

METHOD AND SYSTEM FOR DISTRIBUTED MANAGEMENT AND CONTROL

TECHNICAL FIELD

5 [0001] The present disclosure relates to the technical field of communications, and particularly to a method and system for distributed management and control.

BACKGROUND

10 [0002] At present, in order to implement multi-regional network communication, a networking environment is generally established using Customer Premises Equipment (CPE), a point-of-presence (PoP) at a central office and a controller, wherein the CPE or PoP devices are used to forward network data from a user side, and the controller is used to manage and control the CPE or PoP devices (e.g., issuing configuration). Since the CPE or PoP devices are distributed in multiple regions, how to deploy the controller and how to manage and control the CPE or PoP
15 devices in different regions by the controller to ensure normal network communications in multiple regions, are issues of close concern in the art.

20 [0003] In the prior art, generally only one controller is configured to manage and control the CPE or PoP devices in multiple regions. When the controller fails, all of the CPE or PoP devices are out of management and control and cannot receive any subsequent control instruction, so they may only maintain a state that is the last state before the out of management and control, or even fail to work normally.

25 [0004] In view of the above problems, some manufacturers respond using domain-division controllers. For example, all of the CPE or PoP devices are divided into a plurality of domains based on a certain dimension (e.g., the regions where they are located), and each domain is configured with a controller, i.e., a domain controller.

30 [0005] Each domain controller only controls the CPE or PoP devices in the domain. Since some businesses involve the cooperation between the CPE or PoP devices in different domains (e.g., the establishment of a network tunnel connection between cross-domain CPE), a set of super controllers are generally configured in addition to the respective domain controllers, so that cross-domain businesses are coordinated and processed by the super controllers.

35 [0006] The scheme of domain-division controllers introduces a plurality of domain controllers, so that when a domain controller in a certain area fails, only a part of CPE or PoP devices are affected, which reduces the overall impact of the area failure to some extent, but the affected CPE or PoP devices are still out of management and control. As a whole, the scheme divides the responsibilities of the respective domain controllers statically, and there is no overlap

therebetween, that is, when a domain controller fails, no other domain controller can take over its responsibility.

[0007] At present, a method for distributed management and control is urgently needed to solve the problem that in the scheme of domain-division controllers in the prior art, no other domain controller can take over its responsibility after a domain controller fails, resulting in that the CPE or PoP devices managed and controlled by the failed domain controller are out of management and control and incapable of receiving any subsequent control instruction, so they can only maintain a state that is the last state before the out of management and control or even fail to work normally.

SUMMARY

[0008] In order to solve the problem that in the scheme of domain-division controllers in the prior art, no other domain controller can take over its responsibility after a domain controller fails, resulting in that the CPE or PoP devices managed and controlled by the failed domain controller are out of management and control and incapable of receiving any subsequent control instruction, so they can only maintain a state that is the last state before the out of management and control or even fail to work normally, the embodiments of the present disclosure provide a method and system for distributed management and control, which enables distributed controllers to manage and control the CPE or PoP devices in multiple regions through negotiation.

[0009] In order to solve the above technical problem, the specific technical solutions of the present disclosure are as follows:

[0010] In an aspect, an embodiment of the present disclosure provides a method for distributed management and control, including:

performing, by a plurality of controllers, consensus verification on a management and control range of each controller using a first consensus algorithm based on a trigger mechanism to obtain a first management and control range of each controller, and the first management and control range includes a plurality of target network devices connected to the controller; and

managing and controlling, by each controller, the plurality of target network devices based on the first management and control range.

[0011] Further, the step of performing, by a plurality of controllers, consensus verification on a management and control range of each controller using a first consensus algorithm further includes:

electing, by the plurality of controllers, to obtain a leader controller and a follower controller;

generating, by each controller, a proposal for its own management and control range, and the

proposal includes data of the management and control range;

after confirming the proposal by the leader controller, storing the proposal in its own storage area and broadcasting the proposal to the follower controller; and

storing, by the follower controller, the proposal in its own storage area.

[0012] Further, the trigger mechanism includes timing triggering, failure triggering and/or
5 controller addition or deletion triggering.

[0013] Further, when the trigger mechanism is the failure triggering, the method further includes:

connecting target network devices managed and controlled by a failed controller to a plurality of non-failed controllers;

10 performing by the plurality of non-failed controllers, consensus verification on a management and control range of each non-failed controller using the first consensus algorithm to obtain a second management and control range of each non-failed controller, and the second management and control range includes a plurality of target network devices connected to the non-failed controller; and

15 managing and controlling, by each non-failed controller, the plurality of target network devices based on the second management and control range.

[0014] Further, the step of connecting the target network devices to the controller further includes:

connecting the target network devices to the controller based on an access strategy.

20 [0015] Further, the access strategy includes:

connecting the target network devices to the controller by taking a connection condition of whether a delay of the connected controller is less than a threshold; and/or,

connecting the target network devices to the controller based on a load balance situation of each controller; and/or,

25 connecting the target network devices to the controller by taking a connection condition of minimizing a network packet loss rate of the connected controller; and/or,

connecting the target network devices to the controller based on a predetermined connection configuration.

[0016] Further, the plurality of target network devices are deployed in a plurality of areas by
30 a user, and the controllers are distributed in the corresponding areas;

managing and controlling, by the plurality of controllers, the plurality of target network devices based on the first management and control range further including:

electing, by the plurality of controllers, a master controller for the user based on a deployment of target network device by the user and a second consensus algorithm, and

35 managing and controlling, by the master controller, the target network devices for the user,

including:

managing and controlling, by the master controller, the target network devices deployed by the user within the corresponding first management and control range; and

through another controller, managing and controlling, by the master controller, the target
5 network devices deployed by the user within the first management and control range of the another controller.

[0017] Further, determining a master controller for each user from the plurality of controllers based on networking configuration of the user further includes:

determining the number of the target network devices deployed by the user in the area, so that
10 the plurality of controllers elect a master controller for the user based on the number of the target network devices and the second consensus algorithm; or,

determining a master controller for the user based on a position of a head server of the user's main business.

