configured to send information elements to a packet forwarding node which is capable of forwarding an incoming packet ~~based on an identifier corresponding to the packet forwarding node~~ by using a link that corresponds to an identifier from among the plurality of identifiers.

22. (Previously Presented) The packet forwarding node according to claim 1, wherein the storage unit stores the table used for forwarding the packet based on the identifier which ~~indentifies~~ identifies a link between adjacent nodes on a packet forwarding path.

23. (Previously Presented) The packet forwarding node according to claim 6, wherein the storage unit stores the packet forwarding table used for forwarding the packet based on the identifier which identifies a link between adjacent nodes on a packet forwarding path.

24. (Previously Presented) The packet forwarding node according to claim 11, further comprising a storage unit that stores a table used for forwarding the packet based on an identifier which identifies a link between adjacent nodes on a packet forwarding path.

25. (Previously Presented) The packet forwarding node according to claim 16, further comprising a storage unit that stores a table used for forwarding the packet based on an identifier which identifies a link between adjacent nodes on a packet forwarding path.

26. (Previously Presented) The server according to claim 21, further comprising a storage unit to store a packet forwarding table used for forwarding the incoming packet based on the identifier which identifies the link between nodes on the packet forwarding path,

wherein the storage unit stores the table used for forwarding the packet based on the identifier which identifies a link between adjacent nodes on a packet forwarding path.

27-28. (Canceled)

29. (New) The packet forwarding node according to claim 1, wherein when the forwarding unit receives the incoming packet including the identifier for the link connecting nodes on the packet forwarding path, the forwarding unit forwards the incoming packet based on the identifier included the received incoming packet from among the plurality of the identifiers.

REMARKS

Claims 1-26 are all of the claims presently pending in the application. Applicant has canceled claims 27-28 without prejudice or disclaimer. Applicant has added new claim 29 to provide additional claim scope. Applicant has amended various claims to more particularly define the claimed invention and/or for editorial purposes.

Further, Applicant specifically states that no amendment to any claim herein should be construed as a disclaimer of any interest in or right to an equivalent of any element or feature of the amended claim.

The amendments are supported by the original specification, claims and drawings. Therefore, no new matter was added.

Claims 1-28 stand rejected under 35 U.S.C. § 112(b) or 35 U.S.C. § 112 (pre-AIA), second paragraph. Claims 1-28 are rejected under 35 U.S.C. 101 because the claimed invention is directed to a judicial exception (i.e., a law of nature, a natural phenomenon, or an abstract idea) without significantly more. Claims 1-28 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Dong, et al. (U.S. Patent No. 7,496,096 B1) in view of EstevE. Rothenberg, et al. (U.S. Patent Application Publication No. 2011/0149973 A1).

These rejections are respectfully traversed in the following discussion.

I. THE INDEFINITESS REJECTION

The Examiner has rejected claims under 35 U.S.C. 112 as allegedly being indefinite. Specifically, claims 1-28 stand rejected under 35 U.S.C. § 112(b) or 35 U.S.C. § 112 (pre-AIA), second paragraph.

1. Concerning the issues of the "plurality of the identifiers" and "an identifier", the claims were clarified.
2. Concerning the Examiner question as to how the packet forwarding node receives

and forwards itself based on the identifier, the claim has been amended to clarify.

3. Concerning claim Claims 12-15,24 and 28: the second reference to "a packet forwarding node" in claim 11 was removed and so the issues in the dependent claims are now moot.
4. Concerning the interpretation under 35USC 112(f) and using it as basis for an indefinite rejection, since the "unit" language has been clarified, such a rejection should now be moot.

Therefore, because of the above, the above rejection should now be removed.

II. THE STATUTORY SUBJECT MATTER REJECTION

Claims 1-28 are rejected under 35 U.S.C. 101 because the claimed invention is directed to a judicial exception (i.e., a law of nature, a natural phenomenon, or an abstract idea) without significantly more.

While Applicant does not agree with the Examiner's rejection, the claims have been amended to clarify that it is statutory subject matter. The amendment is supported by, for example, paragraph [0113] of the published version of the specification (US Pub. 20140219281) which recites that recites in part that "function blocks can be realized by a computer program (software) executed in one or a plurality of CPUs installed in respective devices, or by hardware". Concerning the storage unit, it was already clarified as including a computer readable medium.

Therefore, this rejection should be removed.

III. THE ALLEGED PRIOR ART REFERENCES

A. The Dong and Rothenberg Reference

Claims 1-28 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over

Dong, et al. (U.S. Patent No. 7,496,096 B1, hereinafter Dong) in view of EstevE. Rothenberg, et al. (U.S. Patent Application Publication No. 2011/0149973 A1, hereinafter Rothenberg).

The Examiner alleges that Dong would have been combined with Rothenberg to teach or suggest the claimed invention of claims 1-28. Applicant submits, however, that, even if combined, the alleged combination of references would not teach or suggest each and every feature of the claimed invention.

The combination fails to teach or suggest (e.g., claim 1), "*a forwarding unit configured to receive an incoming packet including a plurality of the identifiers, and to forward the incoming packet by using a link that corresponds to the identifier from among the plurality of the identifiers*".

The examiner asserts that the technical feature of the claimed invention is disclosed in Dong. However, respectfully, this understanding of the examiner is incorrect.

The claimed invention has a technical feature that when the packet forwarding node receives a packet including identifier for links connecting nodes on a packet forwarding path, the packet forwarding node forwards this packet based on the identifier included the received packet. That is, in the present application, the packet itself has technical feature (refer to Fig. 4 for illustration purposes and not to limit the claims).

The cited reference Dong does not disclose or suggest the above-mentioned feature. Dong discloses a generation method for routing table regarding a network where IP path and MPLS path are mixed.

More specifically, Dong discloses the following.

FIG. 1 of Dong discloses a network in which a network based on the IP path (the upper side of the figure) and a network based on the MPLS (the lower side of the figure) are mixed.

The central network in Fig. 1 is connected to other networks (Network A to C, Network

X).

There are two types of paths from Network X to another network (Network A to C), one passing through the IP path and one passing the MPLS path (col 3, lines 39 to 43).

For example, the path from Network X to Network A includes a path (PATH 1) passing through a switch with IP = 151.1.1.1, a path (PATH 2) passing through a switch with IP = 152.1.1.1, and a path (PATH 3) passing through a label switch LPS 1.

Fig. 3 summarizes information on paths from Network X to other networks.

In Fig. 3, path information of Network A (Prefix 10.0.0.0), Network B, and Network C is described in order from the top.

Next, an identifier for identifying each path is set. At that time, the path passing through the IP network and the path passing through the MPLS network are distinguished by the identifier given (col 5, lines 38 to 43).

For the path passing through the IP network, the IP address of the next hop (transfer destination) is used as the identifier. In Fig. 4, since the next hop of PATH 1 is a switch with IP = 151.1.1.1, the address is used as an identifier.

The IP multicast address is used as the identifier for the path passing through the MPLS network. In Fig. 4, 224.0.0.1 and 224.0.0.2 are used as identifiers for PATH 3 and PATH 4.

In Fig. 5, a routing table is generated using the information on the path in Fig. 3 and the information on the path identifier in Fig. 4.

In Fig. 5, in the "Route Table" on the left side, the network to which the packet is transferred is described, and in the "Adjacency Table" on the right side, a breakdown of the path to each network is described.

On the right side of Fig. 5, if the breakdown of the paths of each network is common, the hardware resources are shared (Abstract, col 2, lines 33 to 36).

In Fig. 5, the path (the path of TABLE Ia in Fig. 3) for reaching Network A, the path (the path of TABLE IIa in Fig. 3) for reaching Network B are the same. Therefore, the breakdown is shared in Fig 5.

The path for reaching the Network C (the path of TABLE IIIa in FIG. 3) is not shared on the right side of Fig. 5 because there is no same breakdown.

A router connected to Network X constructs a routing table as shown in Fig. 5, and forwards the received packet according to the table (col 4, line 39 to 41).

As described above, Dong does not disclose or suggest a packet of the claimed invention including a plurality of identifiers to identify the link. At least, it is evident that Fig 5 of Dong shows a kind of routing table built inside the router, and does not show the packet configuration.

Additionally, the Rothenberg is silent as to the above mentioned limitations as seen, for example, in Figs. 5-6. There is no reference to forward the incoming packet by using a link that corresponds to the identifier as seen for example in paragraphs [0018], [0083] and [0084] of Rothenberg.

The other independent claims and therefore, the dependent claims are similarly not taught or suggested.

Therefore, Applicant submits that, even if combined, the alleged combination of references would not teach or suggest each and every feature of the claimed invention. Therefore, Applicant respectfully requests the Examiner to withdraw this rejection.

IV. NEW CLAIMS

Applicant has added new claim 29 to claim additional features of the invention and to provide more varied protection for the claimed invention. This claim is independently patentable because of the novel and nonobvious features recited therein.

Applicant submits that new claims are patentable over the cited prior art references at least for analogous reasons to those set forth above with respect to the above mentioned claims.

V. FORMAL MATTERS AND CONCLUSION

With respect to the Examiner's objection, Applicant submits that the claims have been amended in a manner fully responsive to the Examiner's objection. The claims have been amended accordingly and therefore, the claim objections should be removed.

In view of the foregoing, Applicant submits that claims 1-26 and 29, all of the claims presently pending in the application, are patentably distinct over the prior art of record and are in condition for allowance. Applicant respectfully requests the Examiner to pass the above application to issue at the earliest possible time.

Should the Examiner find the application to be other than in condition for allowance, Applicant requests the Examiner to contact the undersigned at the local telephone number listed below to discuss any other changes deemed necessary in a telephonic or personal interview.

The undersigned authorizes the Commissioner to charge any deficiency in fees or to credit any overpayment in fees to Attorney's Deposit Account No. 50-0481.

Respectfully Submitted,

Date: February 22, 2017

Sam S. Sahota, Esq.
Registration No. 47,051

Sean M. McGinn, Esq.
Registration No. 34,386

MCGINN INTELLECTUAL PROPERTY LAW GROUP, PLLC
8321 Old Courthouse Road, Suite 200
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(703) 761-4100
Customer No. 21254

Electronic Acknowledgement Receipt

EFS ID:	28423113
Application Number:	14244701
International Application Number:	
Confirmation Number:	2010
Title of Invention:	Communication system, forwarding node, path management server, communication method, and program
First Named Inventor/Applicant Name:	JUN AWANO
Customer Number:	21254
Filer:	Saryadvinder S. Sahota
Filer Authorized By:	
Attorney Docket Number:	NEG-1440PCT-US2CT
Receipt Date:	22-FEB-2017
Filing Date:	03-APR-2014
Time Stamp:	08:53:07
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Amendment/Req. Reconsideration-After Non-Final Reject	amendmentfinalizedforfilingEFS.pdf	134682 43cadfcb737d06869d7dbbaf6c3f67c09b45ea39	no	14

Warnings:

Information:	
Total Files Size (in bytes):	134682

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 14/244,701	Filing Date 04/03/2014	☐ To be Mailed

ENTITY: ☒ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED – PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	

APPLICATION AS AMENDED – PART II

AMENDMENT **02/22/2017**

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	* 27	Minus	** 28	= 0	X $80 =	0
Independent (37 CFR 1.16(h))	* 5	Minus	***5	= 0	X $420 =	0
☐ Application Size Fee (37 CFR 1.16(s))						
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
					TOTAL ADD'L FEE	0

AMENDMENT

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	*	Minus	**	=	X $ =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	X $ =	
☐ Application Size Fee (37 CFR 1.16(s))						
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
					TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

LIE
KIM WATSON

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**
If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

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UNITED STATES DEPARTMENT OF COMMERCE
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/244,701	04/03/2014	JUN AWANO	NEG-1440PCT-US2CT	2010

21254 7590 03/28/2017

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VIENNA, VA 22182-3817

EXAMINER
AUNG, SAI

ART UNIT	PAPER NUMBER
2475	

MAIL DATE	DELIVERY MODE
03/28/2017	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Applicant-Initiated Interview Summary	Application No.	Applicant(s)	
	14/244,701	AWANO, JUN	
	Examiner	Art Unit	
	SAI AUNG	2475	

All participants (applicant, applicant's representative, PTO personnel):

(1) *SAI AUNG*. (3)_____.

(2) *Sam (Reg. 47,051)*. (4)_____.

Date of Interview: *23 March 2017*.

Type: ☒ Telephonic ☐ Video Conference
☐ Personal [copy given to: ☐ applicant ☐ applicant's representative]

Exhibit shown or demonstration conducted: ☐ Yes ☐ No.
If Yes, brief description: _____.

Issues Discussed ☒101 ☐112 ☐102 ☒103 ☐Others
(For each of the checked box(es) above, please describe below the issue and detailed description of the discussion)

Claim(s) discussed: *All*.

Identification of prior art discussed: _____.

Substance of Interview
(For each issue discussed, provide a detailed description and indicate if agreement was reached. Some topics may include: identification or clarification of a reference or a portion thereof, claim interpretation, proposed amendments, arguments of any applied references etc...)

During the interview, the examiner discussed the newly amended limitations and 101 Abstract. The examiner explained that the amended limitations may not overcome current prior art rejection and 101 rejection. The examiner further suggested to add further specific limitations from figures 10 and 11 in order to overcome the rejections. No further agreement was reached.

Applicant recordation instructions: The formal written reply to the last Office action must include the substance of the interview. (See MPEP section 713.04). If a reply to the last Office action has already been filed, applicant is given a non-extendable period of the longer of one month or thirty days from this interview date, or the mailing date of this interview summary form, whichever is later, to file a statement of the substance of the interview

Examiner recordation instructions: Examiners must summarize the substance of any interview of record. A complete and proper recordation of the substance of an interview should include the items listed in MPEP 713.04 for complete and proper recordation including the identification of the general thrust of each argument or issue discussed, a general indication of any other pertinent matters discussed regarding patentability and the general results or outcome of the interview, to include an indication as to whether or not agreement was reached on the issues raised.

☐ Attachment

/SAI AUNG/ Examiner, Art Unit 2475	

Summary of Record of Interview Requirements

Manual of Patent Examining Procedure (MPEP), Section 713.04, Substance of Interview Must be Made of Record
A complete written statement as to the substance of any face-to-face, video conference, or telephone interview with regard to an application must be made of record in the application whether or not an agreement with the examiner was reached at the interview.

Title 37 Code of Federal Regulations (CFR) § 1.133 Interviews
Paragraph (b)

In every instance where reconsideration is requested in view of an interview with an examiner, a complete written statement of the reasons presented at the interview as warranting favorable action must be filed by the applicant. An interview does not remove the necessity for reply to Office action as specified in §§ 1.111, 1.135. (35 U.S.C. 132)

37 CFR §1.2 Business to be transacted in writing.
All business with the Patent or Trademark Office should be transacted in writing. The personal attendance of applicants or their attorneys or agents at the Patent and Trademark Office is unnecessary. The action of the Patent and Trademark Office will be based exclusively on the written record in the Office. No attention will be paid to any alleged oral promise, stipulation, or understanding in relation to which there is disagreement or doubt.

The action of the Patent and Trademark Office cannot be based exclusively on the written record in the Office if that record is itself incomplete through the failure to record the substance of interviews.

It is the responsibility of the applicant or the attorney or agent to make the substance of an interview of record in the application file, unless the examiner indicates he or she will do so. It is the examiner's responsibility to see that such a record is made and to correct material inaccuracies which bear directly on the question of patentability.

Examiners must complete an Interview Summary Form for each interview held where a matter of substance has been discussed during the interview by checking the appropriate boxes and filling in the blanks. Discussions regarding only procedural matters, directed solely to restriction requirements for which interview recordation is otherwise provided for in Section 812.01 of the Manual of Patent Examining Procedure, or pointing out typographical errors or unreadable script in Office actions or the like, are excluded from the interview recordation procedures below. Where the substance of an interview is completely recorded in an Examiners Amendment, no separate Interview Summary Record is required.

The Interview Summary Form shall be given an appropriate Paper No., placed in the right hand portion of the file, and listed on the "Contents" section of the file wrapper. In a personal interview, a duplicate of the Form is given to the applicant (or attorney or agent) at the conclusion of the interview. In the case of a telephone or video-conference interview, the copy is mailed to the applicant's correspondence address either with or prior to the next official communication. If additional correspondence from the examiner is not likely before an allowance or if other circumstances dictate, the Form should be mailed promptly after the interview rather than with the next official communication.

The Form provides for recordation of the following information:
- Application Number (Series Code and Serial Number)
- Name of applicant
- Name of examiner
- Date of interview
- Type of interview (telephonic, video-conference, or personal)
- Name of participant(s) (applicant, attorney or agent, examiner, other PTO personnel, etc.)
- An indication whether or not an exhibit was shown or a demonstration conducted
- An identification of the specific prior art discussed
- An indication whether an agreement was reached and if so, a description of the general nature of the agreement (may be by attachment of a copy of amendments or claims agreed as being allowable). Note: Agreement as to allowability is tentative and does not restrict further action by the examiner to the contrary.
- The signature of the examiner who conducted the interview (if Form is not an attachment to a signed Office action)

It is desirable that the examiner orally remind the applicant of his or her obligation to record the substance of the interview of each case. It should be noted, however, that the Interview Summary Form will not normally be considered a complete and proper recordation of the interview unless it includes, or is supplemented by the applicant or the examiner to include, all of the applicable items required below concerning the substance of the interview.

A complete and proper recordation of the substance of any interview should include at least the following applicable items:
1) A brief description of the nature of any exhibit shown or any demonstration conducted,
2) an identification of the claims discussed,
3) an identification of the specific prior art discussed,
4) an identification of the principal proposed amendments of a substantive nature discussed, unless these are already described on the Interview Summary Form completed by the Examiner,
5) a brief identification of the general thrust of the principal arguments presented to the examiner,
   (The identification of arguments need not be lengthy or elaborate. A verbatim or highly detailed description of the arguments is not required. The identification of the arguments is sufficient if the general nature or thrust of the principal arguments made to the examiner can be understood in the context of the application file. Of course, the applicant may desire to emphasize and fully describe those arguments which he or she feels were or might be persuasive to the examiner.)
6) a general indication of any other pertinent matters discussed, and
7) if appropriate, the general results or outcome of the interview unless already described in the Interview Summary Form completed by the examiner.

Examiners are expected to carefully review the applicant's record of the substance of an interview. If the record is not complete and accurate, the examiner will give the applicant an extendable one month time period to correct the record.

Examiner to Check for Accuracy

If the claims are allowable for other reasons of record, the examiner should send a letter setting forth the examiner's version of the statement attributed to him or her. If the record is complete and accurate, the examiner should place the indication, "Interview Record OK" on the paper recording the substance of the interview along with the date and the examiner's initials.

14/244,701
NEG-1440PCT-US2CT
KATO.327CONT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of Jun Awano

Serial No.: 14/244,701 Group Art Unit: 2475

Filed: April 3, 2014 Examiner: AUNG, SAI

For: COMMUNICATION SYSTEM, FORWARDING NODE, PATH MANAGEMENT SERVER, COMMUNICATION METHOD, AND PROGRAM

Honorable Commissioner of Patents
Alexandria, VA 22313-1450

STATEMENT OF SUBSTANCE OF INTERVIEW

Applicants provide the following statement of the substance of an interview for completion of the written record. See 37 C.F.R. §1.2, 37 C.F.R. §1.133, and MPEP §713.04

Applicants gratefully acknowledges Examiner Aung for courtesies extended during the Examiner interview, for taking time from his busy schedule to an interview on March 23, 2017.

The pending claims and cited art were discussed with the Examiner.

Applicants' representative presented arguments that previously presented references do not teach or suggest the claim limitations and that the amendments overcome the statutory subject matter rejection.

No agreement was reached, but the Examiner suggested amending to add further specific limitations from figures 10 and 11 in order to overcome the rejections.

Applicants thank Examiner Aung for being very helpful in expediting the prosecution of the present Application.

14/244,701
NEG-1440PCT-US2CT
KATO.327CONT

Respectfully Submitted,

Date: March 31, 2017

S. S. Sahota, Esq.
Registration No. 47,051

Sean M. McGinn, Esq.
Registration No. 34,386

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Customer No. 21254

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/244,701	04/03/2014	JUN AWANO	NEG-1440PCT-US2CT	2010

21254 7590 03/28/2017

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8321 OLD COURTHOUSE ROAD
SUITE 200
VIENNA, VA 22182-3817

EXAMINER
AUNG, SAI

ART UNIT	PAPER NUMBER
2475	

MAIL DATE	DELIVERY MODE
03/28/2017	PAPER

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	Examiner SAI AUNG	Art Unit 2475	

All participants (applicant, applicant's representative, PTO personnel):

(1) *SAI AUNG*. (3)_____.

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Type: ☒ Telephonic ☐ Video Conference
☐ Personal [copy given to: ☐ applicant ☐ applicant's representative]

Exhibit shown or demonstration conducted: ☐ Yes ☐ No.
If Yes, brief description: _____.

Issues Discussed ☒101 ☐112 ☐102 ☒103 ☐Others
(For each of the checked box(es) above, please describe below the issue and detailed description of the discussion)

Claim(s) discussed: *All*.

Identification of prior art discussed: _____.

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/SAI AUNG/ Examiner, Art Unit 2475	

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All business with the Patent or Trademark Office should be transacted in writing. The personal attendance of applicants or their attorneys or agents at the Patent and Trademark Office is unnecessary. The action of the Patent and Trademark Office will be based exclusively on the written record in the Office. No attention will be paid to any alleged oral promise, stipulation, or understanding in relation to which there is disagreement or doubt.

The action of the Patent and Trademark Office cannot be based exclusively on the written record in the Office if that record is itself incomplete through the failure to record the substance of interviews.

It is the responsibility of the applicant or the attorney or agent to make the substance of an interview of record in the application file, unless the examiner indicates he or she will do so. It is the examiner's responsibility to see that such a record is made and to correct material inaccuracies which bear directly on the question of patentability.

Examiners must complete an Interview Summary Form for each interview held where a matter of substance has been discussed during the interview by checking the appropriate boxes and filling in the blanks. Discussions regarding only procedural matters, directed solely to restriction requirements for which interview recordation is otherwise provided for in Section 812.01 of the Manual of Patent Examining Procedure, or pointing out typographical errors or unreadable script in Office actions or the like, are excluded from the interview recordation procedures below. Where the substance of an interview is completely recorded in an Examiners Amendment, no separate Interview Summary Record is required.

The Interview Summary Form shall be given an appropriate Paper No., placed in the right hand portion of the file, and listed on the "Contents" section of the file wrapper. In a personal interview, a duplicate of the Form is given to the applicant (or attorney or agent) at the conclusion of the interview. In the case of a telephone or video-conference interview, the copy is mailed to the applicant's correspondence address either with or prior to the next official communication. If additional correspondence from the examiner is not likely before an allowance or if other circumstances dictate, the Form should be mailed promptly after the interview rather than with the next official communication.

