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(54) **CONTROL DEVICE, CONTROL METHOD, AND NON-TRANSITORY RECORDING MEDIUM FOR STORING INSTRUCTION FOR TRANSMITTING REQUESTS**

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CPC *H04L 47/122* (2013.01); *H04L 43/16* (2013.01)

(58) **Field of Classification Search**
CPC H04L 47/122; H04L 43/16; H04L 43/0876
See application file for complete search history.

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(57) **ABSTRACT**

A control device includes a control unit configured to transmit a request received from an information processing device performing setting on a relay device relaying a packet in software defined networking (SDN) to the relay device. The control unit sequentially transmits each request from the information processing device to the relay device and sequentially transmits each response from the relay device in response to each of the requests to the information processing device when a processing load of the control device is equal to or less than a threshold, and transmits a request in which a plurality of requests from the information processing device are collected to the relay device and transmits a response in which responses to the plurality of requests are collected to the information processing device when the processing load of the control device is not equal to or less than the threshold.

4 Claims, 8 Drawing Sheets
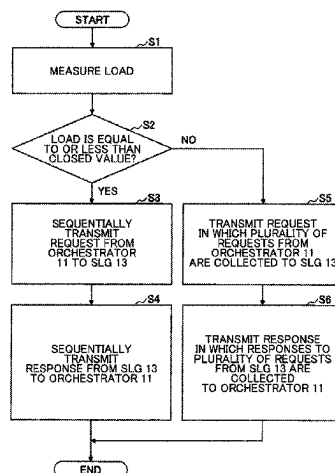
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Fig. 1

Fig. 2

Fig. 3

```
                    ( START )
                        │
                        ▼          ⌇S1
        ┌───────────────────────────────┐
        │         MEASURE LOAD          │
        └───────────────────────────────┘
                        │
                        ▼              ⌇S2
                   ╱─────────╲                    NO
              ╱   LOAD IS EQUAL  ╲──────────────────────┐
             ⟨   TO OR LESS THAN   ⟩                      │
              ╲   CLOSED VALUE?   ╱                       │
                   ╲─────────╱                            │
                        │                                 │