[0018] Further, the step in which the plurality of controllers elect a master controller for the
15 user based on the number of the target network devices and the second consensus algorithm further includes:

voting, by the plurality of controllers, based on the number of the target network devices of the user in an area, so as to elect the master controller from the plurality of controllers.

[0019] Further, in the step of electing, by the plurality of controllers, a master controller for
20 the user through the second consensus algorithm, the method further includes:

electing a standby controller for the user by the plurality of controllers through the second consensus algorithm;

in a process of managing and controlling the target network devices of the user by the master controller, the method further includes:

25 synchronizing management and control data to the standby controller by the master controller, so that the standby controller implements the function of the master controller when the trigger mechanism is the failure triggering and the failed controller is the master controller for the user.

[0020] Further, when there are a plurality of the standby controllers, the step in which the standby controller implements the function of the master controller further includes:

30 re-electing a master controller for the user by a plurality of non-failed controllers from the standby controllers through the second consensus algorithm; and

implementing the function of the master controller before failure by the re-elected master controller.

[0021] Further, in the step of re-electing a master controller for the user by a plurality of non-
35 failed controllers from the standby controllers through the second consensus algorithm, the method

further includes:

re-electing a standby controller for the user by the plurality of non-failed controllers through the second consensus algorithm.

[0022] Further, after the step of performing, by a plurality of controllers, consensus verification on a management and control range of each controller using a first consensus algorithm based on a trigger mechanism to obtain a first management and control range of each controller, the method further includes:

respectively storing the first management and control range of each controller by the plurality of controllers;

the step of managing and controlling, by each controller, the plurality of target network devices based on the first management and control range further includes:

after receiving a management and control message for the target network device, judging, by the controller, whether the target network device belongs to its own first management and control range; and if not, forwarding, by the controller, the management and control message to a controller corresponding to the target network device based on the stored first management and control range of each controller.

[0023] Based on the same inventive concept, an embodiment of the present disclosure further provides a system for distributed management and control, including a plurality of target network devices and a plurality of controllers; and

the above method is performed when the plurality of controllers manage and control the plurality of target network devices.

[0024] In another aspect, an embodiment of the present disclosure further provides a computer device, including a memory, a processor and a computer program stored in the memory, and when being executed by the processor, the computer program implements the above method for distributed management and control.

[0025] Finally, an embodiment of the present disclosure further provides a computer storage medium, and the computer storage medium stores a computer program, when being executed by a processor, the computer program implements the above method for distributed management and control.

[0026] According to the embodiments of the present disclosure, the target network devices may be CPE or PoP devices. After a plurality of target network devices are respectively connected to a plurality of controllers, each controller takes the target network devices connected thereto as its own management and control range. However, in order to prevent the target network devices from being managed and controlled by a plurality of controllers or without any controller, the plurality of controllers perform consensus verification on a management and control range of each

controller using a first consensus algorithm based on a trigger mechanism. After the consensus verification succeeds, the first management and control range of each controller is obtained, and finally each controller manages and controls the target network devices based on its own first management and control range. Since the first management and control range of each controller is
5 obtained after consensus among a plurality of controllers, it prevents the target network devices from being managed and controlled by a plurality of controllers or without any controller. In addition, since a plurality of controllers perform consensus verification on the management control range of each controller using the first consensus algorithm based on the trigger mechanism, when a new target network device is connected to a controller or an existing target network device re-
10 selects a controller to be connected, the plurality of target network devices perform consensus verification on the current management and control range of each controller using the first consensus algorithm based on the trigger mechanism, so that the plurality of controllers can still perform consensus verification on the management and control range of each controller again using the first consensus algorithm when the target network device connected to the controller
15 changes, and obtain the first management and control range of each controller again, thereby ensuring that the changed target network device can still be managed and controlled by an assigned controller. Compared with the scheme of domain-division controllers in the prior art, the present disclosure solves the problem that after a controller fails, no other controller can take over its responsibility, resulting in that the CPE or PoP devices managed and controlled by the failed
20 controller are out of management and control and incapable of receiving any subsequent control instruction, so they may only maintain a state that is the last state before the out of management and control or even fail to work normally.

BRIEF DESCRIPTION OF THE DRAWINGS

25 [0027] In order to more clearly describe the technical solutions in the embodiments of the present disclosure or in the prior art, the drawings to be used in the description of the embodiments or the prior art will be briefly introduced as follows. Obviously, the drawings in the following description merely illustrate some embodiments of the present disclosure, and those of ordinary skill in the art may obtain other drawings from them without any creative labor.

30 [0028] FIG. 1 illustrates a schematic diagram of an implementation system of a method for distributed management and control in an embodiment of the present disclosure;

[0029] FIG. 2 illustrates a flowchart of a method for distributed management and control in an embodiment of the present disclosure;

[0030] FIG. 3 illustrates steps of consensus verification on a management and control range
35 of each controller by a plurality of controllers using a first consensus algorithm in an embodiment

of the present disclosure;

[0031] FIG. 4 illustrates a process of determining a second management and control range of each non-failed controller by a plurality of non-failed controllers after a controller fails in an embodiment of the present disclosure;

5 [0032] FIG. 5 illustrates steps of managing and controlling a plurality of target network devices by a plurality of controllers based on a first management and control range in an embodiment of the present disclosure;

[0033] FIG. 6 illustrates a process of re-electing a master controller for a user after a physical controller corresponding to the master controller for the user fails in an embodiment of the present
10 disclosure;

[0034] FIG. 7 illustrates a schematic structural diagram of a computer device in an embodiment of the present disclosure.

[Reference numerals]

101: target network device group; 102: controller; 702: computer device; 704: processing
15 device; 706: storage resource; 708: drive mechanism; 710: input/output module; 712: input device;
714: output device; 716: presentation device; 718: graphic user interface; 720: network interface;
722: communication link; 724: communication bus.

DETAILED DESCRIPTION

20 [0035] The technical solutions in the embodiments of the present disclosure will be described clearly and completely below with reference to the drawings for the embodiments of the present disclosure. Obviously, those described are only a part, rather than all, of the embodiments of the present disclosure. Based on the embodiments of the present disclosure, any other embodiment obtained by those of ordinary skill in the art without creative work should fall within
25 the protection scope of the present disclosure.

