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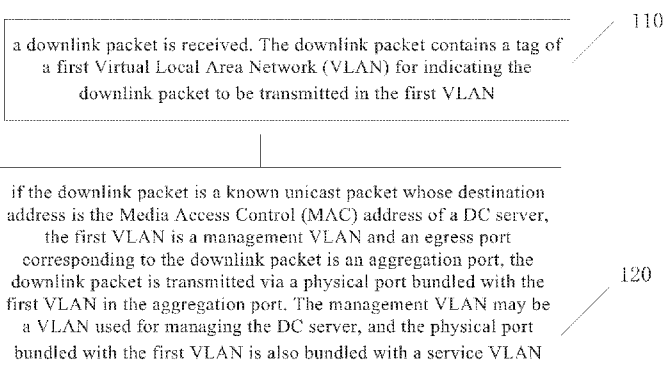


FIG. 1

(57) Abstract: In an example, a downlink packet is received. The downlink packet contains a tag of a first Virtual Local Area Network (VLAN) for indicating the downlink packet to be transmitted in the first VLAN. If the downlink packet is a known unicast packet whose destination address is a Media Access Control (MAC) address of a Data Center (DC) server, the first VLAN is a management VLAN and an egress port corresponding to the downlink packet is an aggregation port, the downlink packet is transmitted via a physical port bundled with first VLAN in the aggregation port. The management VLAN may be a VLAN used for managing the DC server, and the physical port bundled with the first VLAN is also bundled with a service VLAN.

PACKET TRANSMISSION

This application claims the benefit of priority from Chinese Patent Application No. 201510064868.2, entitled “Method and apparatus for managing data center servers”, filed on February 6, 2015, the entire content of which is hereby incorporated by reference.

5 Background

[0001] A Data Center (DC) server may be managed via an Integrated Light-Out (ILO) port which is also called a server out-of-band management port. ILO is also sometimes referred to as “in case of line out”. The ILO port is a separate dedicated physical port, and the DC server sets a physical port aside as the ILO port. Management
10 packets may be transmitted between a network management device and the DC server via the ILO port. A dedicated management network is necessary so that the network management device can manage the DC server via the ILO port. The management network is separated from a service network of the DC server.

Brief Description of the Drawings

15 [0002] Features of the present disclosure are illustrated by way of example and not limited in the following figure(s), in which like numerals indicate like elements, in which:

[0003] FIG. 1 is a flowchart illustrating a packet transmission method according to some examples of the present disclosure.

[0004] FIG. 2 is a flowchart illustrating a packet transmission method according to
20 some examples of the present disclosure.

[0005] FIG. 3 is a diagram illustrating the structure of a DC network according to some examples of the present disclosure.

[0006] FIG. 4 is a diagram illustrating the structure of a packet transmission apparatus according to some examples of the present disclosure.

25 [0007] FIG. 5 is a diagram illustrating the structure of a packet transmission apparatus according to some examples of the present disclosure.

Detailed Description

[0008] For simplicity and illustrative purposes, the present disclosure is described by referring mainly to an example thereof. 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. 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.

[0009] In a management packet transmission method, a DC server sets a physical port aside as an ILO port. A network management device transmits management packets via the ILO port, so as to manage the DC server. Accordingly, physical port resources of the DC server are occupied.

[0010] In addition, a dedicated management network is necessary so that the network management device can manage the DC server, which causes high network construction costs.

[0011] FIG. 1 is a flowchart illustrating a packet transmission method according to some examples of the present disclosure. The method may be applicable to an Intelligent Resilient Framework (IRF) system. In the IRF system, multiple network devices may be connected through physical IRF ports and may be virtualized into a device after necessary configurations are performed.

[0012] As shown in FIG. 1, the method includes the following blocks.

[0013] At block 110, a downlink packet is received. The downlink packet contains a tag of a first Virtual Local Area Network (VLAN) for indicating the downlink packet to be transmitted in the first VLAN.

[0014] At block 120, if the downlink packet is a known unicast packet whose destination address is the Media Access Control (MAC) address of a DC server, the first VLAN is a management VLAN and an egress port corresponding to the downlink packet is an aggregation port, the downlink packet is transmitted via a physical port bundled with the first VLAN in the aggregation port. The management

VLAN may be a VLAN used for managing the DC server, and the physical port bundled with the first VLAN is also bundled with a service VLAN.

[0015] In some examples of the present disclosure, the downlink packet is a packet sent by a network management device or a core network to the DC server.

5 [0016] In some examples of the present disclosure, a physical port in the aggregation port for transmitting service packets of the DC server is bundled with the management VLAN. A downlink packet is received. If the downlink packet is a known unicast packet whose destination address is the MAC address of the DC server, the first VLAN is a management VLAN and an egress port corresponding to
10 the downlink packet is an aggregation port, the downlink packet is transmitted via the physical port bundled with the management VLAN in the aggregation port. Thus, the management packets transmitted in the management VLAN may be transmitted via a service network and it is unnecessary to set a physical port for transmitting the management packets aside, thereby reducing network construction costs and fully
15 utilizing physical port resources of the IRF system.

[0017] In some examples of the present disclosure, the aggregation port may include multiple physical ports. One or more physical ports may be selected from the multiple physical ports to transmit service packets. By the aggregation port, load balance and flow backup may be implemented. One of the multiple physical ports
20 may be bundled with the management VLAN to transmit management packets.

[0018] In some examples of the present disclosure, if the downlink packet is an unknown unicast packet or a broadcast packet and the first VLAN is the management VLAN, the downlink packet is transmitted via all physical ports bundled with the management VLAN except a physical port receiving the downlink
25 packet.

[0019] In some examples of the present disclosure, if the downlink packet is a known unicast packet whose destination address is the MAC address of the DC server, the first VLAN is a service VLAN and an egress port corresponding to the downlink packet is an aggregation port, a physical port corresponding to the
30 downlink packet is selected from the multiple physical ports included in the aggregation port according to a load balance algorithm.

[0020] The downlink packet is forwarded to the DC server via the physical port corresponding to the downlink packet.

[0021] In some examples of the present disclosure, after the downlink packet is received and if the downlink packet is a unicast packet, a forwarding table is searched. A forwarding entry in the forwarding table may indicate a relationship between a MAC address, a VLAN and an egress port.

5 [0022] When the egress port corresponding to the downlink packet is identified according to the destination MAC address of the downlink packet and the tag of the first VLAN, it is determined that the downlink packet is a known unicast packet.

