(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
20 December 2018 (20.12.2018)

WIPO | PCT

(10) International Publication Number
WO 2018/228708 A1

(51) International Patent Classification:
H04L 29/08 (2006.01)

(21) International Application Number:
PCT/EP2017/064842

(22) International Filing Date:
16 June 2017 (16.06.2017)

(25) Filing Language: English

(26) Publication Language: English

(71) Applicant: **SIEMENS SCHWEIZ AG** [CH/CH]; Freilagerstrasse 40, 8047 Zürich (CH).

(72) Inventors: **GOKHALE, Pratima**; F-501, Sylvan Heights, Sanewadi, Aundh, Pune, Maharashtra 411007 (IN). **ISLER, Bernhard**; Hungerstr. 36a, 8832 Wilen b. Wollerau (CH). **JAISWAL, Sudhir**; Flat 901, Bldg-A, Pride World City, Off Dhanori-Lohegaon Road, Near D. Y Patil College, Pune, Maharashtra 412105 (IN).

(74) Agent: **MAIER, Daniel**; Siemens Aktiengesellschaft, Postfach 22 16 34, 80506 München (DE).

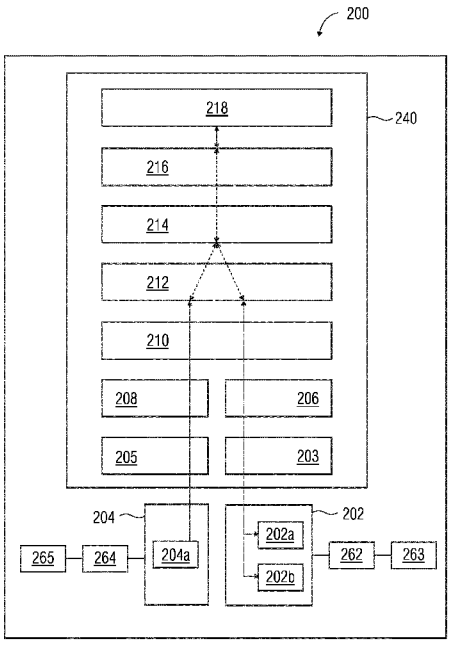
(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report (Art. 21(3))*

(54) Title: METHOD, DEVICE AND SYSTEM FOR CONCEALED COMMUNICATION WITH DEVICES IN DIFFERENT NETWORKS IN A BUILDING AUTOMATION ENVIRONMENT

FIG 2



(57) Abstract: A method of communicating with devices in different networks in a building automation system (200), the building automation system (200) comprising a first network of devices (202) and a second network of devices (204), and a shared device (240) connected to both the first network and the second network. The method includes routing a message received on a port of the share d device (240) directly to an application (218) on the shared device (240), without routing the message to another port of the shared device (240). The method also includes routing a further message sent by the application (218) to one of the ports of the shared device (240), based on a destination network number of the further message. Further, the method includes duplicating and routing a global broadcast message sent by the application (218) to each of the ports of the shared device (240).

WO 2018/228708 A1

Description

Method, Device and System for concealed communication with devices in different networks in a building automation environment

The present invention relates to communication between devices in a building automation environment.

The building automation environment typically includes integrated and controlled systems that are arranged and organized into one or more networks of devices, where the devices communicate to each other according to a network protocol, such as the Building Automation and Control Networks (BACnet, ANSI/ASHRAE Standard 135) protocol.

Devices communicating with the BACnet protocol are known as BACnet devices and multiple BACnet devices in two or more BACnet networks constitute a BACnet internetwork. Generally, messages between BACnet devices in different BACnet networks are routed by a BACnet router. The BACnet router facilitates communication by forwarding unicast and global or directed broadcast messages across the BACnet networks. In certain scenarios, it is preferable that the messages between BACnet devices in a BACnet network be restricted to the same network and not be visible to other networks. For example, if a BACnet device in a network has resource constraints, it may be preferable to restrict irrelevant or broadcast messages from another network, to avoid processing by the resource constrained BACnet device. Accordingly, it is preferable not to receive the irrelevant or broadcast messages.

In another example, a BACnet internetwork may sometimes include an on-site network including field devices, and a cloud server. In this setup, the BACnet devices may be required to have a distinct connection to the cloud server, for data upload and download, using the BACnet protocol. For this, the BACnet devices need at least two ports, i.e. one for the on-

site interaction and another for connecting to the cloud server. Normally, BACnet devices having more than one port are referred to as BACnet router and are expected to provide message routing between on-site devices and the cloud server via the ports.

FIG. 1 illustrates a graphical representation 100 of the communication mechanism in a BACnet router, according to the state of the art. The BACnet router includes a processor, a first port 102 and a second port 104. The first port 102 and the second port 104 are connected to devices in a first network and a second network (not shown in the FIG 1). The BACnet router communicates with the BACnet protocol, which includes a network layer 106 and an application layer 108. The BACnet router also includes a BACnet application 110 in addition to the application layer 108.

As shown in FIG 1, a message 112a received on the first port 102 is routed to the second port 104 at the network layer 106, as indicated by arrow 112b. For example, the first port 102 has Media Access Control (MAC) address=6 and assigned first network number 40. The second port 104 has MAC address=7 and assigned second network number 10. The message 112a is a global broadcast message received from a BACnet device with MAC address=8 on the first network connected to the first port 102. The global broadcast message 112a is a type of BACnet Network Protocol Data Unit (NPDU), whose format includes a header (no source BACnet address SNET/SLEN/SADR), global broadcast destination DNET=X'FFFF'/DLEN=0/no DADR) and a payload. The global broadcast message 112a is received by port 102 with the data link frame indicating source MAC address 8 (SA=8), and broadcast destination MAC address (DA=BCAST).