                    YES │  ⌇S3                        ⌇S5 │
                        ▼                                 ▼
        ┌──────────────────────┐        ┌──────────────────────────┐
        │     SEQUENTIALLY      │        │      TRANSMIT REQUEST     │
        │       TRANSMIT        │        │   IN WHICH PLURALITY OF   │
        │    REQUEST FROM       │        │      REQUESTS FROM        │
        │     ORCHESTRATOR      │        │      ORCHESTRATOR 11      │
        │     11 TO SLG 13      │        │   ARE COLLECTED TO SLG 13 │
        └──────────────────────┘        └──────────────────────────┘
                        │  ⌇S4                        ⌇S6 │
                        ▼                                 ▼
        ┌──────────────────────┐        ┌──────────────────────────┐
        │                      │        │     TRANSMIT RESPONSE     │
        │     SEQUENTIALLY      │        │   IN WHICH RESPONSES TO   │
        │       TRANSMIT        │        │   PLURALITY OF REQUESTS   │
        │  RESPONSE FROM SLG 13 │        │       FROM SLG 13 ARE     │
        │   TO ORCHESTRATOR 11  │        │        COLLECTED          │
        │                      │        │    TO ORCHESTRATOR 11     │
        └──────────────────────┘        └──────────────────────────┘
                        │                                 │
                        ▼◄────────────────────────────────┘
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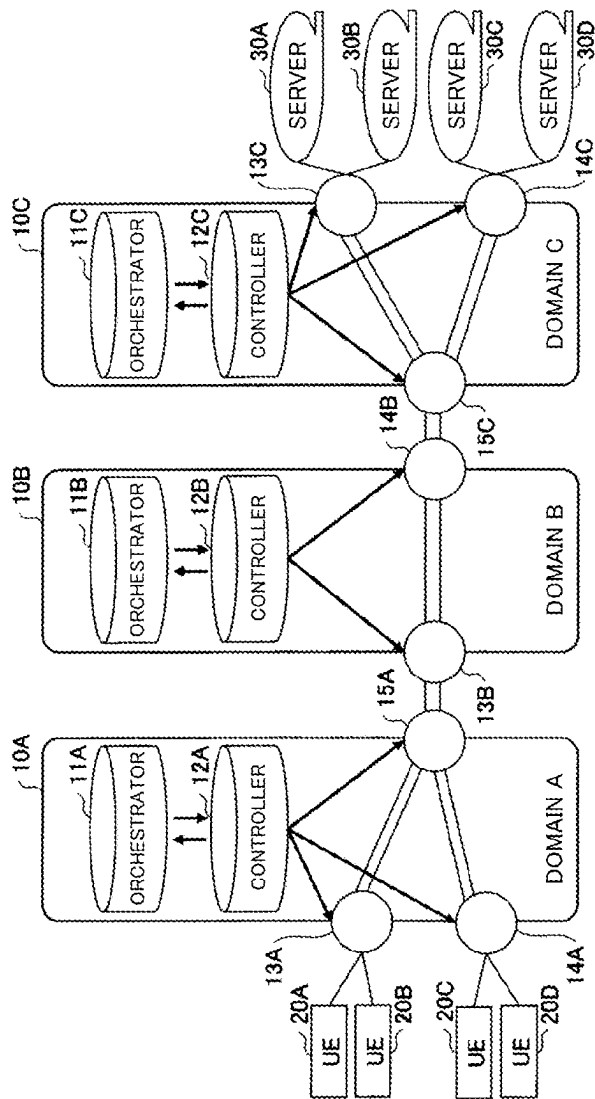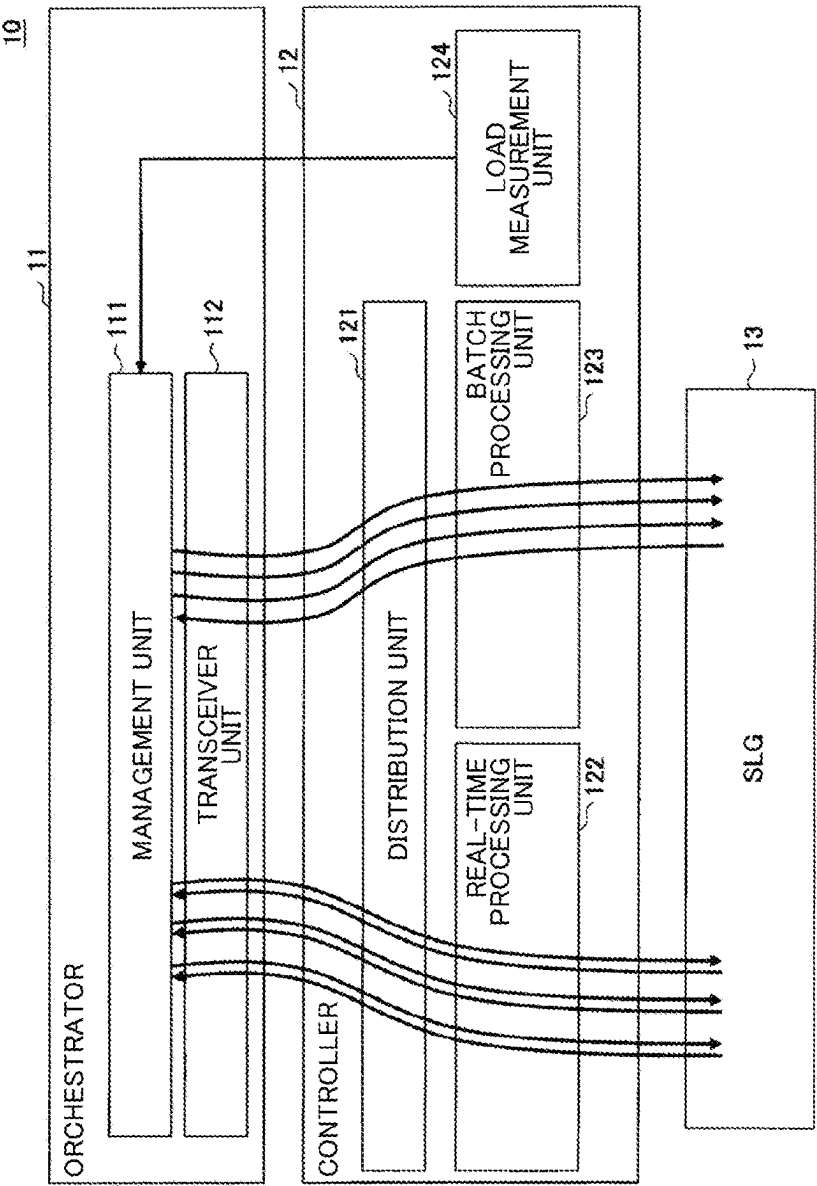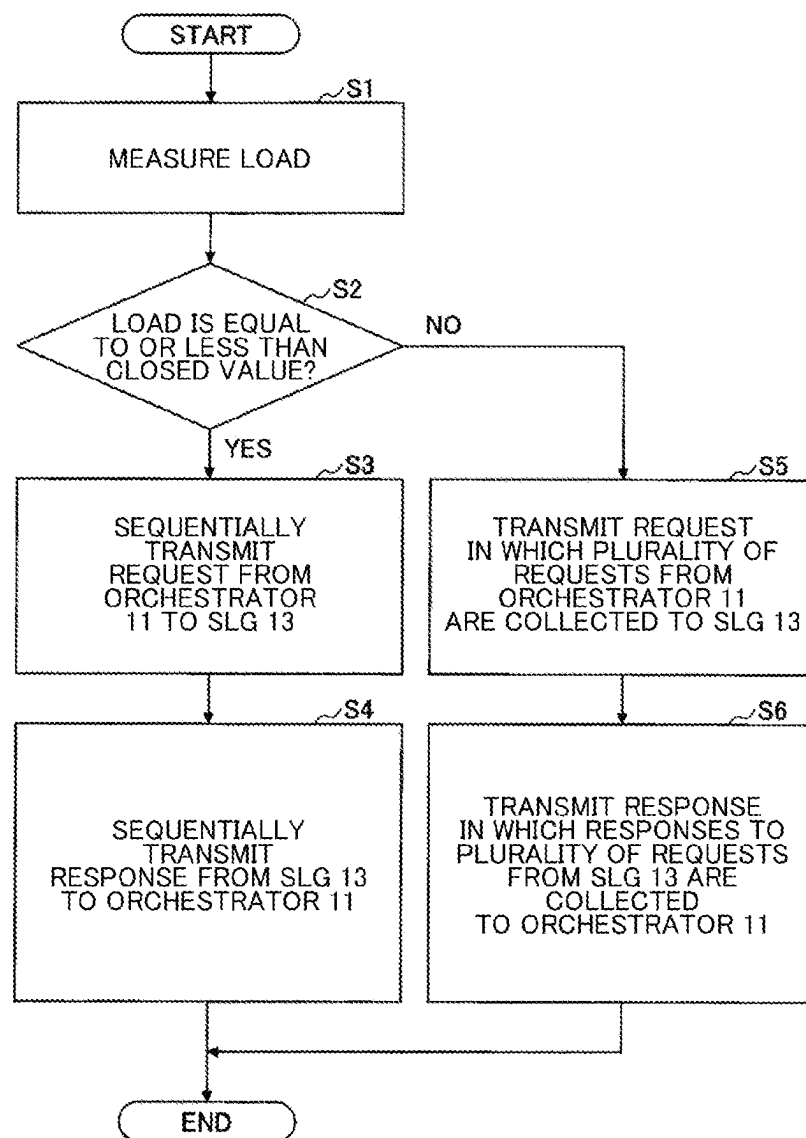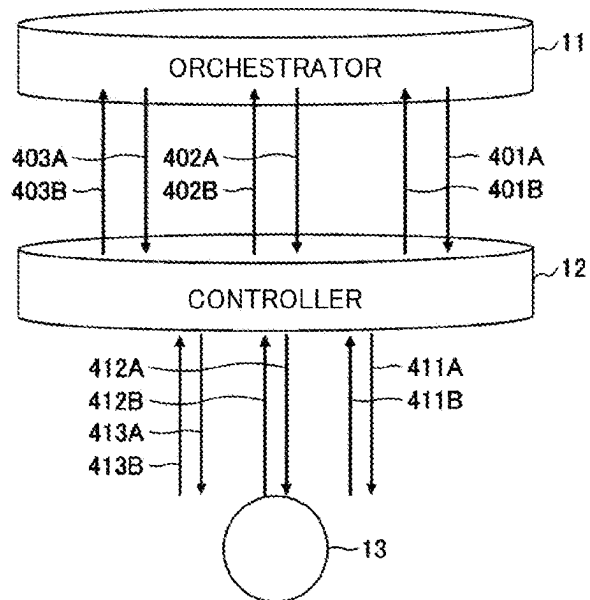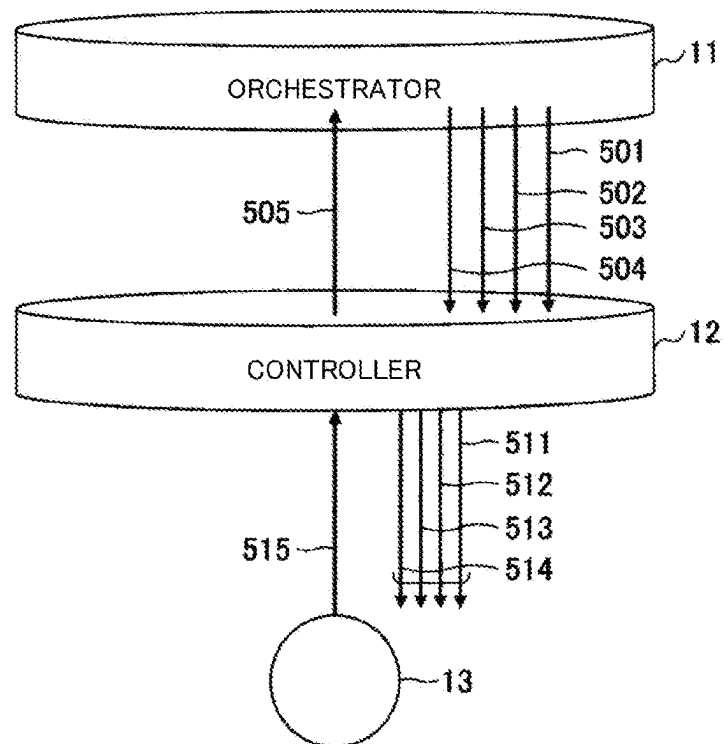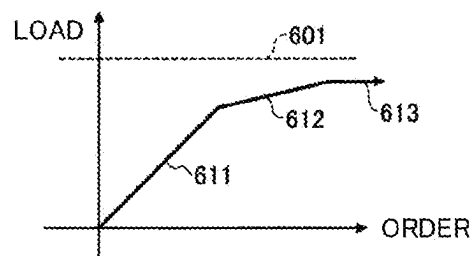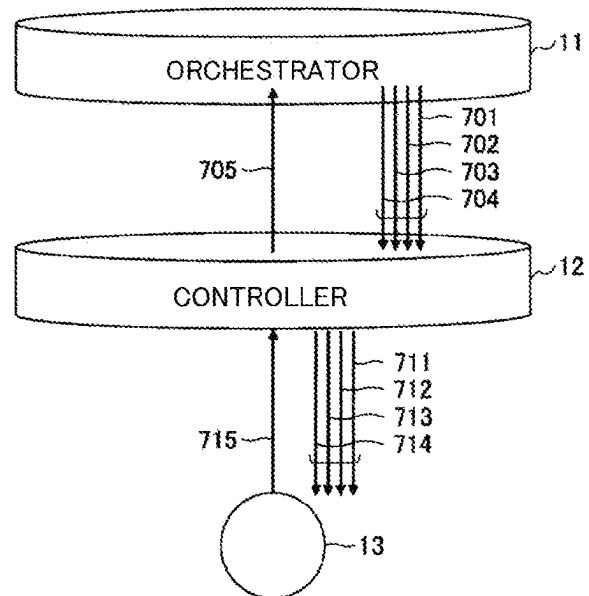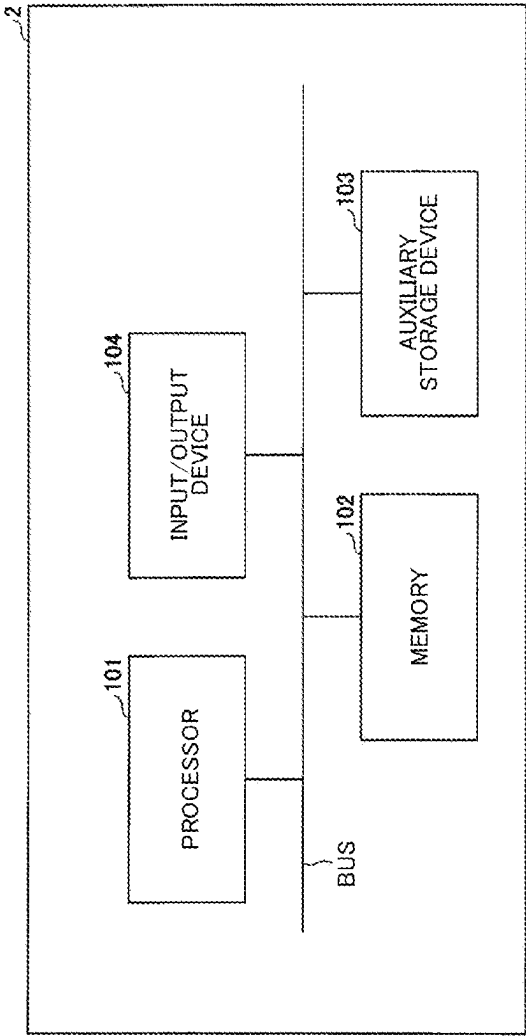
Fig. 4

Fig. 5

Fig. 6

Fig. 7

Fig. 8

CONTROL DEVICE, CONTROL METHOD, AND NON-TRANSITORY RECORDING MEDIUM FOR STORING INSTRUCTION FOR TRANSMITTING REQUESTS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a U.S. National Stage Application filed under 35 U.S.C. § 371 claiming priority to International Patent Application No. PCT/JP2020/032487, filed on 27 Aug. 2020, the disclosure of which is hereby incorporated herein by reference in its entirety.