The Form provides for recordation of the following information:
- Application Number (Series Code and Serial Number)
- Name of applicant
- Name of examiner
- Date of interview
- Type of interview (telephonic, video-conference, or personal)
- Name of participant(s) (applicant, attorney or agent, examiner, other PTO personnel, etc.)
- An indication whether or not an exhibit was shown or a demonstration conducted
- An identification of the specific prior art discussed
- An indication whether an agreement was reached and if so, a description of the general nature of the agreement (may be by attachment of a copy of amendments or claims agreed as being allowable). Note: Agreement as to allowability is tentative and does not restrict further action by the examiner to the contrary.
- The signature of the examiner who conducted the interview (if Form is not an attachment to a signed Office action)

It is desirable that the examiner orally remind the applicant of his or her obligation to record the substance of the interview of each case. It should be noted, however, that the Interview Summary Form will not normally be considered a complete and proper recordation of the interview unless it includes, or is supplemented by the applicant or the examiner to include, all of the applicable items required below concerning the substance of the interview.

A complete and proper recordation of the substance of any interview should include at least the following applicable items:
1) A brief description of the nature of any exhibit shown or any demonstration conducted,
2) an identification of the claims discussed,
3) an identification of the specific prior art discussed,
4) an identification of the principal proposed amendments of a substantive nature discussed, unless these are already described on the Interview Summary Form completed by the Examiner,
5) a brief identification of the general thrust of the principal arguments presented to the examiner,
   (The identification of arguments need not be lengthy or elaborate. A verbatim or highly detailed description of the arguments is not required. The identification of the arguments is sufficient if the general nature or thrust of the principal arguments made to the examiner can be understood in the context of the application file. Of course, the applicant may desire to emphasize and fully describe those arguments which he or she feels were or might be persuasive to the examiner.)
6) a general indication of any other pertinent matters discussed, and
7) if appropriate, the general results or outcome of the interview unless already described in the Interview Summary Form completed by the examiner.

Examiners are expected to carefully review the applicant's record of the substance of an interview. If the record is not complete and accurate, the examiner will give the applicant an extendable one month time period to correct the record.

Examiner to Check for Accuracy

If the claims are allowable for other reasons of record, the examiner should send a letter setting forth the examiner's version of the statement attributed to him or her. If the record is complete and accurate, the examiner should place the indication, "Interview Record OK" on the paper recording the substance of the interview along with the date and the examiner's initials.

Electronic Acknowledgement Receipt

EFS ID:	28801409
Application Number:	14244701
International Application Number:	
Confirmation Number:	2010
Title of Invention:	Communication system, forwarding node, path management server, communication method, and program
First Named Inventor/Applicant Name:	JUN AWANO
Customer Number:	21254
Filer:	Saryadvinder S. Sahota/Amber Carroll
Filer Authorized By:	Saryadvinder S. Sahota
Attorney Docket Number:	NEG-1440PCT-US2CT
Receipt Date:	31-MAR-2017
Filing Date:	03-APR-2014
Time Stamp:	14:57:12
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Applicant summary of interview with examiner	701_SSI.pdf	58276 02540d20cb3c4697bc4c7e9be69e83807ce bc7ec	no	2

Warnings:

Information:					
2	Miscellaneous Incoming Letter	701_Summary.pdf	183739 043d64351a58c6a855b15ba1167836abe1a86405	no	3
Warnings:					
Information:					
			Total Files Size (in bytes):	242015	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/244,701	04/03/2014	JUN AWANO	NEG-1440PCT-US2CT	2010

21254 7590 05/31/2017

MCGINN INTELLECTUAL PROPERTY LAW GROUP, PLLC
8321 OLD COURTHOUSE ROAD
SUITE 200
VIENNA, VA 22182-3817

EXAMINER
AUNG, SAI

ART UNIT	PAPER NUMBER
2416	

MAIL DATE	DELIVERY MODE
05/31/2017	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Examiner-Initiated Interview Summary	Application No.	Applicant(s)	
	14/244,701	AWANO, JUN	
	Examiner	Art Unit	
	SAI AUNG	2416	

All participants (applicant, applicant's representative, PTO personnel):

(1) *SAI AUNG*. (3)_____.

(2) *Sam Sahota Reg. 47,051*. (4)_____.

Date of Interview: *24 April 2017*.

Type: ☒ Telephonic ☐ Video Conference
☐ Personal [copy given to: ☐ applicant ☐ applicant's representative]

Exhibit shown or demonstration conducted: ☐ Yes ☐ No.
If Yes, brief description: _____.

Issues Discussed ☐101 ☐112 ☐102 ☒103 ☐Others
(For each of the checked box(es) above, please describe below the issue and detailed description of the discussion)

Claim(s) discussed: *1-26*.

Identification of prior art discussed: _____.

Substance of Interview
(For each issue discussed, provide a detailed description and indicate if agreement was reached. Some topics may include: identification or clarification of a reference or a portion thereof, claim interpretation, proposed amendments, arguments of any applied references etc...)

During the interview, the examiner discussed with the applicant especially for the independent claims 1, 6, 11, 16 and 21. The examiner proposed the claim amendments using the limitations from the applicant's figures 10 and 11 to overcome the current prior art rejections. The applicant responded to review the examiner's proposed amendment. No further agreement was reached..

Applicant recordation instructions: It is not necessary for applicant to provide a separate record of the substance of interview.

Examiner recordation instructions: Examiners must summarize the substance of any interview of record. A complete and proper recordation of the substance of an interview should include the items listed in MPEP 713.04 for complete and proper recordation including the identification of the general thrust of each argument or issue discussed, a general indication of any other pertinent matters discussed regarding patentability and the general results or outcome of the interview, to include an indication as to whether or not agreement was reached on the issues raised.

☐ Attachment

/SAI AUNG/ Examiner, Art Unit 2416	

Office Action Summary	Application No. 14/244,701	Applicant(s) AWANO, JUN	
	Examiner SAI AUNG	Art Unit 2416	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *02/22/2017*.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5)☒ Claim(s) *1-26 and 29* is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6)☐ Claim(s) _____ is/are allowed.

7)☒ Claim(s) *1-26 and 29* is/are rejected.

8)☐ Claim(s) _____ is/are objected to.

9)☐ Claim(s) _____ are subject to restriction and/or election requirement.

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)

2) ☐ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date _____.

3) ☒ Interview Summary (PTO-413) Paper No(s)/Mail Date. *04/24/2017*.

4) ☐ Other: _____.

DETAILED ACTION

Claims status

1. In the application filed on 02/22/2017, claims 27-28 are cancelled, and claim 29 has been added. Claims 1-26 and 29 are currently pending for the examination. The present application is being examined under the pre-AIA first to invent provisions.

Claim Analysis under 35 U.S.C. 112(f)

2. The following is a quotation of 35 U.S.C. 112(f):

> *(f) Element in Claim for a Combination. – An element in a claim for a combination may be expressed as a means or step for performing a specified function without the recital of structure, material, or acts in support thereof, and such claim shall be construed to cover the corresponding structure, material, or acts described in the specification and equivalents thereof.*

3. Claim 1 recites "*a processor configured to execute program instructions to provide a forwarding unit configured to receive...and...to forward*", and thus the claim has NOT been interpreted under 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph. Even though it uses a generic placeholder "forwarding unit" coupled with functional language "to receive and to forward", the generic placeholder has been preceded by a structural modifier, i.e., a processor configured to execute program instructions. See the applicant's figures 2, 5, and 6. The processor configured to execute program instructions to process the forwarding unit can serve as sufficient structure for functions that can be achieved by any general purpose computer. Thus 112(f) is not invoked. Hence, the claim 1 limitations shall be given under broadest reasonable interpretation consistent with the specification.

If applicant wishes to provide further explanation or dispute the examiner's interpretation of the corresponding structure, applicant must identify the corresponding structure with reference to the specification by page and line number, and to the drawing, if any, by reference characters in response to this Office action.

For more information, see MPEP § 2173 et seq. and Supplementary Examination Guidelines for Determining Compliance With 35 U.S.C. 112 and for Treatment of Related Issues in Patent Applications, 76 FR 7162, 7167 (Feb. 9, 2011).

Claims 6, 11, 6 and 21 have NOT been interpreted under 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph under a similar analysis of claim 1.

Claim Rejections - 35 USC § 101

4. 35 U.S.C. 101 reads as follows:

> *Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title.*

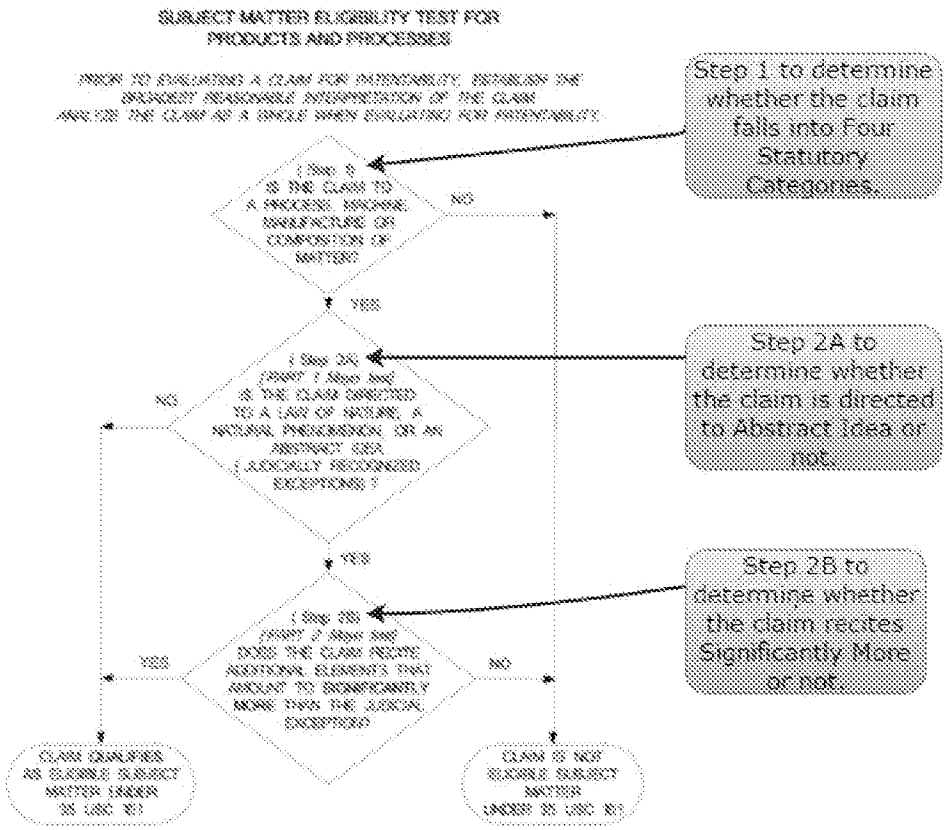
5. Claims 1-26 and 29 are rejected under 35 U.S.C. 101 because the claimed invention is directed to a judicial exception (i.e., a law of nature, a natural phenomenon, or an abstract idea) without significantly more.

Claimed:

> *"1. A packet forwarding node, comprising:*
> *a storage unit including a non-transitory computer readable medium configured to store a packet forwarding table used for forwarding a packet based on an identifier which identifies a link between nodes on a packet forwarding path; and*
> *at least a processor configured to execute program instructions to provide a forwarding unit configured to receive an incoming packet including a plurality of the*

identifiers, and to forward the incoming packet by using a link that corresponds to the identifier from among the identifiers."

Analysis:



I. Thus, the claimed invention directs to a Machine statutory category [Step 1: YES].

II.

A. The concept of the claimed invention is receiving an incoming data packet that includes identifier(s), and comparing or identifying the identifier based upon the storage unit that stores packet forwarding table before forwarding to the packet forwarding node. In other words, the claimed limitation directs to comparing a new identifier and selecting the identifier from the storage that previously stored

data in records. The main concept is similar to the others types of basic concepts that have been ruled as "Abstract Idea" by the Courts. For instance, according to the similar court case "*SmartGene V. Advanced Biological*", the court found that the steps of comparing new and stored information involve a mental process or abstract idea, as in *Bilski*. A further relevant court case of comparing a new and stored data message can also be found in the relevant court case *Cybersource Corp. V. Retail Decisions, Inc.* [Step 2A: YES].

B. Upon considering the claimed elements individually, *receiving incoming packet including and forwarding the incoming packet based on the identifier*, the intended concept doesn't impose a sufficiently meaningful limit on the claim's scope because those steps could be routinely performed by a generic-purpose computer. Upon reviewing all the claim identified elements in combination and as a whole, *the storage unit to store data along with receiving incoming packet including and forwarding the incoming packet based on the identifier*, the identified limitations do not amount to significantly more than the Abstract Idea. Further, *In re Abele* made clear that the basic character of a process claim drawn to an abstract idea is not changed by claiming only its performance by processors or computers, or by claiming the process embodied in program instructions on a computer readable medium. Therefore, the additional elements/steps have not appended any meaningful limitations to the abstract idea itself. When viewed either individually, or as an ordered combination, the additional limitations do not

amount to the claim as a whole that is significantly more than the abstract idea [Step 2B: NO].

In view of the above analysis, **claim 1 is held to be patent ineligible under 35 U.S.C. 101**.

Dependent Claims 2-5 and 22 when analyzed as a whole are held to be patent ineligible under 35 U.S.C. § 101 because the additional recited limitations fail to establish that the claims are directed to an abstract idea, and none of the additionally recited limitations amount to significantly more than the abstract idea.

As per the claim 6, upon reviewing under similar analysis, the claim is also found to be patent ineligible under 35 U.S.C. 101 the claim do not amount to significantly more than the abstract idea. Dependent Claims 7-10 and 23 when analyzed as a whole are held to be patent ineligible under 35 U.S.C. § 101 because the additional recited limitations fail to establish that the claims are directed to an abstract idea, and none of the additionally recited limitations amount to significantly more than the abstract idea.

As per the claim 11, upon reviewing under similar analysis, the claim is also found to be patent ineligible under 35 U.S.C. 101 the claim do not amount to significantly more than the abstract idea. Dependent claims 12-15, 24 and 28 when analyzed as a whole are held to be patent ineligible under 35 U.S.C. § 101 because the additional recited limitations fail to establish that the claims are directed to an abstract idea, and none of the additionally recited limitations amount to significantly more than the abstract idea.

As per the claim 16, upon reviewing under similar analysis, the claim is also found to be patent ineligible under 35 U.S.C. 101 the claim do not amount to significantly more than the abstract idea. Dependent claims 17-20 and 25 when analyzed as a whole are held to be patent ineligible under 35 U.S.C. § 101 because the additional recited limitations fail to establish that the claims are directed to an abstract idea, and none of the additionally recited limitations amount to significantly more than the abstract idea.

As per the claim 21, upon reviewing under similar analysis, the claim is also found to be patent ineligible under 35 U.S.C. 101 the claim do not amount to significantly more than the abstract idea. Dependent claim 26 when analyzed as a whole are held to be patent ineligible under 35 U.S.C. § 101 because the additional recited limitations fail to establish that the claims are directed to an abstract idea, and none of the additionally recited limitations amount to significantly more than the abstract idea. See also 101 Publicly Accessible Link for more information: http://www.uspto.gov/patent/laws-and-regulations/examination-policy/2014-interim-guidance-subject-matter-eligibility-0

Claim Rejections - 35 USC § 103

6. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject

matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time of the claimed invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

7. The factual inquiries set forth in Graham v. John Deere Co., 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows: (See MPEP Ch. 2141)

a) Determining the scope and contents of the prior art;

b) Ascertaining the differences between the prior art and the claims in issue;

c) Resolving the level of ordinary skill in the pertinent art; and

d) Evaluating evidence of secondary considerations for indicating obviousness or nonobviousness.

8. Claims 1-26 and 29 are rejected under 35 U.S.C. 103(a) as being unpatentable over **Dong et al. (US 7,496,096 B1)** in view of **EstevE. Rothenberg et al. (US 2011/0149973 A1).**

Regarding claim 1; **Dong** discloses a packet forwarding node (***See Fig. 1; Router(s) 38-42***), comprising:

a storage unit including a non-transitory computer readable medium (***See Fig. 2: the Memory 22 for storing the path IDs; Col. 2, Lines 40-43***) configured to store a packet forwarding table (***See Fig. 3 and 4: the memory to store Path ID's tables; Col. 5, Lines 55-65***) used for forwarding a packet (***See Fig. 1; the router decides the next hop to forward passed upon the path ID received in the IP packet; Col. 1, Lines 64-67, and Col. 2, Lines 40-47***) based on an identifier which identifies a link (***See Figs. 1 and 3; See Figs. 1 and 3; determining the IP path or link ID; Col. 5, Lines 26-30***) between

nodes on a packet forwarding path (***See Fig. 1; routing between Edge Routers, such as 38, 40 and 42, using IP path or IP address; Col. 5, Lines 26-32***) ; and

at least one processor configured to execute program instructions (***See Fig. 2: Processor 20 to execute instructions in memory 22***) to provide a forwarding unit (***See Fig. 2: the hardware forwarding engine 29; Col. 4, Lines 30-34***) configured to receive an incoming packet (***See Fig. 6; at step 80, receiving the path information or packet; Col. 6, Lines 18-24***) including in a path identifier (***See Fig. 6; steps 80-90, the received path information to assign a path ID for the next-hop IP address; Col. 6, Lines 18-25***), and to forward the incoming packet by using a link that corresponds to the identifier (***See Fig. 6; steps 82-90, assigning the path/link ID for each path in the path groups and using the path ID for the next hop IP address; Col. 6, Lines 21-26***).

Even though, **Dong** discloses receiving the path information to assign the path ID for the path group and next hop IP address for forwarding, **Dong** doesn't explicitly discuss the receiving path information/packet includes the multiple path identifiers or the identifiers.

However, **E. Rothenberg** from the same field of endeavor teaches the path or routing information includes a plurality of link identifiers or the identifiers (***See Fig. 5 and 6; the routing information comprises a plurality of identifiers, each identifying a respective network link or node; Para. [0018]***).

[***For example, E. Rothenberg's is invention is from the same field of endeavor because it originally discusses routing and forwarding the data packet based upon identifying network link and link identifier in a label switching network. The invention further discusses identifying and encoding the link identifiers and putting into the packet header, and then the identified path is chosen through the network from a source node to a destination node. Para. 0018 and 0083-0084***].

In the manner of combining is that **E. Rothenberg**'s routing information that includes multiple link identifiers (IDs) could apparently be implemented into **Dong**'s conventional the path/link information that only a path ID for the next hop IP address for forwarding.

Therefore, it would have been obvious to one having ordinary skill in the art at the time of the claimed invention was made to provide that the path or routing information includes a plurality of link identifiers as taught by **Dong** to have incorporated in the system of **E. Rothenberg**, so that it would not only provide a virtual link or physical link to be defined from multiple single links (where a single "link" directly links two network nodes), allowing a more efficient way of describing delivery trees in the network but also support more efficient and powerful forwarding schemes by providing finer control over false positives. ***E. Rothenberg: Para. [0107] and [0144].***

Regarding claim 2; **Dong** discloses the packet forwarding node wherein the storage unit stores the table (***See Figs. 3 and 4; the routing tables with stored path IDs; Col. 5, Lines 55-60***) used for forwarding the packet based on the identifier (***See Fig. 6; steps 82-90, assigning the path ID for each path in the path groups and using the path ID for the next hop IP address; Col. 6, Lines 21-26***) which uniquely identifies the link (***See Fig. 6: at step 82 to assign or identify the path ID; Col. 6, Lines 18-25***) within a predetermined domain (***See Figs. 2 and 4; Col. 1, Lines 50-54***).

Regarding claim 3; **Dong** in view of **E. Rothenberg** discloses the packet forwarding node wherein the storage unit stores the table (**Dong**: ***See Figs. 2 and 3: the Memory 22 for storing the path IDs and the memory to store Path ID's tables; Col. 2, Lines 40-43*** and ***Col. 5, Lines 55-65***) used

for forwarding the packet based on the identifier (**Dong**: ***See Fig. 6; steps 82-90, assigning the path ID for each path in the path groups and using the path ID for the next hop IP address; Col. 6, Lines 21-26***) which uniquely identifies the link (**Dong**: ***See Fig. 6: at step 82 to assign or identify the path ID; Col. 6, Lines 18-25***) within a predetermined local domain (***See Figs. 2 and 4; Col. 1, Lines 50-54 and see also Fig. 1 for internally/locally managed IP identifiers***) and (***E. Rothenberg: See Fig. 9; for inter-domain links; Para. [0185]***)

Regarding claim 4; **Dong** discloses the packet forwarding node wherein the storage unit stores the table (***See Figs. 2 and 3: the Memory 22 for storing the path IDs and the memory to store Path ID's tables; Col. 2, Lines 40-43*** and ***Col. 5, Lines 55-65***) used for forwarding the packet based on the identifier (***See Fig. 6; steps 82-90, assigning the path ID for each path in the path groups and using the path ID for the next hop IP address; Col. 6, Lines 21-26***) which uniquely identifies the link (***See Fig. 6: at step 82 to assign or identify the path ID; Col. 6, Lines 18-25***) within the packet forwarding node (***See Fig. 6; at step 90; assigning the path ID within the path group of the router and see also Fig. 1 for internally/locally managed IP identifiers within a router***).

Regarding claim 5; **Dong** in view of **E. Rothenberg** discloses the packet forwarding node wherein the storage unit stores the table (**Dong**: ***See Figs. 2 and 3: the Memory 22 for storing the path IDs and the memory to store Path ID's tables; Col. 2, Lines 40-43*** and ***Col. 5, Lines 55-65***) used for forwarding the packet based on the identifier (**Dong**: ***See Fig. 6; steps 82-90, assigning the path ID for each path in the path groups and using the path ID for the next hop IP address; Col. 6, Lines 21-26***) which uniquely identifies the link (**Dong**: ***See Fig. 6: at step 82 to assign or identify the path ID;***

Col. 6, Lines 18-25) among the packet forwarding nodes (***E. Rothenberg: See Fig. 9: among the source and destination nodes; Para. [0084]***).

