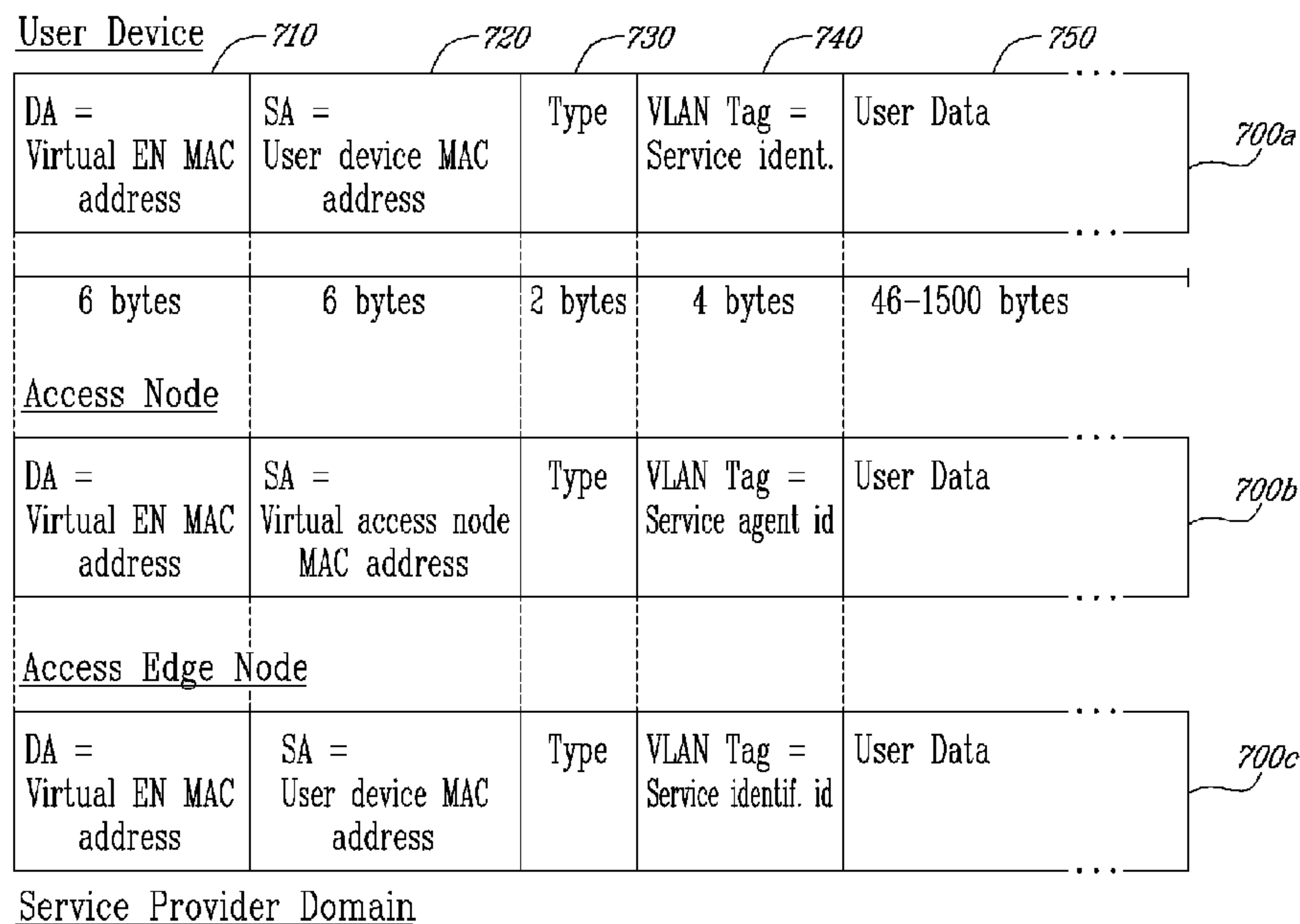




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DIFFUSION A DESTINATION UNIQUE SUR UN DOMAINE D'ACCES A L'AIDE DE LIAISONS DE SERVICE
(54) Title: METHOD AND NODES FOR AGGREGATING DATA TRAFFIC THROUGH UNICAST MESSAGES OVER AN
ACCESS DOMAIN USING SERVICE BINDINGS



(57) **Abrégé/Abstract:**

The present invention relates to a method and nodes for performing data traffic aggregation over an access domain using service bindings. Upon receipt of a service request related message at an access edge node for a first device of a user domain, the service request related message identifying the first device of the user domain and one of the service provider domains, a service binding is created at the access edge node. The service binding rules data traffic between the first device of the user domain and the service provider domain by committing an access node serving the user domain and the access edge node in a manner of managing data traffic therebetween over the access domain. An access node serving the user domain for which the service request related message is received is informed of the created service binding. The created service binding is enforced at the access node and the access edge node for data traffic over the access domain between the first device of the user domain and the service provider domain by removing a user device MAC address from Unicast messages exchanged therebetween over the access domain and replacing with a virtual MAC address recognized by the access node and the access edge node.



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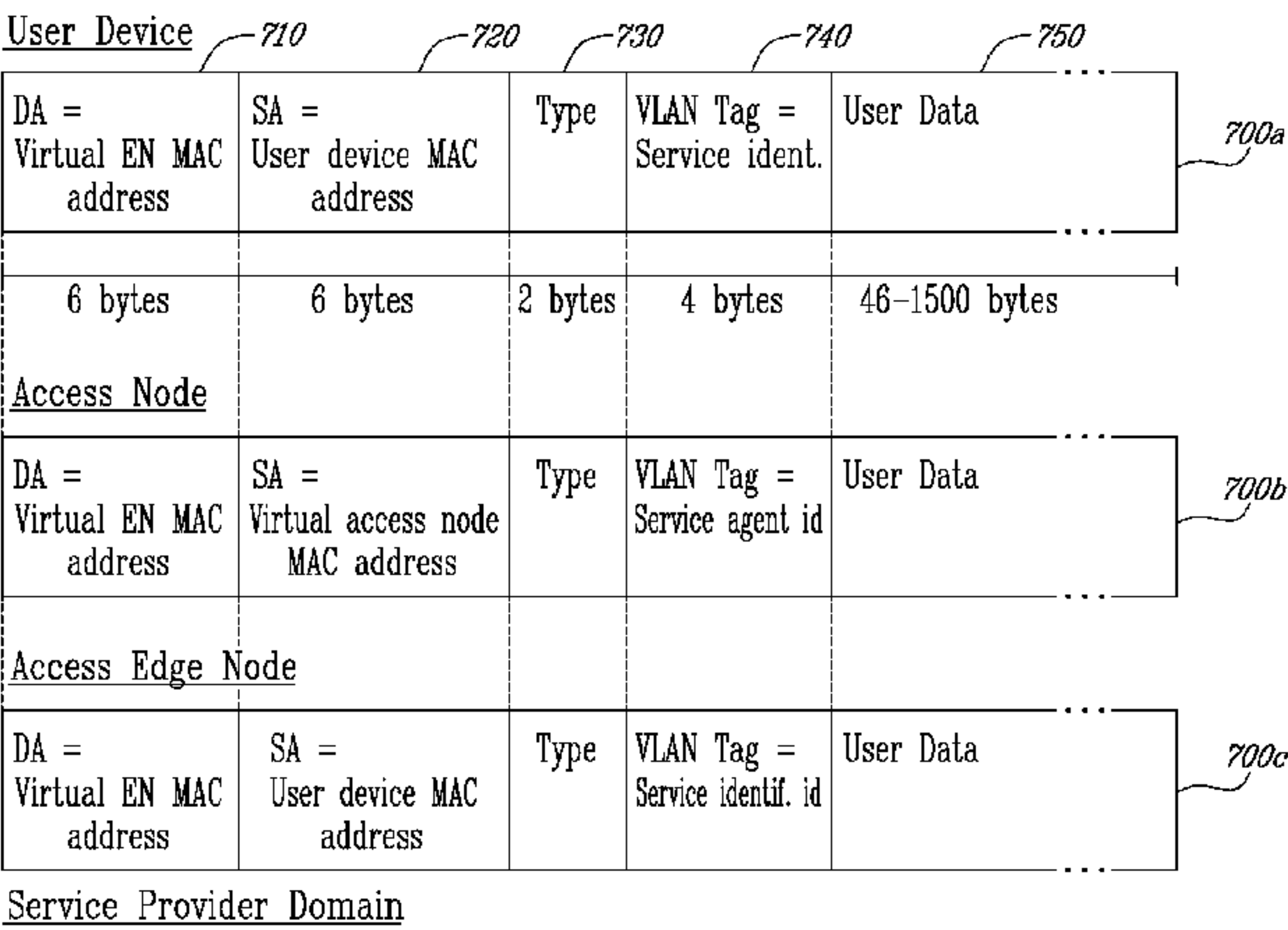
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(54) Title: METHOD AND NODES FOR AGGREGATING DATA TRAFFIC THROUGH UNICAST MESSAGES OVER AN ACCESS DOMAIN USING SERVICE BINDINGS



(57) Abstract: The present invention relates to a method and nodes for performing data traffic aggregation over an access domain using service bindings. Upon receipt of a service request related message at an access edge node for a first device of a user domain, the service request related message identifying the first device of the user domain and one of the service provider domains, a service binding is created at the access edge node. The service binding rules data traffic between the first device of the user domain and the service provider domain by committing an access node serving the user domain and the access edge node in a manner of managing data traffic therebetween over the access domain. An access node serving the user domain for which the service request related message is received is informed of the created service binding. The created service binding is enforced at the access node and the access edge node for data traffic over the access domain between the first device of the user domain and the service provider domain by removing a user device MAC address from Unicast messages exchanged therebetween over the access domain and replacing with a virtual MAC address recognized by the access node and the access edge node.