TECHNICAL FIELD

The present invention relates to a control device, a control method, a program, and a communication system.

BACKGROUND ART

In recent years, discussion on introduction of software defined networking (SDN) technology capable of flexibly setting and managing network resources has progressed. In SDN, control and data transmission are separated to unify the control, and thus equipment costs and operation costs can be reduced. As a method for efficiently constructing and controlling an end-to-end network, a slice control method using a dedicated header has been proposed (for example, see NPL 1).

In the technology disclosed in NPL 1, a controller corresponding to an edge slice gateway (SLG) performs control in conjunction with addition, change and deletion of user equipment (UE).

CITATION LIST

Non Patent Literature

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SUMMARY OF INVENTION

Technical Problem

In the technology disclosed in NPL 1, since a controller corresponding to an edge SLG performs control in conjunction with addition, change, and deletion of UE, when many UEs are connected and setting of the UEs is changed, loads are concentrated on the controller. In this case, there is a possibility of a functional failure such as omission of order processing occurring.

An objective of the present disclosure is to provide a technology capable of appropriately performing processing even when a load on a controller increases.

Solution to Problem

According to the disclosed technology,
a control device includes
a control unit configured to transmit a request received from an information processing device performing setting on a relay device relaying a packet in software defined networking (SDN) to the relay device.

The control unit
sequentially transmits each request from the information processing device to the relay device and sequentially transmits each response from the relay device in response to each of the requests to the information processing device when a processing load of the control device is equal to or less than a threshold, and
