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(54) **PROXY MECHANISM FOR MESH-TYPE NETWORKS**

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(30) **Foreign Application Priority Data**

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H04W 40/22 (2009.01)
H04W 84/18 (2009.01)
H04W 84/10 (2009.01)
H04W 88/04 (2009.01)

(52) **U.S. Cl.**

CPC ***H04W 40/22*** (2013.01); ***H04W 84/18*** (2013.01); *H04W 84/10* (2013.01); *H04W 88/04* (2013.01)

(58) **Field of Classification Search**

CPC H04W 40/22
USPC 370/254
See application file for complete search history.

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(57) **ABSTRACT**

The present invention relates to an apparatus and method for connecting a mesh type network via an access device (C) to another network. A proxy mechanism is provided in the mesh type network, that allows for interconnection and range extension of legacy access point based mesh type networks.

20 Claims, 6 Drawing Sheets

FC	D / ID	A1	A2	A3	SC	A4	B	FCS

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FC	D / ID	A1	A2	A3	SC	A4	B	FCS

Fig. 1

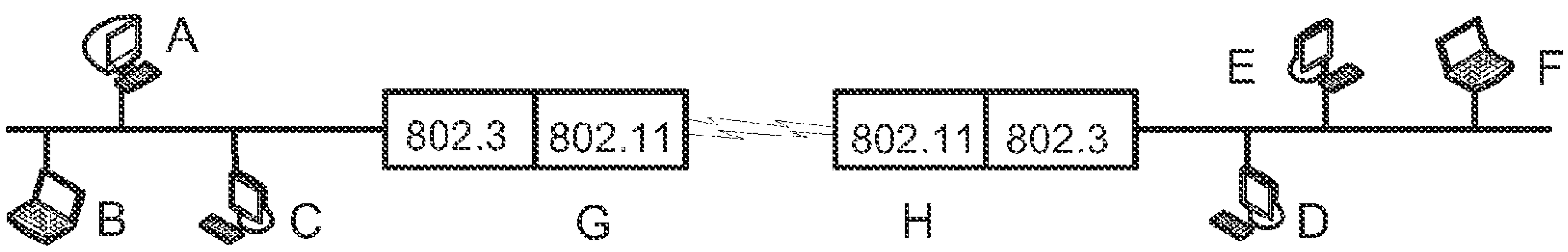

Fig. 2

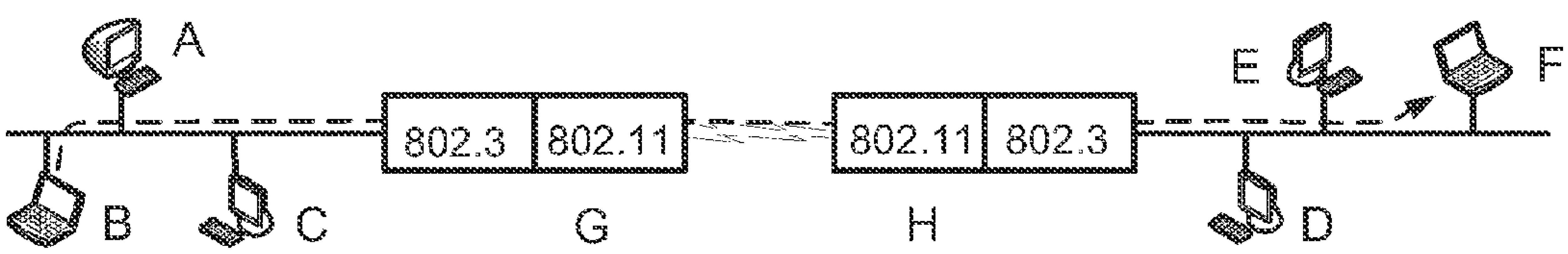

Fig. 3

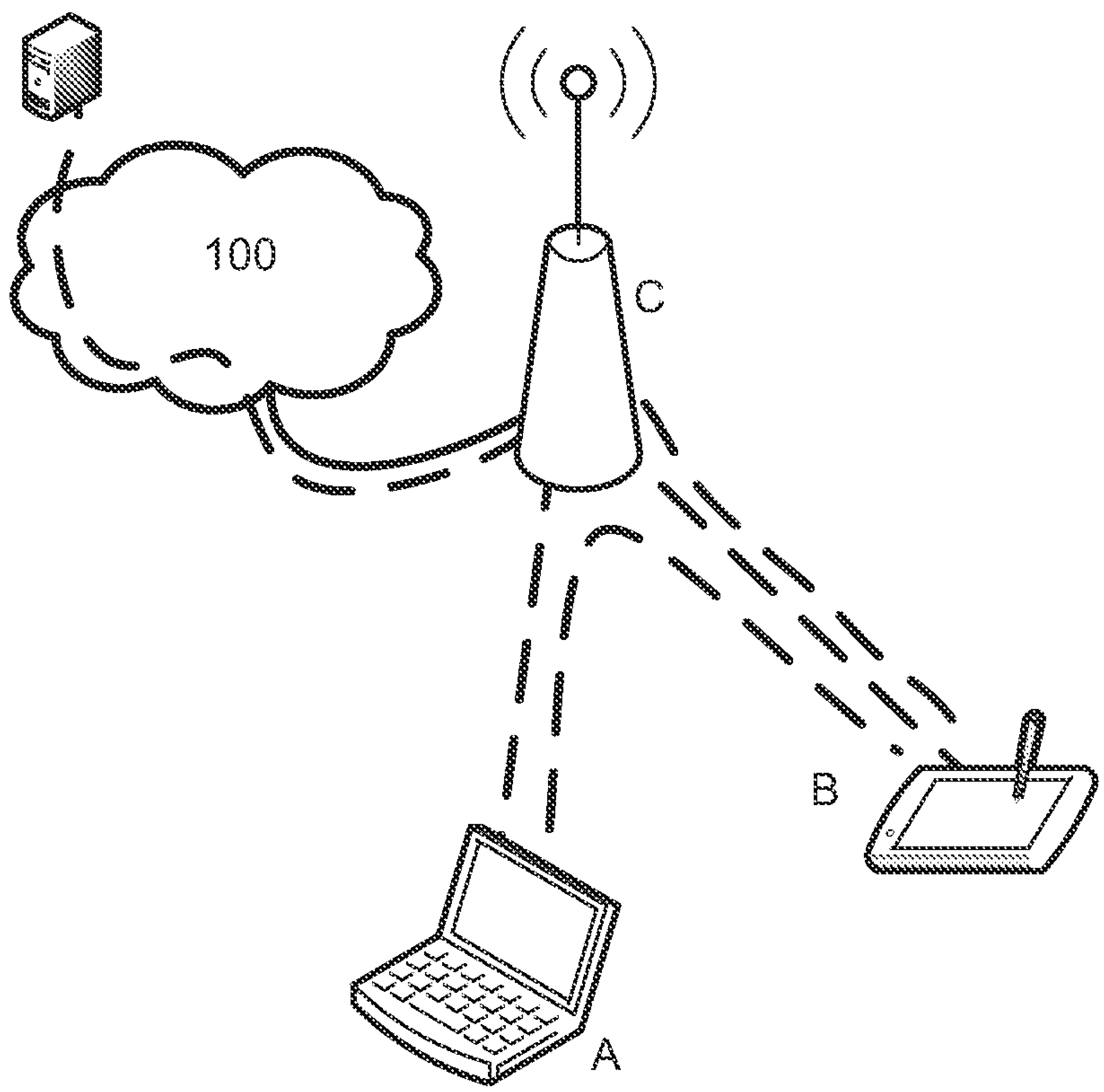