[0036] It should be noted that the terms ‘first’, ‘second’ and the like in the specification and claims herein and the above drawings are used to distinguish similar objects, and are not necessarily used to describe a particular order or precedence. It should be understood that data so used may be interchanged under appropriate circumstances, so that the embodiments described
30 herein may be implemented in orders other than those illustrated or described herein. Furthermore, the terms ‘comprise’ and ‘include’ and any variation thereof are intended to cover non-exclusive inclusions. For example, a process, method, apparatus, product or device that includes a series of steps or units is not necessarily limited to those explicitly listed, but may include other steps or units not explicitly listed or inherent to such process, method, apparatus, product or device.

35 [0037] It should be noted that the steps illustrated in the flowchart of the drawings may be

performed in a computer system such as a set of computer-executable instructions, and although a logical order is illustrated in the flowchart, in some cases, the steps illustrated or described may be performed in an order different from that described herein.

[0038] FIG. 1 illustrates a schematic diagram of an implementation system of a method for distributed management and control in an embodiment of the present disclosure, which may include a plurality of target network device groups 101 and a plurality of controllers 102, and the target network device groups 101 include target network devices of a plurality of users, which may be CPE or PoP devices, and one controller 102 is deployed in an area where one target network device group 101 is located to manage and control the target network devices in the target network device group 101. The target network devices in the target network device group 101 may communicate with any controller 102 through a network. In addition, the plurality of controllers 102 may also communicate with each other through a network including a Local Area Network (LAN), a Wide Area Network (WAN), the Internet or combinations thereof and the network is connected to a website, user equipment (e.g., a computing device) and a back-end system.

[0039] Any target network device in the target network device group 101 may select the controller 102 to be connected. When the target network device is connected to the controller 102, the management and control range of the controller 102 can be obtained, including all of the target network devices connected to the controller 102, and the controller 102 manages and controls the target network devices within its own management and control range. A management and control system of the target network devices is deployed in the controller 102. Alternatively, the controller 102 may be a node of a cloud computing system (not illustrated in the figure), or each server may be a separate cloud computing system, including a plurality of computers interconnected by a network and operating as a distributed processing system.

[0040] Since any target network device in the target network device group 101 can select the controller 102 to be connected, the target network device in one area may be connected to the controller 102 in another area. In order to avoid the situation that one target network device is managed and controlled by a plurality of controllers 102, an optional method in the prior art is to deploy a centralized head controller among a plurality of controllers 102. The target network devices managed and controlled by each controller 102 are assigned by the deployed head controller. If one controller 102 fails, the head controller needs to assign the target network devices managed and controlled by the failed controller 102 to other non-failed controllers 102 for management and control. However, if the head controller also fails, these target network devices will not be re-assigned to the non-failed controllers 102 for management and control, resulting in that the target network devices are out of management and control. In some other application scenarios, the head controller only handles cross-domain businesses and cannot assign these target

network devices to other controllers.

[0041] Aiming at the problems in the existing management and control technology of the target network devices, the embodiments of the present disclosure provide a method for distributed management and control, which abandons the method of assigning a controller to each target network device through a centralized head controller. FIG. 2 illustrates a flowchart of a method for distributed management and control in an embodiment of the present disclosure. FIG. 2 depicts a process of managing and controlling target network devices by a controller, but more or fewer operational steps may be included based on routine or non-creative labor. An order of steps listed in the embodiments is only one of performing orders of steps, and does not represent a unique performing order. In practical systems or apparatus products, the steps may be performed sequentially or concurrently according to the order of the method illustrated in the embodiments or the drawings. Specifically, as illustrated in FIG. 2, the method may include:

Step 201: a plurality of controllers perform consensus verification on a management and control range of each controller using a first consensus algorithm based on a trigger mechanism to obtain a first management and control range of each controller, and the first management and control range includes a plurality of target network devices connected to the controller;

Step 202: each controller manages and controls the plurality of target network devices based on the first management and control range.

[0042] Through the method of the embodiment of the present disclosure, after a plurality of target network devices are respectively connected to a plurality of controllers, each controller takes the target network devices connected thereto as its own management and control range. However, in order to prevent the target network devices from being managed and controlled by a plurality of controllers or without any controller, the plurality of controllers perform consensus verification on a management and control range of each controller using a first consensus algorithm based on a trigger mechanism. After the consensus verification succeeds, the first management and control range of each controller is obtained, and finally each controller manages and controls the target network devices based on its own first management and control range. Since the first management and control range of each controller is obtained after consensus among a plurality of controllers, it prevents the target network devices from being managed and controlled by a plurality of controllers or without any controller. In addition, since a plurality of controllers perform consensus verification on the management control range of each controller using the first consensus algorithm based on the trigger mechanism, when a new target network device is connected to a controller or an existing target network device re-selects a controller to be connected, the plurality of target network devices perform consensus verification on the current management and control range of each controller using the first consensus algorithm based on the trigger mechanism, so that the

plurality of controllers can still perform consensus verification on the management and control range of each controller again using the first consensus algorithm when the target network device connected to the controller changes, and obtain the first management and control range of each controller again, thereby ensuring that the changed target network device can still be managed and controlled by an assigned controller. Compared with the scheme of domain-division controllers in the prior art, the present disclosure solves the problem that after a controller fails, no other controller can take over its responsibility, resulting in that the CPE or PoP devices which are managed and controlled by the failed controller are out of management and control and incapable of receiving any subsequent control instruction, so they may only maintain a state that is the last state before the out of management and control or even fail to work normally.

[0043] In the embodiment of the present disclosure, the target network devices may be CPE or PoP devices, and they actively connect the controller. After the target network devices connect the controller, the management and control range of the controller can be obtained. But the management and control range is only formed based on the connection of the target network devices, and the controller connected to some target network devices may currently have a high load, and it is necessary to assign those target network devices to any other controller with a low load. Thus, a plurality of controllers should perform consensus verification on the management and control range of each controller using the first consensus algorithm, and then determine the first management and control range of each controller after the plurality of controllers reach an agreement. It should be noted that the management and control range of the controller may include a plurality of target network devices of a plurality of users. It can be understood that the controller may be a physical controller, which manages and controls target network devices of a plurality of users within its own first management and control range. For example, when a user A requests to issue a configuration to his target network device 1, the controller managing and controlling the target network device 1 determines the target network device 1 of the user A within its own first management and control range, and issues a configuration to the target network device 1.