Description

METHOD AND NODES FOR AGGREGATING DATA TRAFFIC THROUGH UNICAST MESSAGES OVER AN ACCESS DOMAIN USING SERVICE BINDINGS

[1] Priority Statement Under 35 U.S.C. S.119 (e) & 37 C.F.R. S.1.78

[2] This non-provisional patent application claims priority based upon the prior U.S. provisional patent applications entitled 'Poly project' and 'Access node-edge node complex protocol (AEP)', having respective application number 60/651,971, filed February 14, 2005, in the names of Sylvain Monette, Mathieu Giguere, Martin Julien and Benoit Tremblay, and application number 60/674,307, filed April 25, 2005 in the names of Sylvain Monette, Mathieu Giguere, Martin Julien and Benoit Tremblay.

BACKGROUND OF THE INVENTION

Field of the invention

[3] The present invention relates to a method and nodes for performing aggregation of data traffic by relying on Unicast messages in an environment using service bindings over an access domain.

Description of the Related Art

[4] Recent years have seen the explosion of Internet Protocol (IP) networks. Initially developed to allow universities and researchers to communicate and cooperate in research projects, it has grown into networks offered at a mass-market level. Nowadays, it is normal for households to have a connection to an IP network to surf the world-wide-web, play interactive games, carry Voice over IP, download documents and softwares, make electronic business transactions, etc.

[5] Reference is now made to Figure 1, which represents a prior art example of an IP network 100. Typically, an IP network is composed of an access domain 115, network service provider domains 140 and application service provider domains 150. The access domain 115 includes Access Nodes (AN) 120 and an access network 130, such as an IP network. The ANs 120 are network providers, which can offer access to the IP network 130 to user domains 110. The user domains 110 include for example User Devices (UDs) (such as computers, mobile phones, personal digital assistants, etc.), Local Area Networks (LANs) and Wireless-LANs (W-LANs). The user domains communicate with the ANs over various possible technologies. Amongst those technologies can be found dial-up connections and Asymmetric Distribution Subscriber Line connections over telephone lines, cable modems connecting over television cable networks, or wireless communications. The access network 130 is composed of a group of independent routers, which task is to route incoming data

traffic based on a destination address embedded therein. As for the network service provider domains 140, they may correspond for example to Voice over IP services, while the application service provider domains 150 may correspond to electronic banking and electronic business transactions.

- [6] Though Figure 1 depicts three user domains, two Access Nodes, two service provider domains and two application service domains, IP networks 100 typically include several thousands of user domains, tenths of Access Nodes, hundreds of service provider domains and application service provider domains. As to the access network 130, it is common to encounter networks including hundreds of routers. It is thus understood that Figure 1 depicts a highly simplified IP network 100 for clarity purposes.
- [7] To ensure a coordinated exchange of data traffic and messages over such IP networks, the IP protocol was developed in the early 1970's. The IP version 4 (IPv4) is used by a majority of currently deployed IP networks. IPv4 provisions for an addressing scheme using 32 bits, which results in a 4, 294, 967, 296 possible addresses, where each address is unique, and directly identifies one device. In the case of IP networks 100 such as the one shown on Figure 1, it is commonly known that such network rely on Ethernet-based data link to provide fast and simple transfer of data traffic and messages throughout the IP network 100.
- [8] But with the increasing number of devices communicating over the IP networks, and some inherent limitations of IPv4, the IP community has seen the need for a new revision of IP: IP version 6 (IPv6). That new version relies on an addressing scheme using 128 bits, which provides for a much wider number of possible addresses.
- [9] Though IPv6 allows for a much greater number of IP addresses, and also addresses some deficiencies found in IPv4, both IPv4 and IPv6 are 'best-effort' protocols. 'Best-effort' means that a network delivers data traffic without making particular effort to meet higher or particular demands on a quality of service required for those types of data traffic. This might be sufficient for some network service providers 140 and application service providers 150, but unfortunately it proves to be insufficient for others. Thus, some network service providers 140 and application service providers 150 cannot easily and fluidly offer their services over IP networks 100.
- [10] To overcome this problem, the MultiProtocol Label Switching (MPLS) is being used over IP networks. MPLS relies on protocols such as ReSerVation Protocol (RSVP) for reserving a path, with a specific quality of service, over the IP network 100. RSVP initially creates a path through a series of routers. To create the path, each router adds an entry to its MPLS table. That entry indicates for data traffic arriving at a specific entry port and having a predetermined label, a corresponding output port and label to be used. By creating such reserved paths in the IP network 100, it makes it

possible to carry data traffic for a larger spectrum of network service providers 140 and application service providers 150.

[11] However, with the increasing number of network service providers 140 and application service providers 150 requiring higher quality of service than 'best effort', along with an expansion of the number User Domains 110 and Access Nodes 120 required to allow these User Domains 110 the possibility to use the access network 130, MPLS does not prove to be a good option.

[12] The initial principle at the basis of IP networks is to rely on routers, which perform as few and as little operations as possible before routing incoming data traffic towards their final destination. Also, it is a widely recognized concept that 'best effort' networks are a trade-off between quality of service and quantity of data traffic. An increased quality of service, for the same number of routers results in a lower quantity of data traffic being transported on those routers. IP networks have not been designed bearing in mind higher level of quality of service. Thus, by creating reserved paths for higher quality of service data traffic over IP networks, a direct consequence is a reduced quantity of data traffic over those IP networks. In addition, such reserved paths needed for MPLS result in consuming more routing effort in each of the router on the reserved paths. Such routing effort is not significant when only a few reserved paths are open simultaneously, but with the current development of services applications requiring more than 'best effort' quality of service, it is possible to envision that thousands of reserved paths will be required simultaneously over the IP networks. Maintaining and routing data traffic with so many reserved paths will become more cumbersome for routers, thus also resulting in slowing routing capabilities of the affected routers. Therefore, the current use of MPLS over IP networks for improving quality of service is resulting in less data traffic being exchanged, and in slower data traffic. Such impacts are not acceptable, as they directly affect all data traffic that is not part of the reserved paths.

[13] There is currently no known solution to the problems associated with the explosion of the number of user devices and of service providers offering services on IP networks. Furthermore, no long-term solution has been identified to allow a tangible and non-destructive solution to the need of increased QoS for certain services and applications.

[14] Accordingly, it should be readily appreciated that in order to overcome the deficiencies and shortcomings of the existing solutions, it would be advantageous to have a method and nodes for efficiently aggregating data traffic using service bindings over access domains, and more particularly a method and nodes for aggregating data traffic using Unicast messages is needed. The present invention provides such a method and nodes.

Summary of the Invention

- [15] The present invention efficiently allows thousands of network service provider domains and application service provider domains to communicate over an access domain by efficiently using service bindings. The method and nodes of the present invention perform data traffic aggregation over the access domain using service bindings and by modifying Unicast messages.
- [16] For doing so, the method of the present invention performs data traffic aggregation over an access domain using service bindings, by upon receipt of a service request related message at an access edge node for a first device of a user domain, creating a service binding at the access edge node. The service request related message identifies the first device of the user domain and one of the service provider domains. The service binding rules data traffic between the first device of the user domain and the service provider domain by committing an access node serving the user domain and the access edge node in a manner of managing data traffic therebetween over the access domain. The method also informs the access node serving the user domain for which the service request related message is received of the created service binding. Then, the method enforces the created service binding at the access node and the access edge node for data traffic over the access domain between the first device of the user domain and the service provider domain by removing a user device MAC address from Unicast messages exchanged therebetween over the access domain and replacing with a virtual MAC address recognized by the access node and the access edge node.
- [17] Another aspect of the present invention relates to an access edge node for performing data traffic aggregation over an access domain using service bindings. More particularly, the access edge node is located in the access domain between user domains and service provider domains. The access edge node comprises an input/output unit, a service agent unit and a controlling unit. The input/output unit receives a service request related message for a first device of a user domain for a service provider domain, and receives and forwards Unicast messages. The service agent unit creates a service binding. The service binding rules data traffic between the first device of the user domain and the service provider domain over the access domain. The service binding commits an access node serving the user domain and the access edge node representing the service provider domain in handling of data traffic therebetween over the access domain. The controlling unit informs the access node serving the user domain for which the service request related message is received of the creation of the service binding through the input/output unit, and enforces the created service binding at the access edge node for data traffic between the first device of the user domain and the service provider domain over the access domain by removing a user device MAC address from Unicast messages and replacing with a virtual MAC address recognized

by the access node and the access edge node.

- [18] In another aspect, the present invention is directed to an access node for performing data traffic aggregation over an access domain using service bindings. The access node is located between user domains and the access domain. The access node comprises an input/output unit, an aggregation unit and a controlling unit. The input/output unit forwards data traffic from user domains over the access domain and receives service binding related messages. The aggregation unit stores and manages service bindings. The controlling unit evaluates the service bindings related messages received at the input/output unit and updates the stored service bindings accordingly. The controlling unit, in turn, controls data traffic and enforces the stored service bindings by removing a user device MAC address from Unicast messages received from the user domain and replacing it with a virtual MAC address of an access edge node.

Brief Description of the Drawings

- [19] For a more detailed understanding of the invention, for further objects and advantages thereof, reference can now be made to the following description, taken in conjunction with the accompanying drawings, in which:
- [20] Figure 1 is a prior art example of an IP network;
- [21] Figure 2 is a schematic exemplifying a network in which the present invention has been incorporated;
- [22] Figure 3 is a simplified flowchart of a method for managing service bindings in accordance with the present invention;
- [23] Figure 4 is a schematic representation of an access edge node in accordance with the teachings of the present invention;
- [24] Figure 5a is an exemplary tabular representation of the content of a service agents management and control unit in accordance with the present invention;
- [25] Figure 5b is an exemplary tabular representation of the content of a service bindings hosting unit in accordance with the teachings of the present invention;
- [26] Figure 6 is a schematic representation of an access node in accordance with the teachings of the present invention;
- [27] Figure 7a is a diagram representing the modifications performed in the network to Unicast messages in the upstream of data traffic; and
- [28] Figure 7b is a diagram representing the modifications performed in the network to Unicast messages in the downstream of data traffic.

