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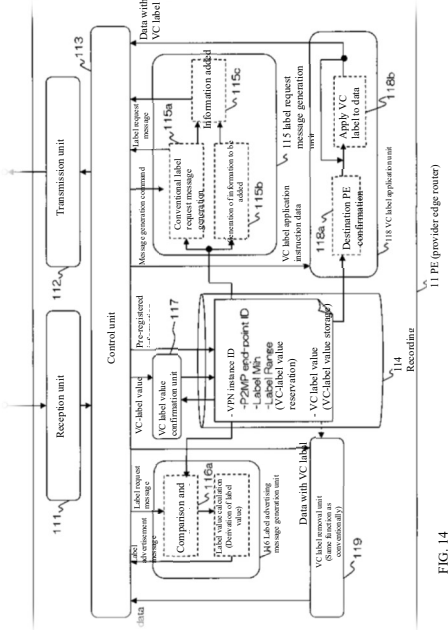
(54)[Title of the Invention] Method for Establishing Multicast Circuit, Communication System Using Said Method, Communication Device, Method for Controlling Communication Device, and Program

(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 transfer 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 range of label values 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 the results are advertised to the upstream PE.

[Selected Diagram] FIG. 14



[Scope of Patent Claims]

[Claim 1]

A method for establishing a multicast virtual circuit, being a method for establishing a multicast virtual circuit using multi-protocol label switching (MPLS) technology, wherein
information for reserving a set range of label values for multiple PEs (provider edge routers) for a multipoint connection group constituting a VPN (virtual private network) (hereinafter referred to as a VPN instance) is registered, and
if one of the reserved PEs (hereinafter referred to as reserved PEs) becomes an upstream PE of the VPN instance, the downstream reserved PEs advertise the same VC-label values as the other downstream reserved PEs to the upstream PE.

[Claim 2]

A system that establishes a multicast virtual circuit, being a system that establishes a multicast virtual circuit using MPLS technology, comprising
a means for registering information for reserving a set range of label values for multiple PEs of a VPN instance; and
a means whereby, if one of the reserved PEs becomes an upstream PE of the VPN instance, the downstream reserved PEs advertise the same VC-label values as the other downstream reserved PEs to the upstream PE.

[Claim 3]

The system as claimed in claim 2, comprising
a means whereby the upstream reserved PE transmits all or some of the label information of the reserved range of the upstream PE to the downstream PEs.

[Claim 4]

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A device capable of establishing a multicast virtual circuit using MPLS technology as a provider edge router, comprising
a means for registering information for reserving a range of label values; and
a means for deriving the same VC-label values as other devices of the same VPN instance.

[Claim 5]

The device as claimed in claim 4, comprising
a means for sending a message containing information about the reserved label values.

[Claim 6]

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The device as claimed in claim 4 or 5, comprising
a means for registering a number identifying at least a VPN instance, a value determining the range of label values to reserve, and a number identifying PEs in the same VPN instance.

[Claim 7]

The device as claimed in claim 6, comprising
a means for transmitting a number that identifies at least a VPN instance, a value that determines the set range of label values to be reserved, and a number that identifies PEs in the same VPN instance, as information about the reserved label values.

[Claim 8]

The device as claimed in claim 7, comprising
a means for finding a VC-label value using [Label Min + upstream PE P2MP endpoint ID - 1].

[Claim 9]

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The device as claimed in any one of claims 4 to 8, comprising
a means for comparing the reserved information with the received label value information to confirm that the reserved range of label values is the same.

[Claim 10]

The device as claimed in any one of claims 4 to 9, comprising
a means for confirming that the advertised label values match the derived label values based on the transmitted information about the labels.

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[Claim 11]

The device as claimed in any one of claims 4 to 10, comprising
a means for establishing a point-to-point virtual circuit with PEs for which a point-to-multipoint virtual circuit cannot be established.

[Claim 12]

A method for controlling a provider edge router, being a method for controlling a provider edge router that establishes a multicast virtual circuit using MPLS technology, wherein
information for reserving a set range of label values for a VPN instance is registered,
the same VC-label values as other devices in the same VPN instance are derived, and
the derived VC-label values are advertised.

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[Claim 13]

A method for establishing a multicast circuit in a network where downstream nodes determine values indicating destinations and advertise same to upstream nodes, being a network where data including the values indicating destinations determined among the nodes can be encapsulated, copied, and transferred in multiple directions, wherein
information for reserving values indicating a set range of destinations for multiple nodes in a group that establishes a multicast circuit connection is registered, and
if one of the reserved nodes (hereinafter referred to as reserved nodes) becomes an upstream node of the group, the downstream reserved nodes advertise the same values indicating destinations as the other downstream reserved nodes to the upstream node.

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[Claim 14]

A multicast circuit system, being a system that establishes a multicast circuit in a network where downstream nodes determine values indicating destinations and advertise same to upstream nodes, being a network where data including the values indicating destinations determined among the nodes can be encapsulated, copied, and transferred in multiple directions, comprising

a means for registering information for reserving values indicating a set range of destinations for multiple nodes in a group that establishes a multicast circuit connection, and
a means whereby, if one of the reserved nodes becomes an upstream node of the group, the downstream reserved nodes advertise the same values indicating destinations as the other downstream reserved nodes to the upstream node.

[Claim 15]

A communication device, being a communication device capable of establishing a multicast circuit in a network where downstream nodes determine values indicating destinations and advertise same to upstream nodes, being a network where data including the values indicating destinations determined among the nodes can be encapsulated, copied, and transferred in multiple directions, comprising

a means for registering information for reserving values indicating a set range of destinations; and
a means for deriving a value indicating the same destination as another device in a group establishing the same multicast circuit connection.

