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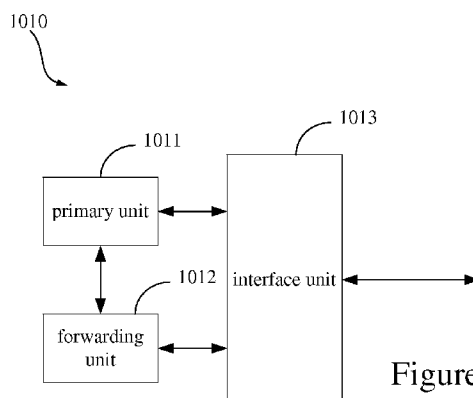


Figure 2

(57) Abstract: A method is provided for a server Edge Device (ED) or a client ED in an Ethernet Virtual Interconnect (EVI) network to learn a Media Access Control (MAC) address. A standby tunnel is established between the server ED and the client ED. The server ED or the client ED receives a unicast packet through the standby tunnel, learns a MAC address of the unicast packet, and forwards the unicast packet.

MAC ADDRESS LEARNING

Background

[0001] Through an Ethernet Virtual Interconnection (EVI) network, multiple network sites deployed in different places may be connected to each other, and the EVI network can implement layer 2 interconnection among the network sites based on virtual links. The EVI network implements Internet protocol (IP) core network based Layer 2 Virtual Private Network (L2VPN) technology.

[0002] The EVI network generally includes a core network, an overlapping network, and multiple network sites.

[0003] The core network is borne by IP routing devices and provides interconnection among the network sites. The core network is a public network and is used for forwarding packets via an IP tunnel.

[0004] The overlapping network is a virtual network established among Edge Devices (EDs) of different sites. The overlapping network is used for realizing the extension of Virtual Local Area Network (VLAN) among different sites and provides layer 2 interconnection among the network sites.

[0005] A network site is a layer 2 network that is connected to the core network by EDs and has independent service functions. The EDs may provide a layer 2 switching function among sites.

Brief Description of the Drawings

[0006] Figure 1 is a schematic diagram illustrating a structure of an EVI network according to an example of the present disclosure.

[0007] Figure 2 is a schematic diagram illustrating the internal structure of a server ED according to an example of the present disclosure.

[0008] Figure 3 is a schematic diagram illustrating the internal structure of a client ED according to an example of the present disclosure.

[0009] Figure 4 is a schematic diagram illustrating a structure of an EVI network according to an example of the present disclosure.

[0010] Figure 5 is a schematic diagram illustrating a format of a packet

containing an ED identifier according to an example of the present disclosure.

[0011] Figure 6 is a flowchart illustrating a procedure for a host connected to a first client edge (CE) to send an Ethernet packet to a host connected to a second CE in an example of the present disclosure.

5 [0012] Figure 7 is a flowchart illustrating a procedure for the host connected to the second CE to return an Ethernet packet to the host connected to the first CE in an example of the present disclosure.

Detailed Description

[0013] For simplicity and illustrative purposes, the present disclosure is described
10 by referring mainly to examples. In the following description, numerous specific details are set forth in order to provide a thorough understanding of the present disclosure. It will be readily apparent however, that the present disclosure may be practiced without limitation to these specific details. In other instances, some methods and structures have not been described in detail so as not to unnecessarily obscure the present disclosure.
15 Throughout the present disclosure, the terms “a” and “an” are intended to denote at least one of a particular element. As used herein, the term “includes” means includes but not limited to, the term “including” means including but not limited to. The term “based on” means based at least in part on.

[0014] In a conventional EVI network, a bi-directional tunnel is established between
20 every two EDs. A Media Access Control (MAC) address is advertised among sites via an Intermediate System-Intermediate System (IS-IS) protocol packet. For example, if a certain ED newly learns a MAC address from a local site, the ED may flood IS-IS protocol packet with the MAC address through tunnels interconnecting other EDs. However, if the number of MAC addresses to be advertised by an ED is very large, some IS-IS
25 protocol packets may be lost so that a peer ED is unable to learn MAC addresses contained in the lost IS-IS protocol packets. In addition, when users of different sites visit with each other, if a certain ED cannot find a destination MAC address of an Ethernet packet in a MAC table of the ED, the packet is an unknown unicast packet. The ED may process the unknown unicast packet through an EVI Flooding mode or an EVI No
30 Flooding mode. If the EVI Flooding mode is adopted, the ED floods the unknown unicast packet to other EDs, which results in problems such as packet loss or resource occupancy.

If the EVI No Flooding mode is adopted, the ED directly discards the unknown unicast packet, which results in visit failure.

[0015] An example of the present disclosure provides a solution, which includes that, when an ED forwards a packet in an EVI network, if the ED receives an unknown unicast packet from a remote site, the ED learns a MAC address contained in the packet and then forwards the packet. As used herein, an EVI network may include not only an Ethernet Virtual Interconnection network, but also other appropriate types of network for connecting geographically dispersed data centers.

[0016] However, in MAC address learning, especially in an early stage, because each ED has not learned MAC addresses of hosts connected to remote sites, most to-be-forwarded packets are unknown unicast packets, which may result in the flooding of large numbers of unknown unicast packets. For example, host1 connected to Customer Edge 1 (CE1) in a site of ED1 intends to send a packet to host2 connected to CE2 in a site of ED2, but ED1 has not learned a MAC address of host2 in advance and thus cannot find a destination MAC address of the received unicast packet in a MAC table of ED1, so the packet is an unknown unicast packet. In order to send the unknown unicast packet to its destination, the ED1 may flood the unknown unicast packet to other EDs in the EVI network. In order to control such flooding, in an example, a primary tunnel is established between each two EDs and a standby tunnel is also established between a server ED and each client ED to bear the unknown unicast packet. Herein, the primary tunnel and the standby tunnel are both EVI tunnels. The EVI tunnels are IP Generic Routing Encapsulation (GRE) tunnels and are used for bearing EVI links. One EVI tunnel may bear multiple EVI links. The EVI tunnel is a point-to-multipoint automatic tunnel. A local site may be connected to multiple adjacent sites through one EVI tunnel, and each connection corresponds to one EVI link.

[0017] In order to indicate a source of the unicast packet, an ED identifier of a source client ED is added into the unknown unicast packet so that an ED receiving the unknown unicast packet may correctly learn the MAC address of the unknown unicast packet. Accordingly, in an example, when the source client ED intends to flood the unknown unicast packet, the source client ED may flood the unknown unicast packet to the server ED through the standby tunnel, and then the server ED forwards the unknown unicast packet to a destination client ED. In the procedure of forwarding the unknown unicast packet, the server ED and the client ED both learn the MAC address.

[0018] Figure 1 is a schematic diagram illustrating a structure of an EVI network according to an example of the present disclosure. As shown in Figure 1, the EVI network includes a server ED and multiple client EDs. A site of each ED includes multiple client edges (CEs), and each CE is connected to multiple hosts. A primary tunnel is established between each two EDs, and a standby tunnel is established between the server ED and each client ED to bear an unknown unicast packet. Herein, each ED and CEs connected to the ED constitute a network site, and a public network through which EDs interact with each other is a core network. An ED identifier of the source client ED may be added into the unknown unicast packet to indicate a source of the unknown unicast packet, and the format of the unknown unicast packet containing the ED identifier of the source client is shown in Figure 5 in an example of the present disclosure.

