US 20250267103A1

(19) United States
(12) Patent Application Publication
KIM et al.

(10) Pub. No.: US 2025/0267103 A1
(43) Pub. Date: Aug. 21, 2025

(54) TECHNIQUES TO USE SERVICE-LEVEL AUTHENTICATION AND AUTHORIZATION FOR MULTIPLE APPLICATIONS

(71) Applicant: **QUALCOMM Incorporated**, San Diego, CA (US)

(72) Inventors: **Sunghoon KIM**, San Diego, CA (US); **Stefano FACCIN**, San Ysidro, CA (US)

(21) Appl. No.: **19/053,334**

(22) Filed: **Feb. 13, 2025**

Related U.S. Application Data

(60) Provisional application No. 63/554,841, filed on Feb. 16, 2024.

Publication Classification

(51) **Int. Cl.**

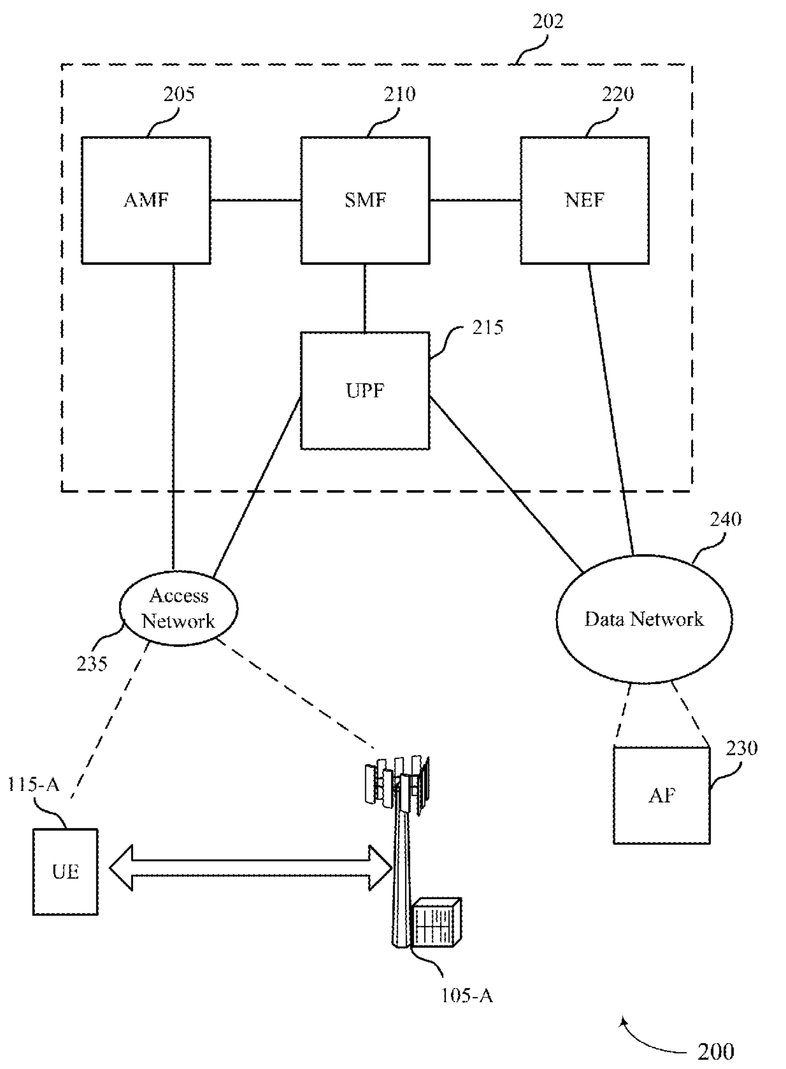
H04L 47/24 (2022.01)
H04W 28/02 (2009.01)

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

CPC *H04L 47/24* (2013.01); *H04W 28/02* (2013.01)

(57) **ABSTRACT**

Methods, systems, and devices for method for wireless communication are described. A network entity may obtain a first request to validate a first service for a user equipment (UE), the first request including an indicator of the first service. The network entity may establish a protocol data unit session with a set of traffic filters in accordance with the first request. The network entity may then obtain a second request to validate a second service for the UE, the second request including an indicator of the second service. The network entity may modify the protocol data unit session based on the second request, where modifying the protocol data unit session includes modifying at least one traffic filter of the set of traffic filters.



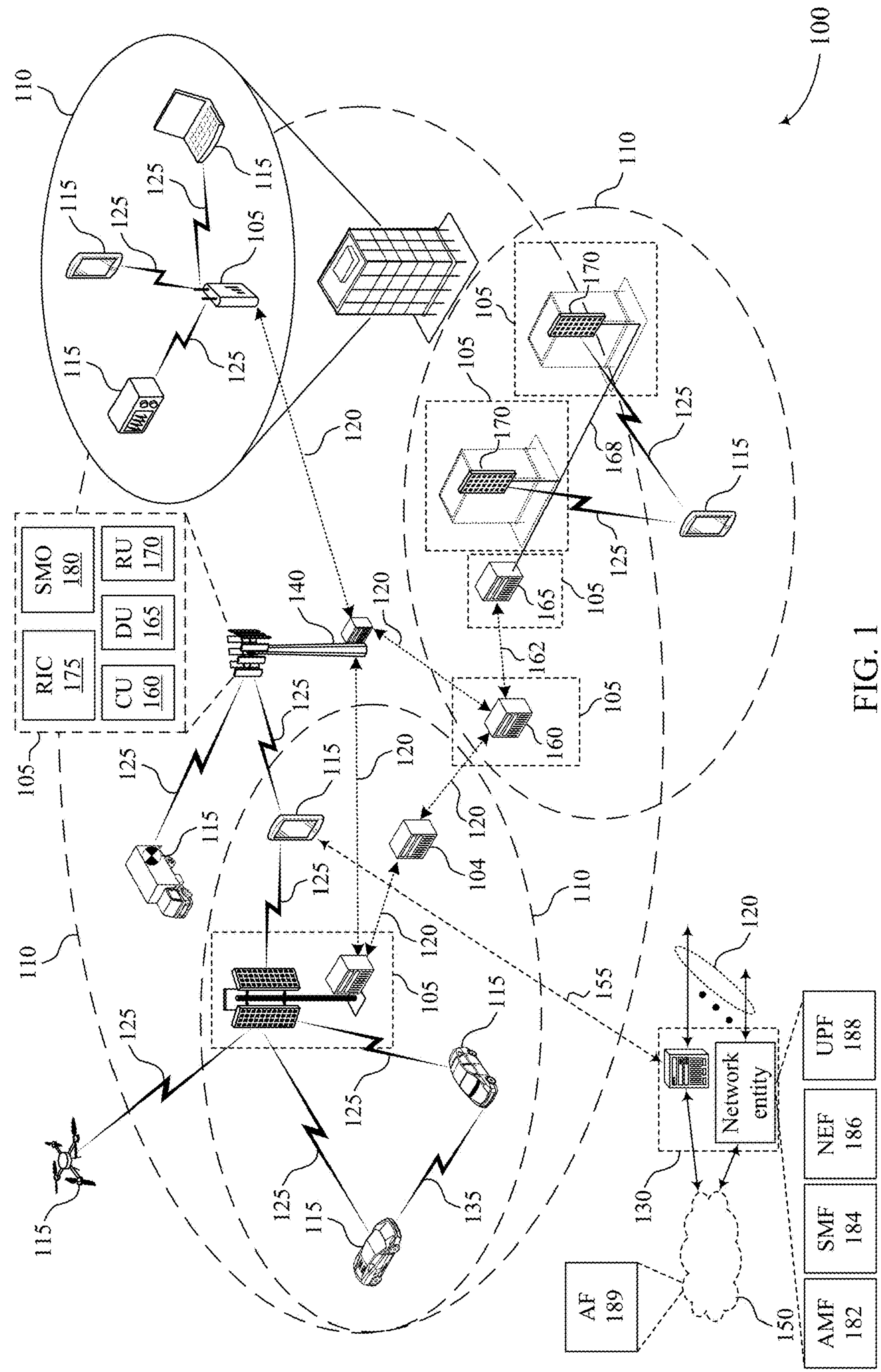

SMO 180
RIC 175
RU 170
DU 165
CU 160
Network entity
UPF 188
NEF 186
SMF 184
AMF 182
AF 189

FIG. 1

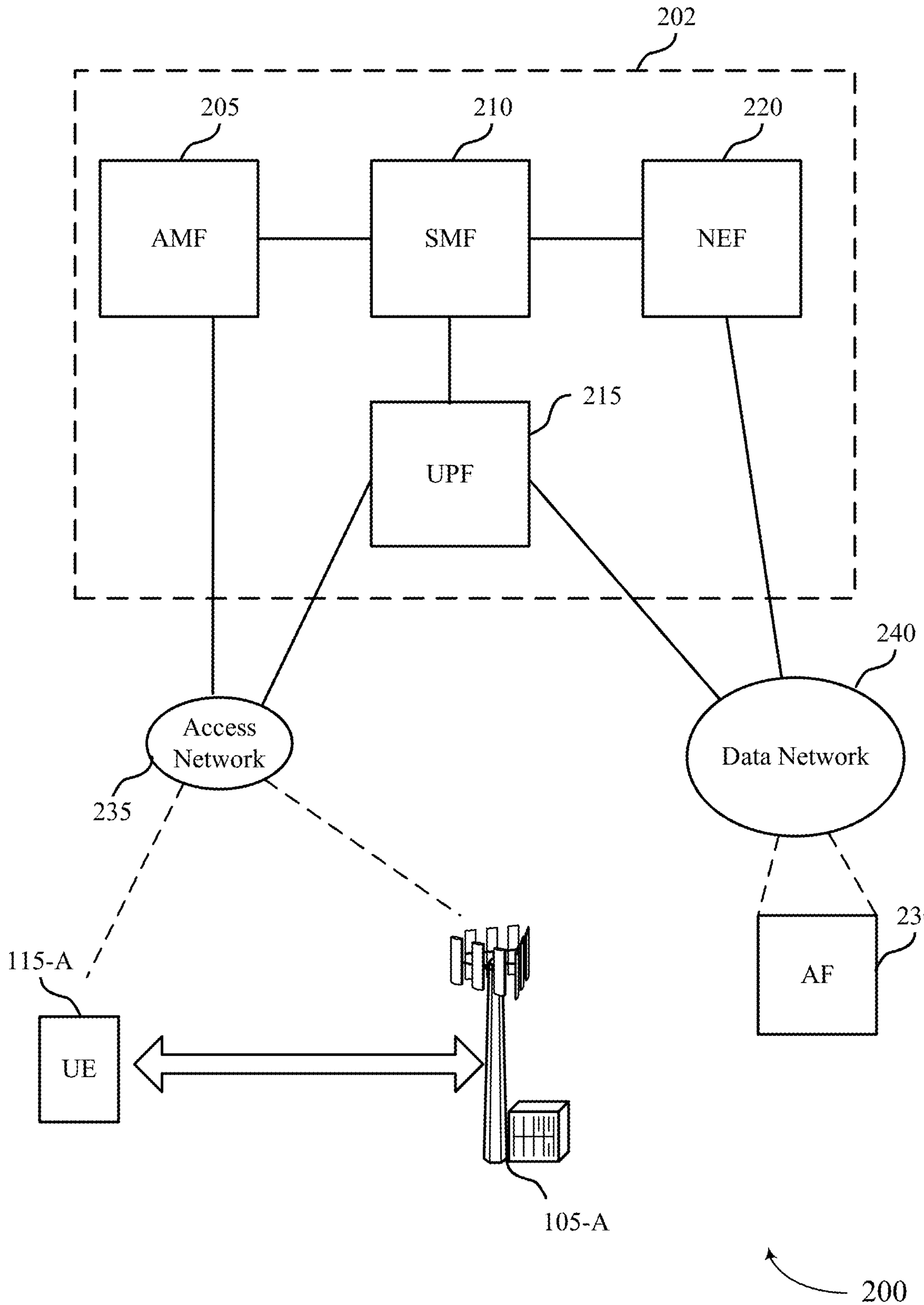

202
205
210
220
AMF
SMF
NEF
215
UPF
240
Access Network
235
Data Network
230
115-A
AF
UE
105-A
200