transmits a request in which a plurality of requests from the information processing device are collected to the relay device and transmits a response in which responses to the plurality of requests are collected to the information processing device when the processing load of the control device is not equal to or less than the threshold.

Advantageous Effects of Invention

According to the disclosed technology, it is possible to appropriately perform processing even when a load on a controller increases.

BRIEF DESCRIPTION OF DRAWINGS

FIG. 1 is a diagram illustrating an example of a configuration of a communication system 1 according to an embodiment.

FIG. 2 is a diagram illustrating an example of a functional configuration of an orchestrator 11 and a controller 12 according to the embodiment.

FIG. 3 is a flowchart illustrating an example of processing of the controller 12 according to the embodiment.

FIG. 4 is a diagram illustrating an example of sequential processing of the controller 12 according to the embodiment.

FIG. 5 is a diagram illustrating an example of batch processing of the controller 12 according to the embodiment.

FIG. 6 is a diagram illustrating an example of a reception frequency and a load of a request in the controller 12 according to the embodiment.

FIG. 7 is a diagram illustrating an example of batch processing of the controller 12 according to the embodiment.

FIG. 8 is a diagram illustrating an example of a configuration of the controller 12 according to the embodiment.

DESCRIPTION OF EMBODIMENTS

Hereinafter, an embodiment of the present disclosure (the present embodiment) will be described with reference to the drawings. Embodiments to be described below are merely exemplary, and the embodiments to which the present invention is applied are not limited to the following embodiments.

<System Configuration>

An example of a configuration of a communication system 1 according to the present embodiment will be described with reference to FIG. 1. FIG. 1 is a diagram illustrating an example of the configuration of the communication system 1 according to the embodiment.