[0019] In order to illustrate the solution of this example, the server ED and the client ED are describe in detail hereinafter.

[0020] Figure 2 is a schematic diagram illustrating the internal structure of a server ED 1010 according to an example of the present disclosure. As shown in Figure 2, the server ED 1010 includes a primary unit 1011, a forwarding unit 1012 and an interface unit 1013. In practical applications, the primary unit 1011 is realized by hardware such as CPU; the forwarding unit 1012 saves a MAC table and enquires an address when a packet is forwarded; and the interface unit 1013 is an external interface of the server ED 1010, which includes a physical port or a logic interface.

[0021] The forwarding unit 1012 is to learn a source MAC address of the received unicast packet when the interface unit 1013 receives a unicast packet containing an ED identifier of a source client ED from the source client ED through a standby tunnel between the server ED 1010 and the source client ED. The forward unit 1012 is to then save the learned source MAC address of the received unicast packet and an outbound interface corresponding to a primary tunnel between the server ED 1010 and the source client ED in the MAC table. The forwarding unit 1012 may then search the MAC table according to a destination MAC address of the unknown unicast packet; if a local site table entry matches the destination MAC address of the received unicast packet, the forwarding unit 1012 is then to forward the received unicast packet locally through the interface unit 1013. If a remote site table entry matches the destination MAC address of the received unicast packet, the forwarding unit 1012 may forward the received unicast packet through the interface unit 1013 and a standby tunnel between the server ED

1010 and a destination client ED of a remote site. If no table entry matches the destination MAC address of the received unicast packet, the forwarding unit 1012 may broadcast the received unicast packet in an EVI instance through the interface unit 1013.

[0022] That is, the server ED 1010 may learn the source MAC address of a unicast packet received through the standby tunnel, and forward the received unicast packet after searching the MAC table. It should be noted that even though the server ED 1010 receives the unicast packet through the standby tunnel, the server ED saves the source MAC address of the unicast packet and the outbound interface corresponding to the primary tunnel between the server ED 1010 and the source client ED in the MAC table, and the reasons are illustrated as follows. After the server ED learns the source MAC address of the unicast packet, any packet destined for a device corresponding to the learned source MAC address of the unicast packet is a known unicast packet. Thus the packet does not need to be sent through the standby tunnel but is sent through the primary tunnel. That is, the packet is sent through the outbound interface corresponding to the primary tunnel in the MAC table. It should also be noted that, when the server ED forwards a unicast packet received via a standby tunnel to a remote site, the server ED 1010 still forwards the received unicast packet through a standby tunnel interconnecting the remote site.

[0023] Figure 3 is a schematic diagram illustrating the internal structure of a client ED 1020 according to an example of the present disclosure. As shown in Figure 3, the client ED 1020 includes a primary unit 1021, a forwarding unit 1022, and an interface unit 1023. In practical applications, the primary unit 1021 is realized by hardware such as CPU; the forwarding unit 1022 saves a MAC table and enquires an address when a packet is forwarded; and the interface unit 1023 is an external interface of the client ED 1020, which includes a physical port or a logic interface.

[0024] When the client ED 1020 is a source client ED that sends an unknown unicast packet, the primary unit 1021 is to add an ED identifier of the client ED 1020 into the unknown unicast packet.

[0025] When the client ED 1020 is the source client ED, the forwarding unit 1022 is to send the unknown unicast packet to the server ED through the interface unit 1023 and a standby tunnel between the client ED 1020 and the server ED. When the client ED 1020 is a destination client ED, the forwarding unit 1022 is to receive a unicast packet delivered via the standby tunnel and sent from the server ED through the interface unit 1023, and obtain a source client ED according to an ED identifier contained in the received unicast

packet. The forwarding unit 1022 is also to learn a source MAC address of the unknown unicast packet, and save the learned source MAC address and an outbound interface corresponding to a primary tunnel between the client ED and the source client ED in the MAC table. When the client ED is a destination client ED, the forwarding unit 1022 is to search the MAC table according to a destination MAC address of the received unicast packet. If one matching table entry for the destination MAC address is found, the forwarding unit 1022 is to forward the received unicast packet locally through the interface unit 1023. If no matching table entry for the destination MAC address is found, the forwarding unit 1022 is to broadcast the received unicast packet in a local VLAN through the interface unit 1023.

[0026] That is, the destination client ED may learn the source MAC address of the unicast packet received through the standby tunnel, and forward the unicast packet after searching the MAC table. It should be noted that, though the destination client ED receives the unicast packet through the standby tunnel, the destination client ED saves the source MAC address and the outbound interface corresponding to the primary tunnel between the destination client ED and the source client ED in the MAC table, and the reasons are illustrated as follows. Because what the destination client ED learns is a MAC address of a host connected to the source client ED and the unicast packet is received from the standby tunnel between the destination client ED and the server ED, if the destination client ED returns a response packet through the standby tunnel, the response packet is unable to reach the source client ED. Accordingly, the outbound interface corresponding to the primary tunnel between the destination client ED and the source client ED is to be saved when the destination client ED learns the MAC address.

[0027] Hereinafter, the solution is described referring to another example of the present disclosure.

[0028] Taking Figure 4 as an example, suppose a site includes server ED211, CE221 and Host231 connected to CE221, a site includes client ED212, CE222 and Host232 connected to CE222, a site includes client ED213, CE223 and Host233 connected to CE223, and a site includes client ED214, CE224 and Host234 connected to CE224. A primary tunnel is established between each two of ED211 to ED214, and a standby tunnel is established between server ED211 and each of ED212 to ED214. The primary tunnel and the standby tunnel are both EVI tunnels. Each EVI tunnel bears at least one EVI link. Links between ED211 and ED212 are LINK1 and LINK1-2, links between ED211 and

ED213 are LINK2 and LINK2-2, and links between ED211 and ED214 are LINK3 and LINK3-2. The primary tunnel and the standby tunnel both may be established with a conventional method, for example, an IP GRE tunnel is established.

[0029] In this example, suppose Host232 intends to access Host233, but client
5 ED212 has not learned MAC addresses of Host232 and Host233 in advance, and client ED213 has not learned a MAC address of Host232 in advance.

[0030] In this example, the ED identifier of the source client ED needs to be added into the unknown unicast packet, and the format of the unknown unicast packet containing the ED identifier of the source client is shown in Figure 5 in an example of the
10 present disclosure. The EVI-ED Identifier field indicates the ED identifier. In practical applications, each ED may be assigned an ED identifier in advance. For example, an ED identifier of ED211 is id1, which corresponds to an address 1.1.1.1; an ED identifier of ED212 is id2, which corresponds to an address 2.2.2.2; an ED identifier of ED213 is id3, which corresponds to an address 3.3.3.3; and an ED identifier of ED214 is id4, which
15 corresponds to an address 4.4.4.4. Herein, the address may uniquely identify a device connected to the EVI tunnel. And thus, the source client ED may be determined according to the address corresponding to the ED identifier contained in the unknown unicast packet.

[0031] The solution that a client ED accesses another client ED is illustrated through two phases in an example of the present disclosure.

[0032] The first phase describes a procedure for a first host such as Host232 connected to a first CE such as CE222 to send an Ethernet packet to a second host such as Host233 connected to a second CE such as CE223, as shown in Figure 6 in an example of the present disclosure.