[Claim 16]

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A method for controlling a communication device capable of establishing a multicast circuit in a network where downstream nodes determine values indicating destinations and advertise same to upstream nodes, being a network where data including the values indicating destinations determined among the nodes can be encapsulated, copied, and transferred in multiple directions, wherein

information for reserving values indicating a range of destinations for a group establishing a multicast circuit connection is registered, a value indicating the same destination as other devices in the group is derived, and the derived value indicating a destination is advertised.

[Claim 17]

A communication program that causes a computer to run the system or device as claimed in any of claims 2 to 11, 14, or 15.¹⁰

(Detailed Description of the Invention)

[Technical field]

【 0 0 0 1 】

The present invention relates to techniques for establishing multicast circuits.

[Background Art]

【 0 0 0 2 】

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

Methods for building pseudo wires using MPLS technology are particularly widespread. Using such methods, layer 2 frames²⁰ sent to a PE from a CE (Customer Edge Router) can be labeled (VC-labeled) to distinguish subscriber lines, and then encapsulated and transferred using the carrier network transfer protocol. This allows multiplexing and forwarding of signals of different subscribers in the carrier network.

【 0 0 0 3 】

Tunnel technology is generally used for the above encapsulation. When labels for tunnels (labels for transfer in the carrier network) are stacked on the VC-label, P (the provider router) sees only the outer label, so data containing the VC-label is encapsulated. Tunnel technology includes MPLS tunnels and IP tunnels, and not only has unicast tunnel technology for point-to-point been established, but also multicast tunnel technology for point-to-multipoint. Multicast tunnel technology is a technology in which the P copies and transfers all data located at the upper layer of the tunnel in multiple directions. In other words, all data other than the tunnel label is copied, including the VC label.³⁰

【 0 0 0 4 】

LDP (Label Distribution Protocol) (Non-Patent Literature 1) is often used as the VC-label setting method. In LDP, the Ps making up the backbone or the PEs typically located downstream of traffic, assign a label value that can be received and identified by themselves, and advertise that label value and ancillary information to the upstream PE or P using LDP. However, if the above 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 PEs regardless of any Ps in between. In other words, the downstream PEs assign the values of the VC-labels and advertise that to the upstream PE.

【 0 0 0 5 】

On the other hand, conventional pseudo wire technology is based on point-to-point, and a set of PEs is established in units of one set per subscriber line. A multipoint layer 2 VPN technology using pseudo wire technology is Virtual Private LAN Service (VPLS), which provides multipoint Ethernet (Registered Trademark) connectivity, but it is realized using a full mesh point-to-point pseudo wire and does not exceed the scope of 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]

【 0 0 0 6 】

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Conventional pseudo wire technology based on point-to-point connections applies VC-labels for VC-LSP traffic transfer to packets to be carried. If a PE (the upstream PE) receives multicast data from a CE, the upstream PE applies a VC-label and sends the data to the requisite PEs (downstream PEs). However, it is normal for the VC-label to 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 transfers all data located at the upper layer of the tunnel in multiple directions, as described above. In other words, because it is a technology that copies and transfers data including VC-labels, it has not been possible to combine pseudo wire technology with multicast tunnel technology because 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 sending multicast data, the upstream PE has established a unicast tunnel with multiple downstream PEs individually and communicated using pseudo wire technology.

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【 0 0 0 7 】

Reasons why conventional pseudo wire technology and multicast tunneling technology could not be combined are explained again using Figures 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. Let us assume that multicast data for users CE10₂, CE10₃ and CE10₄ has been sent to PE11₁ from CE10₁. PE11₁ sends an LDP label request message to PE11₂. PE11₂ determines the value of the VC-label and sends the VC-label value to PE11₁ in an LDP label advertisement message. In the example of FIG. 2, 20 is advertised. PE11₁ then sends an LDP label request message to PE11₃, and PE11₃ determines the value of the VC-label and sends the VC-label value to PE11₁ in an LDP label advertisement message. In the example of FIG. 2, 30 is advertised. Let us assume that after a similar procedure, PE11₄ has advertised 40 as the value of the VC-label. As noted above, the VC-label value is determined by a downstream PE, 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, the same VC-label data reaches PE11₂, PE11₃, and PE11₄. In the example in FIG. 2, although PE11₁ is transmitting with a VC-label value of 20, data having a VC-label value of 20 will also reach PEs other than PE11₂ (PE11₃ and PE11₄) which had advertised 20 as the VC-label value, rendering communication impossible. Thus, as shown in FIG. 3, PE11₁ establishes a unicast tunnel separately with PE11₂, PE11₃, and PE11₄, copies data from CE10₁, and sends it with the advertised VC-label for each downstream PE. In this way, even though the data actually desired to be sent (the data received from CE10₁) is the same, there are three instances of traffic between PE11₁ and P 12₁. In other words, if a multicast tunnel could be utilized using a common VC-label for the downstream PEs, the traffic between PE11₁ and P 12₁ could be made 1/3 that of conventionally.

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【 0 0 0 8 】

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 transfer pseudo wire traffic using a multicast tunnel.

[Means for Solving the Problem]

【 0 0 0 9 】

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 are the same, and the results are advertised to the upstream PE.

[Effects of the Invention]

【 0 0 1 0 】

This method allows pseudo wire traffic to be transferred 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.]

【 0 0 1 1 】

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 VPN access lines that provide multipoint connectivity. 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.

【 0 0 1 2 】

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 and Label Min + Label Range as candidates for use in VC-labels in the VPN instance, and do not use them 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 also parameters other than these two 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.

【 0 0 1 3 】

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 used solely for multicast traffic in the VPN instance make it easy to determine label values used for multicast traffic without overlapping with other traffic label values. By setting Label Min larger than the label value 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 facilitates management so as to apply non-overlapping label values for each network unit that is being managed.