Regarding claim 6; **Dong** discloses a packet forwarding node (***See Fig. 1; Router(s) 38-42***), comprising:

a storage unit including a non-transitory computer readable medium (***See Fig. 2: the Memory 22 for storing the path IDs; Col. 2, Lines 40-43***) configured to store a packet forwarding table (***See Fig. 3 and 4: the memory to store Path ID's tables; Col. 5, Lines 55-65***) used for forwarding a packet (***See Fig. 1; the router decides the next hop to forward passed upon the path ID received in the IP packet; Col. 1, Lines 64-67, and Col. 2, Lines 40-47***) based on an identifier which identifies IP path link (***See Figs. 1 and 3; See Figs. 1 and 3; determining the IP path or link ID; Col. 5, Lines 26-30***) of a packet forwarding path (***See Fig. 1; routing between Edge Routers, such as 38, 40 and 42, using IP path or IP address; Col. 5, Lines 26-32***) ; and

at least one processor configured to execute program instructions (***See Fig. 2: Processor 20 to execute instructions in memory 22***) to provide a forwarding unit (***See Fig. 2: the hardware forwarding engine 29; Col. 4, Lines 30-34***) configured to receive an incoming packet (***See Fig. 6; at step 80, receiving the path information or packet; Col. 6, Lines 18-24***) including in a path identifier (***See Fig. 6; steps 80-90, the received path information to assign a path ID for the next-hop IP address; Col. 6, Lines 18-25***), and to forward the incoming packet by using a link that corresponds to the identifier among the plurality of the identifiers (***See Fig. 6; steps 82-90, assigning the path/link ID for each path in the path groups and using the path ID for the next hop IP address; Col. 6, Lines 21-26***).

Even though, **Dong** discloses receiving the path information to assign the path ID for the path group and next hop IP address for forwarding, **Dong** doesn't explicitly discuss identifying an interface and the receiving path information/packet includes multiple path identifiers or the identifiers.

However, **E. Rothenberg** from the same field of endeavor teaches identifying the interface (***See Fig. 15; the router to assign the link ID of the next router and identify each output interface with a link ID; Para. [0152]***) and the path or routing information includes a plurality of link identifiers (***See Fig. 5 and 6; the routing information comprises a plurality of identifiers, each identifying a respective network link or node; Para. [0018]***).

[***For example, E. Rothenberg's is invention is from the same field of endeavor because it originally discusses routing and forwarding the data packet based upon identifying network link and link identifier in a label switching network. The invention further discusses identifying and encoding the link identifiers and putting into the packet header, and then the identified path is chosen through the network from a source node to a destination node. Para. 0018 and 0083-0084***].

In the manner of combining is that **E. Rothenberg**'s routing information that includes multiple link identifiers (IDs) could apparently be implemented into **Dong**'s conventional the path/link information that only a path ID for the next hop IP address for forwarding.

Therefore, it would have been obvious to one having ordinary skill in the art at the time of the claimed invention was made to provide that the path or routing information includes a plurality of link identifiers and identifying the output interface using the link ID as taught by **Dong** to have incorporated in the system of **E. Rothenberg**, so that it would not only provide a virtual link or physical link to be defined from multiple single links allowing a more efficient way of describing delivery trees in the network but also support more efficient and powerful

forwarding schemes by providing finer control over false positives. ***E. Rothenberg: Para. [0107] and [0144].***

Regarding claim 7; **Dong** discloses the packet forwarding node wherein the storage unit stores the table (***See Figs. 3 and 4; the routing tables with stored path IDs; Col. 5, Lines 55-60***) used for forwarding the packet based on the identifier (***See Fig. 6; steps 82-90, assigning the path ID for each path in the path groups and using the path ID for the next hop IP address; Col. 6, Lines 21-26***) which uniquely identifies the link (***See Fig. 6: at step 82 to assign or identify the path ID; Col. 6, Lines 18-25***) within a predetermined domain (***See Figs. 2 and 4; Col. 1, Lines 50-54***).

Regarding claim 8; **Dong** in view of **E. Rothenberg** discloses the packet forwarding node wherein the storage unit stores the table (**Dong**: ***See Figs. 2 and 3: the Memory 22 for storing the path IDs and the memory to store Path ID's tables; Col. 2, Lines 40-43*** and ***Col. 5, Lines 55-65***) used for forwarding the packet based on the identifier (**Dong**: ***See Fig. 6; steps 82-90, assigning the path ID for each path in the path groups and using the path ID for the next hop IP address; Col. 6, Lines 21-26***) which uniquely identifies the link (**Dong**: ***See Fig. 6: at step 82 to assign or identify the path ID; Col. 6, Lines 18-25***) within a predetermined local domain (***See Figs. 2 and 4; Col. 1, Lines 50-54 and see also Fig. 1 for internally/locally managed IP identifiers***) and (***E. Rothenberg: See Fig. 9; for inter-domain links; Para. [0185]***)

Regarding claim 9; **Dong** discloses the packet forwarding node wherein the storage unit stores the table (***See Figs. 2 and 3: the Memory 22 for storing the path IDs and the memory to store***

Path ID's tables; Col. 2, Lines 40-43 and ***Col. 5, Lines 55-65***) used for forwarding the packet based on the identifier (***See Fig. 6; steps 82-90, assigning the path ID for each path in the path groups and using the path ID for the next hop IP address; Col. 6, Lines 21-26***) which uniquely identifies the link (***See Fig. 6: at step 82 to assign or identify the path ID; Col. 6, Lines 18-25***) within the packet forwarding node (***See Fig. 6; at step 90; assigning the path ID within the path group of the router and see also Fig. 1 for internally/locally managed IP identifiers within a router***).

Regarding claim 10; **Dong** in view of **E. Rothenberg** discloses the packet forwarding node wherein the storage unit stores the table (**Dong**: ***See Figs. 2 and 3: the Memory 22 for storing the path IDs and the memory to store Path ID's tables; Col. 2, Lines 40-43*** and ***Col. 5, Lines 55-65***) used for forwarding the packet based on the identifier (**Dong**: ***See Fig. 6; steps 82-90, assigning the path ID for each path in the path groups and using the path ID for the next hop IP address; Col. 6, Lines 21-26***) which uniquely identifies the link (**Dong**: ***See Fig. 6: at step 82 to assign or identify the path ID; Col. 6, Lines 18-25***) among the packet forwarding nodes (***E. Rothenberg: See Fig. 9: among the source and destination nodes; Para. [0084]***).

Regarding claim 11; **Dong** discloses a packet forwarding node (***See Fig. 1; Router(s) 38-42***), comprising:

A memory storing a program;

At least one processor configured to execute the program to provide:

a communication unit (***See Fig. 2: processor 20***) configured to communicate with a source node for receiving an identifier (***See Fig. 6; at step 80, receiving the path information or packet to***

assign the Path ID; Col. 6, Lines 18-24), each of which identifies a link (***See Figs. 1 and 3; See Figs. 1 and 3; determining the IP path or link ID; Col. 5, Lines 26-30***) between nodes on a packet forwarding path (***See Fig. 1; routing between Edge Routers, such as 38, 40 and 42, using IP path or IP address; Col. 5, Lines 26-32***); and

a forwarding unit (***See Fig. 2: the hardware forwarding engine 29; Col. 4, Lines 30-34***) for configured to forward an incoming packet (***See Fig. 6; at step 80, receiving the path information or packet; Col. 6, Lines 18-24***) by using a link that corresponds to the identifier among the plurality of the identifiers (***See Fig. 6; steps 82-90, assigning the path/link ID for each path in the path groups and using the path ID for the next hop IP address; Col. 6, Lines 21-26***).

Even though, **Dong** discloses receiving the path information to assign the path ID for the path group and next hop IP address for forwarding, **Dong** doesn't explicitly discuss the receiving path information/packet includes multiple path identifiers or the identifiers.

However, **E. Rothenberg** from the same field of endeavor teaches the path or routing information includes a plurality of link identifiers (***See Fig. 5 and 6; the routing information comprises a plurality of identifiers, each identifying a respective network link or node; Para. [0018]***).

[***For example, E. Rothenberg's is invention is from the same field of endeavor because it originally discusses routing and forwarding the data packet based upon identifying network link and link identifier in a label switching network. The invention further discusses identifying and encoding the link identifiers and putting into the packet header, and then the identified path is chosen through the network from a source node to a destination node. Para. 0018 and 0083-0084***].

Therefore, it would have been obvious to one having ordinary skill in the art at the time of the claimed invention was made to provide that the path or routing information includes a plurality of link identifiers as taught by **Dong** to have incorporated in the system of **E.**

Rothenberg, so that it would not only provide a virtual link or physical link to be defined from multiple single links (where a single "link" directly links two network nodes), allowing a more efficient way of describing delivery trees in the network but also support more efficient and powerful forwarding schemes by providing finer control over false positives. ***E. Rothenberg: Para. [0107] and [0144].***

Regarding claim 12; **Dong** discloses the packet forwarding node wherein the storage unit stores the table (***See Figs. 3 and 4; the routing tables with stored path IDs; Col. 5, Lines 55-60***) used for forwarding the packet based on the identifier (***See Fig. 6; steps 82-90, assigning the path ID for each path in the path groups and using the path ID for the next hop IP address; Col. 6, Lines 21-26***) which uniquely identifies the link (***See Fig. 6: at step 82 to assign or identify the path ID; Col. 6, Lines 18-25***) within a predetermined domain (***See Figs. 2 and 4; Col. 1, Lines 50-54***).

Regarding claim 13; **Dong** in view of **E. Rothenberg** discloses the packet forwarding node wherein the storage unit stores the table (**Dong**: ***See Figs. 2 and 3: the Memory 22 for storing the path IDs and the memory to store Path ID's tables; Col. 2, Lines 40-43*** and ***Col. 5, Lines 55-65***) used for forwarding the packet based on the identifier (**Dong**: ***See Fig. 6; steps 82-90, assigning the path ID for each path in the path groups and using the path ID for the next hop IP address; Col. 6, Lines 21-26***) which uniquely identifies the link (**Dong**: ***See Fig. 6: at step 82 to assign or identify the path ID; Col. 6, Lines 18-25***) within a predetermined local domain (***See Figs. 2 and 4; Col. 1, Lines 50-54 and see also Fig. 1 for internally/locally managed IP identifiers***) and (***E. Rothenberg: See Fig. 9; for inter-domain links; Para. [0185]***)

Regarding claim 14; **Dong** discloses the packet forwarding node wherein the storage unit stores the table (***See Figs. 2 and 3: the Memory 22 for storing the path IDs and the memory to store Path ID's tables; Col. 2, Lines 40-43*** and ***Col. 5, Lines 55-65***) used for forwarding the packet based on the identifier (***See Fig. 6; steps 82-90, assigning the path ID for each path in the path groups and using the path ID for the next hop IP address; Col. 6, Lines 21-26***) which uniquely identifies the link (***See Fig. 6: at step 82 to assign or identify the path ID; Col. 6, Lines 18-25***) within the packet forwarding node (***See Fig. 6; at step 90; assigning the path ID within the path group of the router and see also Fig. 1 for internally/locally managed IP identifiers within a router***).

Regarding claim 15; **Dong** in view of **E. Rothenberg** discloses the packet forwarding node wherein the storage unit stores the table (**Dong**: ***See Figs. 2 and 3: the Memory 22 for storing the path IDs and the memory to store Path ID's tables; Col. 2, Lines 40-43*** and ***Col. 5, Lines 55-65***) used for forwarding the packet based on the identifier (**Dong**: ***See Fig. 6; steps 82-90, assigning the path ID for each path in the path groups and using the path ID for the next hop IP address; Col. 6, Lines 21-26***) which uniquely identifies the link (**Dong**: ***See Fig. 6: at step 82 to assign or identify the path ID; Col. 6, Lines 18-25***) among the packet forwarding nodes (***E. Rothenberg: See Fig. 9: among the source and destination nodes; Para. [0084]***).

Regarding claim 16; **Dong** discloses a packet forwarding node (***See Fig. 1; Router(s) 38-42***), comprising:

a communication unit (***See Fig. 2: processor 20***) configured to communicate with a source node for receiving an identifier (***See Fig. 6; at step 80, receiving the path information or packet to assign the Path ID; Col. 6, Lines 18-24***), each of which identifies a path link (***See Figs. 1 and 3; See Figs. 1 and 3; determining the IP path or link ID; Col. 5, Lines 26-30***) of the packet forwarding node (***See Fig. 6; steps 84-86, the path ID is assigned to the next hop IP address; Col. 6, Lines 21-26, and see also Col. 5, Lines 26-35***); and

at least one processor configured to execute program instructions (See Fig. 2: Processor 20 to execute instructions in memory 22) to provide a forwarding unit (***See Fig. 2: the hardware forwarding engine 29; Col. 4, Lines 30-34***) for configured to forward an incoming packet (***See Fig. 6; at step 80, receiving the path information or packet; Col. 6, Lines 18-24***) by using a link that corresponds to the identifier among the plurality of the identifiers (***See Fig. 6; steps 82-90, assigning the path/link ID for each path in the path groups and using the path ID for the next hop IP address; Col. 6, Lines 21-26***).

Even though, **Dong** discloses receiving the path information to assign the path ID for the path group and next hop IP address for forwarding, **Dong** doesn't explicitly discuss identifying an interface and the receiving path information/packet includes multiple path identifiers.

However, **E. Rothenberg** from the same field of endeavor teaches identifying the interface (***See Fig. 15; the router to assign the link ID of the next router and identify each output interface with a link ID; Para. [0152]***) and the path or routing information includes a plurality of link identifiers (***See Fig. 5 and 6; the routing information comprises a plurality of identifiers, each identifying a respective network link or node; Para. [0018]***). **E. Rothenberg** further discuses a method to communicate with a server (***See Fig. 9; Para. [0011]***).

[***For example, E. Rothenberg's is invention is from the same field of endeavor because it originally discusses routing and forwarding the data packet based upon identifying network link and link identifier in a label switching network. The invention further discusses identifying and encoding the link identifiers and putting into the packet header, and then the identified path is chosen through the network from a source node to a destination node. Para. 0018 and 0083-0084***].

In the manner of combining is that **E. Rothenberg**'s routing information that includes multiple link identifiers (IDs) could apparently be implemented into **Dong**'s conventional the path/link information that only a path ID for the next hop IP address for forwarding.

Therefore, it would have been obvious to one having ordinary skill in the art at the time of the claimed invention was made to provide that the path or routing information includes a plurality of link identifiers and identifying the output interface using the link ID as taught by **Dong** to have incorporated in the system of **E. Rothenberg**, so that it would not only provide a virtual link or physical link to be defined from multiple single links allowing a more efficient way of describing delivery trees in the network but also support more efficient and powerful forwarding schemes by providing finer control over false positives. ***E. Rothenberg: Para. [0107] and [0144].***

Regarding claim 17; **Dong** discloses the packet forwarding node wherein the storage unit stores the table (***See Figs. 3 and 4; the routing tables with stored path IDs; Col. 5, Lines 55-60***) used for forwarding the packet based on the identifier (***See Fig. 6; steps 82-90, assigning the path ID for each path in the path groups and using the path ID for the next hop IP address; Col. 6, Lines 21-26***) which uniquely identifies the link (***See Fig. 6: at step 82 to assign or identify the path ID; Col. 6, Lines 18-25***) within a predetermined domain (***See Figs. 2 and 4; Col. 1, Lines 50-54***).

Regarding claim 18; **Dong** in view of **E. Rothenberg** discloses the packet forwarding node wherein the storage unit stores the table (**Dong**: ***See Figs. 2 and 3: the Memory 22 for storing the path IDs and the memory to store Path ID's tables; Col. 2, Lines 40-43*** and ***Col. 5, Lines 55-65***) used for forwarding the packet based on the identifier (**Dong**: ***See Fig. 6; steps 82-90, assigning the path ID for each path in the path groups and using the path ID for the next hop IP address; Col. 6, Lines 21-26***) which uniquely identifies the link (**Dong**: ***See Fig. 6: at step 82 to assign or identify the path ID; Col. 6, Lines 18-25***) within a predetermined local domain (***See Figs. 2 and 4; Col. 1, Lines 50-54 and see also Fig. 1 for internally/locally managed IP identifiers***) and (***E. Rothenberg: See Fig. 9; for inter-domain links; Para. [0185]***)

Regarding claim 19; **Dong** discloses the packet forwarding node wherein the storage unit stores the table (***See Figs. 2 and 3: the Memory 22 for storing the path IDs and the memory to store Path ID's tables; Col. 2, Lines 40-43*** and ***Col. 5, Lines 55-65***) used for forwarding the packet based on the identifier (***See Fig. 6; steps 82-90, assigning the path ID for each path in the path groups and using the path ID for the next hop IP address; Col. 6, Lines 21-26***) which uniquely identifies the link (***See Fig. 6: at step 82 to assign or identify the path ID; Col. 6, Lines 18-25***) within the packet forwarding node (***See Fig. 6; at step 90; assigning the path ID within the path group of the router and see also Fig. 1 for internally/locally managed IP identifiers within a router***).

Regarding claim 20; **Dong** in view of **E. Rothenberg** discloses the packet forwarding node wherein the storage unit stores the table (**Dong**: ***See Figs. 2 and 3: the Memory 22 for storing***

the path IDs and the memory to store Path ID's tables; Col. 2, Lines 40-43 and ***Col. 5, Lines 55-65***) used for forwarding the packet based on the identifier (**Dong**: ***See Fig. 6; steps 82-90, assigning the path ID for each path in the path groups and using the path ID for the next hop IP address; Col. 6, Lines 21-26***) which uniquely identifies the link (**Dong**: ***See Fig. 6: at step 82 to assign or identify the path ID; Col. 6, Lines 18-25***) among the packet forwarding nodes (***E. Rothenberg: See Fig. 9: among the source and destination nodes; Para. [0084]***).

Regarding claim 21; **Dong** discloses a packet forwarding node (***See Fig. 1; Router(s) 38-42***), comprising:

a memory storing a computer program;

one processor configured to execute the computer program to provide:

a first unit (***See Fig. 2: the processing unit 20***) configured to determine an identifier (***See Fig. 6; steps 82-90, assigning the path ID for each path in the path groups and using the path ID for the next hop IP address; Col. 6, Lines 21-26***), each of which identifies a link (***See Figs. 1 and 3; See Figs. 1 and 3; determining the IP path or link ID; Col. 5, Lines 26-30***) between nodes on a packet forwarding path (***See Fig. 1; routing between Edge Routers, such as 38, 40 and 42, using IP path or IP address; Col. 5, Lines 26-32***) ; and

a second unit (***See Fig. 2: the hardware forwarding engine 29; Col. 4, Lines 30-34***) for configured to send information elements to a packet forwarding node (***See Figs. 1 and 2: a router with a hardware forwarding engine 29; Col. 4, Lines 30-34***) which is capable of forwarding an incoming packet (***See Fig. 6; at step 80, receiving the path information or packet; Col. 6, Lines 18-24***) by using a link that corresponds to the identifier among the plurality of the identifiers (***See Fig. 6;***

steps 82-90, assigning the path/link ID for each path in the path groups and using the path ID for the next hop IP address; Col. 6, Lines 21-26).

Even though, **Dong** discloses receiving the path information to assign the path ID for the path group and next hop IP address for forwarding, **Dong** doesn't explicitly discuss the receiving path information/packet includes multiple path identifiers.

However, **E. Rothenberg** from the same field of endeavor teaches the path or routing information includes a plurality of link identifiers (***See Fig. 5 and 6; the routing information comprises a plurality of identifiers, each identifying a respective network link or node; Para. [0018]***).

[***For example, E. Rothenberg's is invention is from the same field of endeavor because it originally discusses routing and forwarding the data packet based upon identifying network link and link identifier in a label switching network. The invention further discusses identifying and encoding the link identifiers and putting into the packet header, and then the identified path is chosen through the network from a source node to a destination node. Para. 0018 and 0083-0084***].

In the manner of combining is that **E. Rothenberg**'s routing information that includes multiple link identifiers (IDs) could apparently be implemented into **Dong**'s conventional the path/link information that only a path ID for the next hop IP address for forwarding.

Therefore, it would have been obvious to one having ordinary skill in the art at the time of the claimed invention was made to provide that the path or routing information includes a plurality of link identifiers as taught by **Dong** to have incorporated in the system of **E. Rothenberg**, so that it would not only provide a virtual link or physical link to be defined from multiple single links (where a single "link" directly links two network nodes), allowing a more efficient way of describing delivery trees in the network but also support more efficient and

powerful forwarding schemes by providing finer control over false positives. ***E. Rothenberg: Para. [0107] and [0144].***

[*Examiner's node: the term "capable of" is not a positively cited term. An alternative term is "configured to" or a positive action verb to perform the function without any unnecessary ambiguity. See MPEP 2111.04.*]

Regarding claim 22; **Dong** in view of **E. Rothenberg** discloses the packet forwarding node wherein the storage unit stores the table used for forwarding the packet based on the identifier which identifies a link between adjacent nodes on a packet forwarding path.

Regarding claim 23; **Dong** in view of **E. Rothenberg** discloses the packet forwarding node, wherein the storage unit stores the packet forwarding table (**Dong**: ***See Figs. 2 and 3: the Memory 22 for storing the path IDs and the memory to store Path ID's tables; Col. 2, Lines 40-43*** and ***Col. 5, Lines 55-65***) used for forwarding the packet based on the identifier (**Dong**: ***See Fig. 6; steps 82-90, assigning the path ID for each path in the path groups and using the path ID for the next hop IP address; Col. 6, Lines 21-26***) which identifies a link (**Dong**: ***See Fig. 6: at step 82 to assign or identify the path ID; Col. 6, Lines 18-25***) between adjacent nodes on a packet forwarding path (***See Fig. 1: between the adjacent nodes 38 and 40 using the Path ID 1; Col. 5, Lines 18-25***) and (***E. Rothenberg: See Fig. 5: between adjacent nodes R1 and R2 using the path ID; Para. [0100]***).

Regarding claim 24; **Dong** in view of **E. Rothenberg** discloses the packet forwarding node further comprising a storage unit that stores the packet forwarding table (**Dong**: ***See Figs. 2 and 3: the Memory 22 for storing the path IDs and the memory to store Path ID's tables; Col. 2, Lines 40-***

43 and ***Col. 5, Lines 55-65***) used for forwarding the packet based on the identifier (**Dong**: ***See Fig. 6; steps 82-90, assigning the path ID for each path in the path groups and using the path ID for the next hop IP address; Col. 6, Lines 21-26***) which identifies a link (**Dong**: ***See Fig. 6: at step 82 to assign or identify the path ID; Col. 6, Lines 18-25***) between adjacent nodes on a packet forwarding path (***See Fig. 1: between the adjacent nodes 38 and 40 using the Path ID 1; Col. 5, Lines 18-25***) and (***E. Rothenberg: See Fig. 5: between adjacent nodes R1 and R2 using the path ID; Para. [0100]***).

Regarding claim 25; **Dong** in view of **E. Rothenberg** discloses the packet forwarding node further comprising a storage unit that stores the packet forwarding table (**Dong**: ***See Figs. 2 and 3: the Memory 22 for storing the path IDs and the memory to store Path ID's tables; Col. 2, Lines 40-43*** and ***Col. 5, Lines 55-65***) used for forwarding the packet based on the identifier (**Dong**: ***See Fig. 6; steps 82-90, assigning the path ID for each path in the path groups and using the path ID for the next hop IP address; Col. 6, Lines 21-26***) which identifies a link (**Dong**: ***See Fig. 6: at step 82 to assign or identify the path ID; Col. 6, Lines 18-25***) between adjacent nodes on a packet forwarding path (***See Fig. 1: between the adjacent nodes 38 and 40 using the Path ID 1; Col. 5, Lines 18-25***) and (***E. Rothenberg: See Fig. 5: between adjacent nodes R1 and R2 using the path ID; Para. [0100]***).

