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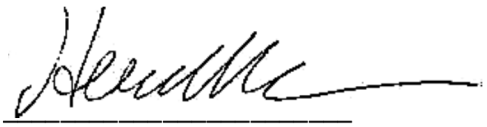

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Continued on last page

(54) [Title of the Invention] Method for Establishing Multicast Circuit, Communication System Using Said Method, Communication Device, Method for Controlling Communication Device, and Program

(57) [Abstract]

[Problem] In the prior art, the value of a VC label used by an upstream PE is different for each downstream PE, making it impossible to forward pseudo wire traffic using a multicast tunnel.

[Solution] The present invention proposes a method in which a PE is provided with a reservation management function for VC labels, a set label value range is reserved for each multipoint connection group that constitutes a VPN, VC label values are derived in downstream PEs according to predetermined rules that are set so that the derivation results are the same as those for other downstream PEs, and those results are advertised to the upstream PE.

[Selected Drawing] FIG. 14

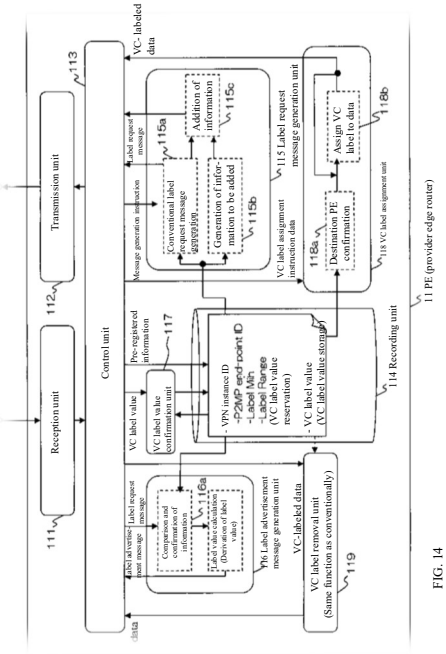

FIG. 14

[Scope of Patent Claims]

[Claim 1]

A method for establishing a multicast virtual circuit using multi-protocol label switching (MPLS) technology, characterized in that

information which effects reservation of a set label value range for a multipoint connection group constituting a VPN (virtual private network) (hereinafter referred to as a VPN instance) is registered in multiple PEs (provider edge routers), and

if one of the PEs in which reservation was effected (hereinafter referred to as reserved PEs) becomes an upstream PE of the VPN instance, a downstream reserved PE will advertise the same VC label value as other downstream reserved PEs to the upstream PE.

[Claim 2]

A multicast virtual circuit system in which a multicast virtual circuit is established using MPLS technology, the system comprising

a means for registering information which reserves a set label value range in multiple PEs of a VPN instance; and

a means whereby, if one of the reserved PEs becomes an upstream PE of the VPN instance, a downstream reserved PE will advertise the same VC label value as other downstream reserved PEs to the upstream PE.

[Claim 3]

The multicast virtual circuit system as claimed in claim 2, comprising

a means whereby an upstream reserved PE transfers all or some of the reserved label range information of the upstream PE to the downstream PEs.

[Claim 4]

A communication device capable of establishing a multicast virtual circuit using MPLS technology as a provider edge router, the device comprising

a means for registering information which reserves a set label value range; and

a means for deriving the same VC label value as other devices of the same VPN instance.

[Claim 5]

The communication device as claimed in claim 4, comprising

a means for sending a message containing information related to the reserved label values.

[Claim 6]

The communication device as claimed in claim 4 or 5, comprising

a means for registering, at least, a number identifying a VPN instance, a value determining a label value range to be reserved, and a number identifying a PE in the same VPN instance.

[Claim 7]

The communication device as claimed in claim 6, comprising

a means for transmitting, as information related to reserved label values, at least a number that identifies a VPN instance, a value that determines a label value range to be reserved, and a number that identifies a PE in the same VPN instance.

[Claim 8]

The communication device as claimed in claim 7, comprising

a means for determining a VC label value using [Label Min + upstream PE P2MP endpoint ID - 1].

[Claim 9]

The communication device as claimed in any one of claims 4 to 8, comprising

a means for comparing reserved information with received label value related information to confirm that the reserved range of the label values is the same.

[Claim 10]

The communication device as claimed in any one of claims 4 to 9, comprising

a means for confirming that advertised label values match label values derived on the basis of transmitted label related information.

[Claim 11]

The communication device as claimed in any one of claims 4 to 10, comprising

a means for establishing a point-to-point virtual circuit with a PE for which a point-to-multipoint virtual circuit cannot be established.

[Claim 12]

A method for controlling a provider edge router that establishes a multicast virtual circuit using MPLS technology, characterized in that

information which reserves a set label value range for a VPN instance is registered,

the same VC label value is derived as for other devices in the same VPN instance, and

the derived VC label value is advertised.

[Claim 13]

A method for establishing a multicast circuit in a network in which a downstream node determines a destination-indicating value and advertises that value to an upstream node and in which data including a destination-indicating value determined between nodes can be encapsulated and copied and forwarded in multiple directions, the method being characterized in that

information which effects reservation of a set destination-indicating value range is registered in multiple nodes within a group for which a multicast circuit connection is to be established, and

if one of the nodes in which reservation was effected (hereinafter referred to as reserved nodes) becomes an upstream node of the group, a downstream reserved node will advertise the same destination-indicating value as other downstream reserved nodes to the upstream node.

[Claim 14]

A multicast circuit system that establishes a multicast circuit in a network in which a downstream node determines a destination-indicating value and advertises that value to an upstream node, and in which data including a destination-indicating value determined between nodes can be encapsulated and copied and forwarded in multiple directions, the system comprising

a means for registering information which effects reservation of a set destination-indicating value range in multiple nodes within a group for which a multicast circuit connection is to be established, and

a means whereby, if one of the reserved nodes becomes an upstream node of the group, a downstream reserved node will advertise the same destination-indicating value as other downstream reserved nodes to the upstream node.

[Claim 15]

A communication device capable of establishing a multicast circuit in a network in which a downstream node determines a destination-indicating value and advertises that value to an upstream node and in which data including a destination-indicating value determined between nodes can be encapsulated and copied and forwarded in multiple directions, the device comprising

a means for registering information which reserves a set destination-indicating value range; and

a means for deriving the same destination-indicating value as other devices of a group for which the same multicast circuit connection is to be established.

[Claim 16]

A method for controlling a communication device that establishes a multicast circuit in a network in which a downstream node determines a destination-indicating value and advertises that value to an upstream node and in which data including a destination-indicating value determined between nodes can be encapsulated and copied and forwarded in multiple directions, the method being characterized in that

information is registered, which reserves a set destination-indicating value range for a group for which a multicast circuit connection is to be established,

the same destination-indicating value is derived as in other devices of the group, and

the derived destination-indicating value is advertised.

[Claim 17]

A communication program that causes a computer to run as the system or device as claimed in any of claims 2 to 11, 14, or 15.

[Detailed Description of the Invention]

[Technical field]

[0001]

The present invention relates to techniques for establishing multicast circuits.