FIG. 2

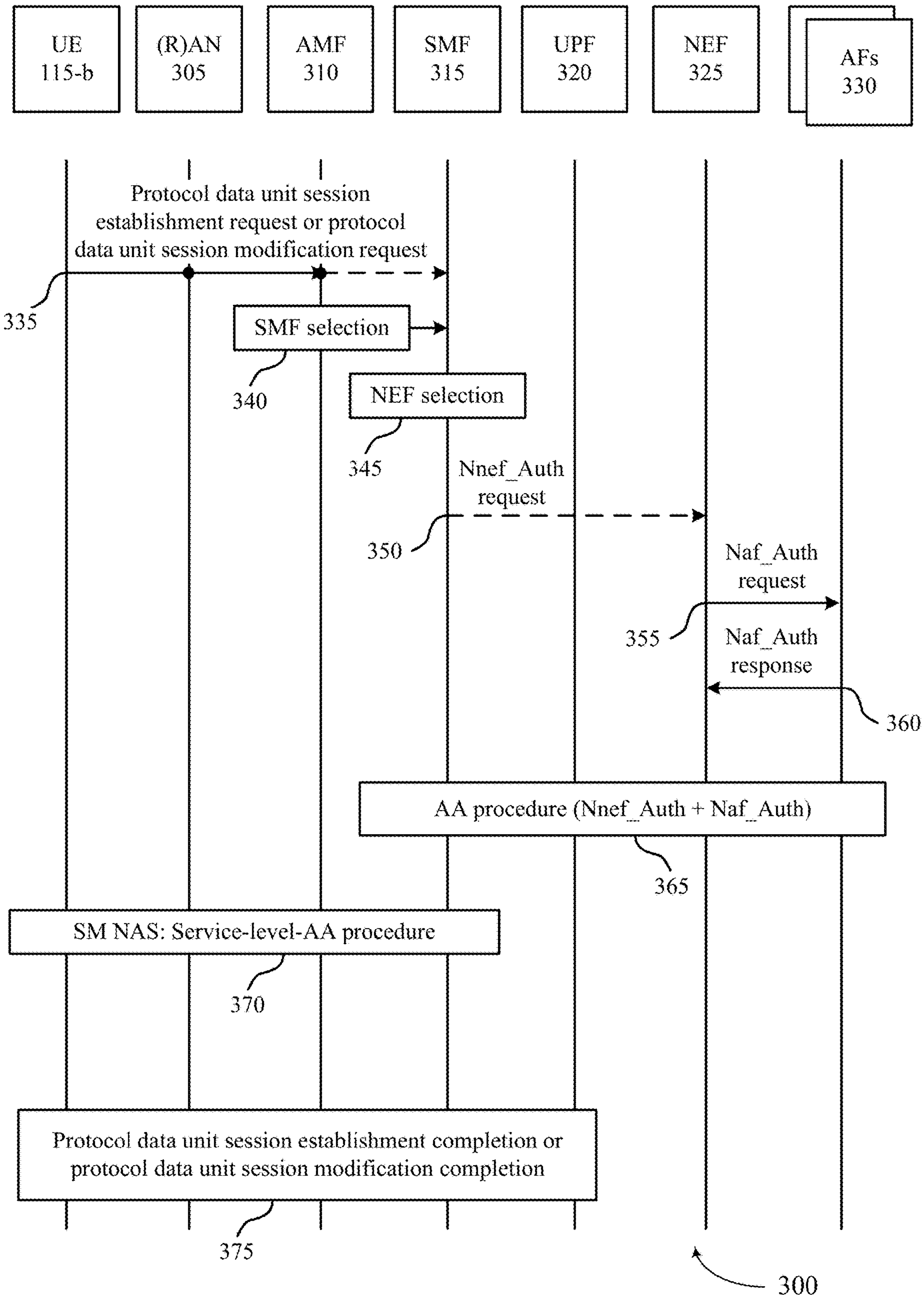

UE
115-b
(R)AN
305
AMF
310
SMF
315
UPF
320
NEF
325
AFs
330
Protocol data unit session establishment request or protocol data unit session modification request
335
SMF selection
340
NEF selection
345
Nnef_Auth request
350
Naf_Auth request
355
Naf_Auth response
360
AA procedure (Nnef_Auth + Naf_Auth)
365
SM NAS: Service-level-AA procedure
370
Protocol data unit session establishment completion or protocol data unit session modification completion
375
300

FIG. 3

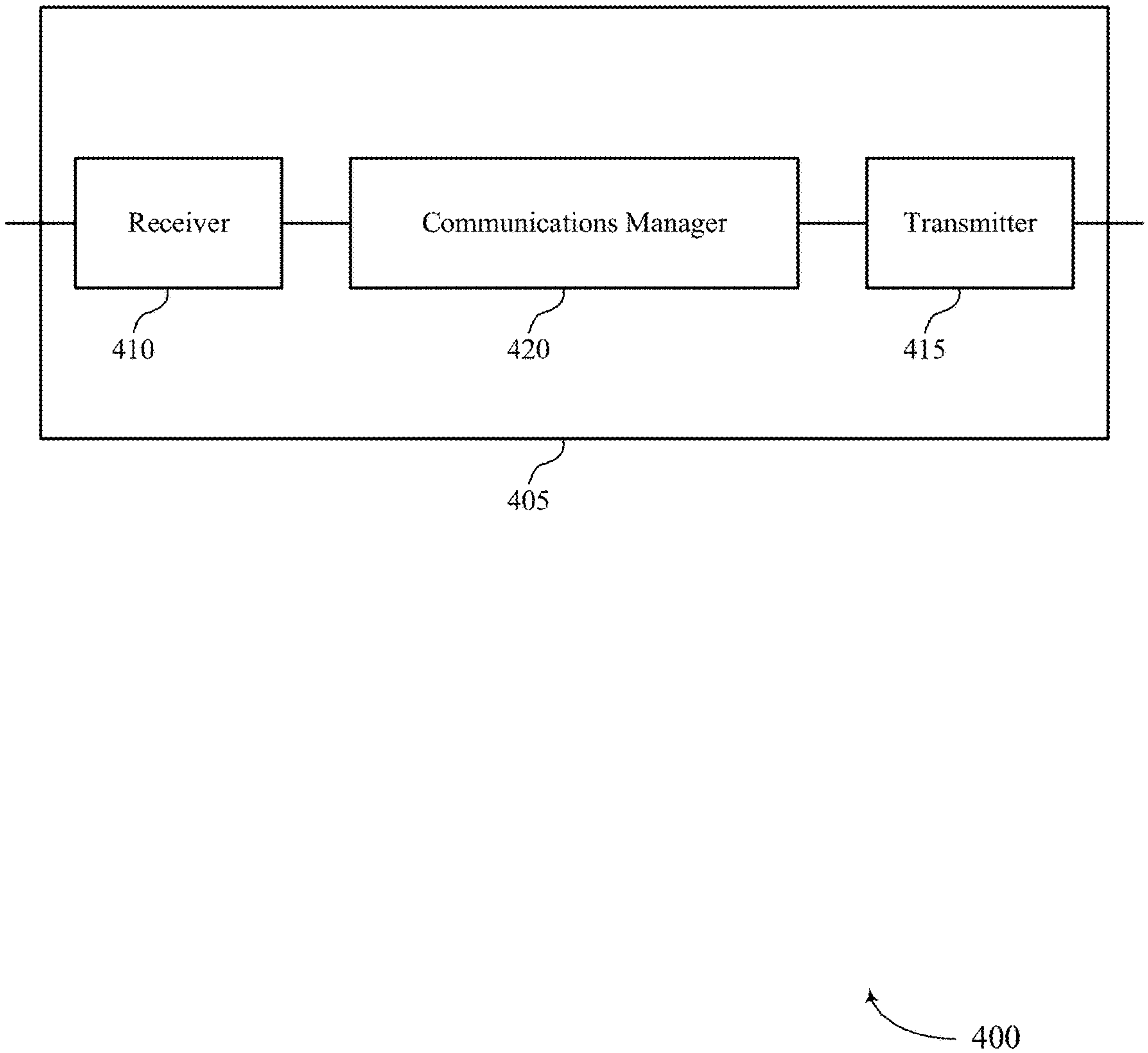

Receiver
Communications Manager
Transmitter
410
420
415
405
400

FIG. 4

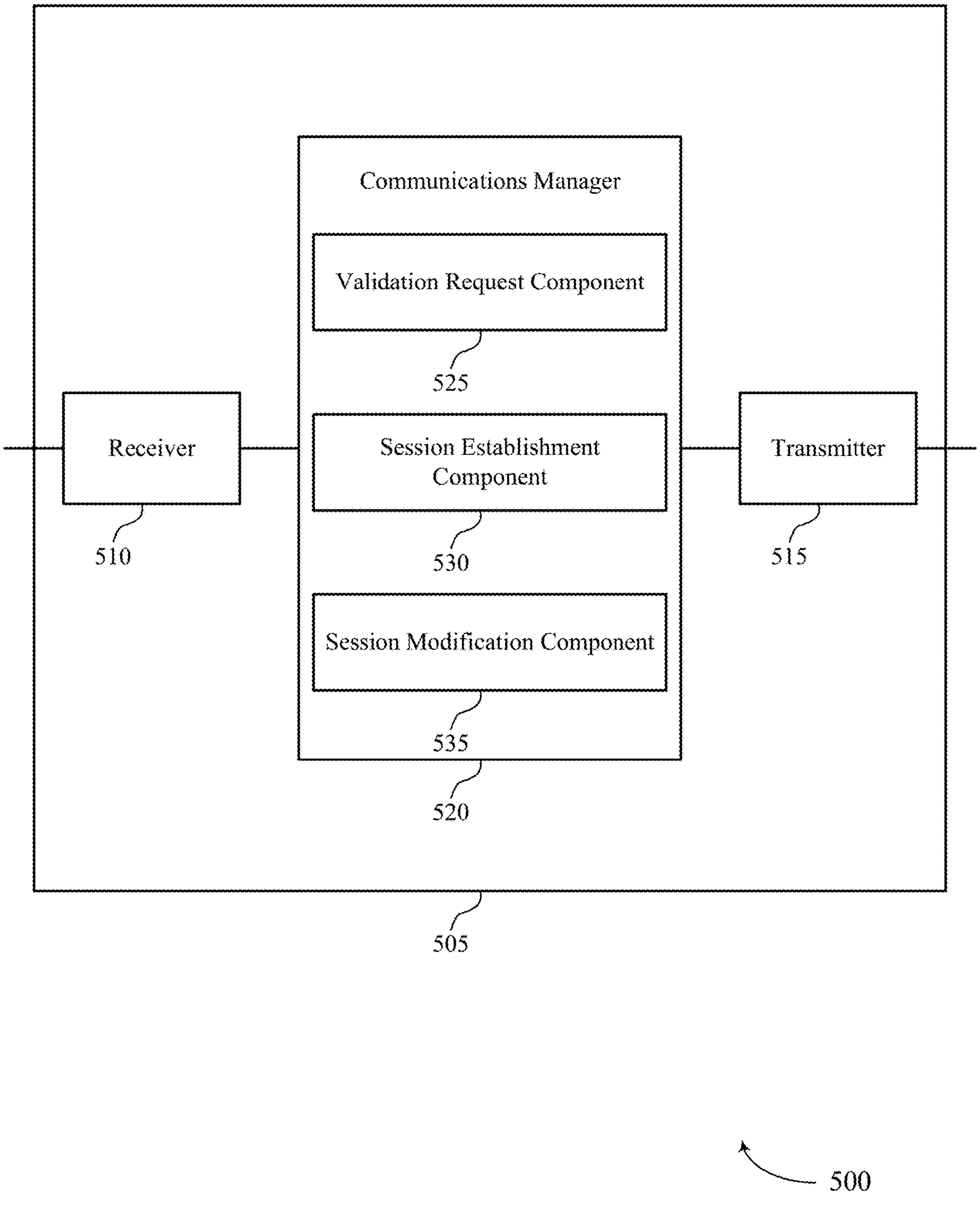

Communications Manager
Validation Request Component
525
Receiver
Session Establishment Component
Transmitter
510
530
515
Session Modification Component
535
520
505
500

FIG. 5

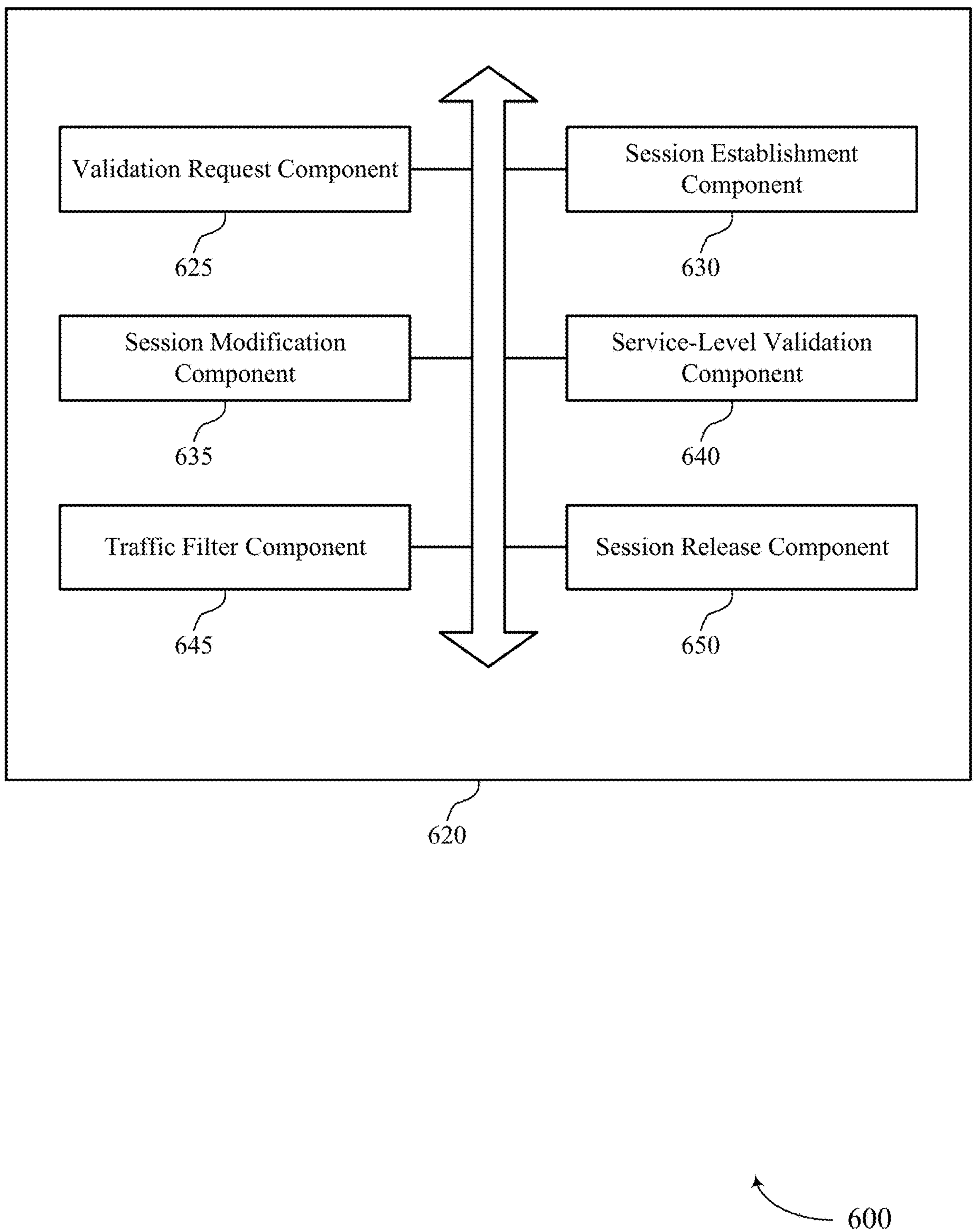

Validation Request Component
625
Session Establishment Component
630
Session Modification Component
635
Service-Level Validation Component
640
Traffic Filter Component
645
Session Release Component
650
620
600