[0023] In some examples of the present disclosure, the forwarding table may be configured in advance, or may be obtained by the IRF system through learning
10 packets exchanged with the DC server. For example, an uplink packet sent by the DC server via a first physical port is received. The uplink packet contains the MAC address of the DC server and the tag of the first VLAN. When the forwarding table does not store a forwarding entry for indicating a relationship between an egress port, the MAC address of the DC server and the first VLAN, an aggregation port
15 including the first physical port is determined as an egress port corresponding to the MAC address of the DC server and the first VLAN, and the forwarding entry for indicating a relationship between the aggregation port including the first physical port, the MAC address of the DC server and the first VLAN is stored into the forwarding table.

20 [0024] In some examples of the present disclosure, the uplink packet is a packet sent from the DC server to the IRF system.

[0025] Some examples of the present disclosure may be applied to the IRF system. The IRF system consists of top-of-rack (TOR) devices, and the TOR devices may be TOR switches.

25 [0026] FIG. 2 is a flowchart illustrating a packet transmission method according to some examples of the present disclosure. As shown in FIG. 2, the method includes the following blocks.

[0027] At block 200, a management VLAN for managing DC servers is allocated in advance. The management VLAN may transmit management packets.

30 [0028] In this example, the tag of the management VLAN is VLAN 401.

[0029] At block 201, the management VLAN is bundled with a physical port of a DC server, and bundled with a physical port of an IRF system connected with the physical port of the DC server.

[0030] The physical ports bundled with the management VLAN may also be bundled with a service VLAN to transmit service packets.

[0031] At block 202, for any IRF system connected with the DC server, the following Access Control List (ACL) rules are configured in the IRF system.

5 [0032] In a first ACL rule, when a condition is met that a known layer 2 unicast downlink management VLAN packet is received and an egress port in a layer 2 MAC forwarding entry corresponding to the known layer 2 unicast downlink management VLAN packet is an aggregation port, an egress port corresponding to the known layer 2 unicast downlink management VLAN packet is set as a physical
10 port bundled with the management VLAN in the aggregation port.

[0033] In a second ACL rule, when a condition is met that an unknown layer 2 unicast or broadcast downlink management VLAN packet is received, an egress port corresponding to the unknown layer 2 unicast or broadcast downlink management VLAN packet is set as all local physical ports bundled with the management VLAN
15 except an ingress port corresponding to the unknown layer 2 unicast or broadcast downlink management VLAN packet.

[0034] At block 203, the IRF system receives a layer 2 management VLAN packet sent by a network management device, and determines whether the layer 2 management VLAN packet is a unicast packet or a broadcast packet according to the
20 destination MAC address of the layer 2 management VLAN packet. When determining that the layer 2 management VLAN packet is a unicast packet, block 204 is performed. When determining that the layer 2 management VLAN packet is a broadcast packet, block 206 is performed.

[0035] At block 204, the IRF system searches a locally generated layer 2 MAC forwarding table for a layer 2 MAC forwarding entry corresponding to the
25 destination MAC address of the unicast packet and the tag of the management VLAN, and determines whether the layer 2 MAC forwarding entry is identified. If the IRF system identifies the layer 2 MAC forwarding entry, block 205 is performed; otherwise, block 206 is performed.

30 [0036] At block 205, the IRF system finds that an egress port in the identified layer 2 MAC forwarding entry is an aggregation port, and forwards the unicast packet via a physical port bundled with the management VLAN in the aggregation port according to the first ACL rule. And thus, this flowchart ends.

[0037] At block 206, the IRF system forwards the broadcast packet via all local physical ports bundled with the management VLAN except an ingress port corresponding to the broadcast packet according to the second ACL rule.

[0038] When the IRF system broadcasts the layer 2 management VLAN packet, if an egress port is a single physical port which is not an aggregation port, the IRF system forwards the layer 2 management VLAN packet via the physical port. If an egress port is an aggregation port, the IRF system forwards the layer 2 management VLAN packet via the physical ports bundled with the management VLAN in the aggregation port.

[0039] According to the above examples, the management VLAN for managing DC servers is allocated, and the first ACL rule is configured in the IRF system. In the first ACL rule, when a condition is met that a known layer 2 unicast downlink management VLAN packet is received and an egress port in a layer 2 MAC forwarding entry corresponding to the known layer 2 unicast downlink management VLAN packet is an aggregation port, an egress port corresponding to the known layer 2 unicast downlink management VLAN packet is set as a physical port bundled with the management VLAN in the aggregation port.

[0040] Because one physical port may support multiple VLANs, a physical port of the DC server may be bundled with the service VLAN after bundled with the management VLAN. Accordingly, both management packets and service packets may be transmitted via the physical port. Therefore, it is unnecessary for the DC server to set a physical port for transmitting management packets aside, thereby fully utilizing physical port resources of the DC server .

[0041] In addition, management packets may be successfully transmitted in a service network. Accordingly, it is unnecessary to establish a dedicated management network separated from the service network, thereby saving network establishment costs.

[0042] An example will be described hereinafter.

[0043] As shown in FIG. 3, an IRF system includes a TOR switch 1 and a TOR switch 2, and a DC server 1 and a DC server 2 are connected with the IRF system.

[0044] The physical port P11 of the DC server 1 is connected with the physical port G1/0/1 of the TOR switch 1.

[0045] The physical port P12 of the DC server 1 is connected with the physical

port G2/0/1 of the TOR switch 2.

[0046] The physical port P21 of the DC server 2 is connected with the physical port G1/0/2 of the TOR switch 1.

5 [0047] The physical port P22 of the DC server 2 is connected with the physical port G2/0/2 of the TOR switch 2.

[0048] In the IRF system, the physical port G1/0/1 of the TOR switch 1 and the physical port G2/0/1 of the TOR switch 2 are bundled as an aggregation port G1 according to Link Aggregation Control Protocol (LACP), and the physical port G1/0/2 of the TOR switch 1 and the physical port G2/0/2 of the TOR switch 2 are
10 bundled as an aggregation port G2 according to the LACP.

[0049] The following processing is performed in advance.

[0050] The physical port P11 of the DC server 1 is bundled with a management VLAN 401, and the physical port P21 of the DC server 2 is bundled with the management VLAN 401.

15 [0051] On the TOR switch 1, the physical port G1/0/1 connected with the physical port P11 is bundled with the management VLAN 401, and the physical port G1/0/2 connected with the physical port P21 is bundled with the management VLAN 401.