[Background Art]

[0002]

As a technology for allowing carriers to provide Layer 2 VPN (Virtual Private Network), a method called PWE3 (Pseudo Wire Emulation Edge-to-Edge) is commonly used to establish a pseudo wire (virtual circuit) between PEs (Provider Edge routers) and provide connectivity between remote subscriber lines over the carrier network.

Methods for building pseudo wires using MPLS technology are particularly widespread. Using such methods, layer 2 frames sent to a PE from a CE (Customer Edge Router) can be assigned a label (VC label) to distinguish subscriber lines, and then encapsulated and forwarded using the carrier network's forwarding protocol. This allows multiplexing and forwarding of signals of different subscribers over the carrier network.

[0003]

Tunneling technology is generally used for the above encapsulation. When a tunnel label (a label for forwarding within the carrier network) is stacked over the VC label, P (the provider router) sees only the outer label, so data containing the VC label is encapsulated. Tunneling technology includes MPLS tunneling and IP tunneling, and not only has unicast tunneling technology for point-to-point been established, but also multicast tunneling technology for point-to-multipoint. Multicast tunneling technology is a technology in which the P copies and forwards all data located in the higher layers of the tunnel in multiple directions. In other words, all data other than the tunnel label is copied, including the VC label.

[0004]

LDP (Label Distribution Protocol) (Non-Patent Document 1) is often used as the VC label setting method. Under LDP, a P making up the backbone or a PE typically located on the downstream side of traffic allocates label values that it can receive and identify, and advertises those label values and ancillary information to the upstream PE or P using LDP. However, if the above-mentioned tunnel is established between opposing PEs, the data including the VC label is encapsulated in the tunnel segment, so that an LSP (Label Switching Path) is established between the PEs based on LDP regardless of any Ps that may be present between the PEs. In other words, the downstream PE allocates the values of the VC labels and advertises those values to the upstream PE.

[0005]

On the other hand, conventional pseudo wire technology is based on point-to-point, with a pseudo wire being established for each circuit handled by a pair of PEs at the pair level. A multipoint layer 2 VPN technology using pseudo wire technology is VPLS (Virtual Private LAN Service), which provides multipoint Ethernet (Registered Trademark) connectivity, but this is implemented using a full mesh point-to-point pseudo wire and does not exceed the scope of the point-to-point concept.

[Non-Patent Document 1] “Pseudo wire setup maintenance using LDP”, IETF Internet Draft, draft-ietf-pwe3-control-protocol-08. txt, July 2004.

[Disclosure of the Invention]

[Problem to be Solved by the Invention]

[0006]

In conventional pseudo wire technology based on point-to-point connection, VC labels are assigned for VC-LSP traffic forwarding to the packets to be carried. If a PE (the upstream PE) receives multicast data from a CE, the upstream PE assigns a VC label and sends the data to the PEs (downstream PEs) to which the data is to be transmitted. However, the VC label will normally have different values for each downstream PE because the downstream PEs determine those values, as described above.

On the other hand, multicast tunnel technology is a technology in which the P copies and forwards all data located in the higher layers of the tunnel in multiple directions, as described above. In other words, because this is a technology that copies and forwards data including the VC label, it has not been possible to combine pseudo wire technology with multicast tunnel technology, since the VC labels differ for each downstream PE even if the information portion to be sent is the same. Therefore, when using conventional pseudo wire technology, even when multicast data is sent to the upstream PE, the upstream PE communicates using pseudo wire technology by establishing a separate unicast tunnel with each of the multiple downstream PEs.

[0007]

The reason why conventional pseudo wire technology and multicast tunneling technology could not be combined will be explained again using FIGS. 1-3. FIG. 1 shows an example of a network configuration providing VPLS, where $CE10_n$ indicates a customer edge router, $PE11_n$ indicates a provider edge router, and $P12_n$ indicates a provider router. Also, an example of the problem to be solved by the invention is shown in FIG. 2. It will be assumed that multicast data destined for users served by $CE10_2$, $CE10_3$ and $CE10_4$ has been sent to $PE11_1$ from $CE10_1$. $PE11_1$ sends an LDP label request message to $PE11_2$. $PE11_2$ determines a value for the VC label and sends the VC label value to $PE11_1$ in an LDP label advertisement message. In the example of FIG. 2, it will be assumed that 20 was advertised. $PE11_1$ then sends an LDP label request message to $PE11_3$, and $PE11_3$ determines a value for the VC label and sends the VC label value to $PE11_1$ in an LDP label advertisement message. In the example of FIG. 2, it will be assumed that 30 was advertised. It will be assumed that, through a similar procedure, $PE11_4$ has advertised 40 as the value of the VC label. As noted above, the VC label values are determined by downstream PEs, so a different VC label is usually advertised for each PE. However, within the multicast tunnel, because each P copies and transmits data containing the VC label to the next P while looking only at the tunnel header, data with the same VC label reaches $PE11_2$, $PE11_3$, and $PE11_4$. In the example in FIG. 2, $PE11_1$ assigns and transmits the VC label value of 20, so data having a VC label value of 20 will reach not only $PE11_2$, which had advertised 20 as a VC label value, but also the other PEs ($PE11_3$ and $PE11_4$), rendering communication impossible. Thus, as shown in FIG. 3, $PE11_1$ establishes separate unicast tunnels with $PE11_2$, $PE11_3$, and $PE11_4$, copies the data that was sent from $CE10_1$, and transmits that data after assigning the advertised VC label for each downstream PE. In this way, even though the actual data to be transmitted (the data that was sent from $CE10_1$) is the same, there are three instances of traffic between $PE11_1$ and $P12_1$. In other words, if a multicast tunnel could be utilized using a common VC label for the downstream PEs, the traffic between $PE11_1$ and $PE12_1$ could be reduced to 1/3 of the conventional volume.

[0008]

The problem to be solved by the present invention is that, as described above, the value of the VC label used by the upstream PE in conventional technology is different for each downstream PE, making it impossible to forward pseudo wire traffic using a multicast tunnel.

[Means for Solving the Problem]

[0009]

The present invention proposes a method in which each PE is provided with VC label reservation management functionality, a set range of label values is reserved for each multipoint connection group (hereinafter referred to as a VPN instance) making up a VPN, and each downstream PE derives VC label values according to prescribed rules set such that the results for each downstream PE will be the same, and those results are advertised to the upstream PE.

[Effects of the Invention]

[0010]

This method allows pseudo wire traffic to be forwarded using a multicast tunnel because all VC labels advertised by the downstream PEs are identical. Therefore, there is the effect that the resources of the carrier network can be conserved for multicast traffic.

[Best Mode for Carrying out the Invention]

[0011]

Embodiments of the invention will be described below with reference to the drawings. Corresponding parts in each drawing are given the same reference numeral and redundant descriptions are omitted.