This message is routed to the second port 104 as message 112b and broadcast on the second network. The message 112b is received by a device on the second network, to which the second port 104 is connected. The message 112b is received with the

NPDU header containing (SNET=40/SLEN=1/SADR=8), (DNET=X'FFFF'/DLEN=0/no DADR), and the payload. Further, the data link layer frame conveying the NPDU indicates (SA=7, DA=BCAST). The message is also routed to the local BACnet application 110.

Also shown in Figure 1, the arrow 114a indicates a global broadcast message sent by the BACnet application 110. The arrows 114a and 114b indicate the global broadcast message sent on the first port 102 and on the second port 104, respectively. This routing of messages consumes significant processing resources of the BACnet router.

In a situation where the BACnet protocol is used on a resource constrained BACnet device, the primary concern is the availability of processing resources. When the BACnet device is connected to multiple BACnet networks by multiple ports, the processor may be overloaded with the routing of messages between multiple ports.

Therefore, in a building automation environment a need exists for providing connectivity with devices in different networks without performing message routing. Further, there exists a need to reduce processing overhead of the BACnet device. Also, it is desirable not to route all messages as it may reveal networks and devices that are hidden or irrelevant.

The method, device and system according to the present invention achieve the aforementioned need by concealing messages received on a first port of a device, from a second port of the device. The device according to the present invention is referred to as a shared device that is capable of communicating with devices in different networks and has multiple ports.

The method according to the present invention provides that the shared device is capable of concealing messages by routing a message received on a port of the shared device directly to an application on the shared device, without routing

the message to another port of the shared device. Also, the shared device routes a further message sent by the application to one of the ports of the shared device, based on a destination network number of the further message. Further, the shared device duplicates and routes a global broadcast message sent by the application to each of the ports of the shared device.

As used herein, the following terms are used interchangeably, "first network of devices" and "first network", "second network of devices" and "second network", "directly connected BACnet network" and "directly connected network", "indirectly connected BACnet network" and "indirectly connected network", and the "device" and the "shared device".

For the purpose of the present invention, the term "building automation environment" refers to a building automation system that is an integration of controls and services within a building or a setup such as an office building, several buildings in a campus, a plant facility, and the like. The controls and services that are integrated and typically include management of heating, ventilation and air conditioning (HVAC) systems, security systems and services, fire alarm systems, and the like. The integrated and controlled systems are arranged and organized into one or more networks operating according to a common communication scheme and/or network protocol. For example, the typical network protocols include BACnet, KNX, Modbus, LonTalk and the like. Further, the network protocols are provided with a cloud link so that they are capable of communicating with a cloud server. Also, the term "BACnet application" refers to an application installed on a BACnet device, such as the shared device. The BACnet application includes machine readable instructions that are executed by a processor in the BACnet device.

According to an embodiment of the present invention, the network protocol used to communicate between devices is the Building Automation and Control Network (BACnet, ANSI/ASHRAE

Standard 135) protocol. According to the BACnet protocol, the purpose of the network layer is to provide the means by which messages can be relayed from one BACnet network to another. Devices that interconnect two BACnet networks are called BACnet routers and their activities are called routing. Accordingly, the shared device according to the present invention is a BACnet router that not only interconnects the first network and a second network, rather connects and communicates with the first network and the second network while concealing them from each other.

Further, according to the BACnet protocol, a message can be a unicast message that is sent from a sending device to a receiving device on another BACnet network (BACnet internetwork). The message can also be a directed broadcast message, i.e. a message sent from the sending device on the first network to all devices on the second network, or a global broadcast message sent from the sending device on the first network to all devices on the BACnet internetwork.

According to the BACnet protocol, the message is represented as a data frame that may include the source network number (SNET) and a source MAC address of the sending device (SLEN/SADR) in an address field of the message. The message is represented as a data frame that may include the destination network number (DNET) and a destination MAC address (DLEN/DADR) for unicast messages, or a respective empty broadcast MAC address (DLEN=0, no DADR) for directed or global broadcasts. Such data frames are referred to as a Network Protocol Data Unit (NPDU). As used herein, the source network number (SLEN) is the network number assigned to the BACnet network of the sending device. The destination network number (DNET) is the network number assigned to the BACnet network of the receiving device(s). Network number X'FFFF' in DNET is used to indicate a global broadcast. In an embodiment, the source network number is associated with the port on which the message is received by the shared device. The destination network number is associated with the port through which the

receiving device can be reached, and through which the message is to be sent. The source network number (SNET) and the destination network number (DNET) depend on the BACnet network in which the sending device and the receiving device are part of. Both the sending and receiving devices may be present on an indirectly connected BACnet network. The indirectly connected BACnet network is reachable through a BACnet router present in the directly connected network of the first port or the second port, respectively.

In an embodiment of the present invention, the shared device comprises two or more ports including a first port and a second port connected to directly connected networks or indirectly connected networks via the directly connected networks. The directly connected networks comprise the first network of devices and the second network of devices connected to the first port and the second port, respectively. The indirectly connected networks comprise one or more networks connected to the first network or the second network via one or more BACnet Routers.

According to an embodiment, a unique network number is assigned to the first network and the first port, and to the second network and the second port. Also, a unique network number is assigned to the indirectly connected networks. When the source network number is not present in the message received, the unique network number of the port through which the message was received is used as the source network number.

According to another embodiment, the message received by the application on the shared device is read and the destination network number for a response is determined from the source network number of the message.

According to an embodiment, the destination network number is determined based on a configuration of the application. For example, in case of messages initiated by the application,

such as event notification messages, the configuration of the application comprises the destination address.