[0052] Following ACL rules are configured in the TOR switch 1 and the TOR
20 switch 2 in the IRF system.

[0053] In a first ACL rule, when a condition is met that a known layer 2 unicast downlink VLAN 401 packet is received and an egress port in a layer 2 MAC forwarding entry corresponding to the known layer 2 unicast downlink VLAN 401 packet is an aggregation port, an egress port corresponding to the known layer 2
25 unicast downlink VLAN 401 packet is set as a physical port bundled with the management VLAN 401 in the aggregation port.

[0054] In a second ACL rule, when a condition is met that an unknown layer 2 unicast or broadcast downlink VLAN 401 packet is received, an egress port corresponding to the unknown layer 2 unicast or broadcast downlink VLAN 401 packet is set as all local physical ports bundled with the management VLAN 401
30 except an ingress port corresponding to the unknown layer 2 unicast or broadcast downlink VLAN 401 packet.

[0055] A process of the TOR switch learning the layer 2 MAC forwarding entry

is implemented as follows.

[0056] The TOR switch 1 receives a layer 2 management VLAN 401 packet from the DC server 1 via the physical port G1/0/1, and searches a local layer 2 MAC forwarding table for a layer 2 MAC forwarding entry corresponding to the source
5 MAC address of the layer 2 management VLAN 401 packet and the VLAN 401. If the TOR switch 1 does not identify the layer 2 MAC forwarding entry, the TOR switch 1 learns the layer 2 MAC forwarding entry.

[0057] The layer 2 MAC forwarding entry includes a VLAN tag, i.e., VLAN 401, a MAC address, i.e., the source MAC address of the layer 2 management
10 VLAN 401 packet (i.e., the MAC address of the DC server 1), and an egress port, i.e., the aggregation port G1 (i.e., the aggregation port to which the ingress port G1/0/1 of the layer 2 management VLAN 401 packet belongs).

[0058] The TOR switch 1 receives a layer 2 management VLAN 401 packet from the DC server 2 via the physical port G1/0/2, and searches the local layer 2
15 MAC forwarding table for a layer 2 MAC forwarding entry corresponding to the source MAC address of the layer 2 management VLAN 401 packet and the VLAN 401. If the TOR switch 1 does not identify the layer 2 MAC forwarding entry, the TOR switch 1 learns the layer 2 MAC forwarding entry.

[0059] The layer 2 MAC forwarding entry includes a VLAN tag, i.e., VLAN
20 401, a MAC address, i.e., the source MAC address of the layer 2 management VLAN 401 packet (i.e., the MAC address of the DC server 2), and an egress port, i.e., the aggregation port G2 (i.e., the aggregation port to which the ingress port G1/0/2 of the layer 2 management VLAN 401 packet belongs).

[0060] According to characteristics of the IRF system, each device in the IRF
25 system, such as the TOR switches 1 and 2 in this example, may synchronize its layer 2 MAC forwarding entry to other devices in the IRF system.

[0061] A process of a TOR switch forwarding a layer 2 management packet is implemented as follows.

[0062] The TOR switch 1 receives a layer 2 unicast management packet sent
30 from a network management device to the DC server 1. A VLAN tag in the layer 2 unicast management packet is the VLAN 401, and the destination address of the layer 2 unicast management packet is the address of the DC server 1. The TOR switch 1 locally identifies a layer 2 MAC forwarding entry. An egress port in the

layer 2 MAC forwarding entry is the aggregation port G1. The TOR switch 1 finds that the layer 2 unicast management packet meets the condition in the first ACL rule, and thus forwards the layer 2 unicast management packet via the physical port G1/0/1 bundled with the VLAN 401 in the aggregation port G1 according to the first
5 ACL rule. The layer 2 unicast management packet may arrive at the physical port P11 of the DC server 1.

[0063] The TOR switch 1 receives a layer 2 unicast management packet sent from the network management device to the DC server 2. A VLAN tag in the layer 2 unicast management packet is the VLAN 401, and the destination address of the
10 layer 2 unicast management packet is the address of the DC server 2. The TOR switch 1 locally identifies a layer 2 MAC forwarding entry. An egress port in the layer 2 MAC forwarding entry is the aggregation port G2. The TOR switch 1 finds that the layer 2 unicast management packet meets the condition in the first ACL rule, and thus forwards the layer 2 unicast management packet via the physical port
15 G1/0/2 bundled with the VLAN 401 in the aggregation port G2 according to the first ACL rule. The layer 2 unicast management packet may arrive at the physical port P21 of the DC server 2.

[0064] The TOR switch 1 receives a layer 2 broadcast management packet from the network management device. A VLAN tag in the layer 2 broadcast management
20 packet is the VLAN 401, and the destination address of the layer 2 broadcast management packet is a broadcast address. The TOR switch 1 finds that the layer 2 broadcast management packet meets the condition in the second ACL rule, and thus forwards the layer 2 broadcast management packet via the physical port G1/0/1 bundled with the VLAN 401 in the aggregation port G1 and the physical port G1/0/2
25 bundled with the VLAN 401 in the aggregation port G2 according to the second ACL rule. The layer 2 broadcast management packet may arrive at the physical port P11 of the DC server 1 and the physical port P21 of the DC server 2.

[0065] A process of a TOR switch forwarding a layer 2 service packet is implemented as follows.

30 **[0066]** The TOR switch 1 receives a layer 2 service packet from a core network, and locally identifies a layer 2 MAC forwarding entry according to a VLAN tag in the layer 2 service packet and the destination MAC address of the layer 2 service packet. The TOR switch 1 finds that an egress port in the layer 2 MAC forwarding

entry is an aggregation port, distributes the layer 2 service packet to a physical port of the aggregation port according to a predefined load balance algorithm and forwards the layer 2 service packet via the physical port.

[0067] For example, if the egress port in the layer 2 MAC forwarding entry is the aggregation port G1, a Hash calculation is performed for five-tuple information of the layer 2 service packet according to a predefined Hash algorithm, and maps a calculation result to a physical port of the aggregation port G1, e.g. G1/0/1 or G2/0/1, and then forwards the layer 2 service packet via the physical port. If the calculation result is mapped to the physical port G2/0/1, the TOR switch 1 forwards the layer 2 service packet and the physical port G2/0/1 to the TOR switch 2, and the TOR switch 2 forwards the layer 2 service packet via the physical port G2/0/1.

[0068] The process of the TOR switch 2 forwarding the layer 2 service packet is similar to the process of the TOR switch 1 forwarding the layer 2 service packet.