[0044] In practice, a user may configure his target network devices on a web page which may be connected to each controller. The user logs in his account through the web page, and the web page obtains a first management and control range of each controller from respective controllers, and filters the target network devices in the first management and control range through user information corresponding to the user to obtain all of the target network devices of the user. Next, the user selects a target network device to be issued with a configuration, from all of the target network devices through the web page. Further, the controller managing and controlling the target network device issues the configuration to the target network device. It is unnecessary for the user to know the controller managing and controlling his target network device,

thereby improving the use convenience for the user.

[0045] In the embodiment of the present disclosure, a plurality of controllers may perform consensus verification on a management and control range of each controller using a first consensus algorithm by means of the existing consensus algorithms. optionally, in order to
 5 improve the efficiency of consensus, according to an embodiment of the present disclosure, as illustrated in FIG. 3, the step of performing consensus verification on a management and control range of each controller using a first consensus algorithm in step 201 further includes:

Step 301: electing by the plurality of controllers to obtain a leader controller and a follower controller; Step 302: each controller generates a proposal for its own management and control
 10 range, and the proposal includes data of the management and control range; Step 303: after confirming the proposal, the leader controller stores the proposal in its own storage area and broadcasts the proposal to the follower controller; Step 304: the follower controller stores the proposal in its own storage area.

[0046] In the embodiment of the present disclosure, the data of the management and control
 15 range may be a hash value obtained based on the management and control range, and may also be any other numerical representation of the management and control range, which is not limited herein. The plurality of controllers may vote depending on the computing power to obtain a leader controller and a follower controller. Next, each controller (including the leader controller and the follower controller) makes a proposal for a management and control range formed based on a
 20 target network device (e.g., a target network device newly connected to the controller) also connected to the controller, and the leader controller confirms the proposal of each controller and stores the proposal in its own storage area. The leader controller broadcasts the proposal to the follower controller, and the follower controller stores the proposal in its own storage area, thereby completing consensus verification. It can be understood that both the leader controller and the
 25 follower controller store the first management and control range of each controller (i.e., the aforementioned management and control range). Therefore, according to an embodiment of the present disclosure, after the step that a plurality of controllers perform consensus verification on a management and control range of each controller using a first consensus algorithm based on a trigger mechanism to obtain a first management and control range of each controller, the method
 30 further includes: the plurality of controllers respectively store the first management and control range of each controller; the step that each controller manages and controls a plurality of target network devices based on the first management and control range further includes: after receiving a management and control message for the target network device, the controller judges whether the target network device belongs to its own first management and control range; and if not, the
 35 controller forwards the management and control message to a controller corresponding to the target

network device based on the stored first management and control range of each controller.

[0047] In the embodiment of the present disclosure, the controller should store the first management and control ranges of other controllers. When receiving a management and control message for a target network device in the first management and control range corresponding to
5 any other controller, a controller forwards the management and control message to the corresponding controller based on the first management and control range of each controller stored by itself.

[0048] According to an embodiment herein, the trigger mechanism in step 201 may include timing triggering, failure triggering and/or controller addition or deletion triggering.

10 [0049] It can be understood that the timing trigger may be implemented by configuring a timer. When a timed moment is reached, the plurality of controllers generate proposals again based on the currently connected target network devices, and then perform consensus verification on the management and control range of each controller using the first consensus algorithm to obtain the first management and control range of each controller again, thereby solving the problem that the
15 new target network devices cannot be managed or controlled after being connected to the controller.

[0050] Further, when too many target network devices are newly connected, the currently deployed controllers may have an excessive load, so new controllers may be added depending on the number of the newly connected target network devices. In some other application scenarios, a certain controller may also be offline or deleted. Therefore, when a new controller is added or a
20 certain controller is deleted, the plurality of controllers again perform consensus verification on the management and control range of each controller using the first consensus algorithm, so that the first management and control range of each controller is re-obtained. Each controller manages and controls a plurality of corresponding target network devices based on the re-obtained first management and control range.

25 [0051] In addition, in order to solve the problem in the prior art that the target network devices controlled by a failed controller cannot be managed or controlled, the trigger mechanism may further include failure triggering. According to an embodiment of the present disclosure, as illustrated in FIG. 4, when a certain controller fails, the method for distributed management and control further includes:

30 Step 401: connecting target network devices managed and controlled by a failed controller to a plurality of non-failed controllers; Step 402: the plurality of non-failed controllers perform consensus verification on a management and control range of each non-failed controller using the first consensus algorithm to obtain a second management and control range of each non-failed controller, and the second management and control range includes a plurality of target network
35 devices connected to the non-failed controller; Step 403: each non-failed controller manages and

controls the plurality of target network devices based on the second management and control range.

[0052] In the embodiment of the present disclosure, when a certain controller fails, the target network devices managed and controlled by the failed controller will be connected to other non-failed controllers. The plurality of non-failed controllers perform consensus verification on the management and control range of each controller using the first consensus algorithm again to obtain a second management and control range of each controller. Each controller manages and controls a plurality of corresponding target network devices based on the second management and control range, thereby solving the problem in the prior art that the target network devices controlled by a failed controller cannot be managed or controlled.

10 [0053] According to an embodiment of the present disclosure, in order to facilitate the target network device to select the controller to be connected, the step of connecting the target network devices to the controller further includes connecting the target network devices to the controller based on an access strategy.

15 [0054] In the embodiment of the present disclosure, compared with the method of connecting the target network devices to the controller randomly, the method of connecting the target network devices to the controller based on the access strategy may better manage and control the target network devices.