【 0 0 1 4 】

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

Pseudo wire type is determined by physical lines and is also used in the conventional point-to-point pseudo wire specification (Non-Patent Literature 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 Literature 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 P2MP Source endpoint ID. Interface Parameter is used in the conventional point-to-point pseudo wire specification (Non-Patent Literature 1). In the present invention, this parameter is used as-is.

【 0 0 1 5 】

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, an arbitrary number which 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 operator in each router, or may be set in each PE using some external protocol or application. Example settings are shown in FIG. 4. For 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. Let us assume that for each PE, P2MP endpoint ID, Label Min, and Label Range are registered, but for VPN instance ID=100, that 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.

【 0 0 1 6 】

By thus reserving VC-label values for multicast traffic in the VPN instance in the same range for all PEs making up one VPN instance, it is not necessary to send a label request message from the upstream PE asking for arbitrary VC-label values or to query all PEs in the VPN instance for open VC-label values.

Step 2

Next, settings are configured for transferring point-to-multipoint traffic from CE10₁ to CE10₂, CE10₃, and CE10₄. First, PE 11₁, which is on the sending side, sends an LDP label request message to the downstream PEs belonging to VPN instance ID = 100, which has the presets. This label request message contains various values managed by the upstream PE in the FEC TLV. FIG. 5 shows PE11₁ sending a label request message to PE11₂ with P2MP Source endpoint ID=1, Label Min=4001, and Label Range=100.

Step 3

The downstream PE receiving this label request message confirms that Label Min and Label Range, which they are managing, are the same as what is in the received message for the applicable VPN instance. 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 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, LDP error messages are sent 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, the LDP label advertisement message is sent to the upstream PE. FIG. 6 shows a message being sent from PE11₂, which is a downstream PE, to PE11₁, which is the upstream PE. This transmission is a copy of the content received from PE11₂ and the value of the label being advertised. The value of the label being advertised is the value defined as [Label Min + P2MP Source endpoint ID - 1]. In FIG. 6, a label value of 4001 is assigned by calculating [4001 + 1 - 1] and sent to PE11₁.

Step 4

The upstream PE receiving the label advertisement message confirms whether the content thereof corresponds to the label request message that was sent. If the confirmation fails, the VC-LSP is not established in accordance with conventional pseudo wire technical specifications. If all the confirmations are successful, the received label value is the VC-label for the downstream PE. In the case of FIG. 6, PE11₁ uses 4001 as the VC-label to PE11₂.

Step 5

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Steps 2 through 4 above are repeated for all downstream PEs that propagate the point-to-multipoint pseudo wire. Figures 7 and 8 show examples of the interaction between PE11₁ and PE11₄. This interaction is the same as the interaction between PE11₁ and PE11₂, and ultimately three VC-LSPs – PE11₁-PE11₂, PE11₁-PE11₃, and PE11₁-PE11₄ – have a VC-label value of 4001. FIG. 9 shows the settings once 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 transfer 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.

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【 0 0 1 7 】

In addition, if VC-LSPs are successfully established among some PEs but not others, point-to-multipoint pseudo wire can be used for communication among 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 among all the PEs. The second embodiment describes establishing a VPN that combines point-to-multipoint pseudo wire and point-to-point pseudo wire.

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[Variation 1]

Let us consider a case where a point-to-multipoint pseudo wire has been established, with PE11₂ as the upstream PE, in a VPN instance with the same configuration as FIG. 4. FIG. 11 shows the configuration of this example. Three VC-LDPs – PE11₂-PE11₁, PE11₂-PE11₃, and PE11₂-PE11₄ – are established by carrying out the same process as in steps 2 to 6 of the first embodiment, with PE11₂ as the upstream PE and PE11₁, PE11₃, and PE11₄ as the downstream PEs. As mentioned above, the VC-label is found as [LabelMin + P2MP Source endpoint ID - 1], and because the P2MP endpoint ID of PE11₂ is 2, the VC-label value is [4001 + 2 - 1], i.e., 4002. From the perspective of PE11₃ and PE11₄, 4001 is applied to the VC-label for traffic coming from PE11₁ and 4002 is applied to the VC-label for traffic coming from PE11₂.

[Variation 2]

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

Step 2

The LDP label request message sent by upstream PE11₁ to the downstream PEs belonging to VPN instance ID=100 with the presets includes 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 defined as [Label Min + P2MP Source endpoint ID - 1], and a value which has been pre-registered in the downstream PEs is used for Label Min.

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Step 4

The upstream PE receiving the label advertisement message confirms whether the content thereof corresponds to the label request message that was sent. The same 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 the VC-label for the downstream PE.

【 0 0 1 8 】

The rest is the same as in the first embodiment. The steps thus 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 pre-registered downstream PEs can 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. Tunneling involves encapsulating data including label values determined between upstream and downstream nodes, and multicast tunneling involves copying and transferring the encapsulated data in multiple directions. In addition, MPLS technology uses a LDP to determine and advertise values indicating a destination (label values), while the downstream nodes determine values indicating a destination and advertise this to the upstream node.

【 0 0 1 9 】

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 in networks where downstream nodes determine values indicating destinations and advertise these to upstream nodes, and data including the values indicating destinations determined among the nodes can be encapsulated, copied, and transferred in various directions.

[Second embodiment]

PE11₅, which is incompatible with the present invention, has been added to the VPN instance (VPN instance ID = 100) shown in FIG. 4. Specifically, PE11₅ 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 sent from CD 10₁ to PE11₁, as in the first embodiment, is described using FIG. 12.