[0069] According to the above examples, the layer 2 management packets may be forwarded via a fixed physical port in the IRF system, and the layer 2 service packets may be forwarded via the physical ports in the IRF system according to the load balance algorithm.

[0070] FIG. 4 is a diagram illustrating the structure of a packet transmission apparatus according to some examples of the present disclosure. The apparatus may be a TOR switch. The apparatus includes a non-transitory machine-readable storage medium 410 and a processor 420. The non-transitory machine-readable storage medium 410 may store machine-readable instructions that can be executed by the processor 420. The processor 420 may read the machine-readable instructions stored in the non-transitory machine-readable storage medium 410 to perform a process of:

receiving a downlink packet, wherein the downlink packet contains a tag of a first VLAN for indicating the downlink packet to be transmitted in the first VLAN; and

if the downlink packet is a known unicast packet whose destination address is the MAC address of a DC server, the first VLAN is a management VLAN and an egress port corresponding to the downlink packet is an aggregation port, transmitting the downlink packet via a physical port bundled with management VLAN in the aggregation port. The management VLAN may be a VLAN used for managing the DC server, and the physical port bundled with the first VLAN is also

bundled with a service VLAN.

[0071] In some examples of the present disclosure, the processor 420 may read the machine-readable instructions stored in the non-transitory machine-readable storage 410 to further perform a process of:

- 5 if the downlink packet is an unknown unicast packet or a broadcast packet and the first VLAN is the management VLAN, transmitting the downlink packet via all physical ports bundled with the management VLAN except a physical port receiving the downlink packet.

[0072] In some examples of the present disclosure, the processor 420 may read
10 the machine-readable instructions stored in the non-transitory machine-readable storage medium 410 to further perform a process of:

- if the downlink packet is a known unicast packet whose destination address is the MAC address of the DC server, the first VLAN is a service VLAN and an egress port corresponding to the downlink packet is an aggregation port, selecting a
15 physical port corresponding to the downlink packet from the multiple physical ports included in the aggregation port according to a load balance algorithm; and

forwarding the downlink packet to the DC server via the physical port corresponding to the downlink packet.

[0073] In some examples of the present disclosure, the processor 420 may read
20 the machine-readable instructions stored in the non-transitory machine-readable storage medium 410 to further perform a process of:

- after the downlink packet is received and if the downlink packet is a unicast packet, searching a forwarding table, wherein a forwarding entry in the forwarding table may indicate a relationship between a MAC address, a VLAN and an egress
25 port; and

when the egress port corresponding to the downlink packet is identified according to the destination MAC address of the downlink packet and the tag of the first VLAN, determining that the downlink packet is a known unicast packet.

[0074] In some examples of the present disclosure, the processor 420 may read
30 the machine-readable instructions stored in the non-transitory machine-readable storage medium 410 to further perform a process of:

receiving an uplink packet sent by the DC server via a first physical port, wherein the uplink packet contains the MAC address of the DC server and the tag of

the first VLAN; and

when the forwarding table does not store a forwarding entry for indicating a relationship between an egress port, the MAC address of the DC server and the first VLAN, determining that an aggregation port including the first physical port as an egress port corresponding to the MAC address of the DC server and the first VLAN, and storing the forwarding entry for indicating a relationship between the aggregation port including the first physical port, the MAC address of the DC server and the first VLAN into the forwarding table.

[0075] A non-transitory machine-readable storage medium is provided according to some examples of the present disclosure. The non-transitory machine-readable storage medium may store machine-readable instructions, and a processor may read the machine-readable instructions stored in the non-transitory machine-readable storage medium to perform a process of:

receiving a downlink packet, wherein the downlink packet contains a tag of a first VLAN for indicating the downlink packet to be transmitted in the first VLAN; and

if the downlink packet is a known unicast packet whose destination address is the MAC address of a DC server, the first VLAN is a management VLAN and an egress port corresponding to the downlink packet is an aggregation port, transmitting the downlink packet via a physical port bundled with the management VLAN in the aggregation port. The management VLAN may be a VLAN used for managing the DC server, and the physical port bundled with the first VLAN is also bundled with a service VLAN.

[0076] In some examples of the present disclosure, the processor may read the machine-readable instructions stored in the non-transitory machine-readable storage medium to further perform a process of:

if the downlink packet is an unknown unicast packet or a broadcast packet and the first VLAN is the management VLAN, transmitting the downlink packet via all physical ports bundled with the management VLAN except a physical port receiving the downlink packet.

[0077] In some examples of the present disclosure, the processor may read the machine-readable instructions stored in the non-transitory machine-readable storage medium to further perform a process of:

if the downlink packet is a known unicast packet whose destination address is the MAC address of the DC server, the first VLAN is a service VLAN and an egress port corresponding to the downlink packet is an aggregation port, selecting a physical port corresponding to the downlink packet from the multiple physical ports included in the aggregation port according to a load balance algorithm; and

forwarding the downlink packet to the DC server via the physical port corresponding to the downlink packet.

[0078] In some examples of the present disclosure, the processor may read the machine-readable instructions stored in the non-transitory machine-readable storage medium to further perform a process of:

after the downlink packet is received and if the downlink packet is a unicast packet, searching a forwarding table, wherein a forwarding entry in the forwarding table may indicate a relationship between a MAC address, a VLAN and an egress port; and

when an egress port corresponding to the downlink packet is identified according to the destination MAC address of the downlink packet and the tag of the first VLAN, determining that the downlink packet is a known unicast packet.

[0079] In some examples of the present disclosure, the processor may read the machine-readable instructions stored in the non-transitory machine-readable storage medium to further perform a process of:

receiving an uplink packet sent by the DC server via a first physical port, wherein the uplink packet contains the MAC address of the DC server and the tag of the first VLAN; and

when the forwarding table does not store a forwarding entry for indicating a relationship between an egress port, the MAC address of the DC server and the first VLAN, determining that an aggregation port including the first physical port as an egress port corresponding to the MAC address of the DC server and the first VLAN, and storing the forwarding entry for indicating a relationship between the aggregation port including the first physical port, the MAC address of the DC server and the first VLAN into the forwarding table.

[0080] The machine-readable storage medium for storing the machine-readable instructions may be any electric, magnetic or optical storage medium or other physical storage medium. The non-transitory storage medium may include or store

information, e.g. executable instructions and data. For example, the non-transitory storage medium may be a Random Access Memory (RAM), a transitory storage medium, a non-transitory storage medium, a Flash card, a storage driver (e.g. a disk driver), a solid-state disk, a storage disk of any type (e.g. an optical disk and a DVD), or a similar storage medium, or any combination of the above.