[0033] In one example, in block S1, the CE (CE222) sends the Ethernet packet
25 received from the first host (Host232) to an edge device such as ED212, where the Ethernet packet contains a source MAC address and a destination MAC address. The source MAC address is a MAC address of the first host (Host232), and the destination MAC address is a MAC address of the second host (Host233).

[0034] In block S2, the ED (ED212) learns the MAC address, and saves the source
30 MAC address of the Ethernet packet. The ED may also save a VLAN to which the Ethernet packet belongs, and a port receiving the Ethernet packet in a MAC table of an EVI instance.

[0035] Herein, the ED (ED212) may determine the EVI instance according to the

EVI instance bundled with the VLAN to which the Ethernet packet belongs.

[0036] In block S3, if the ED (ED212) does not find a table entry matching with the destination MAC address of the Ethernet packet in the MAC table, the ED(ED212) encapsulates the Ethernet packet into an IP tunnel packet such as an Ethernet over IP GRE tunnel packet based on a standby tunnel between ED212 and server ED211. It may also add the ED identifier of the ED(ED212) into the Ethernet over IP GRE tunnel packet.

[0037] Figure 5 shows a format of the Ethernet over IP GRE tunnel packet containing the ED identifier that is sent by ED212. In Figure 5, an IP GRE tunnel header contains an IP packet header and a GRE packet header. Compared with an IP packet header of an IP packet borne by the Ethernet packet shown in Figure 5, the IP packet header contained in the IP GRE tunnel header may be taken as an outer IP packet header of the Ethernet over IP GRE tunnel packet. A source IP address of the IP packet header contained in the IP GRE tunnel header is an IP address of ED212, and a destination IP address of the IP packet header contained in the IP GRE tunnel header is an IP address of ED211. The GRE packet header indicates that the borne protocol packet is the Ethernet packet.

[0038] A public layer 2 packet header shown in Figure 5 may be taken as an outer Ethernet header of the Ethernet over IP GRE tunnel packet. A destination MAC address of the public layer 2 packet header is a MAC address of a next hop device of ED212, for example, device P2 shown in Figure 4. If the next hop device is ED211, the destination MAC address of the public layer 2 packet header is the MAC address of ED211. A source MAC address of the public layer 2 packet header is a virtual interface MAC address of ED212, and a VLAN ID of the public layer 2 packet header is a public VLAN number.

[0039] Blocks S1 to S3 describes a procedure for Host232 to send the Ethernet packet to ED212 and ED212, for example, determines that the Ethernet packet is an unknown unicast packet.

[0040] In block S4, the ED (ED212) sends the IP tunnel packet such as Ethernet over IP GRE tunnel packet to server ED211 through the standby tunnel LINK1-2, where the ED identifier of the source client ED (called source ED identifier for short) contained in the Ethernet over IP GRE tunnel packet is the ED identifier of ED212.

[0041] In block S5, server ED (ED211) receives the Ethernet over IP GRE tunnel packet containing the source ED identifier from the standby tunnel LINK1-2.

[0042] In block S6, server ED(ED211) saves the source MAC address of

innerEthernet packet of the IP tunnel packet such as theEthernet over IP GRE tunnel packet, the VLAN to which the inner Ethernet packet belongs, and a tunnel interface of a primary tunnel between the server ED(ED211) and the source client ED in the MAC table of EVI instance.

5 [0043] After the server ED(ED211) receives the Ethernet over IP GRE tunnel packet, the server ED(ED211) removes the public layer 2 packet header and IP GRE tunnel header, and determines the EVI instance according to the VLAN to which the Ethernet packet belongs.

[0044] In this example, the server ED(ED211) determines, according to the source
10 ED identifier, that the Ethernet over IP GRE tunnel packet is from ED212, the server ED (ED211) records the tunnel interface of the primary tunnel between server ED211 and ED212 in a table entry corresponding to the source MAC address of the innerEthernet packet. The tunnel interface is an outbound interface corresponding to the primary tunnel between ED211 and ED212.

15 [0045] In practical applications, the server ED(ED211) may also learn the MAC address of a packet received from a local CE or received through a primary tunnel. For the packet received from the local site, the server ED211 learns source MAC address and VLAN ID of the packet and a port at which the packet is received. For the packet received through the primary tunnel, the primary unit 1011 of the server ED shown in
20 Figure 2 is further to, when the interface unit 1013 receives a unicast packet from the source client ED through the primary tunnel between the server ED and the source client ED, learn a source MAC address of the unicast packet delivered by the primary tunnel, and save the learned source MAC address and an outbound interface corresponding to the primary tunnel between the server ED and the source client ED in the MAC table.
25 Correspondingly, the forwarding unit 1012 is further to search the MAC table based on a destination MAC address of the unicast packet delivered by the primary tunnel. A local site table entry (that is, a MAC address of host in the local site) matches the destination MAC address, the forwarding unit 1012 is to forward the packet locally. If no table entry matches the destination MAC address, the forwarding unit 1012 is to broadcast the packet
30 in the local VLAN.

[0046] In block S7, if the server ED(ED211) finds a table entry of the destination MAC address in the MAC table of the EVI instance based on the destination MAC address of the Ethernet packet and the table entry contains a tunnel interface, the server

ED(ED211) determines, based on the tunnel interface, that the destination client ED is ED213, encapsulates the Ethernet packet into an Ethernet over IP GRE tunnel packet based on a standby tunnel between server ED211 and ED213, adds a source ED identifier into the Ethernet over IP GRE tunnel packet, which is the ED identifier of ED212, and sends the Ethernet over IP GRE tunnel packet containing the source ED identifier to ED213 through the standby tunnel LINK2-2.

[0047] In this example, if the table entry found by server ED211 contains a port, server ED211 forwards the Ethernet packet locally.

[0048] In this example, if server ED211 does not find a table entry with the destination MAC address of the Ethernet packet in the MAC table of the EVI instance, server ED211 broadcasts the Ethernet packet in the EVI instance. The method of broadcasting the Ethernet packet includes the forwarding unit 1012 of server ED211 broadcasting the Ethernet packet in the local VLAN of the EVI instance through the interface unit 1013, encapsulating the Ethernet packet into the Ethernet over IP GRE tunnel packet based on the standby tunnels between server ED211 and other client EDs except the source client ED, adding the source ED identifier into the Ethernet over IP GRE tunnel packet, and sending the Ethernet over IP GRE tunnel packet to client ED213 and client ED214.

[0049] In block S8, the ED(ED213) receives the IP tunnel packet such as the Ethernet over IP GRE tunnel packet containing the source ED identifier from the standby tunnel LINK2-2.

[0050] In block S9, the ED (ED213) obtains, based on the source ED identifier contained in the Ethernet over IP GRE tunnel packet, that the source client ED is ED212, and learns the source MAC address of the inner Ethernet packet, the VLAN to which the inner Ethernet packet belongs, and the tunnel interface of the primary tunnel between ED 213 and the source client ED in the MAC table of the EVI instance.

[0051] Herein, blocks S8 and S9 describe how client ED213 learns the MAC address of the packet received from the standby tunnel. In practical applications, client ED213 may learn the MAC address of a packet received from a local site or received through the primary tunnel.

