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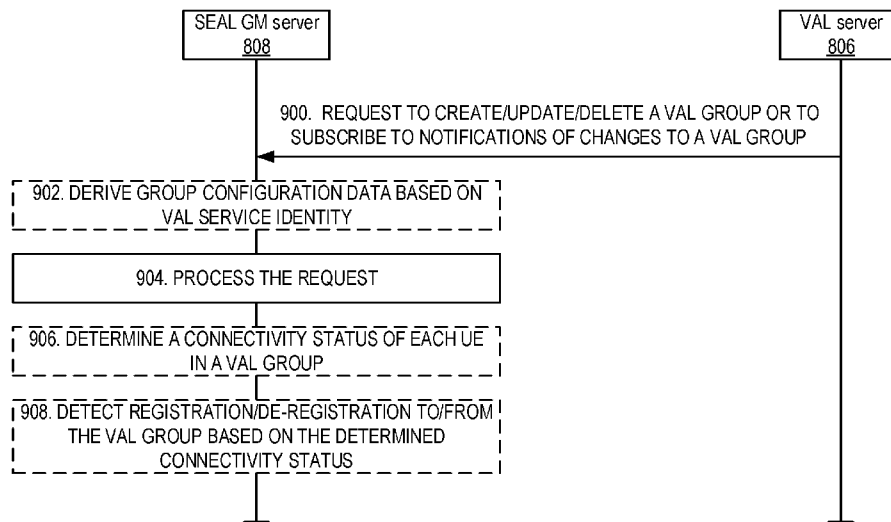


FIG. 9

(57) Abstract: Disclosed herein is a method performed by a group management server 808 for service enabler architecture layer, SEAL, over a cellular communications system for support of vertical applications. The method comprises: receiving (900; Fig. 10, step 2) a request from a vertical application layer, VAL, server (806), the request being at least one of: (a) a request to create a VAL group, (b) a request to update a VAL group, (c) a request to delete a VAL group, or (d) a request to subscribe to changes of a VAL group; and processing (904; Fig. 10, steps 3-4) the request.



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GROUP MANAGEMENT BASED ON SEAL ENHANCEMENTS

BACKGROUND

[0001] Generally, all terms used herein are to be interpreted according to their ordinary meaning in the relevant technical field, unless a different meaning is clearly given and/or is implied from the context in which it is used. All references to a/an/the element, apparatus, component, means, step, etc. are to be interpreted openly as referring to at least one instance of the element, apparatus, component, means, step, etc., unless explicitly stated otherwise. The steps of any methods disclosed herein do not have to be performed in the exact order disclosed, unless a step is explicitly described as following or preceding another step and/or where it is implicit that a step must follow or precede another step. Any feature of any of the embodiments disclosed herein may be applied to any other embodiment, wherever appropriate. Likewise, any advantage of any of the embodiments may apply to any other embodiments, and vice versa. Other objectives, features, and advantages of the enclosed embodiments will be apparent from the following description.

[0002] Third Generation Partnership Project (3GPP) Technical Specification (TS) 23.434 V16.4.0 specifies the functional architecture for the service enabler architecture layer (SEAL) over 3GPP networks (Long Term Evolution (LTE) and Fifth Generation (5G)) to support vertical applications (e.g. Vehicle to Anything (V2X) applications, industrial Internet of Things (IoT) applications). The SEAL functional architecture includes common application functionalities such as group management, configuration management, location management, and network resource management that can be shared among different vertical applications. Also, the SEAL functional architecture takes into consideration the common capabilities to support mission critical services.

Figure 1

[0003] **Figure 1** describes the generic functional model for SEAL. As described in 3GPP TS 23.434, the SEAL servers (e.g. group management server) provide enabling services to vertical application layer (VAL) servers (e.g. industrial IoT application servers or mission critical application servers) towards User Equipments (UEs) connected to 3GPP networks. Likewise, the UEs consist of SEAL clients (e.g. group management client) providing enabling services to VAL clients operating on the UE (e.g. industrial IoT application users or mission critical users). SEAL services like group management are used to establish group communications for VAL UEs connected to a 3GPP network.

Figure 2

[0004] **Figure 2** illustrates the generic SEAL functional model for group management.

[0005] As described in 3GPP TS 23.434, the group management client communicates with the group management server over the GM-UU reference point. The group management client provides the support for group management functions to the VAL client(s) over GM-C reference point. The VAL server(s) communicate with the group management server over the GM-S reference point.

5 *Figure 3*

[0006] Currently, to establish a group communication, the following procedure shown in **Figure 3** is specified in 3GPP TS 23.434 clause 10.3.8 to create a group and request VAL UEs to register to the corresponding group. The configuration of such a group is fully created in the application layer based on the SEAL group management capabilities. This means that the 3GPP network is not aware of the group creation and which VAL UEs belong to such a group.

[0007] Pre-conditions:

1. The group management client, group management server, VAL server and the VAL clients belong to the same VAL system.
2. The VAL server is aware of the users' identities and is authorized to form a VAL group.

15 **[0008]** Procedure, as illustrated in Figure 3:

1. The VAL server determines group information and the identity list to which the group announcement shall be sent. The decision can be based on the list of authorized UEs and other criteria (e.g. user consent, service, or vehicle driving profile).
2. The VAL server configures VAL group for Uu communication defined by VAL Group ID for one or more VAL services with list of VAL Service ID with the group management server.
3. The group management server creates an empty group based on the information provided in the Configure VAL group request.
4. The group management server announces the VAL group to the group management clients.
5. The group management client registers to VAL group communication using the VAL Group ID.
6. The group management server records the users who have registered to be the members of the group.
7. The group management server sends a VAL group registration response to the group management client.
8. The group management server sends a configure VAL group response to the VAL server.
NOTE: Step 8 may occur any time after Step 4.

9. The group management server sends identity list notification about the newly registered users.
10. The group management client may inform VAL client about the updated identity list.

[0009] Industrial IoT applications may require that 5GLAN-type services are supported on the 5G system, as specified in 3GPP TS 23.501 V16.5.0 clause 5.29. Note that a 5GLAN-type service is defined as a service over the 5G system offering private communication using Internet Protocol (IP) and/or non-IP type communications. Based on the fact that industrial IoT applications may require that 5GLAN-type services are supported on the 5G system, a 5G Virtual Network (5G VN) group or 5GLAN group is defined in the 5G system to consist of a set of UEs using private communication for 5G LAN-type services. For such 5GLAN (5G VN) groups, the 5G system provides group management capabilities to manage the connectivity services provided to UEs within a 5GLAN group. The 5G VN Group management can be configured by a network administrator or can be managed dynamically by an application function.

[0010] 3GPP Technical Report (TR) 23.745 is currently addressing application architecture aspects to support factories of the future (i.e. industrial vertical applications) over a 3GPP 5G system (5GS), and corresponding architectural solutions. For that, SEAL is introduced as the enabling service layer to support common functionalities, such as group management, for industrial vertical applications.

Figure 4

[0011] **Figure 4** illustrates the factories of the future (FF) application layer functional model using SEAL. Compared to Figure 1, the FF application enabler server (FAE server) and the FF application specific server represent a VAL server in the SEAL functional model. Likewise, the FF application enabler client (FAE client) and the FF application specific client represent a VAL client in the SEAL.

[0012] As part of 3GPP TR 23.745 solutions, group management aspects are being addressed for the support of industrial vertical applications that may require 5GLAN-type services.

SUMMARY

[0013] There currently exist certain challenge(s). Group management is required for vertical applications, e.g. industrial IoT applications which may require 5GLAN-type service, for establishing group communications with a target group of UEs on the 5G system. The existing group management procedures based on SEAL do not support capabilities to create corresponding application groups in the 3GPP network, e.g. a 5G system. Therefore, the 5G system is not configured and is not aware of groups created by SEAL for a specific vertical application and which UEs belong to a corresponding group. Additionally, it is unclear how the SEAL group management server can announce a created group to the SEAL clients operating on UEs registered to the 5G system when the SEAL clients do not have any established 5G Protocol Data Unit (PDU) session to the SEAL server.

[0014] Certain aspects of the present disclosure and their embodiments may provide solutions to the aforementioned or other challenges. In some embodiments, the proposed solutions define enhancements to the SEAL group management capabilities for group creation and group announcement based on capabilities provided by the 5G system. These enhancements enable the SEAL group management server to create
5 application groups in the 5G system. Hence, the 5G system is aware and configured with corresponding group information managed by SEAL. Likewise, in some embodiments, the SEAL group management capabilities are enhanced to define that the registration status on the SEAL group management server of the group member UEs can be based on notifications from the 5G system about the UE's PDU connectivity status.

[0015] Embodiments of the solutions disclosed herein enhance SEAL group management capabilities for
10 group creation and group announcement based on capabilities provided by the 5G system. Likewise, in some embodiments, the connectivity status on the SEAL management server of the group member UEs can be defined by 5G system notifications.

[0016] There are, proposed herein, various embodiments which address one or more of the issues disclosed herein.

[0017] Certain embodiments may provide one or more of the following technical advantage(s). For
15 example, embodiments of the solutions described herein provide enhancements to the SEAL group management capabilities to create application groups in the 5G system and to manage connectivity status of group members based on notifications from the 5G system about the UE's PDU connectivity status.

20 BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 describes the generic functional model for SEAL.

Figure 2 illustrates the generic SEAL functional model for group management.

Figure 3 shows a procedure for establishing a group communication to create a group and request VAL UEs to register to the corresponding group.

Figure 4 illustrates the factories of the future (FF) application layer functional model using SEAL.

Figure 5 illustrates one example of a cellular communications system 500 in which embodiments of the present disclosure may be implemented.

Figure 6 illustrates a 5G network architecture with core Network Functions (NFs) using point-to-point reference point/interface architecture.

Figure 7 illustrates a 5G network architecture using service-based interfaces between the NFs in the CP.

Figure 8 illustrates a system 800 for SEAL group management in accordance with one embodiment of the present disclosure.

Figure 9 illustrates a procedure according to at least some of the embodiments described herein.

Figure 10 illustrates a procedure to create and register to a 5G-VN group in accordance with one embodiment of the present disclosure.

5 **Figure 11** is a schematic block diagram of a network node 1100 according to some embodiments of the present disclosure.

Figure 12 is a schematic block diagram that illustrates a virtualized embodiment of the network node 1100 according to some embodiments of the present disclosure.

Figure 13 is a schematic block diagram of the network node 1100 according to some other embodiments of the present disclosure.

10 **Figure 14** is a schematic block diagram of a wireless communication device 1400 according to some embodiments of the present disclosure.

Figure 15 is a schematic block diagram of the wireless communication device 1400 according to some other embodiments of the present disclosure.

15 DETAILED DESCRIPTION

[0018] Some of the embodiments contemplated herein will now be described more fully with reference to the accompanying drawings. Other embodiments, however, are contained within the scope of the subject matter disclosed herein, the disclosed subject matter should not be construed as limited to only the embodiments set forth herein; rather, these embodiments are provided by way of example to convey the scope
20 of the subject matter to those skilled in the art. Additional information may also be found in the document(s) provided in the Appendix.

[0019] Radio Node: As used herein, a “radio node” is either a radio access node or a wireless communication device.

[0020] Radio Access Node: As used herein, a “radio access node” or “radio network node” or “radio
25 access network node” is any node in a Radio Access Network (RAN) of a cellular communications network that operates to wirelessly transmit and/or receive signals. Some examples of a radio access node include, but are not limited to, a base station (e.g., a New Radio (NR) base station (gNB) in a Third Generation Partnership Project (3GPP) Fifth Generation (5G) NR network or an enhanced or evolved Node B (eNB) in a 3GPP Long Term Evolution (LTE) network), a high-power or macro base station, a low-power base station (e.g., a micro
30 base station, a pico base station, a home eNB, or the like), a relay node, a network node that implements part of the functionality of a base station (e.g., a network node that implements a gNB Central Unit (gNB-CU) or a network node that implements a gNB Distributed Unit (gNB-DU)) or a network node that implements part of the functionality of some other type of radio access node.

[0021] Core Network Node: As used herein, a “core network node” is any type of node in a core network or any node that implements a core network function. Some examples of a core network node include, e.g., a Mobility Management Entity (MME), a Packet Data Network Gateway (P-GW), a Service Capability Exposure Function (SCEF), a Home Subscriber Server (HSS), or the like. Some other examples of a core network node
5 include a node implementing a Access and Mobility Management Function (AMF), a User Plane Function (UPF), a Session Management Function (SMF), an Authentication Server Function (AUSF), a Network Slice Selection Function (NSSF), a Network Exposure Function (NEF), a Network Function (NF) Repository Function (NRF), a Policy Control Function (PCF), a Unified Data Management (UDM), or the like.

[0022] Communication Device: As used herein, a “communication device” is any type of device that has
10 access to an access network. Some examples of a communication device include, but are not limited to: mobile phone, smart phone, sensor device, meter, vehicle, household appliance, medical appliance, media player, camera, or any type of consumer electronic, for instance, but not limited to, a television, radio, lighting arrangement, tablet computer, laptop, or Personal Computer (PC). The communication device may be a portable, hand-held, computer-comprised, or vehicle-mounted mobile device, enabled to communicate voice
15 and/or data via a wireless or wireline connection.

[0023] Wireless Communication Device: One type of communication device is a wireless communication device, which may be any type of wireless device that has access to (i.e., is served by) a wireless network (e.g., a cellular network). Some examples of a wireless communication device include, but are not limited to: a User Equipment device (UE) in a 3GPP network, a Machine Type Communication (MTC)
20 device, and an Internet of Things (IoT) device. Such wireless communication devices may be, or may be integrated into, a mobile phone, smart phone, sensor device, meter, vehicle, household appliance, medical appliance, media player, camera, or any type of consumer electronic, for instance, but not limited to, a television, radio, lighting arrangement, tablet computer, laptop, or PC. The wireless communication device may be a portable, hand-held, computer-comprised, or vehicle-mounted mobile device, enabled to communicate
25 voice and/or data via a wireless connection.

[0024] Network Node: As used herein, a “network node” is any node that is either part of the RAN or the core network of a cellular communications network/system.

[0025] Note that the description given herein focuses on a 3GPP cellular communications system and, as such, 3GPP terminology or terminology similar to 3GPP terminology is oftentimes used. However, the
30 concepts disclosed herein are not limited to a 3GPP system.