According to another embodiment, the shared device determines the destination address by determining the port of the shared device on which the message is to be sent. The port on which the message is to be sent is the port assigned with the unique network number matching the destination network number. In case of the indirectly connected networks, the port connected to the directly connected network that is in turn connected to the BACnet router and to the indirectly connected network is associated with the unique network number matching the destination network number of the indirectly connected network.

When the destination address is in the directly connected network, the shared device compares the destination network number of the message to the unique network numbers assigned to the first port and the second port. When the destination address is in the indirectly connected network, the shared device compares the destination network number of the message to unique network numbers of the indirectly connected networks connected to the first network and the second network. Based on the comparison, the shared device encodes a Media Access Control (MAC) address associated with the sending port as the source MAC address.

According to another embodiment, the shared device encodes the MAC address associated with the destination device in the directly connected network, as the destination MAC address.

According to yet another embodiment, the shared device encodes the MAC address associated with the BACnet router to the indirectly connected network, as the destination MAC address.

Therefore, according to the present invention, the message is not routed at the network layer to any other port and the

message is sent to the BACnet application of the receiving device. This method advantageously conceals the first network and all remote networks behind the first network from the second network and all remote networks behind the second network. For example, the shared device can communicate with devices on a cloud server through the first network, as well as with devices of the on-site building automation environment through the second network by not revealing the presence of either to devices connected to the other network and all indirectly connected networks behind. Additionally, this method is advantageous as the shared device is capable of fully participating in multiple BACnet inter-networks (i.e. the first network and the second network) as if the shared device is part of each of the first and second network.

The above-mentioned and other features of the invention will now be addressed with reference to the accompanying drawings of the present invention. The illustrated embodiments are intended to illustrate, but not to limit the invention.

The present invention is further described hereinafter with reference to illustrated embodiments shown in the accompanying drawings, in which:

FIG 1 illustrates a schematic representation of a communication mechanism in a BACnet router, according to state of the art;

FIG 2 illustrates a schematic representation of a shared device according to the present invention;

FIG 3 illustrates a schematic representation of a communication mechanism of the shared device according to the present invention; and

FIG 4 is a flowchart illustrating a method for a shared device for communicating with devices in different networks in a building automation environment.

Various embodiments are described with reference to the drawings, wherein like reference numerals are used to refer to like elements throughout. In the following description, devices operating with the BACnet protocol have been considered as an example for the purpose of explanation. These examples must not be considered to limit the application of the invention to a particular communication protocol used in a building automation environment. It may be evident that such embodiments may be practiced without these specific details. Further, numerous specific details are set forth in order to provide thorough understanding of one or more embodiments of the present invention.

In the following description, the term "application" refers to a BACnet application installed on a BACnet device, such as the shared device. The application includes machine readable instructions that are executed by a processor in the BACnet device.

FIG 2 illustrates a schematic representation of a shared device according to the present invention. The shared device is connected to the directly connect networks 202, 204 and to the indirectly connected networks 263, 265 via the directly connected networks 202, 204. The directly connected networks 202, 204 are referred to as first network 202 and second network 204. As shown in FIG 2, the first network 202 includes one or more devices 202a, 202b. The devices 202a, 202b communicate according to the BACnet protocol. The second network 204 includes device 204a that is configured to communicate according to the BACnet protocol. Also shown in FIG 2, the indirectly connected networks 263, 265 comprise one or more networks connected to the first network 202 and the second network 204 via BACnet routers 262, 264.

The building automation system 200 also includes a device 240 connected to the first network 202 and the second network 204 and is also referred to as the shared device 240. The shared device 240 includes a first port 203 and a second port 205 to communicate with the first network 202 and the second network 204, respectively. In an embodiment, the shared device 240 is configured to communicate according to the BACnet protocol and therefore, includes the layers of the BACnet protocol. As shown in FIG.2, the shared device 240 includes data link layers 206 and 208. In an embodiment, the data link layer 206 is configured as a BACnet/IP or BACnet/MSTP data link. In another embodiment, the data link layer 208 is configured as a proprietary cloud data link layer port.

As shown in FIG. 2, the shared device 240 further includes a network layer 212, an application layer 214 and an application program interface (API) 216. The API 216 is used by application 218 of the shared device 240. The shared device 240 is capable of participating in the networks 202 and 204 without disclosing the existence of the first network 202 to the second network 204, and without disclosing the second network 204 to the first network 202, according the present invention. The shared device 240 achieves the above by routing a message received on either one of ports 203, 205 of the shared device 240 directly to the application 218 on the shared device 240, without routing the message to the other port 205, 203 of the shared device 240. In case of a message sent by the application 218, the shared device routes to one of the ports 203, 205 of the shared device 240, based on a destination network number of the message. Additionally, the shared device 240 duplicates and routes a global broadcast message sent by the application 218 to each of the ports 203, 205 of the shared device 240. This is achieved by configuring the network layer 212 as concealing network layer 212. This is further explained in FIG. 3 and FIG. 4.

FIG. 3 illustrates a schematic representation 300 of a communication mechanism between devices in different networks ac-

cording to the present invention. The graphical representation 300 indicates how broadcast messages are routed in the shared device 350. The first port 303 is configured to be part of the first network 302 and the second port 305 is configured to be part of the second network 304. In an embodiment, the first port 303 receives a message 320 from a sending device 302a in the first network 302. The application 310 replies with a global broadcast message 334. The first port 303 sends the reply 314 to the first network 302. The reply 314 is configured such that the source MAC address (SA) of the reply 314 is the MAC address of the first port 303. The second port 305 sends a reply 324 to the second network 304. The reply 324 is configured such that the source MAC address (SA) of the reply 324 is the MAC address of the second port 305. This can be explained with the following example.