[First embodiment]

Terms are described first. A “VPN instance ID” is an identifier determined by the carrier for a set of circuits handled by the same VPN for which multipoint connectivity is to be provided. For example, in a VPLS environment, the VPLS ID is used as-is. Moreover, it is set so as to be the same among PEs belonging to the same VPN instance. The “P2MP endpoint ID” is assigned a value of between 1 and the Label Range, so that each PE is unique within the same VPN instance. In other words, each PE is uniquely defined by the combination of the VPN instance ID and the P2MP endpoint ID. If the same PE is used in different VPN instances, the P2MP endpoint ID may be set to different values. However, the P2MP endpoint ID associated with a particular VPN instance must be different from that of other PEs belonging to the same VPN instance.

[0012]

Label Min and Label Range are configured to the same settings among PEs belonging to the same VPN instance. The PEs reserve label values in the range of Label Min or higher but less than Label Min + Label Range as candidates for use in VC labels in the given VPN instance, and do not use these values for other unrelated instances. Note also that “Label Min” and “Label Range” are important parameters for determining the range for reserving candidates for VC label values, but there are parameters for reserving candidates for VC label values besides the combination of these two parameters. For example, there are methods in which “Label Max” is set as the maximum value of the label values to be reserved, instead of setting “Label Range”. The following description describes a case where “Label Min” and “Label Range” are used as parameters to indicate the range to be reserved as candidates for VC label values.

[0013]

The “P2MP endpoint ID” number identifying each PE in the same VPN instance and the “Label Min” and “Label Range” values that determine the range of VC label values to be used solely for multicast traffic in the VPN instance make it easy to determine label values to be used for multicast traffic without overlapping with other traffic label values. By setting “Label Min” larger than the label values used for unicast traffic, overlap with label values used for other unicast traffic can be easily avoided. In addition, if management is carried out such that “Label Range” is set greater than the number of PEs that make up the VPN instance, this will

facilitate the management of assigning non-overlapping label values for each network unit that is being managed.

[0014]

"P2MP pseudo wire TLV" is a unit of information storage used in the present invention. New information according to the invention and information for conventional purposes are stored therein. P2MP pseudo wire TLV stores, at least, pseudo wire type, AGI, P2MP Source endpoint ID, Label Min, Label Range, and Interface Parameter.

"Pseudo wire type" is determined according to the physical line and is also used in the conventional point-to-point pseudo wire specification (Non-Patent Document 1). In the present invention, this parameter is used as-is. "AGI (Attachment Group Identifier)" is also used in the conventional point-to-point pseudo wire specification (Non-Patent Document 1). This parameter is also used as-is in the present invention. "P2MP Source endpoint ID" is a parameter newly defined and used in the present invention. The P2MP endpoint ID of the upstream PE is used for the P2MP Source endpoint ID. "Interface Parameter" is used in the conventional point-to-point pseudo wire specification (Non-Patent Document 1). In the present invention, this parameter is used as-is.

[0015]

The procedure of the present invention is described using the network configuration example in FIG. 1. FIG. 1 shows four instances each of CE10, PE11, and P12, but the number is in each case arbitrary and varies depending on the size of the VPN and carrier network.

Step 1

Presets are registered in each PE for each VPN instance. This setting may be set manually by the carrier in each router, or may be set in each PE using some external protocol or application. Example settings are shown in FIG. 4. In VPLS, the VPLS ID is used as-is for the VPN instance. FIG. 4 shows pre-registration values for PEs related to VPN instance ID=VPLS ID=100. It will be assumed that for each PE, P2MP endpoint ID, Label Min, and Label Range are registered, but in the case of VPN instance ID=100, Label Min and Label Range are registered as 4001 and 100, respectively. In other words, the VC label values 4001-4100 are reserved for multicast traffic in the VPN instance where the VPN instance ID=100.

[0016]

By thus reserving VC label values for multicast traffic in the VPN instance in the same range for all PEs making up the same VPN instance, it becomes unnecessary to send a label request message from the upstream PE asking for an arbitrary VC label value or to query all PEs in the VPN instance for available VC label values.

Step 2

Next, settings are configured for forwarding point-to-multipoint traffic from $CE10_1$ to $CE10_2$, $CE10_3$, and $CE10_4$. First, $PE11_1$, which is on the transmitting side, sends an LDP label request message, including presets, to the downstream PEs belonging to VPN instance ID = 100. This label request message contains various values managed by the upstream PE in the FEC TLV. FIG. 5 shows $PE11_1$ sending a label request message to $PE11_2$ with P2MP Source endpoint ID=1, Label Min=4001, and Label Range=100.

Step 3

A downstream PE receiving this label request message confirms that the Label Min and Label Range managed by that PE are the same as what is in the received message for the applicable VPN instance. This is because Label Min and Label Range are information that indicates the VC label values reserved for multicast traffic in VPN instance ID=100. Furthermore, confirmation is made that the PE's own P2MP endpoint ID is different from the P2MP Source endpoint ID in the received message. The P2MP endpoint ID is a parameter for ensuring each PE is unique within the same VPN instance. If these consistency checks fail, an LDP error message is transmitted and error processing is carried out in accordance with conventional pseudo wire technical specifications, and the VC-LSP is not established. If all consistency checks are successfully completed, an LDP label advertisement message is transmitted to the upstream PE. FIG. 6 shows a message being transmitted from $PE11_2$, which is a downstream PE, to $PE11_1$, which is the upstream PE. The content of this transmission is a copy of the content received from $PE11_1$ and the value of the label to be advertised. The value of the label to be advertised is a value determined using [Label Min + P2MP Source endpoint ID - 1]. In FIG. 6, a label value of 4001 is allocated as the result of the calculation [4001 + 1 - 1] and is transmitted to $PE11_1$.

Step 4

The upstream PE receiving the label advertisement message confirms whether the content thereof corresponds to the label request message that was sent by it. If the confirmation fails, a VC-LSP is not established, in accordance with conventional pseudo wire technical specifications. If all the confirmations are successful, the received label value is taken as the VC label for the downstream PE. In the case of FIG. 6, $PE11_1$ uses 4001 as the VC label for $PE11_2$.

Step 5

Steps 2 through 4 above are repeated for all downstream PEs to which the point-to-multipoint pseudo wire is to be established. FIGS. 7 and 8 show examples of the exchange between $PE11_1$ and $PE11_4$. This exchange is the same as the exchange between $PE11_1$ and $PE11_2$, and ultimately the three VC-LSPs – $PE11_1$-$PE11_2$, $PE11_1$-$PE11_3$, and $PE11_1$-$PE11_4$ – all come to have a VC label value of 4001. FIG. 9 shows the settings once establishment of the point-to-multipoint pseudo wire is complete.

Step 6

The upstream PE confirms that a VC-LSP has been established to each downstream PE and initiates forwarding of traffic. This is shown in FIG. 10. In this example, multicast tunnel 21 is also using MPLS, so the labels are stacked. It can be seen that the internal VC label is the same, 4001, for all the VC-LSPs.

[0017]

It should be noted that, to accommodate cases where VC-LSPs are successfully established between some PEs but not others, point-to-multipoint pseudo wire can be used for communication between those PEs where VC-LSPs using the same VC label value have successfully been established and point-to-point pseudo wire for the others, instead of simply giving up on using point-to-multipoint pseudo wire for all the PEs. The second embodiment describes establishing a VPN that combines point-to-multipoint pseudo wire and point-to-point pseudo wire.