[0081] The machine-readable storage medium described above may be non-transitory.

[0082] FIG. 5 is a diagram illustrating the structure of a packet transmission apparatus according to some examples of the present disclosure. The apparatus may be a TOR switch. The apparatus includes a receiving unit 510, a processing unit 520 and a transmitting unit 530.

[0083] The receiving unit 510 is to receive a downlink packet. The downlink packet contains a tag of a first VLAN for indicating the downlink packet to be transmitted in the first VLAN.

[0084] The processing unit 520 is to determine whether the downlink packet is a known unicast packet whose destination address is the MAC address of a DC server, whether the first VLAN is a management VLAN, and whether an egress port corresponding to the downlink packet is an aggregation port.

[0085] If the downlink packet is a known unicast packet whose destination address is the MAC address of a DC server, the first VLAN is a management VLAN and an egress port corresponding to the downlink packet is an aggregation port, the transmitting unit 530 is to transmit the downlink packet via a physical port bundled with the management VLAN in the aggregation port. The management VLAN may be a VLAN used for managing the DC server, and the physical port bundled with the first VLAN is also bundled with a service VLAN.

[0086] In some examples of the present disclosure, if the downlink packet is an unknown unicast packet or a broadcast packet and the first VLAN is the management VLAN, the transmitting unit 530 is to transmit the downlink packet via all physical ports bundled with the management VLAN except a physical port receiving the downlink packet.

[0087] In some examples of the present disclosure, if the downlink packet is a known unicast packet whose destination address is the MAC address of the DC server, the first VLAN is a service VLAN and an egress port corresponding to the

downlink packet is an aggregation port, the processing unit 520 is to select a physical port corresponding to the downlink packet from the multiple physical ports included in the aggregation port according to a load balance algorithm. The transmitting unit 530 is to forward the downlink packet to the DC server via the physical port corresponding to the downlink packet.

[0088] In some examples of the present disclosure, after the receiving unit 510 receives the downlink packet and if the downlink packet is a unicast packet, the processing unit 520 is to search a forwarding table. A forwarding entry in the forwarding table may indicate a relationship between a MAC address, a VLAN and an egress port. The processing unit 520 is to determine that the downlink packet is a known unicast packet when identifying an egress port corresponding to the downlink packet according to the destination MAC address of the downlink packet and the tag of the first VLAN.

[0089] In some examples of the present disclosure, the receiving unit 510 is to receive an uplink packet sent by the DC server via a first physical port. The uplink packet contains the MAC address of the DC server and the tag of the first VLAN. When the forwarding table does not store a forwarding entry for indicating a relationship between an egress port, the MAC address of the DC server and the first VLAN, the processing unit 520 is to determine that an aggregation port including the first physical port as an egress port corresponding to the MAC address of the DC server and the first VLAN, and store the forwarding entry for indicating a relationship between the aggregation port including the first physical port, the MAC address of the DC server and the first VLAN into the forwarding table.

[0090] In an examples of the present disclosure, a physical port in the aggregation port for transmitting service packets of the DC server is bundled with the first VLAN which may transmit management packets of the DC server. After a management packet is received, the management packet may be transmitted via the physical port bundled with first VLAN. Thus, the management packet may be transmitted via a service network and it is unnecessary to set a physical port for transmitting management packets aside, thereby reducing network construction costs and fully utilizing physical port resources of the IRF system.

[0091] 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.

[0092] What has been described and illustrated herein is an example along with
5 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 all terms are meant in their broadest reasonable sense unless otherwise indicated.

What is claimed is:

1. A packet transmission method, comprising:

receiving a downlink packet, the downlink packet containing a tag of a first Virtual Local Area Network (VLAN) for indicating the downlink packet to be transmitted in the first VLAN; and

if the downlink packet is a known unicast packet whose destination address is a Media Access Control (MAC) address of a Data Center (DC) server, the first VLAN is a management VLAN and an egress port corresponding to the downlink packet is an aggregation port, transmitting the downlink packet via a physical port bundled with the first VLAN in the aggregation port,

wherein the management VLAN is a VLAN used for managing the DC server, and the physical port bundled with the first VLAN is bundled with a service VLAN.

2. The method of claim 1, further comprising:

if the downlink packet is an unknown unicast packet or a broadcast packet and the first VLAN is the management VLAN, transmitting the downlink packet via all physical ports bundled with the management VLAN except a physical port receiving the downlink packet.

3. The method of claim 1, further comprising:

if the downlink packet is a known unicast packet whose destination address is the MAC address of the DC server, the first VLAN is a service VLAN and the egress port corresponding to the downlink packet is the aggregation port, selecting a physical port corresponding to the downlink packet from multiple physical ports included in the aggregation port according to a load balance algorithm; and

forwarding the downlink packet to the DC server via the physical port corresponding to the downlink packet.

4. The method of claim 1, further comprising:

after the downlink packet is received and if the downlink packet is a unicast packet, searching a forwarding table, wherein a forwarding entry in the forwarding table indicates a relationship between a MAC address, a VLAN and an egress port; and

when the egress port corresponding to the downlink packet is identified according to the destination MAC address of the downlink packet and the tag of the

first VLAN, determining that the downlink packet is a known unicast packet.

5. The method of claim 4, further comprising:

receiving an uplink packet sent by the DC server via a first physical port, wherein the uplink packet contains the MAC address of the DC server and the tag of the first VLAN; and

when the forwarding table does not store a forwarding entry for indicating a relationship between an egress port, the MAC address of the DC server and the first VLAN, determining that an aggregation port including the first physical port as the egress port corresponding to the MAC address of the DC server and the first VLAN, and storing the forwarding entry for indicating a relationship between the aggregation port including the first physical port, the MAC address of the DC server and the first VLAN into the forwarding table.

6. A packet transmission apparatus, comprising a non-transitory storage medium and a processor,

the non-transitory storage medium storing machine-readable instructions to be executed by the processor; and

the processor is to read the machine-readable instructions stored in the non-transitory storage medium to perform a process of:

receiving a downlink packet, the downlink packet containing a tag of a first Virtual Local Area Network (VLAN) for indicating the downlink packet to be transmitted in the first VLAN; and

if the downlink packet is a known unicast packet whose destination address is a Media Access Control (MAC) address of a Data Center (DC) server, the first VLAN is a management VLAN and an egress port corresponding to the downlink packet is an aggregation port, transmitting the downlink packet via a physical port bundled with the first VLAN in the aggregation port,

wherein the management VLAN is a VLAN used for managing the DC server, and the physical port bundled with the first VLAN is bundled with a service VLAN.