[0055] According to an embodiment of the present disclosure, the access strategy includes: connecting the target network devices to the controller by taking a connection condition of whether a delay of the connected controller is less than a threshold; and/or, connecting the target network devices to the controller based on a load balance situation of each controller; and/or, connecting the target network devices to the controller by taking a connection condition of minimizing a network packet loss rate of the connected controller; and/or connecting the target network devices to the controller based on a predetermined connection configuration.

25 [0056] In the embodiment of the present disclosure, the target network device may send probe link messages to a plurality of controllers, calculate connection delays based on moments of returning messages by the controllers, and selectively connects a controller with a connection delay less than the threshold.

[0057] In addition, the target network devices may be connected to a controller based on the load balance situation of each controller. For example, the target network device selectively connects a controller with a lowest load at the current moment. The target network device may also calculate a packet loss rate of message transmission with each controller and selectively connect a controller with a minimum packet loss rate. The target network devices may also be connected to a controller according to a predetermined connection configuration, and the connection configuration may be specified in advance by the user. For example, the user may

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specify a range of controllers connectable to the target network devices in advance.

[0058] In addition, the access strategy may further include combinations of two or more of the above connection modes, for example, the combinations by weighting, which will be omitted here.

5 **[0059]** In the embodiment of the present disclosure, a plurality of target network devices may be deployed in a plurality of areas by a plurality of users. For example, a user 1 deploys his own target network devices a_1 , b_1 and c_1 in an area A_1 , deploys target network devices a_2 , b_2 and c_2 in an area A_2 , and deploys target network devices a_3 , b_3 and c_3 in an area A_3 ; and a user 2 deploys his own target network devices d_1 , e_1 and f_1 in the area A_1 , deploys target network devices d_2 , e_2 and f_2 in the area A_2 , and deploys target network devices d_3 , e_3 and f_3 in the area A_3 . A controller m_1 is deployed in the area A_1 , a controller m_2 is deployed in the area A_2 , and a controller m_3 is deployed in the area A_3 . If the controller connected to the target network devices in the same area has a minimum delay, a management and control range of the controller m_1 includes the target network devices a_1 , b_1 , c_1 , d_1 , e_1 and f_1 , a management and control range of the controller m_2 includes the target network devices a_2 , b_2 , c_2 , d_2 , e_2 and f_2 , and a management and control range of the controller m_3 includes the target network devices a_3 , b_3 , c_3 , d_3 , e_3 and f_3 . When the user 1 wants to establish a tunnel connection between the target network devices a_1 and a_2 , because the target network device a_1 is managed and controlled by the controller m_1 and the target network device a_2 is managed and controlled by the controller m_2 , there may be a problem that the controller m_1 and the controller m_2 are inconsistent in the tunnel configuration or the connection state between the target network device a_1 and the target network device a_2 .

15 **[0060]** Therefore, in order to solve the above problem, according to an embodiment of the present disclosure, as illustrated in FIG. 5, the step that a plurality of controllers manage and control a plurality of target network devices based on a first management and control range further includes:

25 Step 501: the plurality of controllers elect a master controller for the user based on a deployment of target network device by the user and a second consensus algorithm, and the master controller manages and controls the target network devices for the user, including: Step 502: the master controller manages and controls the target network devices deployed by the user within the corresponding first management and control range; and Step 503: through another controller, the master controller manages and controls the target network devices deployed by the user within the first management and control range of the another controller.

35 **[0061]** In the embodiment of the present disclosure, a plurality of controllers may elect the master controller for the user based on the user's deployment of the target network devices and the second consensus algorithm, and the deployment of target network device by the user may include

the importance degrees of the target network devices for the user in each area (e.g., the user may configure corresponding importance degrees for the target network devices in each area in advance; specifically, the user may place different target network devices in different positions, and the target network device in each position has a different importance degree, e.g., the importance degree of a target network device placed in a headquarter is higher than that of a target network device placed in a branch office), and the second consensus algorithm may be any optional consensus algorithm commonly used in the prior art, which is not limited here.

[0062] For example, if the user 1 configures a highest importance degree for the target network devices a_1 , b_1 and c_1 , the controller m_1 that manages and controls the target network devices a_1 , b_1 and c_1 may be the master controller for the user 1, and if the user 2 configures a highest importance degree for the target network devices d_2 , e_2 and f_2 , the controller m_2 that manages and controls the target network devices d_2 , e_2 and f_2 may be the master controller for the user 2.

[0063] The master controller manages and controls the target network devices deployed by the user within the corresponding first management and control range. For example, the master controller m_1 for the user 1 manages and controls the target network devices (i.e., a_1 , b_1 and c_1) deployed by the user 1 within the corresponding first management and control range of a_1 , b_1 , c_1 , d_1 , e_1 and f_1 . Through another controller, which is a controller other than the master controller, the master controller manages and controls the target network devices deployed by the user within the first management and control range of the another controller. For example, except the master controller m_1 , other controllers for the user 1 are m_2 and m_3 , and through the controller m_2 , the master controller m_1 manages and controls the target network devices (i.e., a_2 , b_2 and c_2) deployed by the user 1 within the first management and control range a_2 , b_2 , c_2 , d_2 , e_2 and f_2 of the controller m_2 . When the user 1 wants to establish a tunnel connection between the target network devices a_1 and a_2 , the master controller m_1 for the user 1 can configure a configuration 1 to the target network device a_1 , and configure a configuration 2 corresponding to the configuration 1 to the target network device a_2 by the controller m_2 , thereby avoiding the inconsistency in the tunnel configuration or the connection state between the target network device a_1 and the target network device a_2 .

[0064] It should be noted that the master controller for each user may represent a virtual controller virtualized on a physical controller, that is, a physical controller may be used as the master controller for a plurality of users at the same time, instead of deploying a master controller for each user separately.

[0065] In addition, since a physical controller used as the master controller for the user is obtained by a second consensus algorithm from a plurality of physical controllers, it avoids the

problem that the results are inconsistent when a plurality of controllers are used as the master controller for the users, that is, the user will only have one master controller rather than a plurality of master controllers.