Regarding claim 26; **Dong** in view of **E. Rothenberg** discloses the server further comprising a storage unit to store a packet forwarding table (**Dong**: ***See Figs. 2 and 3: the Memory 22 for storing the path IDs and the memory to store Path ID's tables; Col. 2, Lines 40-43*** and ***Col. 5, Lines 55-65***) used for forwarding the incoming packet based on the identifier (**Dong**: ***See Fig. 6; steps 82-90, assigning the path ID for each path in the path groups and using the path ID for the next hop IP address; Col. 6, Lines 21-26***) which identifies the link (**Dong**: ***See Fig. 6: at step 82 to assign***

or identify the path ID; Col. 6, Lines 18-25) between nodes on the packet forwarding path (***See Fig. 1; routing between Edge Routers, such as 38, 40 and 42, using IP path or IP address; Col. 5, Lines 26-32***), wherein the storage unit stores the table used for forwarding the packet (***See Fig. 2: the Memory 22 for storing the path IDs; Col. 2, Lines 40-43***) based on the identifier which identifies a link (**Dong**: ***See Fig. 6: at step 82 to assign or identify the path ID; Col. 6, Lines 18-25***) between adjacent nodes on a packet forwarding path (***See Fig. 1: between the adjacent nodes 38 and 40 using the Path ID 1; Col. 5, Lines 18-25***) and (***E. Rothenberg: See Fig. 5: between adjacent nodes R1 and R2 using the path ID; Para. [0100]***).

Regarding claim 29; **Dong** in view of **E. Rothenberg** the packet forwarding node wherein when the forwarding unit receives the incoming packet (**Dong**: ***See Fig. 6; at step 80, receiving the information packet; Col. 6, Lines 17-24***) including the identifier for the link (**Dong**: ***See Fig. 6; steps 80-90, the received path information to assign a path ID for the next-hop IP address; Col. 6, Lines 18-25***) connecting nodes on the packet forwarding path (**Dong**: ***See Fig. 6; steps 82-90, assigning the path ID for each path in the path groups and using the path ID for the next hop IP address; Col. 6, Lines 21-26***), the forwarding unit forwards the incoming packet based on the identifier included the received incoming packet (***See Fig. 6; steps 82-90, assigning the path/link ID for each path in the path groups and using the path ID for the next hop IP address; Col. 6, Lines 21-26***) from among the plurality of the identifiers (**Rothenberg**: ***See Fig. 5 and 6; the routing information comprises a plurality of identifiers, each identifying a respective network link or node; Para. [0018]***).

Response to Arguments

9. As per Applicant's amendment filed on 02/22/2017, the applicant has amended all the independent claims. Therefore, the claims have been fully considered but are moot because the arguments do not apply to any of the references being used in the current rejection.

Conclusion

10. Applicant's amendment necessitated the new ground of rejection presented in this Office action.

Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to SAI AUNG whose telephone number is (571)272-3507. The examiner can normally be reached on Monday-Friday, Alt Fridays, 7:30 AM- 5:00 PM (EST).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, PHAM CHI can be reached on 571-272-3179. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/SAI AUNG/

Examiner, Art Unit 2416

Examiner-Initiated Interview Summary	Application No.	Applicant(s)	
	14/244,701	AWANO, JUN	
	Examiner	Art Unit	
	SAI AUNG	2416	

All participants (applicant, applicant's representative, PTO personnel):

(1) *SAI AUNG*. (3)_____.

(2) *Sam Sahota Reg. 47,051*. (4)_____.

Date of Interview: *24 April 2017*.

Type: ☒ Telephonic ☐ Video Conference
☐ Personal [copy given to: ☐ applicant ☐ applicant's representative]

Exhibit shown or demonstration conducted: ☐ Yes ☐ No.
If Yes, brief description: _____.

Issues Discussed ☐101 ☐112 ☐102 ☒103 ☐Others
(For each of the checked box(es) above, please describe below the issue and detailed description of the discussion)

Claim(s) discussed: *1-26*.

Identification of prior art discussed: _____.

Substance of Interview
(For each issue discussed, provide a detailed description and indicate if agreement was reached. Some topics may include: identification or clarification of a reference or a portion thereof, claim interpretation, proposed amendments, arguments of any applied references etc...)

During the interview, the examiner discussed with the applicant especially for the independent claims 1, 6, 11, 16 and 21. The examiner proposed the claim amendments using the limitations from the applicant's figures 10 and 11 to overcome the current prior art rejections. The applicant responded to review the examiner's proposed amendment. No further agreement was reached..

Applicant recordation instructions: It is not necessary for applicant to provide a separate record of the substance of interview.

Examiner recordation instructions: Examiners must summarize the substance of any interview of record. A complete and proper recordation of the substance of an interview should include the items listed in MPEP 713.04 for complete and proper recordation including the identification of the general thrust of each argument or issue discussed, a general indication of any other pertinent matters discussed regarding patentability and the general results or outcome of the interview, to include an indication as to whether or not agreement was reached on the issues raised.

☐ Attachment

/SAI AUNG/ Examiner, Art Unit 2416	

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14244701	AWANO, JUN
	Examiner	Art Unit
	SAI AUNG	2475

CPC- SEARCHED		
Symbol	Date	Examiner
H04L45/04; H04L45/24; H04L45/66; H04L45/00;	11/16/2016	SA

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
370	370/401; 370/392; 370/231; 370/252; 370/352; 370/395.53	3/1/2016	SA

SEARCH NOTES		
Search Notes	Date	Examiner
EAST SEARCH (INCLUDING INVENTORS AND ASSIGNEE SEARCH)	5/22/2017	SA
GOOGLE PATENTS SEARCH	5/22/2017	SA
OTHER RELATED CPC SEARCH: H04L45/302; H04L45/50; H04L49/351	5/22/2017	SA

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner

/SAI AUNG/ Examiner.Art Unit 2416	

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14244701	AWANO, JUN
	Examiner	Art Unit
	SAI AUNG	2475

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	12/12/2014	04/13/2015	10/28/2015	03/01/2016	11/18/2016	05/22/2017			
	1	✓	✓	✓	✓	✓	✓			
	2	✓	✓	✓	✓	✓	✓			
	3	✓	✓	✓	✓	✓	✓			
	4	✓	✓	✓	✓	✓	✓			
	5	✓	✓	✓	✓	✓	✓			
	6	✓	✓	✓	✓	✓	✓			
	7	✓	✓	✓	✓	✓	✓			
	8	✓	✓	✓	✓	✓	✓			
	9	✓	✓	✓	✓	✓	✓			
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	25			✓	✓	✓	✓			
	26			✓	✓	✓	✓			
	27				✓	✓	-			
	28				✓	✓	-			
	29						✓			

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S317	41	(liqin near2 dong, Milton near2 xu).in.	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/16 17:48
S318	10	(link and mpls and rout$4 and forward$4 and table) and S317	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/16 17:48
S319	22	(link and rout$4 and forward$4 and table) and S317	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/16 17:49
S320	6	@ad<="20090914" and S319	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/11/16 17:50
S321	2702	(path link channel) same (ID identif$4) same (rout$4 forward$4) same (mpls)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/11/16 18:14
S322	6	(@ad<="20090914" or @pd<="20080914") and S319	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/11/16 18:16
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S324	1005	((source destination) with address) and S323	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/16 18:17
S325	58985	(virtu$4 or logical or physical) same (link path channel) same (ID identifier)	US-PGPUB; USPAT	OR	ON	2016/11/16 18:17
S326	397	S324 and S325	US-PGPUB; USPAT	OR	ON	2016/11/16 18:18
S327	74355	(virtu$4 or logical or physical) same (link path channel) same (ID identifier)	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/16 18:18
S328	399	S324 and S327	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/16 18:18
S329	399	S324 and S327	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/16 18:18
S330	218	(stor$4 storage) with (table) and S329	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/16 18:18
S331	162	(path with information) and S330	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/16 18:20
S332	3	("7496096").PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/11/21 11:03
S333	2	("20110149973").PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/11/21 11:04
S334	2703	(path link channel) same (ID identif$4) same (rout$4 forward$4) same (mpls)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/11/21 11:04
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S336	1005	((source destination) with address) and S335	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/21 11:04
S337	74449	(virtu$4 or logical or physical) same (link path channel) same (ID identifier)	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/21 11:04
S338	399	S336 and S337	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/21 11:04
S339	218	(stor$4 storage) with (table) and S338	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/21 11:04

S340	162	(path with information) and S339	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/21 11:04
S341	131	(path link) near10 (ID identifier Identify$4) and S340	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/21 11:04
S342	2	("20020176363").PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/11/21 11:06
S343	131	(path link) near10 (ID identifier Identify$4) and S340	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/21 11:06
S344	2824	(path link channel) same (ID identif$4) same (rout$4 forward$4) same (mpls)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/05/22 13:57
S345	1549	(@ad<="20090914" or @pd<="20080914") and S344	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/05/22 13:57
S346	1006	((source destination) with address) and S345	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2017/05/22 13:57
S347	78023	(virtu$4 or logical or physical) same (link path channel) same (ID identifier)	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2017/05/22 13:57
S348	400	S346 and S347	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2017/05/22 13:57
S349	218	(stor$4 storage) with (table) and S348	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2017/05/22 13:57
S350	162	(path with information) and S349	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2017/05/22 13:57
S351	131	(path link) near10 (ID identifier Identify$4) and S350	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2017/05/22 13:57
S352	898	jean near2 vasseur.in.	US-PGPUB; USPAT; USOCR	OR	ON	2017/05/22 13:57
S353	79638	((virtu$4 logical pseudo$5) same (physical)) with (link connection path channel)	US-PGPUB; USPAT	OR	ON	2017/05/22 13:57
S354	116	S352 and S353	US-PGPUB; USPAT	OR	ON	2017/05/22 13:57
S355	54	@pd<="20110705" and S354	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2017/05/22 13:57
S356	447421	(source destination) with (node station)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/05/22 13:57
S357	408034	(virtu$4 logical pseudo) same (physical)	US-PGPUB; USPAT	OR	ON	2017/05/22 13:57
S358	39552	S356 and S357	US-PGPUB; USPAT	OR	ON	2017/05/22 13:57
S359	48757	370/229-235,251-254,230-236.ccls.	US-PGPUB; USPAT	OR	ON	2017/05/22 13:57
S360	2944	S359 and S358	US-PGPUB; USPAT	OR	ON	2017/05/22 13:57
S361	79558	((virtu$4 logical pseudo) same (physical)) with (link connection path channel)	US-PGPUB; USPAT	OR	ON	2017/05/22 13:57
S362	1105	(redundant redundan$3) and S360	US-PGPUB; USPAT	OR	ON	2017/05/22 13:57
S363	2164	((source destination) with (node station)) with (redundant redundan$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/05/22 13:57
S364	20	S362 and S363 and S361	US-PGPUB; USPAT	OR	ON	2017/05/22 13:57
S365	19	@ad<="20110705" and S364	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2017/05/22 13:57

EAST Search History (Interference)

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5/25/2017 10:27:42 AM
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DELL - Exhibit 1002 - Page 743

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NEG-1440PCT-US2CT
KATO.327CONT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of Jun Awano

Serial No.: 14/244,701 Group Art Unit: 2475

Filed: April 3, 2014 Examiner: AUNG, SAI

For: COMMUNICATION SYSTEM, FORWARDING NODE, PATH MANAGEMENT SERVER, COMMUNICATION METHOD, AND PROGRAM

Honorable Commissioner of Patents
Alexandria, VA 22313-1450

STATEMENT OF SUBSTANCE OF INTERVIEW

Applicants provide the following statement of the substance of an interview for completion of the written record. See 37 C.F.R. §1.2, 37 C.F.R. §1.133, and MPEP §713.04

Applicants gratefully acknowledges Examiner Aung for courtesies extended during the Examiner interview, for taking time from his busy schedule to an interview on July 25, 2017 and electronic mail correspondence on July 27 and 28, 2017.

Proposed claim amendments were discussed. It was agreed that the proposed amendment appear to overcome the cited and may be allowable, pending a further search and consideration. The Examiner indicated that the amendment can be filed under the after final pilot program AFCP 2.0.

Applicants thank Examiner Aung for being very helpful in expediting the prosecution of the present Application.

14/244,701
NEG-1440PCT-US2CT
KATO.327CONT

Respectfully Submitted,

Date: July 28, 2017

S. S. Sahota, Esq.
Registration No. 47,051

Sean M. McGinn, Esq.
Registration No. 34,386

MCGINN INTELLECTUAL PROPERTY LAW GROUP, PLLC
8321 Old Courthouse Road, Suite 200
Vienna, VA 22182-3817
(703) 761-4100
Customer No. 21254

Electronic Acknowledgement Receipt

EFS ID:	29925239
Application Number:	14244701
International Application Number:	
Confirmation Number:	2010
Title of Invention:	Communication system, forwarding node, path management server, communication method, and program
First Named Inventor/Applicant Name:	JUN AWANO
Customer Number:	21254
Filer:	Saryadvinder S. Sahota/Amber Carroll
Filer Authorized By:	Saryadvinder S. Sahota
Attorney Docket Number:	NEG-1440PCT-US2CT
Receipt Date:	28-JUL-2017
Filing Date:	03-APR-2014
Time Stamp:	17:03:31
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Applicant summary of interview with examiner	701_SSI.pdf	56270 c3f5799e74ea496f42b540bd8461eb92d6afd7f6	no	2

Warnings:

Information:	
Total Files Size (in bytes):	56270

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Doc Code: A.NE.AFCP
Document Description: After Final Consideration Pilot Program Request

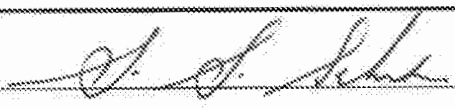
PTO/SB/434 (05-13)

CERTIFICATION AND REQUEST FOR CONSIDERATION UNDER THE AFTER FINAL CONSIDERATION PILOT PROGRAM 2.0

Practitioner Docket No.:	Application No.:	Filing Date:
NEG-1440PCT-US2CT	14/244,701	April 3, 2014
First Named Inventor:	**Title:**	
JUN AWANO	Communication system, forwarding node, path management server, communication method, and program	

APPLICANT HEREBY CERTIFIES THE FOLLOWING AND REQUESTS CONSIDERATION UNDER THE AFTER FINAL CONSIDERATION PILOT PROGRAM 2.0 (AFCP 2.0) OF THE ACCOMPANYING RESPONSE UNDER 37 CFR 1.116.

1. The above-identified application is (i) an original utility, plant, or design nonprovisional application filed under 35 U.S.C. 111(a) (a continuing application (*e.g.*, a continuation or divisional application) is filed under 35 U.S.C. 111(a) and is eligible under (i)), or (ii) an international application that has entered the national stage in compliance with 35 U.S.C. 371(c).
2. The above-identified application contains an outstanding final rejection.
3. Submitted herewith is a response under 37 CFR 1.116 to the outstanding final rejection. The response includes an amendment to at least one independent claim, and the amendment does not broaden the scope of the independent claim in any aspect.
4. This certification and request for consideration under AFCP 2.0 is the only AFCP 2.0 certification and request filed in response to the outstanding final rejection.
5. Applicant is willing and available to participate in any interview requested by the examiner concerning the present response.
6. This certification and request is being filed electronically using the Office's electronic filing system (EFS-Web).
7. Any fees that would be necessary consistent with current practice concerning responses after final rejection under 37 CFR 1.116, *e.g.*, extension of time fees, are being concurrently filed herewith. [There is no additional fee required to request consideration under AFCP 2.0.]
8. By filing this certification and request, applicant acknowledges the following:
   - Reissue applications and reexamination proceedings are not eligible to participate in AFCP 2.0.
   - The examiner will verify that the AFCP 2.0 submission is compliant, *i.e.*, that the requirements of the program have been met (see items 1 to 7 above). For compliant submissions:
     - The examiner will review the response under 37 CFR 1.116 to determine if additional search and/or consideration (i) is necessitated by the amendment and (ii) could be completed within the time allotted under AFCP 2.0. If additional search and/or consideration is required but cannot be completed within the allotted time, the examiner will process the submission consistent with current practice concerning responses after final rejection under 37 CFR 1.116, *e.g.*, by mailing an advisory action.
     - If the examiner determines that the amendment does not necessitate additional search and/or consideration, or if the examiner determines that additional search and/or consideration is required and could be completed within the allotted time, then the examiner will consider whether the amendment places the application in condition for allowance (after completing the additional search and/or consideration, if required). If the examiner determines that the amendment does not place the application in condition for allowance, then the examiner will contact the applicant and request an interview.
       - The interview will be conducted by the examiner, and if the examiner does not have negotiation authority, a primary examiner and/or supervisory patent examiner will also participate.
       - If the applicant declines the interview, or if the interview cannot be scheduled within ten (10) calendar days from the date that the examiner first contacts the applicant, then the examiner will proceed consistent with current practice concerning responses after final rejection under 37 CFR 1.116.

Signature	Date
	August 31, 2017
Name (Print/Typed) S. S. Sahota	**Practitioner Registration No.** 47,051

Note: *This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. Submit multiple forms if more than one signature is required, see below*.*

☐ * Total of _____ forms are submitted.

14/244,701
NEG-1440PCT-US2CT
KATO.327CONT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of Jun Awano

Serial No.: 14/244,701 Group Art Unit: 2475

Filed: April 3, 2014 Examiner: AUNG, SAI

For: COMMUNICATION SYSTEM, FORWARDING NODE, PATH MANAGEMENT SERVER, COMMUNICATION METHOD, AND PROGRAM

Honorable Commissioner of Patents
Alexandria, VA 22313-1450
MAIL STOP AF

AMENDMENT UNDER 37 C.F.R. §1.116 with REQUEST FOR CONSIDERATION UNDER THE AFTER FINAL CONSIDERATION PILOT PROGRAM 2.0

Sir:

In response to Office Action dated **May 31, 2017**, please amend the above identified application as follows:

INTRODUCTORY COMMENTS

Amendments to the Claims begin on page 2 of this paper. The amendments to the claims do not add new matter.

Remarks begin on page 9 of this paper.

AMENDMENTS TO THE CLAIMS

Please amend the claims as follows:

1. (Currently Amended) A packet forwarding node, comprising:

a storage unit including a non-transitory computer readable medium configured to store a packet forwarding table used for forwarding a packet based on an identifier which identifies a link between nodes on a packet forwarding path; and

at least one processor configured to execute program instructions to provide a forwarding unit configured to:

receive an incoming packet including a plurality of the identifiers~~;, and~~

determine a direction to forward the incoming packet;

determine whether to forward to an external network;

add the number of bytes to path/link information when the incoming packet is not forwarded to the external network;

remove path/link information header when the incoming packet is forwarded to the external network; and

forward the incoming packet by using a path/link that corresponds to the identifier from among the plurality of the identifiers.

2. (Original) The packet forwarding node according to claim 1, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link within a predetermined domain.

3. (Original) The packet forwarding node according to claim 1, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely

identifies the link within a predetermined local domain.

4. (Original) The packet forwarding node according to claim 1, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link within the packet forwarding node.

5. (Original) The packet forwarding node according to claim 1, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link among the packet forwarding nodes.

6. (Currently Amended) A packet forwarding node, comprising:

a storage unit including a non-transitory computer readable medium configured to store a packet forwarding table used for forwarding a packet based on an identifier which identifies an interface of a packet forwarding node; and

at least one processor configured to execute program instructions to provide a forwarding unit configured to receive an incoming packet including a plurality of identifiers, determine a direction to forward the incoming packet, determine whether to forward to an external network, add the number of bytes to path/link information when the incoming packet is not forwarded to the external network, remove path/link information header when the incoming packet is forwarded to the external network, and to forward the incoming packet by using a path/link that corresponds to the identifier from among the plurality of identifiers.

7. (Currently Amended) The packet forwarding node according to claim 6, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies [[a]] the link within a predetermined domain.

8. (Currently Amended) The packet forwarding node according to claim 6, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies [[a]] the link within a predetermined local domain.

9. (Currently Amended) The packet forwarding node according to claim 6, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies [[a]] the link within the packet forwarding node.

10. (Currently Amended) The packet forwarding node according to claim 6, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies [[a]] the link among the packet forwarding nodes.

11. (Currently Amended) A packet forwarding node, comprising:

a memory storing a program;

at least one processor configured to execute the program to provide:

a communication unit configured to communicate with a server for receiving a plurality of identifiers, each of which identifies a link between nodes on a packet forwarding path; and

a forwarding unit configured to:

receive an incoming packet including the plurality of the identifiers,

determine a direction to forward the incoming packet,

determine whether to forward to an external network,

add the number of bytes to path/link information when the incoming packet is not forwarded to the external network.

remove path/link information header when the incoming packet is forwarded to the external network, and

forward [[an]] the incoming packet by using a path/link that corresponds to an identifier from among the plurality of identifiers.

12. (Currently Amended) The packet forwarding node according to claim 11, wherein the forwarding unit forwards the packet based on the identifier which uniquely identifies [[a]] the link within a predetermined domain.

13. (Previously Presented) The packet forwarding node according to claim 11, wherein the forwarding unit forwards the packet based on the identifier which uniquely identifies the link within a predetermined local domain.

14. (Previously Presented) The packet forwarding node according to claim 11, wherein the forwarding unit forwards the packet based on the identifier which uniquely identifies the link within the packet forwarding node.

15. (Previously Presented) The packet forwarding node according to claim 11, wherein the forwarding unit forwards the packet based on the identifier which uniquely identifies the link among the packet forwarding nodes.

16. (Currently Amended) A packet forwarding node, comprising:

a communication unit configured to communicate with a server for receiving a plurality of identifiers, each of which identifies an interface of the packet forwarding node; and

at least one processor configured to execute program instructions to provide a forwarding unit configured to receive an incoming packet including a plurality of identifiers, determine a direction to forward the incoming packet, determine whether to forward to an external network, add the number of bytes to path/link information when the incoming packet is not forwarded to the external network, remove path/link information header when the incoming packet is forwarded to the external network, and forward [[an]] the incoming packet by using a path/link that corresponds to an identifier from among the plurality of identifiers.

17. (Currently Amended) The packet forwarding node according to claim 16, wherein the forwarding unit forwards the packet based on the identifier which uniquely identifies [[a]] the link within a predetermined domain.

18. (Currently Amended) The packet forwarding node according to claim 16, wherein the forwarding unit forwards the packet based on the identifier which uniquely identifies [[a]] the link within a predetermined local domain.

19. (Currently Amended) The packet forwarding node according to claim 16, wherein the forwarding unit forwards the packet based on the identifier which uniquely identifies [[a]] the link within the packet forwarding node.