7. The apparatus of claim 6, wherein the processor is to read the machine-readable instructions stored in the non-transitory storage medium to further perform a process of:

if the downlink packet is an unknown unicast packet or a broadcast packet and the first VLAN is the management VLAN, transmitting the downlink packet via all

physical ports bundled with the management VLAN except a physical port receiving the downlink packet.

8. The apparatus of claim 6, wherein the processor is to read the machine-readable instructions stored in the non-transitory storage medium to further
5 perform a process of:

if the downlink packet is a known unicast packet whose destination address is the MAC address of the DC server, the first VLAN is a service VLAN and the egress port corresponding to the downlink packet is the aggregation port, selecting a physical port corresponding to the downlink packet from multiple physical ports
10 included in the aggregation port according to a load balance algorithm; and

forwarding the downlink packet to the DC server via the physical port corresponding to the downlink packet.

9. The apparatus of claim 6, wherein the processor is to read the machine-readable instructions stored in the non-transitory storage medium to further
15 perform a process of:

after the downlink packet is received and if the downlink packet is a unicast packet, searching a forwarding table, wherein a forwarding entry in the forwarding table indicates a relationship between a MAC address, a VLAN and an egress port; and

20 when the egress port corresponding to the downlink packet is identified according to the destination MAC address of the downlink packet and the tag of the first VLAN, determining that the downlink packet is a known unicast packet.

10. The apparatus of claim 9, wherein the processor is to read the machine-readable instructions stored in the non-transitory storage medium to further
25 perform a process of:

receiving an uplink packet sent by the DC server via a first physical port, wherein the uplink packet contains the MAC address of the DC server and the tag of the first VLAN; and

when the forwarding table does not store a forwarding entry for indicating a
30 relationship between an egress port, the MAC address of the DC server and the first VLAN, determining that an aggregation port including the first physical port as the egress port corresponding to the MAC address of the DC server and the first VLAN, and storing the forwarding entry for indicating a relationship between the

aggregation port including the first physical port, the MAC address of the DC server and the first VLAN into the forwarding table.

11. A non-transitory storage medium, to store machine-readable instructions that can be executed by a processor, wherein the machine-readable instructions are
5 executed by the processor to perform a process of:

receiving a downlink packet, the downlink packet containing a tag of a first Virtual Local Area Network (VLAN) for indicating the downlink packet to be transmitted in the first VLAN; and

if the downlink packet is a known unicast packet whose destination address is a
10 Media Access Control (MAC) address of a Data Center (DC) server, the first VLAN is a management VLAN and an egress port corresponding to the downlink packet is an aggregation port, transmitting the downlink packet via a physical port bundled with the first VLAN in the aggregation port,

wherein the management VLAN is a VLAN used for managing the DC server,
15 and the physical port bundled with the first VLAN is bundled with a service VLAN.

12. The non-transitory storage medium of claim 11, wherein the machine-readable instructions are executed by the processor to further perform a process of:

if the downlink packet is an unknown unicast packet or a broadcast packet and
20 the first VLAN is the management VLAN, transmitting the downlink packet via all physical ports bundled with the management VLAN except a physical port receiving the downlink packet.

13. The non-transitory storage medium of claim 11, wherein the machine-readable instructions are executed by the processor to further perform a
25 process of:

if the downlink packet is a known unicast packet whose destination address is the MAC address of the DC server, the first VLAN is a service VLAN and the egress port corresponding to the downlink packet is the aggregation port, selecting a physical port corresponding to the downlink packet from multiple physical ports
30 included in the aggregation port according to a load balance algorithm; and

forwarding the downlink packet to the DC server via the physical port corresponding to the downlink packet.

14. The non-transitory storage medium of claim 11, wherein the

machine-readable instructions are executed by the processor to further perform a process of:

after the downlink packet is received and if the downlink packet is a unicast packet, searching a forwarding table, wherein a forwarding entry in the forwarding table indicates a relationship between a MAC address, a VLAN and an egress port;
5 and

when the egress port corresponding to the downlink packet is identified according to the destination MAC address of the downlink packet and the tag of the first VLAN, determining that the downlink packet is a known unicast packet.

10 15. The non-transitory storage medium of claim 14, wherein the machine-readable instructions are executed by the processor to further perform a process of:

receiving an uplink packet sent by the DC server via a first physical port, wherein the uplink packet contains the MAC address of the DC server and the tag of the first VLAN; and
15

when the forwarding table does not store a forwarding entry for indicating a relationship between an egress port, the MAC address of the DC server and the first VLAN, determining that an aggregation port including the first physical port as the egress port corresponding to the MAC address of the DC server and the first VLAN, and storing the forwarding entry for indicating a relationship between the
20 aggregation port including the first physical port, the MAC address of the DC server and the first VLAN into the forwarding table.

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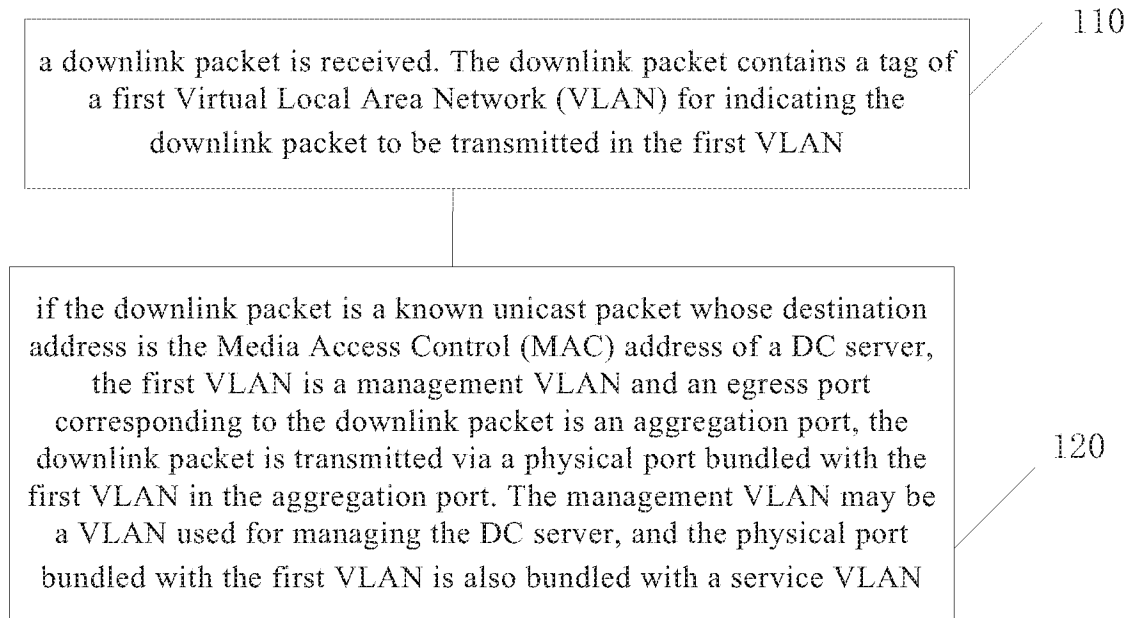