5 **[0066]** According to an embodiment of the present disclosure, determining a master controller for each user from the plurality of controllers based on networking configuration of the user further includes: determining the number of the target network devices deployed by each user in the area, so that the plurality of controllers elect a master controller for the user based on the number of the target network devices and the second consensus algorithm; or, determining a master controller for the user based on a position of a head server of the user's main business.

10 **[0067]** In the embodiment of the present disclosure, as more target network devices are deployed by the user in an area, it means that more configurations are provided by the user for the target network devices in this area. Therefore, in order to improve the management and control efficiency, the master controller for the user may be elected based on the number of the target network devices deployed by the user and the second consensus algorithm. If the first management
15 and control range of a controller in an area further includes target network devices of other areas, the number of the target network devices deployed by the user within the first management and control range may also be determined, and a plurality of controllers elect the master controller for the user based on the number of the target network devices and the second consensus algorithm.

20 **[0068]** In addition, the master controller for the user may be determined based on a position of a head server of the user's main business, which may be understood as that the head server of the user's main business carries most businesses of the user. Thus, a controller corresponding to the position of the head server may be taken as the master controller for the user.

25 **[0069]** According to an embodiment of the present disclosure, electing the master controller for the user based on the number of network devices and the second consensus algorithm by the plurality of controllers further includes: the plurality of controllers vote based on the number of the target network devices of the user in an area, so as to elect the master controller from the plurality of controllers.

30 **[0070]** In the embodiment of the present disclosure, in a case where the trigger mechanism is the failure triggering, if the failed physical controller is the master controller for a user, the target network devices of all of the users managed and controlled by the failed controller need to be connected to a new controller, so as to be controlled by any other controller. The non-failed controllers need to re-elect a master controller for the user. Because the configuration or data of all of the target network devices of the user may be stored in the original master controller for the user, when the controller corresponding to the master controller fails, the configuration or data of
35 the target network devices of the user may only be obtained through the controller that controls

the corresponding target network devices. Moreover, after the non-failed controllers re-elect a master controller for the user, the master controller needs to obtain the configuration or data from other controllers of the user again, resulting in huge workload of a plurality of controllers after the physical controller corresponding to the master controller for the user fails. In order to solve the

5 above problems, according to an embodiment of the present disclosure, in the step of electing the master controller for the user by the plurality of controllers based on the second consensus algorithm, the method further includes electing the standby controller for the user by the plurality of controllers through the second consensus algorithm. In the process of managing and controlling the target network devices of the user by the master controller, the method further includes

10 synchronizing management and control data to the standby controller by the master controller, so that the standby controller implements the function of the master controller when the trigger mechanism is the failure triggering and the failed controller is the master controller for the user.

[0071] In the embodiment of the present disclosure, in the step of electing a master controller for the user by a plurality of controllers through a second consensus algorithm, the standby

15 controller for the user is also elected by the plurality of controllers through the second consensus algorithm. In the process of managing and controlling the target network devices of the user by the elected master controller, the elected master controller synchronizes the management and control data to the standby controller. That is, before the physical controller corresponding to the master controller fails, the standby controller is only used for data backup and does not manage or

20 control any target network device of the user. When the physical controller corresponding to the master controller fails, because the corresponding data has been stored in the standby controller, the standby controller can directly serve as the master controller for the user and continue to manage and control all of the target network devices of the user.

[0072] In the embodiment of the present disclosure, in a case where the master controller for

25 the user fails and the target network devices of the user managed and controlled by the physical controller corresponding to the master controller are connected to the standby controller, if the physical controller corresponding to the standby controller manages and controls only few target network devices of the user, taking the standby controller as the master controller for the user may lead to a low management and control efficiency for the target network devices of the user. In view

30 of the above situation, according to an embodiment of the present disclosure, in the step of electing a master controller for the user by a plurality of controllers through a second consensus algorithm, a plurality of standby controllers of the user are also elected by the plurality of controllers through the second consensus algorithm, and the elected master controller synchronizes the management and control data to the plurality of standby controllers. When the physical controller corresponding

35 to the master controller fails, as illustrated in FIG. 6, the method for distributed management and

control in the embodiment of the present disclosure further includes step 601: re-electing a master controller for the user by a plurality of non-failed controllers from the standby controllers through the second consensus algorithm; Step 602: implementing the function of the master controller before failure by the re-elected master controller.

5 **[0073]** In the embodiment of the present disclosure, when the physical controller corresponding to the master controller fails, the plurality of non-failed controllers re-elect a master controller for the user from the standby controllers through the second consensus algorithm, and the re-elected master controller implements the function of the master controller before failure, thereby solving the problem that in a case where the master controller for the user fails and the
10 target network devices of the user managed and controlled by the physical controller corresponding to the master controller are connected to the standby controller, if the physical controller corresponding to the standby controller manages and controls only few target network devices of the user, taking the standby controller as the master controller for the user may lead to a low management and control efficiency for the target network devices of the user.

15 **[0074]** It should be noted that in the step of electing a master controller for the user by a plurality of controllers through a second consensus algorithm, the number of standby controllers for the user elected by the plurality of controllers through the second consensus algorithm may be determined on the needs of the user. It should be noted that the more the number of standby controllers, the higher the efficiency of re-determining the optimal master controller for the user
20 when the physical controller corresponding to the master controller fails. However, since the master controller needs to synchronize data to a plurality of standby controllers, and each standby controller needs to store the same data as the master controller, the cost of the distributed management and control increases. The number of standby controllers may be determined based on the actual needs of the user.

25 **[0075]** According to an embodiment of the present disclosure, in the step (or before or after the step) of re-electing a master controller for the user by the plurality of non-failed controllers from the standby controllers through the second consensus algorithm, the method further includes: re-electing standby controllers for the user by the plurality of non-failed controllers through the second consensus algorithm.

30 **[0076]** It can be understood that after a first master controller for the user fails, a plurality of controllers re-elect a second master controller for the user from a plurality of standby controllers. In addition, one or more standby controllers for the user may be re-elected. The advantageous effect of the step is the same as that of the above step of electing a standby controller for the user by a plurality of controllers through the second consensus algorithm, and will not be repeated here.