Fig. 4

FC	D / ID	A1	A2	A3	SC	B	FCS

Fig. 5

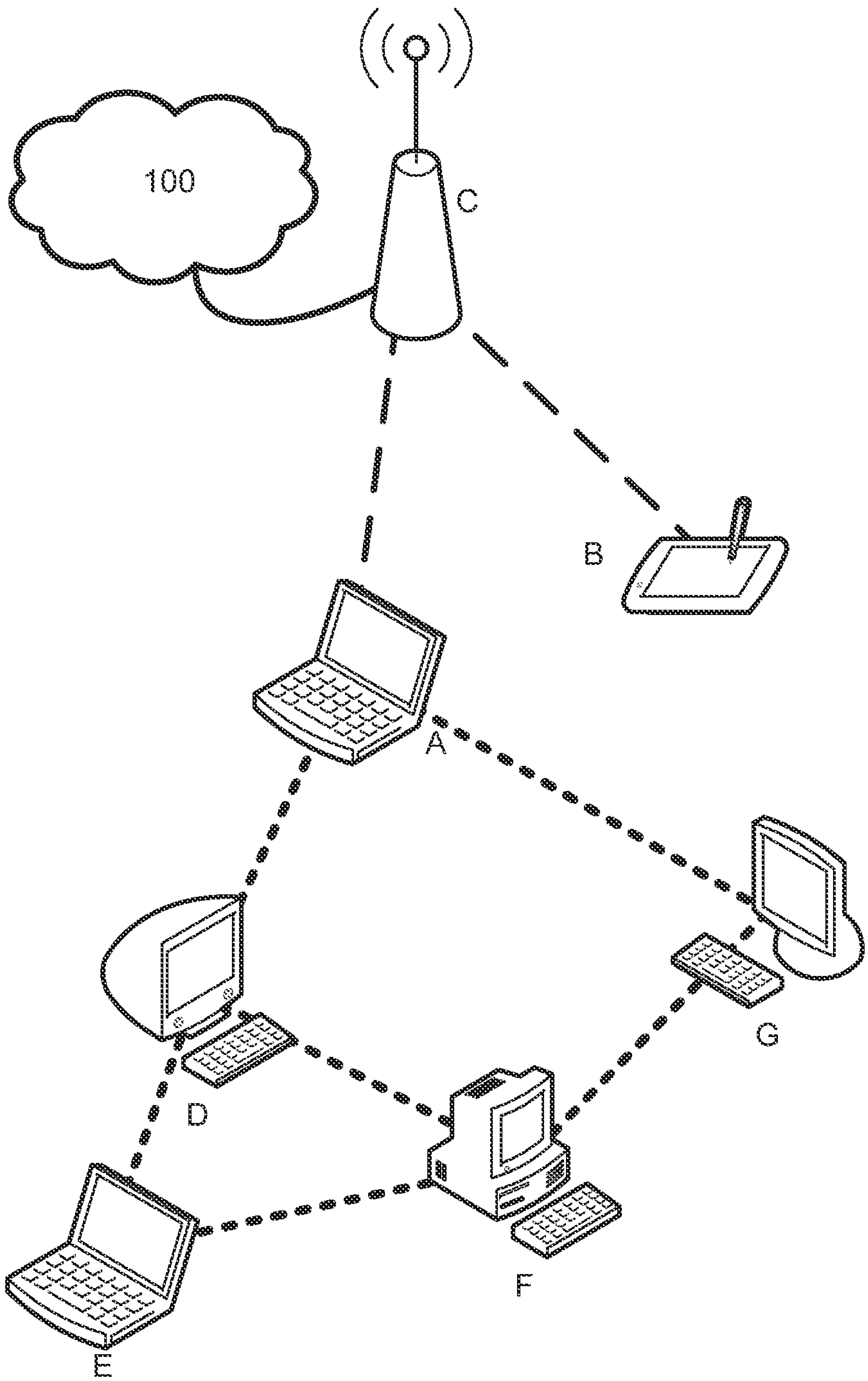

Fig. 6

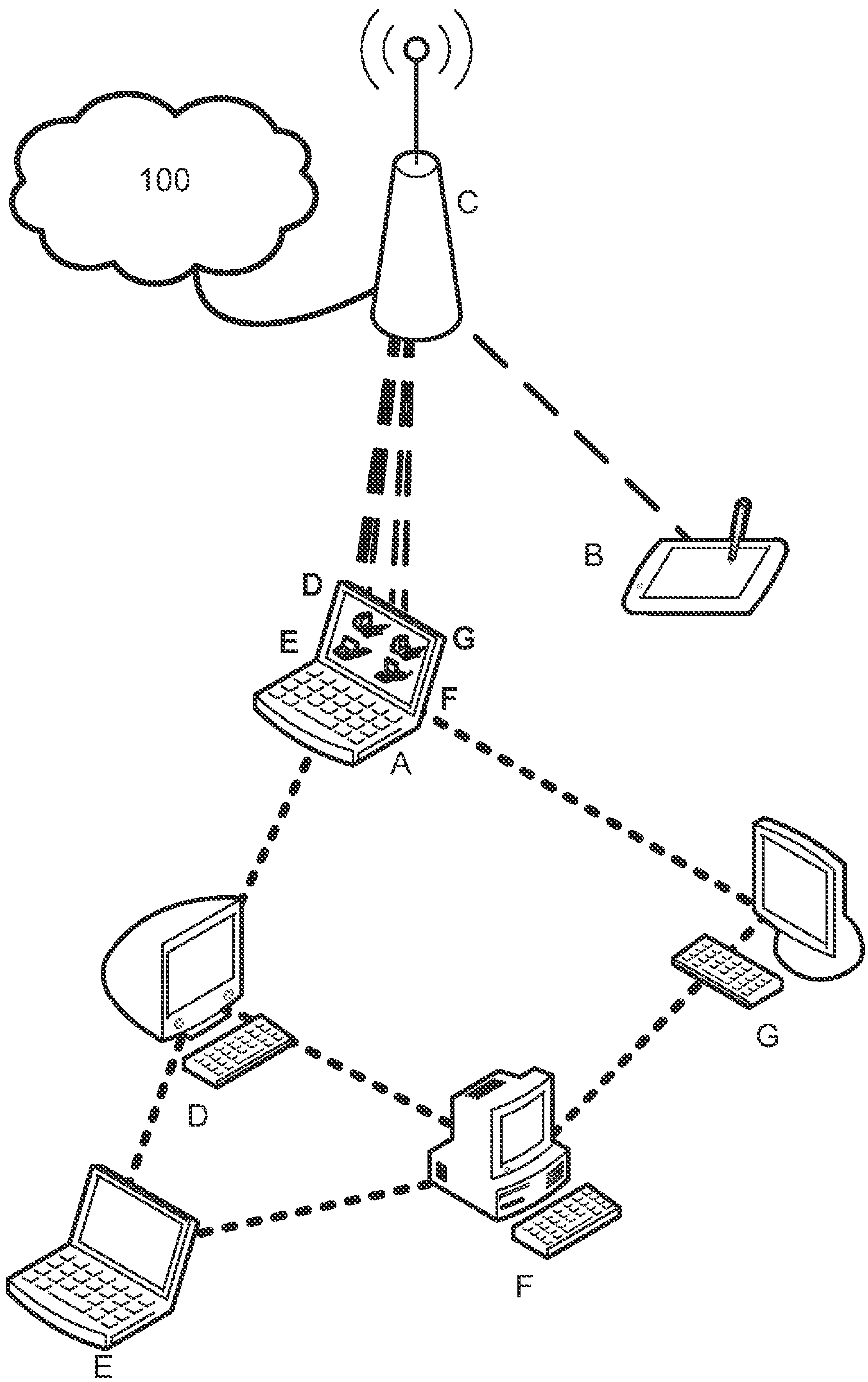

Fig. 7

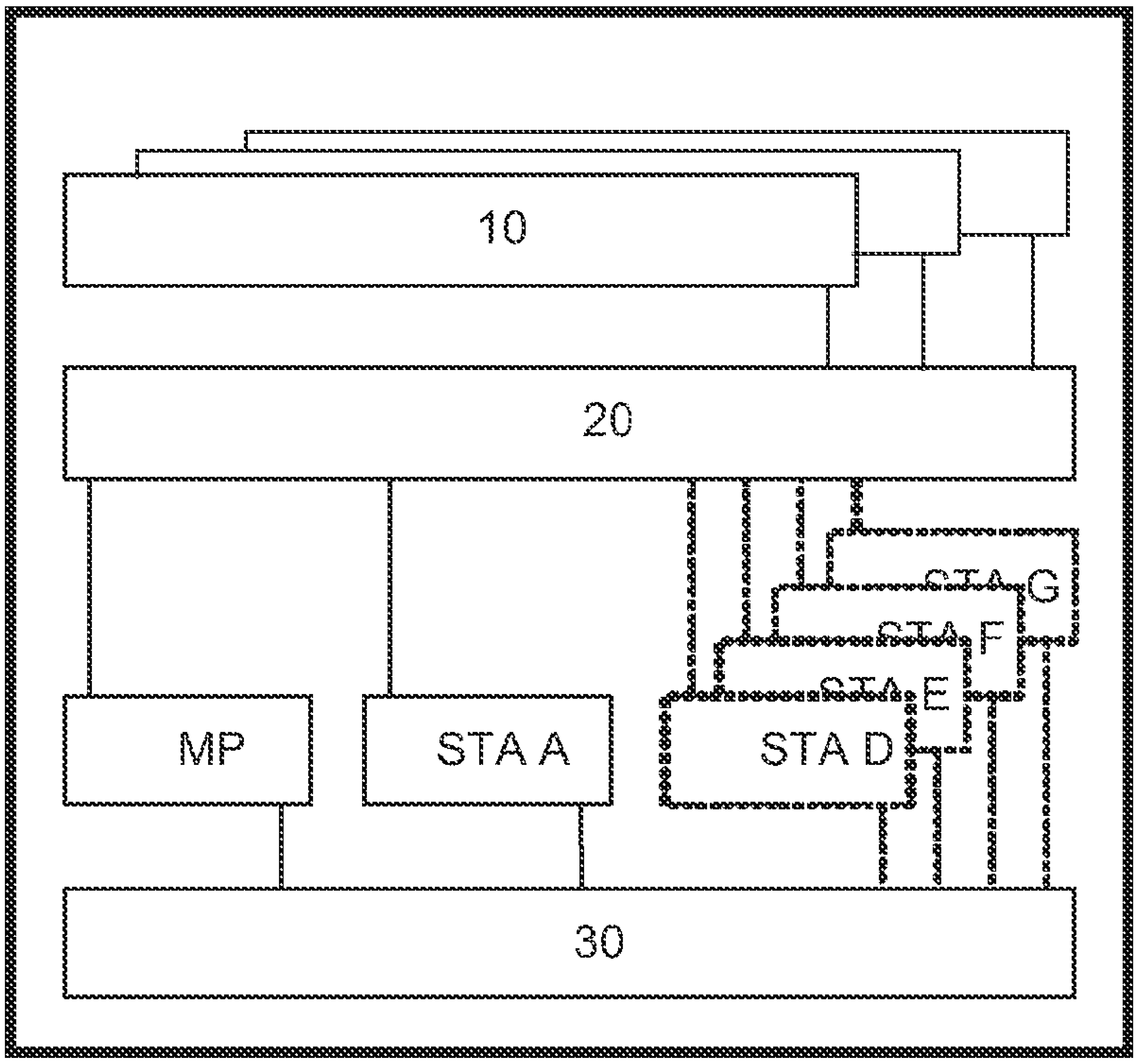
10
20
MP
STA A
STA D
E
F
G
30

Fig. 8

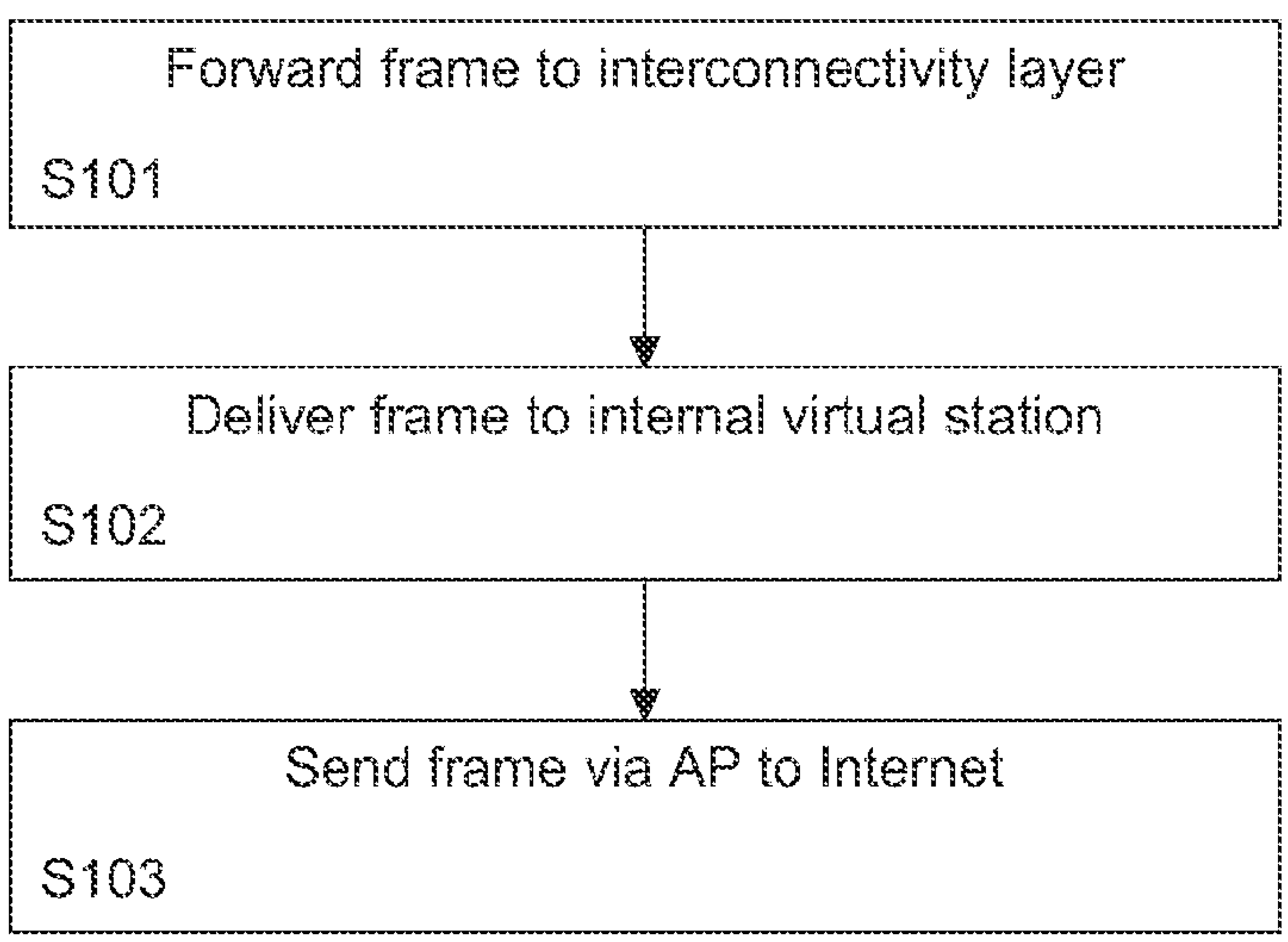
Forward frame to interconnectivity layer
S101
Deliver frame to internal virtual station
S102
Send frame via AP to Internet
S103