[Variation 1]

The case will be considered where a point-to-multipoint pseudo wire has been established, with $PE11_2$ as the upstream PE, in a VPN instance with the same settings as in FIG. 4. FIG. 11 shows the configuration of this example. Three VC-LDPs – $PE11_2$-$PE11_1$, $PE11_2$-$PE11_3$, and $PE11_2$-$PE11_4$ – are established by carrying out the same process as in steps 2 to 6 of the first embodiment, with $PE11_2$ as the upstream PE and $PE11_1$, $PE11_3$, and $PE11_4$ as the downstream PEs. As mentioned above, the VC label is determined using [Label Min + P2MP Source endpoint ID - 1], and because the P2MP endpoint ID of $PE11_2$ is 2, this becomes [4001 + 2 - 1], yielding a unified label value of 4002. From the perspective of $PE11_3$ and $PE11_4$, 4001 is assigned to the VC label for traffic coming from $PE11_1$ and 4002 is assigned to the VC label for traffic coming from $PE11_2$.

[Variation 2]

A method in which some of the steps in the first embodiment are modified is also possible. The modifications are described below.

Step 2

The LDP label request message, including presets, sent by upstream $PE11_1$ to the downstream PEs belonging to VPN instance ID=100, contains the VPN instance ID and the P2MP Source endpoint ID, but not Label Min or Label Range.

Step 3

The downstream PE that receives this label request message only confirms that its own P2MP endpoint ID is different from the P2MP Source endpoint ID in the received message for the applicable VPN instance. The value of the label advertised by the downstream PEs is determined using [Label Min + P2MP Source endpoint ID - 1], and a value which has been pre-registered in the downstream PEs is used for Label Min.

Step 4

The upstream PE receiving the label advertisement message confirms whether the content thereof corresponds to the label request message that was sent by it. The Label Min value registered in the upstream PE and the Label Min value registered in the downstream PEs are confirmed as being the same for the first time in this step. If all the confirmations are successful, the received label value is taken as the VC label for the downstream PE.

[0018]

The rest is the same as in the first embodiment. In this way, the steps given in the first embodiment need not be limited to the pre-registration content, message content, or method of deriving the VC label value described above, as long as the specification allows the pre-registered downstream PEs to advertise the same VC label value to the upstream PE.

[Variation 3]

The first embodiment describes a combination of multicast tunneling technology and MPLS technology. Here, tunneling technology involves encapsulating data, including the label value determined between upstream and downstream nodes, and multicast tunneling technology involves copying and forwarding the encapsulated data in multiple directions. In addition, in MPLS technology, LDP is used to determine and advertise destination-indicating values (label values), and the downstream nodes determine destination-indicating values and advertise these values to the upstream node.

[0019]

The present invention can be most easily realized using techniques already established as the multicast tunneling and MPLS technology described above. However, a multicast circuit can be established in the same manner as in the first embodiment provided that the network is one in which downstream nodes determine destination-indicating values and advertise these values to upstream nodes, and in which data including the destination-indicating values determined between the nodes can be encapsulated and copied and forwarded in multiple directions.

[Second embodiment]

It will be assumed that $PE11_5$, which is incompatible with the present invention, has been added to the VPN instance (VPN instance ID = 100) shown in FIG. 4. Specifically, $PE11_5$ is a conventional PE that does not have the VC label reservation functionality needed to establish a point-to-multipoint pseudo wire. A case where the multicast data is transmitted from CD 10_1 to $PE11_1$, as in the first embodiment, is described using FIG. 12.

[0020]

$PE11_1$ attempts to establish a VC-LSP using the same VC label value with $PE11_2$ to $PE11_5$ through steps 2 to 5 of the first embodiment, and succeeds in establishing VC-LSPs with $PE11_2$ to $PE11_4$. However, because $PE11_5$ is a conventional PE (i.e., a PE that is incompatible with the present invention), a VC-LSP fails to be established with $PE11_5$. A VC-LSP is then established between $PE11_1$ and $PE11_5$ using conventional LDP technology. In this case, for the VC label for $PE11_5$, a value determined by $PE11_5$ is advertised to $PE11_1$, so the value is different from the VC label value for other downstream PEs. FIG. 12 shows an example in which the VC label value for $PE11_2$ to $PE11_4$ is 4001, but is 59 for $PE11_5$.

[0021]

A VC-LSP is successfully established between $PE11_1$ and the downstream PEs, but as indicated in "Problem to be Solved by the Invention," traffic having different VC labels cannot be communicated using the same multicast tunnel. Therefore, multicast tunneling technology is used for communication with $PE11_2$ to $PE11_4$, which have the same VC label value, while unicast tunneling technology is used for communication with $PE11_5$.

It is thus possible to establish a VPN that combines point-to-multipoint pseudo wire and point-to-point pseudo wire.

[Variation]

It should be noted that it is also possible simply to pre-register $PE11_5$ as a conventional PE in $PE11_1$ and immediately use conventional LDP technology in the flow for establishing a VC-LSP with $PE11_5$, without trying the steps of the first embodiment. However, such registration must be done not only in $PE1_{11}$ but also in $PE11_2$ to $PE11_4$, which entails the cumbersomeness of registration in other PEs when adding or removing PEs.

[Third embodiment]

With the present invention, different VPN multicast traffic can also be multiplexed in the same multicast tunnel. FIG. 13 shows an example of this. $PE11_1$ establishes a different point-to-multipoint pseudo wire for two VPN instances (VPN instance ID=100 and 110). For the point-to-multipoint pseudo wire with a VPN instance ID of 110, the P2MP endpoint ID set in $PE11_1$ is 2, and Label Min is 5001, so the value of the VC label is [5001 + 2 - 1 = 5002]. For the point-to-multipoint pseudo wire with VPN instance ID 100, a VC label value of 4001 is used. By setting Label Min and Label Range for each VPN instance this way, the use of overlapping VC label values in different VPN instances is prevented. Because the VC labels are different, downstream PEs can identify VPNs even if the traffic is coming through the same multicast tunnel, allowing demultiplexing.

[Fourth embodiment]

An example of a functional configuration of a PE for realizing the present invention is shown in FIG. 14. Although the PE has many functions unrelated to the present invention, functions unrelated to the present invention are generally omitted in the drawing. Because the PE may be an upstream or downstream PE, it must be provided with functionality allowing it to serve both as an upstream and downstream PE in the steps given in the first embodiment. The PE must also have some type of functionality for encapsulating and transferring data including VC labels for tunneling technology such as MPLS tunneling and IP tunneling. The following description describes the functions of each part in FIG. 14 in accordance with the steps in the first embodiment.

Configuration for realizing step 1

Information for each VPN instance is pre-registered in the PE. Upon receiving the pre-registered information, the PE registers it in a recording unit 114. This function serves to register the VPN Instance ID, the P2MP endpoint ID, Label Min, Label Range, and so on, which are information for reserving VC label values, in the PE.