In the example of FIG. 1, the communication system 1 includes a communication network 10A of a domain A, a communication network 10B of a domain B, and a communication network 10C of a domain C (hereinafter simply referred to as the "communication network 10" when it is not necessary to distinguish them from each other).

The communication system 1 includes user equipment (UE) 20A, UE 20B, UE 20C, and UE 20D (hereinafter

simply referred to as the "UE **20**" when it is not necessary to distinguish them from each other). The communication system **1** includes a server **30A**, a server **30B**, a server **30C**, and a server **30D** (hereinafter simply referred to as the "server **30**" when it is not necessary to distinguish them from each other). The numbers of the communication networks **10**, UE **20**, and servers **30** are not limited to the examples of FIG. **1**.

The UE **20** communicates with the server **30** via the communication network **10**. The UE **20** is a terminal which is used by a user. The UE **20** may be, for example, a personal computer, a smartphone, a tablet terminal, or the like. The server **30** is an information processing device that provides various services to the UE **20**.

The communication network **10** is a network to which a software defined networking (SDN) technology is applied. In the example of FIG. **1**, the communication network **10A** of the domain A includes an orchestrator **11A**, a controller **12A**, an edge SLG **13A**, an edge SLG **14A** and an intermediate SLG **15A**. The communication network **10B** of the domain B includes an orchestrator **11B**, a controller **12B**, an intermediate SLG **13B**, and an intermediate SLG **14B**. The communication network **10C** of the domain C includes an orchestrator **11C**, a controller **12C**, an intermediate SLG **15C**, an edge SLG **13C**, and an edge SLG **14C**.

Hereinafter, each SLG is simply referred to as an "SLG **13**" when it is not necessary to distinguish the SLGs (**13A**, **14A**, **15A**, **13B**, **14B**, **13C**, **14C**, and **15C**) of the domains A to C from each other. When it is not necessary to distinguish the orchestrators **11A** to **11C** of the domains A to C from each other, the orchestrators A to C are simply referred to as the "orchestrator **11**." When it is not necessary to distinguish the controllers **12A** to **12C** of the domains A to C, the controllers **12A** to **12C** are simply referred to as the "controller **12**."

The controller **12** is an example of a "control device." The orchestrator **11** is an example of an "information processing device." The SLG **13** is an example of a "relay device."

The orchestrator **11** manages and sets each device of the domain in which the orchestrator **11** is installed. The orchestrator **11** instructs, for example, the controller **12** of the domain to perform various settings on the SLG **13** of the domain.

The controller **12** of each domain receives a request from the orchestrator **11** of the domain and transmits the request to the SLG **13** of the domain. Accordingly, the controller **12** performs various settings on the SLG **13** in accordance with the instruction from the orchestrator **11**.

The SLG **13** is a relay device (a gateway, a router, or a switch) for the SDN that determines a transmission destination of a packet (data) transmitted from the device for each device such as each UE **20** in conformity content (rules) set in the controller **12**, and transmits (relays or transfers) the packet to the determined transmission destination.

The edge SLG **13A** and the edge SLG **14A** are requested to perform predetermined setting (flow) by the controller **12A** in response to an instruction from the orchestrator **11A** when the UE **20A** is added, changed, or deleted as a UE to be accommodated. Then, for example, when a packet transferred from the UE **20A** is received, the edge SLG **13A** may add a slice identifier (ID) to the packet based on the predetermined setting and 5-tuple of the packet and the transmit the packet to the intermediate SLG. The 5-tuple is, for example, information regarding a source address, a destination address, a protocol, a source port, and a destination port in an internet protocol (IP) packet.

In the subsequent intermediate SLG or the like, packets are distributed to tunnels between the SLGs **13** based on the slice ID. The tunnel may be set in advance for each transmission specification such as transmission priority and whether a path is redundant. The packet is transmitted to the server **30** via the tunnels satisfying requirements of a service in which a slice is used.

<Functional Configuration>

Next, a configuration of the orchestrator **11** and the controller **12** according to the present embodiment will be described with reference to FIG. **2**. FIG. **2** is a functional configuration diagram of the orchestrator **11** and the controller **12** according to the present embodiment.

<<Orchestrator **11**>>

In the example of FIG. **2**, the orchestrator **11** according to the embodiment includes a management unit **111** and a transceiver unit **112**. These functional units may be implemented through cooperation between one or more programs installed in the orchestrator **11** and hardware such as a central processing unit (CPU) of the orchestrator **11**.

The management unit **111** manages and sets the SLG **13**, the UE **20**, and the like. For example, the management unit **111** instructs the controller **12** to perform predetermined setting on the specific SLG **13**. The transceiver unit **112** communicates with the controller **12**.

<<Controller **12**>>

In the example of FIG. **2**, the controller **12** according to the embodiment includes a distribution unit **121**, a real-time processing unit **122**, a batch processing unit **123**, and a load measurement unit **124**. These units may be implemented through cooperation between one or more programs installed in the controller **12** and hardware such as a CPU of the controller **12**.

The load measurement unit **124** measures a processing load of the controller **12**. A load measurement unit **124** measures a processing load of each SLG **13** controlled by the controller **12**.

The distribution unit **121** distributes a request (an instruction or an order) from the orchestrator **11** to one of the real-time processing unit **122** and the batch processing unit **123** in accordance with the load measured by the load measurement unit **124**.