[0052] If the client ED learns the MAC address of the packet received from the local site, the forwarding unit 1022 shown in Figure 3 is further to, when the client ED receives a unicast packet from the local site, learn a source MAC address of the unicast

packet and save the learned source MAC address and a port receiving the unicast packet in the MAC table. The forwarding unit 1022 is further to search the MAC table based on a destination MAC address of the unicast packet. If a local site table entry associated with a host in the local site matches the destination MAC address, the forwarding unit 1022 is to forward the unicast packet locally through the interface unit 1023. If a remote site table entry associated with a host connected to the server ED or the destination client ED matches the destination MAC address, the forwarding unit 1022 is to forward the unicast packet through the interface unit 1023 and the primary tunnel between the client ED and the server ED or the destination client ED. If no table entry matches the destination MAC address, the forwarding unit 1022 is to process the unicast packet by taking the unicast packet as an unknown unicast packet.

[0053] If the client ED learns the MAC address of the packet received through the primary tunnel, the forwarding unit 1022 shown in Figure 3 is further to receive a unicast packet from the source client ED through the primary tunnel when the client ED is the destination client ED, learn a source MAC address of the unicast packet received via the primary tunnel, and save the learned source MAC address and an outbound interface corresponding to the primary tunnel between the destination client ED and the source client ED in the MAC table. The forwarding unit 1022 is further to search the MAC table based on a destination MAC address of the unicast packet received via the primary tunnel. If a local site table entry associated with a host in the local site matches the destination MAC address, the forwarding unit 1022 is to forward the unicast packet received via the primary tunnel deliver locally. If no table entry matches the destination MAC address, the forwarding unit 1022 is to broadcast the unicast packet received via the primary tunnel in the local VLAN.

[0054] In block S10, if the ED (ED213) finds a port corresponding to the destination MAC address of the Ethernet packet in the MAC table of the EVI instance, ED213 forwards the Ethernet packet to CE223 through the port and then CE223 forwards the Ethernet packet to Host233.

[0055] In this example, suppose ED213 has already learned the MAC address of Host233, then in this block Host233 connected to ED213 inevitably matches the destination MAC address. In practical applications, if no host matches the destination MAC address, ED213 broadcasts the Ethernet packet in the local VLAN of the EVI instance. In this way, after CE223 receives the Ethernet packet, CE223 forwards the

Ethernet packet to Host233.

[0056] A second phase describes a procedure for Host233 to return an Ethernet packet to Host232 as shown in Figure 7 in an example of the present disclosure.

[0057] In block H1, a second CE (CE223) sends an Ethernet packet returned by a second host (Host233) to a second ED(ED213), where a source MAC address of the Ethernet packet is a MAC address of the second host (Host233), and a destination MAC address is a MAC address of a first host (Host232).

[0058] In block H2, the second ED(ED213) finds a table entry with the destination MAC address of the Ethernet packet in the MAC table of the EVI instance, and the table entry contains a tunnel interface, which is the tunnel interface of the primary tunnel between the second ED(ED213) and a first ED(ED212).

[0059] In block H3, the second ED (ED213) encapsulates the Ethernet packet into an IP tunnel packet such as an Ethernet over IP GRE tunnel packet, and sends the Ethernet over IP GRE tunnel packet to the first ED (ED212) through the primary tunnel between the second ED (ED213) and the first ED(ED212).

[0060] Herein, the second ED(ED213) searches the MAC table for a table entry based on the tunnel interface, obtains the source IP address and destination IP address of IP GRE tunnel header, and a public VLAN, destination MAC address, and an outbound port of public layer 2 packet header, encapsulates the Ethernet packet into the Ethernet over IP GRE tunnel packet, and forwards the Ethernet over IP GRE tunnel packet.

[0061] In block H4, the first ED (ED212) receives the Ethernet over IP GRE tunnel packet, decapsulates the Ethernet over IP GRE tunnel packet into the Ethernet packet, searches the MAC table of the EVI instance for the table entry of the destination MAC address of the Ethernet packet, where an outbound interface in the table entry is a port, and forwards the Ethernet packet to the first CE (CE222) through the port.

[0062] The first CE (CE222) forwards the Ethernet packet to the first host(Host232) based on the destination MAC address of the Ethernet packet.

[0063] If ED212 has learned the MAC address of CE222, such as through block S2 in Figure 6 for example, in this block, the ED212 may find the matching table entry with the destination MAC address, obtain a corresponding port, and forward the Ethernet packet to CE222 through the port, and then CE222 forwards the Ethernet packet to Host232. Thus Host232 has successfully accessed Host233. In the packet forwarding procedure, server ED211, client ED212, and client ED213 have directly learned the MAC

address of the packet.

[0064] In the example, if Host231 is to send an Ethernet unicast packet to Host232, CE221 forwards the Ethernet unicast packet to ED211, and ED211 records the source MAC address, VLAN information, and port information of the Ethernet unicast packet in the MAC table of the EVI instance. If ED211 does not find a table entry with the destination MAC address of the Ethernet packet in the MAC table of the EVI instance, ED211 broadcasts the Ethernet packet in the local VLAN of the EVI instance, encapsulates the Ethernet packet into an Ethernet over IP GRE tunnel packet based on primary tunnels between ED211 and each client ED, and sends the Ethernet over IP GRE tunnel packet to each client ED through the primary tunnels between ED211 and the client EDs. In another example, ED211 broadcasts the Ethernet packet in the local VLAN of the EVI instance, encapsulates the Ethernet packet into an Ethernet over IP GRE tunnel packet based on standby tunnels between ED211 and each client ED, adds the ED identifier of server ED as the source ED identifier into the Ethernet over IP GRE tunnel packet, and sends the Ethernet over IP GRE tunnel packet containing the source ED identifier to each client ED through the standby tunnels between ED211 and the client EDs.

[0065] If Host231 is to send an Ethernet broadcast packet, CE221 forwards the Ethernet packet to ED211, ED211 records the source MAC address, VLAN information, and port information of the Ethernet packet in the MAC table of the EVI instance, broadcasts the Ethernet packet in the local VLAN of the EVI instance, encapsulates the Ethernet packet into an Ethernet over IP GRE tunnel packet based on the primary tunnels between ED211 and each client ED, and sends the Ethernet over IP GRE tunnel packet to each client ED through the primary tunnels between ED211 and the client EDs. In another example ED211 broadcasts the Ethernet packet in the local VLAN of the EVI instance, encapsulates the Ethernet packet into an Ethernet over IP GRE tunnel packet based on the standby tunnels between ED211 and each client ED, adds the ED identifier of the server ED as the source ED identifier into the Ethernet over IP GRE tunnel packet, and sends the Ethernet over IP GRE tunnel packet containing the source ED identifier to each client ED through the standby tunnels between ED211 and the client EDs.

[0066] In the above examples, the server ED and the client ED may learn the MAC address without advertising the MAC address by flooding the IS-IS protocol packets.

Moreover, in the example, the flooding of the unknown unicast packet can be controlled effectively and the loss of the unknown unicast packet and resource occupation may also be avoided, so as to guarantee the reliable transmission of the unknown unicast packet.

5 [0067] Although described specifically throughout the entirety of the instant disclosure, representative examples of the present disclosure have utility over a wide range of applications, and the above discussion is not intended and should not be construed to be limiting, but is offered as an illustrative discussion of aspects of the disclosure.

10 [0068] What has been described and illustrated herein is an example along with some of its variations. The terms, descriptions and figures used herein are set forth by way of illustration only and are not meant as limitations. Many variations are possible within the spirit and scope of the subject matter, which is intended to be defined by the following claims -- and their equivalents -- in which the terms are meant in their broadest
15 reasonable sense unless otherwise indicated.