Fig. 9

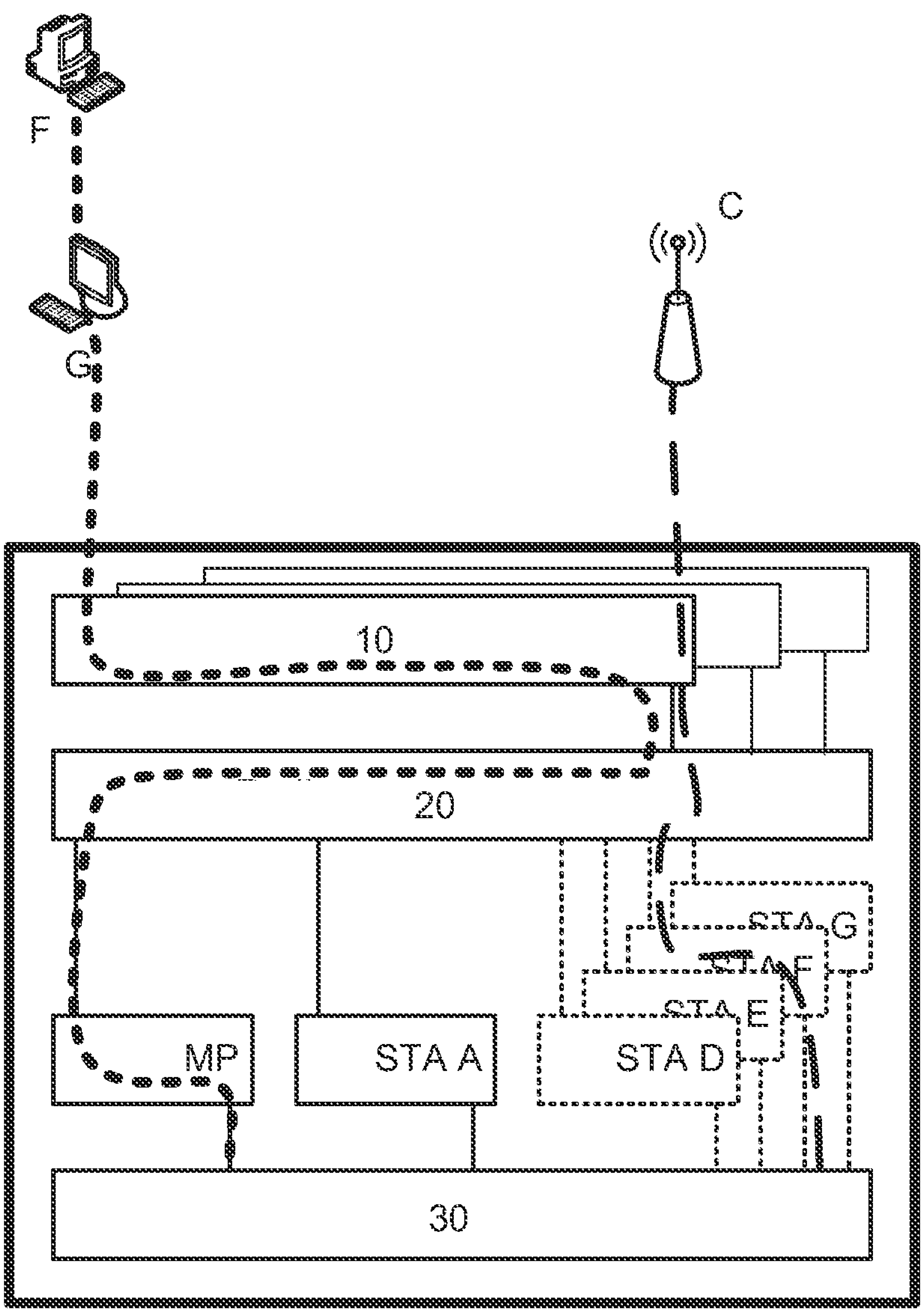

Fig. 10

PROXY MECHANISM FOR MESH-TYPE NETWORKS

CROSS REFERENCE TO RELATED APPLICATIONS

This application claims the benefit or priority of and describes the relationships between the following applications: wherein this application is a continuation of U.S. patent application Ser. No. 13/060,293, filed Feb. 23, 2011, which is the National Stage of International Application No. PCT/IB2009/053751, filed Aug. 27, 2009, which claims the priority of foreign application EP08163484 filed Sep. 2, 2008 all of which are incorporated herein in whole by reference.

FIELD OF THE INVENTION

The present invention generally relates to an apparatus, a method, a computer program product and a system for connecting a mesh type network via an access device to another network.

BACKGROUND OF THE INVENTION

In WLAN deployments without mesh services, client stations or end stations (STAs) must associate with an access point (AP) in order to gain access to the network. These STAs are dependent on the AP with which they are associated to communicate.

IEEE (Institute of Electrical and Electronics Engineers) standard 802.11s develops a wireless local area network (WLAN) mesh standard. With wireless mesh networks (WMNs) devices can easily interconnect. Each device works as a wireless router that forwards frames for other devices. Thus, networks can be easily deployed without an additional fixed infrastructure.

A so-called mesh network appears functionally equivalent to a broadcast Ethernet from the perspective of other networks and higher layer protocols. As an example, the mesh network may be an LAN according to the IEEE 802.11 specifications, where links and control elements forward frames among the network members. Thus, it normally appears as if all mesh points (MPs) in a mesh are directly connected at the link layer. This functionality is transparent to higher layer protocols.

A standard 'infrastructure' wireless local area network is a centralized network in which STAs attach to the AP which acts as a 'master station'. This centralized topology makes network formation and initial channel selection easy. The AP is configured to start transmitting at a certain frequency channel and the STAs only need to find this channel e.g. by scanning a list of available frequencies. They can do so actively, by broadcasting probe requests on each visited channel, or passively, by listening for advertisements or beacons on each visited channel. After having visited all available channels, they will have found all APs that are in the vicinity, and can select one to associate with.

In many households, a digital subscriber line (DSL) provides high-speed Internet access. Due to economies of scale and strong competition, DSL modems often provide a rich set of features at an affordable price. They do not only integrate an Internet Protocol (IP) router but may furthermore work as print and file server and connect wireless clients via 802.11 links. Accordingly, 802.11 networks have a high penetration rate in the home. Furthermore, APs have become a commodity and can be found nearly everywhere.

Due to the current 802.11 design, the central AP manages the whole WLAN. However, APs typically do not interconnect. Each WLAN established by an AP is an independent network. For large scale coverage, APs require wired backbones that interconnect them. With WMN technology, devices can interconnect over the air. Each device becomes a wireless router that provides the frame forwarding service for other devices. To be able to operate as wireless router, a device needs special capabilities or software modules. However, many existing APs cannot be upgraded. Either the device's manufacturer considers a product to be end of life and thus product maintenance has ended or, the device's hardware limits possible implementations. Thus, a generic solution is needed that connects a WMN with one or more existing APs and thus provides the WMN with the AP's Internet connectivity.

FIG. **1** shows a mesh data frame structure according to the IEEE 802.11 specifications. A frame control (FC) field contains amongst other control information a type and subtype for the mesh data frame and two flags "To DS" and "From DS". The two flags are set to "1" in order to indicate that the data frame is in the wireless distribution system and therefore in the mesh network. Additionally, address fields A**1** to A**4** are provided to convey and indicate destination, source, transmitter and receiver addresses. The four address fields contain 48-bit long MAC (Media Access Control) addresses. The first address field A**1** indicates a receiver address which defines the mesh point that has to receive the wireless transmission. The second address field A**2** indicates a transmitter address which defines the mesh point that sent this wireless data frame. The third address field A**3** indicates a destination address which defines the final (layer **2** or link layer) destination of this data frame. The fourth address field A**4** indicates a source address which defines the (layer **2** or link layer) source of this data frame.

Furthermore, duration/identity (D/ID), sequence control (SC) and frame check sequence (FCS) fields are provided, which are not discussed here for brevity and simplicity reasons. Further details can be gathered from the IEEE 802.11 specifications. A body (B) portion is provided to convey desired payload data up to a length of 2304 octets.

Each of the above addresses may have a length of 6 octets and maps on the address fields A**1** to A**4** depending on the "To DS" and "From DS" information of the FC field. The IEEE 802.11 standard clearly states that an address field is omitted "where the content of a field is shown as not applicable (N/A)." Solely when both bits "To DS" and "From DS" are set to "1", four address fields appear in an 802.11 frame.

FIG. **2** shows a schematic network architecture, where the four address fields A**1** to A**4** are used to interconnect to different IEEE 802.3 network segments with the help of a wireless network (e.g. an IEEE 802.11 WLAN) comprising devices G and H. Here, the wireless network is used to provide a bridge between a first independent wired LAN comprising devices A to C and a second independent wired LAN comprising devices D to F. APs form infrastructure basic service sets (BSSs). In a BSS, the AP relays all traffic. Although the IEEE 802.11 standard provides four address fields, only three address fields A**1** to A**3** are typically needed in an infrastructure BSS.

FIG. **3** shows a signaling example based on the network architecture of FIG. **2**, wherein device B sends a frame destined to device F. In this case, four address fields are needed on the wireless link between devices G and H. The fourth address field A**4** corresponds to a source address (SA) field that holds device B's address. The third address field A**3** corresponds to a transmitter address (TA) field that holds device G's address. The first address field A**1** corresponds to a receiver address (RA) field that holds device H's address. The second address field A**2** corresponds to a destination address (DA) field that holds device F's address. Once device H has successfully received the 802.11 frame from device G, it strips off the data portion in the 802.11 body and sends out the data portion in an 802.3 frame that solely contains device B's address as source address and device's F address as destination address.

However, most of the current 802.11 APs, however, cannot operate in this bridging mode as described above. They solely serve as AP in their local infrastructure BSS.