FIG. 1

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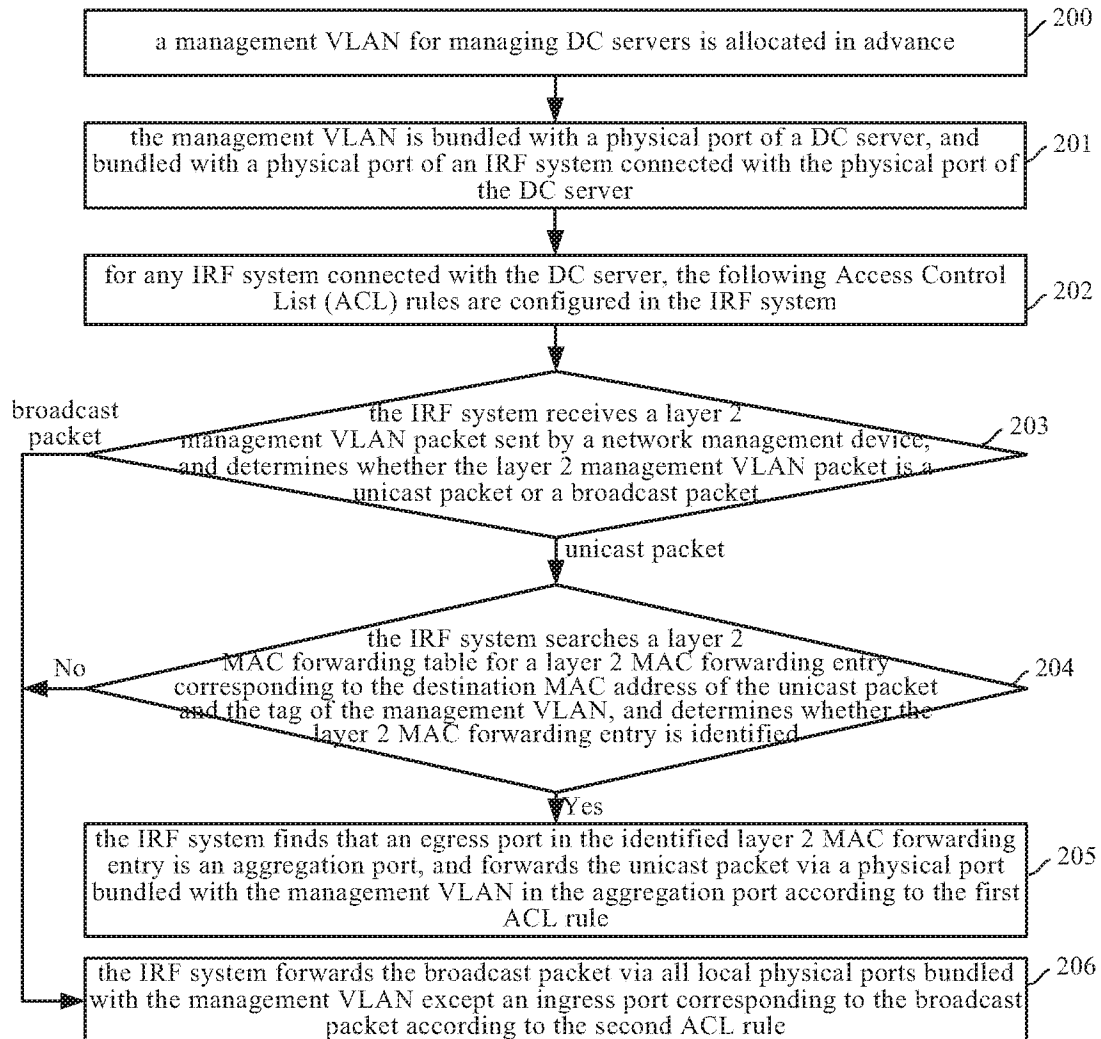