What is claimed is:

1. A method for a server Edge Device (ED) in a Ethernet Virtual Interconnect (EVI) network to learn Media Access Control (MAC) addresses, wherein primary tunnels are established between the server ED and client EDs in the EVI network, standby tunnels are established between the server ED and the client EDs in the EVI network, and the method comprises:

the server ED receiving a first unicast packet from a first source client ED through a standby tunnel between the server ED and the first source client ED, the first unicast packet containing an ED identifier of the first source client ED;

the server ED learning a source MAC address of the first unicast packet;

the server ED saving the source MAC address of the first unicast packet and an outbound interface corresponding to a primary tunnel between the server ED and the first source client ED in a MAC table of the server ED;

the server ED searching the MAC table based on a destination MAC address of the first unicast packet;

when a local site table entry matches the destination MAC address of the first unicast packet, the server ED forwarding the first unicast packet locally;

when a remote site table entry matches the destination MAC address of the first unicast packet, the server ED forwarding the first unicast packet through a standby tunnel between the server ED and a destination client ED; and

when no table entry matches the destination MAC address of the first unicast packet, the server ED broadcasting the unicast packet in an EVI instance.

2. The method of claim 1, wherein the broadcasting the unicast packet in the EVI instance comprises:

the server ED broadcasting the first unicast packet in a local Virtual Local Area Network (VLAN); and

the server ED forwarding the unicast packet through the standby tunnels between the server ED and the client EDs except the first source client ED.

3. The method of claim 1, further comprising:

the server ED receiving a second unicast packet from a second source client ED through a primary tunnel between the server ED and the second source client ED;

the server ED learning a source MAC address of the second unicast packet;

the server ED saving the source MAC address and an outbound interface corresponding to a primary tunnel between the server ED and the second source client ED in the MAC table of the server ED;

5 the server ED searching the MAC table based on a destination MAC address of the second unicast packet;

when a local site table entry matches the destination MAC address of the second unicast packet, forwarding the second unicast packet locally; and

when no table entry matches the destination MAC address of the second unicast packet, broadcasting the second unicast packet in a local VLAN.

4. The method of claim 1, further comprising:

the server ED receiving a local site unicast packet from a host in a local site;

the server ED learning a source MAC address of the local site unicast packet;

15 the server ED saving the source MAC address of the local site unicast packet and a port in the MAC table;

the server ED searching the MAC table based on a destination MAC address of the local site unicast packet;

20 when no table entry matches with the destination MAC address of the local site unicast packet:

the server ED broadcasting the local site unicast packet in the local VLAN and forwarding the local site unicast packet through the primary tunnels between the server ED and the client EDs; or

25 the server ED adding an ED identifier of the server ED into the local host unicast packet and forwarding the local host unicast packet through the standby tunnels between the server ED and the client EDs.

5. The method of claim 1, further comprising:

the server ED receiving a broadcast packet from a host in a local site;

30 the server ED learning a source MAC address of the broadcast packet;

the server ED saving the source MAC address of the broadcast packet and a port in the MAC table; and

the server ED broadcasting the broadcast packet in a local VLAN and forwarding the

broadcast packet through the primary tunnels or the standby tunnels between the server ED and the client EDs.

6. A server Edge Device (ED) in an Ethernet Virtual Interconnection (EVI) network, the server ED comprising a primary unit, a forwarding unit, and an interface unit, wherein:

primary tunnels are established between the server ED and client EDs in the EVI network, and standby tunnels are established between the server ED and the client EDs in the EVI network;

the forwarding unit is to, when the interface unit receives a first unicast packet from a first source client ED through a standby tunnel between the server ED and the first source client ED, the first unicast packet carrying an ED identifier of the first source client ED:

learn a source MAC address of the first unicast packet;

save the source MAC address of the first unicast packet and an outbound interface corresponding to a primary tunnel between the server ED and the first source client ED in a MAC table of the server ED;

search the MAC table based on a destination MAC address of the second unicast packet;

when a local site table entry matches the destination MAC address of the first unicast packet, forward the first unicast packet locally through the interface unit;

when a remote site table entry matches the destination MAC address of the first unicast packet, forward the first unicast packet through the interface unit and a standby tunnel between the server ED and a destination client ED; and

when no table entry matches the destination MAC address of the first unicast packet, broadcast the first unicast packet in an EVI instance through the interface unit.

7. The ED of claim 6, wherein the forwarding unit broadcasts the first unicast packet in a local VLAN through the interface unit, and forwards the first unicast packet through the interface unit and the standby tunnels between the server ED and the client EDs except the first source client ED.

8. The server ED of claim 6, wherein the forwarding unit is further to, when the interface unit receives a second unicast packet from a second source client ED through a primary tunnel between the server ED and the second source client ED:

learn a source MAC address of the second unicast packet;

5 save the source MAC address of the second unicast packet and an outbound interface corresponding to the primary tunnel between the server ED and the second source client ED in the MAC table;

search the MAC table based on a destination MAC address of the second unicast packet;

10 when a local site table entry matches the destination MAC address of the second unicast packet, forward the second unicast packet locally; and

when no table entry matches the destination MAC address of the second unicast packet, broadcast the second unicast packet in a local VLAN.

15 9. The server ED of claim 6, wherein the forwarding unit is further to, when the interface unit receives a local site unicast packet from a host in a local site:

learn a source MAC address of the local site unicast packet;

save the source MAC address of the local site unicast packet and a port in the MAC table;

20 search the MAC table based on a destination MAC address of the local site unicast packet;

when no table entry matches the destination MAC address of the local site unicast packet:

25 broadcast the local site unicast packet in the local VLAN and forward the local site unicast packet through the primary tunnels between the server ED and the client EDs; or

add an ED identifier of the server ED into the local site unicast packet and forward the local site unicast packet through the standby tunnels between the server ED and the client EDs.

30

10. The server ED of claim 6, wherein the forwarding unit is further to, when the interface unit receives a broadcast packet from a host in a local site:

learn a source MAC address of the broadcast packet;

save the source MAC address of the broadcast packet and a port in the MAC table;
broadcast the broadcast packet in a local VLAN; and
forward the broadcast packet through the standby tunnels or the primary tunnels
between the server ED and the clientEDs.

5

11. A client Edge Device (ED) in an Ethernet Virtual Interconnection (EVI) network, the client ED comprising a primary unit, a forwarding unit and an interface unit, wherein

a primary tunnel is established between the client ED and a server ED in the EVI network, and a standby tunnel is established between the clientED and the server ED in the EVI network;

the primary unit is to, when the client ED is a first source client ED that sends an unknown unicast packet, add an ED identifier of the client ED into the unknown unicast packet; and

15 the forwarding unit is to:

when the client ED is the first source client ED, send the unknown unicast packet to the server ED through the interface unit and the standby tunnel;

when the client ED is a first destination client ED:

receive a first unicast packet from the server ED sent via the standby tunnel through the interface unit;

20 obtain a source client ED based on an ED identifier carried in the first unicast packet;

learn a source MAC address of the first unicast packet;

save the source MAC address of the first unicast packet and an outbound interface corresponding to the primary tunnel in the MAC table;

25 search the MAC table based on a destination MAC address of the first unicast packet;

when a local site table entry matches the destination MAC address of the first unicast packet, forward the first unicast packet locally through the interface unit; and

30 when no table entry matches the destination MAC address of the second unicast packet, broadcast the first unicast packet to a local VLAN through the interface unit.