35 **[0077]** Based on the same inventive concept, an embodiment of the present disclosure further

provides a system for distributed management and control, including a plurality of target network devices and a plurality of controllers; and the above method is performed when the plurality of controllers manage and control the plurality of target network devices.

5 [0078] The advantageous effect of the system is the same as that of the above method, and will not be repeated here.

[0079] FIG. 7 illustrates a schematic structural diagram of a computer device in an embodiment of the present disclosure, and the controller in the present disclosure may be the computer device in the embodiment to perform the above method of the present disclosure. The computer device 702 may include one or more processing devices 704, such as one or more central
10 processing units (CPUs), each of which can implement one or more hardware threads. The computer device 702 may further include any storage resource 706 to store any kind of information such as codes, settings, data, etc. Without limitation, for example, the storage resource 706 may include any one or combinations of: any type of RAM, any type of ROM, a flash memory device, a hard disk, an optical disk, etc. More generally, any storage resource can use any technology to
15 store information. Further, any storage resource can provide volatile or nonvolatile retention of information. Further, any storage resources may represent fixed or removable components of the computer device 702. In one case, when the processing device 704 executes an associated instruction stored in any storage resource or combination of storage resources, the computer device 702 may perform any operation of the associated instruction. The computer device 702 further
20 includes one or more drive mechanisms 708 interacted with any storage resource, such as a hard disk drive mechanism, an optical disk drive mechanism, etc.

[0080] The computer device 702 may further include an input/output module 710 (I/O) configured to receive various inputs (via an input device 712) and provide various outputs (via an output device 714). A specific output mechanism may include a presentation device 716 and an
25 associated graphical user interface (GUI) 718. In other embodiments, the input/output module 710 (I/O), the input device 712, and the output device 714 may not be included, and the computer device 702 is only used as a computer device in a network. The computer device 702 may further include one or more network interfaces 720 configured to exchange data with other devices via one or more communication links 722. One or more communication buses 724 couple the
30 components described above together.

[0081] The communication link 722 may be implemented in any way, for example, through a local area network, a wide area network (e.g., the Internet), a point-to-point connection, etc., or any combination thereof. The communication link 722 may include any combination of a hardwired link, a wireless link, a router, a gateway function, a name server, etc. governed by any
35 protocol or combination of protocols.

[0082] In correspondence with the methods in FIGS. 2 to 6, an embodiment of the present disclosure further provides a computer-readable storage medium which stores a computer program, and the computer program implements the above steps when being executed by a processor.

5 [0083] An embodiment of the present disclosure further provides a computer-readable instruction, and when the instruction is executed by a processor, a program therein causes the processor to perform the method as illustrated in FIGS. 2 to 6.

[0084] It should be understood that in various embodiments of the present disclosure, the serial numbers of the above processes do not mean the execution order, and the execution order of the processes should be determined according to the functions and internal logics thereof, and
10 should not make any restriction on the implementation processes of the embodiments of the present disclosure.

[0085] It should also be understood that in the embodiments of the present disclosure, the term ‘and/or’ only describes an association relationship between the associated objects, indicating that there may be three relationships. For example, A and/or B can mean that A exists alone, A and
15 B exist at the same time, and B exists alone. In addition, the character ‘/’ in the present disclosure generally indicates that the contextual associated objects are an ‘OR’ relationship.

[0086] Those skilled in the art can recognize that the units and algorithm steps of the examples described in connection with the embodiments disclosed herein can be implemented by electronic hardware, computer software or a combination of both. In order to clearly illustrate the
20 interchangeability of hardware and software, the components and steps of the examples have been generally described as above in terms of functions. Whether these functions are implemented by hardware or software depends on the specific applications and design constraints of the technical solutions. Professionals can use different methods to implement the described functions for each specific application, but such implementations should not be construed as going beyond the scope
25 of the present disclosure.

[0087] It can be clearly understood by those skilled in the art that for the convenience and conciseness of description, the specific working processes of the systems, apparatuses and units described above can refer to the corresponding processes in the aforementioned method embodiments, and will not be repeated here.

30 [0088] In several embodiments provided herein, it should be understood that the disclosed systems, apparatuses and methods can be implemented in other ways. For example, the apparatus embodiments described above are only schematic. For example, the division of units is only a logical function division. In actual implementation, there may be other division ways, e.g., a plurality of units or components may be combined or integrated into another system, or some
35 features may be ignored or not implemented. In addition, the mutual coupling or direct coupling

or communication connection illustrated or discussed may be indirect coupling or communication connection through some interfaces, apparatuses or units, and may also be electrical, mechanical or other forms of connections.

[0089] The units described as separate components may or may not be physically separated,
5 and the components displayed as units may or may not be physical units, that is, they may be located in one place or distributed to a plurality of network units. Some or all of the units may be selected based on the actual needs to implement the objectives of the embodiments of the present disclosure.

[0090] In addition, the functional unit in various embodiments of the present disclosure may
10 be integrated into one processing unit, or each unit may be existed physically alone, or two or more units may be integrated into one unit. The integrated units may be implemented in the form of hardware, or software functional units.

[0091] The integrated units may be stored in a computer-readable storage medium if they are implemented in the form of software functional units and sold or used as independent products.
15 Based on this understanding, the essence of the technical solutions of the present disclosure or a portion thereof contributing to the prior art, or all or part of the technical solutions can be embodied in the form of a software product, which is stored in a storage medium and includes several instructions to enable a computer device (a personal computer, a server, a network device, etc.) to perform all or part of the steps of the methods in various embodiments of the present disclosure.
20 The aforementioned storage medium includes a U disk, a mobile hard disk, a Read-Only Memory (ROM), a Random Connect Memory (RAM), a magnetic disk, an optical disk or any other medium that can store program codes.

[0092] In the present disclosure, specific embodiments are used to set forth the principles and implementations of the present disclosure, and the descriptions of those embodiments are only
25 used to help understanding of the methods and core ideas of the present disclosure. Meanwhile, those of ordinary skill in the art may change the specific embodiments and the application scope based on the concept of the present disclosure. To sum up, the content of the present disclosure should not be understood as limitations thereto.