FIG. 6

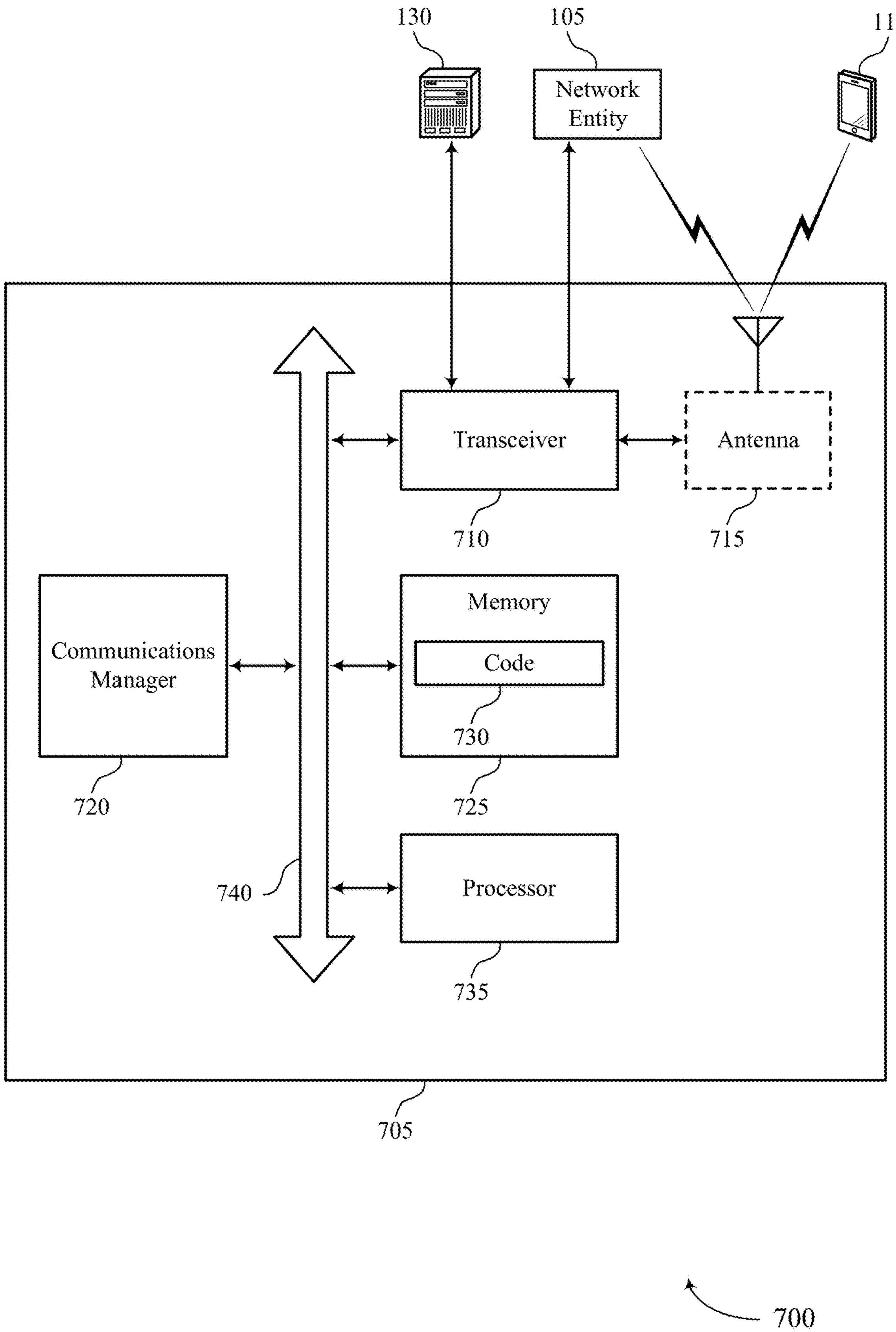

130
105
Network Entity
115
Transceiver
Antenna
710
715
Communications Manager
Memory
Code
730
720
725
740
Processor
735
705
700

FIG. 7

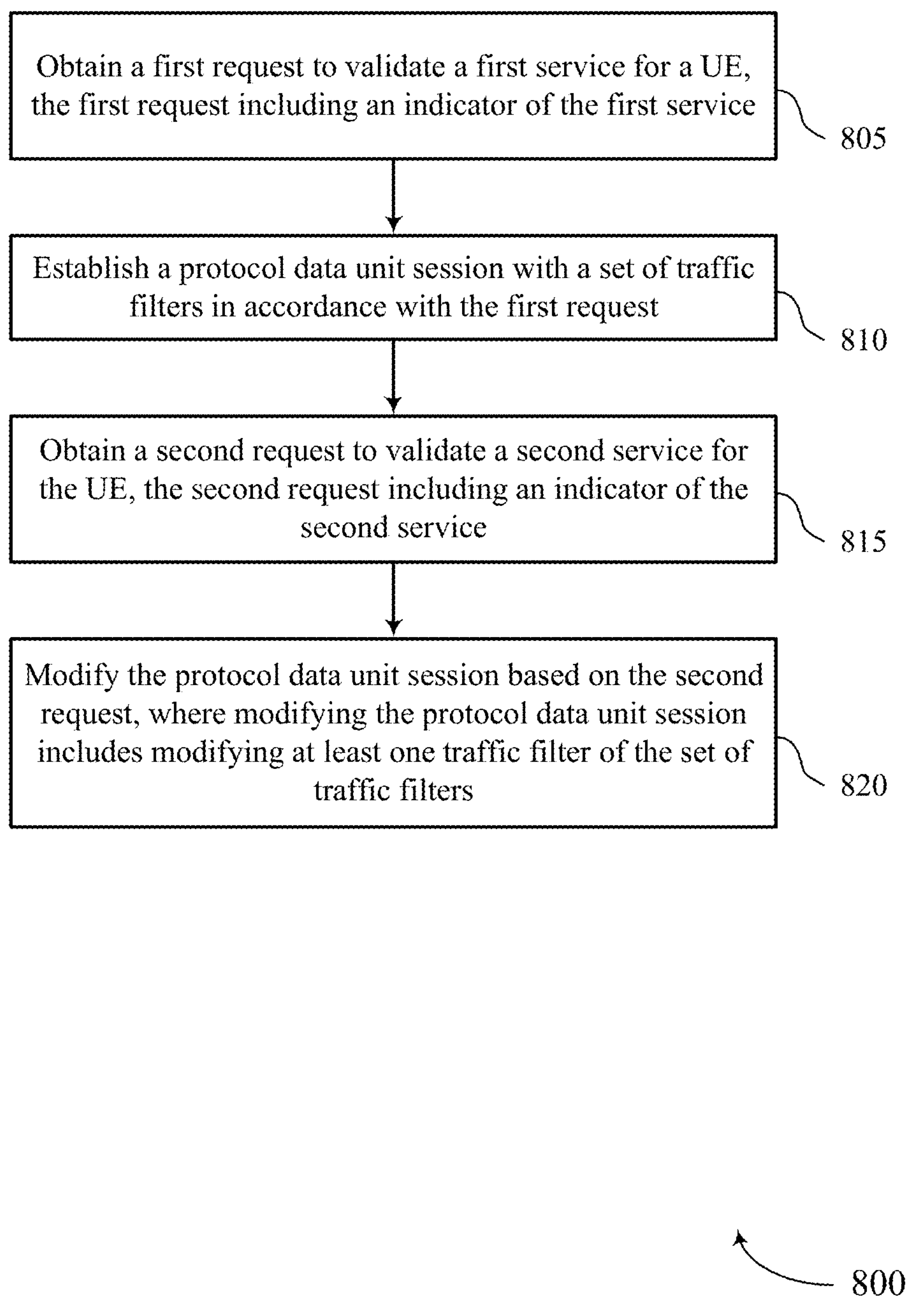

Obtain a first request to validate a first service for a UE, the first request including an indicator of the first service
805
Establish a protocol data unit session with a set of traffic filters in accordance with the first request
810
Obtain a second request to validate a second service for the UE, the second request including an indicator of the second service
815
Modify the protocol data unit session based on the second request, where modifying the protocol data unit session includes modifying at least one traffic filter of the set of traffic filters
820
800

FIG. 8

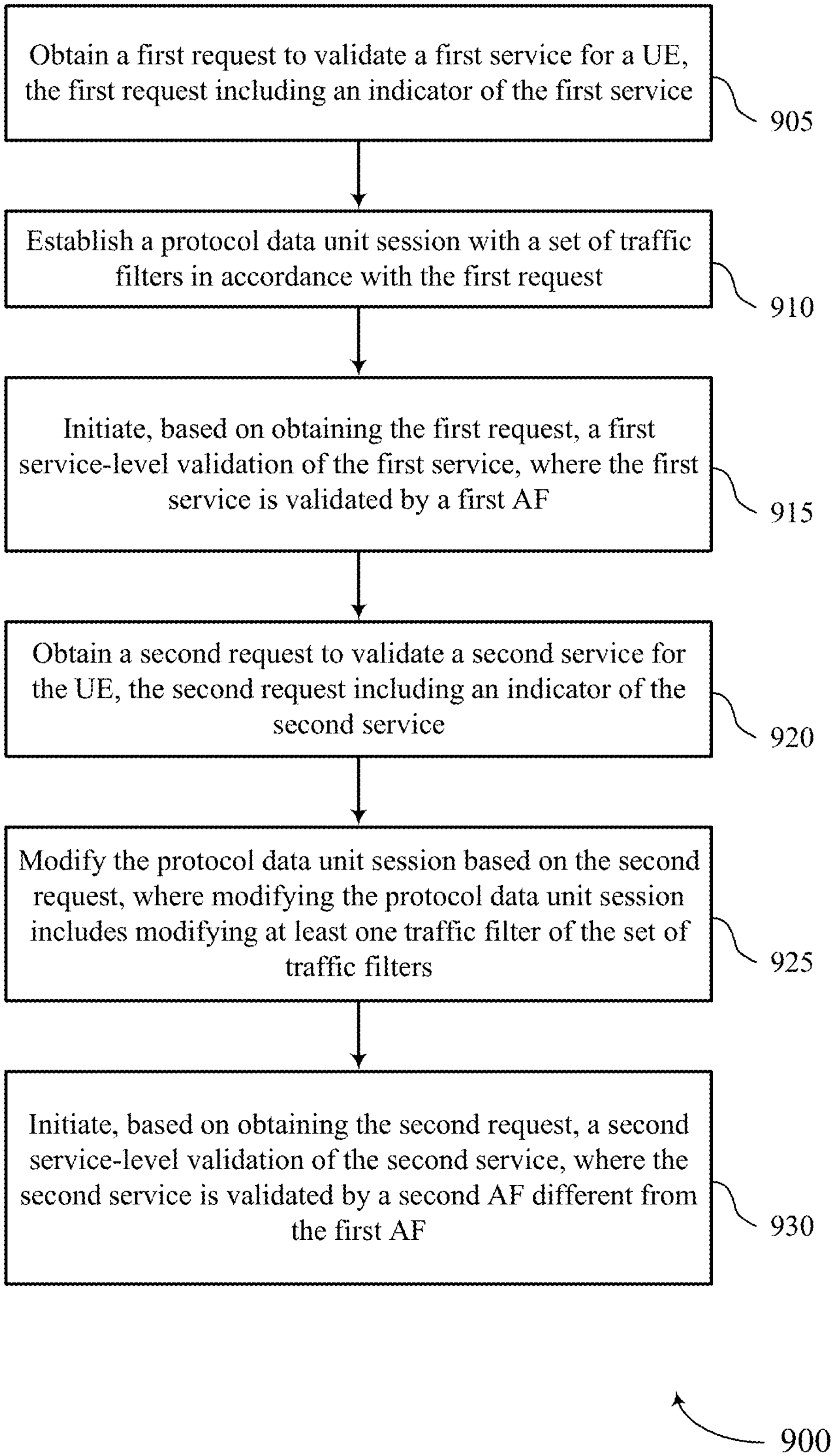

Obtain a first request to validate a first service for a UE, the first request including an indicator of the first service
905
Establish a protocol data unit session with a set of traffic filters in accordance with the first request
910
Initiate, based on obtaining the first request, a first service-level validation of the first service, where the first service is validated by a first AF
915
Obtain a second request to validate a second service for the UE, the second request including an indicator of the second service
920
Modify the protocol data unit session based on the second request, where modifying the protocol data unit session includes modifying at least one traffic filter of the set of traffic filters
925
Initiate, based on obtaining the second request, a second service-level validation of the second service, where the second service is validated by a second AF different from the first AF
930
900