20. (Currently Amended) The packet forwarding node according to claim 16, wherein the forwarding unit forwards the packet based on the identifier which uniquely identifies [[a]] the link among the packet forwarding nodes.

21. (Currently Amended) A server, comprising:

a memory storing a computer program;

at least one processor configured to execute the computer program to provide:

a first unit configured to determine a plurality of identifiers, each of which identifies a link between nodes on a packet forwarding path; and

a second unit configured send information elements to a packet forwarding node which is capable of receiving an incoming packet including a plurality of identifiers, determining a direction to forward the incoming packet, determining whether to forward to an external network, adding the number of bytes to path/link information when the incoming packet is not forwarded to the external network, removing path/link information header when the incoming packet is forwarded to the external network, and forwarding [[an]] the incoming packet by using a path/link that corresponds to an identifier from among the plurality of identifiers.

22. (Currently Amended) The packet forwarding node according to claim 1, wherein the storage unit stores the table used for forwarding the packet based on the identifier which identifies [[a]] the link between adjacent nodes on a packet forwarding path.

23. (Currently Amended) The packet forwarding node according to claim 6, wherein the storage unit stores the packet forwarding table used for forwarding the packet based on the identifier which identifies [[a]] the link between adjacent nodes on a packet forwarding path.

24. (Currently Amended) The packet forwarding node according to claim 11, further comprising a storage unit that stores a table used for forwarding the packet based on an identifier which identifies [[a]] the link between adjacent nodes on a packet forwarding path.

25. (Currently Amended) The packet forwarding node according to claim 16, further comprising a storage unit that stores a table used for forwarding the packet based on an identifier which identifies [[a]] the link between adjacent nodes on a packet forwarding path.

26. (Previously Presented) The server according to claim 21, further comprising a storage unit to store a packet forwarding table used for forwarding the incoming packet based on the identifier which identifies the link between nodes on the packet forwarding path,

wherein the storage unit stores the table used for forwarding the packet based on the identifier which identifies a link between adjacent nodes on a packet forwarding path.

27-28. (Canceled)

29. (Previously Presented) The packet forwarding node according to claim 1, wherein when the forwarding unit receives the incoming packet including the identifier for the link connecting nodes on the packet forwarding path, the forwarding unit forwards the incoming packet based on the identifier included the received incoming packet from among the plurality of the identifiers.

REMARKS

Claims 1-26 and 29 are all of the claims presently pending in the application. Applicant has amended various claims to more particularly define the claimed invention and/or for editorial purposes.

Further, Applicant specifically states that no amendment to any claim herein should be construed as a disclaimer of any interest in or right to an equivalent of any element or feature of the amended claim.

Entry of this Response is believed proper since no new issues are being presented to the Examiner which would require further consideration and/or search under 37 C.F.R. §1.116 in light of the REQUEST FOR CONSIDERATION UNDER THE AFTER FINAL CONSIDERATION PILOT PROGRAM 2.0. The Amendments are made as discussed with the Examiner on the interviews of July 25, 27 and 28, 2017 that are supported by, for example, Fig. 10 and 11. Therefore, no new matter was added.

Claims 1-26 and 29 stand rejected under 35 U.S.C. § 101, because the claimed invention is directed to a judicial exception (i.e, a law of nature, a natural phenomenon, or an abstract idea) without significantly more. Claims 1-26 and 29 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Dong, et al. (U.S. Patent No. 7,496,096 B1) in view of EstevE. Rothenberg, et al. (U.S. Patent Application Publication No. 2011/0149973 A1).

These rejections are respectfully traversed in the following discussion.

I. CLAIM ANALYSIS UNDER 35 USC 112(f)

Applicant appreciates the Examiner's indication on pages 2-3 of the Office Action that claims 1, 6, 11, 6 and 21 do not invoke interpreted under 35 U.S.C. 112(f) or pre-AIA 35 U.S. C. 112, sixth paragraph.

II. THE STATUTORY SUBJECT MATTER REJECTION

Claims 1-26 and 29 are rejected under 35 U.S.C. 101 because the claimed invention is directed to a judicial exception (i.e., a law of nature, a natural phenomenon, or an abstract idea) without significantly more.

While Applicant does not agree with the Examiner, the claims have been amended as suggested by the Examiner. Thus, as indicated in the interviews of July 25, 27 and 28, the discussed amendment should overcome the rejection.

Therefore, this rejection should be removed.

III. THE ALLEGED PRIOR ART REFERENCES

A. The Dong and Rothenberg Reference

Claims 1-26 and 29 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Dong, et al. (U.S. Patent No. 7,496,096 B1) in view of EstevE. Rothenberg, et al. (U.S. Patent Application Publication No. 2011/0149973 A1).

Applicant respectfully traverse as the combination fail to teach or suggest, (e.g., claim 1) "*determine a direction to forward the incoming packet;*

determine whether to forward to an external network;

add the number of bytes to path/link information when the incoming packet is not forwarded to the external network;

remove path/link information header when the incoming packet is forwarded to the external network". The other independent claims 6, 11, 16 and 21 are also not taught or suggested.

The claims have been amended as discussed in the interviews of July 25 and correspondence of July 27 and 28, 2017 where it was agreed that the amendment would

overcome the cite art, and maybe allowable pending a further search and consideration.

Therefore, Applicant submits that, even if combined, the alleged combination of references would not teach or suggest each and every feature of the claimed invention. Therefore, Applicant respectfully requests the Examiner to withdraw this rejection.

IV. FORMAL MATTERS AND CONCLUSION

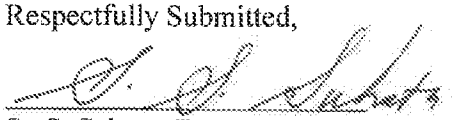
In view of the foregoing, Applicant submits that claims 1-26 and 29, all of the claims presently pending in the application, are patentably distinct over the prior art of record and are in condition for allowance. Applicant respectfully requests the Examiner to pass the above application to issue at the earliest possible time.

Should the Examiner find the application to be other than in condition for allowance, Applicant requests the Examiner to contact the undersigned at the local telephone number listed below to discuss any other changes deemed necessary in a telephonic or personal interview.

The undersigned authorizes the Commissioner to charge any deficiency in fees or to credit any overpayment in fees to Attorney's Deposit Account No. 50-0481.

Respectfully Submitted,

Date: August 31, 2017



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Customer No. 21254

Electronic Acknowledgement Receipt

EFS ID:	30245363
Application Number:	14244701
International Application Number:	
Confirmation Number:	2010
Title of Invention:	Communication system, forwarding node, path management server, communication method, and program
First Named Inventor/Applicant Name:	JUN AWANO
Customer Number:	21254
Filer:	Sean Michael McGinn/Amber Carroll
Filer Authorized By:	Sean Michael McGinn
Attorney Docket Number:	NEG-1440PCT-US2CT
Receipt Date:	31-AUG-2017
Filing Date:	03-APR-2014
Time Stamp:	17:52:52
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	After Final Consideration Program Request	701_AFCP.pdf	91931 129b3f655e5ab2cebef958d8d3f935038368dfc4	no	1

Warnings:

Information:					
2	Response After Final Action	701_Amendment.pdf	425960 6b49c66276f28030f14a3a6aa8aab5b6cd3791a5	no	11
Warnings:					
Information:					
			Total Files Size (in bytes):	517891	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 14/244,701	Filing Date 04/03/2014	☐ To be Mailed

ENTITY: ☒ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED – PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	

APPLICATION AS AMENDED – PART II

AMENDMENT **08/31/2017**

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	* 27	Minus	** 28	= 0	X $80 =	0
Independent (37 CFR 1.16(h))	* 5	Minus	***5	= 0	X $420 =	0
☐ Application Size Fee (37 CFR 1.16(s))						
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
					TOTAL ADD'L FEE	0

AMENDMENT

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	*	Minus	**	=	X $ =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	X $ =	
☐ Application Size Fee (37 CFR 1.16(s))						
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
					TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".

The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

LIE
MYRTLE LEIGH

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

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NOTICE OF ALLOWANCE AND FEE(S) DUE

21254 7590 10/02/2017

MCGINN INTELLECTUAL PROPERTY LAW GROUP, PLLC
8321 OLD COURTHOUSE ROAD
SUITE 200
VIENNA, VA 22182-3817

EXAMINER
AUNG, SAI

ART UNIT	PAPER NUMBER
2416	

DATE MAILED: 10/02/2017

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/244,701	04/03/2014	JUN AWANO	NEG-1440PCT-US2CT	2010

TITLE OF INVENTION: Communication system, forwarding node, path management server, communication method, and program

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$960	$0	$0	$960	01/02/2018

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 1/2 the amount of undiscounted fees, and micro entity fees are 1/2 the amount of small entity fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Maintenance fees are due in utility patents issuing on applications filed on or after Dec. 12, 1980. It is patentee's responsibility to ensure timely payment of maintenance fees when due. More information is available at www.uspto.gov/PatentMaintenanceFees.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

21254 7590 10/02/2017
MCGINN INTELLECTUAL PROPERTY LAW GROUP, PLLC
8321 OLD COURTHOUSE ROAD
SUITE 200
VIENNA, VA 22182-3817

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission
I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/244,701	04/03/2014	JUN AWANO	NEG-1440PCT-US2CT	2010

TITLE OF INVENTION: Communication system, forwarding node, path management server, communication method, and program

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$960	$0	$0	$960	01/02/2018

EXAMINER	ART UNIT	CLASS-SUBCLASS
AUNG, SAI	2416	370-254000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).
- ❑ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
- ❑ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.
1 _____
2 _____
3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ❑ Individual ❑ Corporation or other private group entity ❑ Government

4a. The following fee(s) are submitted:
- ❑ Issue Fee
- ❑ Publication Fee (No small entity discount permitted)
- ❑ Advance Order - # of Copies _____

4b. Payment of Fee(s): **(Please first reapply any previously paid issue fee shown above)**
- ❑ A check is enclosed.
- ❑ Payment by credit card. Form PTO-2038 is attached.
- ❑ The director is hereby authorized to charge the required fee(s), any deficiency, or credits any overpayment, to Deposit Account Number _____ (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)
- ❑ Applicant certifying micro entity status. See 37 CFR 1.29 — NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
- ❑ Applicant asserting small entity status. See 37 CFR 1.27 — NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
- ❑ Applicant changing to regular undiscounted fee status. — NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

PTOL-85 Part B (10-13) Approved for use through 10/31/2013. OMB 0651-0033 U.S. Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

DELL - Exhibit 1002 - Page 764

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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Alexandria, Virginia 22313-1450
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/244,701	04/03/2014	JUN AWANO	NEG-1440PCT-US2CT	2010

21254 7590 10/02/2017

MCGINN INTELLECTUAL PROPERTY LAW GROUP, PLLC
8321 OLD COURTHOUSE ROAD
SUITE 200
VIENNA, VA 22182-3817

EXAMINER	
AUNG, SAI	
ART UNIT	**PAPER NUMBER**
2416	

DATE MAILED: 10/02/2017

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

DELL - Exhibit 1002 - Page 765

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Notice of Allowability	Application No. 14/244,701	Applicant(s) AWANO, JUN	
	Examiner SAI AUNG	Art Unit 2416	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to *08/31/2017*.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on_____.
2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.
3. ☒ The allowed claim(s) is/are *1-26 and 29 (Renumbered claims 1-27 respectively)*. As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.
4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

   Certified copies:

   a) ☐ All b) ☐ Some *c) ☐ None of the:
   1. ☐ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)
2. ☐ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
4. ☐ Interview Summary (PTO-413), Paper No./Mail Date _____ .
5. ☐ Examiner's Amendment/Comment
6. ☒ Examiner's Statement of Reasons for Allowance
7. ☒ Other *PTO 2323*.

/SAI AUNG/
Primary Examiner, Art Unit 2416

DETAILED ACTION

Claims status

1. In the amendment filed on 08/31/2017, Claims 1-26, and 29 are currently pending for the examination. The present application is being examined under the pre-AIA first to invent provisions.

Claim Analysis under 35 U.S.C. § 101

2. 35 U.S.C. 101 reads as follows:

> *Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title.*

3. **With regard to claim 1**, the claim recites "a method" which is statutory category of invention. **[Step 1: Yes].**

The claim is then analyzed to determine if the claim is directed to a judicial exception. The limitations in the claim set forth that describe the abstract are: "*storing a packet forwarding table used for forwarding a packet, receiving an incoming packet, determining a direction to forward the incoming packet and forwarding the incoming packet...*". These steps may recite the abstract idea of storing and comparing the received information with the stored data. See *Relevant Court Case: Obtaining and comparing intangible data (CyberSource and/or SmartGene: 17 see Section IV.B.4).* Therefore, the idea described in this claim is directed to several abstract ideas found by the courts. **[Step 2A: Yes].**

Thus, the claim is further required to analyze the additional elements under *Step 2B.*

The claim elements in addition to the abstract idea recited in the claim further include "*add the number of bytes to path/link information when the incoming packet is not forwarded to the external network; remove oath/link information header when the incoming packet is forwarded to the external network: and forward the incoming packet by using a path/link that corresponds to the identifier from among the plurality of the identifiers*."

Even though some of the claim elements when viewed individually do not amount to significantly more, when identifying the additional elements, and viewed as a whole combination, **result in the claim amounting to significantly more than** the judicial exception by simply using the method of adding the number of bytes to path/link information when the incoming packet is not forwarded to the external network; removing oath/link information header when the incoming packet is forwarded to the external network; and forwarding the incoming packet by using a path/link. [Emphasis Added].

Under *Step 2B,* the claim as a whole being analyzed to determine whether the claim of any element, or combination of elements, is sufficient to ensure the claim amounts to significantly more than the judicial exception itself. **[Step 2B: Yes].** The claim is patent eligible. Claims 1-26 are further analyzed and found patent eligible based upon the same or similar reason as discussed in claim 1.

Examiner's note

4. With respect to claim 1, the claim recites the phrase "*A packet forwarding node, comprising a storage unit..., and coupled with a processor*" to perform the multiple functions. See applicant's figures 2, 5, 6 and 16. Therefore, independent claims 1, 6, 11, 16 and 21 are statutory and definite. 112(f) is not invoked. According to MPEP Section § 2181, storage unit, i.e. memory, for storing and processor for processing are non-specialized structures which function known by those of ordinary skill in the art as being commonly performed by a general purpose computer or computer component. [Emphasis Added].

Allowable Subject Matter

5. After conducting a complete search and consideration, claims 1-26 and 29 are found to be allowable. Claims 1-26 and 29 are considered allowable since no prior art reference alone or combination of prior art references disclose or suggest the combination of limitations specified in the independent claims including:

> *"...adding the number of bytes to path/link information when the incoming packet is not forwarded to the external network; removing oath/link information header when the incoming packet is forwarded to the external network: and forwarding the incoming packet by using a path/link that corresponds to the identifier from among the plurality of the identifiers."* in combination with other claim limitations as specified in claims 1-26 and 29.

In accordance with the Examiner's best judgement, the best prior arts found during prosecution with respect to independent claims 1-26 and 29 fail to, either singularly or in combination, to anticipate or render the claim features obvious, particularly the combination of features of the

independent claims. The references used, fail to singularly or in combination, to anticipate and render obvious the inventive concept identified by the specific claim features of the inventive concept claims. Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Conclusion

6. Any inquiry concerning this communication or earlier communications from the examiner should be directed to SAI AUNG whose telephone number is (571)272-3507. The examiner can normally be reached on Monday-Friday, Alt Fridays, 7:30 AM- 5:00 PM (EST).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Noel Beharry can be reached on 571-270-5630. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300. Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/SAI AUNG/

Primary Examiner, Art Unit 2416

AFCP 2.0 Decision	Application No.	Applicant(s)
	14/244,701	AWANO, JUN
	Examiner	Art Unit
	SAI AUNG	2416

This is in response to the After Final Consideration Pilot request filed 08/31/2017.

1. **Improper Request** – The AFCP 2.0 request is improper for the following reason(s) and the after final amendment submitted with the request will be treated under pre-pilot procedure.

   ☐ An AFCP 2.0 request form PTO/SB/434 (or equivalent document) was not submitted.

   ☐ A non-broadening amendment to at least one independent claim was not submitted.

   ☐ A proper AFCP 2.0 request was submitted in response to the most recent final rejection.

   ☐ Other:

2. **Proper Request**

   A. After final amendment submitted with the request will not be treated under AFCP 2.0.
   The after final amendment cannot be reviewed and a search conducted within the guidelines of the pilot program.

   ☐ The after final amendment will be treated under pre-pilot procedure.

   B. Updated search and/or completed additional consideration.
   The examiner performed an updated search and/or completed additional consideration of the after final amendment within the time authorized for the pilot program. The result(s) of the updated search and/or completed additional consideration are:

   ☒ 1. All of the rejections in the most recent final Office action are overcome and a Notice of Allowance is issued herewith.

   ☐ 2. The after final amendment would not overcome all of the rejections in the most recent final Office action. See attached interview summary for further details.

   ☐ 3. The after final amendment was reviewed, and it raises a new issue(s). See attached interview summary for further details.

   ☐ 4. The after final amendment raises new issues, but would overcome all of the rejections in the most recent final Office action. A decision on determining allowability could not be made within the guidelines of the pilot. See attached interview summary for further details, including any newly discovered prior art.

   ☐ 5. Other:

   Examiner Note: Please attach an interview summary when necessary as described above.

See Allowability Notice for more detail.

DELL - Exhibit 1002 - Page 774

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14244701	AWANO, JUN
	Examiner	**Art Unit**
	SAI AUNG	2416

CPC								
Symbol							**Type**	**Version**
H04L		45	/	745			F	2013-01-01
H04L		45	/	34			I	2013-01-01
H04L		45	/	42			A	2013-01-01
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CPC Combination Sets								
Symbol					**Type**	**Set**	**Ranking**	**Version**
			/					
			/					

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	27	
/SAI AUNG/ Primary Examiner.Art Unit 2416	09/22/2017	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	10

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14244701	AWANO, JUN
	Examiner	**Art Unit**
	SAI AUNG	2416

US ORIGINAL CLASSIFICATION		INTERNATIONAL CLASSIFICATION										
CLASS	SUBCLASS	CLAIMED					NON-CLAIMED					
370	254	H	0	4	L	12 / 741 (2013.01.01)						

CROSS REFERENCE(S)					
CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)				

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	27	
/SAI AUNG/ Primary Examiner.Art Unit 2416	09/22/2017	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	10

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14244701	AWANO, JUN
	Examiner	**Art Unit**
	SAI AUNG	2416

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
1	1	17	17												
2	2	18	18												
3	3	19	19												
4	4	20	20												
5	5	21	21												
6	6	22	22												
7	7	23	23												
8	8	24	24												
9	9	25	25												
10	10	26	26												
11	11	-	27												
12	12	-	28												
13	13	27	29												
14	14														
15	15														
16	16														

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	27	
/SAI AUNG/ Primary Examiner.Art Unit 2416	09/22/2017	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	10

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L11	8	(packet and identifier and path and link and external and header and remov$4).clm.	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2017/09/22 00:09
S1	46007	370/389,473,474,352-356,349,310.2,328,338,312.ccls.	US-PGPUB; USPAT	OR	ON	2012/06/19 19:15
S2	17081	370/218-225,401,237,238.ccls.	US-PGPUB; USPAT	OR	ON	2012/06/19 19:15
S3	21369	avaya.as. or (bank new york mellon trust).as.	US-PGPUB; USPAT	OR	ON	2012/06/19 19:15
S4	717668	(switch$4 or rout$4 or gate$4) and (encapsulat$4 or authenticat$4 or encod$4) and (packe$2 or data$1)	US-PGPUB; USPAT	OR	ON	2012/06/19 19:16
S5	400097	(virtu$4 or tunne$3) same (media or access$3 or control$3 or MAC)	US-PGPUB; USPAT	OR	ON	2012/06/19 19:17
S6	364	(source$1 or origi$3) and ((dual or multi$3) adj3 hom$3 adj3 (connect$3 or host$1))	US-PGPUB; USPAT	OR	ON	2012/06/19 19:18
S7	215	(source$3 or origi$4) and ((dual or multi$3) adj3 hom$3 adj3 connect$3)	US-PGPUB; USPAT	OR	ON	2012/06/19 19:18
S9	282	((dual or multi$3) adj3 hom$3 adj3 connect$3)	US-PGPUB; USPAT	OR	ON	2012/06/19 19:19
S10	6566	((dual or multi$3) adj3 hom$3)	US-PGPUB; USPAT	OR	ON	2012/06/19 19:19
S11	124	S10 and S1 and S2	US-PGPUB; USPAT	OR	ON	2012/06/19 19:19
S12	80	S11 and S4	US-PGPUB; USPAT	OR	ON	2012/06/19 19:20
S17	80	S11 and S4 and (media or access$3 or control$3 or MAC)	US-PGPUB; USPAT	OR	ON	2012/06/19 19:34
S19	398071	(switch$4 or rout$4 or gate$4) and (encapsulat$4 or authenticat$4 or encod$4) same (packe$2 or data$1)	US-PGPUB; USPAT	OR	ON	2012/06/19 19:35
S26	400097	(virtu$4 or tunne$3) same (media or access$3 or control$3 or MAC)	US-PGPUB; USPAT	OR	ON	2012/06/20 16:30
S27	6566	((dual or multi$3) adj3 hom$3)	US-PGPUB; USPAT	OR	ON	2012/06/20 16:30
S28	398071	(switch$4 or rout$4 or gate$4) and (encapsulat$4 or authenticat$4 or encod$4) same (packe$2 or data$1)	US-PGPUB; USPAT	OR	ON	2012/06/20 16:30
S29	46007	370/389,473,474,352-356,349,310.2,328,338,312.ccls.	US-PGPUB; USPAT	OR	ON	2012/06/20 16:32
S32	124	S27 and S29 and S31	US-PGPUB; USPAT	OR	ON	2012/06/20 18:44
S33	717668	(switch$4 or rout$4 or gate$4) and (encapsulat$4 or authenticat$4 or encod$4) and (packe$2 or data$1)	US-PGPUB; USPAT	OR	ON	2012/06/20 18:45
S34	80	S32 and S33	US-PGPUB; USPAT	OR	ON	2012/06/20 18:45
S35	38	S34 and S26	US-PGPUB; USPAT	OR	ON	2012/06/20 18:45
S36	468	((dual or multi$3) adj3 hom$3) and S31	US-PGPUB; USPAT	OR	ON	2012/06/20 18:57
S37	8447	(virtu$4 or tunne$3) same (media or access$3 or control$3 or MAC) and "L3"	US-PGPUB; USPAT	OR	ON	2012/06/20 18:58
S38	230	(virtu$4 or tunne$3) same (media or access$3 or control$3 or MAC) and S36	US-PGPUB; USPAT	OR	ON	2012/06/20 18:58
S42	105	(virtu$4 or tunne$3) near10 ((media and	US-PGPUB;	OR	ON	2012/06/20

		access$3) or control$3 or MAC) and S36 not S30	USPAT			19:01
S43	65	(switch$4 or rout$4 or gate$4) and (encapsulat$4 or authenticat$4 or encod$4) same (packe$2 or data$1) and S42	US-PGPUB; USPAT	OR	ON	2012/06/20 19:06
S65	21392	avaya.as. or (bank new york mellon trust).as.	US-PGPUB; USPAT	OR	ON	2012/06/25 18:18
S66	17095	370/218-225,401,237,238.ccls.	US-PGPUB; USPAT	OR	ON	2012/06/25 18:18
S67	468	((dual or multi$3) adj3 hom$3) and S66	US-PGPUB; USPAT	OR	ON	2012/06/25 18:18
S68	105	(virtu$4 or tunne$3) near10 ((media and access$3) or control$3 or MAC) and S67 not S65	US-PGPUB; USPAT	OR	ON	2012/06/25 18:18
S95	6042098	Encapsulation Method for Transport	US-PGPUB; USPAT	OR	ON	2012/06/27 13:02
S96	1734704	S95 and ethernet frames	US-PGPUB; USPAT	OR	ON	2012/06/27 13:03
S117	48595	370/389,473,474,352-356,349,310.2,328,338,312.ccls.	US-PGPUB; USPAT	OR	ON	2012/10/30 17:56
S118	17789	370/218-225,401,237,238.ccls.	US-PGPUB; USPAT	OR	ON	2012/10/30 17:56
S121	2	("20070195700").PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/02/07 17:42
S125	7644	(rout$5) near4 (setup)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:12
S127	1553238	(flow) with (manage$5 control$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:13
S128	2159	S125 and S127	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:14
S129	1788	@ad<="20090326" and S128	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:15
S130	8916	370/218-225,254.ccls.	US-PGPUB; USPAT	OR	ON	2013/02/07 18:16
S131	42	S130 and S129	US-PGPUB; USPAT	OR	ON	2013/02/07 18:16
S132	5262	370/254.ccls.	US-PGPUB; USPAT	OR	ON	2013/02/07 18:16
S134	42078	(IP near3 rout$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:18
S135	363	S129 and S134	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:18
S136	301	(data with packet) and S135	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:19
S137	284	(request$4) and S136	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	OR	ON	2013/02/07 18:20