FIG. 2

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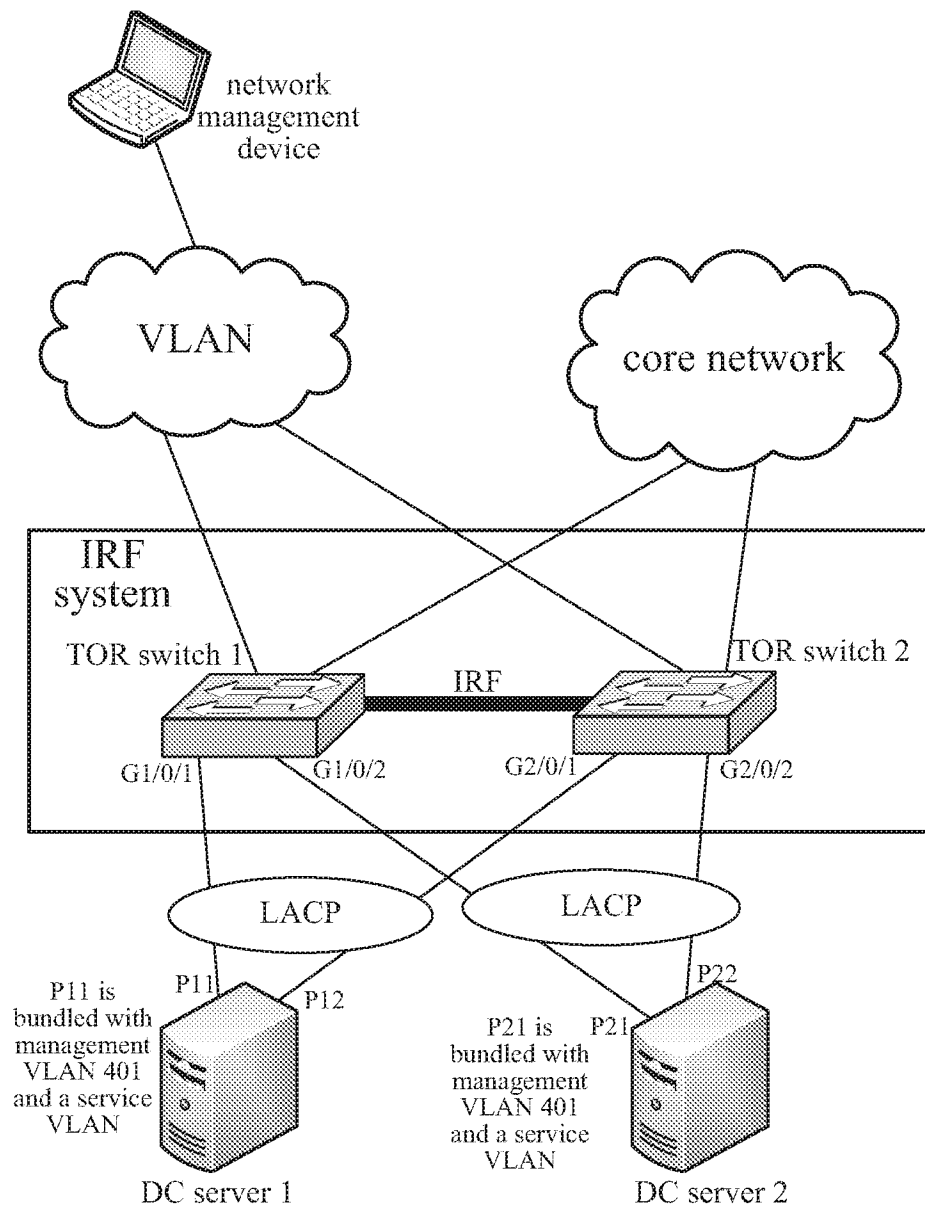


FIG. 3

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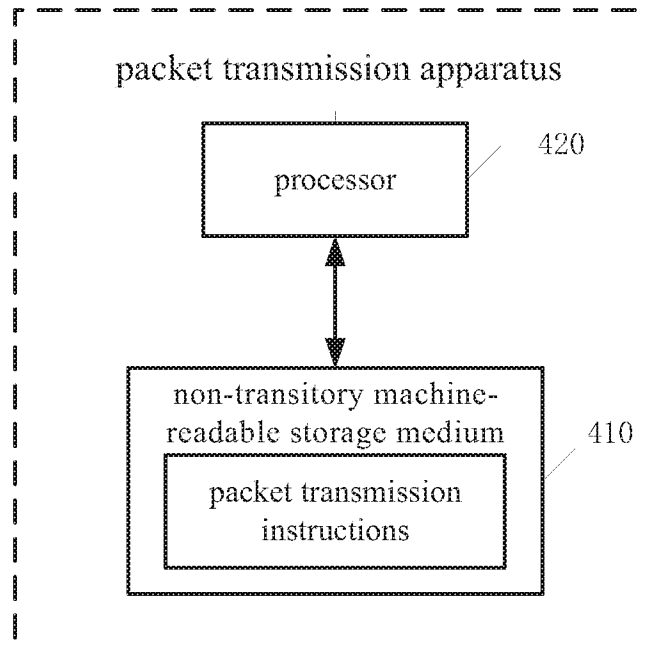


FIG. 4

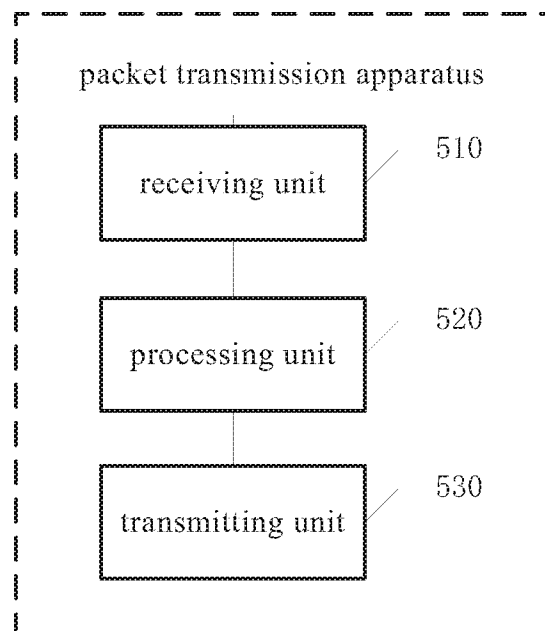


FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2016/073611

A. CLASSIFICATION OF SUBJECT MATTER

H04L 12/883(2013.01)i; H04L 12/46(2006.01)i; H04L 29/12(2006.01)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)

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)

WPI;EPODOC;IEEE;CNPAT;CNKI:VLAN, manage+, data center, DC, destination address, egress port

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 101764752 A (HANGZHOU H3C TECHNOLOGIES CO., LTD.) 30 June 2010 (2010-06-30) paragraphs [0007]-[0051] in description	1-15
A	CN 103227757 A (HANGZHOU H3C TECHNOLOGIES CO., LTD.) 31 July 2013 (2013-07-31) the whole document	1-15
A	CN 103166874 A (HANGZHOU H3C TECHNOLOGIES CO., LTD.) 19 June 2013 (2013-06-19) the whole document	1-15
A	US 2012287785 A1 (INTERNATIONAL BUSINESS MACHINES CORPORATION) 15 November 2012 (2012-11-15) the whole document	1-15



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

“A” document defining the general state of the art which is not considered to be of particular relevance

“E” earlier application or patent but published on or after the international filing date

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“O” document referring to an oral disclosure, use, exhibition or other means

“P” document published prior to the international filing date but later than the priority date claimed

“T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

“X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

“Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

“&” document member of the same patent family

Date of the actual completion of the international search

18 April 2016

Date of mailing of the international search report

11 May 2016

Name and mailing address of the ISA/CN

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2016/073611

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CN	103227757	A	31 July 2013	CN	103227843	A	31 July 2013
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				US	2015172190	A1	18 June 2015
				US	2015169351	A1	18 June 2015
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				WO	2014032623	A1	06 March 2014
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				EP	2891304	A1	08 July 2015
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				CN	102821038	A	12 December 2012