Detailed Description of the Preferred Embodiments

- [29] The innovative teachings of the present invention will be described with particular reference to various exemplary embodiments. However, it should be understood that this class of embodiments provides only a few examples of the many advantageous

uses of the innovative teachings of the invention. In general, statements made in the specification of the present application do not necessarily limit any of the various claimed aspects of the present invention. Moreover, some statements may apply to some inventive features but not to others. In the drawings, like or similar elements are designated with identical reference numerals throughout the several views.

[30] The present invention provides a method and nodes for efficiently aggregating data traffic over an access domain using service bindings. For doing so, an access edge node is introduced within the access domain, between the user domains and the service provider domains. The access edge node includes a service agent unit, which manages and controls service agents. Each of the service agents corresponds on one hand to one of the service provider domain, and on the other hand manages and controls therefor a Virtual Local Area Network (VLAN) over the access domain. Whenever a user domain wishes to communicate with a selected one of the service provider domains, a service request related message is to the access edge node. The service request related message includes information identifying one of the service provider domain and one of the user domain. The access edge node determines whether one of the service agent correspond to the service provider domain identified in the service request related message, and if so creates a service binding for the received service request related message. The service binding identifies one of the service agents, user domain information and access domain transport primitives. Then, an access node serving the requesting user domain is informed of the creation of the service binding, and enforcement of the service binding is performed at the access node and access edge node so as to aggregate data traffic therebetween in accordance with the created service binding. The following paragraphs will provide a more detailed explanation of how service agents, service bindings, and the access edge node and access node are woven together so as to manage service bindings.

[31] The expression 'data traffic' is used throughout the present specification and relates to messages and information transferred over a data network.

[32] To understand the present invention and its inventive mechanisms, reference is now made to Figure 2, which is a schematic exemplifying a network 200 in which the present invention has been incorporated. The schematic representation of the network 200 has been simplified for clarity purposes, and the various elements depicted have been grouped by similar functions rather than graphically representing geographical network entities. However, each group of similar functions would typically correspond to a multitude of physical network entities performing those specific functions, geographically scattered throughout the network 200. The schematic representation of the network 200 includes user domains 110, an access domain 115 (including: access nodes 120, an access network 130, an access edge node 160 and a regional network

135), network service providers 140, and application servers 150. An exhaustive description and examples for each of those elements will be provided in the following paragraphs, with continued reference to Figure 2.

- [33] The network 200 corresponds to one or multiple data networks communicating together. Thus, the network 200 could be operated by one or multiple operators. As data networks are usually supported by a number of different operational entities and/or organizations, it is necessary to define how those entities and organizations can successfully communicate. For this reason, data networks are usually explained and detailed using the Open System Interconnection (OSI) model. The OSI model defines a networking framework for implementing protocols in seven layers. Those seven layers are in the respective order: 1) Physical layer; 2) Data Link Layer; 3) Network Layer; 4) Transport Layer; 5) Session Layer; 6) Presentation Layer and 7) Application Layer. Each layer corresponds to an aspect to be considered and actions to be undertaken when performing data transmission over a data network. Using the OSI model to describe the network 200 of the present invention, it is possible to layer some of the various protocols used and/or supported by the network of the present invention as follows:

- [34] Layer 2: Ethernet, Asynchronous Transfer Mode;
[35] Layer 3: Internet Protocol (IP) versions 4 and 6,
[36] Layers 4 and 5: Transmission Control Protocol (TCP) and User Datagram Protocol (UDP); and
[37] Layers 6 and 7: various presentations and applications protocols currently existing and to come.

- [38] It should be understood that the above list of protocols is provided for exemplary purposes, rather than for limiting the protocols supported by the present invention.

- [39] Turning now to the access domain 115, it is possible to summarize its function as a means to provide end-to-end access between the user domains 110 and the network service providers 140 and application service providers 150. The access domain includes the access nodes 120, the access network 130, the regional network 135 and the access edge node 160. Thus, the access domain 115 is not an entity per se; it is rather an aggregation of components, which when interconnected together either directly or indirectly, act as a domain for providing access, hence its name 'access domain'. It should thus be clear that the current representation of the access domain 115 including only one access node 120, one access network 130, one access edge node 160 and one regional network 135 does not mean that such entities are found single in the access domain, but rather that for sake of clarity only one such entity is represented. The following paragraphs explain in greater details the various components of the access domain.

- [40] The access nodes 120, which also include access gateways (not shown), represent the first component of the access domain 115. The access nodes 120 typically refer to access providers, which allow user domains 110 accesses to the access network 130, upon, for example, subscription or pay-per-usage basis. Such access can be made possible using various mediums and technologies. Amongst the possible mediums are cable, landline phone, and wireless phone. As to the possible technologies, Integrated Services Digital Network (ISDN) and Asymmetric Digital Subscriber Line (ADSL), Worldwide Interoperability for Microwave Access (WiMax) are examples of possible technologies. However, it should be noted that the present invention is not limited to those mediums or technologies. Also, even though only three access nodes have been depicted, it should be noted that the network 200 potentially includes hundreds or thousands of access nodes.
- [41] The access domain also includes the access network 130 and the regional network 135 which will be discussed together. The primary function of the access network 130 and the regional network 135 is to provide end-to-end, and independent transport between the access nodes 120 and the network service providers 140 and the application service providers 150. The access network 130 and regional network 135 are networks capable of tasks such as: aggregation, switching and routing downstream and upstream data traffic. The access network 130 is preferably capable of using Ethernet, or other similar protocols, which correspond to the Layer 2 of the OSI model, but is not limited thereto. It could advantageously be capable of supporting IPv4 and/or IPv6. The regional network 135 preferably supports Ethernet and/or IP and MPLS, and possibly other Layer 3 capable protocols. Furthermore, it should be noted that the access network 130 and the regional network 135 could be operated and/or managed by a single operator or by many different operators.
- [42] It is through a tight coupling of their traffic-engineering capabilities through the access edge node 160, that the access network 130 and the regional network 135 can provide end-to-end Quality of Service (QoS). The access edge node's role 160 is the creation, management and hosting of service agents 170 and service bindings (not shown in Figure 2, but depicted on Figure 4). Each of the service agents 170 corresponds to one of the service provider domains (140 or 150), and manages and controls therefor a VLAN over the access network 130. The expression 'service binding' refers to a binding between the user domain 110 and one of the network service provider domain 140 or one of the application service provider domain 150. The access edge node and the concepts of service agents and service bindings will be described in further detail in the description referring to Figures 4, 5a and 5b.
- [43] Turning now to the user domains 110, the latter rely on the access domain 115 for handling end-to-end communication with the network service providers 140 and the

application service providers 150. It should be noted that in the present description, use of the word 'domain' refers to one or multiple network elements sharing similar functional features. Thus, in the context of the present invention, the expression 'user domains' may refer to independent computers, local networks of computers connected through a router either physically or wirelessly, wireless phones, Personal Digital Assistants (PDAs), and all other devices that are capable of data communication over a data network such as network 200. Additionally, the expression 'user domain' is intended to also include multiple simultaneous data traffic sessions performed with a multitude of devices, through one single user port. For example, a user could concurrently access different applications and network services such as Internet access, video conferencing, and television programs with one or multiple devices through a user domain located VLAN, or one single user port referred to herein as 'user domain'.

[44] The network service providers 140 refer to entities that use the access domain 115 to provide IP addressing and connectivity to another IP network, and to offer and deliver specific application. In the context of data traffic with the user domains 110, the network service providers 140 typically own and assign IP addresses to the user domains 110, using an identification based on for example Remote Authentication Dial-In User Service (RADIUS). The network service providers 140 may further perform user-level authentication and authorization if desired and/or necessary.

[45] The application service providers 150 use the access domain 115 to offer and deliver application to end-users of the user domains 110. Examples of such applications include gaming, video on demand, videoconferencing, and many other possible applications. It is however the access domain 115 that assigns IP addresses on behalf of the applications service providers to the user domains 110. If desired, the application service providers 150 can also perform authentication at the user-level and authorization if necessary. It should be noted that in the foregoing description, the expression 'service providers' and 'service providers domains' will be alternatively used to represent concurrently both network service providers 140 and application service providers 150, and the expression 'service provider' represents one of the network service providers 140 or application service providers 150.

[46] Reference is now made to Figure 3 that represents a simplified flowchart of a method for managing service binding in accordance with the present invention. The present method performs management of service bindings over the access domain 115, which transports data traffic between a plurality of network service providers 140 and application service providers 150, and user domains 110. The method may optionally start with a step 300 for establishing a plurality of service agents at the access edge node 160. However, it should be noted that the step 300 of establishing a plurality of service agents is not to be performed each time, but rather when an access edge node

160 is introduced in the access domain 115. Afterwards, the method starts at step 310 with the receiving of a service request related message at the access edge node 160. The service request related message identifies one of the service providers and one of the user domains. The service request related message may have been generated for example through accessing by the identified user domain of a web page of the identified service provider. The method pursues with a step 320 for identifying whether one of the established service agents corresponds to the identified service providers 140 or 150. Then, the method has a step 330 for determining whether a new service binding is needed. If the determining step 330 is positive, the method pursues with a step 340 of creating a service binding for the received service request related message. The method then continues with step 350 of informing an access node 120 responsible for providing access to the user domain identified in the service request related message, of the creation of the service binding. The access node 120 is thus informed that data traffic received from the user domain identified in the service request related message and addressed to the identified service provider is to be aggregated over the access domain in accordance with the created service binding. The method continues with step 360 which consists of enforcing the created service binding so as to aggregate data traffic to be transported over the access domain 115, received at the access node or the access edge node for the identified user domain and service provider, in accordance with the created service binding. In the event in step 330 that it is determined that a new service binding is not needed, the method further proceeds with a step 370 for determining whether a service binding already exists for the received service request related message and requires modifying. In the event that the outcome of the determination step 370 is that a service binding already exists but does not require modifying, the method then continues by returning to step 310 and waiting for the receipt of another service request message in step 310. However, in the event that the outcome of the determination step 370 is that a service binding already exists and requires modifying, the method continues with step 380 of verifying whether the corresponding existing service binding requires to be removed in step 380. If the service binding needs to be removed, the method continues at step 390 with the removing of the service binding from the access edge node, and the step of informing 350 of the access node of the service binding to be removed and the step of enforcing 360 the removal of the service binding. In the event that it is determined that the service binding does not need to be removed in step 380, the method then continues at step 395 where the modifications indicated in the received service request message are performed, and the method continues from that point by going to step 350. Examples of modifications to the service binding including adding or removing a device from the user domain, modifying quality of service requirement, and many other examples, as

further on described.