FIG. 9

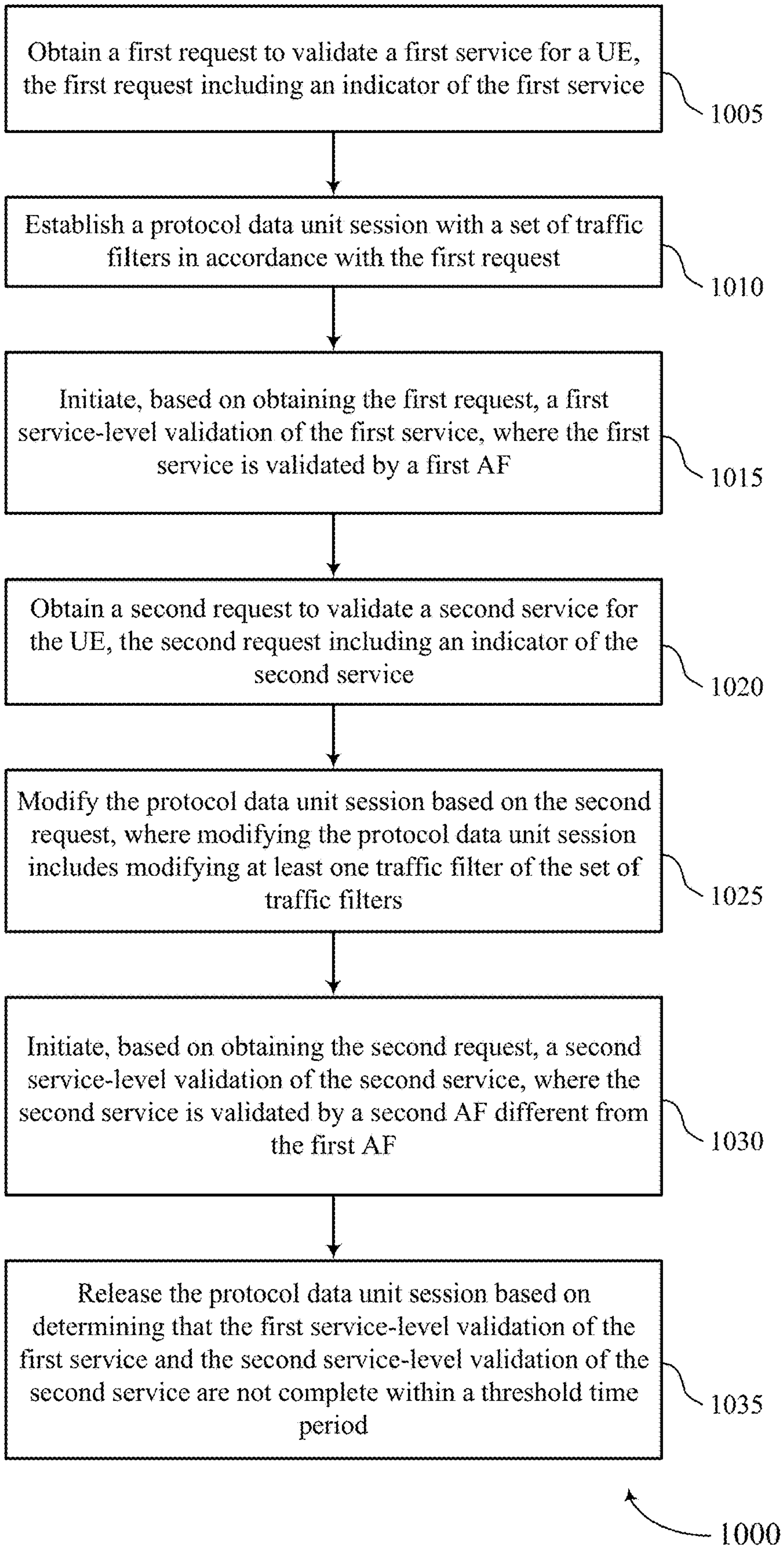

Obtain a first request to validate a first service for a UE, the first request including an indicator of the first service
1005
Establish a protocol data unit session with a set of traffic filters in accordance with the first request
1010
Initiate, based on obtaining the first request, a first service-level validation of the first service, where the first service is validated by a first AF
1015
Obtain a second request to validate a second service for the UE, the second request including an indicator of the second service
1020
Modify the protocol data unit session based on the second request, where modifying the protocol data unit session includes modifying at least one traffic filter of the set of traffic filters
1025
Initiate, based on obtaining the second request, a second service-level validation of the second service, where the second service is validated by a second AF different from the first AF
1030
Release the protocol data unit session based on determining that the first service-level validation of the first service and the second service-level validation of the second service are not complete within a threshold time period
1035
1000

FIG. 10

TECHNIQUES TO USE SERVICE-LEVEL AUTHENTICATION AND AUTHORIZATION FOR MULTIPLE APPLICATIONS

CROSS REFERENCES

[0001] The present application for patent claims benefit of U.S. Provisional Patent Application No. 63/554,841 by Kim et al., entitled "TECHNIQUES TO USE SERVICE-LEVEL AUTHENTICATION AND AUTHORIZATION FOR MULTIPLE APPLICATIONS," filed Feb. 16, 2024, assigned to the assignee hereof, and expressly incorporated herein.

FIELD OF TECHNOLOGY

[0002] The following relates to method for wireless communication, including techniques to use service-level authentication and authorization (AA) for multiple applications.

BACKGROUND

[0003] Wireless communications systems are widely deployed to provide various types of communication content such as voice, video, packet data, messaging, broadcast, and so on. These systems may be capable of supporting communication with multiple users by sharing the available system resources (e.g., time, frequency, and power). Examples of such multiple-access systems include fourth generation (4G) systems such as Long Term Evolution (LTE) systems, LTE-Advanced (LTE-A) systems, or LTE-A Pro systems, and fifth generation (5G) systems which may be referred to as New Radio (NR) systems. These systems may employ technologies such as code division multiple access (CDMA), time division multiple access (TDMA), frequency division multiple access (FDMA), orthogonal FDMA (OFDMA), or discrete Fourier transform spread orthogonal frequency division multiplexing (DFT-S-OFDM). A wireless multiple-access communications system may include one or more base stations, each supporting wireless communication for communication devices, which may be known as user equipment (UE).

SUMMARY

[0004] The described techniques relate to improved methods, systems, devices, and apparatuses that support techniques to use service-level AA for multiple applications. For example, the described techniques provide for a network entity (e.g., session management function (SMF)) to receive a first request from a UE to validate a first service associated with a first application function (AF). The network entity may establish a protocol data unit session with a set of pre-defined traffic filters associated with the first service. The network entity may further receive a second request to validate a second service associated with a second AF. The network entity may modify the existing protocol data unit session to update the set of traffic filters for the second service.

[0005] A method by a network entity is described. The method may include obtaining a first request to validate a first service for a user equipment (UE), the first request including an indicator of the first service, establishing a protocol data unit session with a set of traffic filters in accordance with the first request, obtaining a second request to validate a second service for the UE, the second request including an indicator of the second service, and modifying the protocol data unit session based on the second request, where modifying the protocol data unit session includes modifying at least one traffic filter of the set of traffic filters.

[0006] A network entity is described. The network entity may include one or more memories storing processor executable code, and one or more processors coupled with the one or more memories. The one or more processors may individually or collectively be operable to execute the code to cause the network entity to obtain a first request to validate a first service for a UE, the first request including an indicator of the first service, establish a protocol data unit session with a set of traffic filters in accordance with the first request, obtain a second request to validate a second service for the UE, the second request including an indicator of the second service, and modify the protocol data unit session based on the second request, where modifying the protocol data unit session includes modifying at least one traffic filter of the set of traffic filters.

[0007] Another network entity is described. The network entity may include means for obtaining a first request to validate a first service for a UE, the first request including an indicator of the first service, means for establishing a protocol data unit session with a set of traffic filters in accordance with the first request, means for obtaining a second request to validate a second service for the UE, the second request including an indicator of the second service, and means for modifying the protocol data unit session based on the second request, where modifying the protocol data unit session includes modifying at least one traffic filter of the set of traffic filters.

[0008] A non-transitory computer-readable medium storing code is described. The code may include instructions executable by one or more processors to obtain a first request to validate a first service for a UE, the first request including an indicator of the first service, establish a protocol data unit session with a set of traffic filters in accordance with the first request, obtain a second request to validate a second service for the UE, the second request including an indicator of the second service, and modify the protocol data unit session based on the second request, where modifying the protocol data unit session includes modifying at least one traffic filter of the set of traffic filters.

[0009] Some examples of the method, network entities, and non-transitory computer-readable medium described herein may further include operations, features, means, or instructions for initiating, based on obtaining the first request, a first service-level validation of the first service, where the first service may be validated by a first application function and initiating, based on obtaining the second request, a second service-level validation of the second service, where the second service may be validated by a second application function different from the first application function.

[0010] In some examples of the method, network entities, and non-transitory computer-readable medium described herein, the set of traffic filters enable a first flow of traffic associated with the first service based on the first service-level validation of the first service being successful and the set of traffic filters including the modified at least one traffic filter enable a second flow of traffic associated with the second service based on the second service-level validation of the second service being successful.

[0011] In some examples of the method, network entities, and non-transitory computer-readable medium described herein, the first application function and the second application function may be external to the network entity.

[0012] In some examples of the method, network entities, and non-transitory computer-readable medium described herein, the network entity communicates with the first application function and the second application function via a network exposure function.

[0013] Some examples of the method, network entities, and non-transitory computer-readable medium described herein may further include operations, features, means, or instructions for releasing the protocol data unit session based on determining that the first service-level validation of the first service and the second service-level validation of the second service may be not complete within a threshold time period.

[0014] Some examples of the method, network entities, and non-transitory computer-readable medium described herein may further include operations, features, means, or instructions for obtaining the set of traffic filters to identify a flow of traffic associated with the first service based on the first service-level validation of the first service being successful.

[0015] Some examples of the method, network entities, and non-transitory computer-readable medium described herein may further include operations, features, means, or instructions for outputting an indication of a capability to support a service-level validation of services supported by the UE, where obtaining the first request and the second request may be based on outputting the indication of the capability.

[0016] Some examples of the method, network entities, and non-transitory computer-readable medium described herein may further include operations, features, means, or instructions for obtaining an indication of revocation of validation of the first service and removing a traffic filter from the set of traffic filters in response to obtaining the indication, where the traffic filter corresponds to the first service.

[0017] Some examples of the method, network entities, and non-transitory computer-readable medium described herein may further include operations, features, means, or instructions for determining that the set of traffic filters may be exclusive of active traffic filters for the protocol data unit session and releasing the protocol data unit session in response to determining that the set of traffic filters may be exclusive of active traffic filters for the protocol data unit session.

[0018] Some examples of the method, network entities, and non-transitory computer-readable medium described herein may further include operations, features, means, or instructions for releasing the protocol data unit session upon expiration of a timer, where the timer may be initiated upon determining that set of traffic filters may be exclusive of active traffic filters for the protocol data unit session.

[0019] Some examples of the method, network entities, and non-transitory computer-readable medium described herein may further include operations, features, means, or instructions for establishing the protocol data unit session may be based on a subscription data, the indicator of the first service, or both and the subscription data indicates that the protocol data unit session may be associated with a service-level validation of the UE.

[0020] In some examples of the method, network entities, and non-transitory computer-readable medium described herein, the set of traffic filters enable flow of traffic not subject to service-level validation, traffic associated with a successful service-level validation, or both.

[0021] In some examples of the method, network entities, and non-transitory computer-readable medium described herein, the indicator of the first service includes a service level indicator.

[0022] In some examples of the method, network entities, and non-transitory computer-readable medium described herein, the network entity includes a session management function.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] FIG. **1** shows an example of a wireless communications system that supports techniques to use service-level AA for multiple applications in accordance with one or more aspects of the present disclosure.

[0024] FIG. **2** shows an example of a wireless communications system that supports techniques to use service-level AA for multiple applications in accordance with one or more aspects of the present disclosure.

[0025] FIG. **3** shows an example of a process flow that supports techniques to use service-level AA for multiple applications in accordance with one or more aspects of the present disclosure.

[0026] FIGS. **4** and **5** show diagrams of devices that support techniques to use service-level AA for multiple applications in accordance with one or more aspects of the present disclosure.

[0027] FIG. **6** shows a diagram of a communications manager that supports techniques to use service-level AA for multiple applications in accordance with one or more aspects of the present disclosure.

[0028] FIG. **7** shows a diagram of a system including a device that supports techniques to use service-level AA for multiple applications in accordance with one or more aspects of the present disclosure.

[0029] FIGS. **8** through **10** show flowcharts illustrating methods that support techniques to use service-level AA for multiple applications in accordance with one or more aspects of the present disclosure.

DETAILED DESCRIPTION

[0030] Some wireless communications systems may provide multiple services to a UE to support different functionality and applications at the UE. In some implementations, a network may be designed to facilitate these services. A UE in combination with the network may support authentication and authorization for various services. In some examples, the services may include services that are enabled via communication provided by the network. A UE may trigger a service-level AA procedure. Such authentication and authorization procedure may involve communications and coordination between different network entities (e.g., a SMF, a network exposure function (NEF), or a network application function (NAF)). However, techniques for facilitating authentication and authorization for different services may be undefined or underdeveloped.

[0031] The described techniques relate to supporting authentication and authorization for various services. In particular, the described techniques relate to supporting a mechanism for generic (e.g., non-service specific) authentication and authorization (AA) by a third party external application function (AF). The generic AA depicted herein enables application programming interface (API)-based and Hypertext Transfer Protocol (HTTP)-based authentication and may allow a network to authenticate or authorize a protocol data unit session for more than one application level identifier (ID) by more than one AF. Thus, the techniques depicted herein may enable a network entity to perform the generic AA for multiple service-level IDs corresponding to one or more AFs. The network entity (e.g., SMF) may establish a single protocol data unit session (e.g., between the UE and the UPF), which may be shared by multiple services, each subject to the generic AA.

[0032] A network entity (e.g., SMF) may receive a first request from a UE to validate a first service associated with a first AF. The UE may include a service-level ID in the first request. The network entity may establish a protocol data unit session with a set of pre-defined traffic filters, upon receiving the request. The network entity may then receive a second request to validate a second service associated with a second AF. Instead of establishing a new protocol data unit session, the network entity may modify the existing protocol data unit session to update the set of traffic filters based on the second request. In some examples, the first AF may provide an AA for the first service and the second AF may provide an AA for the second service. Upon a successful generic AA, each corresponding AF may provide new traffic policies to identify the traffic that is enabled for the protocol data unit session.

[0033] Aspects of the disclosure are initially described in the context of wireless communications systems. Aspects of the disclosure are further illustrated by and described with reference to process flows. Aspects of the disclosure are further illustrated by and described with reference to apparatus diagrams, system diagrams, and flowcharts that relate to techniques to use service-level AA for multiple applications.

[0034] FIG. **1** shows an example of a wireless communications system **100** that supports techniques to use service-level AA for multiple applications in accordance with one or more aspects of the present disclosure. The wireless communications system **100** may include one or more devices, such as one or more network devices (e.g., network entities **105**), one or more UEs **115**, and a core network **130**. In some examples, the wireless communications system **100** may be a Long Term Evolution (LTE) network, an LTE-Advanced (LTE-A) network, an LTE-A Pro network, a New Radio (NR) network, or a network operating in accordance with other systems and radio technologies, including future systems and radio technologies not explicitly mentioned herein.

[0035] The network entities **105** may be dispersed throughout a geographic area to form the wireless communications system **100** and may include devices in different forms or having different capabilities. In various examples, a network entity **105** may be referred to as a network element, a mobility element, a radio access network (RAN) node, or network equipment, among other nomenclature. In some examples, network entities **105** and UEs **115** may wirelessly communicate via communication link(s) **125** (e.g., a radio frequency (RF) access link). For example, a network entity **105** may support a coverage area **110** (e.g., a geographic coverage area) over which the UEs **115** and the network entity **105** may establish the communication link(s) **125**. The coverage area **110** may be an example of a geographic area over which a network entity **105** and a UE **115** may support the communication of signals according to one or more radio access technologies (RATs).

[0036] The UEs **115** may be dispersed throughout a coverage area **110** of the wireless communications system **100**, and each UE **115** may be stationary, or mobile, or both at different times. The UEs **115** may be devices in different forms or having different capabilities. Some example UEs **115** are illustrated in FIG. **1**. The UEs **115** described herein may be capable of supporting communications with various types of devices in the wireless communications system **100** (e.g., other wireless communication devices, including UEs **115** or network entities **105**), as shown in FIG. **1**.