FIG. **4** shows an exemplary conventional network architecture, where a single device C works as AP, router and modem that connects a WLAN with an external network **100**, e.g. the Internet. Client devices A and B have associated with the AP C. The devices A and B may exchange data via the AP C or access the external network **100**. In any case, the devices A, B and, C use three address fields only. The client devices A and B set the "To DS" bit to "1" and the "From DS" bit to "0" when sending a frame to the AP C. If the device B sends a frame to the device A, the first address field A**1** contains the AP's address as the receiver address (RA). The second address field A**2** contains the source's address. Here, the source address is device B's address. The third address field A**3** contains the ultimate destination's address. Here, the destination address (DA) equals device A's address. In case device B wants to communicate with an Internet station, the DA address holds the AP's address since device C works as an IP router or default gateway.

Once AP C has received device B's frame, it analyzes the third address field for the destination address. If destined to AP C, the frame is sent to a higher layer where the IP router operates. If destined to device A, AP C relays the frame. Thus, AP C sends a frame to device A that has the "From DS" bit set to one and the "To DS" bit set to zero. The frame's address field **1** contains the Receiver Address (RA). In this case, it contains device A's address. The second address field contains the Transmitter Address (TA) that is AP C's address. The third address field contains the Source Address (SA), which equals device B's address.

FIG. **5** shows a correspondingly reduced **802.11** mesh data frame structure with only three address fields A**1** to A**3**, sufficient for all of the aforementioned frames in an infrastructure BSS that uses three address fields only.

With APs that can handle three addresses only, the local BSS is limited to a single wireless hop. FIG. **6** shows an exemplary conventional network structure, where a device A connects with an AP C and a WMN. The device A can use any service of the AP C's infrastructure BSS. However, the device A cannot provide its network connectivity to the WMN. Although the device A and other devices D to G form a single WMN, the addressing limitation at the AP C prevents the device A from sharing its connectivity.

Since the AP C allows for the usage of three addresses only, all frames transmitted to the WMN must be destined to the device A. Without further information however, the device A cannot decide about a frame's final destination. Thus, the device A cannot forward frames to another destination in the WMN.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a more flexible approach which allows for interconnection and range extension of legacy networks.

This object is achieved by one aspect of the invention in which an apparatus for connecting a mesh type network via an access device to another network, the apparatus operating as a proxy device on behalf of at least one actual device present within the mesh type network, the apparatus comprises:

a) an interconnectivity layer configured for receiving frames from actual devices present within the mesh type network and for internally routing the received frames to at least one virtual device internally configured within the apparatus, and

b) a radio access controller configured to maintain individual connections between the apparatus and the access device on behalf of the at least one actual device of the mesh type network via the interconnectivity layer.

This object is also achieved by another aspect of the invention in which a method for connecting a mesh type network to another network via an access device, at least one network node of the mesh type network having an apparatus operating as a proxy device on behalf of at least one other network node in the mesh type network, the network comprises:

a) internally configuring at least one virtual device within the apparatus, wherein the at least one virtual device corresponds to an associated actual device present in the mesh type network;

b) receiving frames from actual devices of the mesh network into the apparatus;

c) internally forwarding the received frames from the actual devices of the mesh type network to a corresponding virtual device internally configured within the apparatus, via an interconnectivity layer within the apparatus;

d) maintaining individual connections between the apparatus and the access device by a radio access controller within the apparatus, and

e) delivering a signal received from the access device to an addressed virtual device within the apparatus.

The object is also achieved by a further aspect of the invention wherein a non-transitory computer readable medium comprising instructions for implementing a method for range extending legacy access point based mesh type networks via an access device when run on a computer device, the method comprising:

a) internally configuring at least one virtual device within a designated proxy device of the mesh type network,

b) using an interconnectivity layer in the designated proxy device of the mesh type network to maintain individual connections with the access device for at least one other device of the mesh type network,

c) receiving frames from the at least one other non-proxy device of the mesh type network,

d) internally routing, via the interconnectivity layer, the received frames from the non-proxy devices of the mesh type network to a corresponding virtual device internally configured within the mesh type network, and

e) forwarding the received frames from the virtual devices to the access device.

Accordingly, a sort of proxy mechanism is provided, that allows to integrate a legacy network with a wireless mesh network (WMN). Thereby, interconnection and range extension of e.g. legacy AP-based WLANs or similar types of networks can be achieved. Moreover, the proposed proxy mechanism does not require any changes or modifications to the access device(s) (e.g. AP). It works with any type of access device.

The proposed apparatuses, which serve as a proxy mechanism, may be implemented, for example, as processor devices, modules, chips, chip sets or circuitries provided in a network node or station. A processor may be controlled by a computer program product comprising code means for performing the steps of the claimed methods when run on a computer or processor device.

According to a first aspect, at least one virtual radio station can be provided within an apparatus serving as a proxy mechanism, wherein a radio access controller configured within the apparatus may be adapted to deliver a signal received from the access device to an addressed virtual device internally configured within the apparatus. Since a communication between the access device and virtual stations within the apparatus acting as a proxy mechanism is established, the correct destination address of an actual device within the mesh type network (MSN) can be easily detected.

According to a second aspect which can be combined with the above first aspect, the radio access controller may be adapted to serialize transmission requests if multiple entities try to transmit simultaneously. Thereby, multiple entities can transmit at the same time.

According to a third aspect which can be combined with any one or both of the above first and second aspects, at least one wireless access network interface card may be comprised for providing a connection to the access device, wherein the radio access controller may be adapted to interconnect the wireless network interface card and logical entities of the apparatus so as to establish the individual connections. This measure allows to maintain several independent connections at a time.

According to a fourth aspect which can be combined with the third aspect, at least one wireless access network interface card may share at least one of the physical layer and link layer channels. This measure saves processing resources.

Further advantageous developments are defined in the dependent claims.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will now be described based on various embodiments with reference to the accompanying drawings in which:

FIG. **1** shows a mesh data frame structure with four address fields according to the prior art;

FIG. **2** shows a schematic network architecture where four address fields are used for interconnection according to the prior art;

FIG. **3** shows a signaling example based on the network architecture of FIG. **2** according to the prior art;

FIG. **4** shows an exemplary conventional network architecture, where a single device works as AP, router and modem according to the prior art;

FIG. **5** shows a reduced mesh data frame structure;

FIG. **6** shows an exemplary network structure, where a single device connects with an AP and a mesh network;

FIG. **7** shows an exemplary network structure, where a single device behaves as a proxy in accordance with embodiments of the present invention;

FIG. **8** shows a schematic block diagram of a device according to a first embodiment;

FIG. **9** shows a flow diagram of proxy mechanism according to a second embodiment; and

FIG. **10** shows a signaling example based on the block diagram of FIG. **8**.