[47] As previously mentioned, a service binding relates to a transport relationship. That transport relationship is established between one of the user domains and one of the service providers, and directly impacts the serving access node 120 and one of the serving agents 170 of the access edge node 160. Conceptually speaking, the creation of a service binding corresponds to adding the identified user domain to the VLAN corresponding to the service provider domain over the access domain. Thus, each service binding represents a tradable business entity, which guarantees delivery of the corresponding service, with the right integrity and QoS, between a specific user port of the user domain and a specific provider port of the service provider. Service bindings are created, managed and hosted in the access edge node, and exist in combination with the service agents 170.

[48] Since the service agents and service bindings are created, managed and hosted in the access edge node, reference is now made concurrently to Figures 2 and 4, where Figure 4 is a schematic representation of an access edge node in accordance with the teachings of the present invention. To be able to perform the tasks of creation, management and hosting of the service agents and service bindings, the access edge node is composed of multiple elements. Because of its location in the access domain 115, the access edge node includes an input output unit including an access domain input/output unit 410 for communicating with the access network 130 of the access domain 115 and with access nodes 120. It is also the access domain input/output unit 410 that receives the service request related messages 420. The input/output unit of the access edge node 160 also includes a network/application service provider domains input/output unit 430 for communicating with the network service providers 140 and application service providers 150 over the regional network 135. Furthermore, the access edge node 160 includes a service agent unit 440, a controlling unit 450, and may further include a translation table 460, a forwarding unit 470 and a regulating unit 480.

[49] The service agent unit 440 is composed of a service agents management and control unit 442 and a service bindings hosting unit 444. The service agent unit 440 keeps existing service agents' 170 information in the service agents' management and control unit 442. The service agents' management and control unit 442 in turn is responsible for the creation and management of the service bindings 446. For doing so, the service agents management and control unit 442 determines when new service bindings 446 are required or can be removed, and proceeds with the creation/removal of service bindings 446. The service agents' management and control unit 442 is also responsible for the adding/removal of user devices to existing service bindings. Furthermore, the service agents management and control unit 442 is responsible for ensuring syn-

chronicity of service bindings 446 related information with access nodes with which it is interacting. The service agents' management and control unit 442 is also responsible for the creation of Multi Protocol Label Switching (MPLS) reserved paths in the access network 130, when such a reserved path is required. The description accompanying Figures 7 and 8 will provide an exhaustive explanation of the various messages used by the service agents' management and control unit 442 to perform its various responsibilities.

[50] Reference to Figure 5a, which represents an exemplary tabular representation of the content of the service agents' management and control unit 442, is now concurrently made with Figure 4. Each of the rows of Figure 5a, at the exception of the first row, which is a header row, represents exemplary content of some of the service agents 170 managed and controlled by the service agents management and control unit 442. Each of the columns of Figure 5a corresponds to specific information, maintained by the service agents' management and control unit 442, for each of the service agents 170. The first column represents an identification of the service agent 170. That identification is typically a number or a service agent identifier corresponding to the service agent. In accordance to a preferred embodiment of the invention, each service agent in the access edge node has a unique service agent identifier, and corresponds to one specific service provider domain 140 or 150. The second column refers to an identification of a specific service type for the corresponding service agent. For example, in cases where one service provider domain 140 or 150 offers multiple services, each of the services offered is associated with a different service type so as to differentiate between the various services of a service provider domain. The third column identifies the preferred or necessary Quality of Service (QoS) required for properly transporting data traffic for that service provider domain and the related service type. Exemplary criteria for QoS may include delay, bit error rate, bandwidth, and preferred protocol. The fourth column indicates a port to be used in the regional network to communicate with the corresponding service provider domain. In addition to this content, the service agents' management and control unit 442 includes sufficient logical software and hardware to create additional service agents and remove unnecessary service agents. It should be noted as well that even though the content of the service agents' management and control unit has been represented in Figure 5a in the form of a table, such content is not limited thereto. The service agents' management and control unit could be composed of a relational database, hard coded components, micro-processors, programming library, etc...

[51] Reference is now made to Figure 5b, which represents an exemplary tabular representation of the content of the service bindings hosting unit 444, concurrently with Figure 4. Each of the rows of Figure 5b, at the exception of the header row, represents

exemplary content of some of the service bindings 446 hosted in the service bindings hosting unit 444. Each of the columns of Figure 5b corresponds to specific information, hosted in the service bindings hosting unit 444, for each of the service bindings 446. The first column represents an identification of a corresponding service agent, by using for example the service agent identifier of the service agent. The second column identifies the service type, as described in relation with Figure 5a. The other columns represent the transport primitives for data traffic related to the service binding. More specifically, the third second column identifies a user domain Media Access Control (MAC) address. The fourth column consists of an identification of a port used by the user domain on the serving access node. The fifth column corresponds to the local network arbitrary identifier used by the user domain, and may include for example implicit or explicit VLAN information. The sixth column refers to a virtual MAC address of the access node serving the user domain. Hence, each service binding 446 binds together one of the service agents, one of the user domains and one of the access nodes for providing data traffic between one user domain and one service provider domain 140 or 150. It should be noted that even though the content of the service bindings hosting unit 444 has been represented in Figure 5b in the form of a table, such content is not limited thereto. The service bindings hosting unit could be composed of a relational database, hard coded components, microprocessors, programming library, etc...

- [52] Furthermore, the service bindings hosting unit may further contain a seventh column which includes an IP address uniquely identifying the user domain or a user device thereof. That unique IP address could be provided to the user domain or user device by the access edge node through a protocol such as Dynamic Host Configuration Protocol (DHCP), using for example Broadcast mechanism that could be performed prior to the service request message. The combination of the service agent identifier and the user domain or user device unique IP address thus represents a simple and reliable way of quickly relating incoming messages to the proper service binding. Typically, once the service binding has been created, the access node has been informed thereof, and the data traffic is being aggregated over the access domain in accordance with the service binding, the aggregated data traffic received at the access edge node is disaggregated prior to its forwarding to the corresponding service provider domain using the information provided in the service bindings hosting unit. More particularly, in the case where the access domain is an Ethernet network, the service agent identifier is provided, for example, in the field known as the VLAN Tag of Unicast, Multicast and Broadcast messages, while the user domain or user device IP address is provided in IP messages embedded in the Ethernet messages. Based on the service agent identifier provided in the VLAN Tag field of Ethernet message, and on

the IP address provided in the embedded IP message, the service agent unit 440 can disaggregate the data traffic and ensures its forwarding to the corresponding service provider domain, and inclusion of necessary information on the sending user domain, such as user MAC info and its local network context.

[53] Returning now to the description of Figure 4, the controlling unit 450 of the access edge node is responsible for determining, upon receipt of the service request related message 420, whether it corresponds to one of the service agents. For doing so, the controlling unit 450 consults the service agents' management and control unit 442 to determine whether one of the service agents 170 corresponds to the service provider domain identified in the service request related message 420. In the event that one of the service agents 170 corresponds thereto, the controlling unit 450 instructs the service agents' management and control unit 442 to create a service binding 446 for the received service request related message. The creation of a service binding 446 for the received service request related message 420 includes adding an entry in the service bindings hosting unit 444, in which:

- [54] - the service agent ID (first column) corresponds to the service agent identifier for the service agent corresponding to the requested service provider domain;
- [55] - the user MAC info is the user device MAC address;
- [56] - the user port on access node is an identification of the port on the serving access node with which the user device is connected;
- [57] - the local network context corresponds to an arbitrary identifier provided in a field labelled 'VLAN tag' of Ethernet messages to be received from the user device and corresponding a local user domain identifier; and
- [58] - the access node MAC is a virtual MAC address for the access node serving the user device for which the service request related message was received.

[59] Then, the controlling unit 450 informs the access node serving the user domain identified in the service request related message, through a service binding related message 490 sent by the access domain input/output unit 410, of the creation of the service binding 446. In the event that a service binding already exists for the service request related message 420, the controlling unit 450 informs the serving access node of the existing service binding through a service binding related message 490.

[60] The controlling unit 450 also interacts with the translation table 460. Since each service agent 170 of the service agents' management and control unit is uniquely identified by a service agent identifier, it is necessary to keep in the translation table a mapping between the service agent identifier corresponding to service agents 170 and corresponding service provider domains (140 or 150). Thus, upon receipt of data traffic at the access domain input/output unit 410 having a destination address corresponding to a virtual AC address for the access edge node 160 and a VLAN tag corresponding to

one of the service agent identifier, the controlling unit 450 consults the translation table 460 to obtain a fast translation of the access edge node virtual MAC address to the destination service provider domain (140 or 150) address corresponding to the service agent identifier provided in the VLAN tag.

[61] The controlling unit 450 further consults with the forwarding unit 470, to determine whether received data traffic at the access domain input/output unit 410 is to be directly forwarded to the service provider domains input/output unit without any modification.

[62] Finally, the controlling unit 450 can also interact with a regulating unit 480, which can perform, on received data traffic at either the access domain input/output unit 410 and the network/application service providers domain input/output unit 430, downstream/upstream traffic policing and marking, traffic remarking, as indicated and/or required by corresponding service agents 170.

[63] Reference is now made to Figure 6, which is a schematic representation of one of the access nodes in accordance with the teachings of the present invention. Because of its location in the access domain 115, the access node 120 includes an access domain input/output unit 610 for communicating with the access network 130 of the access domain 115 and with the access edge node 160. The access node 120 also includes a user domains input/output unit 620 for communicating with the user domains 110. A type of message received at the access domain input/output unit 610 is the service binding related messages 490. The service binding related messages 490 are generated by the access edge node 160, and sent over the access network 130. Examples of service binding messages 490 will be provided in the description of Figures 7 and 8.