Configuration for realizing step 2

The upstream PE needs to send a label request message, to which various values managed by the upstream PE have been added, to the downstream PEs. PE11 has a label request message generation unit 115, in which a label request message is generated by generating and adding (115c) a conventional label request message (115a) and a message (115b) added for purposes of the present invention, based on the information in the recording unit 114. However, in cases of a combination with a point-to-point pseudo wire, as in the third embodiment, only the conventional label request message (115a) is generated for downstream PEs to which a point-to-point pseudo wire is to be established. The generated label request message is sent to the downstream PEs.

Configuration for realizing step 3

When PE11 receives a label request message, the label request message is sent to a label advertisement message generation unit 116 and compared to the information in the recording unit 114 (116a). When all consistency checks have been successfully completed, a VC label value is determined using [Label Min + P2MP Source endpoint ID - 1] and a label advertisement message is transmitted to the upstream PE.

Configuration for realizing step 4

When the PE receives the label advertisement message, it uses a VC label value confirmation unit 117 to confirm whether the content corresponds to the label request message which it sent, and records the received label value as the VC label for the downstream PE in the recording unit 114.

Configuration for realizing step 5

Step 5 is a step in which steps 2 to 4 are repeated for all downstream PEs, and can therefore be handled using conventional functions for transmitting multicast data.

Configuration for realizing step 6

PE11 confirms VC-LSP establishment and initiates forwarding of traffic. When PE11 is operating as an upstream PE, it uses a VC label assignment unit 118 to confirm (118a) the destination PE, assign a VC label to the data (118b), and transmit the data. The VC label is assigned one time if the VPN is configured using only one point-to-multipoint pseudo wire, but two or more times if the VPN also uses point-to-point pseudo wire, as in the third embodiment. For example, in the case of $PE11_1$ in FIG. 12, VC label assignment is performed two times because there are two VC labels for the same VPN. When PE11 is operating as a downstream PE, it receives VC-labeled data, removes the VC label with a VC label removal unit 119, and transmits the data to CEs under it. This function is the same as the conventional function.

[0022]

If an error occurs in any of the steps, LDP error processing is performed in accordance with the conventional pseudo wire specification.

[Brief Description of the Drawings]

[0023]

[FIG. 1] A drawing illustrating an example of a network configuration providing VPLS.

[FIG. 2] A drawing illustrating problems which arise when combining multicast tunneling with conventional pseudo wire technology.

[FIG. 3] A drawing illustrating tunneling technology when sending multicast data using conventional pseudo wire technology.

[FIG. 4] A drawing illustrating an example of presets for individual VPN instances.

[FIG. 5] A drawing illustrating $PE1_{11}$ sending a label request message to $PE11_2$.

[FIG. 6] A drawing illustrating $PE11_2$ sending a label advertisement message to $PE11_1$.

[FIG. 7] A drawing illustrating $PE11_1$ sending a label request message to $PE11_4$.

[FIG. 8] A drawing illustrating $PE11_4$ sending a label advertisement message to $PE11_1$.

[FIG. 9] A drawing illustrating an example of settings upon completion of a point-to-multipoint pseudo wire establishment.

[FIG. 10] A drawing illustrating $PE11_1$ using an established VC-LSP to forward traffic to $PE11_2$, $PE11_3$, and $PE11_4$.

[FIG. 11] A drawing illustrating an example of settings when point-to-multipoint pseudo wire has been established in which $PE11_2$ is the upstream PE in a VPN instance having the same settings as in FIG. 4.

[FIG. 12] A drawing illustrating an example of a VPN in which point-to-multipoint pseudo wire and point-to-point pseudo wire are used.

[FIG. 13] A drawing illustrating an example of multiplexing different VPN multicast traffic in the same multicast tunnel.

[FIG. 14] A drawing illustrating an example of a functional configuration of a PE.

[FIG. 1]

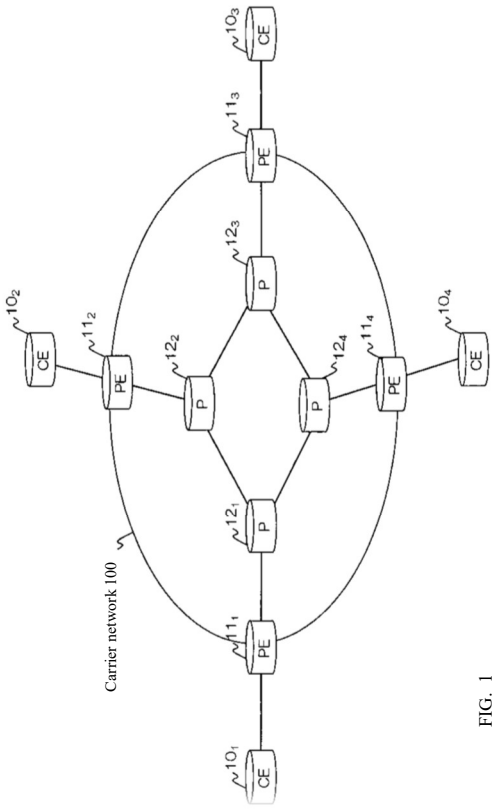

FIG. 1

[FIG. 2]

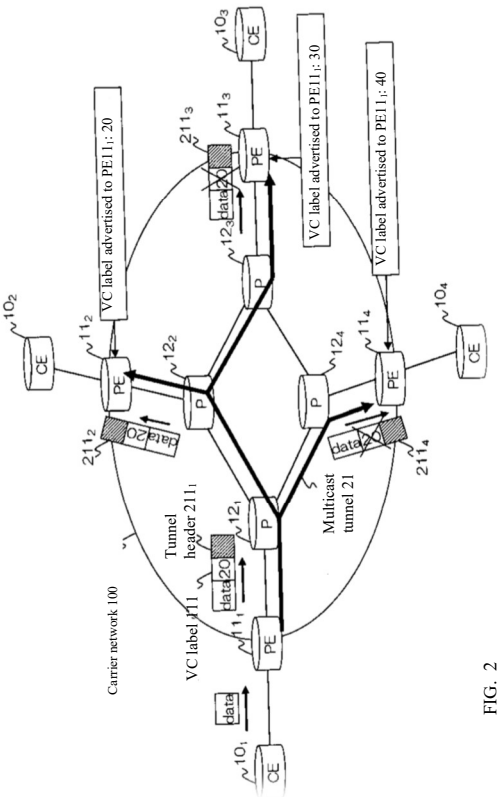

FIG. 2

[FIG. 5]