[0026] Note that, in the description herein, reference may be made to the term “cell”; however, particularly with respect to 5G NR concepts, beams may be used instead of cells and, as such, it is important to note that the concepts described herein are equally applicable to both cells and beams.

Figure 5

5 **[0027]** **Figure 5** illustrates one example of a cellular communications system 500 in which embodiments of the present disclosure may be implemented. In the embodiments described herein, the cellular communications system 500 is a 5G system (5GS) including a Next Generation RAN (NG-RAN) and a 5G Core (5GC); however, the present disclosure is not limited thereto. The solutions described herein can be used in other types of cellular communications systems such as, for example, an Evolved Packet System (EPS)
10 including an Evolved Universal Terrestrial RAN (E-UTRAN) and an Evolved Packet Core (EPC). In this example, the RAN includes base stations 502-1 and 502-2, which in the 5GS include NR base stations (gNBs) and optionally next generation eNBs (ng-eNBs) (e.g., LTE RAN nodes connected to the 5GC), controlling corresponding (macro) cells 504-1 and 504-2. The base stations 502-1 and 502-2 are generally referred to herein collectively as base stations 502 and individually as base station 502. Likewise, the (macro) cells 504-1
15 and 504-2 are generally referred to herein collectively as (macro) cells 504 and individually as (macro) cell 504. The RAN may also include a number of low power nodes 506-1 through 506-4 controlling corresponding small cells 508-1 through 508-4. The low power nodes 506-1 through 506-4 can be small base stations (such as pico or femto base stations) or Remote Radio Heads (RRHs), or the like. Notably, while not illustrated, one or more of the small cells 508-1 through 508-4 may alternatively be provided by the base stations 502. The low power
20 nodes 506-1 through 506-4 are generally referred to herein collectively as low power nodes 506 and individually as low power node 506. Likewise, the small cells 508-1 through 508-4 are generally referred to herein collectively as small cells 508 and individually as small cell 508. The cellular communications system 500 also includes a core network 510, which in the 5G System (5GS) is referred to as the 5GC. The base stations 502 (and optionally the low power nodes 506) are connected to the core network 510.

25 **[0028]** The base stations 502 and the low power nodes 506 provide service to wireless communication devices 512-1 through 512-5 in the corresponding cells 504 and 508. The wireless communication devices 512-1 through 512-5 are generally referred to herein collectively as wireless communication devices 512 and individually as wireless communication device 512. In the following description, the wireless communication devices 512 are oftentimes UEs, but the present disclosure is not limited thereto.

Figure 6

[0029] **Figure 6** illustrates a wireless communication system represented as a 5G network architecture composed of core Network Functions (NFs), where interaction between any two NFs is represented by a point-to-point reference point/interface. Figure 6 can be viewed as one particular implementation of the system 500 of Figure 5.

[0030] Seen from the access side the 5G network architecture shown in Figure 6 comprises a plurality of UEs 512 connected to either a RAN 502 or an Access Network (AN) as well as an AMF 600. Typically, the R(AN) 502 comprises base stations, e.g. such as eNBs or gNBs or similar. Seen from the core network side, the 5GC NFs shown in Figure 6 include a NSSF 602, an AUSF 604, a UDM 606, the AMF 600, a SMF 608, a PCF 610, and an Application Function (AF) 612.

[0031] Reference point representations of the 5G network architecture are used to develop detailed call flows in the normative standardization. The N1 reference point is defined to carry signaling between the UE 512 and AMF 600. The reference points for connecting between the AN 502 and AMF 600 and between the AN 502 and UPF 614 are defined as N2 and N3, respectively. There is a reference point, N11, between the AMF 600 and SMF 608, which implies that the SMF 608 is at least partly controlled by the AMF 600. N4 is used by the SMF 608 and UPF 614 so that the UPF 614 can be set using the control signal generated by the SMF 608, and the UPF 614 can report its state to the SMF 608. N9 is the reference point for the connection between different UPFs 614, and N14 is the reference point connecting between different AMFs 600, respectively. N15 and N7 are defined since the PCF 610 applies policy to the AMF 600 and SMF 608, respectively. N12 is required for the AMF 600 to perform authentication of the UE 512. N8 and N10 are defined because the subscription data of the UE 512 is required for the AMF 600 and SMF 608.

[0032] The 5GC network aims at separating UP and CP. The UP carries user traffic while the CP carries signaling in the network. In Figure 6, the UPF 614 is in the UP and all other NFs, i.e., the AMF 600, SMF 608, PCF 610, AF 612, NSSF 602, AUSF 604, and UDM 606, are in the CP. Separating the UP and CP guarantees each plane resource to be scaled independently. It also allows UPFs to be deployed separately from CP functions in a distributed fashion. In this architecture, UPFs may be deployed very close to UEs to shorten the Round Trip Time (RTT) between UEs and data network for some applications requiring low latency.

[0033] The core 5G network architecture is composed of modularized functions. For example, the AMF 600 and SMF 608 are independent functions in the CP. Separated AMF 600 and SMF 608 allow independent evolution and scaling. Other CP functions like the PCF 610 and AUSF 604 can be separated as shown in Figure 6. Modularized function design enables the 5GC network to support various services flexibly.

[0034] Each NF interacts with another NF directly. It is possible to use intermediate functions to route messages from one NF to another NF. In the CP, a set of interactions between two NFs is defined as service so that its reuse is possible. This service enables support for modularity. The UP supports interactions such as forwarding operations between different UPFs.

5 *Figure 7*

[0035] **Figure 7** illustrates a 5G network architecture using service-based interfaces between the NFs in the CP, instead of the point-to-point reference points/interfaces used in the 5G network architecture of Figure 6. However, the NFs described above with reference to Figure 6 correspond to the NFs shown in Figure 7. The service(s) etc. that a NF provides to other authorized NFs can be exposed to the authorized NFs through the service-based interface. In Figure 7 the service based interfaces are indicated by the letter "N" followed by the name of the NF, e.g. Namf for the service based interface of the AMF 600 and Nsmf for the service based interface of the SMF 608, etc. The NEF 700 and the NRF 702 in Figure 7 are not shown in Figure 6 discussed above. However, it should be clarified that all NFs depicted in Figure 6 can interact with the NEF 700 and the NRF 702 of Figure 7 as necessary, though not explicitly indicated in Figure 6.

15 **[0036]** Some properties of the NFs shown in Figures 6 and 7 may be described in the following manner. The AMF 600 provides UE-based authentication, authorization, mobility management, etc. A UE 512 even using multiple access technologies is basically connected to a single AMF 600 because the AMF 600 is independent of the access technologies. The SMF 608 is responsible for session management and allocates Internet Protocol (IP) addresses to UEs. It also selects and controls the UPF 614 for data transfer. If a UE 512 has multiple sessions, different SMFs 608 may be allocated to each session to manage them individually and possibly provide different functionalities per session. The AF 612 provides information on the packet flow to the PCF 610 responsible for policy control in order to support QoS. Based on the information, the PCF 610 determines policies about mobility and session management to make the AMF 600 and SMF 608 operate properly. The AUSF 604 supports authentication function for UEs or similar and thus stores data for authentication of UEs or similar while the UDM 606 stores subscription data of the UE 512. The Data Network (DN), not part of the 5GC network, provides Internet access or operator services and similar.

25 **[0037]** An NF may be implemented either as a network element on a dedicated hardware, as a software instance running on a dedicated hardware, or as a virtualized function instantiated on an appropriate platform, e.g., a cloud infrastructure.

Figure 8

[0038] **Figure 8** illustrates a system 800 for SEAL group management in accordance with one embodiment of the present disclosure. As illustrated, the system 800 includes a UE 802, a 3GPP network system 804, a VAL server 806, and a SEAL group management server 808. In one embodiment, the 3GPP network system 804 is the cellular communication system 500 and, in particular, is a 5GS as illustrated in Figure 7 or 8. The VAL UE 802 is a UE (e.g., a UE 512) that includes SEAL and VAL functionality. In particular, the VAL UE 802 includes a VAL client(s) 810 and a SEAL group management client 812. Note that the VAL client(s) 810 is(are), in one embodiment, implemented in software that is executed by a processor(s) of the VAL UE 802 to thereby cause the VAL UE 802 to provide the functionality of the VAL client(s) 802 disclosed herein. Likewise, the SEAL group management client 812 is, in one embodiment, implemented in software that is executed by a processor(s) of the VAL UE 802 to thereby cause the VAL UE 802 to provide the functionality of the SEAL group management client 812 disclosed herein. The VAL server(s) 806 is, in one embodiment, implemented in software that is executed by a processor(s) of a network node(s) to thereby cause the network node(s) to provide the functionality of the VAL server(s) 806 described herein. Likewise, the SEAL group management server 808 is, in one embodiment, implemented in software that is executed by a processor(s) of a network node(s) to thereby cause the network node(s) to provide the functionality of the SEAL group management server 808 described herein.

SEAL Group Management Enhancements

[0039] In one embodiment, the SEAL group management server 808 (e.g., specified in 3GPP TS 23.434) is enhanced to enable the VAL server 806 (e.g. a FAE server) to create, update, delete, and/or subscribe to changes of a group used for a specific service, e.g. a 5GLAN group used for 5G LAN-Type service as defined in 3GPP TS 23.501. In one embodiment, the SEAL group management client 812 and the VAL server 806 (e.g., specified in 3GPP TS 23.434) are also enhanced to be able to identify that a group managed by the SEAL server 808 is used for 5G LAN-Type service.

[0040] In one embodiment, for group management creation procedures related to a specific service group, the SEAL group management server 808 is enhanced to use existing capabilities provided by the 5G system. For instance, for 5GLAN groups, the SEAL group management server 808 is enhanced to use the dynamic 5G Virtual Network (5G VN) group management procedures exposed by the NEF 700 via the N33 reference point, as specified in 3GPP TS 23.501 clause 5.29.2 and in 3GPP TS 23.502 clause 4.15.6, to create a 5GLAN group. Hence, the 5GS delivers 5G-VN group configuration information (e.g., Data Network Name (DNN), Single Network Slice Selection Assistance Information (S-NSSAI), PDU session type) to the UE 802 for each

General Public Subscription Identifier (GPSI) that belongs to the 5GLAN group. The 5G VN group configuration information is delivered in the UE Route Selection Policy (URSP) from the 5GS to the UE 802 using the UE Configuration Update procedure for transparent UE Policy delivery as described in TS 23.502 clause 4.2.4.3.

5 **[0041]** In one embodiment, the SEAL group management server 808 is also enhanced to use the Application Trigger service provided by the NEF 70 described in 3GPP TS 23.502 clause 5.2.6.5 for group announcement to the SEAL group management clients.

[0042] Also, in one embodiment, the SEAL group management server 808 is enhanced to use the VAL service identity to derive the 5G VN group data such as DNN, S-NSSAI, and PDU session type, as described in 3GPP TS 23.502 clauses 4.15.6.3b and 4.15.6.3c.

10 **[0043]** In one embodiment, the SEAL group management server 808 is also enhanced to use the procedures of event monitoring of Packet Data Network (PDN) Connectivity Status provided by the 5GS (specified in 3GPP TS 23.502 clause 4.15.3.2.3) to keep track of the connectivity status of the group member UEs, e.g. to detect VAL UE registration/de-registration to/from a group.

Figure 9

15 **[0044]** In this regard, a procedure according to at least some of the embodiments described above is illustrated in **Figure 9**. Optional steps are represented by dashed lines/boxes. As illustrated, the VAL server 806 sends a request to the group management server 808, where the request is a request to create a VAL group, a request to update a VAL group, a request to delete a VAL group, or a request to subscribe to changes of a VAL group (step 900). As discussed above, in one embodiment, the VAL group is for a specific service
20 such as, e.g., a 5GLAN group used for a 5GLAN-type service. Responsive to the received request, the group management server 808 either itself or through interaction with one or more other network entities creates a VAL group, updates a VAL group, deletes a VAL group, or provides notifications of changes to a VAL group to the VAL server 806 (step 902).

[0045] In one embodiment, the request of step 900 is a request to create a VAL group where the VAL
25 group is a 5GLAN group, and processing the request in step 904 includes creating the 5GLAN group using a dynamic 5G VN group management procedure, as described above. In one embodiment, 5G VN group configuration information is provided to each UE 802 of multiple UEs that belong to the 5GLAN group. In one embodiment, the 5G VN group configuration information includes a DNN, S-NSSAI, and/or a PDU session type. In one embodiment, the 5G VN group configuration information is provided to each UE 802 in a URSP using a
30 UE configuration update procedure for transparent UE policy delivery. In one embodiment, the process of Figure 9 includes deriving the 5G VN group configuration data based on a VAL service identity, which may be included in the request of step 900.

[0046] As discussed above, in one embodiment, the group management server 808 additionally or alternatively determines a connectivity status (e.g., in the cellular communications system 804, which may be a 5G system) of each UE 802 of multiple UEs in a VAL group (step 906). This VAL group that is the subject of the request in step 900 or a different VAL group (e.g., an existing VAL group). In one embodiment, the group management server 808 detects VAL UE registration/de-registration to/from the VAL group based on the determined connectivity status (step 908), as described above.

Figure 10

Group Creation and Registration Procedure for 5GLAN Groups

[0047] Figure 10 illustrates a procedure to create and register to a 5G-VN group in accordance with one embodiment of the present disclosure. Note that while the illustrated figure focuses on group creation, a similar procedure may be used for updating a VAL group, deleting a VAL group, or subscribing to notifications of updates/changes to a VAL group.

[0048] Pre-conditions:

1. The group management client 812, group management server 808, VAL server 806, and the VAL clients 810 (at multiple VAL UEs 802) belong to the same VAL system. The VAL clients at multiple VAL UEs are denoted herein as VAL clients 810-1 through 810-N at respective VAL UEs 802-1 through 802-N. An individual VAL client is denoted as VAL client 810-n. Likewise, in general, an individual VAL UE is denoted as VAL UE 802-n.
2. The VAL server 806 is aware of the users' identities and is authorized to form a VAL group for 5G LAN-Type communication.
3. The VAL clients 810-1 through 810-N (i.e., the VAL UEs 802-1 through 802-N) belong to the same 5G-VN group.