			IBM_TDB			
S138	271283	(source destination) near5 (node address MAC)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:21
S140	244	S137 and S138	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:21
S141	242	(pre$determin$3 determin$3 reserv$3) and S140	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:22
S142	219	(pre$determin$3 pre$defin$3 reserv$3) and S140	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:22
S143	6	S132 and S142	US-PGPUB; USPAT	OR	ON	2013/02/07 18:23
S144	46911	370/389,352-356,349,310.2,328,338,312.ccls.	US-PGPUB; USPAT	OR	ON	2013/02/07 18:23
S145	71	S142 and S144	US-PGPUB; USPAT	OR	ON	2013/02/07 18:23
S146	26048	370/389,352-356,349.ccls.	US-PGPUB; USPAT	OR	ON	2013/02/07 18:24
S147	64	S142 and S146	US-PGPUB; USPAT	OR	ON	2013/02/07 18:24
S148	7644	(rout$5) near4 (setup)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:33
S149	1553238	(flow) with (manage$5 control$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:33
S150	2159	S148 and S149	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:33
S151	1788	@ad<="20090326" and S150	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:33
S152	42078	(IP near3 rout$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:33
S153	363	S151 and S152	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:33
S154	301	(data with packet) and S153	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:33
S155	284	(request$4) and S154	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:33
S156	271283	(source destination) near5 (node address MAC)	US-PGPUB;	OR	ON	2013/02/07

			USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			18:33
S157	244	S155 and S156	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:33
S158	219	(pre$determin$3 pre$defin$3 reserv$3) and S157	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:33
S159	26048	370/389,352-356,349.ccls.	US-PGPUB; USPAT	OR	ON	2013/02/07 18:33
S160	64	S158 and S159	US-PGPUB; USPAT	OR	ON	2013/02/07 18:33
S161	64	S160	US-PGPUB; USPAT	OR	ON	2013/02/07 18:33
S175	31571	370/229-235,251-254,230-236.ccls.	US-PGPUB; USPAT	OR	ON	2013/02/07 22:44
S176	29	S158 and S175	US-PGPUB; USPAT	OR	ON	2013/02/07 22:44
S177	58	(look$up LUT map$4 hash$4) and S161	US-PGPUB; USPAT	OR	ON	2013/02/07 22:55
S178	24	(rout$5 near3 server) and S177	US-PGPUB; USPAT	OR	ON	2013/02/07 22:55
S181	108	S150 and ((server gatewy) near3 (set$up (set$4 adj up)))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 23:47
S183	2837	S175 and S159	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 23:48
S184	28	S181 and S159	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 23:48
S186	135	jean near3 vasseur.in.	USPAT	OR	ON	2013/02/07 23:56
S187	103	(pre$determin$3 pre$defin$3 reserv$3 predict$3) and S186	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 23:57
S188	827364	(switch$4 or rout$4 or gate$4) with (IP or packet or data)	US-PGPUB; USPAT	OR	ON	2013/02/07 23:58
S189	168189	S188 and S149	US-PGPUB; USPAT	OR	ON	2013/02/07 23:58
S190	40	S187 and S189	US-PGPUB; USPAT	OR	ON	2013/02/07 23:58
S191	22	(look$up LUT map$4 hash$4) and S190	US-PGPUB; USPAT	OR	ON	2013/02/07 23:58
S192	21	@ad<="20090326" and S191	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 23:59
S193	273959	(source destination) with (node station)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/22 10:25
S194	215582	(virtu$4 logical pseudo) same (physical)	US-PGPUB; USPAT	OR	ON	2013/02/22 10:27

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S195	21741	S193 and S194	US-PGPUB; USPAT	OR	ON	2013/02/22 10:28
S196	31743	370/229-235,251-254,230-236.ccls.	US-PGPUB; USPAT	OR	ON	2013/02/22 10:28
S197	1843	S196 and S195	US-PGPUB; USPAT	OR	ON	2013/02/22 10:28
S198	1172	(redundant repeat$3 redundan$3) and S197	US-PGPUB; USPAT	OR	ON	2013/02/22 10:57
S199	41964	((virtu$4 logical pseudo) same (physical)) with (link connection path channel)	US-PGPUB; USPAT	OR	ON	2013/02/22 10:58
S200	5393	((source destination) with (node station)) with (redundant repeat$3 redundan$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/22 10:58
S201	339	S199 and S200	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/22 10:58
S202	54	S196 and S201	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/22 10:58
S203	53	@ad<="20110705" and S202	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/22 10:59
S204	48	@pd<="20110705" and S202	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/22 10:59
S208	12	("20090274155" | "8125928" | "20110299535" | "8107457" | "20120147740" | "7447151" | "7339929" | "7535828" | "7782841" | "7995500" | "7411916" | "7969978").PN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/02/22 11:34
S209	324	jean near2 vasseur.in.	US-PGPUB; USPAT; USOCR	OR	ON	2013/02/22 11:36
S210	26	S209 and S200	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/22 11:37
S211	42013	((virtu$4 logical pseudo$5) same (physical)) with (link connection path channel)	US-PGPUB; USPAT	OR	ON	2013/02/22 13:00
S212	73	S209 and S211	US-PGPUB; USPAT	OR	ON	2013/02/22 13:01
S213	54	@pd<="20110705" and S212	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/22 13:01
S214	653	(redundant redundan$3) and S197	US-PGPUB; USPAT	OR	ON	2013/02/22 13:40
S215	1268	((source destination) with (node station)) with (redundant redundan$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/22 13:41
S216	18	S214 and S215 and S199	US-PGPUB; USPAT	OR	ON	2013/02/22 13:41
S217	17	@ad<="20110705" and S216	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/22 13:41
S218	85143	((node station)) with (redundant repeat$3 redundan$3)	US-PGPUB; USPAT; USOCR;	OR	ON	2013/02/22 13:42

			FPRS; EPO; JPO; DERWENT; IBM_TDB			
S219	20706	((node station)) with (redundant redundan$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/22 13:42
S227	20348	(multiple multi$4) with (logical pseudo$wire virtual) same (link path connection)	US-PGPUB; USPAT	OR	ON	2013/02/22 13:52
S230	32097	((node station)) with (redundant redundan$3 diversity)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/22 14:13
S283	11493	h04w4/00.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/12/19 14:13
S284	12	h04w28/0242.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/12/19 14:13
S285	2586	h04w28/065.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/12/19 14:13
S286	160	h04w52/0222.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/12/19 14:14
S287	81	@ad<="20090326" and S286	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/12/19 14:14
S288	5	S287 and (((updat$ add$4 re$purpo$5 upgrad$4) same3 header) and (table list))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/12/19 14:17
S289	4554	h04w36/12.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/12/19 14:18
S290	74758	h04w36/$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/12/19 14:18
S291	94382	h04w52/$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/12/19 14:18
S292	1119	S291 and (((updat$ add$4 re$purpo$5 upgrad$4) same3 header) and (table list))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/12/19 14:19
S293	773	@ad<="20090326" and S292	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/12/19 14:20
S294	1292	(boundary border bound$4) same (node switch router) same (packet with header)	US-PGPUB; USPAT	OR	ON	2013/12/19 14:22
S295	1490	(boundary border bound$4) same (node switch	US-PGPUB;	OR	ON	2013/12/19

		router) same (packet same header)	USPAT			14:22
S296	1	S293 and S295	US-PGPUB; USPAT	OR	ON	2013/12/19 14:22
S301	1	"201080040817"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/05/12 09:28
S304	1524	h04l1/1858.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/12/14 19:45
S305	0	(SGSN and IMSI) and S304	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/12/14 19:46
S306	28	("20030028612" | "7643456" | "8111666" | "20040032882" | "20050207374" | "20080219218" | "6847610" | "20070025301" | "7167475" | "20040017798" | "20050021746").PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/12/14 19:48
S307	53	(Combarros near2 Jose near2 Javier near2 Cabero, Esteban near2 Miguel near2 Cobo, Thierry near2 Josse).in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/12/14 20:00
S308	63639	Ericsson.as.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/12/14 20:00
S309	7	S307 and S308	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/12/14 20:00
S310	130	("6104929").URPN.	USPAT	OR	ON	2014/12/14 20:03
S311	9	(US-20100165995-$ or US-20080279196-$ or US-20070280102-$ or US-20080123651-$ or US-20080137615-$ or US-20030053427-$).did. or (US-8125928-$ or US-7522603-$ or US-7447151-$).did.	US-PGPUB; USPAT	OR	ON	2014/12/14 23:09
S312	9	(US-20100165995-$ or US-20080279196-$ or US-20070280102-$ or US-20080123651-$ or US-20080137615-$ or US-20030053427-$).did. or (US-8125928-$ or US-7522603-$ or US-7447151-$).did.	US-PGPUB; USPAT	OR	ON	2014/12/14 23:10
S313	84	(Jun near2 Awano).in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/30 00:32
S314	4	(packet and forward$4 and node and path and identif$6).clm. and S313	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/30 00:33
S315	9	(US-20100165995-$ or US-20080279196-$ or US-20070280102-$ or US-20080123651-$ or US-20080137615-$ or US-20030053427-$).did. or (US-8125928-$ or US-7522603-$ or US-7447151-$).did.	US-PGPUB; USPAT	OR	ON	2015/09/30 00:36
S316	5	S315 and (adjacent and node)	US-PGPUB; USPAT	OR	ON	2015/09/30 00:36
S317	41	(liqin near2 dong, Milton near2 xu).in.	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/16 17:48
S318	10	(link and mpls and rout$4 and forward$4 and table) and S317	US-PGPUB; USPAT; USOCR;	OR	ON	2016/11/16 17:48

			EPO; JPO			
S319	22	(link and rout$4 and forward$4 and table) and S317	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/16 17:49
S320	6	@ad<="20090914" and S319	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/11/16 17:50
S321	2702	(path link channel) same (ID identif$4) same (rout$4 forward$4) same (mpls)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/11/16 18:14
S322	6	(@ad<="20090914" or @pd<="20080914") and S319	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/11/16 18:16
S323	1547	(@ad<="20090914" or @pd<="20080914") and S321	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/11/16 18:16
S324	1005	((source destination) with address) and S323	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/16 18:17
S325	58985	(virtu$4 or logical or physical) same (link path channel) same (ID identifier)	US-PGPUB; USPAT	OR	ON	2016/11/16 18:17
S326	397	S324 and S325	US-PGPUB; USPAT	OR	ON	2016/11/16 18:18
S327	74355	(virtu$4 or logical or physical) same (link path channel) same (ID identifier)	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/16 18:18
S328	399	S324 and S327	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/16 18:18
S329	399	S324 and S327	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/16 18:18
S330	218	(stor$4 storage) with (table) and S329	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/16 18:18
S331	162	(path with information) and S330	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/16 18:20
S332	3	("7496096").PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/11/21 11:03
S333	2	("20110149973").PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/11/21 11:04
S334	2703	(path link channel) same (ID identif$4) same (rout$4 forward$4) same (mpls)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/11/21 11:04
S335	1547	(@ad<="20090914" or @pd<="20080914") and S334	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/11/21 11:04
S336	1005	((source destination) with address) and S335	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/21 11:04
S337	74449	(virtu$4 or logical or physical) same (link path channel) same (ID identifier)	US-PGPUB; USPAT; USOCR;	OR	ON	2016/11/21 11:04

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			EPO; JPO			
S338	399	S336 and S337	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/21 11:04
S339	218	(stor$4 storage) with (table) and S338	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/21 11:04
S340	162	(path with information) and S339	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/21 11:04
S341	131	(path link) near10 (ID identifier Identify$4) and S340	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/21 11:04
S342	2	("20020176363").PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/11/21 11:06
S343	131	(path link) near10 (ID identifier Identify$4) and S340	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/21 11:06
S344	2824	(path link channel) same (ID identif$4) same (rout$4 forward$4) same (mpls)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/05/22 13:57
S345	1549	(@ad<="20090914" or @pd<="20080914") and S344	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/05/22 13:57
S346	1006	((source destination) with address) and S345	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2017/05/22 13:57
S347	78023	(virtu$4 or logical or physical) same (link path channel) same (ID identifier)	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2017/05/22 13:57
S348	400	S346 and S347	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2017/05/22 13:57
S349	218	(stor$4 storage) with (table) and S348	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2017/05/22 13:57
S350	162	(path with information) and S349	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2017/05/22 13:57
S351	131	(path link) near10 (ID identifier Identify$4) and S350	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2017/05/22 13:57
S352	898	jean near2 vasseur.in.	US-PGPUB; USPAT; USOCR	OR	ON	2017/05/22 13:57
S353	79638	((virtu$4 logical pseudo$5) same (physical)) with (link connection path channel)	US-PGPUB; USPAT	OR	ON	2017/05/22 13:57
S354	116	S352 and S353	US-PGPUB; USPAT	OR	ON	2017/05/22 13:57
S355	54	@pd<="20110705" and S354	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2017/05/22 13:57
S356	447421	(source destination) with (node station)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/05/22 13:57
S357	408034	(virtu$4 logical pseudo) same (physical)	US-PGPUB; USPAT	OR	ON	2017/05/22 13:57
S358	39552	S356 and S357	US-PGPUB; USPAT	OR	ON	2017/05/22 13:57
S359	48757	370/229-235,251-254,230-236.ccls.	US-PGPUB; USPAT	OR	ON	2017/05/22 13:57

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S360	2944	S359 and S358	US-PGPUB; USPAT	OR	ON	2017/05/22 13:57
S361	79558	((virtu$4 logical pseudo) same (physical)) with (link connection path channel)	US-PGPUB; USPAT	OR	ON	2017/05/22 13:57
S362	1105	(redundant redundan$3) and S360	US-PGPUB; USPAT	OR	ON	2017/05/22 13:57
S363	2164	((source destination) with (node station)) with (redundant redundan$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/05/22 13:57
S364	20	S362 and S363 and S361	US-PGPUB; USPAT	OR	ON	2017/05/22 13:57
S365	19	@ad<="20110705" and S364	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2017/05/22 13:57

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	38413	(multiple multi$4) with (logical pseudo$wire virtual) same (link path connection)	US-PGPUB; USPAT	OR	ON	2017/09/22 00:06
L2	8	(packet and identifier and path and link and external and header and remov$4).clm.	US-PGPUB; USPAT	OR	ON	2017/09/22 00:06
L3	53432	NEC.AS.	US-PGPUB; USPAT	OR	ON	2017/09/22 00:07
L4	27	JUN NEAR2 AWANO.IN.	US-PGPUB; USPAT	OR	ON	2017/09/22 00:07
L5	2	2 and 3	US-PGPUB; USPAT	OR	ON	2017/09/22 00:07
L6	2	2 and 4	US-PGPUB; USPAT	OR	ON	2017/09/22 00:07
L7	83104	((virtu$4 logical pseudo) same (physical)) with (link connection path channel)	US-PGPUB; USPAT	OR	ON	2017/09/22 00:07
L8	1801	((source destination) with (node station)) with (redundant redundan$3)	US-PGPUB; USPAT	OR	ON	2017/09/22 00:07
L9	43	1 and L7 and L8	US-PGPUB; USPAT	OR	ON	2017/09/22 00:07
L10	23	@ad<="20090914" and 9	US-PGPUB; USPAT	OR	ON	2017/09/22 00:08
L12	31301	((H04L45/34 OR H04L45/00 OR H04L45/02 OR H04L45/22 OR H04L45/28 OR H04L45/42 OR H04L45/50 OR H04L45/745 OR H04L12/18 OR H04L12/1877 OR H04L12/1886 OR H04L12/46).CPC.)	US-PGPUB; USPAT	OR	ON	2017/09/22 00:09
L13	9	9 and 12	US-PGPUB; USPAT	OR	ON	2017/09/22 00:09
L14	6	10 and 12	US-PGPUB; USPAT	OR	ON	2017/09/22 00:09
S366	83104	((virtu$4 logical pseudo) same (physical)) with (link connection path channel)	US-PGPUB; USPAT	OR	ON	2017/09/22 00:04
S367	1801	((source destination) with (node station)) with (redundant redundan$3)	US-PGPUB; USPAT	OR	ON	2017/09/22 00:04
S368	215288	(virtu$4 or tunne$3) near10 ((media and access$3) or control$3 or MAC)	US-PGPUB; USPAT	OR	ON	2017/09/22 00:04

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9/ 22/ 2017 12:09:47 AM
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14/244,701
NEG-1440PCT-US2CT
KATO.327CONT

DO NOT ENTER: /S.A/

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of Jun Awano

Serial No.: 14/244,701 Group Art Unit: 2475

Filed: April 3, 2014 Examiner: AUNG, SAI

For: COMMUNICATION SYSTEM, FORWARDING NODE, PATH MANAGEMENT SERVER, COMMUNICATION METHOD, AND PROGRAM

Honorable Commissioner of Patents
Alexandria, VA 22313-1450
MAIL STOP AF

AMENDMENT UNDER 37 C.F.R. §1.116 with REQUEST FOR CONSIDERATION UNDER THE AFTER FINAL CONSIDERATION PILOT PROGRAM 2.0

Sir:

In response to Office Action dated **May 31, 2017**, please amend the above identified application as follows:

INTRODUCTORY COMMENTS

Amendments to the Claims begin on page 2 of this paper. The amendments to the claims do not add new matter.

Remarks begin on page 9 of this paper.

DO NOT ENTER: /S.A/

/S.A/ (09/21/2017)

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14244701	AWANO, JUN
	Examiner	Art Unit
	SAI AUNG	2416

CPC- SEARCHED		
Symbol	Date	Examiner
H04L45/04; H04L45/24; H04L45/66; H04L45/00;	9/21/2017	SA

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
370	370/401; 370/392; 370/231; 370/252; 370/352; 370/395.53	9/21/2017	SA

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

SEARCH NOTES		
Search Notes	Date	Examiner
EAST SEARCH (INCLUDING INVENTORS AND ASSIGNEE SEARCH)	9/21/2017	SA
GOOGLE PATENTS SEARCH	5/22/2017	SA
OTHER RELATED CPC SEARCH: H04L45/302; H04L45/50; H04L49/351	5/22/2017	SA

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner
	EAST AND PALM SEARCHES INCLUDING ASSIGNEE	9/21/2017	SA
	UPDATED ALL SEARCHES	9/21/2017	SA

/SAI AUNG/ Examiner.Art Unit 2416	/SAI AUNG/ Primary Examiner.Art Unit 2416

14/244,701
NEG-1440PCT-US2CT
KATO.327CONT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of Jun Awano

Serial No.: 14/244,701 Group Art Unit: 2475

Filed: April 3, 2014 Examiner: AUNG, SAI

For: COMMUNICATION SYSTEM, FORWARDING NODE, PATH MANAGEMENT SERVER, COMMUNICATION METHOD, AND PROGRAM

Honorable Commissioner of Patents
Alexandria, VA 22313-1450

AMENDMENT UNDER 37 C.F.R. §1.312

Sir:

In response to Notice of Allowance dated October 2, 2017, please amend the above identified application as follows:

INTRODUCTORY COMMENTS

Amendments to the Claims begin on page 2 of this paper. The amendments to the claims do not add new matter.

Remarks begin on page 9 of this paper.

AMENDMENTS TO THE CLAIMS

Please amend the claims as follows:

1. (Currently Amended) A packet forwarding node, comprising:

a storage unit including a non-transitory computer readable medium configured to store a packet forwarding table used for forwarding a packet based on an identifier which identifies a link between nodes on a packet forwarding path; and

at least one processor configured to execute program instructions to provide a forwarding unit configured to:

receive an incoming packet including a plurality of the identifiers;

determine a direction to forward the incoming packet;

determine whether to forward to an external network;

add ~~the number of bytes~~ to ~~path/link~~ path or link information when the incoming packet is not forwarded to the external network;

remove ~~path/link~~ path or link information header when the incoming packet is forwarded to the external network; and

forward the incoming packet by using a ~~path/link~~ path or link that corresponds to the identifier from among the plurality of the identifiers.

2. (Original) The packet forwarding node according to claim 1, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link within a predetermined domain.

3. (Original) The packet forwarding node according to claim 1, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely

identifies the link within a predetermined local domain.

4. (Original) The packet forwarding node according to claim 1, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link within the packet forwarding node.

5. (Original) The packet forwarding node according to claim 1, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link among the packet forwarding nodes.

6. (Currently Amended) A packet forwarding node, comprising:

a storage unit including a non-transitory computer readable medium configured to store a packet forwarding table used for forwarding a packet based on an identifier which identifies an interface of a packet forwarding node; and

at least one processor configured to execute program instructions to provide a forwarding unit configured to receive an incoming packet including a plurality of identifiers, determine a direction to forward the incoming packet, determine whether to forward to an external network, add ~~the number of bytes~~ to ~~path/link~~ path or link information when the incoming packet is not forwarded to the external network, remove ~~path/link~~ path or link information header when the incoming packet is forwarded to the external network, and to forward the incoming packet by using a ~~path/link~~ path or link that corresponds to the identifier from among the plurality of identifiers.