[0037] As described herein, a node of the wireless communications system **100**, which may be referred to as a network node, or a wireless node, may be a network entity **105** (e.g., any network entity described herein), a UE **115** (e.g., any UE described herein), a network controller, an apparatus, a device, a computing system, one or more components, or another suitable processing entity configured to perform any of the techniques described herein. For example, a node may be a UE **115**. As another example, a node may be a network entity **105**. As another example, a first node may be configured to communicate with a second node or a third node. In one aspect of this example, the first node may be a UE **115**, the second node may be a network entity **105**, and the third node may be a UE **115**. In another aspect of this example, the first node may be a UE **115**, the second node may be a network entity **105**, and the third node may be a network entity **105**. In yet other aspects of this example, the first, second, and third nodes may be different relative to these examples. Similarly, reference to a UE **115**, network entity **105**, apparatus, device, computing system, or the like may include disclosure of the UE **115**, network entity **105**, apparatus, device, computing system, or the like being a node. For example, disclosure that a UE **115** is configured to receive information from a network entity **105** also discloses that a first node is configured to receive information from a second node.

[0038] In some examples, network entities **105** may communicate with a core network **130**, or with one another, or both. For example, network entities **105** may communicate with the core network **130** via backhaul communication link(s) **120** (e.g., in accordance with an S1, N2, N3, or other interface protocol). In some examples, network entities **105** may communicate with one another via backhaul communication link(s) **120** (e.g., in accordance with an X2, Xn, or other interface protocol) either directly (e.g., directly between network entities **105**) or indirectly (e.g., via the core network **130**). In some examples, network entities **105** may communicate with one another via a midhaul communication link **162** (e.g., in accordance with a midhaul interface protocol) or a fronthaul communication link **168** (e.g., in accordance with a fronthaul interface protocol), or any combination thereof. The backhaul communication link(s) **120**, midhaul communication links **162**, or fronthaul communication links **168** may be or include one or more wired links (e.g., an electrical link, an optical fiber link) or one or more wireless links (e.g., a radio link, a wireless optical link), among other examples or various combinations thereof. A UE **115** may communicate with the core network **130** via a communication link **155**.

[0039] One or more of the network entities **105** or network equipment described herein may include or may be referred to as a base station **140** (e.g., a base transceiver station, a radio base station, an NR base station, an access point, a radio transceiver, a NodeB, an eNodeB (eNB), a next-generation NodeB or giga-NodeB (either of which may be referred to as a gNB), a 5G NB, a next-generation eNB (ng-eNB), a Home NodeB, a Home eNodeB, or other suitable terminology). In some examples, a network entity **105** (e.g., a base station **140**) may be implemented in an aggregated (e.g., monolithic, standalone) base station architecture, which may be configured to utilize a protocol stack that is physically or logically integrated within one network entity (e.g., a network entity **105** or a single RAN node, such as a base station **140**).

[0040] In some examples, a network entity **105** may be implemented in a disaggregated architecture (e.g., a disaggregated base station architecture, a disaggregated RAN architecture), which may be configured to utilize a protocol stack that is physically or logically distributed among multiple network entities (e.g., network entities **105**), such as an integrated access and backhaul (IAB) network, an open RAN (O-RAN) (e.g., a network configuration sponsored by the O-RAN Alliance), or a virtualized RAN (vRAN) (e.g., a cloud RAN (C-RAN)). For example, a network entity **105** may include one or more of a central unit (CU), such as a CU **160**, a distributed unit (DU), such as a DU **165**, a radio unit (RU), such as an RU **170**, a RAN Intelligent Controller (RIC), such as an RIC **175** (e.g., a Near-Real Time RIC (Near-RT RIC), a Non-Real Time RIC (Non-RT RIC)), a Service Management and Orchestration (SMO) system, such as an SMO system **180**, or any combination thereof. An RU **170** may also be referred to as a radio head, a smart radio head, a remote radio head (RRH), a remote radio unit (RRU), or a transmission reception point (TRP). One or more components of the network entities **105** in a disaggregated RAN architecture may be co-located, or one or more components of the network entities **105** may be located in distributed locations (e.g., separate physical locations). In some examples, one or more of the network entities **105** of a disaggregated RAN architecture may be implemented as virtual units (e.g., a virtual CU (VCU), a virtual DU (VDU), a virtual RU (VRU)).

[0041] The split of functionality between a CU **160**, a DU **165**, and an RU **170** is flexible and may support different functionalities depending on which functions (e.g., network layer functions, protocol layer functions, baseband functions, RF functions, or any combinations thereof) are performed at a CU **160**, a DU **165**, or an RU **170**. For example, a functional split of a protocol stack may be employed between a CU **160** and a DU **165** such that the CU **160** may support one or more layers of the protocol stack and the DU **165** may support one or more different layers of the protocol stack. In some examples, the CU **160** may host upper protocol layer (e.g., layer 3 (L3), layer 2 (L2)) functionality and signaling (e.g., Radio Resource Control (RRC), service data adaption protocol (SDAP), Packet Data Convergence Protocol (PDCP)). The CU **160** (e.g., one or more CUs) may be connected to a DU **165** (e.g., one or more DUs) or an RU **170** (e.g., one or more RUs), or some combination thereof, and the DUs **165**, RUs **170**, or both may host lower protocol layers, such as layer 1 (L1) (e.g., physical (PHY) layer) or L2 (e.g., radio link control (RLC) layer, medium access control (MAC) layer) functionality and signaling, and may each be at least partially controlled by the CU **160**. Additionally, or alternatively, a functional split of the protocol stack may be employed between a DU **165** and an RU **170** such that the DU **165** may support one or more layers of the protocol stack and the RU **170** may support one or more different layers of the protocol stack. The DU **165** may support one or multiple different cells (e.g., via one or multiple different RUs, such as an RU **170**). In some cases, a functional split between a CU **160** and a DU **165** or between a DU **165** and an RU **170** may be within a protocol layer (e.g., some functions for a protocol layer may be performed by one of a CU **160**, a DU **165**, or an RU **170**, while other functions of the protocol layer are performed by a different one of the CU **160**, the DU **165**, or the RU **170**). A CU **160** may be functionally split further into CU control plane (CU-CP) and CU user plane (CU-UP) functions. A CU **160** may be connected to a DU **165** via a midhaul communication link **162** (e.g., F1, F1-c, F1-u), and a DU **165** may be connected to an RU **170** via a fronthaul communication link **168** (e.g., open fronthaul (FH) interface). In some examples, a midhaul communication link **162** or a fronthaul communication link **168** may be implemented in accordance with an interface (e.g., a channel) between layers of a protocol stack supported by respective network entities (e.g., one or more of the network entities **105**) that are in communication via such communication links.

[0042] In some wireless communications systems (e.g., the wireless communications system **100**), infrastructure and spectral resources for radio access may support wireless backhaul link capabilities to supplement wired backhaul connections, providing an IAB network architecture (e.g., to a core network **130**). In some cases, in an IAB network, one or more of the network entities **105** (e.g., network entities **105** or IAB node(s) **104**) may be partially controlled by each other. The IAB node(s) **104** may be referred to as a donor entity or an IAB donor. A DU **165** or an RU **170** may be partially controlled by a CU **160** associated with a network entity **105** or base station **140** (such as a donor network entity or a donor base station). The one or more donor entities (e.g., IAB donors) may be in communication with one or more additional devices (e.g., IAB node(s) **104**) via supported access and backhaul links (e.g., backhaul communication link(s) **120**). IAB node(s) **104** may include an IAB mobile termination (IAB-MT) controlled (e.g., scheduled) by one or more DUs (e.g., DUs **165**) of a coupled IAB donor. An IAB-MT may be equipped with an independent set of antennas for relay of communications with UEs **115** or may share the same antennas (e.g., of an RU **170**) of IAB node(s) **104** used for access via the DU **165** of the IAB node(s) **104** (e.g., referred to as virtual IAB-MT (vIAB-MT)). In some examples, the IAB node(s) **104** may include one or more DUs (e.g., DUs **165**) that support communication links with additional entities (e.g., IAB node(s) **104**, UEs **115**) within the relay chain or configuration of the access network (e.g., downstream). In such cases, one or more components of the disaggregated RAN architecture (e.g., the IAB node(s) **104** or components of the IAB node(s) **104**) may be configured to operate according to the techniques described herein.

[0043] For instance, an access network (AN) or RAN may include communications between access nodes (e.g., an IAB donor), IAB node(s) **104**, and one or more UEs **115**. The IAB donor may facilitate connection between the core network **130** and the AN (e.g., via a wired or wireless connection to the core network **130**). That is, an IAB donor may refer to a RAN node with a wired or wireless connection to the core network **130**. The IAB donor may include one or more of a CU **160**, a DU **165**, and an RU **170**, in which case the CU **160** may communicate with the core network **130** via an interface (e.g., a backhaul link). The IAB donor and IAB node(s) **104** may communicate via an F1 interface according to a protocol that defines signaling messages (e.g., an F1 AP protocol). Additionally, or alternatively, the CU **160** may communicate with the core network **130** via an interface, which may be an example of a portion of a backhaul link, and may communicate with other CUs (e.g., including a CU **160** associated with an alternative IAB donor) via an Xn-C interface, which may be an example of another portion of a backhaul link.

[0044] IAB node(s) **104** may refer to RAN nodes that provide IAB functionality (e.g., access for UEs **115**, wireless self-backhauling capabilities). A DU **165** may act as a distributed scheduling node towards child nodes associated with the IAB node(s) **104**, and the IAB-MT may act as a scheduled node towards parent nodes associated with IAB node(s) **104**. That is, an IAB donor may be referred to as a parent node in communication with one or more child nodes (e.g., an IAB donor may relay transmissions for UEs through other IAB node(s) **104**). Additionally, or alternatively, IAB node(s) **104** may also be referred to as parent nodes or child nodes to other IAB node(s) **104**, depending on the relay chain or configuration of the AN. The IAB-MT entity of IAB node(s) **104** may provide a Uu interface for a child IAB node (e.g., the IAB node(s) **104**) to receive signaling from a parent IAB node (e.g., the IAB node(s) **104**), and a DU interface (e.g., a DU **165**) may provide a Uu interface for a parent IAB node to signal to a child IAB node or UE **115**.

[0045] For example, IAB node(s) **104** may be referred to as parent nodes that support communications for child IAB nodes, or may be referred to as child IAB nodes associated with IAB donors, or both. An IAB donor may include a CU **160** with a wired or wireless connection (e.g., backhaul communication link(s) **120**) to the core network **130** and may act as a parent node to IAB node(s) **104**. For example, the DU **165** of an IAB donor may relay transmissions to UEs **115** through IAB node(s) **104**, or may directly signal transmissions to a UE **115**, or both. The CU **160** of the IAB donor may signal communication link establishment via an F1 interface to IAB node(s) **104**, and the IAB node(s) **104** may schedule transmissions (e.g., transmissions to the UEs **115** relayed from the IAB donor) through one or more DUs (e.g., DUs **165**). That is, data may be relayed to and from IAB node(s) **104** via signaling via an NR Uu interface to MT of IAB node(s) **104** (e.g., other IAB node(s)). Communications with IAB node(s) **104** may be scheduled by a DU **165** of the IAB donor or of IAB node(s) **104**.

[0046] In the case of the techniques described herein applied in the context of a disaggregated RAN architecture, one or more components of the disaggregated RAN architecture may be configured to support test as described herein. For example, some operations described as being performed by a UE **115** or a network entity **105** (e.g., a base station **140**) may additionally, or alternatively, be performed by one or more components of the disaggregated RAN architecture (e.g., components such as an IAB node, a DU **165**, a CU **160**, an RU **170**, an RIC **175**, an SMO system **180**).

[0047] A UE **115** may include or may be referred to as a mobile device, a wireless device, a remote device, a handheld device, or a subscriber device, or some other suitable terminology, where the "device" may also be referred to as a unit, a station, a terminal, or a client, among other examples. A UE **115** may also include or may be referred to as a personal electronic device such as a cellular phone, a personal digital assistant (PDA), a tablet computer, a laptop computer, or a personal computer. In some examples, a UE **115** may include or be referred to as a wireless local loop (WLL) station, an Internet of Things (IoT) device, an Internet of Everything (IoE) device, or a machine type communications (MTC) device, among other examples, which may be implemented in various objects such as appliances, vehicles, or meters, among other examples.

[0048] The UEs **115** described herein may be able to communicate with various types of devices, such as UEs **115** that may sometimes operate as relays, as well as the network entities **105** and the network equipment including macro eNBs or gNBs, small cell eNBs or gNBs, or relay base stations, among other examples, as shown in FIG. **1**.

[0049] The UEs **115** and the network entities **105** may wirelessly communicate with one another via the communication link(s) **125** (e.g., one or more access links) using resources associated with one or more carriers. The term "carrier" may refer to a set of RF spectrum resources having a defined PHY layer structure for supporting the communication link(s) **125**. For example, a carrier used for the communication link(s) **125** may include a portion of an RF spectrum band (e.g., a bandwidth part (BWP)) that is operated according to one or more PHY layer channels for a given RAT (e.g., LTE, LTE-A, LTE-A Pro, NR). Each PHY layer channel may carry acquisition signaling (e.g., synchronization signals, system information), control signaling that coordinates operation for the carrier, user data, or other signaling. The wireless communications system **100** may support communication with a UE **115** using carrier aggregation or multi-carrier operation. A UE **115** may be configured with multiple downlink component carriers and one or more uplink component carriers according to a carrier aggregation configuration. Carrier aggregation may be used with both frequency division duplexing (FDD) and time division duplexing (TDD) component carriers. Communication between a network entity **105** and other devices may refer to communication between the devices and any portion (e.g., entity, sub-entity) of a network entity **105**. For example, the terms "transmitting," "receiving," or "communicating," when referring to a network entity **105**, may refer to any portion of a network entity **105** (e.g., a base station **140**, a CU **160**, a DU **165**, a RU **170**) of a RAN communicating with another device (e.g., directly or via one or more other network entities, such as one or more of the network entities **105**).