[0049] The steps of the procedure of Figure 10 are as follows:

1. The VAL server 806 decides to create a VAL group and defines the group information and the identity list to which the group announcement is to be sent. The identity list is, in this example, a list of identities of the VAL UEs 802-1 through 802-N. The decision can be based on the list of authorized UEs and other criteria such as, for example, requirement for 5G LAN-Type communication service. Likewise, the VAL server can decide to update, delete, or subscribe to changes to an already configured VAL group.
2. The VAL server 806 requests the SEAL group management server 808 to configure a new VAL group for 5G LAN-Type communication service providing a VAL Group ID, a list of VAL UEs 802-1 through 802-N, and a list of VAL services. Note that the list of VAL UEs is the same as the list of identities of the VAL UEs from step 1. The request sent by the VAL server 806 in step 2 is referred to as a configure

VAL group request. As described in 3GPP 23.434, the configure VAL group request includes a VAL group description, which includes information related to the VAL group such as, e.g., a group definition including policy, group size, and group leader. In one embodiment, the request includes, within the VAL group description, an indication that the VAL group requires 5GLAN-Type service and communication type (IP or Ethernet) for the group communication. Likewise, the request can be used to update, delete or subscribe to changes to an already configured VAL group.

3. The SEAL group management server 808 creates an empty group and determines that the group is for 5G LAN-Type communication, based on the information provided in the configure VAL group request. The SEAL group management server 808 determines the 5GLAN group data, such as DNN, S-NSSAI, PDU session type, for the corresponding VAL server 806. The 5GLAN group data is defined in 3GPP TS 23.502 clauses 4.15.6.3b and 4.15.6.3c.
4. The SEAL group management server 808 creates a 5GLAN group with the corresponding list of UEs 802-1 through 802-N in the 5GS. In one embodiment, this is done via N33 using the dynamic group management procedures specified in 3GPP TS 23.501 clause 5.29.2 and 3GPP TS 23.502 clause 4.15.6. The 5GS delivers 5G VN group data (e.g., DNN, S-NSSAI, PDU session type) to the UE 802-n for each GPSI that belongs to the 5GLAN group. In one embodiment, the 5G VN group configuration information is delivered in the UE Route Selection Policy (URSP) from the 5GS to the UE 802-n using the UE Configuration Update procedure for transparent UE Policy delivery as described in TS 23.502 clause 4.2.4.3. Likewise, based on the configure VAL group request, the SEAL group management server can request to update, delete or subscribe to changes to an already configured VAL group.
5. The SEAL group management server 808 may subscribe to PDN Connectivity Status events in order to be notified of the connectivity status of the VAL UEs 802-1 through 802-N of the 5GLAN group. In one embodiment, this subscription is done via N33 using the procedures specified in 3GPP TS 23.502 clause 4.15.3.2.3.

NOTE 1: The SEAL group management server 808 may use PDN Connectivity Status events e.g. to determine VAL UE's registration/de-registration state in the group.

6. The SEAL group management server 808 announces the VAL group to the SEAL group management clients 810-1 through 810-N on the corresponding UEs 802-1 through 802-N, including the DNN and communication type (e.g., IP or Ethernet) corresponding to the 5GLAN group.

NOTE 2: The SEAL group management server 808 can decide to use the Application Trigger service provided by the NEF 700 described in 3GPP TS 23.502 clause 5.2.6.5 for group announcement to the

SEAL group management clients 812 or to use the group announcement already specified in 3GPP TS 23.434.

7. The SEAL group management clients 812-1 through 812-N in the VAL UEs 802-1 through 802-N each determines the group to be a 5GLAN group and triggers establishment of a PDU session corresponding to the 5GLAN group.

8. If the SEAL group management server 808 subscribed to PDN Connectivity Status events in step 5, it is notified once the VAL UE 802-n establishes a PDU session to the 5GLAN group. Receiving this event is sufficient for the SEAL group management server 808 to determine that the VAL UE 802-n is a member of the group and to define its status as registered.

NOTE 3: In the same way, the SEAL group management server 808 can update the VAL UE status to de-registered when a corresponding PDN connectivity status event is notified.

9. The SEAL group management client 812-n in the VAL UE 802-n registers to VAL group communication using the VAL Group ID.

10. The SEAL group management server 808 records the users (e.g., UEs 802) who have registered to be the members of the group.

NOTE 4: Step 10 may occur as a result of Step 8.

11. The SEAL group management server 808 sends a VAL group registration response to the group management client 812-n.

12. The SEAL group management server 808 sends a configure VAL group response to the VAL server 806.

NOTE 5: Step 12 may occur any time after Step 6.

13. The SEAL group management server 808 sends identity list notification about the newly registered VAL clients 810-1 through 810-N. The SEAL group management clients 812-1 through 812-N in the VAL UEs 802-1 through 802-N may inform the respective VAL clients 810-1 through 810-N about the updated identity list.

Figure 11

Additional Aspects

[0050] **Figure 11** is a schematic block diagram of a network node 1100 according to some embodiments of the present disclosure. Optional features are represented by dashed boxes. The network node 1100 may be, for example, a radio access node, a core network node, or other network node that implements some or all of the functionality of the VAL server 806 and/or the group communication server 808 in accordance with any of the embodiments described herein. As illustrated, the network node 1100 includes a control system 1102 that

includes one or more processors 1104 (e.g., Central Processing Units (CPUs), Application Specific Integrated Circuits (ASICs), Field Programmable Gate Arrays (FPGAs), and/or the like), memory 1106, and a network interface 1108. The one or more processors 1104 are also referred to herein as processing circuitry. In addition, if the network node 1100 is a radio access node, the network node 1100 may also include one or more radio units 1110 that each includes one or more transmitters 1112 and one or more receivers 1114 coupled to one or more antennas 1116. The radio units 1110 may be referred to or be part of radio interface circuitry. In some embodiments, the radio unit(s) 1110 is external to the control system 1102 and connected to the control system 1102 via, e.g., a wired connection (e.g., an optical cable). However, in some other embodiments, the radio unit(s) 1110 and potentially the antenna(s) 1116 are integrated together with the control system 1102. The one or more processors 1104 operate to provide one or more functions of the network node 1100 as described herein (e.g., some or all of the functionality of the VAL server 806 and/or the group communication server 808 in accordance with any of the embodiments described herein). In some embodiments, the function(s) are implemented in software that is stored, e.g., in the memory 1106 and executed by the one or more processors 1104.

15 *Figure 12*

[0051] **Figure 12** is a schematic block diagram that illustrates a virtualized embodiment of the network node 1100 according to some embodiments of the present disclosure. As used herein, a “virtualized” network node is an implementation of the network node 1100 in which at least a portion of the functionality of the network node 1100 is implemented as a virtual component(s) (e.g., via a virtual machine(s) executing on a physical processing node(s) in a network(s)). As illustrated, in this example, the network node 1100 may include the control system 1102 and/or the one or more radio units 1110, as described above. The control system 1102 may be connected to the radio unit(s) 1110 via, for example, an optical cable or the like. The network node 1100 includes one or more processing nodes 1200 coupled to or included as part of a network(s) 1202. If present, the control system 1102 or the radio unit(s) is connected to the processing node(s) 1200 via the network 1202. Each processing node 1200 includes one or more processors 1204 (e.g., CPUs, ASICs, FPGAs, and/or the like), memory 1206, and a network interface 1208.

[0052] In this example, functions 1210 of the network node 1100 described herein (e.g., some or all of the functionality of the VAL server 806 and/or the group communication server 808 in accordance with any of the embodiments described herein) are implemented at the one or more processing nodes 1200 or distributed across the one or more processing nodes 1200 and the control system 1102 and/or the radio unit(s) 1110 in any desired manner. In some particular embodiments, some or all of the functions 1210 of the network node

1100 described herein are implemented as virtual components executed by one or more virtual machines implemented in a virtual environment(s) hosted by the processing node(s) 1200.

[0053] In some embodiments, a computer program including instructions which, when executed by at least one processor, causes the at least one processor to carry out the functionality of the network node 1100 or a node (e.g., a processing node 1200) implementing one or more of the functions 1210 of the network node 1100 in a virtual environment according to any of the embodiments described herein is provided. In some embodiments, a carrier comprising the aforementioned computer program product is provided. The carrier is one of an electronic signal, an optical signal, a radio signal, or a computer readable storage medium (e.g., a non-transitory computer readable medium such as memory).

10 *Figure 13*

[0054] **Figure 13** is a schematic block diagram of the network node 1100 according to some other embodiments of the present disclosure. The network node 1100 includes one or more modules 1300, each of which is implemented in software. The module(s) 1300 provide the functionality of the network node 1100 described herein (e.g., some or all of the functionality of the VAL server 806 and/or the group communication server 808 in accordance with any of the embodiments described herein). This discussion is equally applicable to the processing node 1200 of Figure 12 where the modules 1300 may be implemented at one of the processing nodes 1200 or distributed across multiple processing nodes 1200 and/or distributed across the processing node(s) 1200 and the control system 1102.

Figure 14

20 **[0055]** **Figure 14** is a schematic block diagram of a wireless communication device 1400 according to some embodiments of the present disclosure. The wireless communication device 1400 may be the UE 512 or the VAL UE 802. As illustrated, the wireless communication device 1400 includes one or more processors 1402 (e.g., CPUs, ASICs, FPGAs, and/or the like), memory 1404, and one or more transceivers 1406 each including one or more transmitters 1408 and one or more receivers 1410 coupled to one or more antennas 1412. The transceiver(s) 1406 includes radio-front end circuitry connected to the antenna(s) 1412 that is configured to condition signals communicated between the antenna(s) 1412 and the processor(s) 1402, as will be appreciated by one of ordinary skill in the art. The processors 1402 are also referred to herein as processing circuitry. The transceivers 1406 are also referred to herein as radio circuitry. In some embodiments, the functionality of the wireless communication device 1400 described above may be fully or partially implemented in software that is, e.g., stored in the memory 1404 and executed by the processor(s) 1402. Note that the wireless communication device 1400 may include additional components not illustrated in Figure 14 such as,

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e.g., one or more user interface components (e.g., an input/output interface including a display, buttons, a touch screen, a microphone, a speaker(s), and/or the like and/or any other components for allowing input of information into the wireless communication device 1400 and/or allowing output of information from the wireless communication device 1400), a power supply (e.g., a battery and associated power circuitry), etc.

5 **[0056]** In some embodiments, a computer program including instructions which, when executed by at least one processor, causes the at least one processor to carry out the functionality of the wireless communication device 1400 according to any of the embodiments described herein is provided. In some embodiments, a carrier comprising the aforementioned computer program product is provided. The carrier is one of an electronic signal, an optical signal, a radio signal, or a computer readable storage medium (e.g., a
10 non-transitory computer readable medium such as memory).

Figure 15

[0057] **Figure 15** is a schematic block diagram of the wireless communication device 1400 according to some other embodiments of the present disclosure. The wireless communication device 1400 includes one or more modules 1500, each of which is implemented in software. The module(s) 1500 provide the functionality of
15 the wireless communication device 1400 described herein.

[0058] Any appropriate steps, methods, features, functions, or benefits disclosed herein may be performed through one or more functional units or modules of one or more virtual apparatuses. Each virtual apparatus may comprise a number of these functional units. These functional units may be implemented via processing circuitry, which may include one or more microprocessor or microcontrollers, as well as other digital
20 hardware, which may include Digital Signal Processor (DSPs), special-purpose digital logic, and the like. The processing circuitry may be configured to execute program code stored in memory, which may include one or several types of memory such as Read Only Memory (ROM), Random Access Memory (RAM), cache memory, flash memory devices, optical storage devices, etc. Program code stored in memory includes program
25 instructions for executing one or more telecommunications and/or data communications protocols as well as instructions for carrying out one or more of the techniques described herein. In some implementations, the processing circuitry may be used to cause the respective functional unit to perform corresponding functions according one or more embodiments of the present disclosure.

[0059] While processes in the figures may show a particular order of operations performed by certain embodiments of the present disclosure, it should be understood that such order is exemplary (e.g., alternative
30 embodiments may perform the operations in a different order, combine certain operations, overlap certain operations, etc.).

[0060] Embodiments

Some of the embodiments described above may be summarized in the following manner:

- 5 1. A method performed by a group management server (808) for service enabler architecture layer, SEAL, over a cellular communications system for support of vertical applications, the method comprising:
 receiving (900; Fig. 10, step 2) a request from a vertical application layer, VAL, server (806), the request being: (a) a request to create a VAL group, (b) a request to update a VAL group, (c) a request to delete a VAL group, or (d) a request to subscribe to changes of a VAL group; and
10 processing (904; Fig. 10, steps 3-4) the request.
2. The method of embodiment 1 wherein the VAL group is for a specific service.
3. The method of embodiment 1 wherein the VAL group is a 5GLAN group used for a 5GLAN-type
15 service.
4. The method of embodiment 1 wherein the request is a request to create a VAL group, the VAL group is a 5GLAN group, and processing (904) the request comprises creating the 5GLAN group using a dynamic 5G Virtual Network, 5G VN, group management procedure.
20
5. The method of embodiment 1 wherein the request can be a request to delete, update or subscribe to changes to an already configured VAL group.
6. The method of embodiment 4 wherein 5G VN group data is provided to each User Equipment, UE,
25 (802) of a plurality of UEs that belong to the 5GLAN group.
7. The method of embodiment 6 wherein the 5G VN group data comprises:
 a Data Network Name, DNN;
 a Single Network Slice Selection Assistance Information, S-NSSAI; and/or
30 a Protocol Data Unit, PDU, session type.
8. The method of embodiment 6 or 7 wherein the 5G VN group data is provided to each UE (802) in a UE Route Selection Policy (URSP) using a UE configuration update procedure for transparent UE policy delivery.

9. The method of any of embodiments 6 to 8 further comprising deriving (step 902) the 5G VN group data based on a VAL service identity (e.g., included in the request).
- 5 10. The method of any of embodiments 1 to 9 further comprising:
determining (step 906) a connectivity status of each UE (802) of a plurality of UEs in a VAL group.
11. The method of embodiment 10 further comprising detecting (step 908) VAL UE registration or de-registration to or from the VAL group based on the determined connectivity status of each UE (802) of the
10 plurality of UEs in the VAL group.
12. The method of embodiment 1 wherein the request is a request to create a VAL group, update a VAL group, delete a VAL group, or subscribe to changes a VAL group, for a 5GLAN-type communication service.
- 15 13. The method of embodiment 12 wherein the request comprises a VAL group ID of the VAL group to be created or updated or deleted or to subscribe to changes.
14. The method of embodiment 12 or 13 wherein the request is a request to create a VAL group for
20 5GLAN-type communication service.
15. The method of embodiment 14 wherein the request comprises a list of IDs of a plurality of UEs (802-1 through 802-N) to be included in the VAL group to be created, and/or information that indicates one or more VAL services for the VAL group to be created.
- 25 16. The method of any of embodiments 14 to 15 wherein processing (Fig. 10, steps 3-4) the request comprises:
creating (Fig. 10, steps 3-4) the VAL group such that the VAL group comprises a plurality of UEs (802-1 through 802-N) identified in the request.
- 30 17. The method of embodiment 16 wherein creating (Fig. 10, steps 3-4) the VAL group comprises creating (Fig. 10, steps 3-4) the VAL group using a dynamic group management procedure.