【 0 0 2 0 】

PE11₁ attempts to establish a VC-LSP using a single VC-label values with PE11₂ to PE11₅ through steps 2 to 5 of the first embodiment, and succeeds in establishing VC-LSPs with PE11₂ to PE11₄. However, because PE11₅ is a conventional PE (i.e., a PE that is incompatible with the present invention), a VC-LSP fails to be established with PE11₅. A VC-LSP is established between PE11₁ and PE11₅ using conventional LDP technology. In this case, the VC-label for PE11₅ has been determined by PE11₅ and advertised to PE11₁, and therefore has a value which is different from the VC-label value for other downstream PEs. FIG. 12 shows an example in which the VC-label value for PE11₂ to PE11₄ is 4001, but 59 for PE11₅.

【 0 0 2 1 】

A VC-LSP is successfully established between PE11₁ and the downstream PEs, but as indicated in “Problem to be Solved by the Invention,” traffic having different VC-labels cannot be communicated using a single multicast tunnel. Therefore, multicast tunneling is used for communication with PE11₂ to PE11₄ using a single VC-label value, while unicast tunneling is used for communication with PE11₅.

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 PE11₅ as a conventional PE in PE11₁ and use conventional LDP technology to establish a VC-LSP with PE11₅, skipping the steps in the first embodiment. However, such registration must be done not only in PE11₁ but also in PE11₂ to PE11₄, 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. PE11₁ 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 PE11₁ is 2, and Label Min is 5001, so the value of the VC-label is $[5001 + 2 - 1 = 5002]$. The point-to-multipoint pseudo wire with VPN instance ID 100 uses a VC-label value of 4001. By setting Label Min and Label Range for each VPN instance this way, using 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 omitted 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. PE must also have some type of functionality for encapsulating and transmitting data including VC-labels for tunneling techniques 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 realizing step 1

Information for each VPN instance is registered ahead of time in the PE. Upon receiving the pre-registered information, the PE registers it in a recording unit 114. This function registers 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 realizing step 2

The upstream PE sends a label request message with the various values managed by the upstream PE 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 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 establishing a point-to-point pseudo wire. The generated label request message is sent to the downstream PEs.

Configuration realizing step 3

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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 obtained by finding [Label Min + P2MP Source endpoint ID - 1] and a label advertisement message is sent 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 see whether the content corresponds to the label request message which was sent, and records the received label value as the VC-label for the downstream PEs in the recording unit 114.

Configuration for realizing step 5

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In step 5, steps 2 to 4 are repeated for all downstream PEs, and can therefore be handled using the conventional function used when of sending multicast data.

Configuration for realizing step 6

PE11 confirms that a VC-LSP has been established and initiates transfer of traffic. When PE11 is operating as an upstream PE, it uses a VC-labeling unit 118 to confirm (118a) the destination PE, apply the VC-label to the data (118b), and send the data. The VC-label is applied once if the VPN is configured using only one point-to-multipoint pseudo wire, but twice or more times if the VPN also uses point-to-point pseudo wire, as in the third embodiment. For example, in the case of PE11₁ in FIG. 12, VC-labeling is done twice because there are two VC-labels for the same VPN. When PE11 is operating as a downstream PE, it receives the VC-labeled data, removes the VC-label with a VC-label removal unit 119, and sends the data to a lower CE. 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 40 specification.

[Brief Description of the Drawings]

[0023]

FIG. 1 is a view showing an example of a network configuration providing a VPLS.

FIG. 2 is a view showing problems which arise when combining multicast tunneling with conventional pseudo wire technology.

FIG. 3 is a view showing tunneling technology when sending multicast data using conventional pseudo wire technology.

FIG. 4 is a view showing an example of presets by VPN instance.

FIG. 5 is a view showing PE1₁₁ sending a label request message to PE1₁₂.

FIG. 6 is a view showing PE1₁₂ sending a label advertisement message to PE1₁₁.

FIG. 7 is a view showing PE1₁₁ sending a label request message to PE1₁₄.

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FIG. 8 is a view showing PE1₁₄ sending a label advertisement message to PE1₁₁.

FIG. 9 is a view showing an example of settings upon completion of a point-to-multipoint pseudo wire.

FIG. 10 is a view showing PE1₁₁ using an established VC-LSP to transfer traffic to PE1₁₂, PE1₁₃, and PE1₁₄.

FIG. 11 is a view showing an example of settings when point-to-multipoint pseudo wire has been established in which PE1₁₂ is the upstream PE in a VPN instance having the same settings as in FIG. 4.

FIG. 12 is a view showing an example of a VPN in which point-to-multipoint pseudo wire and point-to-point pseudo wire are used.

FIG. 13 is a view showing an example of multiplexing different VPN multicast traffic in one multicast tunnel.

FIG. 14 is a view showing an example of a functional configuration of a PE.

[FIG. 1]

[FIG. 2]

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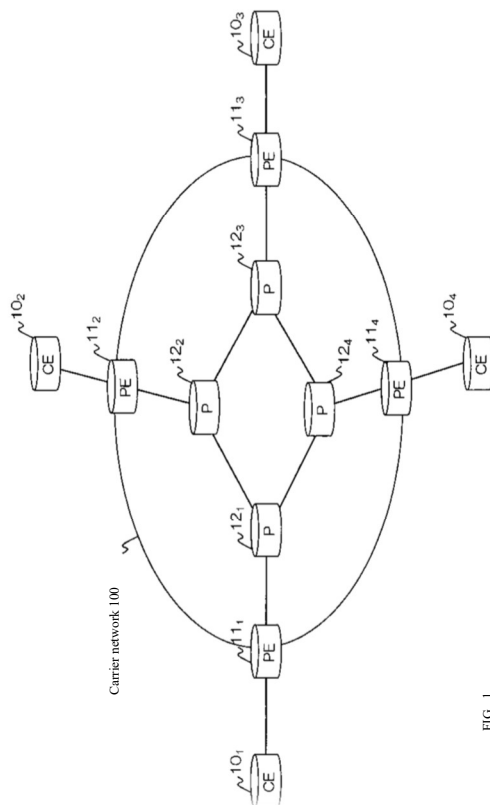