[0050] The communication link(s) **125** of the wireless communications system **100** may include downlink transmissions (e.g., forward link transmissions) from a network entity **105** to a UE **115**, uplink transmissions (e.g., return link transmissions) from a UE **115** to a network entity **105**, or both, among other configurations of transmissions. Carriers may carry downlink or uplink communications (e.g., in an FDD mode) or may be configured to carry downlink and uplink communications (e.g., in a TDD mode).

[0051] A carrier may be associated with a particular bandwidth of the RF spectrum and, in some examples, the carrier bandwidth may be referred to as a "system bandwidth" of the carrier or the wireless communications system **100**. For example, the carrier bandwidth may be one of a set of bandwidths for carriers of a particular RAT (e.g., 1.4, 3, 5, 10, 15, 20, 40, or 80 megahertz (MHz)). Devices of the wireless communications system **100** (e.g., the network entities **105**, the UEs **115**, or both) may have hardware configurations that support communications using a particular carrier bandwidth or may be configurable to support communications using one of a set of carrier bandwidths. In some examples, the wireless communications system **100** may include network entities **105** or UEs **115** that support concurrent communications using carriers associated with multiple carrier bandwidths. In some examples, each served UE **115** may be configured for operating using portions (e.g., a sub-band, a BWP) or all of a carrier bandwidth.

[0052] Signal waveforms transmitted via a carrier may be made up of multiple subcarriers (e.g., using multi-carrier modulation (MCM) techniques such as orthogonal frequency division multiplexing (OFDM) or discrete Fourier transform spread OFDM (DFT-S-OFDM)). In a system employing MCM techniques, a resource element may refer to resources of one symbol period (e.g., a duration of one modulation symbol) and one subcarrier, in which case the symbol period and subcarrier spacing may be inversely related. The quantity of bits carried by each resource element may depend on the modulation scheme (e.g., the order of the modulation scheme, the coding rate of the modulation scheme, or both), such that a relatively higher quantity of resource elements (e.g., in a transmission duration) and a relatively higher order of a modulation scheme may correspond to a relatively higher rate of communication. A wireless communications resource may refer to a combination of an RF spectrum resource, a time resource, and a spatial resource (e.g., a spatial layer, a beam), and the use of multiple spatial resources may increase the data rate or data integrity for communications with a UE **115**.

[0053] The time intervals for the network entities **105** or the UEs **115** may be expressed in multiples of a basic time unit which may, for example, refer to a sampling period of $T_S=1/(\Delta f_{max}\cdot N_f)$ seconds, for which Δf_{max} may represent a supported subcarrier spacing, and Ne may represent a supported discrete Fourier transform (DFT) size. Time intervals of a communications resource may be organized according to radio frames each having a specified duration (e.g., 10 milliseconds (ms)). Each radio frame may be identified by a system frame number (SFN) (e.g., ranging from 0 to 1023).

[0054] Each frame may include multiple consecutively-numbered subframes or slots, and each subframe or slot may have the same duration. In some examples, a frame may be divided (e.g., in the time domain) into subframes, and each subframe may be further divided into a quantity of slots. Alternatively, each frame may include a variable quantity of slots, and the quantity of slots may depend on subcarrier spacing. Each slot may include a quantity of symbol periods (e.g., depending on the length of the cyclic prefix prepended to each symbol period). In some wireless communications systems, such as the wireless communications system **100**, a slot may further be divided into multiple mini-slots associated with one or more symbols. Excluding the cyclic prefix, each symbol period may be associated with one or more (e.g., N_f) sampling periods. The duration of a symbol period may depend on the subcarrier spacing or frequency band of operation.

[0055] A subframe, a slot, a mini-slot, or a symbol may be the smallest scheduling unit (e.g., in the time domain) of the wireless communications system **100** and may be referred to as a transmission time interval (TTI). In some examples, the TTI duration (e.g., a quantity of symbol periods in a TTI) may be variable. Additionally, or alternatively, the smallest scheduling unit of the wireless communications system **100** may be dynamically selected (e.g., in bursts of shortened TTIs (STTIs)).

[0056] Physical channels may be multiplexed for communication using a carrier according to various techniques. A physical control channel and a physical data channel may be multiplexed for signaling via a downlink carrier, for example, using one or more of time division multiplexing (TDM) techniques, frequency division multiplexing (FDM) techniques, or hybrid TDM-FDM techniques. A control region (e.g., a control resource set (CORESET)) for a physical control channel may be defined by a set of symbol periods and may extend across the system bandwidth or a subset of the system bandwidth of the carrier. One or more control regions (e.g., CORESETs) may be configured for a set of the UEs **115**. For example, one or more of the UEs **115** may monitor or search control regions for control information according to one or more search space sets, and each search space set may include one or multiple control channel candidates in one or more aggregation levels arranged in a cascaded manner. An aggregation level for a control channel candidate may refer to an amount of control channel resources (e.g., control channel elements (CCEs)) associated with encoded information for a control information format having a given payload size. Search space sets may include common search space sets configured for sending control information to UEs **115** (e.g., one or more UEs) or may include UE-specific search space sets for sending control information to a UE **115** (e.g., a specific UE).

[0057] A network entity **105** may provide communication coverage via one or more cells, for example a macro cell, a small cell, a hot spot, or other types of cells, or any combination thereof. The term "cell" may refer to a logical communication entity used for communication with a network entity **105** (e.g., using a carrier) and may be associated with an identifier for distinguishing neighboring cells (e.g., a physical cell identifier (PCID), a virtual cell identifier (VCID)). In some examples, a cell also may refer to a coverage area **110** or a portion of a coverage area **110** (e.g., a sector) over which the logical communication entity operates. Such cells may range from smaller areas (e.g., a structure, a subset of structure) to larger areas depending on various factors such as the capabilities of the network entity **105**. For example, a cell may be or include a building, a subset of a building, or exterior spaces between or overlapping with coverage areas **110**, among other examples.

[0058] A macro cell generally covers a relatively large geographic area (e.g., several kilometers in radius) and may allow unrestricted access by the UEs **115** with service subscriptions with the network provider supporting the macro cell. A small cell may be associated with a network entity **105** operating with lower power (e.g., a base station **140** operating with lower power) relative to a macro cell, and a small cell may operate using the same or different (e.g., licensed, unlicensed) frequency bands as macro cells. Small cells may provide unrestricted access to the UEs **115** with service subscriptions with the network provider or may provide restricted access to the UEs **115** having an association with the small cell (e.g., the UEs **115** in a closed subscriber group (CSG), the UEs **115** associated with users in a home or office). A network entity **105** may support one or more cells and may also support communications via the one or more cells using one or multiple component carriers.

[0059] In some examples, a network entity **105** (e.g., a base station **140**, an RU **170**) may be movable and therefore provide communication coverage for a moving coverage area, such as the coverage area **110**. In some examples, coverage areas **110** (e.g., different coverage areas) associated with different technologies may overlap, but the coverage areas **110** (e.g., different coverage areas) may be supported by the same network entity (e.g., a network entity **105**). In some other examples, overlapping coverage areas, such as a coverage area **110**, associated with different technologies may be supported by different network entities (e.g., the network entities **105**). The wireless communications system **100** may include, for example, a heterogeneous network in which different types of the network entities **105** support communications for coverage areas **110** (e.g., different coverage areas) using the same or different RATs.

[0060] The wireless communications system **100** may support synchronous or asynchronous operation. For synchronous operation, network entities **105** (e.g., base stations **140**) may have similar frame timings, and transmissions from different network entities (e.g., different ones of the network entities **105**) may be approximately aligned in time. For asynchronous operation, network entities **105** may have different frame timings, and transmissions from different network entities (e.g., different ones of network entities **105**) may, in some examples, not be aligned in time. The techniques described herein may be used for either synchronous or asynchronous operations.

[0061] The wireless communications system **100** may be configured to support ultra-reliable communications or low-latency communications, or various combinations thereof. For example, the wireless communications system **100** may be configured to support ultra-reliable low-latency communications (URLLC). The UEs **115** may be designed to support ultra-reliable, low-latency, or critical functions. Ultra-reliable communications may include private communication or group communication and may be supported by one or more services such as push-to-talk, video, or data. Support for ultra-reliable, low-latency functions may include prioritization of services, and such services may be used for public safety or general commercial applications. The terms ultra-reliable, low-latency, and ultra-reliable low-latency may be used interchangeably herein.

[0062] In some examples, a UE **115** may be configured to support communicating directly with other UEs (e.g., one or more of the UEs **115**) via a device-to-device (D2D) communication link, such as a D2D communication link **135** (e.g., in accordance with a peer-to-peer (P2P), D2D, or sidelink protocol). In some examples, one or more UEs **115** of a group that are performing D2D communications may be within the coverage area **110** of a network entity **105** (e.g., a base station **140**, an RU **170**), which may support aspects of such D2D communications being configured by (e.g., scheduled by) the network entity **105**. In some examples, one or more UEs **115** of such a group may be outside the coverage area **110** of a network entity **105** or may be otherwise unable to or not configured to receive transmissions from a network entity **105**. In some examples, groups of the UEs **115** communicating via D2D communications may support a one-to-many (1:M) system in which each UE **115** transmits to one or more of the UEs **115** in the group. In some examples, a network entity **105** may facilitate the scheduling of resources for D2D communications. In some other examples, D2D communications may be carried out between the UEs **115** without an involvement of a network entity **105**.

[0063] In some systems, a D2D communication link **135** may be an example of a communication channel, such as a sidelink communication channel, between vehicles (e.g., UEs **115**). In some examples, vehicles may communicate using vehicle-to-everything (V2X) communications, vehicle-to-vehicle (V2V) communications, or some combination of these. A vehicle may signal information related to traffic conditions, signal scheduling, weather, safety, emergencies, or any other information relevant to a V2X system. In some examples, vehicles in a V2X system may communicate with roadside infrastructure, such as roadside units, or with the network via one or more network nodes (e.g., network entities **105**, base stations **140**, RUs **170**) using vehicle-to-network (V2N) communications, or with both.

[0064] The core network **130** may provide user authentication, access authorization, tracking, Internet Protocol (IP) connectivity, and other access, routing, or mobility functions. The core network **130** may include one or more network entities **105**, such as an AMF **182**, an SMF **184**, an NEF **186**, or a UPF **188**. The core network **130** may be an evolved packet core (EPC) or 5G core (5GC), which may include at least one control plane entity that manages access and mobility (e.g., a mobility management entity (MME), an access and mobility management function (AMF)) and at least one user plane entity that routes packets or interconnects to external networks (e.g., a serving gateway (S-GW), a Packet Data Network (PDN) gateway (P-GW), or a user plane function (UPF)). The control plane entity may manage non-access stratum (NAS) functions such as mobility, authentication, and bearer management for the UEs **115** served by the network entities **105** (e.g., base stations **140**) associated with the core network **130**. User IP packets may be transferred through the user plane entity, which may provide IP address allocation as well as other functions. The user plane entity may be connected to IP services **150** for one or more network operators. The IP services **150** may include access to the Internet, Intranet(s), an IP Multimedia Subsystem (IMS), or a Packet-Switched Streaming Service. The IP services **150** may include data networks, and may include or be coupled with one or more AFs **189**.

[0065] The wireless communications system **100** may operate using one or more frequency bands, which may be in the range of 300 megahertz (MHz) to 300 gigahertz (GHz). Generally, the region from 300 MHz to 3 GHz is known as the ultra-high frequency (UHF) region or decimeter band because the wavelengths range from approximately one decimeter to one meter in length. UHF waves may be blocked or redirected by buildings and environmental features, which may be referred to as clusters, but the waves may penetrate structures sufficiently for a macro cell to provide service to the UEs **115** located indoors. Communications using UHF waves may be associated with smaller antennas and shorter ranges (e.g., less than one hundred kilometers) compared to communications using the smaller frequencies and longer waves of the high frequency (HF) or very high frequency (VHF) portion of the spectrum below 300 MHz.

[0066] The wireless communications system **100** may also operate using a super high frequency (SHF) region, which may be in the range of 3 GHz to 30 GHz, also known as the centimeter band, or using an extremely high frequency (EHF) region of the spectrum (e.g., from 30 GHz to 300 GHz), also known as the millimeter band. In some examples, the wireless communications system **100** may support millimeter wave (mmW) communications between the UEs **115** and the network entities **105** (e.g., base stations **140**, RUs **170**), and EHF antennas of the respective devices may be smaller and more closely spaced than UHF antennas. In some examples, such techniques may facilitate using antenna arrays within a device. The propagation of EHF transmissions, however, may be subject to even greater attenuation and shorter range than SHF or UHF transmissions. The techniques disclosed herein may be employed across transmissions that use one or more different frequency regions, and designated use of bands across these frequency regions may differ by country or regulating body.

[0067] The wireless communications system **100** may utilize both licensed and unlicensed RF spectrum bands. For example, the wireless communications system **100** may employ License Assisted Access (LAA), LTE-Unlicensed (LTE-U) RAT, or NR technology using an unlicensed band such as the 5 GHz industrial, scientific, and medical (ISM) band. While operating using unlicensed RF spectrum bands, devices such as the network entities **105** and the UEs **115** may employ carrier sensing for collision detection and avoidance. In some examples, operations using unlicensed bands may be based on a carrier aggregation configuration in conjunction with component carriers operating using a licensed band (e.g., LAA). Operations using unlicensed spectrum may include downlink transmissions, uplink transmissions, P2P transmissions, or D2D transmissions, among other examples.

[0068] A network entity **105** (e.g., a base station **140**, an RU **170**) or a UE **115** may be equipped with multiple antennas, which may be used to employ techniques such as transmit diversity, receive diversity, multiple-input multiple-output (MIMO) communications, or beamforming. The antennas of a network entity **105** or a UE **115** may be located within one or more antenna arrays or antenna panels, which may support MIMO operations or transmit or receive beamforming. For example, one or more base station antennas or antenna arrays may be co-located at an antenna assembly, such as an antenna tower. In some examples, antennas or antenna arrays associated with a network entity **105** may be located at diverse geographic locations. A network entity **105** may include an antenna array with a set of rows and columns of antenna ports that the network entity **105** may use to support beamforming of communications with a UE **115**. Likewise, a UE **115** may include one or more antenna arrays that may support various MIMO or beamforming operations. Additionally, or alternatively, an antenna panel may support RF beamforming for a signal transmitted via an antenna port.