18. The method of embodiment 17 wherein 5G VN group configuration data is delivered to each UE in the VAL group (e.g., in a URSP using the configuration update procedure for transparent UE policy delivery).
19. The method of any of embodiments 12 to 18 wherein the request comprises information that indicates a 5G LAN-type service for the VAL group.
20. The method of any of embodiments 12 to 19 wherein the request comprises information that indicates a communication type (e.g., IP or Ethernet) for group communication for the VAL group.
21. The method of embodiment 12 or 13 wherein the request is a request to update, delete, or subscribe to changes to an existing VAL group.
22. The method of embodiment 12 or 13 wherein the request is a request to update an existing VAL group, and processing the request comprises updating the VAL group using a dynamic group management procedure.
23. The method of embodiment 12 or 13 wherein the request is a request to subscribe to changes to an existing VAL group, and processing the request comprises subscribing to changes to the existing VAL group using a dynamic group management procedure.
24. The method of embodiment 12 or 13 wherein the request is a request to delete an existing VAL group, and processing the request comprises deleting the VAL group using a dynamic group management procedure.
25. The method of any of embodiments 12 to 24 further comprising subscribing (Fig. 10, step 5) to PDN connectivity status events of the UEs in the VAL group.
26. The method of any of embodiments 12 to 25 further comprising announcing (Fig. 10, step 6) the VAL group to group management clients on the UEs in the VAL group.
27. The method of embodiment 25 further comprising receiving (Fig. 10, step 8), from a UE in the VAL group, a notification that the UE has established a PDU session to the VAL group.

28. The method of embodiment 25 or 27 further comprising recording (Fig. 10, step 10) UEs that have registered to be members of the VAL group.

29. The method of any of embodiments 25, 27, or 28 further comprising sending (Fig. 10, step 13) a notification about newly registered VAL clients to group management clients at the UEs in the VAL group.

30. A group management server (808) for service enable architecture layer, SEAL, over a cellular communications system for support of vertical applications, the group management server (808) adapted to perform the method of any of embodiments 1 to 29.

31. A network node (1100) that implements a group management server (808) for service enable architecture layer, SEAL, over a cellular communications system for support of vertical applications, the network node (1100) comprising processing circuitry (1104; 1204) configured to cause the network node (1100) to perform the method of any of embodiments 1 to 29.

32. A method performed by a User Equipment, UE, (802-n) comprising:

- receiving (Fig. 10, step 4), from a cellular communications system (500; 804), 5G Virtual Network, 5G VN, group configuration information (e.g., in a URSP using a configuration update procedure for transparent UE policy delivery);
- at a group management client (812-n) of the UE (802-n):
 - receiving (Fig. 10, step 6) an announcement of a VAL group from a group management server (812);
 - triggering (Fig. 10, step 7) establishment of a PDU session corresponding to the VAL group;
 - registering (Fig. 10, step 9) to group communication for the VAL group.

33. A User Equipment, UE, (802-n) adapted to perform the method of embodiment 32.

34. A User Equipment, UE, (802-n) comprising:

- one or more transmitters (1408);
- one or more receivers (1410); and

processing circuitry (1402) associated with the one or more transmitters (1408) and the one or more receivers (1410), the processing circuitry (1402) configured to cause the UE (802-n) to perform the method of embodiment 32.

5

Abbreviations

At least some of the following abbreviations may be used in this disclosure. If there is an inconsistency between abbreviations, preference should be given to how it is used above. If listed multiple times below, the first listing should be preferred over any subsequent listing(s).

10

- 3GPP Third Generation Partnership Project
- 5G Fifth Generation
- 5GC Fifth Generation Core
- 5GS Fifth Generation System

15

- AF Application Function
- AMF Access and Mobility Management Function
- AN Access Network
- ASIC Application Specific Integrated Circuit
- AUSF Authentication Server Function
- CPU Central Processing Unit

20

- DN Data Network
- DSP Digital Signal Processor
- eNB Enhanced or Evolved Node B
- EPC Evolved Packet Core
- E-UTRA Evolved Universal Terrestrial Radio Access

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- FPGA Field Programmable Gate Array
- gNB New Radio Base Station
- gNB-CU New Radio Base Station Central Unit
- gNB-DU New Radio Base Station Distributed Unit
- HSS Home Subscriber Server

30

- IoT Internet of Things
- IP Internet Protocol
- LTE Long Term Evolution

- MME Mobility Management Entity
- MTC Machine Type Communication
- NEF Network Exposure Function
- NF Network Function
- 5 • NR New Radio
- NRF Network Function Repository Function
- NSSF Network Slice Selection Function
- OTT Over-the-Top
- PC Personal Computer
- 10 • PCF Policy Control Function
- P-GW Packet Data Network Gateway
- QoS Quality of Service
- RAM Random Access Memory
- RAN Radio Access Network
- 15 • ROM Read Only Memory
- RRH Remote Radio Head
- RTT Round Trip Time
- SCEF Service Capability Exposure Function
- SMF Session Management Function
- 20 • UDM Unified Data Management
- UE User Equipment
- UPF User Plane Function

[0061] Appendix

**3GPP TSG-SA WG6 Meeting #38-e
e-meeting, 20th – 31st July 2020**

**S6-20xxxx
(revision of S6-20xxxx)**

5

Source: Ericsson

Title: Pseudo-CR on 5GLAN group management solution

Spec: 3GPP TR 23.745 v0.8.0

Agenda item: x.x

10 **Document for: Approval**

Contact: Camilo Solano (camilo.solano@ericsson.com)

1. Introduction

This contribution proposes to expand the scope of KI#6 to investigate the use of SEAL
 15 Group Management for 5GLAN group management and proposes changes to Solution #9
 describing needed SEAL GM enhancements.

2. Reason for Change

This contribution proposes to enhance the solution #9 for KI#6 – 5GLAN group management.

3. Conclusions

20 <Conclusion part (optional)>

4. Proposal

It is proposed to agree the following changes to 3GPP TR 23.745 v0.8.0.

25

*** First Change ***

5.6 Key issue 6 - 5GLAN group management

3GPP TS 22.261 [2] describes 5G LAN-type service and 5GLAN traffic types, service exposure requirements as follow:

- The 5G system shall support 5G LAN-type service in a shared RAN configuration.
- 30 The 5G system shall support 5G LAN-type service over a wide area mobile network.

The 5G network shall support service continuity for 5G LAN-type service, i.e., the private communication between UEs shall not be interrupted when one or more UEs of the private communication move within the same network that provides the 5G LAN-type service.

5 The 5G system shall support use of unlicensed as well as licensed spectrum for 5G LAN-type services.

The 5G system shall enable the network operator to provide the same 5G LAN-type service to any 5G UE, regardless of whether it is connected via public base stations, indoor small base stations connected via fixed access, or via relay UEs connected to
10 either of these two types of base stations.

The 5G system shall support traffic scenarios typically found in an industrial setting (from sensors to remote control, large amount of UEs per group) for 5G LAN-type service.

The 5G network shall provide suitable APIs to allow a trusted 3rd party to add/remove an authorized UE to/from a specific 5G LAN-VN managed by the trusted 3rd party.

15

3GPP TS 23.501 [7] describes features to support 5G LAN Group Management. 5G System supports management of 5G VN Group identification and membership (i.e. definition of 5G VN group identifiers and membership) and 5G VN Group data (i.e. definition of 5G VN group data). In order to support dynamic management of 5G VN Group
20 identification and membership, the NEF exposes a set of services to manage (e.g. add/delete/modify) 5G VN group and 5G VN member. The NEF also exposes services to dynamically manage 5G VN group data.

3GPP TS 22.104 [3] describes Ethernet applications:

25 "This section lists the requirements applicable to the 5G system for supporting cyber-physical applications using Ethernet.

For requirements pertaining to common, fundamental Ethernet transport requirements, and any requirements necessary to support the 5G LAN-type service, see Clause 6.24 in TS 22.261 [2]."

30 The following Ethernet applications requirements:

For infrastructure dedicated to high performance Ethernet applications, the 3GPP system shall support enhancements for time-sensitive networking as defined by IEEE 802.1Q,

e.g. time-aware scheduling with absolute cyclic time boundaries defined by IEEE 802.1Qbv, for 5G-based Ethernet links with PDU sessions type Ethernet.

The Ethernet transport service shall support routing based on information extracted from the Ethernet header information created based on 802.1Qbv.

5

Open issues for the application layer support of Factories of the Future :

- a. How to integrate 5G LAN type service with TSN for group management?
- b. Investigate whether and how SEAL Group management service should support 5GLAN group management.

10

* * * Next Change * * * *

7.9.1.1 General

In factory network, the FF UE is using 5G LAN-type of services, when a FF UE is in a group, which includes 5GLAN related network information.

- 15 The FAE capabilities (FAE client and FAE server) utilize the group management service procedures (e.g. creation, group membership update) of SEAL based on the 5GLAN group configuration information provided by the FF application specific layer.

* * * Next Change * * * *

7.9.1.2 Information flows

The following information flows of group management service of SEAL as specified in 3GPP TS 23.434 [8] are applicable for the FF applications:

- Group creation request from the SEAL group management client to the SEAL group management server, information specified in table 10.3.2.1-1;
- 25 - Group creation response from the SEAL group management server to the SEAL group management client, information specified in table 10.3.2.2-1;
- Group creation notification from the SEAL group management server to the FAE server, information specified in table 10.3.2.3-1;
- Group information query request from the SEAL group management client to the SEAL group management server, specified in subclause 10.3.2.4;
- 30 - Group information query response from the SEAL group management server to the SEAL group management client specified in subclause 10.3.2.5;

- Group membership update request from the SEAL group management client to the SEAL group management server, information specified in table 10.3.2.6-1;
- Group membership update response from the SEAL group management server to the SEAL group management client, information specified in table 10.3.2.7-1;
- 5 - Group membership notification from the SEAL group management server to the FAE server, information specified in table 10.3.2.8-2;
- Group deletion request from the SEAL group management client to the SEAL group management server, information specified in table 10.3.2.9-1;
- 10 - Group deletion response from the SEAL group management server to the SEAL group management client, information specified in table 10.3.2.10-1;
- Group deletion notification from the SEAL group management server to the SEAL group management client and FAE server, information specified in table 10.3.2.11-1;
- Store group configuration request from the SEAL group management client to the SEAL group management server, information specified in table 10.3.2.18-1;
- 15 - Store group configuration response from the SEAL group management server to the SEAL group management client, information specified in table 10.3.2.19-1;
- Get group configuration request from the SEAL group management client to the SEAL group management server, specified in subclause 10.3.2.20;
- 20 - Get group configuration response from the SEAL group management server to the SEAL group management client, specified in subclause 10.3.2.21;
- Subscribe group configuration request from the SEAL group management client to the SEAL group management server, information specified in table 10.3.2.22-1;
- Subscribe group configuration response from the SEAL group management server to the SEAL group management client, information specified in table 10.3.2.23-1;
- 25 - Notify group configuration request from the SEAL group management server to the SEAL group management client, information specified in table 10.3.2.24-1;
- Notify group configuration response from the SEAL group management client to the SEAL group management server, information specified in table 10.3.2.25-1;
- 30 - Group announcement from the SEAL group management server to the SEAL group management client, information specified in table 10.3.2.28-1;
- Group registration request from the SEAL group management client to the SEAL group management server, information specified in table 10.3.2.29-1;
- Group registration response from the SEAL group management server to the SEAL group management client, information specified in table 10.3.2.30-1;
- 35 - Group de-registration request from the SEAL group management client to the SEAL group management server, information specified in table 10.3.2.32-1;
- Group de-registration response from the SEAL group management server to the SEAL group management client, information specified in table 10.3.2.33-1;
- 40 - Identity list notification from the SEAL group management server to the SEAL group management client and to the FEA server, information specified in tables 10.3.2.31-1 and tables 10.3.2.31-2 respectively;
- Configure VAL group request from the FAE server to the SEAL group management server with FF 5GLAN group configuration information, information specified in table 7.9.1.2-1 as below;

Table 7.9.1.2-1, which is based on Table 10.3.2.26-1 in 3GPP TS 23.434 [8], describes the information flow for configure VAL group request from a VAL server to the SEAL group management server.

Table 7.9.1.2-1: Configure VAL group request

Information element	Status	Description
Requester Identity	M	The identity of the VAL server performing the request.
VAL group ID	M	The group ID used for the VAL group.
VAL group description	M	Information related to the VAL group e.g. group definition including policy, group size, group leader.
VAL service ID list (see NOTE)	O	List of VAL services whose service communications are to be enabled on the group.
Geo ID list (see NOTE)	O	List of geographical areas to be addressed by the group.
Identity list (see NOTE)	O	List of VAL UE IDs who are member of the group.
Identity list subscription	O	Indicates interest to receive notifications of newly registered VAL UE IDs.
NOTE: At least one of these IEs shall be present.		

5

- Configure VAL group response from the group management server to the FAE server, specified in subclause 10.3.2.27;

The usage of the above information flows is clarified as below:

- The identity list is the list of FF UE IDs.
 - During group creation the identity list contains the list of FF UE IDs that are part of the group to be created. If the group member list is empty, an empty group is created; and
- The VAL group ID is the FF 5GLAN group ID, which corresponds to the External Group ID in 3GPP TS 23.502 clause 4.15.3b;
- The identity is the FF UE ID;
- The VAL server is the FAE server;
- The VAL group description shall include description of the group indicating 5G LAN-Type service and communication type (IP or Ethernet) for the group communication. 5GLAN-Type service is defined in 3GPP TS 23.501 [7];
- The VAL service ID list should include at least the FF service identity;

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*** Next Change ***

7.9.1.x Required SEAL group management enhancements

SEAL group management server shall enable a VAL server (FAE server) to create, update, delete, subscribe to changes of a 5GLAN group. 5GLAN group is defined in 3GPP TS 23.501 [7]. The SEAL group management client and the VAL server shall be able to identify that a group managed by the SEAL server is used for 5G LAN-Type service.