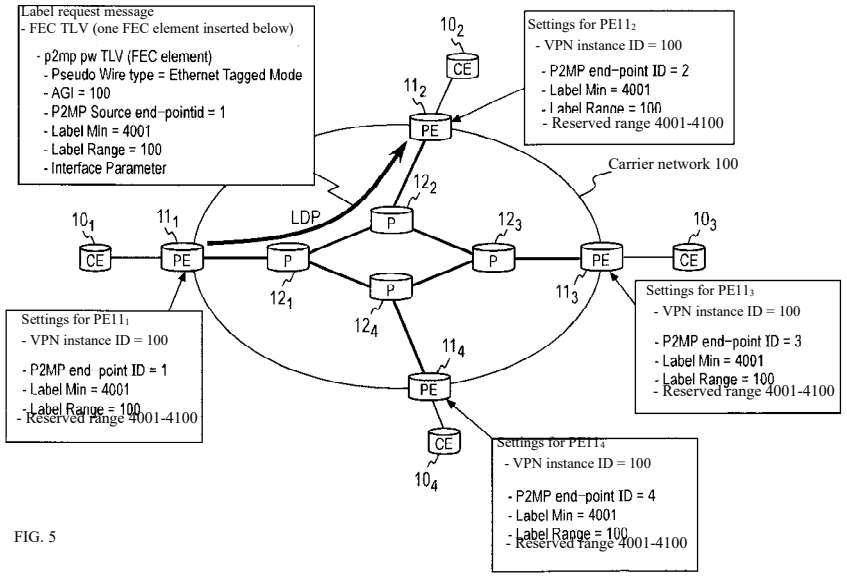

FIG. 5

[FIG. 3]

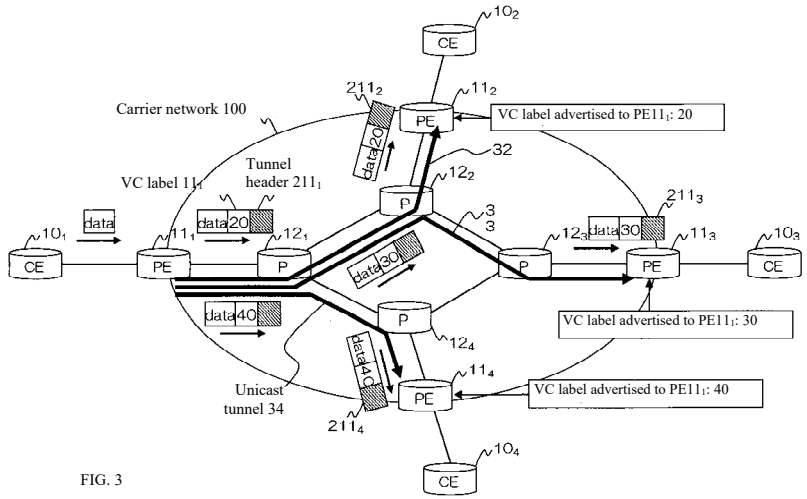

FIG. 3

[FIG. 6]

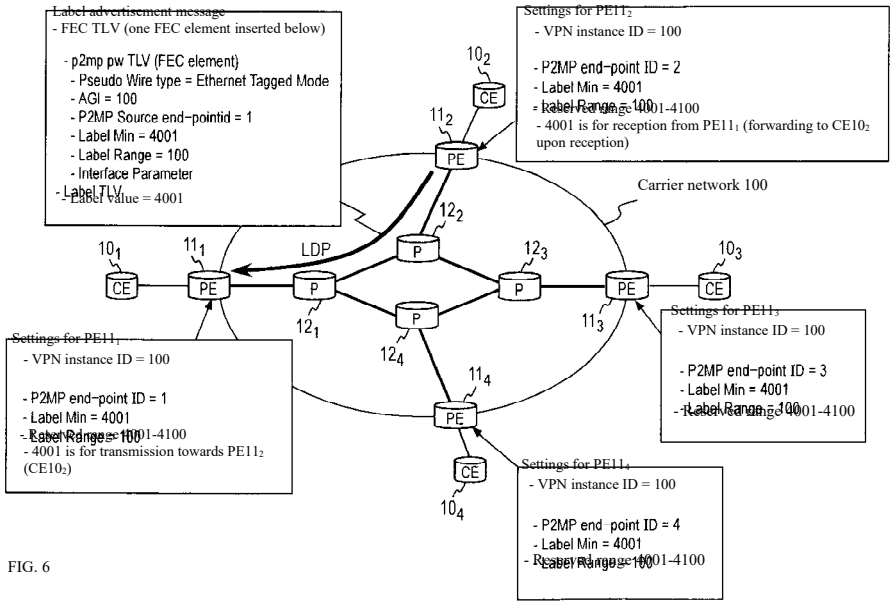

FIG. 6

[FIG. 4]

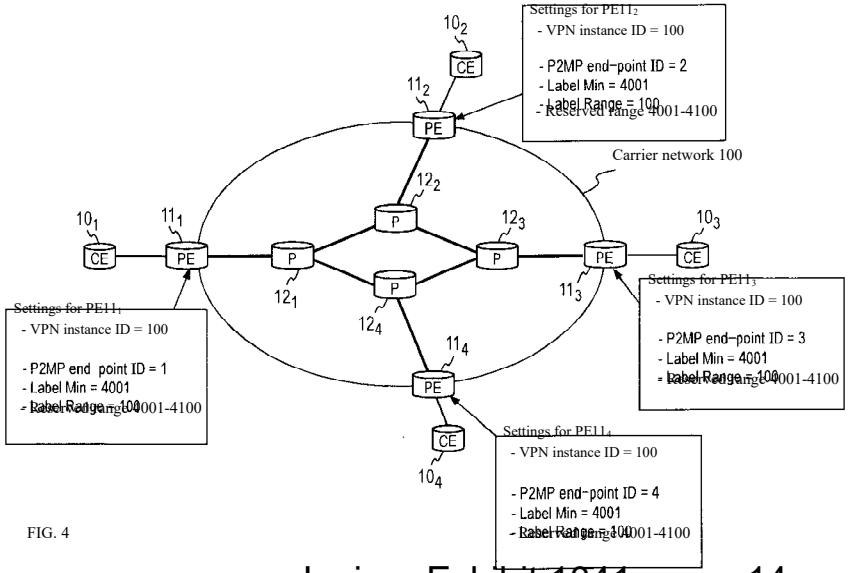

FIG. 4

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(13) JP 2006-129339 A 2006.5.18

[FIG. 9]

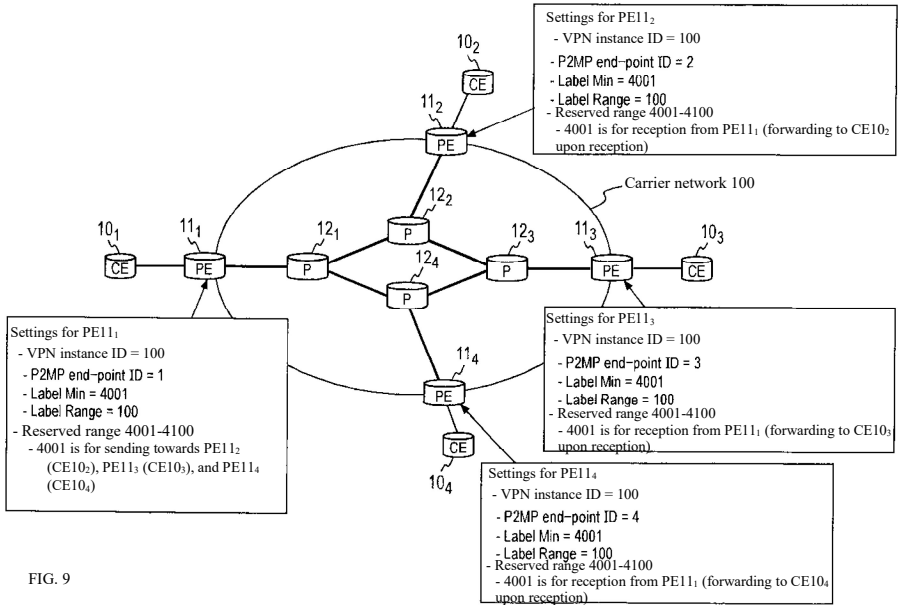

FIG. 9

[FIG. 7]