[0069] Beamforming, which may also be referred to as spatial filtering, directional transmission, or directional reception, is a signal processing technique that may be used at a transmitting device or a receiving device (e.g., a network entity **105**, a UE **115**) to shape or steer an antenna beam (e.g., a transmit beam, a receive beam) along a spatial path between the transmitting device and the receiving device. Beamforming may be achieved by combining the signals communicated via antenna elements of an antenna array such that some signals propagating along particular orientations with respect to an antenna array experience constructive interference while others experience destructive interference. The adjustment of signals communicated via the antenna elements may include a transmitting device or a receiving device applying amplitude offsets, phase offsets, or both to signals carried via the antenna elements associated with the device. The adjustments associated with each of the antenna elements may be defined by a beamforming weight set associated with a particular orientation (e.g., with respect to the antenna array of the transmitting device or receiving device, or with respect to some other orientation).

[0070] A network entity **105** or a UE **115** may use beam sweeping techniques as part of beamforming operations. For example, a network entity **105** (e.g., a base station **140**, an RU **170**) may use multiple antennas or antenna arrays (e.g., antenna panels) to conduct beamforming operations for directional communications with a UE **115**. Some signals (e.g., synchronization signals, reference signals, beam selection signals, or other control signals) may be transmitted by a network entity **105** multiple times along different directions. For example, the network entity **105** may transmit a signal according to different beamforming weight sets associated with different directions of transmission. Transmissions along different beam directions may be used to identify (e.g., by a transmitting device, such as a network entity **105**, or by a receiving device, such as a UE **115**) a beam direction for later transmission or reception by the network entity **105**.

[0071] Some signals, such as data signals associated with a particular receiving device, may be transmitted by a transmitting device (e.g., a network entity **105** or a UE **115**) along a single beam direction (e.g., a direction associated with the receiving device, such as another network entity **105** or UE **115**). In some examples, the beam direction associated with transmissions along a single beam direction may be determined based on a signal that was transmitted along one or more beam directions. For example, a UE **115** may receive one or more of the signals transmitted by the network entity **105** along different directions and may report to the network entity **105** an indication of the signal that the UE **115** received with a highest signal quality or an otherwise acceptable signal quality.

[0072] In some examples, transmissions by a device (e.g., by a network entity **105** or a UE **115**) may be performed using multiple beam directions, and the device may use a combination of digital precoding or beamforming to generate a combined beam for transmission (e.g., from a network entity **105** to a UE **115**). The UE **115** may report feedback that indicates precoding weights for one or more beam directions, and the feedback may correspond to a configured set of beams across a system bandwidth or one or more sub-bands. The network entity **105** may transmit a reference signal (e.g., a cell-specific reference signal (CRS), a channel state information reference signal (CSI-RS)), which may be precoded or unprecoded. The UE **115** may provide feedback for beam selection, which may be a precoding matrix indicator (PMI) or codebook-based feedback (e.g., a multi-panel type codebook, a linear combination type codebook, a port selection type codebook). Although these techniques are described with reference to signals transmitted along one or more directions by a network entity **105** (e.g., a base station **140**, an RU **170**), a UE **115** may employ similar techniques for transmitting signals multiple times along different directions (e.g., for identifying a beam direction for subsequent transmission or reception by the UE **115**) or for transmitting a signal along a single direction (e.g., for transmitting data to a receiving device).

[0073] A receiving device (e.g., a UE **115**) may perform reception operations in accordance with multiple receive configurations (e.g., directional listening) when receiving various signals from a transmitting device (e.g., a network entity **105**), such as synchronization signals, reference signals, beam selection signals, or other control signals. For example, a receiving device may perform reception in accordance with multiple receive directions by receiving via different antenna subarrays, by processing received signals according to different antenna subarrays, by receiving according to different receive beamforming weight sets (e.g., different directional listening weight sets) applied to signals received at multiple antenna elements of an antenna array, or by processing received signals according to different receive beamforming weight sets applied to signals received at multiple antenna elements of an antenna array, any of which may be referred to as "listening" according to different receive configurations or receive directions. In some examples, a receiving device may use a single receive configuration to receive along a single beam direction (e.g., when receiving a data signal). The single receive configuration may be aligned along a beam direction determined based on listening according to different receive configuration directions (e.g., a beam direction determined to have a highest signal strength, highest signal-to-noise ratio (SNR), or otherwise acceptable signal quality based on listening according to multiple beam directions).

[0074] The wireless communications system **100** may be a packet-based network that operates according to a layered protocol stack. In the user plane, communications at the bearer or PDCP layer may be IP-based. An RLC layer may perform packet segmentation and reassembly to communicate via logical channels. A MAC layer may perform priority handling and multiplexing of logical channels into transport channels. The MAC layer also may implement error detection techniques, error correction techniques, or both to support retransmissions to improve link efficiency. In the control plane, an RRC layer may provide establishment, configuration, and maintenance of an RRC connection between a UE **115** and a network entity **105** or a core network **130** supporting radio bearers for user plane data. A PHY layer may map transport channels to physical channels.

[0075] Techniques described herein, in addition to or as an alternative to be carried out between UEs **115** and network entities **105**, may be implemented via additional or alternative wireless devices, including IAB nodes **104**, DUs **165**, CUs **160**, RUs **170**, and the like. For example, in some implementations, aspects described herein may be implemented in the context of a disaggregated RAN architecture (e.g., open RAN (O-RAN) architecture). Some wireless communications systems (e.g., wireless communications system **100**), infrastructure and spectral resources for NR access may additionally support wireless backhaul link capabilities in supplement to wireline backhaul connections, providing an IAB network architecture.

[0076] In some examples, the wireless communications system **100** may include a core network **130** (e.g., a next generation core network (NGC)), one or more IAB donors, IAB nodes **104**, and UEs **115**, where IAB nodes **104** may be partially controlled by each other and/or the IAB donor. The IAB donor and IAB nodes **104** may be examples of aspects of network entities **105**. IAB donor and one or more IAB nodes **104** may be configured as (e.g., or in communication according to) some relay chain.

[0077] In the case of the techniques described herein applied in the context of a disaggregated RAN architecture, one or more components of the disaggregated RAN architecture (e.g., one or more IAB nodes **104** or components of IAB nodes **104**) may be configured to support techniques for large round trip times in random access channel procedures as described herein. For example, some operations described as being performed by a UE **115** or a network entity **105** may additionally, or alternatively, be performed by components of the disaggregated RAN architecture (e.g., IAB nodes, DUs, CUs, etc.).

[0078] The wireless communications system **100** may support uplink or downlink communications with one or more cells or sidelink communications with each other. To facilitate the uplink, downlink, and sidelink communications by UEs **115** (e.g., aerial UEs, terrestrial UEs, or both), the wireless communications system **100** may define a spectrum dedicated to UEs **115**. The dedicated spectrum may be for uplink and downlink communications between UEs **115** and one or more cells (e.g., over a Uu interface), or the dedicated spectrum may be for sidelink communications between UEs **115** (e.g., over a PC5 interface). In addition to the dedicated spectrum, UEs **115** may operate in other wireless spectrums. The wireless communications system **100** may support efficient techniques for operation of UEs **115** in dedicated spectrum and other spectrums. In some examples, a UE **115** may be a UAV or drone, or a UE **115** installed in a UAV or drone.

[0079] The wireless communications system **100** may support a generic AA procedure to authenticate and authorize a UE **115** for multiple services, in some examples. The AA procedure may be a part of a NAS procedure for multiple services (e.g., aerial services, autonomous navigation services, low-latency services, mission-critical services, IoT services). The NAS procedure may include operations by a UE **115** and a network. A UE **115** supporting UAS services may include a service-level device identifier (ID) in a request for AA, and the service-level device identifier may trigger a service-level AA procedure. The service-level device identifier may refer to a unique identifier of a service at a UE **115**. An SMF may receive the request for AA from the UE **115**, and the SMF may check a subscription of the UE **115** for UAS. The SMF may then trigger a UAV USS AA (UUAA) procedure or reject the request from the UE (e.g., with a cause of 'UAS services not allowed').

[0080] Various messages may be exchanged between a UE **115** and a network and between network entities **105** in the network to facilitate an AA procedure for services. Examples of these messages include a service-level AA container (SLAC) carrying the request for AA from the UE **115** to the SMF, an NEF authentication message from the SMF to an NEF, and a AF authentication message from the NEF to an AF. In some examples, in addition to aerial services, the wireless communications system **100** may provide other services to UEs **115** to support different functionality and applications at the UEs **115**. Examples of services supported by the wireless communications system **100** may include gaming services, streaming services, extended reality services, virtual office services, aerial services, and others. In some examples, it may be appropriate for the wireless communications system **100** to support AA for various services provided by the wireless communications system **100**. A UE **115** may transmit the SLAC as part of a session management (SM) NAS, service-level AA procedure or to initiate the SM NAS, service-level AA procedure. The SMF may transmit the NEF authentication message to the NEF along with other messages to facilitate AA (e.g., AA for aerial services), and the NEF may transmit the AF authentication message to the AF along with other messages to facilitate AA for aerial services.

[0081] An SLAC may include fields for a service-level-AA device identifier, a service-level-AA server address, a service-level-AA response, a service-level-AA payload type, a service-level-AA pending indication, and a service-level-AA payload. The service-level-AA device identifier field may include a service-level device identifier information element identifier, a service-level device identifier length, and the service-level-AA device identifier. The service-level-AA response field may include a service-level-AA response or a command and control (C2) AA response. A service-level-AA payload type field may include eight bits where a first value indicates a UUAA payload, a second value indicates a C2 authorization payload, and all other values are reserved. In some examples, payload type encoding in an SLAC for UUAA and C2 authorization may be specified.

[0082] Upon receiving an application layer request, the UE may include the SLAC in a protocol data unit session establishment message with a service-level device ID set to CAA-level UAV ID. Upon receiving the SLAC, the SMF may check UE subscription to determine whether it requires UUAA, and trigger UUAA procedure by invoking Nnef_auth services (including service-level device ID). The UAS network function (UAS-NF) (NEF) may trigger Naf_auth services by including the service-level device ID. The USS (AF) may trigger Naf_auth notification service to UAS-NF (NEF) including an authentication message. The UAS-NF (NEF) may then trigger Nnef_auth notification services to SMF with including the authentication message. An NEF authentication message may be modeled according to an Nnef_auth data model and may include UAV authentication information, an authentication notification, a UAV authentication response, a UAV authentication failure, an authentication result, and a notification type. The UAV authentication information may include a generic public subscription identifier (GPSI), a service-level device identifier, an internet protocol (IP) address of a UE **115**, an authentication message, a permanent equipment identifier (PEI), an authentication server address, an authentication notification uniform resource identifier (URI), a data network name (DNN), single network slice selection assistance information (S-NSSAI), UE location information, and a network function type (e.g., AMF or SMF).

[0083] The SMF may further set the service-level AA payload of the SLAC to the received authentication msg message, and may include the SLAC in the Service-Level Authentication Command message. The UE **115** may forward the received service-level AA payload to an upper layer. The upper layer of the UE **115** may provide the UE **115** with a UUAA payload, and the UE **115** may then set the service-level AA payload of the SLAC to the received UUAA payload and include the SLAC in the Service-Level Authentication Complete message. The SMF may then forward the service-level AA payload to UAS-NF (NEF) by invoking Nnef_auth service (including authentication message). In particular, the UAS-NF (NEF) may trigger Naf_auth services by including the authentication message. In some examples, the USS (AF) may send an authentication result by invoking Naf_auth notification service. The UAS-NF (NEF) may use the authentication result to trigger Nnef_auth notification services for SMF. The SMF may send a protocol data unit session establishment accept message with including SLAC, where the service-level-AA result (SLAR field) is set to successful. Finally, the UE **115** may forward the result of service-level AA procedure and proceed with a NAS procedure.

[0084] As depicted herein, a UE supporting UAS services can include a service-level device ID which triggers a service-level AA procedure. In addition, the SMF may check UE session management subscription data for UAS, and may accept the request and trigger UUAA procedure, or reject the request from the UE with cause 'UAS services not allowed'. The SLAC may support two types of payload-UUAA and command and control (C2) authorization. In some examples, the techniques depicted herein may provide for adapting an AA procedure to make the AA procedure generic (e.g., not limited to UAS features). A NAS procedure and container may be introduced to cope with a vertical service supporting AA. In addition, data model and descriptions may be updated to be more generic and not limited to UAS. Further, although an authentication message (e.g., 'authmsg') from an SMF may be used for any service, a data model and descriptions for an NEF authentication message may be UAS-specific. Similarly, although an authentication message (e.g., 'authmsg') from an NEF may be used for any service, a data model and descriptions for an AF authentication message may be UAS-specific.

[0085] If multiple services are available to UEs **115**, techniques depicted herein provide for adapting an AA procedure (e.g., update one or more APIs for the AA procedure) to enable AA for multiple services (e.g., vertical services). For instance, it may be appropriate to allow for the selection of network functions (e.g., an NEF or AF) supporting a target function or service. In addition, the AA procedure may be adopted to generic AA by a third party external AF. Such generic AA for multiple services may extend the usage of service-level AA procedure to any services associated with a RAN assisted AA. The techniques depicted herein enables an API-based and HTTP-based authentication, thereby supporting security mechanisms that may be implemented by third party services and providers.

[0086] Aspects of the present disclosure provide for control plane (UE and network) enhancement for services associated with the AA procedure. In some examples, SM NAS procedure and information may be enhanced to support service-level AA procedure for general purpose. In some examples, a service-level identifier may be defined for all services supported by a UE **115**, and a UE **115** may include a service-level device identifier in a request for AA. A subscription of a UE **115** (e.g., UE subscription) may allow a network to perform an AA procedure for the UE **115** for one or more services. An SMF may check a subscription of a UE **115** to determine if a vertical service for which AA is requested is allowed for the UE **115**. In some cases, if a UE **115** is capable of supporting multiple services, there may be multiple services applicable for a single UE subscription (e.g., a first UE may have a subscription for service X, service Y, and service Z). In such cases, it may be appropriate for an SMF or NEF to identify a service for which a UE **115** is requesting AA.