The real-time processing unit **122** immediately transmits a request from the orchestrator **11** to the SLG **13** in accordance with an instruction from the distribution unit **121**. The real-time processing unit **122** immediately transmits a response from the SLG **13** to the orchestrator **11** in accordance with the instruction of the distribution unit **121**.

The batch processing unit **123** transmits a request in which a plurality of requests from the orchestrator **11** are collected to the SLG **13** in accordance with an instruction of the distribution unit **121**. The real-time processing unit **122** transmits a response in which responses to each of the plurality of requests from the SLGs **13** are collected as one response to the orchestrator **11** in accordance with the instruction of the distribution unit **121**.

<Processing>

An example of processing of the controller **12** according to the present embodiment will be described with reference to FIGS. **3** to **7**. FIG. **3** is a flowchart illustrating an example of processing of the controller **12** according to the embodiment. FIG. **4** is a diagram illustrating an example of sequential processing of the controller **12** according to the embodiment. FIG. **5** is a diagram illustrating an example of batch processing of the controller **12** according to the embodiment. FIG. **6** is a diagram illustrating an example of a reception frequency and a load of a request in the controller

12 according to the embodiment. FIG. 7 is a diagram illustrating an example of batch processing of the controller 12 according to the embodiment.

The following processing may be performed, for example, when the controller 12 of a certain domain receives a request from the orchestrator 11 of that domain.

In step S1, the measurement unit 124 measures a load of the controller 12. Here, the load measurement unit 124 may measure, for example, use rates or the like of the CPU and the memory of the controller 12. The load measurement unit 124 may measure, for example, a frequency at which a request from the orchestrator 11 is transmitted to a specific SLG 13. Subsequently, the load measurement unit 124 of the controller 12 determines whether a load (processing load) of the controller 12 is equal to or less than a threshold (step S2).

(Sequential Processing)

When the load of the controller 12 is equal to or less than a threshold (YES in step S2), the distribution unit 121 sequentially transmits (sequentially processes) each request from an orchestrator 11 to each SLG 13 through the real-time processing unit 122 (step S3). Here, when one request destined for the SLG 13 is received from the orchestrator 11, the distribution unit 121 immediately transmits the one request to the SLG 13.

Subsequently, the distribution unit 121 sequentially transmits each response to each request to the orchestrator 11 through the real-time processing unit 122 (step S4) and ends the processing for the request received from the orchestrator 11. When one response destined for the orchestrator 11 is received from the SLG 13 in the processing of step S4, the distribution unit 121 immediately transmits the one response to the orchestrator 11. Through the processing of steps S3 and S4, setting content instructed by the orchestrator 11 is reflected in the SLG 13 without delay.

In the example of FIG. 4, when the controller 12 receives a request 401A transferred from the orchestrator 11, the controller 12 transmits the request 401A as a request 411A to the SLG 13 through the processing of step S3. When a response 411B is received from the SLG 13, the response 411B is transmitted as a response 401B to the orchestrator 11 through the processing of step S4.

Similarly, when the controller 12 receives a request 402A transmitted from the orchestrator 11, the controller 12 transmits the request 402A as a request 412A to the SLG 13 through the processing of step S3. When a response 412B is received from the SLG 13, the response 412B is transmitted as a response 402B to the orchestrator 11 through the processing of step S4.

Similarly, when the controller 12 receives a request 403A transferred from the orchestrator 11, the controller 12 transmits the request 403A as a request 413A to the SLG 13 through the processing of step S3. When a response 413B is received from the SLG 13, the response 413B is transmitted to the orchestrator 11 as a response 403B through the processing of step S4.

(Batch Processing)

Conversely, when the load of the controller 12 is not equal to or less than the threshold (exceeds the threshold) (NO in step S2), the distribution unit 121 transmits one request including the content of a plurality of requests from the orchestrator 11 to the SLG 13 through the batch processing unit 123 (batch processing) (step S5).

In the distribution unit 121, for example, when the frequency at which the request is transmitted from the orchestrator 11 to the specific SLG 13 and which is measured by the load measurement unit 124 exceeds the threshold, only the requests destined for the SLG 13 may be collected into

one request. Accordingly, for example, it is possible to reduce occurrence of delay in setting processing for the other SLG 13 since the setting for the specific SLG 13 is busy.

(Example in which Plurality of Requests are Collected into One Request in Controller 12)

As illustrated in FIG. 5 to be described below, the distribution unit 121 may receive a plurality of requests from the orchestrator 11 and cause the batch processing unit 123 to generate a request in which a plurality of requests received within a predetermined interval (for example, 1 minute) are collected and transmit the request to the SLG 13.

In this case, the distribution unit 121 may notify the orchestrator 11 that the plurality of requests are collected and processed. The orchestrator 11 may include information regarding a sequence number (serial number) in each request and transfer the request to the controller 12. The distribution unit 121 may generate one request including a plurality of sets of the sequence number and content of the request.

The sequence number (serial number) for each request may be given by the controller 12. In this case, for example, the distribution unit 121 may give the sequence number (the serial number) to each request received from the orchestrator 11 in the order of date and time received by the controller 12 or in the order of date and time transmitted from the orchestrator 11.