DETAILED DESCRIPTION OF EMBODIMENTS

In the following, embodiments of the present invention are described on the basis of an exemplary wireless mesh network topology as shown in FIG. **7**.

End-user devices (such as end stations (STAs)) A, B and D to G can benefit from the ability to establish interoperable peer-to-peer wireless links with neighboring end-user devices and legacy access device AP "C" or base station sub-system (BSS) in a wireless mesh type network. Mesh points (MPs) can be quality of service (QoS) STAs that support mesh services, i.e. they participate in interoperable formation and operation of the mesh network. An MP may be collocated with one or more other entities (e.g., AP, portal, etc.). The client stations or end stations, e.g., STAs "A" and "B" of the wireless mesh type network (WMN) can associate with the access point (AP) "C" to gain access to an external network, e.g. the Internet. T.

According to a first embodiment, a proxy mechanism or functionality is provided, where a device that connects with both the wireless mesh network (WMN) and a legacy access device, access point (AP), or BSS base station sub-system (BSS) operates on behalf of all devices that are present in the WMN.

FIG. **7** shows an exemplary network structure, where a single device behaves as a proxy device in accordance with embodiments of the present invention. More specifically, actual device "A" of the wireless mesh network (MSN) behaves as a proxy device for devices "D" to "G" of the wirelss mesh network (MSN). For access point (AP) "C", all frame exchanges appear to occur locally. In other words, the access point AP "C" considers actual devices "D" to "G" to be one hop away, as proxy device A is configured to maintain a separate connection with the access point (AP) C for each of the member of the wireless mesh network (WMN). Thus, proxy device "A" serves as an actual device of the wireless mesh network (WMN) and in addition virtually implements actual devices "E"to "G" as well. From the perspective of the access point (AP) "C", all traffic appears to be local (e.g., appears to be one hop away). Thus, the access point (AP) "C" treats the actual devices of the mesh type network "E" to "G" as part of its base station sub-system (BSS).

FIG. **8** shows a schematic block diagram of a configuration of device (e.g. proxy device A in FIG. **7**) according to a first embodiment. A radio access controller or management entity **20** interconnects wireless network interface cards **10** and each logical entity via an interconnectivity arrangement, unit, or layer **30**. The radio access management entity **20** delivers received frames to a selected one of a plurality of virtual entities STA "D" to STA "F", internally configured within proxy device "A", and may serialize frame transmission requests if multiple logical entities try to transmit at the same time. The proxy device "A" with the proposed proxy mechanism or functionality may thus incorporate more than one actual radio device of the wireless mesh type network (WMN). Each radio device may have its own physical layer (PHY) and link layer (e.g. MAC) channel. Alternatively, two or more radio devices may share a PHY and/or link layer (e.g. MAC) channel.

Additionally, the block diagram of FIG. **8** shows a mesh point functionality (MP) and a station functionality STA "A" of the proxy device A, which both can be addressed by the radio access management unit **20** e.g. in dependence on the functionality of the proxy device A.

FIG. **9** shows a flow diagram of proxy mechanism, which is incorporated into a proxy device, according to a second embodiment in a mesh network. This procedure may be implemented as a software routine controlling a processor or controller provided in the radio access management unit **20** of FIG. **8**.

The procedure is initiated as soon as a frame is received from one of the devices of the wireless mesh type network

(WMN) (e.g. one of devices "D" to "G" of FIG. **7**). The received frame is forwarded to the interconnectivity layer **30** of proxy device "A" (step S**101**). Then, based on the source address of the received frame, a corresponding one of the virtual stations STA D to STA G is selected and the frame is internally routed (i.e., delivered) to the selected internal virtual station implemented in proxy device "A" (step S**102**). Finally, the frame can be sent via the access point (AP) to the external network **100** (step S**103**).

The same procedure can be applied in reverse when a frame is received via the access point (AP) from the external network **100**. Here, one of the virtual stations can be selected based on the destination address provided in the frame from the access point (AP). From there, the frame can be forwarded from the proxy device "A" based on the destination address to the respective actual device of the WAN.

FIG. **10** shows a signaling example based on the block diagram of FIG. **8**. Device A connects as mesh point with a WMN by using its internal mesh point functionality MP. Alternatively, the device connects as station with the AP C by using its internal station functionality STA A. For every device or mesh point of the WMN that device A proxies, a virtual station can be established. The virtual stations STA "D" to STA "G" connect with the AP C, and thus, appear as being locally in the infrastructure base station sub-system (BSS) of the access point (AP) "C". Thus, proxy device A comprises its station functionality STA "A" as a logical entity that connects with the access point (AP) "C". This station functionality STA "A" forms part of access point (AP) C's infrastructure base station sub-system (BSS). Via the access point (AP) "C", the station functionality STA "A" has access to the external network **100**, e.g., the Internet.

Furthermore, proxy device "A" also comprises the mesh point functionality MP that connects to the wireless mesh network (WMN). Proxy device "A" can instantiate a virtual station for each device of the WMN that proxy device "A" proxies. The interconnectivity layer **30** of proxy device "A" interconnects all logical and physical stations, mesh points and other functionality, and thus enables frame forwarding between the different entities and ensures frame delivery to the correct entity.

In the example of FIG. **10**, actual device "F" needs to access the external network (e.g. Internet). It uses the wireless mesh network (WMN) to reach proxy device "A". In the wireless mesh network (WMN), intermediate devices of the wireless mesh network (WMN), for example, actual device "G" may forward frames to the proxy device A. Having received device F's frame, the proxy device "A" forwards the received frame to its interconnectivity layer **30**. The interconnectivity layer **30** internally routes or delivers the frame to the corresponding virtual station STA "F" that proxy device "A" implements on behalf of the actual device F. Appearing as actual station F to the access point (AP) "C", the frame can be sent from the proxy device "A" to the external network **100**, e.g., the Internet. Frames that are received in the reverse direction (e.g., from the external network, via the Access point (AP) "C" to the wireless mesh network) can be easily forwarded from the proxy device "A" to the final destination (e.g., an actual device) in the wireless mesh network (WMN). Since the access point (AP) "C" communicates with the internally configured virtual stations, e.g., STA "D" to STA "F" at proxy device A, proxy device A can easily detect the correct destination address. Thus, even with a three address format that is used in the AP C's infrastructure base station sub-system (BSS), the network connectivity of the proxy device AP "C" to the external network can be provided via the proxy device A to the whole wireless mesh network (WMN).

In summary, an apparatus and method for connecting a mesh type network via an access device to another network have been described, wherein a proxy mechanism is provided in the mesh type network, that allows for interconnection and range extension of legacy access point based mesh type networks.