In an embodiment, the first port 303 has MAC address=6 and is connected to network 302 with network number 40. The second port 305 has MAC address=7 and is connected to network 304 with network number 10. The message 320 is received from device 302a and is a type of BACnet Network Protocol Data Unit (NPDU), whose format includes the header (no source BACnet address SNET/SLEN/SADR), global broadcast destination DNET=X'FFFF'/DLEN=0/no DADR) and the payload. The message 320 has the source MAC addresses 8 (SA=8) and broadcast destination MAC address (DA=BCAST). As indicated by the arrow, the message 320, the source network number (SNET=40), and the source MAC address (SLEN/SADR=SA=8) is directly forwarded to the application 310 without routing or forwarding to other ports by the network layer 316. The application 310 responds to the message 320 with a global broadcast message 334. The reply 334 must be routed to both the first network 302, and the second network 304. The reply 314 is sent to the first network 302 and the reply 324 is sent to the second network 304. The reply 314 is sent to the first network 302 with NDPU header containing (no SNET/SLEN/SADR) (DNET=X'FFFF'/DLEN=0/no DADR). Further, the data link layer frame conveying the NPDU indicates MAC addresses (SA=6, DA=BCAST). The source of the

reply 314 is indicated as being the first port 303 having the MAC address=6. Further, the reply 324 is sent to the second network 304 with the NPDU header containing (no SNET/SLEN/SADR) (DNET=X'FFFF'/DLEN=0/no DADR). Further, the data link layer frame conveying the NPDU indicates MAC addresses (SA=7, DA=BCAST). The source of the reply 324 is the second port 305 having MAC address=7. Since the second port 305 is configured as part of the second network 304, a receiving device 304a in the second network 304 reads the reply 324 as if it was sent from the second port 305 within the second network 304.

The present invention is advantageous with respect to the routing mechanism known in the art and is elaborated in comparison with the example in FIG 1. It can be seen that the first network 302 and the second network 304 are able to view only the first port 303 and the second port 305, respectively. Accordingly, the devices 302a and 302b in the first network 302 are concealed from the device 304a and the second network 304. Further, the MAC address of the shared device 350 is the MAC address of the port 303, 305 used to send the message or reply initiated by the local application.

FIG. 4 is a flowchart illustrating a method 400 of communicating between devices in different networks in a building automation system. The building automation system includes a shared device connected to directly connected networks such as a first network and a second network, each having one or more devices. The devices in the first network and the second network are configured to communicate according to the BACnet protocol. Further, the building automation system includes indirectly connected networks comprising one or more networks connected to the first network or the second network via one or more BACnet routers.

At step 402, the method begins by assigning a unique network number to the first network and a first port of the shared device, and to the second network and a second port of the

shared device. Further, a unique network number is assigned to indirectly connected networks in the building automation system.

At step 404, the first network of the building automation system is assigned a first network number. The first port of the shared device is configured as part of the first network and is therefore assigned the first network number.

At step 406, the second network and a second port of the shared device are assigned a second network number.

At step 408, a message is received by the shared device, from a sending device. In an embodiment, the sending device is in the first network and therefore, the message is received on the first port.

At step 410, the message is received by the network layer from the first port.

At step 412, the network layer assigns one of the first network number and the second network number as the source network number based on whether the message was received from the first network of devices or the second network of devices. Considering the example where the sending device is in the first network, the network layer determines that the message was received from the first network. Accordingly, the source network number (SNET) is the first network number. The source MAC address (SLEN/SADR) is the MAC address of the sending device (SLEN/SADR=SA). When the source network number is not present in the message received, the unique network number of the port through which the message was received is used as the source network number. The source MAC address is the MAC address of the sending device in this case.

At step 414, the message is received by the application on the shared device. In an embodiment, the application may respond to the sending device on the message and therefore de-

termines the destination address for the response from the source address of the message.

At step 416, the application creates a response. The application determines a destination network number for the response based on the source network number of the received message. In addition, the destination MAC address (DLEN/DADR) for the response is determined from the source MAC address (SLEN/SADR). At step 416, the destination network number is also determined based on a configuration of the application. The configuration of the application comprises the destination address for messages initiated by the application such as event notification messages.

At step 418, the network layer checks the destination network number to determine the port through which the response is to be sent to the original sending device. When the destination network number of the response is the network number of the network connected to first port, or an indirectly connected network behind, step 420 is performed. When the destination network number of the response is the network number of the network connected to the second port, or an indirectly connected network behind, step 424 is performed.

At step 420, the network layer encodes the response into an NPDU. If the response is to be sent to the indirectly connected network behind the network connected to the first port, the destination address of the NPDU (DNET/DLEN/DADR) is the network number and MAC address of the original sending device. If the response is sent to a device connected to the network of the first port, the destination address of the NPDU is absent (no DNET/DLEN/DADR). The source address of the NPDU (SNET/SLEN/SADR) is omitted in both cases. Step 422 is performed.

At step 424, the network layer encodes the response into an NPDU. If the response is to be sent to a network behind the network connected to the second port, the destination address

of the NPDU (DNET/DLEN/DADR) is the network number and MAC address of the original sending device. If the response is sent to a device connected to the network of the second port, the destination address of the NPDU is absent (no DNET/DLEN/DADR). The source address of the NPDU (SNET/SLEN/SADR) is omitted in both cases. Step 422 is performed.

At step 422, the message is transmitted to the receiving device in the network connected to the port, or to some BACnet router in that network. The source MAC address (SA) of the response is the MAC address of the port through which the message is sent. The destination MAC address (DA) of the response is the MAC address of the original sending device, or the MAC address of the BACnet router to the indirectly connected destination network on which the original sending device resides.