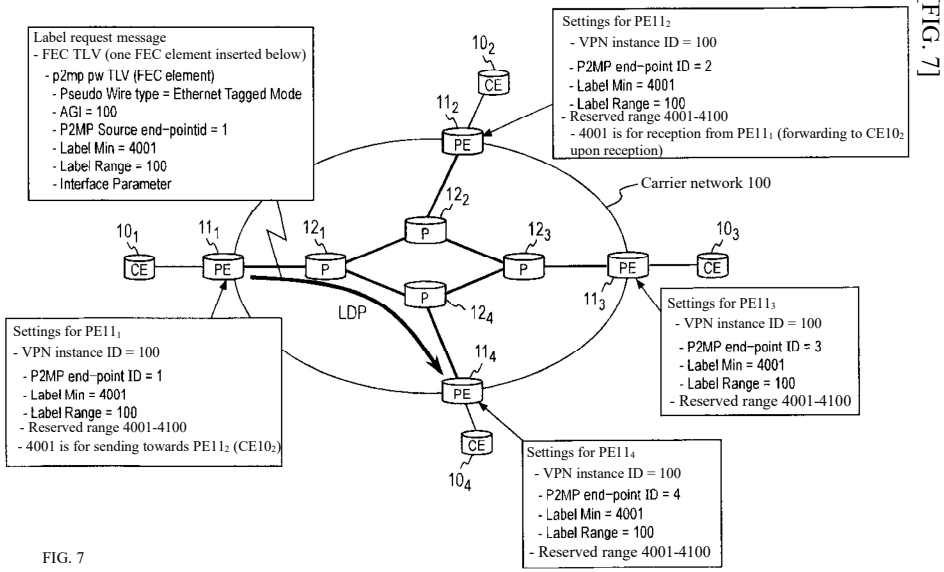

FIG. 7

[FIG. 10]

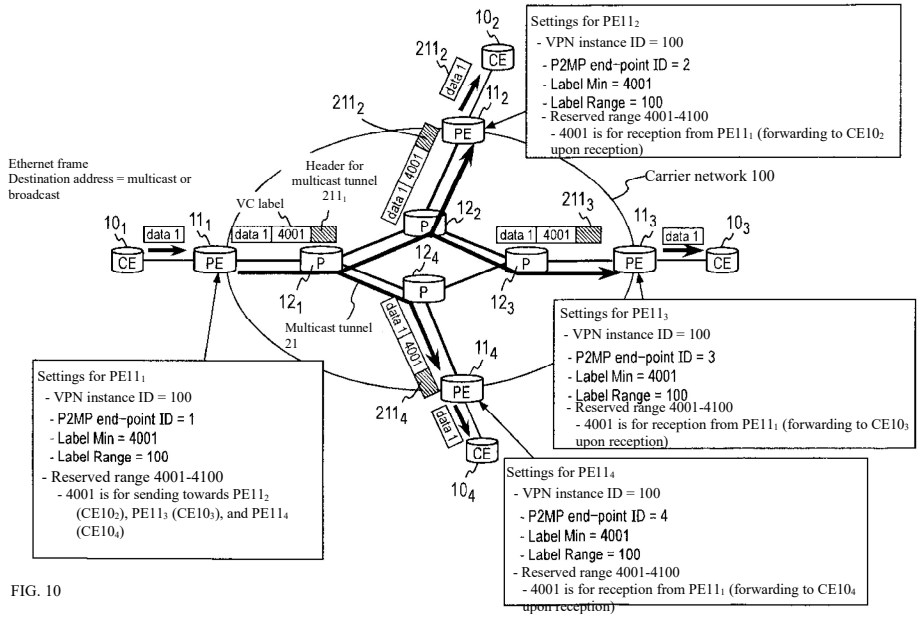

FIG. 10

[FIG. 8]

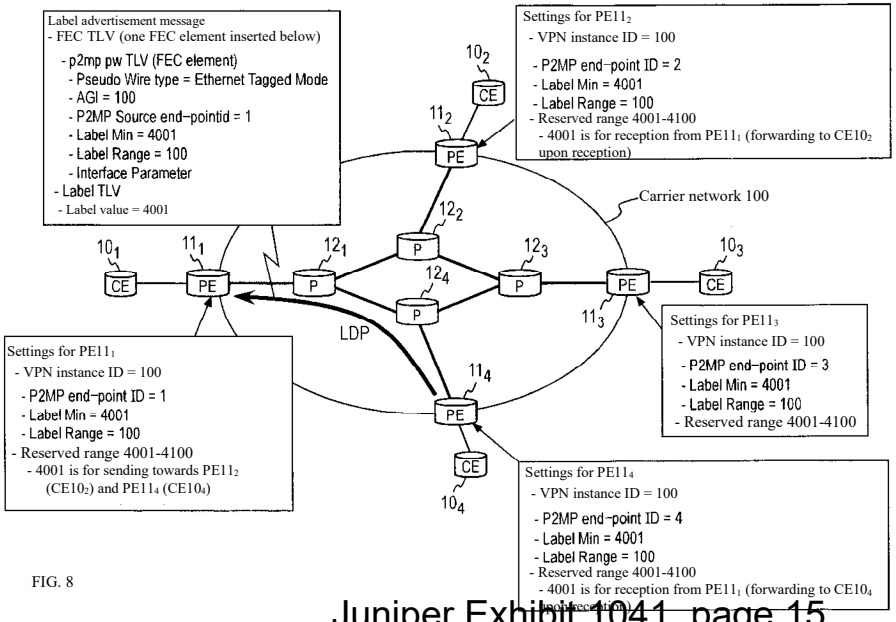

FIG. 8

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(14) JP 2006-129359 A 2006.5.18