25

For group management procedures pertaining to a 5GLAN group the SEAL group management server shall use dynamic 5G VN group management procedures exposed by NEF via the N33 reference point, as specified in TS 23.501 [7] clause 5.29.2 and in TS 23.502 [12] clause 4.15.6.

- 5 5GLAN (also referred to as 5G VN) group data is specified in TS 23.502 [12] clauses 4.15.6.3b and 4.15.6.3c. The SEAL group management server shall use the VAL service identity to derive the 5G VN group data such as DNN, S-NSSAI, etc.

The SEAL group management may use the procedures of the event monitoring of PDN Connectivity Status specified in 3GPP TS 23.502 [12] clause 4.15.3.2.3 to keep track of the connectivity status of the group member UEs, e.g. to detect VAL UE registration/de-registration to/from the group.

* * * Next Change * * * *

7.9.1.y 5GLAN group creation and join procedure

15 This procedure is based on the Group announcement and join procedure in 3GPP TS 23.434 [8] clause 10.3.8. In this procedure the VAL server is composed of the FAE server and the FF application specific server.

Pre-conditions:

1. The group management client, group management server, VAL server and the VAL clients belong to the same VAL system.
- 20 2. The VAL server is aware of the users' identities and is authorized to form a VAL group for 5G LAN-Type communication.

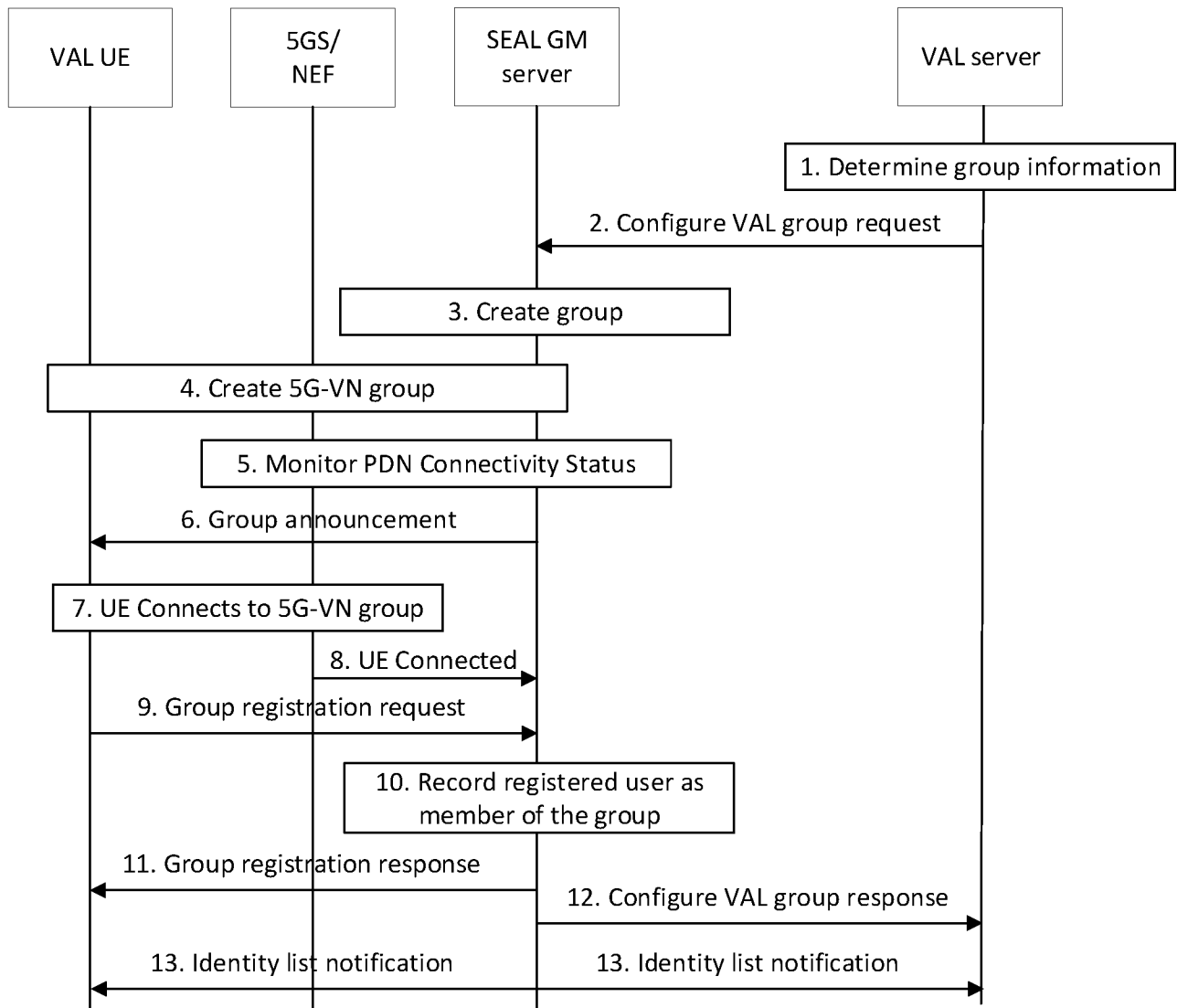


Figure 7.9.1.y-1: Procedure for creating a VAL group for 5G LAN-Type communication.

- 5 14. The VAL server determines group information and the identity list to which the group announcement shall be sent. The decision can be based on the list of authorized UEs and other criteria such as requirement for 5G LAN-Type communication service.
- 15. The VAL server requests the SEAL group management server to configure a new VAL group for 5G LAN-Type communication service providing a VAL Group ID, a list of VAL UEs and a list of VAL services.
- 10 16. The SEAL group management server creates an empty group and determines that the group is for 5G LAN-Type communication, based on the information provided in the Configure VAL group request. The SEAL group management server determines 5GLAN group data for the VAL server.
- 15 17. The SEAL group management server creates a 5GLAN group in the 5GS via N33 using the dynamic group management procedures specified in 3GPP TS 23.501 [7] clause 5.29.2 and 3GPP TS 23.502 [12] clause 4.15.6. The 5GS delivers 5G VN group configuration information (DNN, S-NSSAI, PDU session type) to the UE for each GPSI that belongs to the 5GLAN group. The 5G VN group configuration information is delivered in the UE Route Selection Policy (URSP) from the 5GS to the UE using the UE Configuration Update procedure for transparent UE Policy delivery as described in TS 23.502 [12] clause 4.2.4.3.

18. The SEAL group management server may subscribe to PDN Connectivity Status events via N33 using the procedures specified in 3GPP TS 23.502 [12] clause 4.15.3.2.3 in order to be notified of the connectivity status of the VAL UEs of the 5GLAN group.

NOTE: The SEAL group management server may use PDN Connectivity Status events e.g. to determine VAL UE's registration state in the group.

19. The SEAL group management server announces the VAL group to the group management clients, including the DNN and communication type (IP or Ethernet) corresponding to the 5GLAN group,

NOTE: The SEAL group management server can decide to use the Application Trigger service provided by the NEF described in 3GPP TS 23.502 [12] clause 5.2.6.5 for group announcement to the group management client or to use the group announcement already specified in 3GPP TS 23.434 [8].

20. The SEAL group management client in the VAL UE determines the group to be a 5GLAN group and triggers establishment of a PDU session corresponding to the 5GLAN group.

21. If the SEAL group management server subscribed to PDN Connectivity Status events in step 5, it is notified once the VAL UE establishes a PDU session to the 5GLAN group. Receiving this event is sufficient for the SEAL group management server to determine that the VAL UE is a member of the group.

22. The SEAL group management client in the VAL UE registers to VAL group communication using the VAL Group ID.

23. The SEAL group management server records the users who have registered to be the members of the group.

NOTE: Step 10 may occur as a result of Step 8.

24. The SEAL group management server sends a VAL group registration response to the group management client.

25. The SEAL group management server sends a configure VAL group response to the VAL server.

NOTE: Step 12 may occur anytime after Step 6.

26. The SEAL group management server sends identity list notification about the newly registered users. The group management client in the VAL UE may inform VAL client about the updated identity list.

CLAIMS

What is claimed is:

1. A method performed by a group management server (808) for service enabler architecture layer, SEAL, over a cellular communications system for support of vertical applications, the method comprising:
5 receiving (900; Fig. 10, step 2) a request from a vertical application layer, VAL, server (806), the request being at least one of: (a) a request to create a VAL group, (b) a request to update a VAL group, (c) a request to delete a VAL group, or (d) a request to subscribe to changes of a VAL group; and
10 processing (904; Fig. 10, steps 3-4) the request.
- 2 The method of claim 1 wherein the request is a request to create a VAL group, the VAL group is a 5GLAN group, and processing (904) the request comprises creating the 5GLAN group using a dynamic 5G Virtual Network, 5G VN, group management procedure.
- 15 3. The method of claim 2 wherein 5G VN group data is provided to each User Equipment, UE, (802) of a plurality of UEs that belong to the 5GLAN group.
4. The method of claim 3 wherein the 5G VN group data is provided to each UE (802) in a UE Route Selection Policy (URSP) using a UE configuration update procedure for transparent UE policy delivery.
- 20 5. The method of any of claim 3 to 4 further comprising deriving (step 902) the 5G VN group data based on a VAL service identity (e.g., included in the request).
6. The method of any of claim 1 to 5 further comprising:
25 determining (step 906) a connectivity status of each UE (802) of a plurality of UEs in a VAL group.
7. The method of claim 6 further comprising detecting (step 908) VAL UE registration or de-registration to or from the VAL group based on the determined connectivity status of each UE (802) of the plurality of UEs in the VAL group.
- 30 8. The method of claim 1 wherein the request is a request to create a VAL group, update a VAL group, delete a VAL group, or subscribe to changes a VAL group, for a 5GLAN-type communication service.

9. The method of claim 8 wherein the request comprises a list of IDs of a plurality of UEs (802-1 through 802-N) to be included in the VAL group to be created, and/or information that indicates one or more VAL services for the VAL group to be created.

5

10. The method of claim 9 wherein processing (Fig. 10, steps 3-4) the request comprises:
creating (Fig. 10, steps 3-4) the VAL group such that the VAL group comprises a plurality of UEs (802-1 through 802-N) identified in the request.

10 11. The method of claim 10 wherein creating (Fig. 10, steps 3-4) the VAL group comprises creating (Fig. 10, steps 3-4) the VAL group using a dynamic group management procedure.

12. The method of claim 11 wherein 5G VN group configuration data is delivered to each UE in the VAL group (e.g., in a URSP using the configuration update procedure for transparent UE policy delivery).

15

13. The method of any of claim 8 to 12 wherein the request comprises information that indicates a 5G LAN-type service for the VAL group, and/or information that indicates a communication type (e.g., IP or Ethernet) for group communication for the VAL group.

20 14. The method of claim 8 wherein the request is a request to update an existing VAL group, and processing the request comprises updating the VAL group using a dynamic group management procedure, and/or the request is a request to subscribe to changes to an existing VAL group, and processing the request comprises subscribing to changes to the existing VAL group using a dynamic group management procedure, and/or the request is a request to delete an existing VAL group, and processing the request comprises deleting
25 the VAL group using a dynamic group management procedure.

15. The method of any of claim 8 to 14 further comprising subscribing (Fig. 10, step 5) to PDN connectivity status events of the UEs in the VAL group.

30 16. The method of any of claim 8 to 15 further comprising announcing (Fig. 10, step 6) the VAL group to group management clients on the UEs in the VAL group.

17. The method of claim 15 further comprising receiving (Fig. 10, step 8), from a UE in the VAL group, a notification that the UE has established a PDU session to the VAL group.

18. A group management server (808) for service enable architecture layer, SEAL, over a cellular communications system for support of vertical applications, the group management server (808) adapted to perform the method of any of claim 1 to 17.

19. A network node (1100) that implements a group management server (808) for service enable architecture layer, SEAL, over a cellular communications system for support of vertical applications, the network node (1100) comprising processing circuitry (1104; 1204) configured to cause the network node (1100) to perform the method of any of claim 1 to 17.

20. A method performed by a User Equipment, UE, (802-n) comprising:

- receiving (Fig. 10, step 4), from a cellular communications system (500; 804), 5G Virtual Network, 5G VN, group configuration information (e.g., in a URSP using a configuration update procedure for transparent UE policy delivery);
- at a group management client (812-n) of the UE (802-n):
 - receiving (Fig. 10, step 6) an announcement of a VAL group from a group management server (812);
 - triggering (Fig. 10, step 7) establishment of a PDU session corresponding to the VAL group;
 - registering (Fig. 10, step 9) to group communication for the VAL group.