Although components and functions are described that may be implemented in particular embodiments with reference to particular standards and protocols, the components and functions are not limited to such standards and protocols. For example, standards for Internet and other packet switched network transmission (e.g., Transmission Control Protocol/Internet Protocol (TCP/IP), User Datagram Protocol/Internet Protocol (UDP/IP), or Hypertext Transfer Protocol (HTTP) represent examples of the state of the art. Such standards are periodically superseded by faster or more efficient equivalents having essentially the same functions. Accordingly, replacement standards and protocols having the same or similar functions as those disclosed herein are considered equivalents thereof.

The illustrations described herein are intended to provide a general understanding of the structure of various embodiments. The illustrations are not intended to serve as a complete description of all of the elements and features of apparatus, processors, and systems that utilize the structures or methods described herein. Many other embodiments may be

apparent to those of skill in the art upon reviewing the disclosure. Other embodiments may be utilized and derived from the disclosure, such that structural and logical substitutions and changes may be made without departing from the scope of the disclosure. Additionally, the illustrations are merely representational and may not be drawn to scale. Certain proportions within the illustrations may be exaggerated, while other proportions may be substantially minimized. Accordingly, the disclosure and the figures are to be regarded as illustrative rather than restrictive.

Although specific embodiments have been illustrated and described herein, it should be appreciated that any subsequent arrangement designed to achieve the same or similar purpose may be substituted for the specific embodiments shown. This disclosure is intended to cover any and all subsequent adaptations or variations of various embodiments. Combinations of the above embodiments, and other embodiments not specifically described herein, may be apparent to those of skill in the art upon reviewing the description.

The Abstract is provided with the understanding that it will not be used to interpret or limit the scope or meaning of the claims. In addition, in the foregoing Detailed Description, various features may be grouped together or described in a single embodiment for the purpose of streamlining the disclosure. This disclosure is not to be interpreted as reflecting an intention that the claimed embodiments require more features than are expressly recited in each claim. Rather, as the following claims reflect, inventive subject matter may be directed to less than all of the features of any of the disclosed embodiments. Thus, the following claims are incorporated into the Detailed Description, with each claim standing on its own as defining separately claimed subject matter.

FIG 1
communication mechanism in a BACnet router 100
first port 102
second port 104
network layer 106
application layer 108
BACnet application 110
message 112a
arrow 112b

FIG 2
building automation system 200
directly connect networks 202, 204
first network devices 202a, 202b
second network devices 202a, 202b
first network 202
first port 203
second network 204
second port 205
data link layers 206 and 208
network layer 212
application layer 214
application program interface (API) 216
shared device 240
BACnet routers 262, 264
indirectly connected networks 263, 265

FIG 3
communication mechanism 300
shared device 350
first network 302
first port 303
second network 304
second port 305
message 320
sending device 302A
application 310
global broadcast message 334

reply 314
reply 324
message 320
application 310
network layer 316
receiving device 304a
devices 302a and 302b

Claims

1. A method of communicating with devices in different networks in a building automation system (200), the building automation system (200) comprising a first network of devices (202) and a second network of devices (204), and a shared device (240) connected to both the first network and the second network, the method comprising:

routing a message received on a port of the shared device (240) directly to an application (218) on the shared device (240), without routing the message to another port of the shared device (240);

routing a further message sent by the application (218) to one of the ports of the shared device (240), based on a destination network number of the further message; and

duplicating and routing a global broadcast message sent by the application (218) to each of the ports of the shared device (240).

2. The method according to claim 1, wherein the shared device (240) comprises two or more ports including a first port and a second port connected to directly connected networks (202, 204) or indirectly connected networks (263, 265) via the directly connected networks; wherein the directly connected networks comprise the first network of devices (202) and the second network of devices (204) connected to the first port and the second port, respectively; and wherein the indirectly connected networks (263, 265) comprise one or more networks connected to the first network or the second network via one or more routers (262, 264).

3. The method according to claim 2, further comprising:

assigning a unique network number to the first network (202) and the first port, and to the second network (204) and the second port.

assigning a unique network number to the indirectly connected networks (263, 265).

4. The method according to claim 2, further comprising:

using the unique network number of the port through which the message was received as a source network number, when the source network number is not present in the message received.

5. The method according to claim 2, further comprising:

determining a destination address of the message to be sent.

6. The method according to claim 5, wherein determining a destination address of the message to be sent, comprises:

reading the message received by the application (218) on the shared device (240); and

determining the destination network number from the source network number of the message received.

7. The method according to claim 5, wherein determining a destination address of the message to be sent, comprises:

determining the destination network number based on a configuration of the application (218); wherein the configuration of the application (218) comprises the destination address for messages initiated by the application comprising event notification messages.

8. The method according to one of the claims 6 or 7, further comprises:

determining the send port and sending the message from the application (218) to the network of the send port.

9. The method according to claim 5, wherein determining a destination address of the message to be sent, comprises:

determining the port of the shared device (240) on which the message is to be sent, wherein the port on which the message is to be sent is the port assigned with the unique network number matching the destination network number, or the port connected to the directly connected network that is con-

nected to the BACnet router and to the indirectly connected network which is assigned with the unique network number matching the destination network number;

comparing the destination network number of the message to the unique network number assigned to the first port and the second port, when the destination address is in the directly connected network;

comparing the destination network number of the message to unique network numbers of the indirectly connected networks connected to the first network and the second network, when the destination address is in the indirectly connected network; and

encoding a Media Access Control (MAC) address associated with the sending port as the source MAC address.

10. The method according to claim 9, further comprising:

encoding the MAC address associated with the destination device, in the directly connected network, as a destination MAC address.

11. The method according to claim 9, further comprising:

encoding the MAC address associated with the BACnet router to the indirectly connected network connected to the directly connected network, as destination MAC address.