The distribution unit 121 may collectively transmit a plurality of requests having at least one of the matched destination and priority of the requests among the plurality of requests from the orchestrator 11 to the SLG 13. In this case, the distribution unit 121 may generate one request in which information regarding the matched portion is deleted (integrated) among information such as the destinations, priority, and the like of the requests included in a plurality of requests from the orchestrator 11 without overlapping. In this case, for example, when information regarding a destination included in a first request matches information regarding a destination included in a second request, the distribution unit 121 may delete the information regarding the destination from the second request and then generate one request including information included in the first request and information included in the second request. Accordingly, for example, it is possible to reduce an amount of data transmitted from the controller 12 to the SLG 13.

For example, the distribution unit 121 may convert destinations of a plurality of requests having parts of the matched destinations of the requests among the plurality of requests from the orchestrator 11 into multicast destinations including the destinations of the plurality of requests and may transmit the converted requests to the SLG 13. Accordingly, for example, it is possible to reduce the number of packets transmitted from the controller 12 to the SLG 13.

(Example in which Plurality of Requests are Collected into One Request in Orchestrator 11)

As illustrated in FIG. 7 to be described below, the distribution unit 121 may collect a plurality of requests into one request in the orchestrator 11. In this case, the distribution unit 121 may notify the orchestrator 11 that a plurality of requests are collected and processed. The orchestrator 11 may generate one request including a plurality of sets of data of the sequence number and the content of the requests and transmit the request to the controller 12.

Subsequently, the distribution unit 121 transmits one response in which responses to the plurality of requests are collected to the orchestrator 11 (step S6) and ends processing on the request received from the orchestrator 11. Here, the distribution unit 121 transmits one response including

information indicating a processing result for each of the plurality of requests to the orchestrator **11**.

(Example in which Plurality of Responses are Collected into One Request in SLG **13**)

As illustrated in FIGS. **5** and **7** to be described below, when a request in which a plurality of requests are collected is received from the controller **12**, the SLG **13** may transmit (responses) one response in which responses to the plurality of requests are collected to the controller **12**. In this case, the SLG **13** may generate one response including a plurality of sets of data of the sequence number for each request and the content of the response to each request.

(Example in which Plurality of Responses are Collected into One Response in Interface Controller **12**)

The distribution unit **121** may receive a response which is each response to each of the plurality of requests and includes a sequence number for each request from the SLG **13** and may cause the batch processing unit **123** to generate a response in which a plurality of responses received within a predetermined interval (for example, 1 minute) are collected into one response and transfer the response to the orchestrator **11**. In this case, the distribution unit **121** may generate one response including a plurality of sets of data of the sequence number for each request and the content of a response to each request.

In the example of FIG. **5**, the controller **12** temporarily records requests **501** and **504** transmitted from the orchestrator **11** at different time points in the processing of step S**5** and collectively transmits requests **511** to **514** to the SLG **13** at one time point. When the controller **12** receives a response **515** in which responses to the requests **511** and **514** are collected into one response from the SLG **13**, the response **515** is transmitted as a response **505** to the orchestrator **11** in the processing of step S**5**.

In the example of FIG. **7**, the controller **12** collectively receives requests **701** to **704** from the orchestrator **11** and collectively transmits the requests **701** to **704** as requests **711** to **714** to the SLG **13**. When the controller **12** receives a response **715** in which responses to the requests **711** to **714** are collected into one response from the SLG **13**, the response **715** is transmitted as a response **705** to the orchestrator **11** in the processing of step S**5**.

Through the processing described with reference to FIG. **3**, as illustrated in FIG. **6**, with an increase in a frequency of the request (order) from the orchestrator **11**, a load of the controller **12** increases, as indicated by a line segment **611**.

When the load of the controller **12** exceeds the first threshold, the processing of steps S**5** and S**6** is performed. Therefore, since the load of the controller **12** increases, as indicated by a line segment **612**, an increase speed is lowered.

When the load of the controller **12** exceeds a second threshold higher than the first threshold, the controller **12** may discard at least some of the requests from the orchestrator **11**. Accordingly, the load of the controller **12** increases, as indicated by a line segment **613**. Therefore, the increase speed is further lowered, and thus the load of the controller **12** does not exceed an upper limit **601** at which a functional failure such as processing omission of an order occurs.

<Advantageous Effects of Present Invention>

In the technology of the related art, for example, when predetermined setting is instructed (the flow is input) to the edge SLG **13** from the orchestrator **11** to the controller **12** due to addition, change, deletion, and the like of the UE **20**, a load is concentrated on the controller **12**, and processing omission of an order and a functional failure may occur. For

example, it is considered that such a problem occurs in particular when many UEs **20** are added at a time, for example, to enlarge (scale) the SDN network.

According to the above-described embodiment, even when the load on the controller **12** is increased, the processing can be appropriately performed.

(Other Exemplary Configurations)

The function of each functional block in the controller **12** illustrated in FIG. **1** may be implemented by dedicated hardware (a Large-Scale-Integration (LSI) or the like) or by a general-purpose computer including a processor (a CPU, a Digital Signal Processor (DSP), or the like) and a memory and software operating on the computer.

FIG. **8** illustrates an example of a configuration of the controller **12** when the controller **12** is implemented using a computer and software.

As illustrated in FIG. **8**, the controller **12** includes a processor **101**, a memory **102**, an auxiliary storage device **103**, and an input/output device **104** which are connected by a bus.

For example, a program implementing processing of the controller **12** is stored in the auxiliary storage device **103** (a computer-readable recording medium). When the controller **12** operates, the program is read to the memory **102** and the processor **101** reads the program from the memory **102** to execute the program. For example, the processor **101** executes processing of the distribution unit **121** or the like in accordance with the program.