FIG. 1

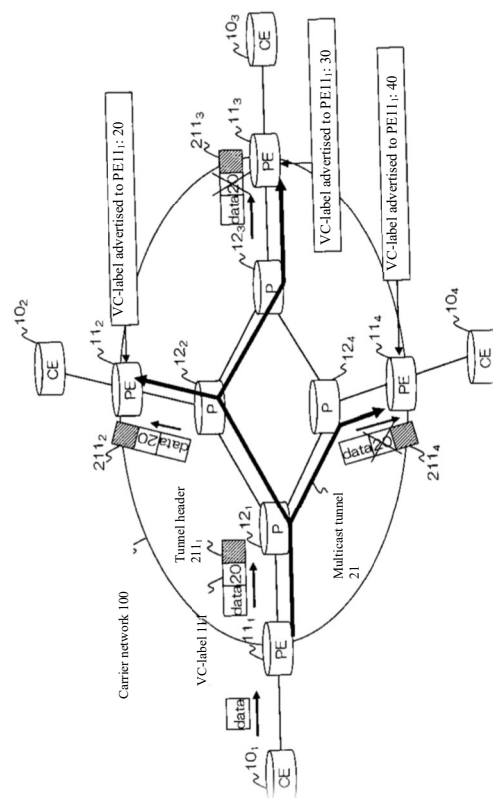
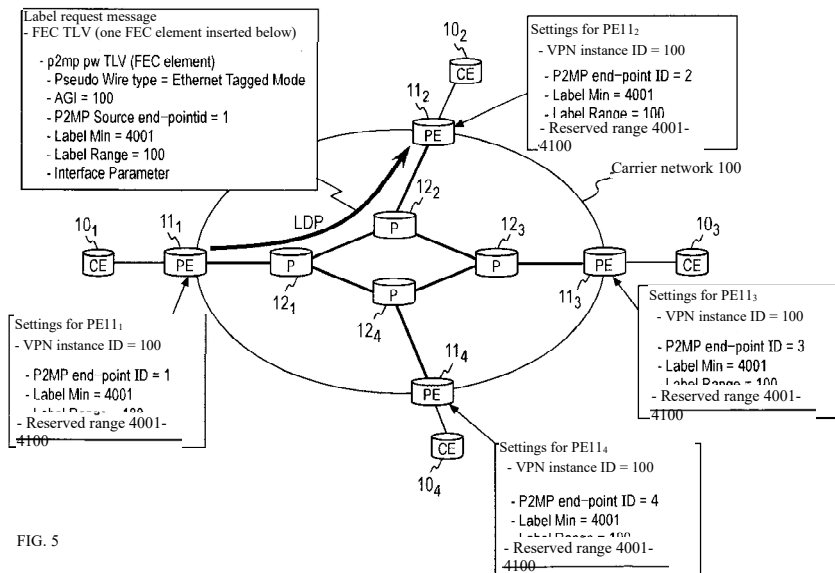


FIG. 2

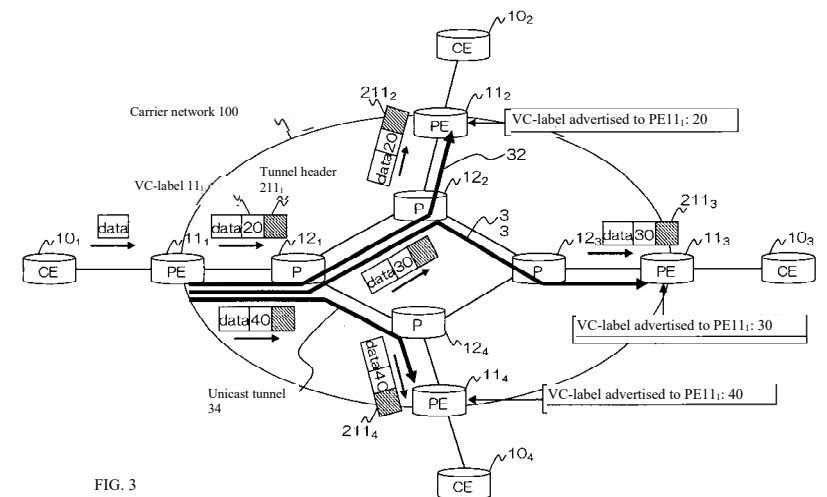
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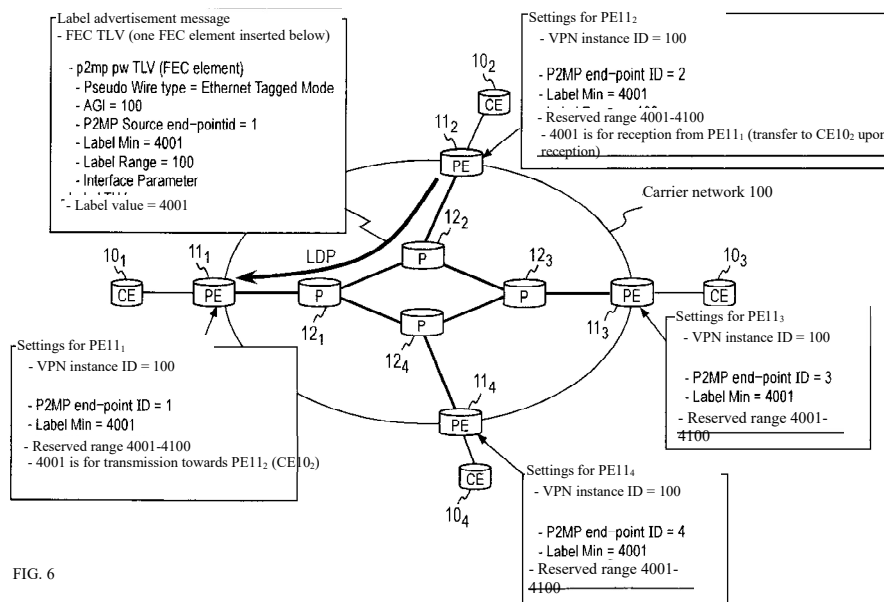
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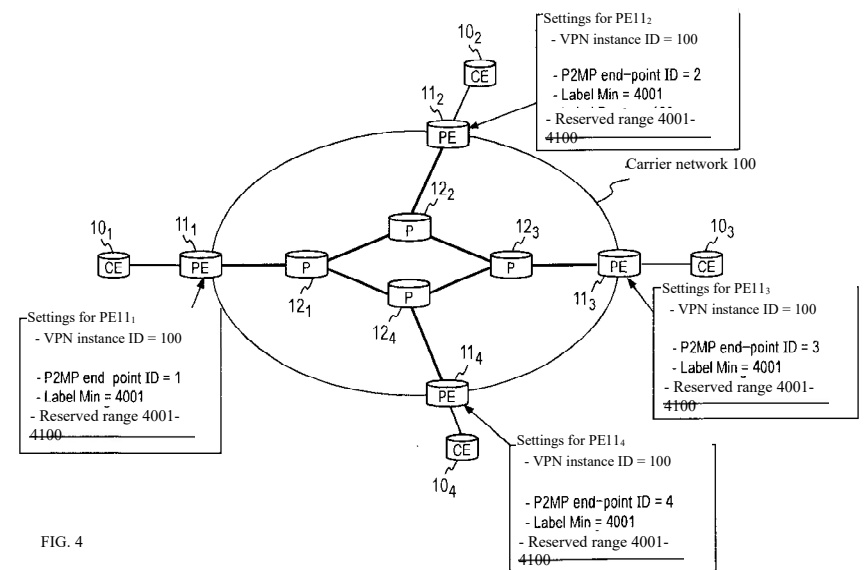
[FIG. 5]