12. A shared device (240) configured to perform the method of one of the claims 1 to 11.

13. The shared device (240) according to claim 12, wherein the shared device is a field device in an on-site building automation system (200) and is communicatively coupled to a cloud server.

14. The shared device (240) according to claim 12, wherein the building automation system (200) comprises two or more networks including a first network of devices (202) and a second network of devices (204), wherein the shared device (240) is connected to both networks, wherein the first net-

work (202) of devices (202A, 202B) is a network of field devices in an on-site building automation system (200), and the second network (204) of devices (204A) is a network of devices located on a cloud server.

15. A system for communicating between devices in different networks in a building automation environment comprising:

a first network of devices (202);

a second network of devices (204); and

a shared device (240) according to one of the claims 12 to 14.

FIG 1

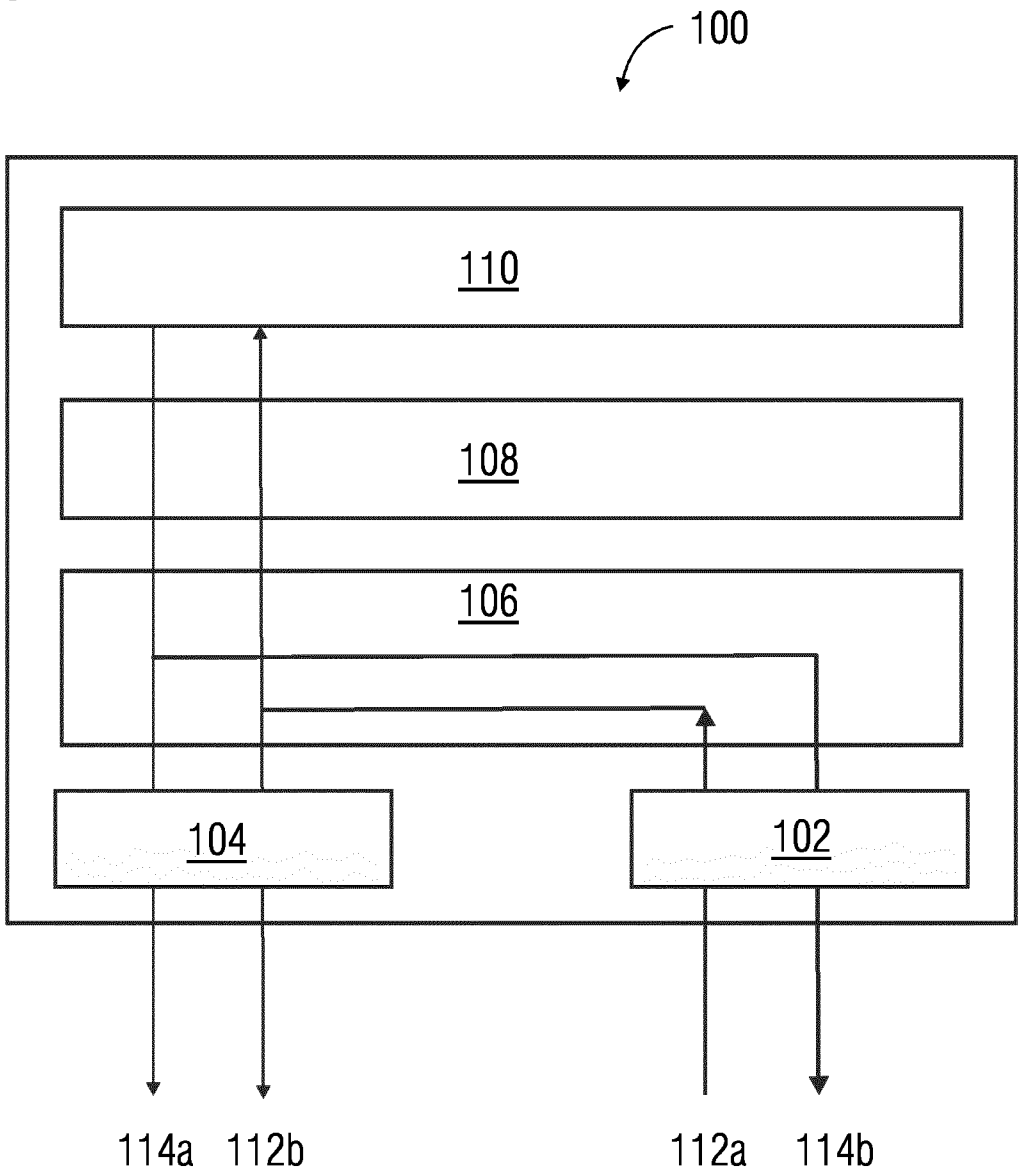


FIG 2

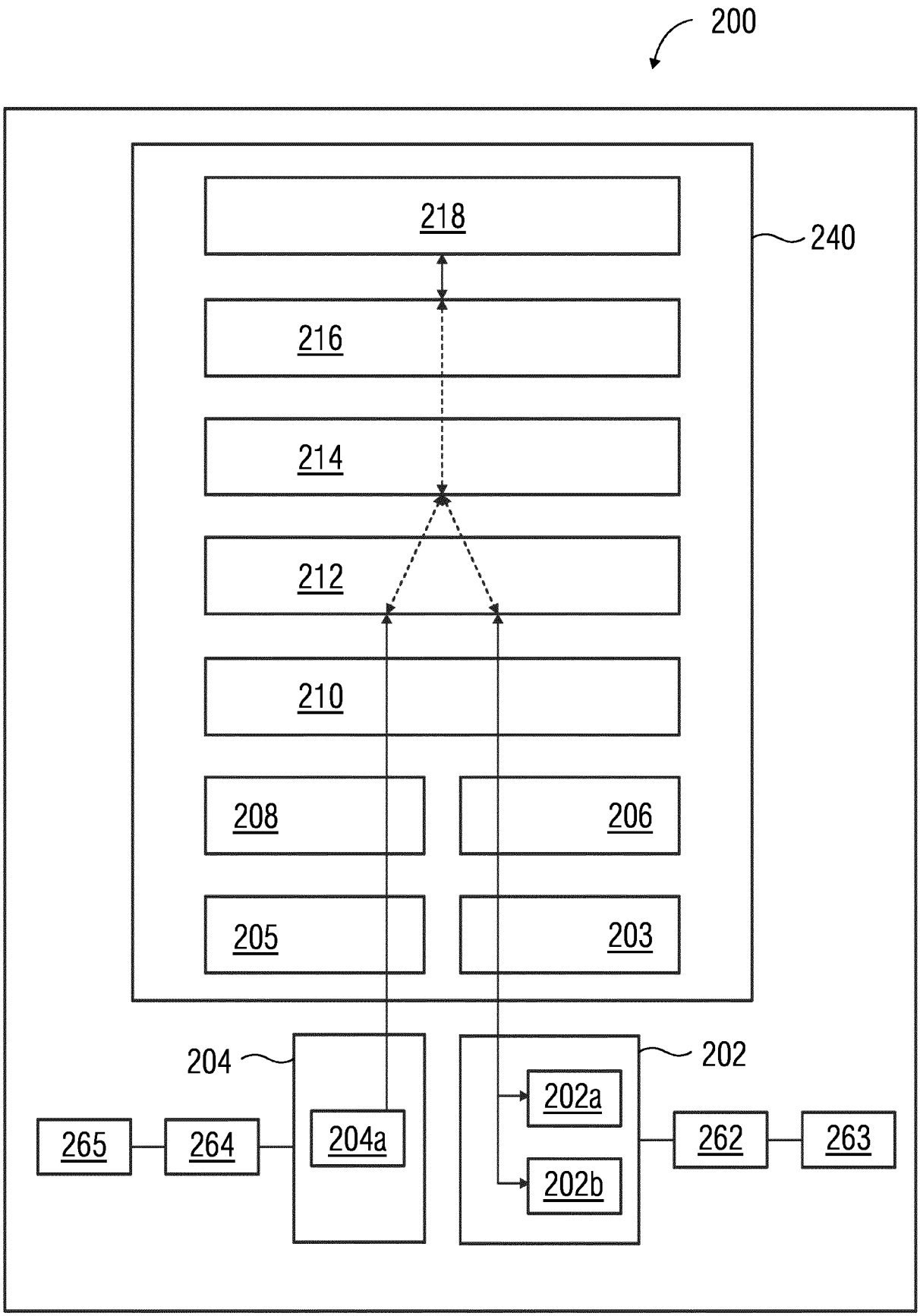

200
240
218
216
214
212
210
208
206
205
203
204
204a
202
202a
202b
262
263
265
264