12. The client ED of claim 11, wherein the forwarding unit is further to, when the interface unit receives a second unicast packet sent from a host in a local site:

learn a source MAC address of the second unicast packet;

5 save the source MAC address of the second unicast packet and a port receiving the second unicast packet in the MAC table.

13. The client ED of claim 11, wherein the forwarding unit is further to, when the interface unit receives a local siteunicast packet from a host in the local site:

10 search the MAC table based on a destination MAC address of the local siteunicast packet;

when a local site table entry matches with the destination MAC address of the local siteunicast packet, forward the local siteunicast packet locally through the interface unit;

15 when a remote table entry associated with the server ED or a second destination client ED matches the destination MAC address of the local siteunicast packet, forward the local siteunicast packet through the interface unit and the primary tunnel between the client ED and the server ED or a primary tunnel between the client ED and the second destination client ED; and

20 when no table entry matches the destination MAC address of the local siteunicast packet, process the unicast packet as an unknown unicast packet.

14. The client ED of claim 11, wherein the forwarding unit is further to, when the client ED is the first destination client ED and receives a second unicast packet from a second source client ED through a primary tunnel between the client ED and the second

25 source client ED;

learn a source MAC address of the second unicast packet

save the learned source MAC address of the second unicast packet and an outbound interface corresponding to the primary tunnel between the client ED and the second source client ED in the MAC table;

30 search the MAC table based on a destination MAC address of the second unicast packet;

when a local site table entry matches with the destination MAC address of the second unicast packet, forward the second unicast packet locally; and

when no table entry matches with the destination MAC address of the second unicast packet, broadcast the second unicast packet in a local VLAN.

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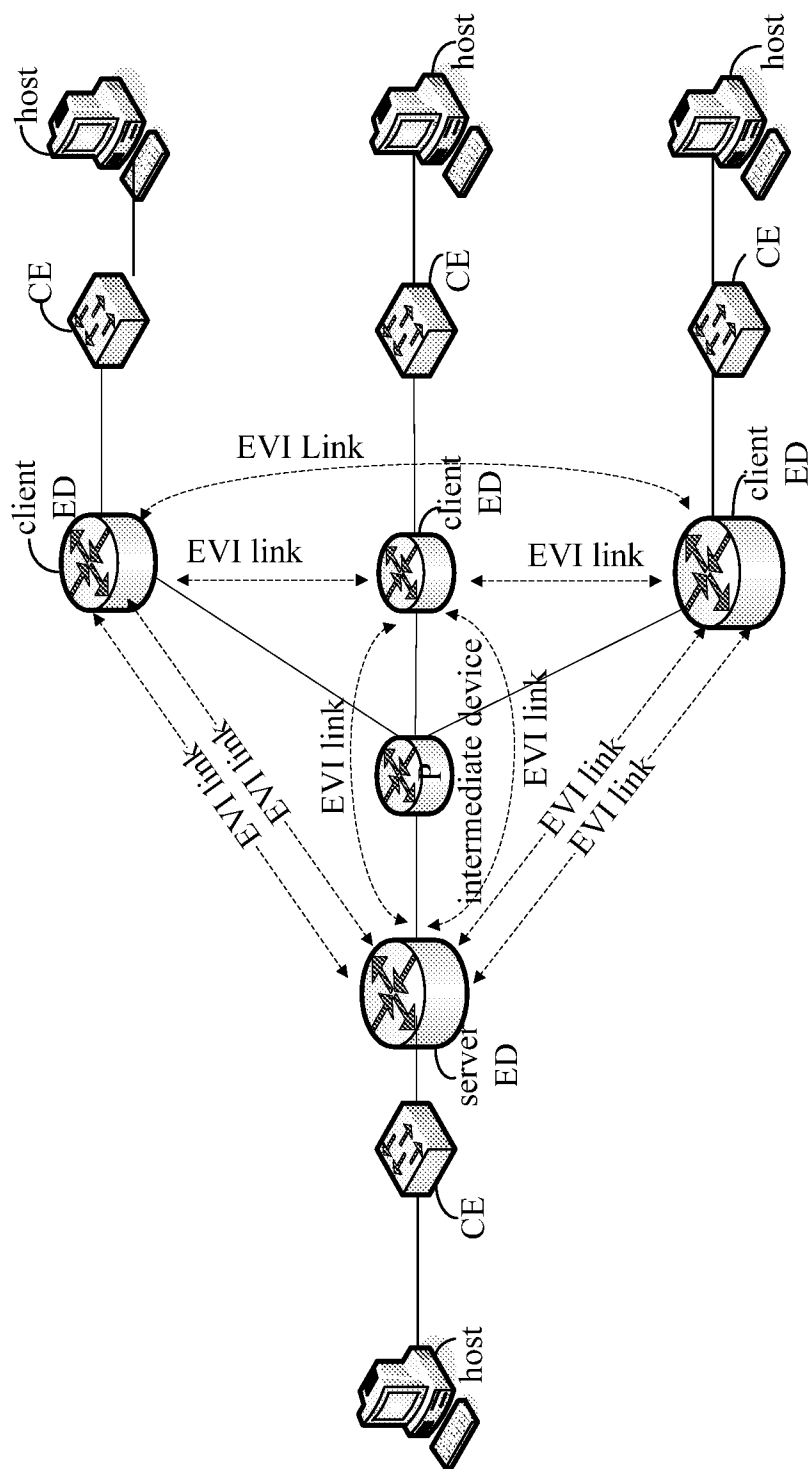


Figure 1

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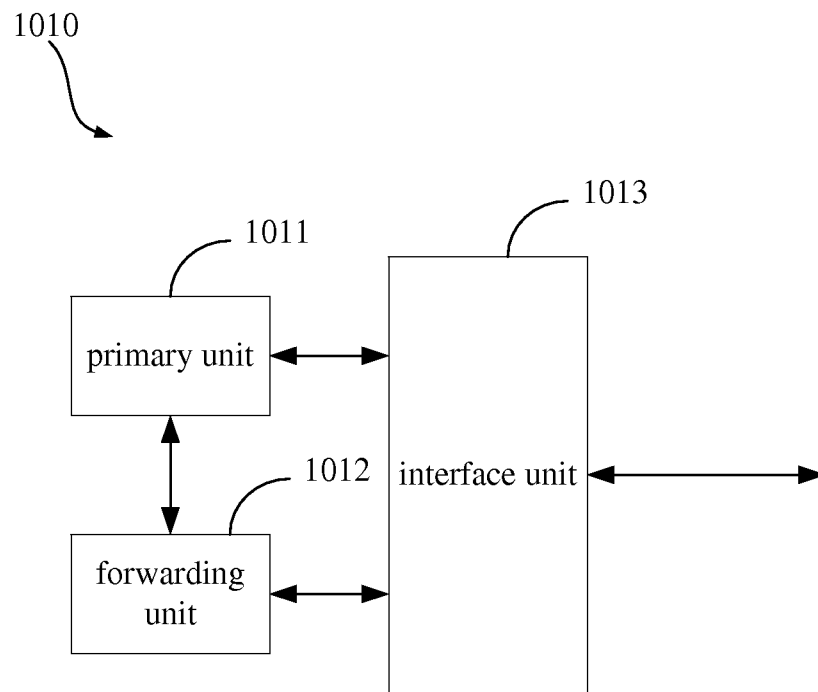