[FIG. 3]



[FIG. 6]



[FIG. 4]

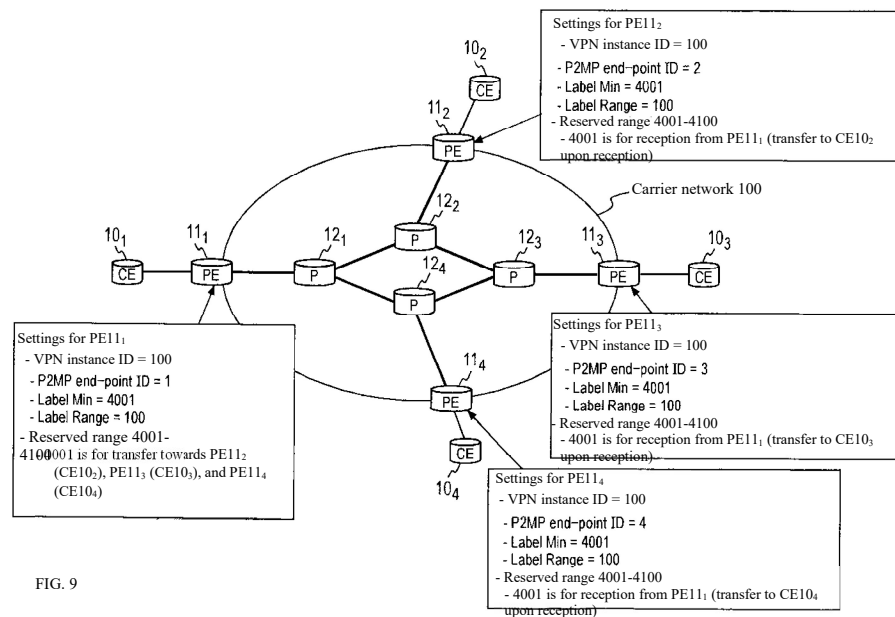


FIG. 9

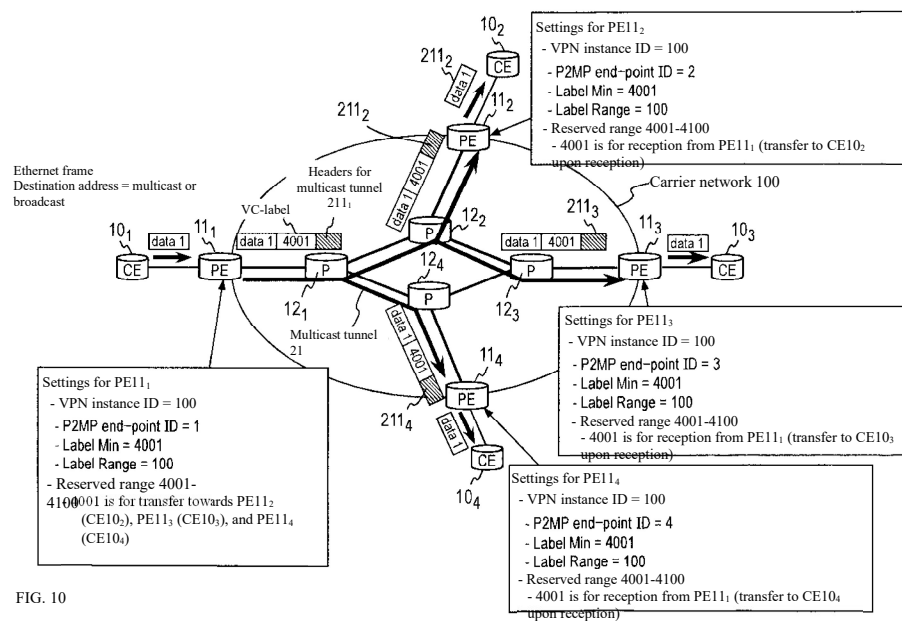


FIG. 10

[FIG. 9]