FIG 3

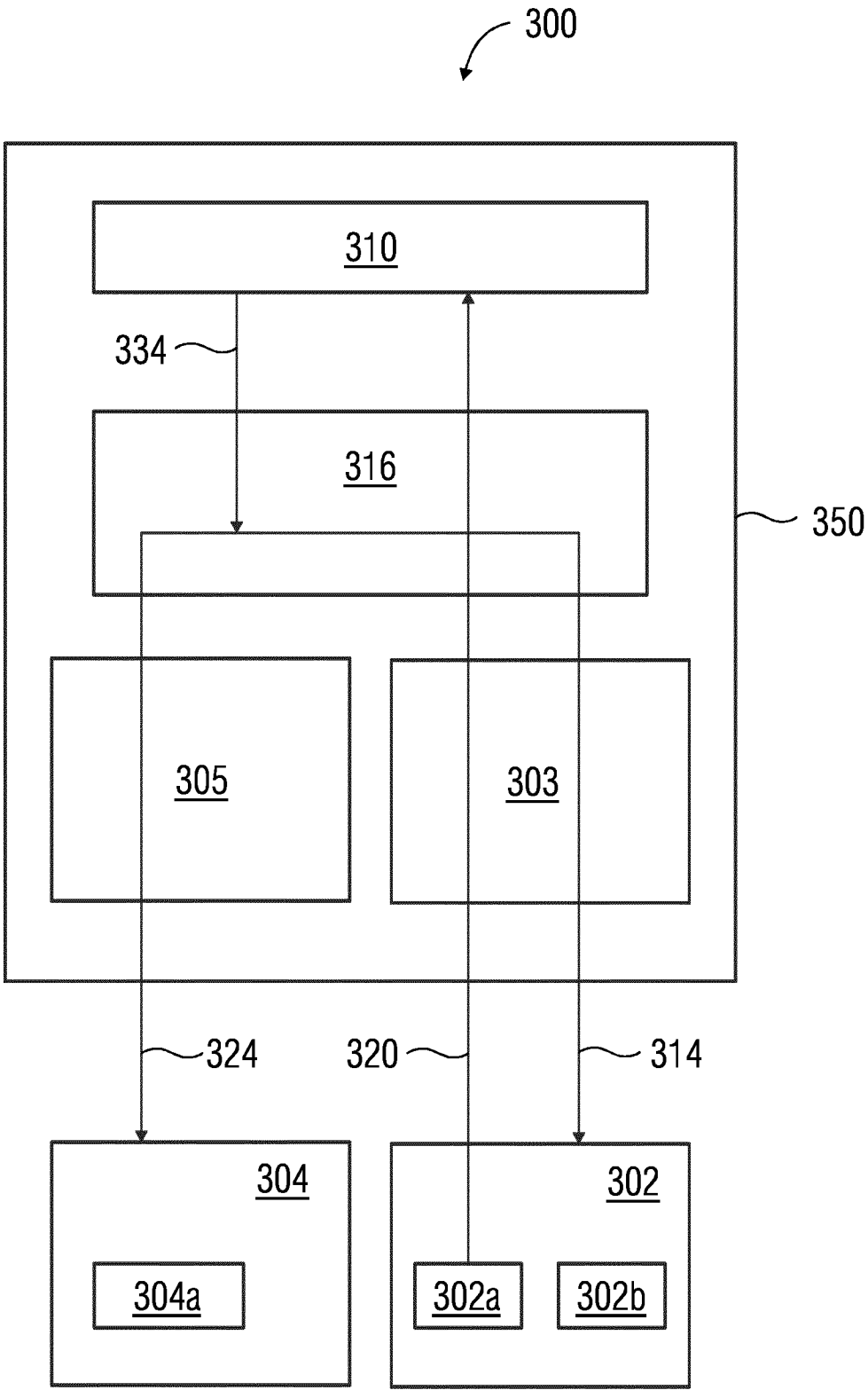
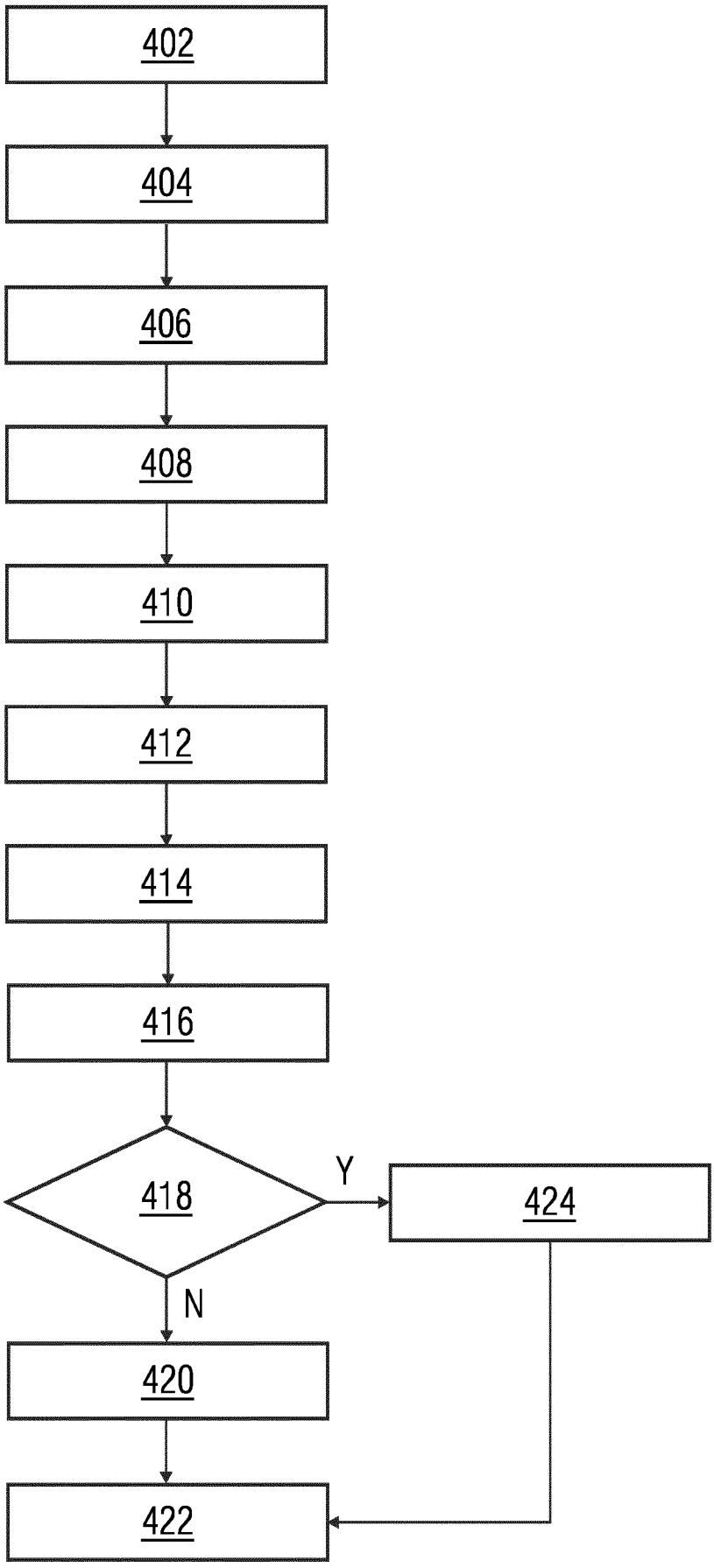


FIG 4



INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2017/064842

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04L29/08
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2015/039752 A1 (HAGUE EDWARD [US]) 5 February 2015 (2015-02-05) abstract paragraphs [0006] - [0010], [0014] - [0020] paragraphs [0030] - [0033], [0038] figures 1-3 -----	1-15
X	US 2015/207773 A1 (MATSEN DEAN C [US]) 23 July 2015 (2015-07-23) abstract paragraphs [0008] - [0011], [0014], [0017], [0018], [0019] paragraphs [0020], [0023] figures 1-3 -----	1-15

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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

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

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

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

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
3 November 2017	10/11/2017

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Lai, Cristiana

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2017/064842

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2015039752 A1	05-02-2015	NONE	
US 2015207773 A1	23-07-2015	NONE	