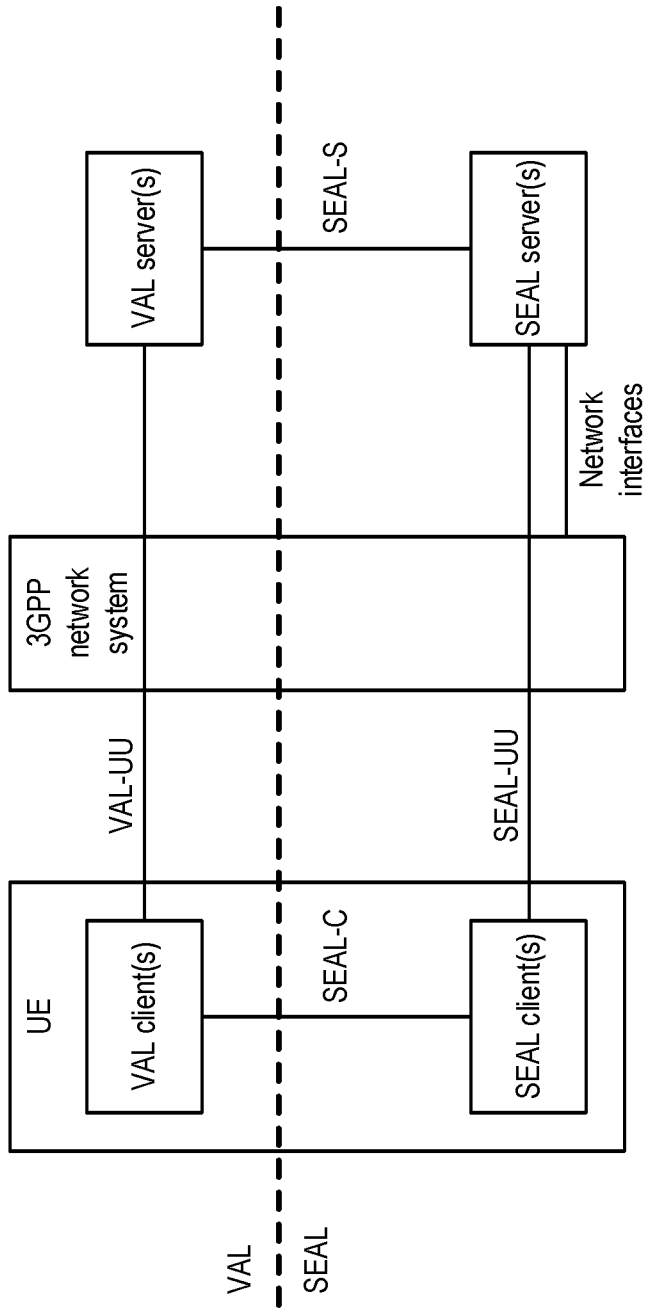


FIG. 1

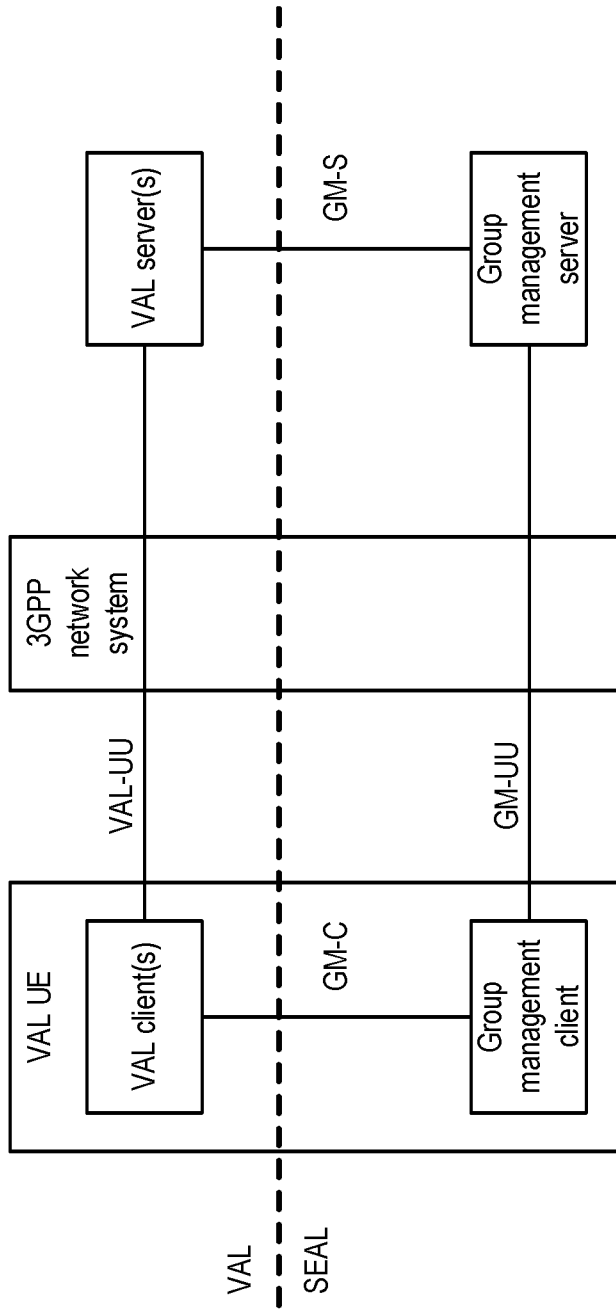


FIG. 2

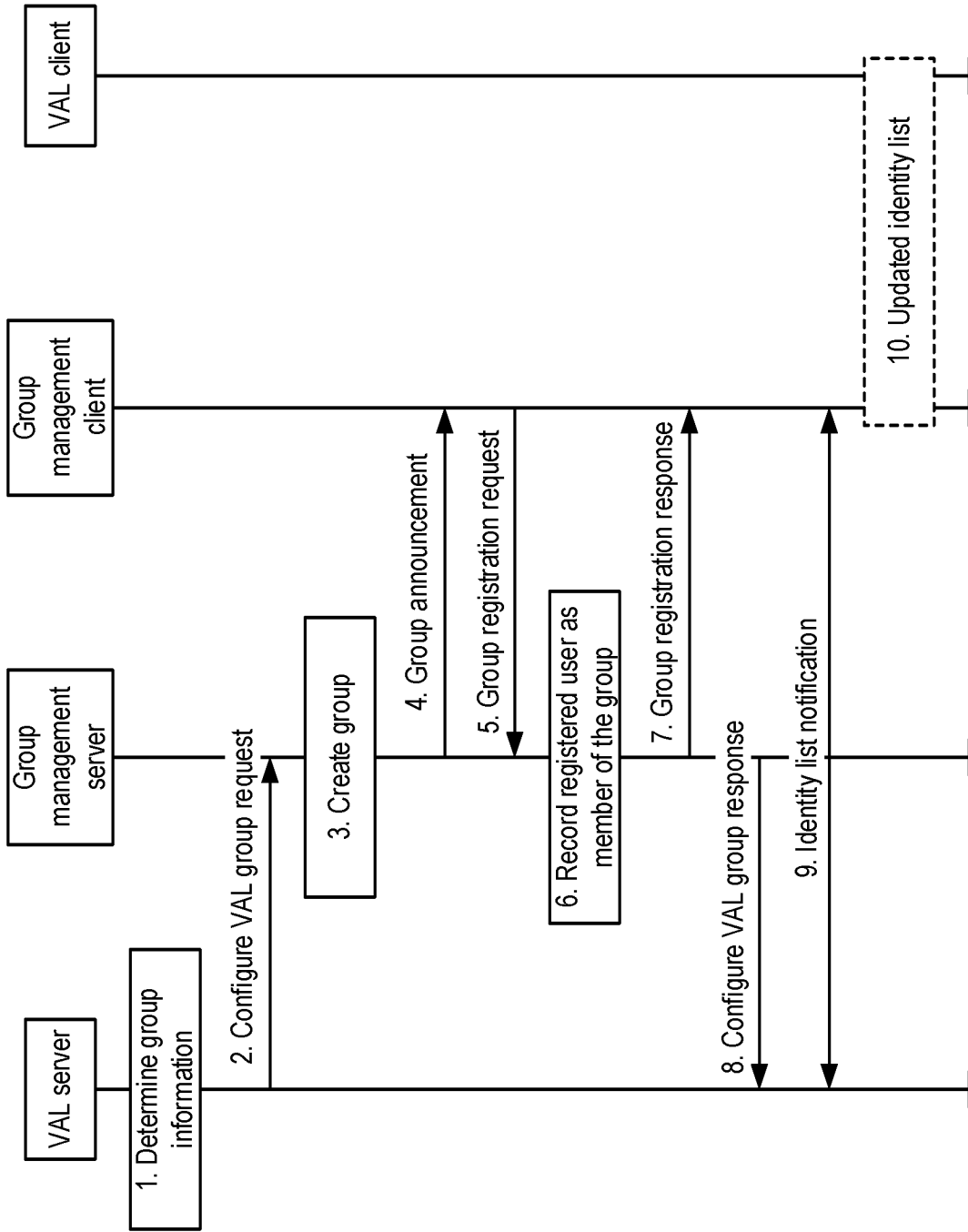


FIG. 3

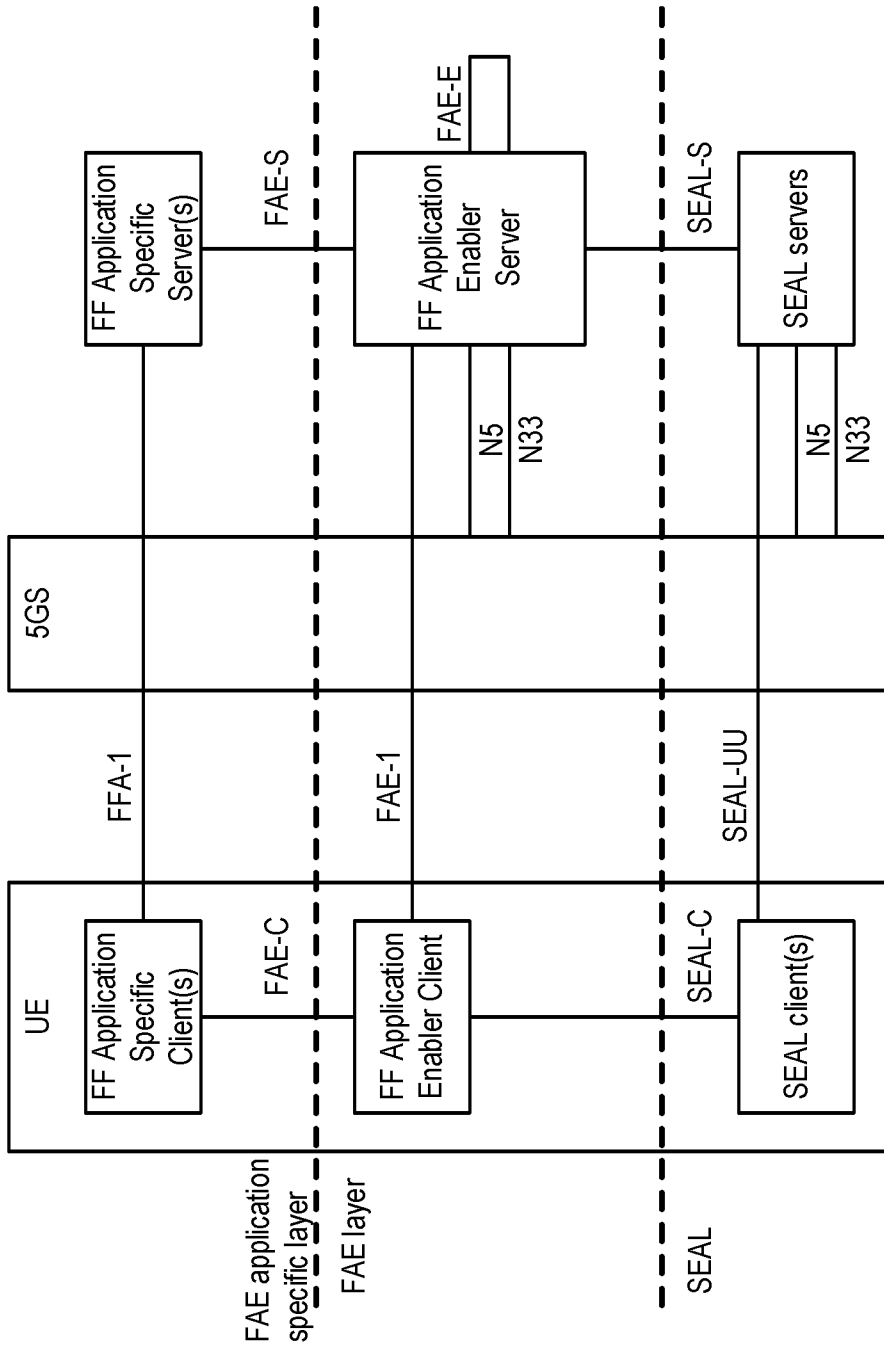


FIG. 4

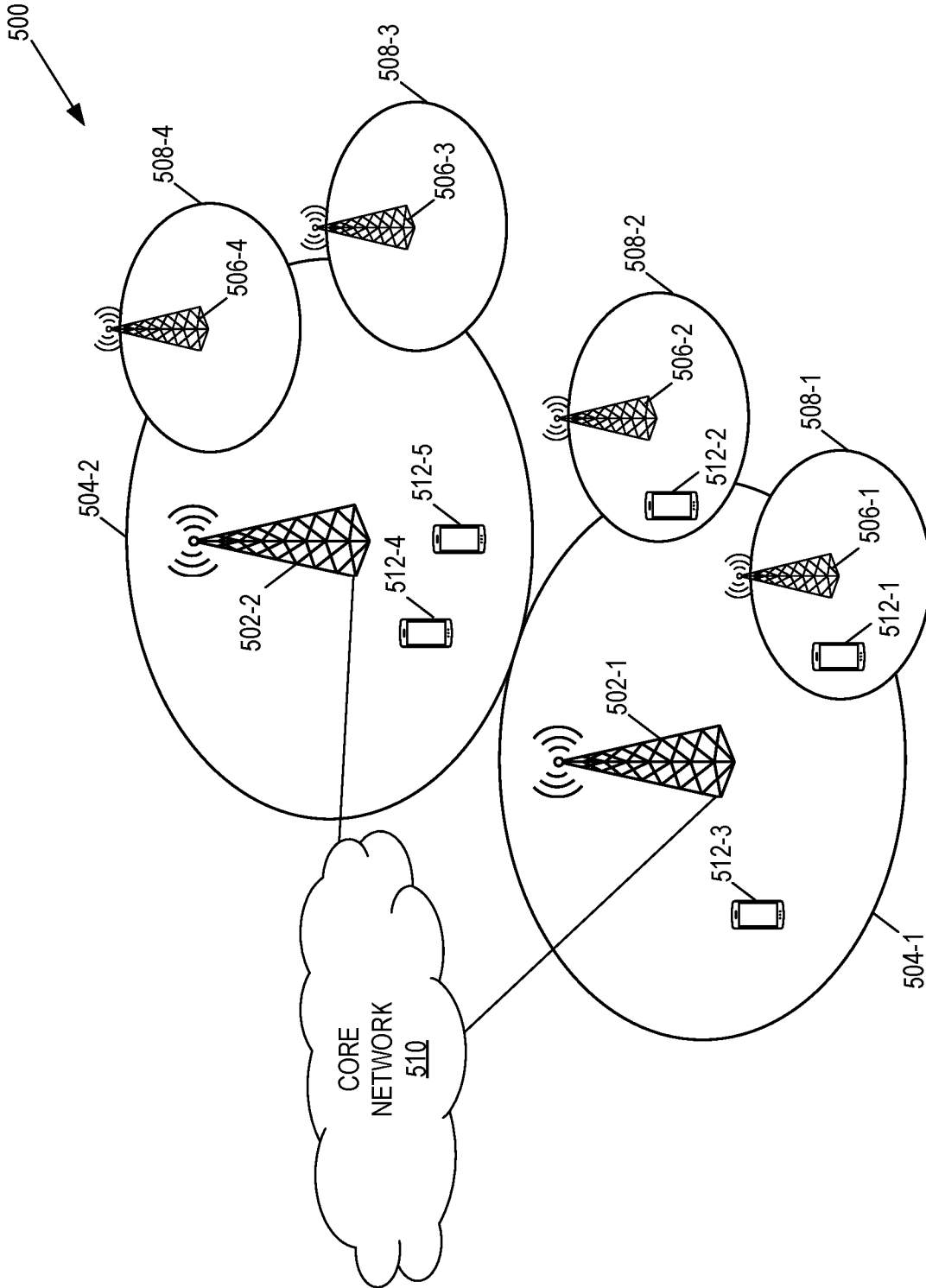


FIG. 5

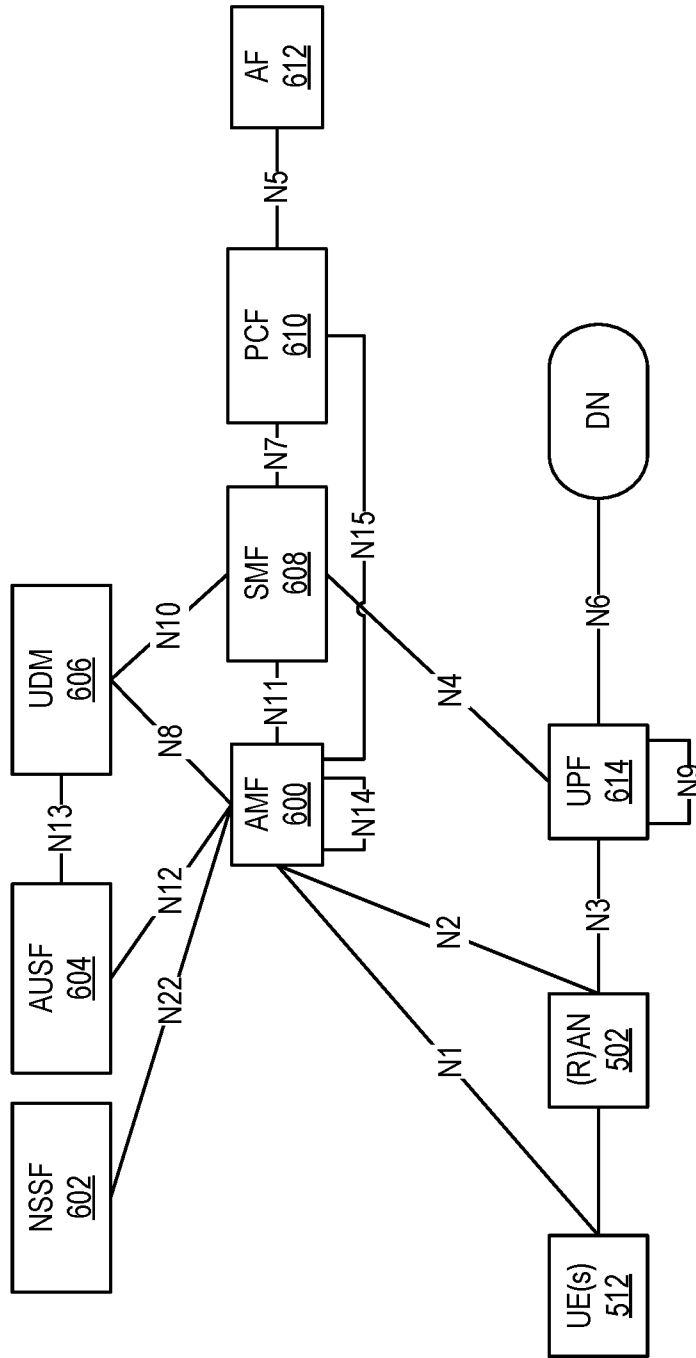


FIG. 6

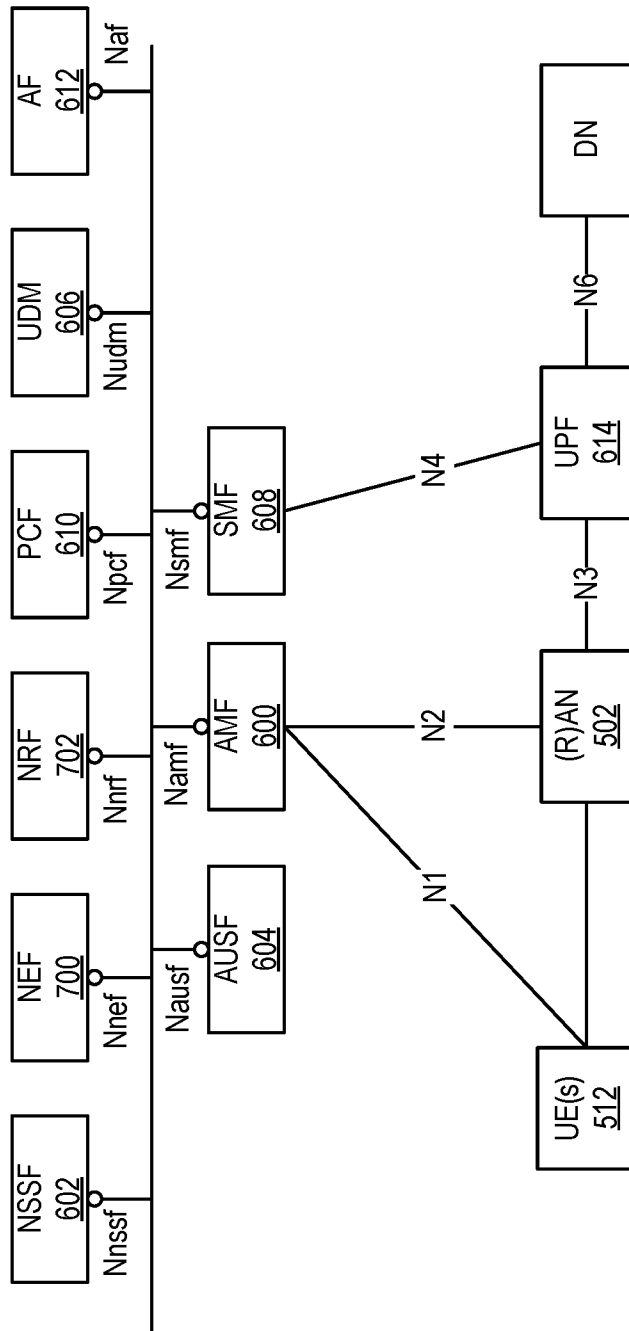


FIG. 7

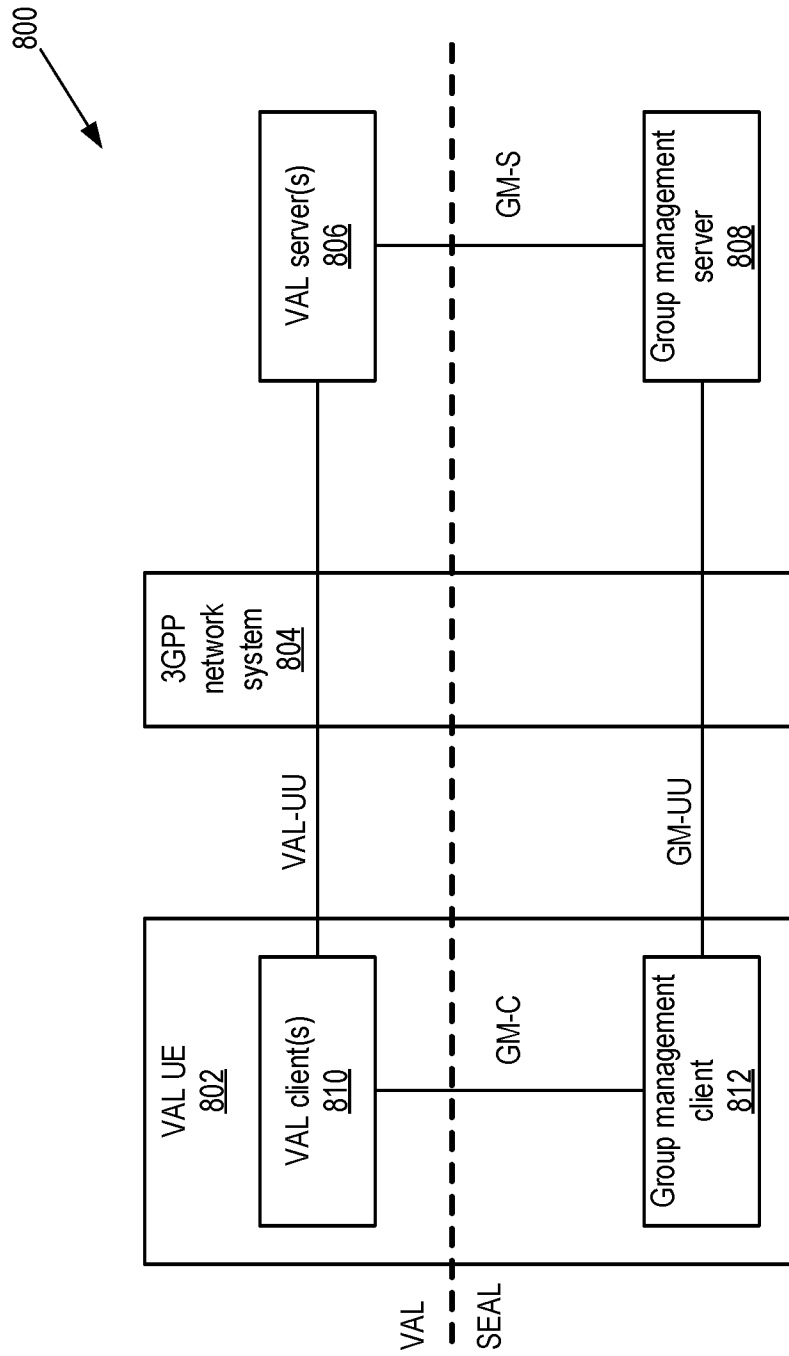


FIG. 8

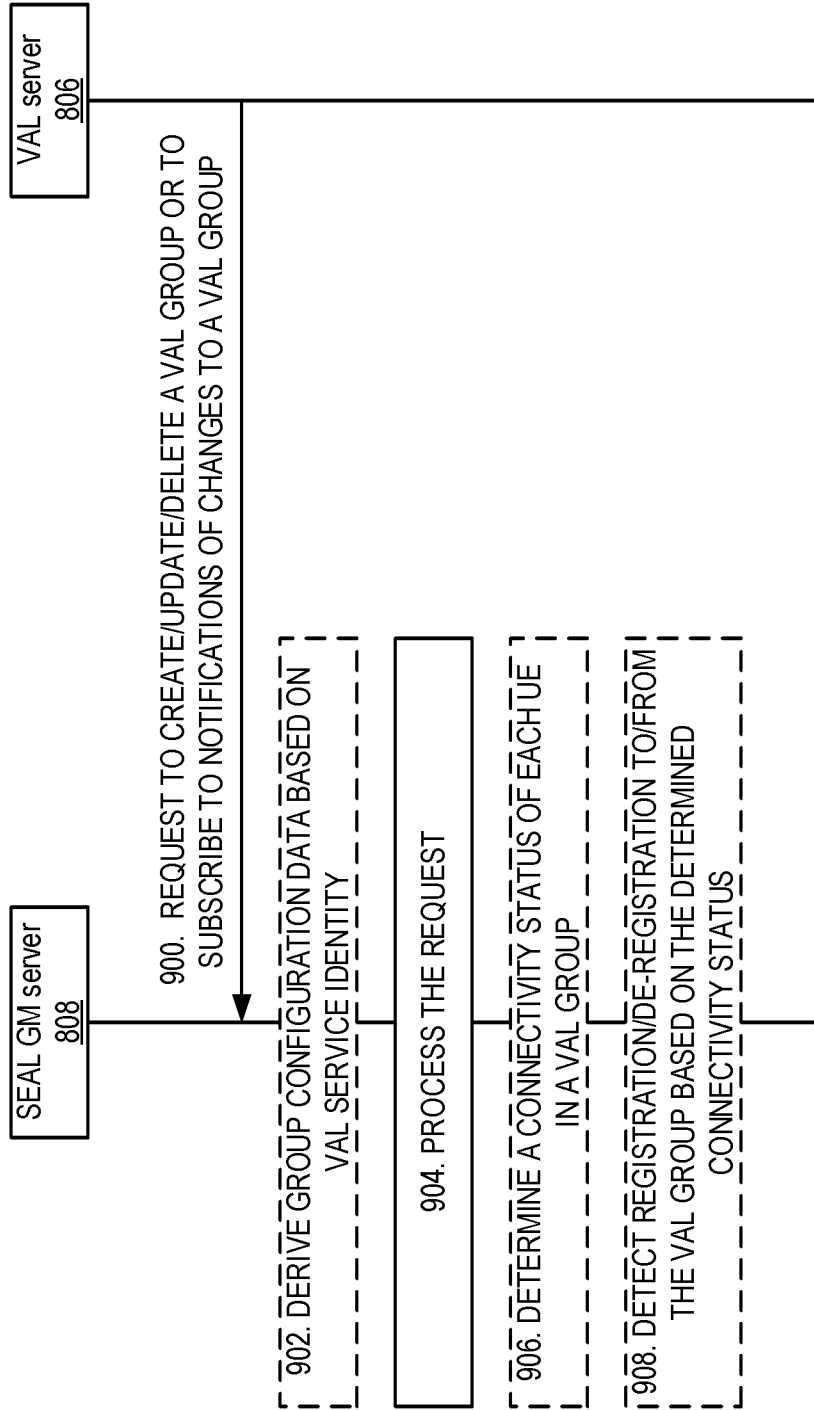


FIG. 9

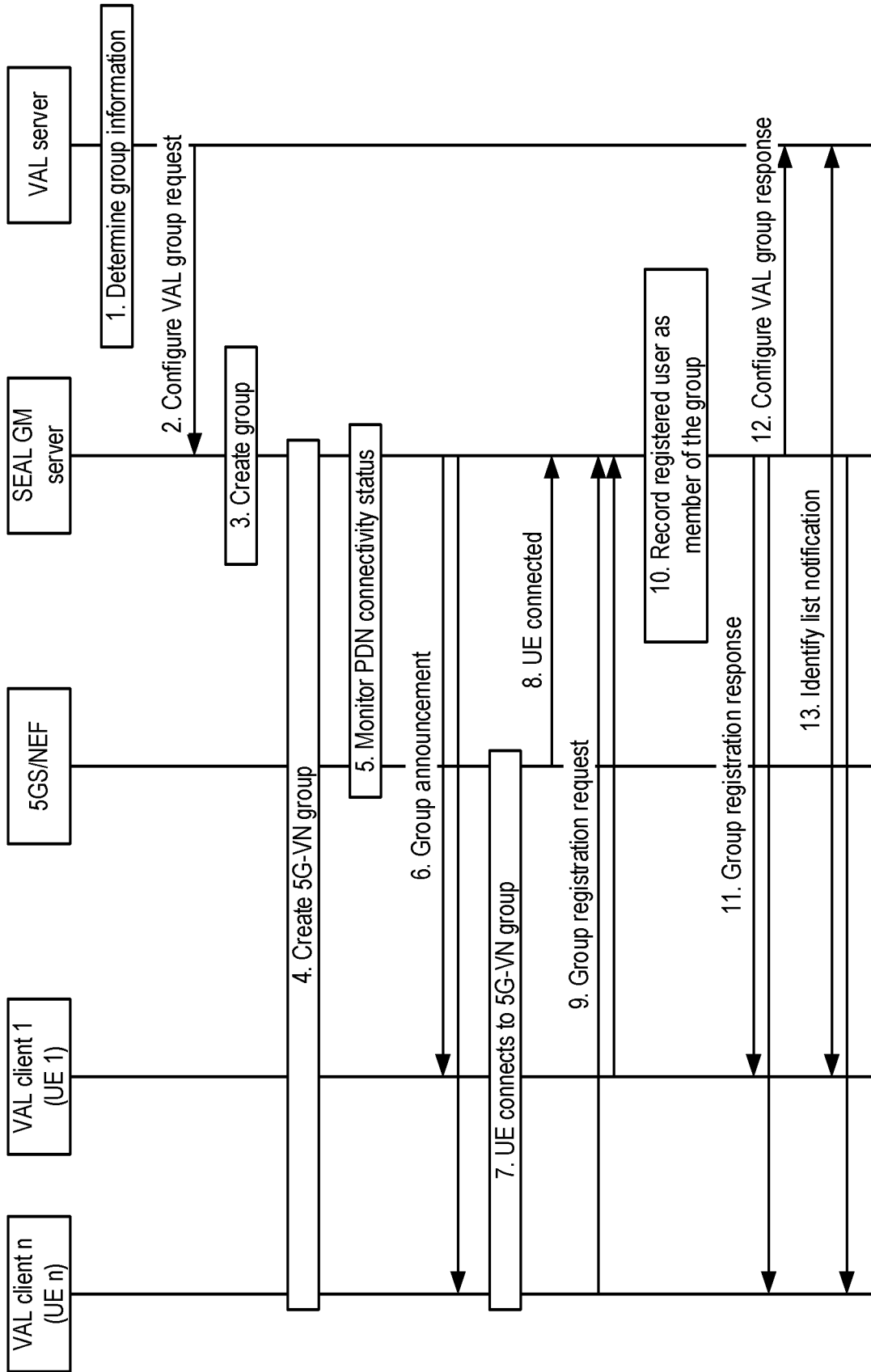


FIG. 10

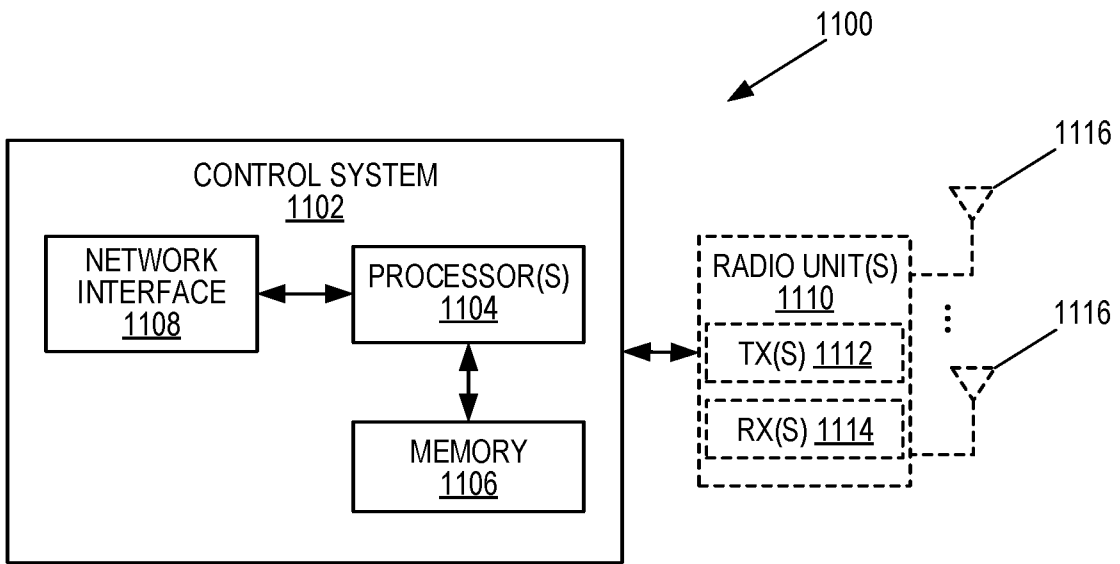


FIG. 11

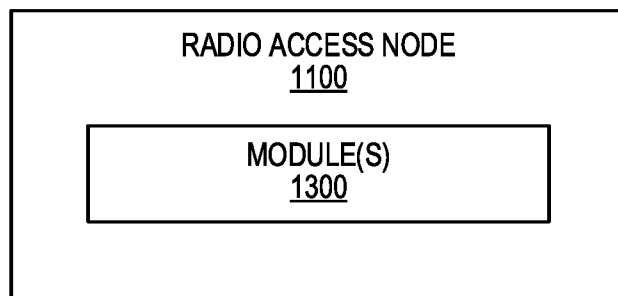


FIG. 13

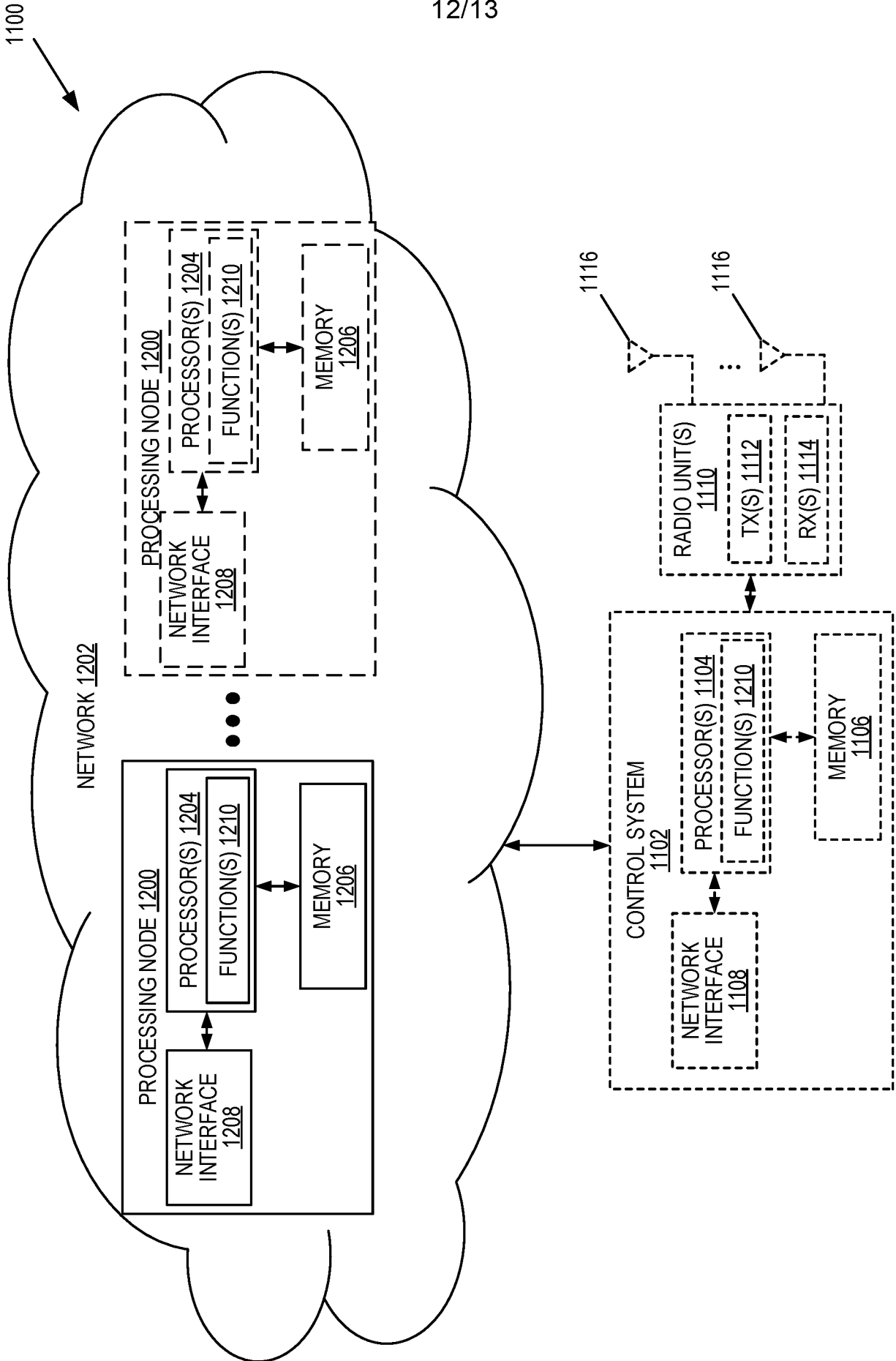


FIG. 12

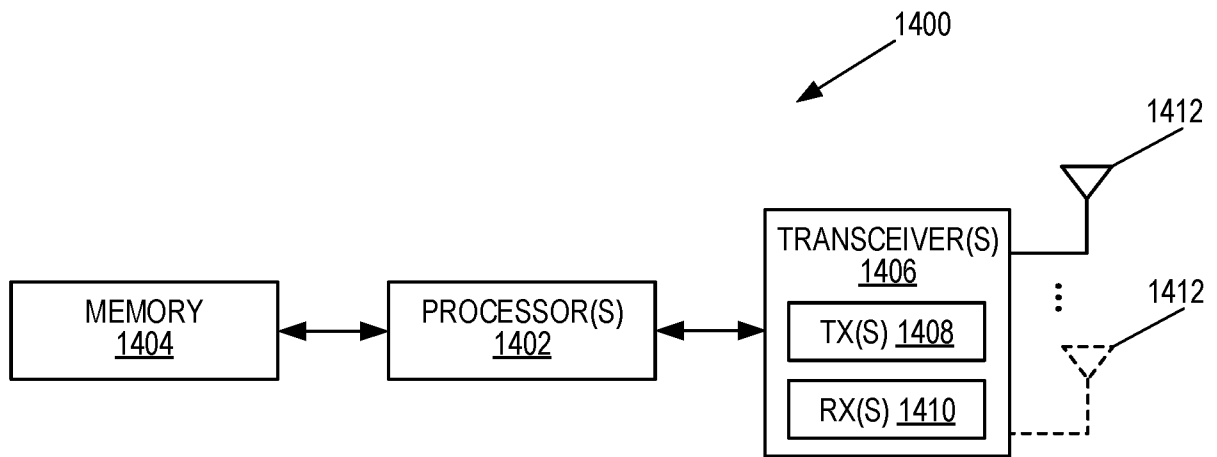


FIG. 14

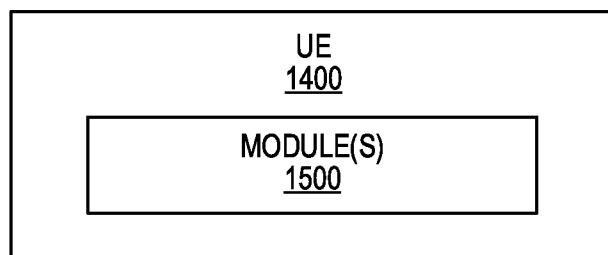


FIG. 15

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2021/069587

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04W4/08 H04L29/08 H04W8/18
ADD.
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED
Minimum documentation searched (classification system followed by classification symbols)
H04W H04L