[64] The access node 120 is capable of receiving and handling multiple service binding related messages 490. The service binding related messages 490 are received at the access node 120 from the access network 130, through the access domain input/output unit 610. Upon receipt of a service binding related message 490, the access domain input/output unit forwards the received service binding related message 490 to the controlling unit 630. The controlling unit 630 extracts the content of the service binding related message 490, and determines whether there are actions to be taken. An example of service binding related message 490 is the information about the creation of a new service binding. As previously described, when the access edge node 160 determines that a new service binding is required, it proceeds with its creation and informs the access node serving the requesting user domain of the creation of the service binding. The service bindings related message 490 used in this particular instance is called ADD_SB (add service binding). The ADD_SB message is sent from the access edge node 160 to the access node 120, and contains information on the created service binding. The information contained in the ADD_SB message must then

be incorporated into an aggregation unit 680 of the access node 120.

[65] One of the various responsibilities of the aggregation unit 680 is the hosting of service bindings related information. Service bindings related information contains specific service binding information (in the form of service agent identity and service type), identification on a port of the access node which received the service request related message, and local network context of the user domain.

[66] The access node 120 further handles incoming data traffic originating from/destined to user domains to which it provides access service to the access network 130. For doing so, the access node 120 further contains a translation table 650, a forwarding unit 660, a regulating unit 670 and an aggregation unit 680. For doing so, data traffic received at the access node 120 by either the user domain input/output unit 620 or the access domain input/output unit 610 is forwarded to the controlling unit 630. The controlling unit 630 interacts with the translation table 650. Since each service binding stored in the service bindings hosting unit 444 of the service agent unit 440 is identified by a combination of parameters (service agent identity, service type, user device MAC address and access node virtual MAC address), it is necessary to keep in the translation table 650 a mapping between the service agent identity corresponding to service agents 170 and corresponding service provider domains (140 or 150). Thus, upon receipt of data traffic at the access domain input/output unit 610 having a destination address corresponding to the virtual MAC address of the access node 120, the controlling unit 630 consults the translation table 650 to obtain a fast translation of the destination address and VLAN tag so as to correspond respectively to the user domain MAC address and the local identifier. Such translation is required, because the user domain information is not carried over the access domain between the access edge node 160 and the access node 120.

[67] The controlling unit 630 further consults with the forwarding unit 660, to determine whether received data traffic at the access domain input/output unit 610 or at the user domain input/output unit 620 is to be directly forwarded to the corresponding user domain 110 or the access network 130 without any modification.

[68] Finally, the controlling unit 630 can also interact with a regulating unit 670. Interaction with the regulating unit 670 is required, for example, when downstream/upstream traffic policing and marking, traffic remarking, is necessary, as indicated in the properties of the service binding.

[69] Now that the access node 120 and the access edge node 160 have been described in detail, the foregoing describes more thoroughly how the data traffic is aggregated over the access domain. In typical Ethernet networks, three types of messages are used for exchanging data traffic between two entities: Unicast messages, Multicast messages and Broadcast messages. The Unicast messages are used to exchange data traffic

between one sender and one recipient. The Multicast messages are used for efficiently sending data traffic from one sender to multiple recipients. As to the Broadcast messages, they are used to send messages from one sender to all nodes of the network. The present invention focuses on using service bindings in conjunction with Unicast message so as to aggregate data traffic over the access domain.

[70] Reference is now made to Figures 7a and 7b. Figure 7a depicts modifications performed in the network to Unicast messages in the upstream data traffic, in accordance with the present invention. Figure 7b is a diagram representing the modifications performed in the network to Unicast messages in the downstream of data traffic. In the present application, upstream data traffic refers to data traffic sent from the user domain 110 to one of the service provider domain 140 or 150, while downstream data traffic refers to data traffic sent from the service provider domain 140 or 150 to one of the user domains 110. Figures 7a and 7b depict Ethernet Unicast messages for exemplary purposes, such as described in International Electrical and Electronic Engineering (IEEE) 802.3ac. Unicast messages typically include the following fields: a Destination Address (DA) 710, a Source Address (SA) 720, a Type 730, a VLAN Tag 740 and User Data 750. The Destination Address 710 refers to an address for which the Unicast message is destined, and consists of 6 bytes. The Source Address 720 indicates from which address the Unicast message originates, and contains 6 bytes. The Type field 730 is 2 bytes long. The VLAN Tag 740 is 4 bytes long, and usually refer to a VLAN identifier only known and meaningful to the destination address and the source address. Finally, the user data 750 varies between 46 - 1500 bytes, and contains the data traffic being sent from the source address 720 to the destination address 710.

[71] Turning now more specifically to Figure 7a, a Unicast message, originating from the User Device 110 is represented through its various modifications through the network in accordance with the present invention. The User Device generates a Unicast message 700a, in which: the Destination Address 710 corresponds to a virtual MAC address for the access edge node 160, the Source Address 720 is the user device MAC address, and the VLAN Tag 740 corresponds to a local service identifier of the user device. The Unicast message 700a generated by the user device is sent and received by the access node 120, where some modifications are performed by the controlling unit 630 prior to forwarding the Unicast message over the access network 130. More particularly, the source address 720 is replaced by a virtual MAC address for the access node, and the VLAN Tag is changed to correspond to the service agent identification. The access node identifies the service agent identification from the service bindings stored in the aggregation unit. By replacing the user device MAC address, the access node improves the performance of the access network 130 by

reducing the learning and switching table of all routers and switches within the access network 130. The modified Unicast message 700b is sent from the access node over the access network 130 to the access edge node. The access edge node receives the modified Unicast message 700b, and changes back the source address 720 and the VLAN Tag 740 to correspond to the source address and the VLAN Tag provided initially by the User Device in the Unicast message 700c. For doing so, the access edge node relies on the service binding information stored in the service bindings hosting unit 444. The Unicast message 700c is sent from the access edge node 160 to the destination service provider domain 140 or 150.

[72] Referring more specifically to Figure 7b, a description of the modifications to the Unicast message on downstream data traffic is now provided. The Unicast message 700d is generated at the service provider domain 140 or 150. The Unicast message 700d has a destination address corresponding to the user device MAC address, a source address equivalent to the service provider MAC address, and a VLAN tag corresponding to the local service identification known to the user domain. The access edge node 160 receives the Unicast message 700d and intercepts it so as to modify its content prior to sending it on the access network 130. The access edge node 160 changes the destination address to correspond to a virtual MAC address of the serving access node, modifies the source address to be the virtual MAC address of the access edge node, and replaces the VLAN tag by the service agent identification, so as to obtain Unicast message 700e. These modifications are performed by the access edge node based on the service binding existing at the access edge node 160 for data traffic between the recipient user device from the sending service provider domain. The Unicast message 700e is sent from the access edge node 160 to the service access node 120 over the access network 130. Upon reception of the Unicast message 700e at the access node 120, the latter relies on its controlling unit 630 and its aggregation unit 680 to identify which service binding it relates to, and to modify the Unicast message 700e so as to bring it into a manner that will be recognizable by the user device 110. For doing so, the access node 120 changes the destination address to make it correspond to the user device MAC address, and modifies the VLAN tag field so as to correspond to the local service identification, known to the user device 110.

[73] As can be appreciated, the modifications to the Unicast message are visible only to the access node 120, access network 130 and the access edge node 160. The modifications to the Unicast message are transparent to the user device 110 and the service provider domain 140 or 150. The modifications are possible because of the service binding created by the access edge node 160, and enforced at both the access node 120 and the access edge node 160. The service binding stored at both the access node and the access edge node store the information required to perform the modifications to the

Unicast messages. The results of the modifications include the aggregation of data traffic for a number of service provider domains 140 or 150 through the access edge node 160, and a better managing of the resources of the access network 130, without impacting the user domains 110 and the service provider domains 140 and 150.

[74] Although several preferred embodiments of the method and nodes of the present invention have been illustrated in the accompanying Drawings and described in the foregoing Detailed Description, it will be understood that the invention is not limited to the embodiments disclosed, but is capable of numerous rearrangements, modifications and substitutions without departing from the spirit of the invention as set forth and defined by the following claims.

Amended page

20

What is claimed is:

1. A method for performing data traffic aggregation over an access domain using service bindings, the method comprising steps of:

upon receipt of a service request related message at an access edge node for a first device of a user domain, the service request related message identifying the first device of the user domain and one of service provider domains, creating a service binding at the access edge node, the service binding ruling data traffic between the first device of the user domain and the service provider domain by committing an access node serving the user domain and the access edge node in a manner of managing data traffic therebetween over the access domain;

informing the access node serving the user domain for which the service request related message is received of the created service binding; and

enforcing the created service binding at the access node and the access edge node for data traffic over the access domain between the first device of the user domain and the service provider domain by:

removing a user device MAC address from Unicast messages exchanged between the access node and the access edge node and replacing the user device MAC address with a virtual MAC address recognized by the access node and the access edge node;

wherein the Unicast messages are used for exchanging data traffic between the user domain and the service provider domain, through the access domain.

2. The method of claim 1, further comprising a step of:

creating a plurality of service agents at the access edge node, each service agent corresponding to a specific service provider domain, each service agent managing therefor a Virtual Local Area Network (VLAN) over the access domain.

3. The method in accordance with claim 2, wherein the service binding identifies the first device of the user domain and the service agent corresponding to the requested service provider domain.

Amended page

21

4. The method in accordance with claim 3, wherein the step of enforcing the created service binding further comprises the step of:

modifying a VLAN Tag field from Unicast messages exchanged therebetween so as to correspond to an identifier of the service agent corresponding to the created service binding.

5. The method in accordance with claim 4, wherein for data traffic sent from the user domain to the service provider domain, the created service binding is enforced at the access node by:

modifying the source address of the user device in the Unicast message for a virtual MAC address of the access edge node; and

replacing content of the VLAN tag field in the Unicast message with the service agent identifier corresponding to the created service binding.