7. (Previously Presented) The packet forwarding node according to claim 6, wherein the storage unit stores the table used for forwarding the packet based on the identifier which

uniquely identifies the link within a predetermined domain.

8. (Previously Presented) The packet forwarding node according to claim 6, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link within a predetermined local domain.

9. (Previously Presented) The packet forwarding node according to claim 6, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link within the packet forwarding node.

10. (Previously Presented) The packet forwarding node according to claim 6, wherein the storage unit stores the table used for forwarding the packet based on the identifier which uniquely identifies the link among the packet forwarding nodes.

11. (Currently Amended) A packet forwarding node, comprising:

a memory storing a program;

at least one processor configured to execute the program to provide:

a communication unit configured to communicate with a server for receiving a plurality of identifiers, each of which identifies a link between nodes on a packet forwarding path; and

a forwarding unit configured to:

receive an incoming packet including the plurality of the identifiers,

determine a direction to forward the incoming packet,

determine whether to forward to an external network,

add ~~the number of bytes~~ to ~~path/link~~ path or link information when the

incoming packet is not forwarded to the external network,

remove ~~path/link~~ path or link information header when the incoming packet is forwarded to the external network, and

forward the incoming packet by using a ~~path/link~~ path or link that corresponds to an identifier from among the plurality of identifiers.

12. (Previously Presented) The packet forwarding node according to claim 11, wherein the forwarding unit forwards the packet based on the identifier which uniquely identifies the link within a predetermined domain.

13. (Previously Presented) The packet forwarding node according to claim 11, wherein the forwarding unit forwards the packet based on the identifier which uniquely identifies the link within a predetermined local domain.

14. (Previously Presented) The packet forwarding node according to claim 11, wherein the forwarding unit forwards the packet based on the identifier which uniquely identifies the link within the packet forwarding node.

15. (Previously Presented) The packet forwarding node according to claim 11, wherein the forwarding unit forwards the packet based on the identifier which uniquely identifies the link among the packet forwarding nodes.

16. (Currently Amended) A packet forwarding node, comprising:

a communication unit configured to communicate with a server for receiving a plurality of identifiers, each of which identifies an interface of the packet forwarding node;

and

at least one processor configured to execute program instructions to provide a forwarding unit configured to receive an incoming packet including a plurality of identifiers, determine a direction to forward the incoming packet, determine whether to forward to an external network, add ~~the number of bytes~~ to ~~path/link~~ path or link information when the incoming packet is not forwarded to the external network, remove ~~path/link~~ path or link information header when the incoming packet is forwarded to the external network, and forward the incoming packet by using a ~~path/link~~ path or link that corresponds to an identifier from among the plurality of identifiers.

17. (Previously Presented) The packet forwarding node according to claim 16, wherein the forwarding unit forwards the packet based on the identifier which uniquely identifies the link within a predetermined domain.

18. (Previously Presented) The packet forwarding node according to claim 16, wherein the forwarding unit forwards the packet based on the identifier which uniquely identifies the link within a predetermined local domain.

19. (Previously Presented) The packet forwarding node according to claim 16, wherein the forwarding unit forwards the packet based on the identifier which uniquely identifies the link within the packet forwarding node.

20. (Previously Presented) The packet forwarding node according to claim 16, wherein the forwarding unit forwards the packet based on the identifier which uniquely identifies the link among the packet forwarding nodes.

21. (Currently Amended) A server, comprising:

a memory storing a computer program;

at least one processor configured to execute the computer program to provide:

a first unit configured to determine a plurality of identifiers, each of which identifies a link between nodes on a packet forwarding path; and

a second unit configured send information elements to a packet forwarding node which is capable of receiving an incoming packet including a plurality of identifiers, determining a direction to forward the incoming packet, determining whether to forward to an external network, adding ~~the number of bytes~~ to ~~path/link~~ path or link information when the incoming packet is not forwarded to the external network, removing ~~path/link~~ path or link information header when the incoming packet is forwarded to the external network, and forwarding the incoming packet by using a ~~path/link~~ path or link that corresponds to an identifier from among the plurality of identifiers.

22. (Previously Presented) The packet forwarding node according to claim 1, wherein the storage unit stores the table used for forwarding the packet based on the identifier which identifies the link between adjacent nodes on a packet forwarding path.

23. (Previously Presented) The packet forwarding node according to claim 6, wherein the storage unit stores the packet forwarding table used for forwarding the packet based on the identifier which identifies the link between adjacent nodes on a packet forwarding path.

24. (Previously Presented) The packet forwarding node according to claim 11, further comprising a storage unit that stores a table used for forwarding the packet based on an

identifier which identifies the link between adjacent nodes on a packet forwarding path.

25. (Previously Presented) The packet forwarding node according to claim 16, further comprising a storage unit that stores a table used for forwarding the packet based on an identifier which identifies the link between adjacent nodes on a packet forwarding path.

26. (Previously Presented) The server according to claim 21, further comprising a storage unit to store a packet forwarding table used for forwarding the incoming packet based on the identifier which identifies the link between nodes on the packet forwarding path,

wherein the storage unit stores the table used for forwarding the packet based on the identifier which identifies a link between adjacent nodes on a packet forwarding path.

27-28. (Canceled)

29. (Previously Presented) The packet forwarding node according to claim 1, wherein when the forwarding unit receives the incoming packet including the identifier for the link connecting nodes on the packet forwarding path, the forwarding unit forwards the incoming packet based on the identifier included the received incoming packet from among the plurality of the identifiers.

REMARKS

Claims 1-26 and 29 are all of the claims presently pending in the application. No new matter has been added.

Applicant notes that the present Application has been allowed and that the Issue Fee will be paid on or before January 2, 2018 and thus expeditious consideration and prompt entry of this Amendment is requested.

In view of the foregoing, Applicant submits that claims 1-26 and 29, all the claims presently under examination, are patentably distinct over the prior art of record and are in condition for allowance. The Examiner is respectfully requested to pass the above application to issue at the earliest possible time.

Should the Examiner find the application to be other than in condition for allowance, the Examiner is requested to contact the undersigned at the local telephone number listed below to discuss any other changes deemed necessary in a telephonic or personal interview.

The Commissioner is hereby authorized to charge any deficiency in fees or to credit any overpayment in fees to Attorney's Deposit Account No. 50-0481.

Respectfully Submitted,

Date: November 9, 2017

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Electronic Acknowledgement Receipt

EFS ID:	30907782
Application Number:	14244701
International Application Number:	
Confirmation Number:	2010
Title of Invention:	Communication system, forwarding node, path management server, communication method, and program
First Named Inventor/Applicant Name:	JUN AWANO
Customer Number:	21254
Filer:	Saryadvinder S. Sahota/Amber Carroll
Filer Authorized By:	Saryadvinder S. Sahota
Attorney Docket Number:	NEG-1440PCT-US2CT
Receipt Date:	09-NOV-2017
Filing Date:	03-APR-2014
Time Stamp:	16:45:22
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Amendment after Notice of Allowance (Rule 312)	701_Amendment.pdf	325259 da92e4cdcdcaa9c131b8df8e81e6a46a86ae928d	no	9

Warnings:

Information:	
Total Files Size (in bytes):	325259

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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PRINTER RUSH
(PTO ASSISTANCE)

Application: 14244701	**Examiner:** Aung	**GAU:** 2416
From: Chuck Bowen	**Location:** RTFM	**Creation Date:** 11/16/2017

Week Date: 10/2/2017

DOC CODE	DOC DATE	MISCELLANEOUS
☐ 1449		☐ Continuing Data
☐ IDS		☐ Foreign Priority
☐ CLM		☐ Document Legibility
☐ IIFW/FWCLM		☐ Fees
☐ SRFW		☐ Petition (TC)
☐ DRW		☐ Other
☐ OATH		
☒ 312	11/09/2017	
☐ SPEC		

[RUSH] Message:

Please respond to the 11/09/17 A.NA.

Thank you.

CB

[XRUSH] Response:

Initials: _____

Examiner: PUBS contact - James Leija, (703) 756-1197
NOTE: This form will be included as part of the official USPTO record with the response document coded as XRUSH.
REV: AUG 16

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PRINTER RUSH
(PTO ASSISTANCE)

Application: 14244701	Examiner: Aung	GAU: 2416
From: Chuck Bowen	Location: RTFM	Creation Date: 11/16/2017

Week Date: 10/2/2017

DOC CODE	DOC DATE	MISCELLANEOUS
☐ 1449		☐ Continuing Data
☐ IDS		☐ Foreign Priority
☐ CLM		☐ Document Legibility
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☐ SRFW		☐ Petition (TC)
☐ DRW		☐ Other
☐ OATH		
☒ 312	11/09/2017	
☐ SPEC		

[RUSH] Message:

Please respond to the 11/09/17 A.NA.

Thank you.

CB

[XRUSH] Response:

The applicant has amended claims 1,6,11,16 and 21 under 37 CFR 1.312 compliance with the provisions of CFR 1.121. The amendment has been entered.

/SAI AUNG/
12/03/2017
Initials: _____

Examiner: PUBS contact - James Leija, (703) 756-1197
NOTE: This form will be included as part of the official USPTO record with the response document coded as XRUSH.
REV: AUG 16

DELL - Exhibit 1002 - Page 803

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	2824	(path link channel) same (ID identif$4) same (rout$4 forward$4) same (mpls)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/05/22 13:57
L2	1549	(@ad<="20090914" or @pd<="20080914") and L1	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/05/22 13:57
L3	1006	((source destination) with address) and L2	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2017/05/22 13:57
L4	78023	(virtu$4 or logical or physical) same (link path channel) same (ID identifier)	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2017/05/22 13:57
L5	400	L3 and L4	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2017/05/22 13:57
L6	218	(stor$4 storage) with (table) and L5	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2017/05/22 13:57
L7	162	(path with information) and L6	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2017/05/22 13:57
L8	131	(path link) near10 (ID identifier Identify$4) and L7	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2017/05/22 13:57
L9	898	jean near2 vasseur.in.	US-PGPUB; USPAT; USOCR	OR	ON	2017/05/22 13:57
L10	79638	((virtu$4 logical pseudo$5) same (physical)) with (link connection path channel)	US-PGPUB; USPAT	OR	ON	2017/05/22 13:57
L11	116	L9 and L10	US-PGPUB; USPAT	OR	ON	2017/05/22 13:57
L12	54	@pd<="20110705" and L11	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2017/05/22 13:57
L13	447421	(source destination) with (node station)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/05/22 13:57
L14	408034	(virtu$4 logical pseudo) same (physical)	US-PGPUB; USPAT	OR	ON	2017/05/22 13:57
L15	39552	L13 and L14	US-PGPUB; USPAT	OR	ON	2017/05/22 13:57
L16	48757	370/229-235,251-254,230-236.ccls.	US-PGPUB; USPAT	OR	ON	2017/05/22 13:57
L17	2944	L16 and L15	US-PGPUB; USPAT	OR	ON	2017/05/22 13:57
L18	79558	((virtu$4 logical pseudo) same (physical)) with (link connection path channel)	US-PGPUB; USPAT	OR	ON	2017/05/22 13:57
L19	1105	(redundant redundan$3) and L17	US-PGPUB; USPAT	OR	ON	2017/05/22 13:57
L20	2164	((source destination) with (node station)) with (redundant redundan$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/05/22 13:57

L21	20	L19 and L20 and L18	US-PGPUB; USPAT	OR	ON	2017/05/22 13:57
L22	19	@ad<="20110705" and L21	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2017/05/22 13:57
S1	46007	370/389,473,474,352-356,349,310.2,328,338,312.ccls.	US-PGPUB; USPAT	OR	ON	2012/06/19 19:15
S2	17081	370/218-225,401,237,238.ccls.	US-PGPUB; USPAT	OR	ON	2012/06/19 19:15
S3	21369	avaya.as. or (bank new york mellon trust).as.	US-PGPUB; USPAT	OR	ON	2012/06/19 19:15
S4	717668	(switch$4 or rout$4 or gate$4) and (encapsulat$4 or authenticat$4 or encod$4) and (packe$2 or data$1)	US-PGPUB; USPAT	OR	ON	2012/06/19 19:16
S5	400097	(virtu$4 or tunne$3) same (media or access$3 or control$3 or MAC)	US-PGPUB; USPAT	OR	ON	2012/06/19 19:17
S6	364	(source$1 or origi$3) and ((dual or multi$3) adj3 hom$3 adj3 (connect$3 or host$1))	US-PGPUB; USPAT	OR	ON	2012/06/19 19:18
S7	215	(source$3 or origi$4) and ((dual or multi$3) adj3 hom$3 adj3 connect$3)	US-PGPUB; USPAT	OR	ON	2012/06/19 19:18
S9	282	((dual or multi$3) adj3 hom$3 adj3 connect$3)	US-PGPUB; USPAT	OR	ON	2012/06/19 19:19
S10	6566	((dual or multi$3) adj3 hom$3)	US-PGPUB; USPAT	OR	ON	2012/06/19 19:19
S11	124	S10 and S1 and S2	US-PGPUB; USPAT	OR	ON	2012/06/19 19:19
S12	80	S11 and S4	US-PGPUB; USPAT	OR	ON	2012/06/19 19:20
S17	80	S11 and S4 and (media or access$3 or control$3 or MAC)	US-PGPUB; USPAT	OR	ON	2012/06/19 19:34
S19	398071	(switch$4 or rout$4 or gate$4) and (encapsulat$4 or authenticat$4 or encod$4) same (packe$2 or data$1)	US-PGPUB; USPAT	OR	ON	2012/06/19 19:35
S26	400097	(virtu$4 or tunne$3) same (media or access$3 or control$3 or MAC)	US-PGPUB; USPAT	OR	ON	2012/06/20 16:30
S27	6566	((dual or multi$3) adj3 hom$3)	US-PGPUB; USPAT	OR	ON	2012/06/20 16:30
S28	398071	(switch$4 or rout$4 or gate$4) and (encapsulat$4 or authenticat$4 or encod$4) same (packe$2 or data$1)	US-PGPUB; USPAT	OR	ON	2012/06/20 16:30
S29	46007	370/389,473,474,352-356,349,310.2,328,338,312.ccls.	US-PGPUB; USPAT	OR	ON	2012/06/20 16:32
S32	124	S27 and S29 and S31	US-PGPUB; USPAT	OR	ON	2012/06/20 18:44
S33	717668	(switch$4 or rout$4 or gate$4) and (encapsulat$4 or authenticat$4 or encod$4) and (packe$2 or data$1)	US-PGPUB; USPAT	OR	ON	2012/06/20 18:45
S34	80	S32 and S33	US-PGPUB; USPAT	OR	ON	2012/06/20 18:45
S35	38	S34 and S26	US-PGPUB; USPAT	OR	ON	2012/06/20 18:45
S36	468	((dual or multi$3) adj3 hom$3) and S31	US-PGPUB; USPAT	OR	ON	2012/06/20 18:57
S37	8447	(virtu$4 or tunne$3) same (media or access$3 or control$3 or MAC) and "L3"	US-PGPUB; USPAT	OR	ON	2012/06/20 18:58
S38	230	(virtu$4 or tunne$3) same (media or access$3 or control$3 or MAC) and S36	US-PGPUB; USPAT	OR	ON	2012/06/20 18:58
S42	105	(virtu$4 or tunne$3) near10 ((media and access$3) or control$3 or MAC) and S36 not S30	US-PGPUB; USPAT	OR	ON	2012/06/20 19:01
S43	65	(switch$4 or rout$4 or gate$4) and (encapsulat$4 or authenticat$4 or encod$4) same (packe$2 or data$1) and S42	US-PGPUB; USPAT	OR	ON	2012/06/20 19:06
S65	21392	avaya.as. or (bank new york mellon trust).as.	US-PGPUB; USPAT	OR	ON	2012/06/25 18:18
S66	17095	370/218-225,401,237,238.ccls.	US-PGPUB; USPAT	OR	ON	2012/06/25 18:18

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S67	468	((dual or multi$3) adj3 hom$3) and S66	US-PGPUB; USPAT	OR	ON	2012/06/25 18:18
S68	105	(virtu$4 or tunne$3) near10 ((media and access$3) or control$3 or MAC) and S67 not S65	US-PGPUB; USPAT	OR	ON	2012/06/25 18:18
S95	6042098	Encapsulation Method for Transport	US-PGPUB; USPAT	OR	ON	2012/06/27 13:02
S96	1734704	S95 and ethernet frames	US-PGPUB; USPAT	OR	ON	2012/06/27 13:03
S117	48595	370/389,473,474,352-356,349,310.2,328,338,312.ccls.	US-PGPUB; USPAT	OR	ON	2012/10/30 17:56
S118	17789	370/218-225,401,237,238.ccls.	US-PGPUB; USPAT	OR	ON	2012/10/30 17:56
S121	2	("20070195700").PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2013/02/07 17:42
S125	7644	(rout$5) near4 (setup)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:12
S127	1553238	(flow) with (manage$5 control$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:13
S128	2159	S125 and S127	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:14
S129	1788	@ad<="20090326" and S128	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:15
S130	8916	370/218-225,254.ccls.	US-PGPUB; USPAT	OR	ON	2013/02/07 18:16
S131	42	S130 and S129	US-PGPUB; USPAT	OR	ON	2013/02/07 18:16
S132	5262	370/254.ccls.	US-PGPUB; USPAT	OR	ON	2013/02/07 18:16
S134	42078	(IP near3 rout$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:18
S135	363	S129 and S134	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:18
S136	301	(data with packet) and S135	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:19
S137	284	(request$4) and S136	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:20
S138	271283	(source destination) near5 (node address MAC)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:21
S140	244	S137 and S138	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	ON	2013/02/07 18:21

			DERWENT; IBM_TDB			
S141	242	(pre$determin$3 determin$3 reserv$3) and S140	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:22
S142	219	(pre$determin$3 pre$defin$3 reserv$3) and S140	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:22
S143	6	S132 and S142	US-PGPUB; USPAT	OR	ON	2013/02/07 18:23
S144	46911	370/389,352-356,349,310.2,328,338,312.ccls.	US-PGPUB; USPAT	OR	ON	2013/02/07 18:23
S145	71	S142 and S144	US-PGPUB; USPAT	OR	ON	2013/02/07 18:23
S146	26048	370/389,352-356,349.ccls.	US-PGPUB; USPAT	OR	ON	2013/02/07 18:24
S147	64	S142 and S146	US-PGPUB; USPAT	OR	ON	2013/02/07 18:24
S148	7644	(rout$5) near4 (setup)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:33
S149	1553238	(flow) with (manage$5 control$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:33
S150	2159	S148 and S149	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:33
S151	1788	@ad<="20090326" and S150	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:33
S152	42078	(IP near3 rout$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:33
S153	363	S151 and S152	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:33
S154	301	(data with packet) and S153	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:33
S155	284	(request$4) and S154	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:33
S156	271283	(source destination) near5 (node address MAC)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:33
S157	244	S155 and S156	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:33

S158	219	(pre$determin$3 pre$defin$3 reserv$3) and S157	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 18:33
S159	26048	370/389,352-356,349.ccls.	US-PGPUB; USPAT	OR	ON	2013/02/07 18:33
S160	64	S158 and S159	US-PGPUB; USPAT	OR	ON	2013/02/07 18:33
S161	64	S160	US-PGPUB; USPAT	OR	ON	2013/02/07 18:33
S175	31571	370/229-235,251-254,230-236.ccls.	US-PGPUB; USPAT	OR	ON	2013/02/07 22:44
S176	29	S158 and S175	US-PGPUB; USPAT	OR	ON	2013/02/07 22:44
S177	58	(look$up LUT map$4 hash$4) and S161	US-PGPUB; USPAT	OR	ON	2013/02/07 22:55
S178	24	(rout$5 near3 server) and S177	US-PGPUB; USPAT	OR	ON	2013/02/07 22:55
S181	108	S150 and ((server gatewy) near3 (set$up (set$4 adj up)))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 23:47
S183	2837	S175 and S159	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 23:48
S184	28	S181 and S159	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 23:48
S186	135	jean near3 vasseur.in.	USPAT	OR	ON	2013/02/07 23:56
S187	103	(pre$determin$3 pre$defin$3 reserv$3 predict$3) and S186	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 23:57
S188	827364	(switch$4 or rout$4 or gate$4) with (IP or packet or data)	US-PGPUB; USPAT	OR	ON	2013/02/07 23:58
S189	168189	S188 and S149	US-PGPUB; USPAT	OR	ON	2013/02/07 23:58
S190	40	S187 and S189	US-PGPUB; USPAT	OR	ON	2013/02/07 23:58
S191	22	(look$up LUT map$4 hash$4) and S190	US-PGPUB; USPAT	OR	ON	2013/02/07 23:58
S192	21	@ad<="20090326" and S191	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/07 23:59
S193	273959	(source destination) with (node station)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/22 10:25
S194	215582	(virtu$4 logical pseudo) same (physical)	US-PGPUB; USPAT	OR	ON	2013/02/22 10:27
S195	21741	S193 and S194	US-PGPUB; USPAT	OR	ON	2013/02/22 10:28
S196	31743	370/229-235,251-254,230-236.ccls.	US-PGPUB; USPAT	OR	ON	2013/02/22 10:28
S197	1843	S196 and S195	US-PGPUB; USPAT	OR	ON	2013/02/22 10:28
S198	1172	(redundant repeat$3 redundan$3) and S197	US-PGPUB; USPAT	OR	ON	2013/02/22 10:57