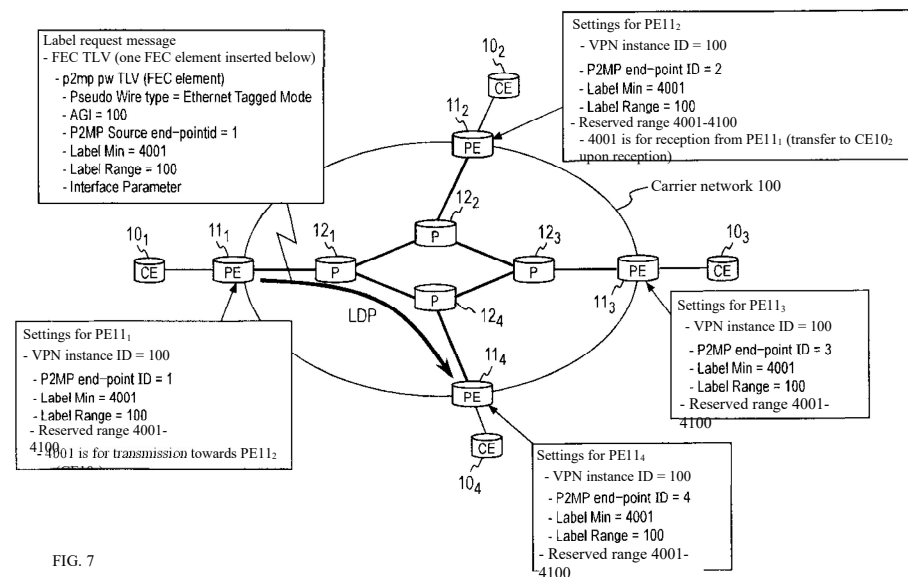


FIG. 7

[FIG. 7]