Figure 2

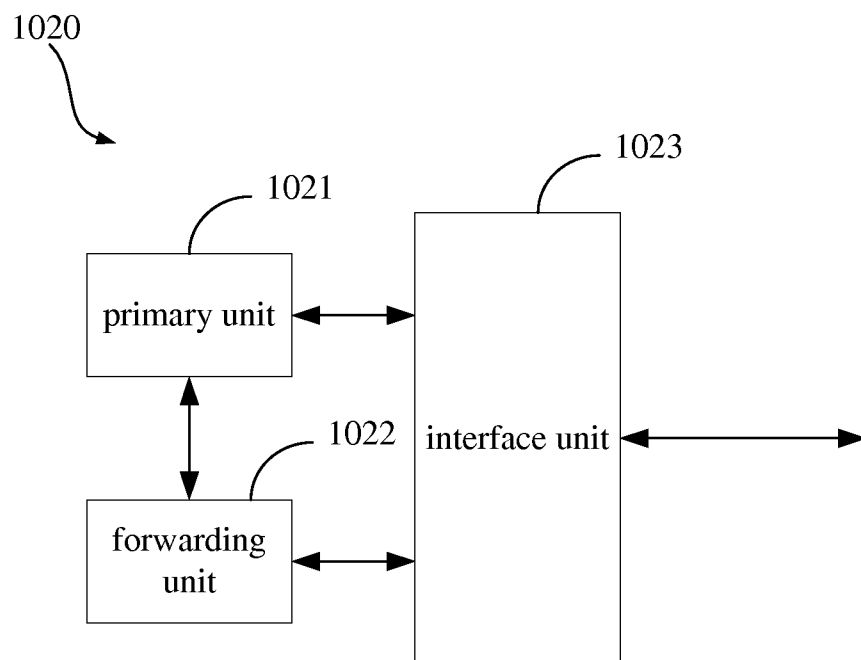


Figure 3

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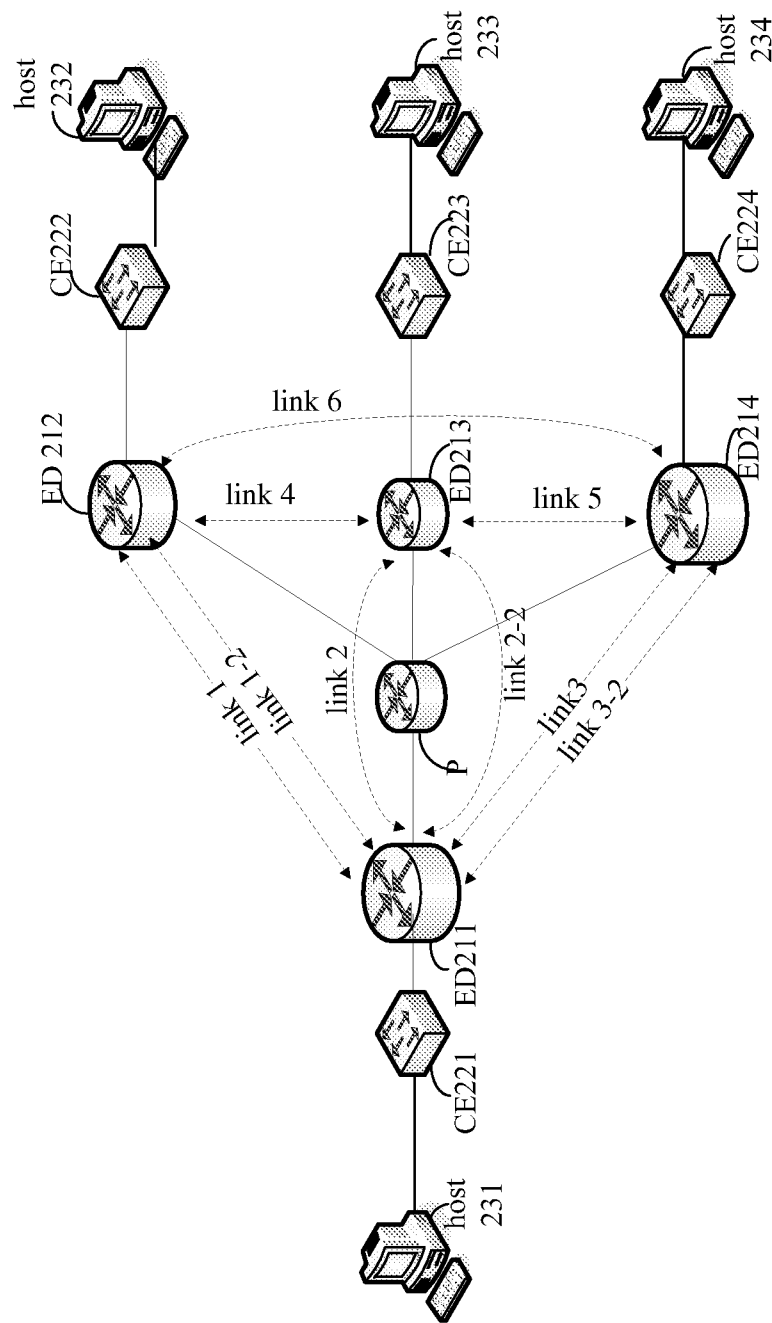


Figure 4

public layer 2 packet header	IP GRE tunnel header	EVI-ED Identifier	Ethernet packet
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Figure 5

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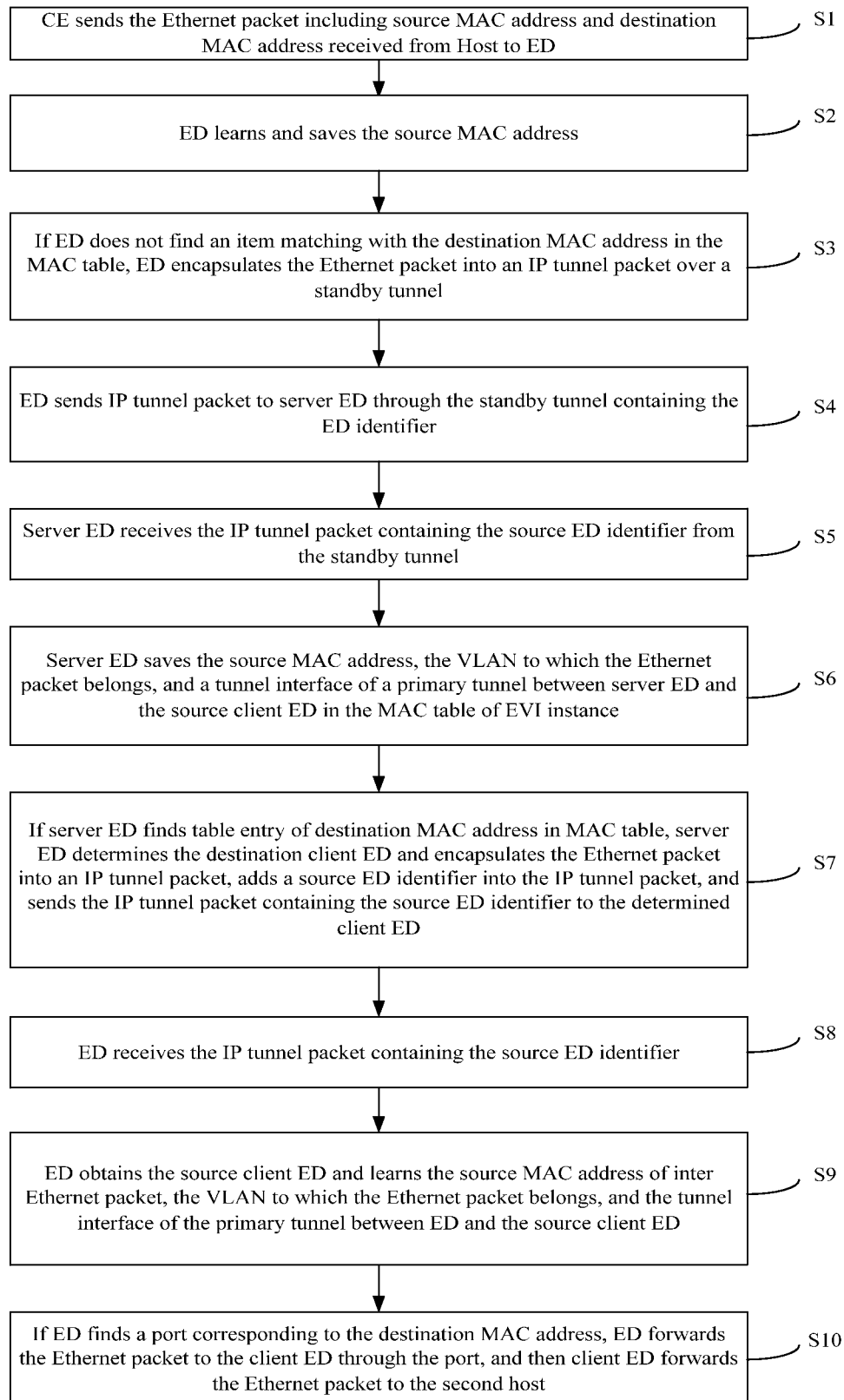