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S199	41964	((virtu$4 logical pseudo) same (physical)) with (link connection path channel)	US-PGPUB; USPAT	OR	ON	2013/02/22 10:58
S200	5393	((source destination) with (node station)) with (redundant repeat$3 redundan$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/22 10:58
S201	339	S199 and S200	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/22 10:58
S202	54	S196 and S201	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/22 10:58
S203	53	@ad<="20110705" and S202	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/22 10:59
S204	48	@pd<="20110705" and S202	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/22 10:59
S208	12	("20090274155" | "8125928" | "20110299535" | "8107457" | "20120147740" | "7447151" | "7339929" | "7535828" | "7782841" | "7995500" | "7411916" | "7969978").PN.	US-PGPUB; USPAT; USOCR	OR	ON	2013/02/22 11:34
S209	324	jean near2 vasseur.in.	US-PGPUB; USPAT; USOCR	OR	ON	2013/02/22 11:36
S210	26	S209 and S200	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/22 11:37
S211	42013	((virtu$4 logical pseudo$5) same (physical)) with (link connection path channel)	US-PGPUB; USPAT	OR	ON	2013/02/22 13:00
S212	73	S209 and S211	US-PGPUB; USPAT	OR	ON	2013/02/22 13:01
S213	54	@pd<="20110705" and S212	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/22 13:01
S214	653	(redundant redundan$3) and S197	US-PGPUB; USPAT	OR	ON	2013/02/22 13:40
S215	1268	((source destination) with (node station)) with (redundant redundan$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/22 13:41
S216	18	S214 and S215 and S199	US-PGPUB; USPAT	OR	ON	2013/02/22 13:41
S217	17	@ad<="20110705" and S216	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/22 13:41
S218	85143	((node station)) with (redundant repeat$3 redundan$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/22 13:42
S219	20706	((node station)) with (redundant redundan$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/22 13:42
S227	20348	(multiple multi$4) with (logical pseudo$wire	US-PGPUB;	OR	ON	2013/02/22

		virtual) same (link path connection)	USPAT			13:52
S230	32097	((node station)) with (redundant redundan$3 diversity)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/02/22 14:13
S283	11493	h04w4/00.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/12/19 14:13
S284	12	h04w28/0242.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/12/19 14:13
S285	2586	h04w28/065.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/12/19 14:13
S286	160	h04w52/0222.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/12/19 14:14
S287	81	@ad<="20090326" and S286	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/12/19 14:14
S288	5	S287 and (((updat$ add$4 re$purpo$5 upgrad$4) same3 header) and (table list))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/12/19 14:17
S289	4554	h04w36/12.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/12/19 14:18
S290	74758	h04w36/$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/12/19 14:18
S291	94382	h04w52/$.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/12/19 14:18
S292	1119	S291 and (((updat$ add$4 re$purpo$5 upgrad$4) same3 header) and (table list))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/12/19 14:19
S293	773	@ad<="20090326" and S292	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/12/19 14:20
S294	1292	(boundary border bound$4) same (node switch router) same (packet with header)	US-PGPUB; USPAT	OR	ON	2013/12/19 14:22
S295	1490	(boundary border bound$4) same (node switch router) same (packet same header)	US-PGPUB; USPAT	OR	ON	2013/12/19 14:22
S296	1	S293 and S295	US-PGPUB; USPAT	OR	ON	2013/12/19 14:22
S301	1	"201080040817"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/05/12 09:28

S304	1524	h04l1/1858.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/12/14 19:45
S305	0	(SGSN and IMSI) and S304	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/12/14 19:46
S306	28	("20030028612" | "7643456" | "8111666" | "20040032882" | "20050207374" | "20080219218" | "6847610" | "20070025301" | "7167475" | "20040017798" | "20050021746").PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/12/14 19:48
S307	53	(Combarros near2 Jose near2 Javier near2 Cabero, Esteban near2 Miguel near2 Cobo, Thierry near2 Josse).in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/12/14 20:00
S308	63639	Ericsson.as.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/12/14 20:00
S309	7	S307 and S308	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/12/14 20:00
S310	130	("6104929").URPN.	USPAT	OR	ON	2014/12/14 20:03
S311	9	(US-20100165995-$ or US-20080279196-$ or US-20070280102-$ or US-20080123651-$ or US-20080137615-$ or US-20030053427-$).did. or (US-8125928-$ or US-7522603-$ or US-7447151-$).did.	US-PGPUB; USPAT	OR	ON	2014/12/14 23:09
S312	9	(US-20100165995-$ or US-20080279196-$ or US-20070280102-$ or US-20080123651-$ or US-20080137615-$ or US-20030053427-$).did. or (US-8125928-$ or US-7522603-$ or US-7447151-$).did.	US-PGPUB; USPAT	OR	ON	2014/12/14 23:10
S313	84	(Jun near2 Awano).in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/30 00:32
S314	4	(packet and forward$4 and node and path and identif$6).clm. and S313	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/09/30 00:33
S315	9	(US-20100165995-$ or US-20080279196-$ or US-20070280102-$ or US-20080123651-$ or US-20080137615-$ or US-20030053427-$).did. or (US-8125928-$ or US-7522603-$ or US-7447151-$).did.	US-PGPUB; USPAT	OR	ON	2015/09/30 00:36
S316	5	S315 and (adjacent and node)	US-PGPUB; USPAT	OR	ON	2015/09/30 00:36
S317	41	(liqin near2 dong, Milton near2 xu).in.	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/16 17:48
S318	10	(link and mpls and rout$4 and forward$4 and table) and S317	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/16 17:48
S319	22	(link and rout$4 and forward$4 and table) and S317	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/16 17:49
S320	6	@ad<="20090914" and S319	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/11/16 17:50

S321	2702	(path link channel) same (ID identif$4) same (rout$4 forward$4) same (mpls)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/11/16 18:14
S322	6	(@ad<="20090914" or @pd<="20080914") and S319	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/11/16 18:16
S323	1547	(@ad<="20090914" or @pd<="20080914") and S321	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/11/16 18:16
S324	1005	((source destination) with address) and S323	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/16 18:17
S325	58985	(virtu$4 or logical or physical) same (link path channel) same (ID identifier)	US-PGPUB; USPAT	OR	ON	2016/11/16 18:17
S326	397	S324 and S325	US-PGPUB; USPAT	OR	ON	2016/11/16 18:18
S327	74355	(virtu$4 or logical or physical) same (link path channel) same (ID identifier)	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/16 18:18
S328	399	S324 and S327	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/16 18:18
S329	399	S324 and S327	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/16 18:18
S330	218	(stor$4 storage) with (table) and S329	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/16 18:18
S331	162	(path with information) and S330	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/16 18:20
S332	3	("7496096").PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/11/21 11:03
S333	2	("20110149973").PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/11/21 11:04
S334	2703	(path link channel) same (ID identif$4) same (rout$4 forward$4) same (mpls)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/11/21 11:04
S335	1547	(@ad<="20090914" or @pd<="20080914") and S334	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/11/21 11:04
S336	1005	((source destination) with address) and S335	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/21 11:04
S337	74449	(virtu$4 or logical or physical) same (link path channel) same (ID identifier)	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/21 11:04
S338	399	S336 and S337	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/21 11:04
S339	218	(stor$4 storage) with (table) and S338	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/21 11:04
S340	162	(path with information) and S339	US-PGPUB; USPAT; USOCR;	OR	ON	2016/11/21 11:04

			EPO; JPO			
S341	131	(path link) near10 (ID identifier Identify$4) and S340	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/21 11:04
S342	2	("20020176363").PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/11/21 11:06
S343	131	(path link) near10 (ID identifier Identify$4) and S340	US-PGPUB; USPAT; USOCR; EPO; JPO	OR	ON	2016/11/21 11:06

EAST Search History (Interference)

<This search history is empty>

5/22/2017 2:00:30 PM
C:\Users\saung1\Documents\EAST\Workspaces\14244701\14244701-A.wsp

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14/244,701
NEG-1440PCT-US2CT
KATO.327CONT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of Jun Awano

Serial No.: 14/244,701 Group Art Unit: 2475

Filed: April 3, 2014 Examiner: AUNG, SAI

For: COMMUNICATION SYSTEM, FORWARDING NODE, PATH MANAGEMENT SERVER, COMMUNICATION METHOD, AND PROGRAM

Honorable Commissioner of Patents
Alexandria, VA 22313-1450

AMENDMENT UNDER 37 C.F.R. §1.312

Sir:

In response to Notice of Allowance dated October 2, 2017, please amend the above identified application as follows:

INTRODUCTORY COMMENTS

Amendments to the Claims begin on page 2 of this paper. The amendments to the claims do not add new matter.

Remarks begin on page 9 of this paper.

OK TO ENTER: /S.A/

12/03/2017

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/244,701	04/03/2014	JUN AWANO	NEG-1440PCT-US2CT	2010

21254 7590 12/27/2017

MCGINN INTELLECTUAL PROPERTY LAW GROUP, PLLC
8321 OLD COURTHOUSE ROAD
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VIENNA, VIRGINIA 22182-3817

EXAMINER	
AUNG, SAI	

ART UNIT	PAPER NUMBER
2416	

MAIL DATE	DELIVERY MODE
12/27/2017	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Corrected Notice of Allowability	Application No. 14/244,701	Applicant(s) AWANO, JUN	
	Examiner SAI AUNG	Art Unit 2416	AIA Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☑ This communication is responsive to 11/09/2017 .
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____ .

2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

3. ☑ The allowed claim(s) is/are See Continuation Sheet . As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see **http://www.uspto.gov/patents/init_events/pph/index.jsp** or send an inquiry to **PPHfeedback@uspto.gov.**

4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

   Certified copies:

   a) ☐ All b) ☐ Some *c) ☐ None of the:

   1. ☐ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____ .

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file areply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____ .

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)
2. ☐ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material _____
4. ☑ Interview Summary (PTO-413), Paper No./Mail Date. 11/30/2017 .
5. ☑ Examiner's Amendment/Comment
6. ☑ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____ .

/SAI AUNG/
Primary Examiner, Art Unit 2416

Continuation of 3. The allowed claim(s) is/are: 1-26 and 29 (Renumbered claims 1-27)

DETAILED ACTION

Claims status

1. In the amendment filed on 11/09/2017, Claims 1-26, and 29 are currently pending for the examination. The present application is being examined under the pre-AIA first to invent provisions.

Examiner's Amendment

2. An examiner's amendment to the record appears below. Should the changes and/or additions be unacceptable to applicant, an amendment may be filed as provided by 37 CFR 1.312. To ensure consideration of such an amendment, it MUST be submitted no later than the payment of the issue fee. Examiner's Amendments to Claims 1, 6, 11, 16, and 21 were authorized by **Applicant's Representative, Sam Sahota, Reg. No. (47,051)** during the examiner-initiated interview conducted on November 30th, 2017. Authorization for this examiner's amendment was given in a telephone interview with **Sam Sahota** on 11/30/2017.

The application has been amended as follows:

1. (Currently Amended) A packet forwarding node, comprising:

a storage unit including a non-transitory computer readable medium configured to store a packet forwarding table used for forwarding a packet based on an identifier which identifies a link between nodes on a packet forwarding path; and

at least one processor configured to execute program instructions to provide a forwarding unit configured to:

receive an incoming packet including a plurality of the identifiers;

determine a direction to forward the incoming packet;

determine whether to forward to an external network;

add ~~the number of bytes to path/link~~ path or link information header when the incoming packet is not forwarded to the external network;

remove ~~path/link~~ the path or link information header when the incoming packet is forwarded to the external network; and

forward the incoming packet by using a ~~path/link~~ path or link that corresponds to the identifier from among the plurality of the identifiers.

6. (Currently Amended) A packet forwarding node, comprising:

a storage unit including a non-transitory computer readable medium configured to store a packet forwarding table used for forwarding a packet based on an identifier which identifies an interface of a packet forwarding node; and

at least one processor configured to execute program instructions to provide a forwarding unit configured to:

receive an incoming packet including a plurality of identifiers, determine a direction to forward the incoming packet,

determine whether to forward to an external network,

add ~~the number of bytes to path/link~~ path or link information header when the incoming packet is not forwarded to the external network,

remove ~~path/link~~ the path or link information header when the incoming packet is forwarded to the external network, and

[to] forward the incoming packet by using a ~~path/link~~ path or link that corresponds to the identifier from among the plurality of identifiers.

11. (Currently Amended) A packet forwarding node, comprising:

a memory storing a program;

at least one processor configured to execute the program to provide:

a communication unit configured to communicate with a server for receiving a plurality of identifiers, each of which identifies a link between nodes on a packet forwarding path; and

a forwarding unit configured to:

receive an incoming packet including the plurality of the identifiers,

determine a direction to forward the incoming packet,

determine whether to forward to an externa! network,

add ~~the number of bytes to path/link~~ path or link information header when the incoming packet is not forwarded to the external network,

remove ~~path/link~~ the path or link information header when the incoming packet is forwarded to the external network; and

forward the incoming packet by using a ~~path/link~~ path or link that corresponds to an identifier from among the plurality of identifiers.

16. (Currently Amended) A packet forwarding node, comprising:

a communication unit configured to communicate with a server for receiving a plurality of identifiers, each of which identifies an interface of the packet forwarding node; and

at least one processor configured to execute program instructions to provide a forwarding unit configured to:

receive an incoming packet including a plurality of identifiers,

determine a direction to forward the incoming packet, determine whether to forward to an external network,

add ~~the number of bytes to path/link~~ path or link information header when the incoming packet is not forwarded to the external network,

remove ~~path/link~~ the path or link information header when the incoming packet is forwarded to the external network; and

forward the incoming packet by using a ~~path/link~~ path or link that corresponds to an identifier from among the plurality of identifiers.

21. (Currently Amended) A server, comprising:

a memory storing a computer program;

at least one processor configured to execute the computer program to provide: a first, unit configured to determine a plurality of identifiers, each of which identifies a link between nodes on a packet forwarding path; and

a second unit configured to send information elements to a packet forwarding node which is capable of receiving an incoming packet including a plurality of identifiers,

determining a direction to forward the incoming packet, determining whether to forward to an external network,

adding ~~the number of bytes to path/link~~ path or link information header when the incoming packet is not forwarded to the external network,

removing ~~path/link~~ the path or link information header when the incoming packet is forwarded to the external network; and

forwarding the incoming packet by using a ~~path/link~~ path or link that corresponds to an identifier from among the plurality of identifiers.

Allowable Subject Matter

3. After conducting a complete search and consideration, claims 1-26 and 29 are found to be allowable. Claims 1-26 and 29 are considered allowable since no prior art reference alone or combination of prior art references disclose or suggest the combination of limitations specified in the independent claims including:

"...add path or link information header when the incoming packet is not forwarded to the external network; remove the path or link information header when the incoming packet is forwarded to the external network..." in combination with other claim limitations as specified in claims 1-26 and 29.

In accordance with the Examiner's best judgement, the best prior arts found during prosecution with respect to independent claims 1-26 and 29 fail to, either singularly or in combination, to anticipate or render the claim features obvious, particularly the combination of features of the independent claims. The references used, fail to singularly or in combination, to anticipate and render obvious the inventive concept identified by the specific claim features of the inventive concept claims. Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Conclusion

4. Any inquiry concerning this communication or earlier communications from the examiner should be directed to SAI AUNG whose telephone number is (571)272-3507. The examiner can normally be reached on Monday-Friday, Alt Fridays, 7:30 AM- 5:00 PM (EST).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Noel Beharry can be reached on 571-270-5630. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300. Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/SAI AUNG/

Primary Examiner, Art Unit 2416

Examiner-Initiated Interview Summary	Application No.	Applicant(s)	
	14/244,701	AWANO, JUN	
	Examiner	Art Unit	AIA Status
	SAI AUNG	2416	No

All participants (applicant, applicant's representative, PTO personnel):

(1) SAI AUNG. (3) _____.

(2) Sam Sahota, Reg., 47,051. (4) _____.

Date of Interview: 30 November 2017.

Type: ☑ Telephonic ☐ Video Conference
☐ Personal [copy given to: ☐ applicant ☐ applicant's representative]

Exhibit shown or demonstration conducted: ☐ Yes ☐ No.
If Yes, brief description: _____.

Issues Discussed ☐ 101 ☐ 112 ☐ 102 ☐ 103 ☐ Others
(For each of the checked box(es) above, please describe below the issue and detailed description of the discussion)

Claim(s) discussed: 1,6,11,16 and 21.

Identification of prior art discussed: _____.

Substance of Interview
(For each issue discussed, provide a detailed description and indicate if agreement was reached. Some topics may include: identification or clarification of a reference or a portion thereof, claim interpretation, proposed amendments, arguments of any applied references etc...)

During the interview, Examiner discussed the claimed amendments after allowance. Examiner further requested to explain more detail of the amended limitations, i.e., adding path or link information. Applicant also agreed to review the claimed elements. No further agreement was reached..

Applicant recordation instructions: It is not necessary for applicant to provide a separate record of the substance of interview.

Examiner recordation instructions: Examiners must summarize the substance of any interview of record. A complete and proper recordation of the substance of an interview should include the items listed in MPEP 713.04 for complete and proper recordation including the identification of the general thrust of each argument or issue discussed, a general indication of any other pertinent matters discussed regarding patentability and the general results or outcome of the interview, to include an indication as to whether or not agreement was reached on the issues raised.

☐ Attachment

/SAI AUNG/ Primary Examiner, Art Unit 2416	

14/244,701
NEG-1440PCT-US2CT
KATO.327CONT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of Jun Awano

Serial No.: 14/244,701 Group Art Unit: 2475

Filed: April 3, 2014 Examiner: AUNG, SAI

For: COMMUNICATION SYSTEM, FORWARDING NODE, PATH MANAGEMENT SERVER, COMMUNICATION METHOD, AND PROGRAM

Honorable Commissioner of Patents
Alexandria, VA 22313-1450

STATEMENT OF SUBSTANCE OF INTERVIEW

Applicants provide the following statement of the substance of an interview for completion of the written record. See 37 C.F.R. §1.2, 37 C.F.R. §1.133, and MPEP §713.04

Applicants gratefully acknowledges Examiner Aung for courtesies extended during the Examiner interviews, for taking time from his busy schedule.

Claim amendments and the specification were discussed. Claims 1, 6, 11, 16 and 21 were discussed in particular. During the interview, the claimed amendments after allowance were discussed. Examiner further requested explanation and more detail of the amended limitations, i.e., adding path or link information, etc. Applicant also agreed to review the claimed elements and provide further explanation. The specification support was discussed and further claim amendments were discussed. Agreement was reached as to claim amendments that are supported by the specification and that may overcome the cited art, pending further search and consideration.

Applicants thank Examiner Aung for being very helpful in expediting the prosecution of the present Application.

14/244,701
NEG-1440PCT-US2CT
KATO.327CONT

Respectfully Submitted,

Date: December 27, 2017

S. S. Sahota, Esq.
Registration No. 47,051

Sean M. McGinn, Esq.
Registration No. 34,386

MCGINN INTELLECTUAL PROPERTY LAW GROUP, PLLC
8321 Old Courthouse Road, Suite 200
Vienna, VA 22182-3817
(703) 761-4100
Customer No. 21254

Electronic Acknowledgement Receipt

EFS ID:	31347041
Application Number:	14244701
International Application Number:	
Confirmation Number:	2010
Title of Invention:	Communication system, forwarding node, path management server, communication method, and program
First Named Inventor/Applicant Name:	JUN AWANO
Customer Number:	21254
Filer:	Sean Michael McGinn/Amber Carroll
Filer Authorized By:	Sean Michael McGinn
Attorney Docket Number:	NEG-1440PCT-US2CT
Receipt Date:	27-DEC-2017
Filing Date:	03-APR-2014
Time Stamp:	17:21:45
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Applicant summary of interview with examiner	701_SSI.pdf	98654 130f9586aa1c6469686a0c9729d7b0edcc37a975	no	2

Warnings:

Information:	
Total Files Size (in bytes):	98654

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

21254 7590 10/02/2017
MCGINN INTELLECTUAL PROPERTY LAW GROUP, PLLC
8321 OLD COURTHOUSE ROAD
SUITE 200
VIENNA, VA 22182-3817

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission
I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/244,701	04/03/2014	JUN AWANO	NEG-1440PCT-US2CT	2010

TITLE OF INVENTION: Communication system, forwarding node, path management server, communication method, and program

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$960	$0	$0	$960	01/02/2018

EXAMINER	ART UNIT	CLASS-SUBCLASS
AUNG, SAI	2416	370-254000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).
☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.
1 McGinn IP Law Group, PLLC
2
3

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE: NEC Corporation
(B) RESIDENCE: (CITY and STATE OR COUNTRY): Tokyo, Japan

Please check the appropriate assignee category or categories (will not be printed on the patent): ☐ Individual ☒ Corporation or other private group entity ☐ Government

4a. The following fee(s) are submitted:
☒ Issue Fee
☐ Publication Fee (No small entity discount permitted)
☐ Advance Order - # of Copies .....

4b. Payment of Fee(s): **(Please first reapply any previously paid issue fee shown above)**
☐ A check is enclosed.
☐ Payment by credit card. Form PTO-2038 is attached.
☒ The director is hereby authorized to charge the required fee(s), any deficiency, or credits any overpayment, to Deposit Account Number 50-0481 (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)
☐ Applicant certifying micro entity status. See 37 CFR 1.29 — NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
☐ Applicant asserting small entity status. See 37 CFR 1.27 — NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
☐ Applicant changing to regular undiscounted fee status. — NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature .....
Date Dec. 29, 207
Typed or printed name Sam S. Sahota
Registration No. 47,081

PTOL-85 Part B (10-13) Approved for use through 10/31/2013. OMB 0651-0033 U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

DELL - Exhibit 1002 - Page 829

Electronic Patent Application Fee Transmittal

Application Number:	14244701
Filing Date:	03-Apr-2014
Title of Invention:	Communication system, forwarding node, path management server, communication method, and program
First Named Inventor/Applicant Name:	JUN AWANO
Filer:	Sean Michael McGinn/Amber Carroll
Attorney Docket Number:	NEG-1440PCT-US2CT

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
UTILITY APPL ISSUE FEE	1501	1	960	960

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**960**

Electronic Acknowledgement Receipt

EFS ID:	31366775
Application Number:	14244701
International Application Number:	
Confirmation Number:	2010
Title of Invention:	Communication system, forwarding node, path management server, communication method, and program
First Named Inventor/Applicant Name:	JUN AWANO
Customer Number:	21254
Filer:	Sean Michael McGinn/Amber Carroll
Filer Authorized By:	Sean Michael McGinn
Attorney Docket Number:	NEG-1440PCT-US2CT
Receipt Date:	29-DEC-2017
Filing Date:	03-APR-2014
Time Stamp:	13:43:46
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$960
RAM confirmation Number	010218INTEFSW00001730500481
Deposit Account	500481
Authorized User	Saryadvinder Sahota

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

37 CFR 1.16 (National application filing, search, and examination fees)

37 CFR 1.17 (Patent application and reexamination processing fees)

37 CFR 1.19 (Document supply fees)

37 CFR 1.20 (Post Issuance fees)

37 CFR 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Issue Fee Payment (PTO-85B)	701_IF.pdf	117085 757daa60ed23043a734e6cf993aa539b43929b18	no	1
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30774 7a82b0122b0297598f2b520bab32187e82f7ccc3	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	147859		

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New Applications Under 35 U.S.C. 111

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New International Application Filed with the USPTO as a Receiving Office

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UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/244,701	02/20/2018	9900249	NEG-1440PCT-US2CT	2010

21254 7590 01/31/2018

MCGINN INTELLECTUAL PROPERTY LAW GROUP, PLLC
8321 OLD COURTHOUSE ROAD
SUITE 200
VIENNA, VA 22182-3817

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment is 0 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

APPLICANT(s) (Please see PAIR WEB site http://pair.uspto.gov for additional applicants):

NEC CORPORATION, Tokyo, JAPAN;
JUN AWANO, Tokyo, JAPAN;

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The USA offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to encourage and facilitate business investment. To learn more about why the USA is the best country in the world to develop technology, manufacture products, and grow your business, visit SelectUSA.gov.