6. The method in accordance with claim 5, wherein the modified Unicast message is received at the access edge node and the source address of the Unicast message is replaced with the user device MAC address prior to its forwarding to the service provider domain.

7. The method in accordance with claim 4, wherein for data traffic sent from the service provider domain to the user domain, the created service binding is enforced at the access edge node by:

modifying a destination address of the Unicast message corresponding to the user domain MAC address by a virtual MAC address of the access node serving the user domain; and

replacing content of the VLAN tag field in the Unicast message with the service agent identifier corresponding to the created service binding.

8. The method in accordance with claim 1, wherein the access edge node and the access node concurrently handle multiple service bindings for multiple user domains and multiple service provider domains.

Amended page

22

9. An access edge node for performing data traffic aggregation over an access domain using service bindings, the access edge node being located in the access domain between user domains and service provider domains, the access edge node comprising:

an input/output unit for receiving a service request related message for a first device of a user domain for a service provider domain, and for receiving and forwarding Unicast messages;

a service agent unit for creating a service binding, the service binding ruling data traffic between the first device of the user domain and the service provider domain over the access domain, the service binding committing an access node serving the user domain and the access edge node representing the service provider domain in handling of data traffic therebetween over the access domain; and

a controlling unit for informing the access node serving the user domain for which the service request related message is received of the creation of the service binding through the input/output unit, and for enforcing the created service binding at the access edge node for data traffic between the first device of the user domain and the service provider domain over the access domain by removing a user device MAC address from Unicast messages and replacing the user device MAC address with a virtual MAC address recognized by the access node and the access edge node;

wherein the Unicast messages are used for exchanging data traffic between the user domain and the service provider domain, through the access domain.

10. The access edge node in accordance with claim 9, wherein:

the service agent unit further maintains a plurality of service agents, each service agent corresponding to one service provider domain and managing therefor a Virtual Local Area Network (VLAN) over the access domain, and

the created service binding includes the first device of the user domain to the VLAN corresponding to the service provider domain over the access domain managed by the service agent unit.

Amended page

23

11. The access edge node in accordance with claim 10, wherein:
 - the service agent unit comprises a service agents' management and control unit and a service bindings hosting unit,
 - the service agents' management and control unit manages the VLAN over the access domain for the service provider domain and creates, modifies or removes the service binding, and
 - the service bindings hosting unit hosts the service bindings; and
 - the controlling unit further informs the access node serving the user domain when the service agents' management and control unit modifies or removes the service binding.
12. The access edge node in accordance with claim 11, wherein:
 - the service agents' management and control unit is concurrently controlling multiple VLANs over the access domain, each of the VLAN corresponding to one service provider domain; and
 - the service bindings hosting unit concurrently hosts multiple service bindings for multiple user domains and multiple service provider domains.
13. The access edge node in accordance with claim 9, wherein for Unicast messages received at the input/output unit from one of the service provider domains for the user domain, the controlling unit removes the user device MAC address from the Unicast messages and substitutes therefor a virtual MAC address of the access node.
14. The access edge node in accordance with claim 13, wherein the controlling unit further removes content of a VLAN tag field and substitutes therefor a service agent identifier corresponding to the service agent managed by the service agent unit for the service provider domain from which the Unicast message is received.
15. The access edge node in accordance with claim 9, wherein for Unicast messages received at the input/output unit from one of the user domains, the

Amended page

24

controlling unit modifies a destination address and a VLAN Tag field to correspond respectively to the address of the service provider domain and a user domain local VLAN tag field identifier prior to forwarding the Unicast message to the service provider domain.

16. An access node for performing data traffic aggregation over an access domain using service bindings, the access node being located between user domains and the access domain, the access node comprising:

an input/output unit for forwarding data traffic from user domains over the access domain and for receiving service binding related messages;

an aggregation unit for storing service bindings and for managing service bindings, the aggregation unit evaluating the service bindings related messages received at the input/output unit and updating the stored service bindings accordingly; and

a controlling unit for controlling data traffic and for enforcing the stored service bindings by removing a user device MAC address from Unicast messages received from the user domain and replacing the user device MAC address with a virtual MAC address of an access edge node;

wherein the Unicast messages are used for exchanging data traffic between the user domain and a service provider domain, through the access domain.

17. The access node in accordance with claim 16, wherein the controlling unit further removes content of a VLAN tag field of Unicast messages received from the user domain and substitutes therefor a service agent identifier corresponding to one of the stored service bindings at the aggregation unit.

18. The access node in accordance with claim 16, wherein the aggregation unit concurrently hosts multiple service bindings for multiple user domains and multiple service provider domains

Amended page

25

19. The access node in accordance with claim 16, wherein each of the service bindings includes the user domain to a Virtual Local Area Network (VLAN) maintained over the access domain for the service provider domain.