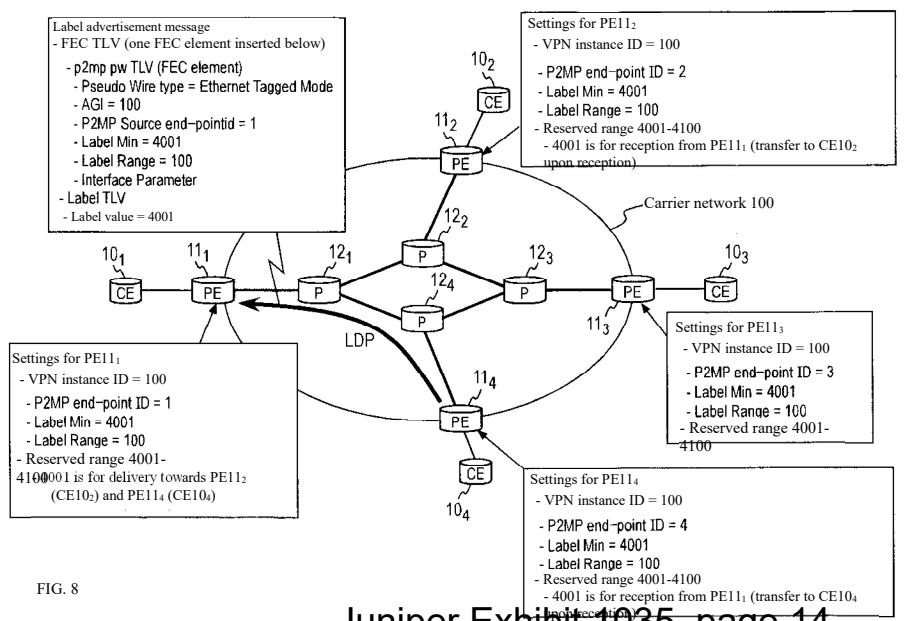
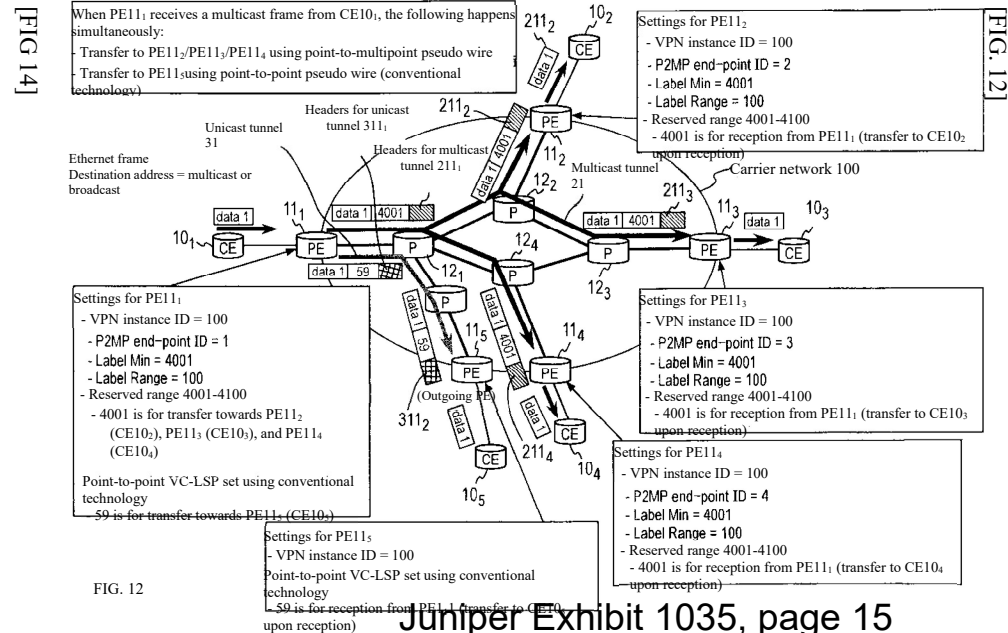
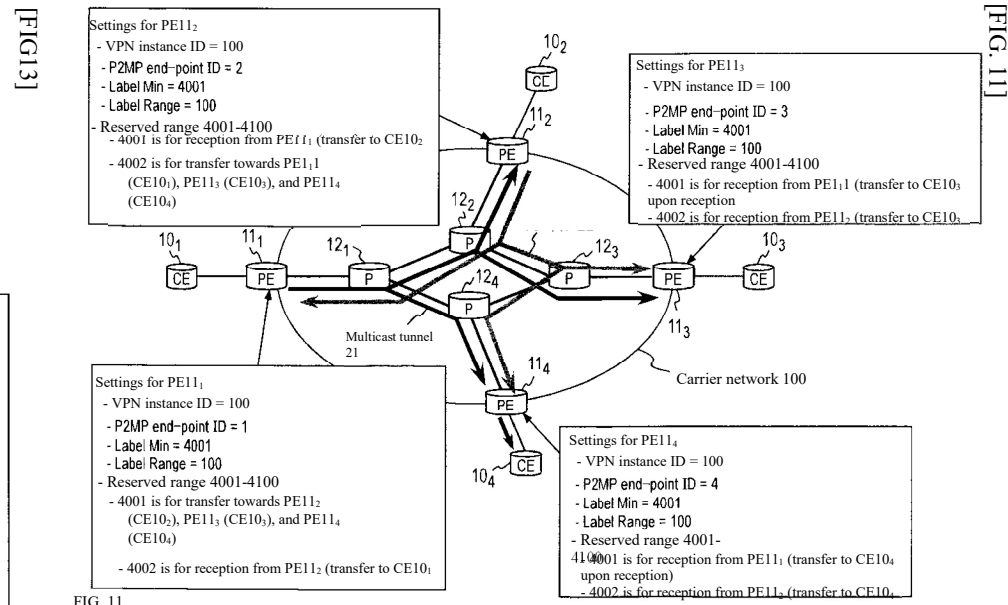
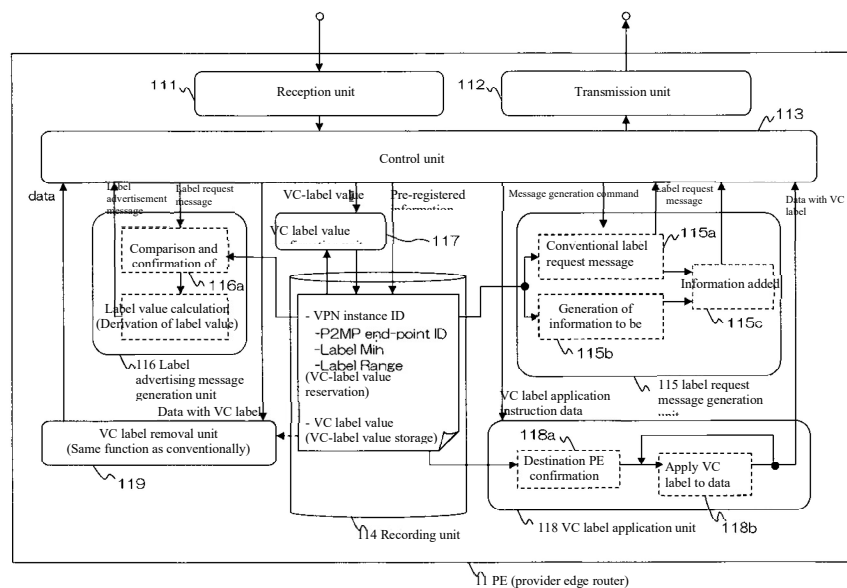
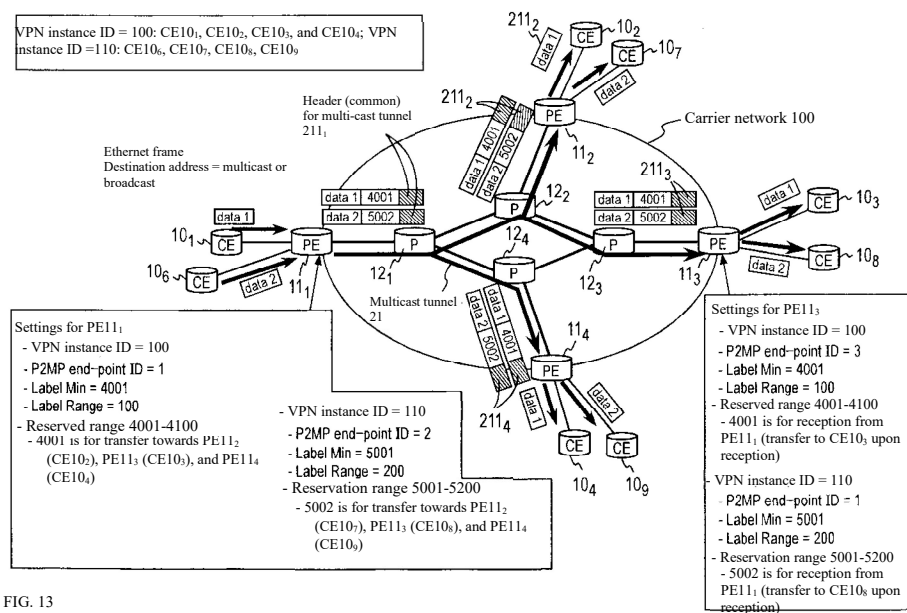


FIG. 8

[FIG. 8]



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