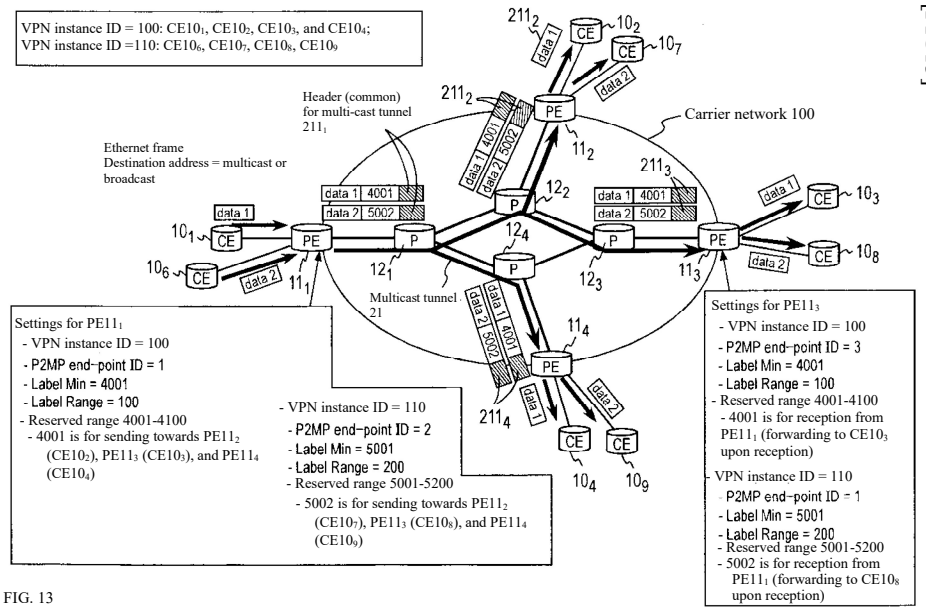

FIG. 13

[FIG13]

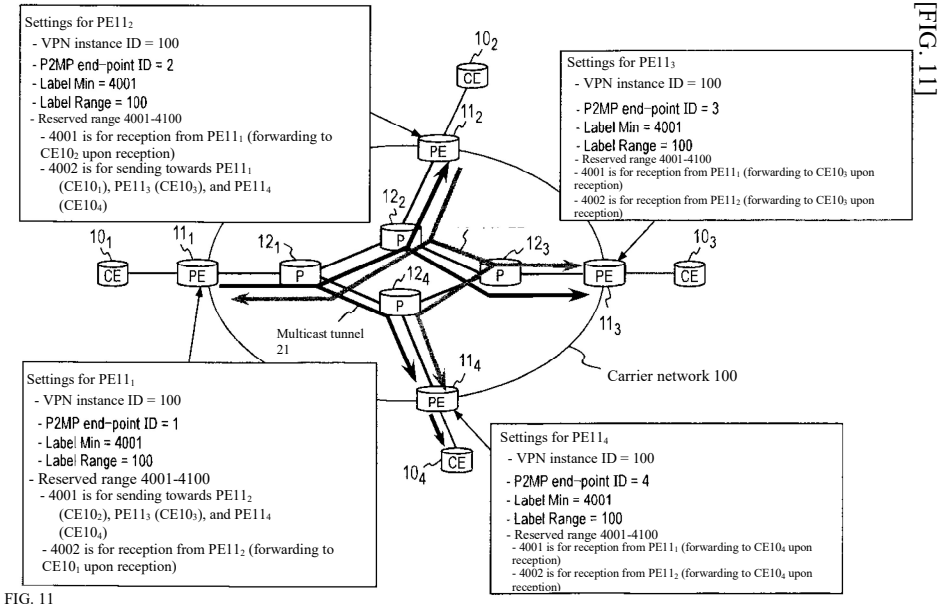

FIG. 11

[FIG. 11]

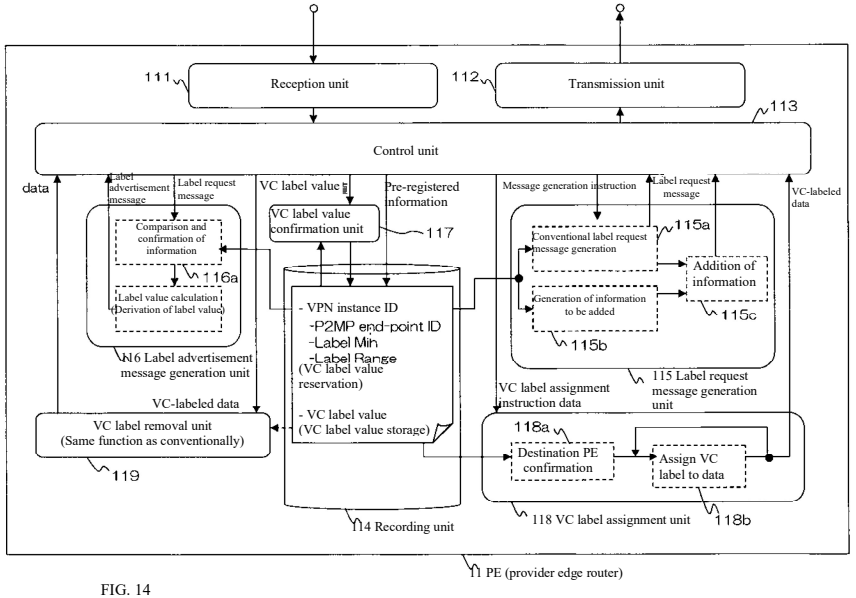

FIG. 14

[FIG14]

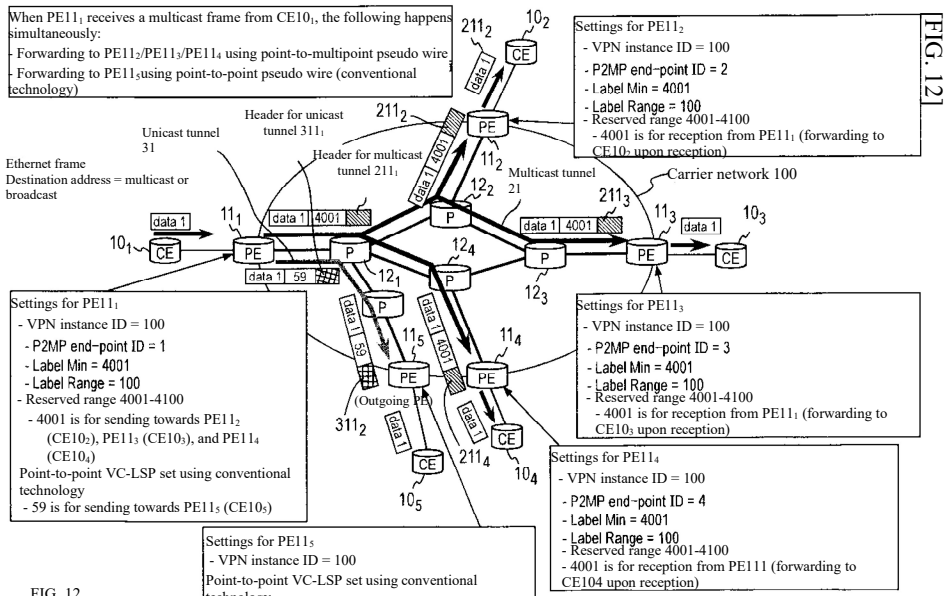

FIG. 12

[FIG. 12]

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Continuation of Front Page

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