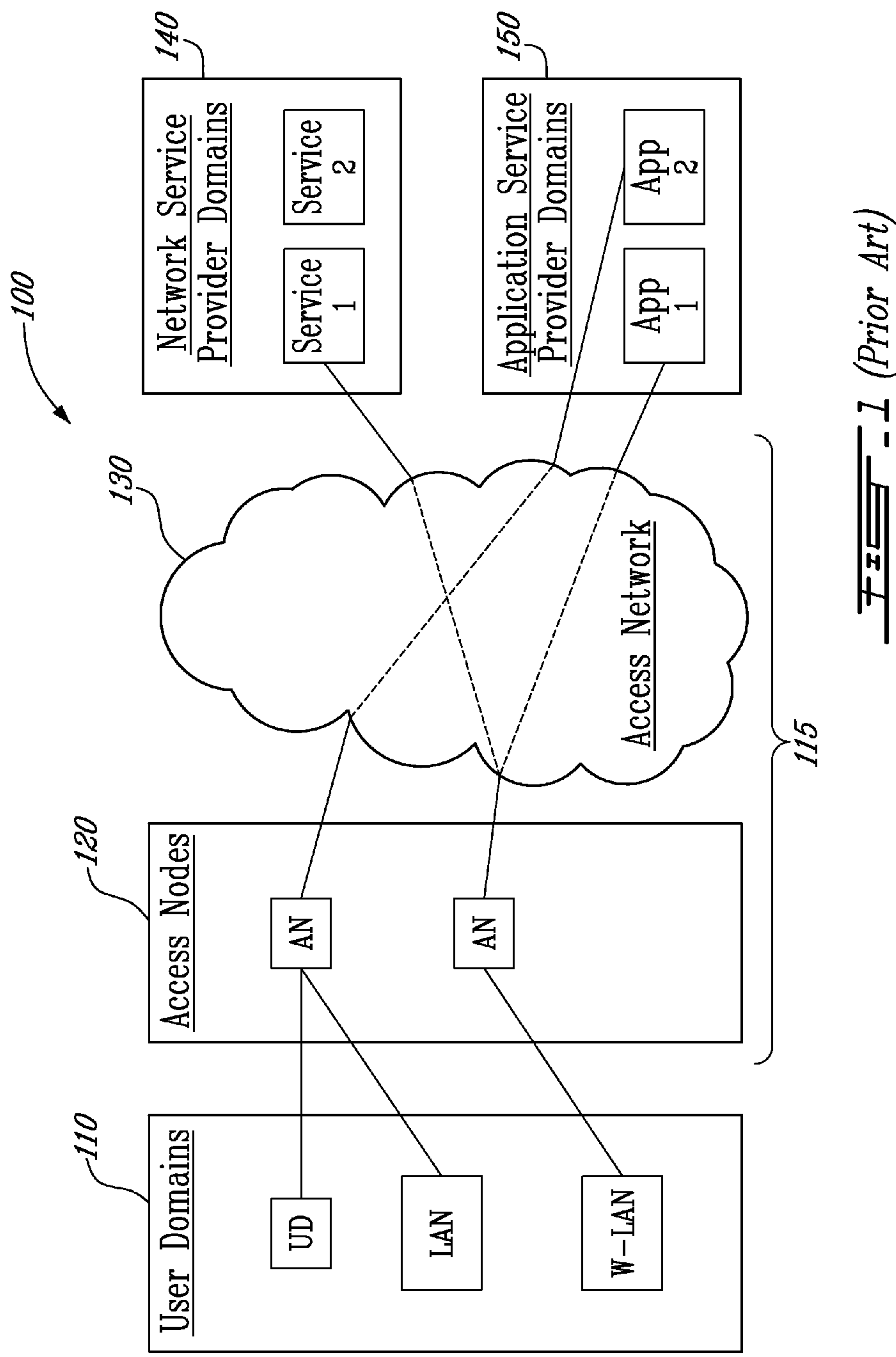
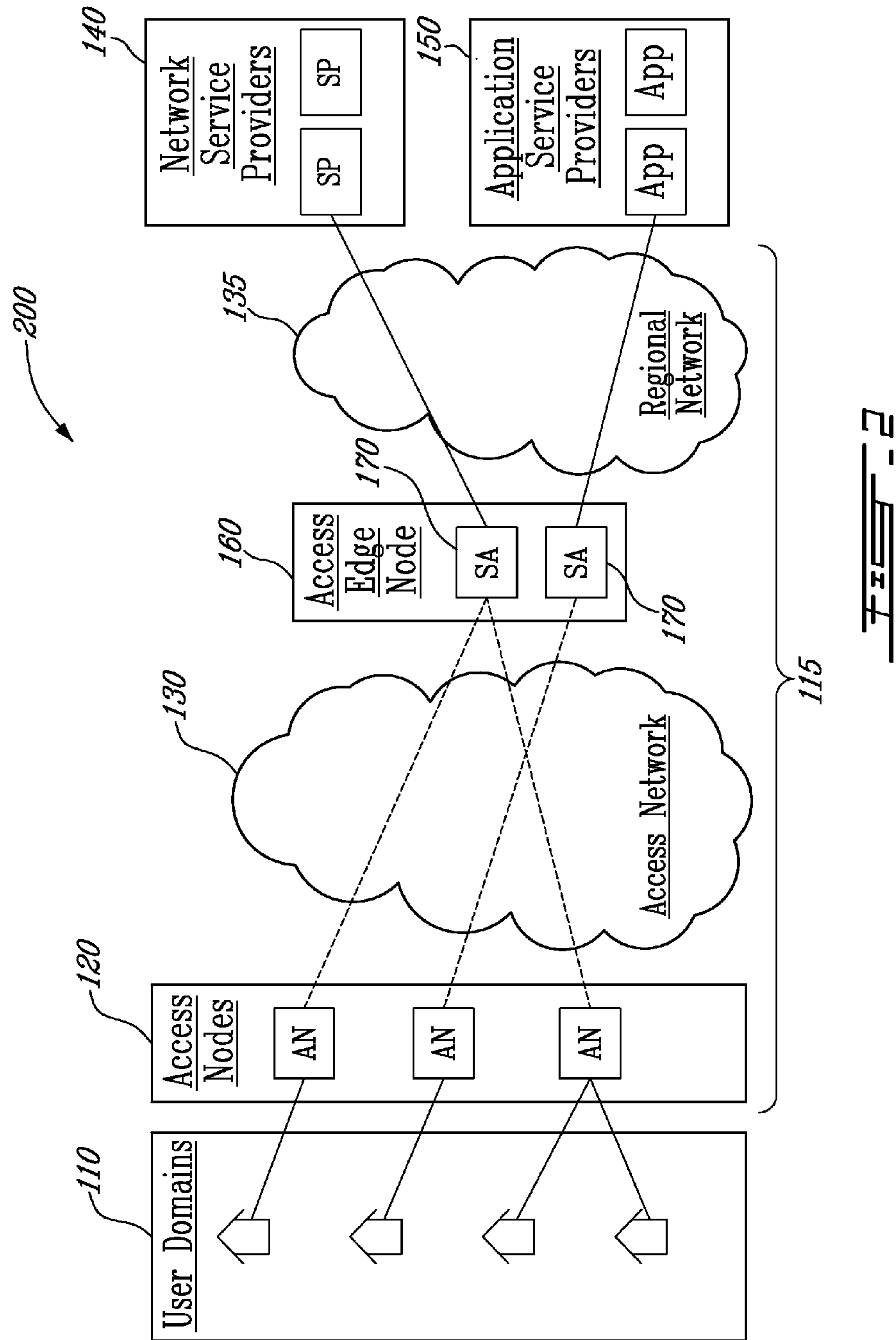
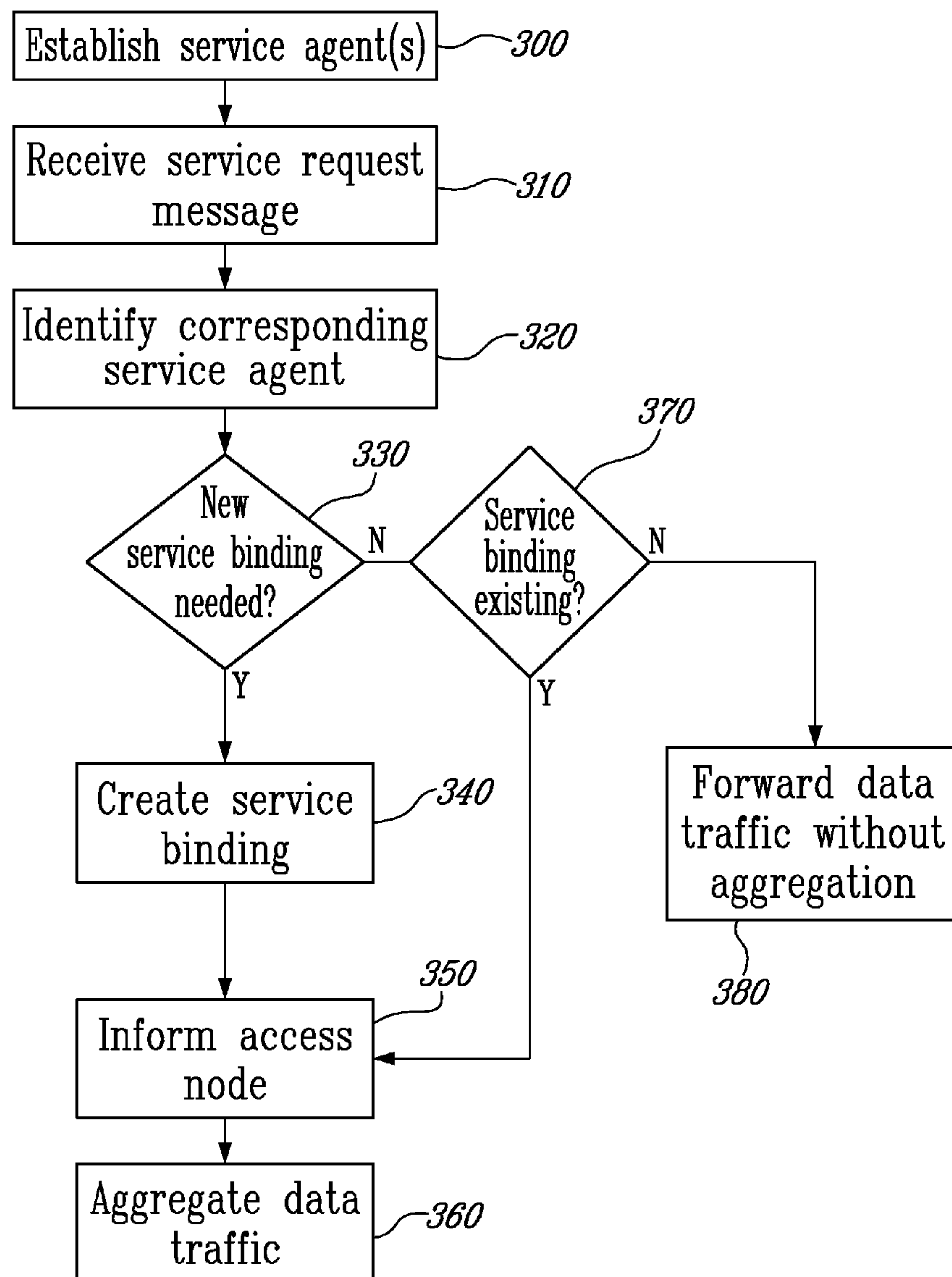


FIG. 1 (Prior Art)