Figure 6

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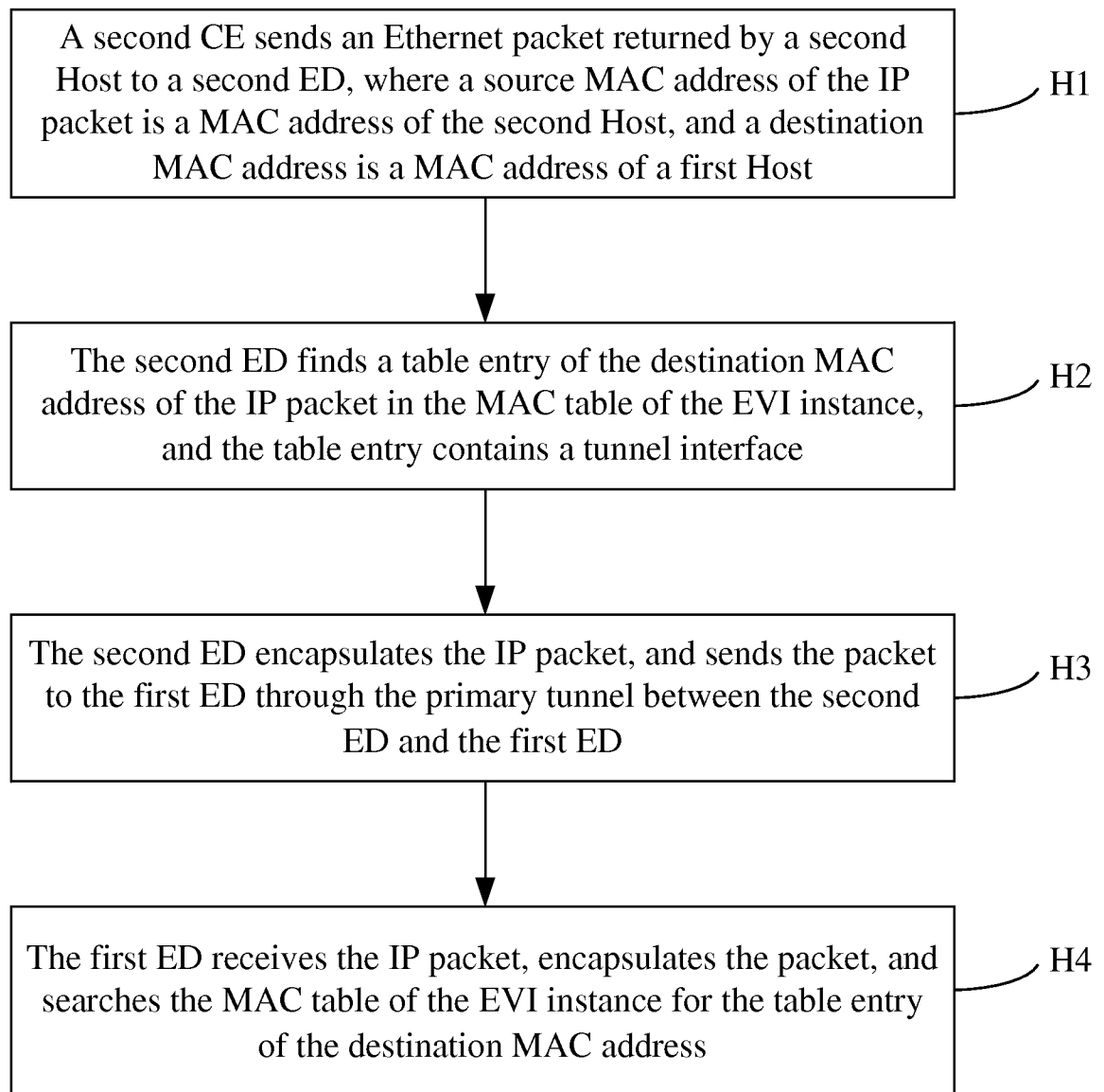


Figure 7

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2013/082638

A. CLASSIFICATION OF SUBJECT MATTER

H04L12/70(2013.01)i

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)

IPC: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 practicable, search terms used)

CNPAT, CNKI, WPI, EPODOC, IEEE: MAC, ADDRESS, LEARN+, IP, EVI, ETHERNET W VIRTUAL W INTERCONNECTION, LAYER W 2, ED, EDGE W DEVICE+, TUNNEL, PACKET, BROADCAST+

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN102594711 A (HANGZHOU H3C TECHNOLOGIES CO., LTD.) 18 July 2012(18.07.2012) description, paragraphs 32-73	1-14
A	US2012063451 A1(AVAYA INC.)15 March 2012(15.03.2012) the whole document	1-14
A	US2008080509 A1(NORTEL NETWORKS LTD.) 03 April 2008 (03.04.2008) the whole document	1-14
A	CN101001196 A(HUAWEI TECHNOLOGIES CO., LTD.) 18 July 2007(18.07.2007) the whole document	1-14

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:	“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
“A” document defining the general state of the art which is not considered to be of particular relevance	“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
“E” earlier application or patent but published on or after the international filing date	“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
“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)	“&”document member of the same patent family
“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	

Date of the actual completion of the international search 06 November 2013(06.11.2013)	Date of mailing of the international search report 05 Dec. 2013 (05.12.2013)
Name and mailing address of the ISA/CN The State Intellectual Property Office, the P.R.China 6 Xitucheng Rd., Jimen Bridge, Haidian District, Beijing, China 100088 Facsimile No. 86-10-62019451	Authorized officer ZHANG Qian Telephone No. (86-10)82245411

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PCT/CN2013/082638

Form PCT/ISA /210 (patent family annex) (July 2009)