CLAIMS

1. A method for distributed management and control, comprising:
performing, by a plurality of controllers, consensus verification on a management and control
5 range of each controller using a first consensus algorithm based on a trigger mechanism to obtain
a first management and control range of each controller, wherein the first management and control
range comprises a plurality of target network devices connected to the controller; and
managing and controlling, by each controller, the plurality of target network devices based
on the first management and control range.
- 10 2. The method for distributed management and control according to claim 1, wherein the step
of performing, by a plurality of controllers, consensus verification on a management and control
range of each controller using a first consensus algorithm further comprises:
electing, by the plurality of controllers, to obtain a leader controller and a follower controller;
generating, by each controller, a proposal for its own management and control range, wherein
15 the proposal comprises data of the management and control range;
after confirming the proposal by the leader controller, storing the proposal in its own storage
area and broadcasting the proposal to the follower controller; and
storing, by the follower controller, the proposal in its own storage area.
- 20 3. The method for distributed management and control according to claim 1, wherein the
trigger mechanism comprises timing triggering, failure triggering and/or controller addition or
deletion triggering.
4. The method for distributed management and control according to claim 3, wherein when
the trigger mechanism is the failure triggering, the method further comprises:
connecting target network devices managed and controlled by a failed controller to a plurality
25 of non-failed controllers;
performing by the plurality of non-failed controllers, consensus verification on a management
and control range of each non-failed controller using the first consensus algorithm to obtain a
second management and control range of each non-failed controller, wherein the second
management and control range comprises a plurality of target network devices connected to the
30 non-failed controller; and
managing and controlling, by each non-failed controller, the plurality of target network
devices based on the second management and control range.
5. The method for distributed management and control according to claim 1 or 4, wherein the

step of connecting the target network devices to the controller further comprises:

connecting the target network devices to the controller based on an access strategy.

6. The method for distributed management and control according to claim 5, wherein the access strategy comprises:

5 connecting the target network devices to the controller by taking a connection condition of whether a delay of the connected controller is less than a threshold; and/or,

connecting the target network devices to the controller based on a load balance situation of each controller; and/or,

10 connecting the target network devices to the controller by taking a connection condition of minimizing a network packet loss rate of the connected controller; and/or,

connecting the target network devices to the controller based on a predetermined connection configuration.

7. The method for distributed management and control according to claim 3, wherein the plurality of target network devices are deployed in a plurality of areas by a user, and the controllers
15 are distributed in the corresponding areas;

managing and controlling, by the plurality of controllers, the plurality of target network devices based on the first management and control range further comprising:

electing, by the plurality of controllers, a master controller for the user based on a deployment of target network device by the user and a second consensus algorithm, and

20 managing and controlling, by the master controller, the target network devices for the user, comprising:

managing and controlling, by the master controller, the target network devices deployed by the user within the corresponding first management and control range; and

25 through another controller, managing and controlling, by the master controller, the target network devices deployed by the user within the first management and control range of the another controller.

8. The method for distributed management and control according to claim 3, wherein the plurality of target network devices are deployed in a plurality of areas by a user, and the controllers are distributed in the corresponding areas;

30 managing and controlling, by the plurality of controllers, the plurality of target network devices based on the first management and control range, wherein further comprises:

determining a master controller for each user from the plurality of controllers based on networking configuration of the user, comprising:

determining the number of the target network devices deployed by the user in the area, so that the plurality of controllers elect a master controller for the user based on the number of the target network devices and the second consensus algorithm; or,

determining a master controller for the user based on a position of a head server of the user's
5 main business.

9. The method for distributed management and control according to claim 8, wherein the step in which the plurality of controllers elect a master controller for the user based on the number of the target network devices and the second consensus algorithm further comprises:

voting, by the plurality of controllers, based on the number of the target network devices of
10 the user in an area, so as to elect the master controller from the plurality of controllers.

10. The method for distributed management and control according to claim 7, wherein in the step of electing, by the plurality of controllers, a master controller for the user through the second consensus algorithm, the method further comprises:

electing a standby controller for the user by the plurality of controllers through the second
15 consensus algorithm;

in a process of managing and controlling the target network devices of the user by the master controller, the method further comprises:

synchronizing management and control data to the standby controller by the master controller, so that the standby controller implements the function of the master controller when the trigger
20 mechanism is the failure triggering and the failed controller is the master controller for the user.

11. The method for distributed management and control according to claim 10, wherein when there are a plurality of the standby controllers, the step in which the standby controller implements the function of the master controller further comprises:

re-electing a master controller for the user by a plurality of non-failed controllers from the
25 standby controllers through the second consensus algorithm; and

implementing the function of the master controller before failure by the re-elected master controller.

12. The method for distributed management and control according to claim 11, wherein in the the step of re-electing a master controller for the user by a plurality of non-failed controllers from
30 the standby controllers through the second consensus algorithm through the second consensus algorithm, the method further comprises:

re-electing a standby controller for the user by the plurality of non-failed controllers through the second consensus algorithm.

13. The method for distributed management and control according to claim 1, wherein after the step of performing, by a plurality of controllers, consensus verification on a management and control range of each controller using a first consensus algorithm based on a trigger mechanism to obtain a first management and control range of each controller, the method further comprises:

5 respectively storing the first management and control range of each controller by the plurality of controllers;

the step of managing and controlling, by each controller, the plurality of target network devices based on the first management and control range further comprises:

after receiving a management and control message for the target network device, judging, by
10 the controller, whether the target network device belongs to its own first management and control range; and if not, forwarding, by the controller, the management and control message to a controller corresponding to the target network device based on the stored first management and control range of each controller.

14. A system for distributed management and control, comprising a plurality of target network
15 devices and a plurality of controllers;

the method according to any one of claims 1 to 13 is performed when the plurality of controllers manage and control the plurality of target network devices.

15. A computer device, comprising a memory, a processor and a computer program stored in the memory and runnable on the processor, wherein when being executed by the processor, the
20 computer program implements the method for distributed management and control according to any one of claims 1 to 13.

16. A computer-readable storage medium, wherein the computer-readable storage medium stores a computer program, wherein when being executed by a processor, the computer program implements the method for distributed management and control according to any one of claims 1
25 to 13.