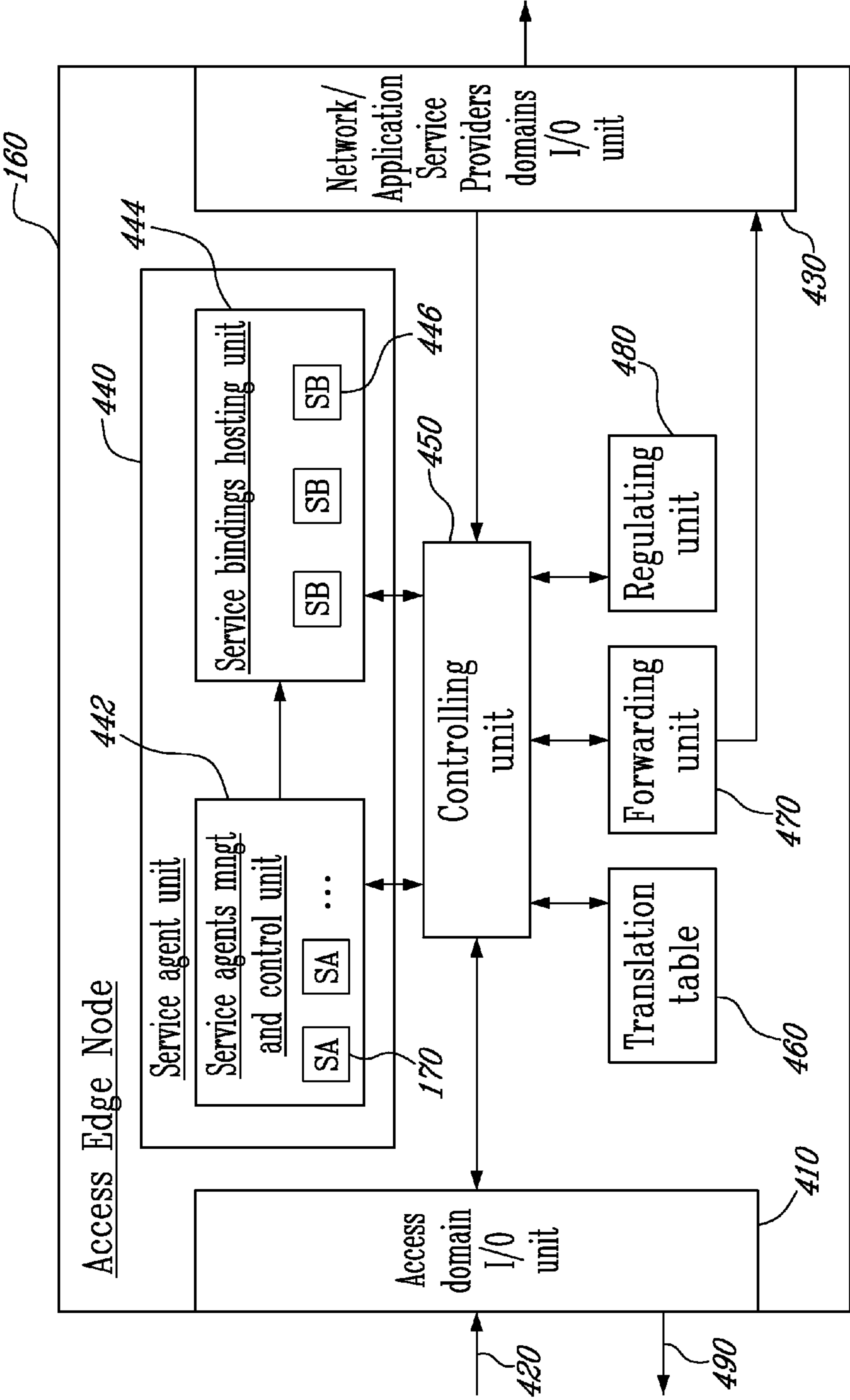


FIG. 4

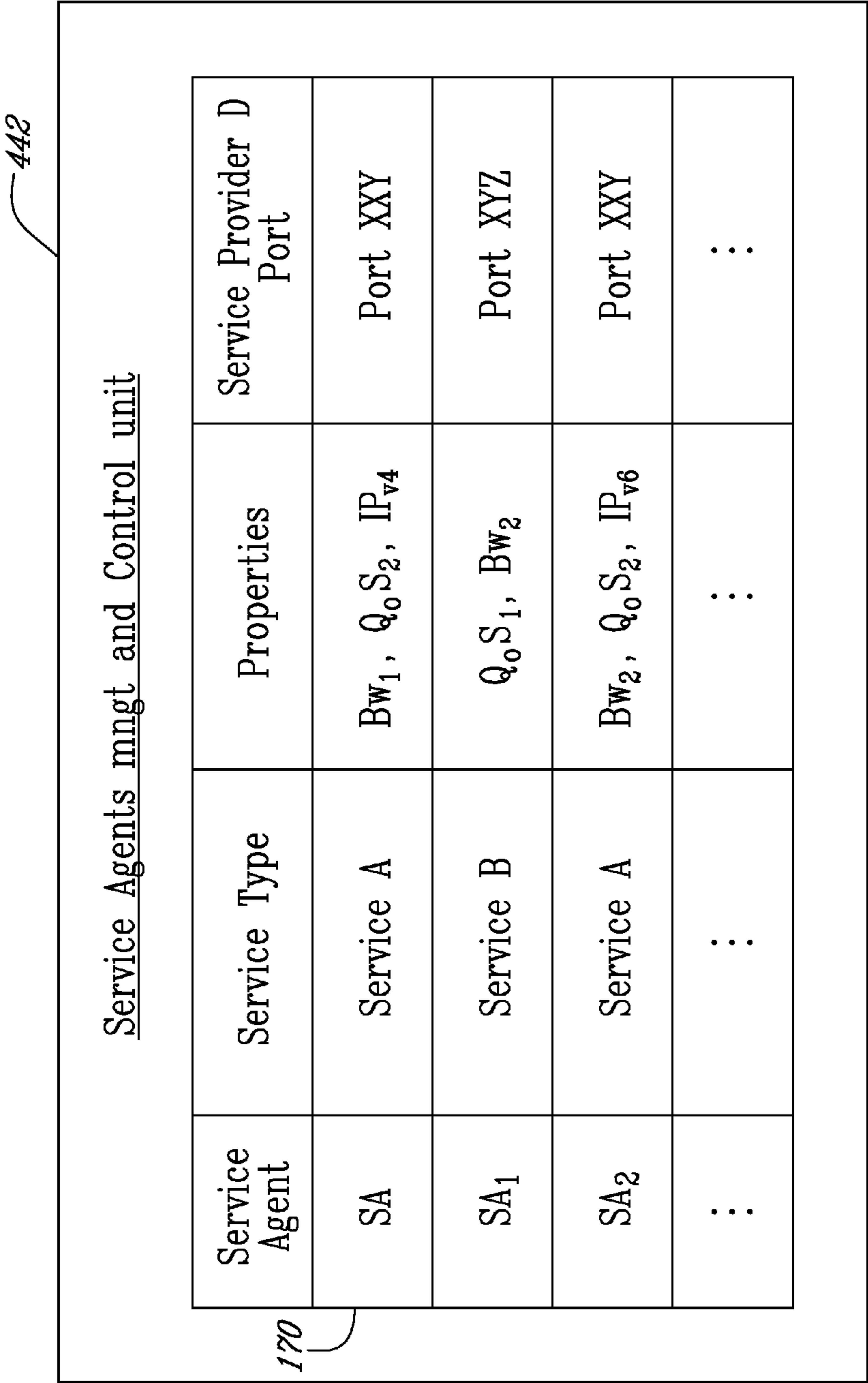


FIG. 5A

444

Service Bindings Hosting Unit					
SA _{1D}	Service Type	User MAC info	User port on access node	Local network context	Access Node MAC
SA ₁	Service A	MAC add 1	Port ABC	Local identifier X	AN ₁ MAC
SA ₂	Service C	MAC add 2	Port AAB	Local identifier Y	AN ₁ MAC
SA ₃	Service B	MAC add 3	Port ABA	Local identifier Z	AN ₂ MAC
⋮	⋮	⋮	⋮	⋮	⋮

446

Transport Primitives

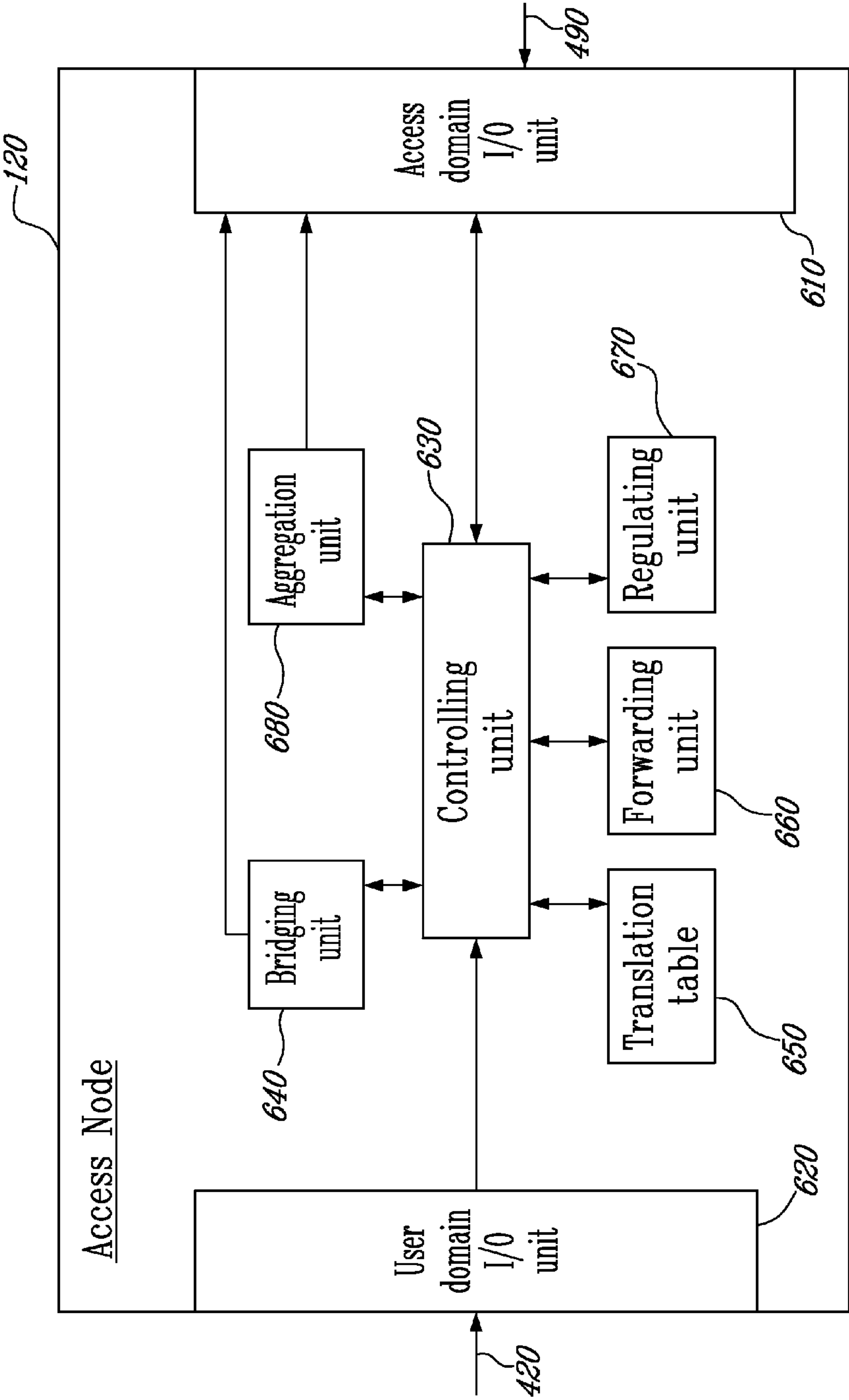


FIG. 8

<u>User Device</u> 710		720		730	740	750
DA = Virtual EN MAC address	SA = User device MAC address	Type	VLAN Tag = Service ident.	User Data		
6 bytes	6 bytes	2 bytes	4 bytes	46-1500 bytes		
<u>Access Node</u>						
DA = Virtual EN MAC address	SA = Virtual access node MAC address	Type	VLAN Tag = Service agent id	User Data		
<u>Access Edge Node</u>						
DA = Virtual EN MAC address	SA = User device MAC address	Type	VLAN Tag = Service identif. id	User Data		

Service Provider Domain 7A

User Device

DA = User Device Mac address	SA = Virtual EN MAC address	Type	VLAN Tag = Local service id	User Data	...
6 bytes	6 bytes	2 bytes	4 bytes	46-1500 bytes	
Access Node					
DA = Virtual AN MAC address	SA = Virtual EN MAC address	Type	VLAN Tag = Service agent id	User Data	...
Access Edge Node					
DA = User Device MAC address	SA = Service Provider MAC address	Type	VLAN Tag = Local service id	User Data	...

Service Provider Domain

FIG. 7B

User Device	710	720	730	740	750	
DA = Virtual EN MAC address	SA = User device MAC address	Type	VLAN Tag = Service ident.	User Data	...	700a
6 bytes	6 bytes	2 bytes	4 bytes	46–1500 bytes	...	
Access Node						
DA = Virtual EN MAC address	SA = Virtual access node MAC address	Type	VLAN Tag = Service agent id	User Data	...	700b
Access Edge Node						
DA = Virtual EN MAC address	SA = User device MAC address	Type	VLAN Tag = Service identif. id	User Data	...	700c
Service Provider Domain						