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	"3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Service Enabler Architecture Layer for Verticals (SEAL); Functional architecture and information flows; (Release 16)", 3GPP DRAFT; 23434-G40, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE 6 July 2020 (2020-07-06), XP051937238, Retrieved from the Internet: URL:https://ftp.3gpp.org/3guInternal/3GPP ultimate versions to be transposed/sentToDpc/23434-g40.zip 23434-g40.doc [retrieved on 2020-07-06]	1,18,19
A	paragraphs [0006], [07.4], [0010], -/--	5-7,9,

Further documents are listed in the continuation of Box C.

See patent family annex.

* Special categories of cited documents :

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- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- "&" document member of the same patent family

Date of the actual completion of the international search 9 September 2021	Date of mailing of the international search report 17/09/2021
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer Sager, Bernard

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2021/069587

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	<p>[0014]</p> <p>-----</p> <p>"3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Study on application layer support for Factories of the Future in 5G network; (Release 17)", 3GPP DRAFT; 23745-080, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE</p> <p>, 29 May 2020 (2020-05-29), XP051910673, Retrieved from the Internet: URL:https://ftp.3gpp.org/tsg_sa/WG6_MissionCritical/Latest_draft_SA6_Specs/archive/23745-080.zip 23745-080-cl.doc [retrieved on 2020-05-29] paragraphs [05.6], [0007]</p> <p>-----</p>	<p>10,14, 17,20</p> <p>1-20</p>
A	<p>"3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; System architecture for the 5G System (5GS); Stage 2 (Release 16)", 3GPP STANDARD; TECHNICAL SPECIFICATION; 3GPP TS 23.501, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE</p> <p>, vol. SA WG2, no. V16.5.0 9 July 2020 (2020-07-09), pages 1-441, XP051924385, Retrieved from the Internet: URL:ftp://ftp.3gpp.org/Specs/archive/23_series/23.501/23501-g50.zip 23501-g50.docx [retrieved on 2020-07-09] paragraph [5.29.2]</p> <p>-----</p>	<p>4,12</p>