The "computer-readable recording medium" is, for example, a portable medium such as a flexible disk, a magneto-optical disc, a Read-Only Memory (ROM), or a Compact Disk Read-Only Memory (CD-ROM), a hard disk built in a computer system, or the like. The "computer-readable recording medium" may also include an element that dynamically retains a program in a short time such as a communication line when the program is transferred over a network such as the Internet or a communication line such as a telephone line, or an element that retains a program for a given time period such as a volatile memory inside a server or a computer system serving as client in that case.

Although the embodiment has been described above, the present invention is not limited to such a specific embodiment, and various modifications and changes can be made within the scope of the gist of the present invention described in the claims.

REFERENCE SIGNS LIST

1 Communication system
10 Communication network
11 Orchestrator
111 Management unit
112 Transceiver unit
12 Controller
121 Distribution unit
122 Real-time processing unit
123 Batch processing unit
124 Load measurement unit
13 SLG
20 UE
30 Server

The invention claimed is:

1. A control device comprising:
a controller configured to:
transmit a collection of individual requests based on respective individual requests received from an information processing device to a relay device,

wherein to transmit the collection of individual requests includes to:

transmit the collection of individual requests in which the respective individual requests of a plurality of individual requests from the information processing device are collected to the relay device and transmit a collection of responses in which respective responses to the plurality of individual requests are collected to the information processing device when a processing load of the control device is not equal to or less than a threshold,

wherein the collection of individual requests comprises a multicast destination setting based on a plurality of destinations of the collected respective individual requests of the plurality of individual requests, and

the transmission of the collection of individual requests further comprises collectively transmitting the plurality of individual requests having at least one of a matched destination and priority of an individual request among the plurality of individual requests from the information processing device to the relay device when the processing load of the control device is not equal to or less than the threshold; and

convert destinations of the plurality of individual requests having parts of matched destinations of two or more individual requests of the plurality of individual requests from the information processing device into multicast destinations, and collectively transmit the converted individual requests as at least a part of the collection of individual requests to the relay device when the processing load of the control device is not equal to or less than the threshold.

2. A control method comprising:

performing, by a processor of a first device, transmission processing of an individual request received from a second device to a third device,

wherein, in the transmission processing,

a collection of individual requests comprising a plurality of individual requests from the second device is collectively transmitted to the third device,

a collection of responses comprising information indicating a processing result for each of the plurality of individual requests is transmitted to the second device when a processing load of the processor of the first device is not equal to or less than a threshold, and

the collection of individual requests further comprises a multicast destination setting based on a plurality of destinations of the collected respective individual requests of the plurality of individual requests,

the plurality of individual requests having at least one of a matched destination and priority of the respective individual request among the plurality of individual requests from the second device are collectively transmitted to the third device as the collection of individual requests when the processing load of the first device is not equal to or less than the threshold,

destinations of the plurality of individual requests having parts of matched destinations of the collected respective individual requests or the plurality of individual requests from the second device are converted into multicast destinations, and

the converted individual requests are collectively transmitted to the third device as the collection of individual requests when the processing load of the first device is not equal to or less than the threshold.

3. A computer-readable non-transitory recording medium storing computer-executable program instructions, that when executed by a processor causes a control device to perform:

processing to transmit an individual request received from an information processing device to a relay device,

wherein, in the transmission processing,

a collection of individual requests comprising a plurality of individual requests from the information processing device is collectively transmitted to the relay device,

a collection of responses comprising information indicating processing results of respective individual request of the plurality of individual requests is transmitted to the information processing device when a processing load of the control device is not equal to or less than a threshold,

the collection of individual requests comprises a multicast destination setting based on a plurality of destinations of the collected respective individual requests of the plurality of individual requests,

the plurality of individual requests having at least one of a matched destination and priority of the respective individual requests among the plurality of individual requests from the information processing device are collectively transmitted to the relay device as the collection of individual requests when the processing load of the control device is not equal to or less than the threshold,

destinations of the plurality of individual requests having parts of matched destinations of the collected respective individual requests among the plurality of individual requests from the information processing device are converted into multicast destinations, and

the converted individual requests are collectively transmitted to the relay device as the collection of individual requests when the processing load of the control device is not equal to or less than the threshold.

4. A communication system comprising:

a first device comprising a first processor configured to execute operations comprising transmitting a request received from a second device to a third device,

wherein the second device comprises a second processor configured to execute operations comprising performing setting on the third device,

the third device comprising a third processor configured to execute operations comprising relaying a packet in software defined networking (SDN),

the transmitting the request further comprises:

collectively transmitting, based on processing load of the first device and a threshold, a collection of individual requests comprising a plurality of individual requests from the second device to the third device, and

transmitting a collection of responses comprising information indicating respective processing results for the respective individual requests of the plurality of individual requests to the second device,

wherein the collection of individual requests comprises a multicast destination setting based on a plurality of destinations of the collected respective individual requests of the plurality of individual requests, and

collectively transmitting the plurality of individual requests having at least one of a matched desti-

nation and priority of the request among the plurality of individual requests from the second device to the third device when the processing load of the first device is not equal to or less than the threshold,

wherein the first processor is further configured to execute operations comprising converting destinations of the plurality of individual requests having parts of matched destinations of two or more individual requests of the plurality of individual requests from the second device into multicast destinations, and

the converted individual requests are collectively transmitted to the third device as the collection of individual requests when the processing load of the first processor of the first device is not equal to or less than the threshold.

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