It is noted that the present invention is not restricted to the above embodiments and can be used for any network environment which comprises at least one central AP or access device for transmitting to or receiving from a connected network. Moreover, the designation of the entities or functions which provide the proposed proxy mechanism may be different, as long as they fulfill similar functions. The invention works even if there is only one other mesh device besides the one that works as forwarder or proxy device. Thus, even a single wireless access network interface card and a single radio device can be provided in the exemplary proxy device of FIGS. **8** and **10**.

Variations to the disclosed embodiments can be understood and effected by those skilled in the art, from a study of the drawings, the disclosure and the appended claims. In the claims, the word "comprising" does not exclude other elements or steps, and the indefinite article "a" or "an" does not exclude a plurality of elements or steps. A single processor or other unit may fulfill the functions of several items recited in the claims. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage. A computer program used for controlling processor to perform the claimed features may be stored/distributed on a suitable medium, such as an optical storage medium or a solid-state medium supplied together with or as part of other hardware, but may also be distributed in other forms, such as via the Internet or other wired or wireless telecommunication systems. Any reference signs in the claims should not be construed as limiting the scope thereof.

The invention claimed is:

1. An apparatus for connecting a mesh type network via an access device to another network, the apparatus operating as a proxy device on behalf of at least one actual device present within the mesh type network, the apparatus comprising:

a) an interconnectivity layer configured for receiving frames from actual devices present within the mesh type network and for internally routing the received frames to at least one virtual device internally configured within the apparatus, and

b) a radio access controller configured to maintain individual connections between the apparatus and the access device on behalf of the at least one actual device of the mesh type network via the interconnectivity layer.

2. The apparatus of claim **1**, wherein the at least one virtual device within the apparatus corresponds to an actual device present within the mesh type network.

3. The apparatus of claim **1**, wherein the radio access controller is further configured to deliver a signal received from the access device to an addressed virtual device within the apparatus.

4. The apparatus of claim **1**, wherein all frame exchanges between the access device and the actual devices of the mesh type network appear to the access device to occur locally.

5. The apparatus of claim **1**, wherein the radio access controller is configured to serialize transmission requests if multiple virtual devices try to transmit simultaneously to the access device.

6. The apparatus of claim **1**, further comprising a wireless access network interface card for providing a connection to the access device, wherein the radio access controller is configured to interconnect the wireless network interface card and logical entities of the apparatus so as to establish the individual connections.

7. The apparatus of claim **6**, wherein at least two of the wireless access network interface cards share at least one physical layer and link layer channel.

8. A method for connecting a mesh type network to another network via an access device, at least one network node of the mesh type network having an apparatus operating as a proxy device on behalf of at least one other network node in the mesh type network, the method comprising:

a) internally configuring at least one virtual device within the apparatus, wherein the at least one virtual device corresponds to an associated actual device present in the mesh type network;

b) receiving frames from actual devices of the mesh network into the apparatus;

c) internally forwarding the received frames from the actual devices of the mesh type network to a corresponding virtual device internally configured within the apparatus, via an interconnectivity layer within the apparatus;

d) maintaining individual connections between the apparatus and the access device by a radio access controller within the apparatus, and

e) delivering a signal received from the access device to an addressed virtual device within the apparatus.

9. The method of claim **8**, wherein the step of receiving frames from devices of the mesh network occur at the inteconnectivity layer of the apparatus, wherein the interconnectivity layer is configured to receive frames from actual devices of the mesh type network.

10. The method of claim **8**, wherein the step of maintaining individual connections between the apparatus and the access device by a radio access controller, comprises maintaining each individual connection on behalf of the at least one device of the mesh type network via the interconnectivity layer.

11. A method for range extending legacy access point based mesh type networks via an access device, the method comprising:

a) internally configuring at least one virtual device within a designated proxy device of the mesh type network,

b) using an interconnectivity layer in the designated proxy device of the mesh type network to maintain individual connections with the access device for at least one other device of the mesh type network,

c) receiving frames from the at least one other non-proxy device of the mesh type network,

d) internally routing, via the interconnectivity layer, the received frames from the non-proxy devices of the mesh type network to a corresponding virtual device internally configured within the mesh type network, and

e) forwarding the received frames from the virtual devices to the access device.

12. The method of claim **11**, wherein the step of receiving frames from devices of the mesh network occur at an inteconnectivity layer of the apparatus, wherein the interconnectivity layer is configured to receive frames from devices of the mesh type network.

13. The method of claim **11**, wherein the step of internally routing the received frames from the devices of the mesh type network, comprises routing the received frames from the interconnectivity layer of the apparatus.

14. The method of claim **11**, wherein the step of maintaining individual connections between the apparatus and the access device by a radio access controller, comprises maintaining each individual connection on behalf of the at least one device of the mesh type network via the interconnectivity layer.

15. The method of claim **11**, further comprising delivering a signal received from the access device to an addressed virtual device within the apparatus.

16. A system for connecting a mesh type network via an access device to another network, the system comprising the access device and at least one other network node in the mesh type network, the apparatus comprising:

a) at least one virtual device internally configured within the apparatus, wherein the at least one virtual device corresponds to an associated actual device present in the mesh type network;

b) an interconnectivity layer configured for receiving frames from devices of the mesh type network and forwarding the received frames to the at least one virtual device internally configured within the apparatus; and

c) a radio access controller configured to maintain individual connections between the apparatus and the access device, wherein each individual connections is maintained on behalf of the at least one device of the mesh type network via the interconnectivity layer, and wherein the radio access controller is further configured to deliver a signal received from the access device to an addressed virtual device within the apparatus.

17. A tangible computer readable storage medium that is not a transitive propagating signal or wave, encoded with modules of instructions and control information, for controlling a processor for performing a method of connecting a mesh type network to another network via an access device, at least one network node of the mesh type network having an apparatus operating as a proxy device on behalf of at least one other network node in the mesh type network, the method comprising:

a) internally configuring at least one virtual device within the apparatus, wherein the at least one virtual device corresponds to an associated actual device present in the mesh type network;

b) receiving frames from actual devices of the mesh network into the apparatus;

c) internally forwarding the received frames from the actual devices of the mesh type network to a corresponding virtual device internally configured within the apparatus, via an interconnectivity layer within the apparatus;

d) maintaining individual connections between the apparatus and the access device by a radio access controller within the apparatus, and

e) delivering a signal received from the access device to an addressed virtual device within the apparatus.

18. A non-transitory computer readable medium comprising code means for generating the steps of claim **11** when run on a computer device.

19. The Apparatus of claim **1**, wherein the access device is an IEEE 802.11 access point device processing only three address fields.

20. The Apparatus of claim **1**, wherein the access device is an IEEE 802.11 access point device processing only three address fields.

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