[0087] The techniques of the present disclosure provide for determining the services requiring service-level AA procedure and identifying target AF or target services (both uplink and downlink). According to one or more aspects depicted herein, a network entity may receive a request to validate a service by a third party AF. In such cases, a UE subscription-based control may determine whether to perform service-level AA procedure for one or more services. In an example, if a UE **115** is requesting AA for a first service X and a second service Y, an SMF may establish a single protocol data unit session with a set of traffic filters in response to receiving the request from the UE **115**. An SMF may identify a service for which a UE **115** is requesting AA, and the SMF may select a proper NEF which may connect the UE **115** to an AF supporting the service. The NEF may then select the AF (e.g., the target AF). The target AF may then provide service-level AA for the service indicated in the request.

[0088] FIG. **2** shows an example of a wireless communications system **200** that supports techniques to use service-level AA for multiple applications in accordance with one or more aspects of the present disclosure. The wireless communications system **200** includes an access network **235**, which may, for example, support communications between a UE **115**-*a* and a network entity **105**-*a*. The wireless communications system **200** also includes a core network **202**, which may be an example of a 5G core network. The wireless communications system **200** may be an example of a wireless communications system **100** as described with reference to FIG. **1**. The UE **115**-*a* may be an example of a UE **115** as described with reference to FIG. **1**. The access network **235** may include one or more network entities **105**, which may be examples of CUs, DUs, RUs, or any combination thereof, as described with reference to FIG. **1**. The core network **202** may include additional network entities **105** such as an AMF **205**, an SMF **210**, a UPF **215**, an NEF **220**, or any combination thereof. The UPF **215** may be connected to a data network **240**, which may include or be coupled with an AF **230** (or multiple AFs). As depicted herein, the wireless communications system **200** may support efficient techniques to facilitate generic service-level AA for various services.

[0089] To support service-level AA (e.g., generic service-level AA) for multiple applications, the UE **115**-*a* may transmit a message to the AMF **205** (e.g., via access network **235**). The message may include, or be an example of, a protocol data unit session establishment message and may indicate that the UE **115**-*a* is requesting validation of a first service for the UE **115**-*a*. The UE **115**-*a* may support a first service and a second service. In some examples, the UE **115**-*a* may output a container to the network entity **105**-*a* to request AA for the first service for the UE **115**-*a*. The container may include an indicator of the first service that distinguishes or identifies the first service from multiple services. Generic service-level AA allows the UE **115**-*a* to authenticate or authorize a protocol data unit session for an application level ID by one AF. In some examples, a protocol data unit session is either accepted or rejected based on service-level AA success or failure. For example, an AF **230** may perform an AA based on the application level ID (e.g., service-level ID) included in a request from the UE **115**-*a*. If the service-level AA is a failure, then the SMF **210** in conjunction with the NEF **220** may release the protocol data unit session.

[0090] The UE **115**-*a* and the network entity **105**-*a* may implement the techniques depicted herein to perform a generic service-level AA for multiple identifiers (e.g., service-level IDs) corresponding to one or more AFs, and have traffic enabled for each service-level IDs separately. A protocol data unit session established by the SMF **210** and the NEF **220** may be shared by multiple services, where each service is subject to service-level AA.

[0091] As depicted in the example of FIG. **2**, the SMF **210** may establish a protocol data unit session configured for service-level AA (in unified data management (UDM) included in subscription information) for authorized UEs **115**. For instance, a UDM may provide SM subscription data to the UE **115**. Such subscription data may indicate that a protocol data unit session associated with the SM is subject to service-level AA of the UE. The SMF **210** may use a data network name (DNN) for the protocol data unit session in a UE subscription profile, to establish the protocol data unit session. In some examples, the UDM subscription for the UE **115**-*a* may include a list of authorized DNNs. For DNNs subject to service-level AA, the DNNs may include an indication of service-level AA (e.g., a GSLAA Required Indication) with associated traffic filter information. The indication of service-level AA may specify that the subscription information indicates that no protocol data unit session for the DNN subject to service-level AA can be established unless the UE **115**-*a* provides a service level ID. Additionally, the indication of service-level AA indicates that the SMF **210** is to trigger a service-level AA at the protocol data unit session establishment. Otherwise, in such cases, the protocol data unit session establishment request is rejected.

[0092] In some examples, the subscription information may also include whether multiple services (e.g., services needing service-level AA) are allowed for the DNN (Multiple GSLAA Indication). Upon receiving such an indication, the SMF **210** may establish and release the protocol data unit session accordingly (e.g., the SMF **210** may analyze each of the service-level IDs prior to releasing the protocol data unit session). In some examples, the NEF **220** may manage a list of SLIDs and a corresponding status of service-level AA for each SLID.

[0093] Upon receiving, from the UE **115**-*a*, a first request to validate a first service and a second request to validate a second service, the SMF **210** may establish a protocol data unit session marked as being subject to service-level AA. The SMF **210** may establish a common protocol data unit session for both requests. Additionally, or alternatively, the SMF **210** may establish the protocol data unit session with pre-defined traffic filters that enable traffic not subjected to service-level AA (e.g., for services that are not subject to third party AF **230** AA). In some examples, the pre-defined traffic filters may state that no traffic is allowed until a successful service-level AA takes place. In some examples, the pre-defined traffic filter can enable the UE **115**-*a* to send initial app-layer signaling (e.g., HTTP request) to the AF **230**, and it may trigger the service-level AA. If no traffic is allowed and the UE **115**-*a* does not perform a service-level AA (e.g., generic service-level AA) within a configured time, then the SMF **210** may release the protocol data unit session.

[0094] Upon receiving the request for validation from the UE **115**-*a*, the AMF **205** may use the UDM subscription information to identify that a DNN associated with the request requires a service-level AA for establishing a connection. In such cases, the AMF **205** may select an SMF capable of supporting service-level AA (e.g., generic service-level AA). As depicted herein, the UE **115**-*a* may be configured with a service level ID for each service that is subject to service-level AA, and a list of DNNs for which service-level AA is to be performed using such service-level ID (e.g., configured in the application client and requested to the data link layer via a hardware component of the UE **115**-*a* (e.g., a modem)).

[0095] For a protocol data unit session associated with service-level AA, the UE **115**-*a* may include the DNN name in the protocol data unit session establishment request. If a protocol data unit session is already available, the UE **115**-*a* may transmit a protocol data unit session modification request including a service-level ID (according to an application client request) and an AF address associated with the services subject to validation.

[0096] The AF **230** corresponding to each service may perform a service-level AA for each service requesting validation. Upon a successful service-level AA, the AF **230** may provide new traffic policies (e.g., via a policy and charging control (PCC)) to identify the traffic that is enabled on the protocol data unit session. The traffic policy may allow any traffic for the protocol data unit session. In some examples, the UE **115**-*a* may receive the indication of the successful service-level AA. Upon receiving the indication of the successful service-level AA, the UE **115**-*a* may provide the result to an application client which corresponds to the service-level ID for the successful service-level AA procedure. For example, the UE **115**-*a* may identify which application's request has been successful by checking the service-level ID, and may indicate the results to the corresponding application client. In some examples, the service-level ID or an application ID may be provided to the PCC to enable application-specific charging.

[0097] When selecting an SMF **210** for establishing the protocol data unit session, the AMF **205** may consider subscription information from the UDM including a service-level AA indication for each DNN (whether each DNN is subject to service-level AA), a service-level AA indication for each S-NSSAI, and a service-level AA indication for each subscribed DNN. Additionally, the AMF **205** may consider whether selecting the same SMF for all protocol data unit sessions to the same S-NSSAI and DNN supporting service-level AA is requested. In some examples, an SMF that identifies a request to support service-level AA, and which does not support service-level AA, may trigger relocation of an incoming validation request (e.g., request for service-level AA) to another SMF. In some examples, selecting the SMF **210** for establishing a protocol data unit session for service-level AA for multiple services may be based on a capability of an SMF to support service-level AA.

[0098] In some examples, an AF **230** may trigger a revocation of a service-level AA for a service. In such cases, the NEF **220** may remove the traffic filters related to the specific service ID (e.g., associated with the service being revoked). For example, the NEF **220** may remove the traffic filter from an allowed traffic filter list. In some examples, if an established protocol data unit session or DNN is marked as being subject to service-level AA (e.g., GSLAA Required Indication is included in the DNN), the NEF **220** may decide to release the protocol data unit session when the last service-level ID is revoked.

[0099] In some examples, the NEF **220** may decide to release the protocol data unit session if the NEF **220** determines that no more service-level IDs are included in the protocol data unit session. In such cases, the NEF **220** may indicate to the SMF **210** to release the protocol data unit session. Additionally, or alternatively, if an established protocol data unit session or DNN is marked as being subject to service-level AA (e.g., GSLAA Required Indication is included in the DNN), and no traffic filters are active for the protocol data unit session (e.g., no traffic is allowed), then the SMF **210** may start a timer. After a preconfigured time from starting the timer, the SMF **210** may release the protocol data unit session. In such cases, the SMF **210** may indicate to the UE **115**-*a* that no traffic is allowed. The SMF **210** may also be able to handle the case where the AF **230** fails to provide a traffic filter or when the PCC rule is not updated to allow traffic filters within the configured time. In some examples, the NEF **220** may manage a context for the traffic filter (e.g., NEF **220** stores the traffic filter for management purpose), and if no traffic filter is available, the NEF **220** may indicate to release the protocol data unit session to the SMF **210**. In some examples, the SMF **210** may release the IP address or prefix(es) that were allocated to the protocol data unit session and may release the corresponding user plane resources. The SMF **210** may communicate one or more messages to the UPF or UE **115**-*a* to release the protocol data unit session.

[0100] In some examples, if an established protocol data unit session or DNN is marked as being subject to service-level AA (e.g., GSLAA Required Indication is included in the DNN), and no traffic filters are active for the protocol data unit session (e.g., no traffic is allowed), the SMF **210** may start a timer when the last service-level ID is revoked. A preconfigured time after initiating the timer, the SMF **210** may release the protocol data unit session. The SMF **210** may indicate "no active service-level AA" as a reason for releasing the protocol data unit session. After release of the protocol data unit session, the UE **115**-*a* may choose to re-initiate the protocol data unit session establishment procedure with requesting service-level AA.

[0101] FIG. **3** shows an example of a process flow **300** that supports techniques to use service-level AA for multiple applications in accordance with one or more aspects of the present disclosure. The process flow **300** includes a UE **115**-*b*, a RAN **305**, an AMF **310**, an SMF **315**, a UPF **320**, an NEF **325**, and AFs **330**, which may be examples of the corresponding devices in accordance with aspects of the present disclosure. The SMF **315** may be an example of a network entity **105**, as described with reference to FIGS. **1** and **2**. The process flow **300** may implement aspects of the wireless communications system **100** or the wireless communications system **200**. For instance, the process flow **300** may support efficient techniques to facilitate AA for various services.

[0102] In the following description of the process flow **300**, the signaling exchanged between the UE **115**-*b*, the RAN **305**, the AMF **310**, the SMF **315**, the UPF **320**, the NEF **325**, and the AFs **330** may be exchanged in a different order than the example order shown, or the operations performed by the UE **115**-*b*, the RAN **305**, the AMF **310**, the SMF **315**, the UPF **320**, the NEF **325**, and the AFs **330** may be performed in different orders or at different times. Some operations may also be omitted from the process flow **300**, and other operations may be added to the process flow **300**.

[0103] At **335**, the UE **115**-*a* may output, to the AMF **310** or the SMF **315**, an SM NAS protocol data unit establishment request or protocol data unit session modification request. The SM NAS protocol data unit establishment request or protocol data unit session modification request may include a container that requests AA for a first service for the UE **115**-*b*. The container may include a payload for an AA procedure. The container may include an indicator of the first service of a set of multiple services. The SMF **315** may obtain the container requesting AA for the first service from the UE **115**-*b*. In some examples, the UE **115**-*a* may output, to the AMF **310** or the SMF **315**, a second request to verify a second service.

[0104] The service-level AA may optionally be triggered by the SMF **315** during a protocol data unit establishment and may be performed transparently via the NEF **325** with the authorizing/authenticating AF **330**. The procedures may apply to the scenario where protocol data unit session(s) or protocol data network connection(s) for third party services may be established after a UE **115**-*b* has been authenticated and authorized by the third party AF **330**. When the UE **115**-*b* requests establishment of a protocol data unit session or a protocol data network connection, the protocol data unit session or a protocol data network connection may be subject to service-level AA of the UE **115**-*b*.

[0105] During the establishment or modification procedure of the protocol data unit session or a protocol data network connection, the AF **330** may provide the 3GPP system (e.g., RAN **305**) with traffic filters that are enabled for the protocol data unit session after successful service-level AA.

[0106] The protocol data unit establishment request from the UE **115**-*b* may include an indicator of the first service requesting validation. Additionally, or alternatively, the protocol data unit establishment request from the UE **115**-*b* may include an indicator of the second service requesting validation. As depicted herein, the SMF **315** may trigger the service-level AA procedure during the protocol data unit establishment based on the SM subscription data obtained from the UDM (not shown), and a service level user identity (e.g., identifier) provided by the UE **115**-*b* in the protocol data unit establishment request, at **335**. In the SM subscription data, it may be indicated that the protocol data unit session or the protocol data network connection is subject to a service-level AA of the UE **115**-*b*.

[0107] In some cases, the protocol data unit establishment request or protocol data unit session modification request may be directly routed to the SMF **315**. However, in some other cases, the AMF **310** may perform an SMF selection, at **340**. The UE **115**-*b* may include a service level user identity, an authentication server address (e.g., the AF address), and a service-level AA payload provided by the application layer, in the protocol data unit establishment request or protocol data unit session modification request establishment request. Upon receiving the request, the AMF **310** may select the SMF **315** supporting the service-level AA procedure if the subscription information indicates that the DNN corresponding to the incoming request is subject to the service-level AA. In some cases, one or more service level user identities may be available in the UE **115**-*b* for a DNN/S-NSSAI combination, which may be corresponding to one or more AFs **330**. The UE **115**-*b* may utilize an application layer configuration to select a service level user identity for the request for protocol data unit session connectivity.

[0108] The SMF **315** may determine to invoke an NEF service operation for service-level AA of the protocol data unit session establishment request based on the provided DNN/S-NSSAI combination, the service level user identity included in the protocol data unit session establishment request and determining that the SM subscription information requests service-level AA. If the SM subscription information indicates that it is subject to service-level AA, and the pre-defined traffic filters enable traffic not subject to service-level AA (e.g., for services allowed without service-level AA), the SMF **315** can proceed to step **375**. If the SM subscription information requests service-level AA but service level user identity is not provided by the UE **115**-*b*, then the SMF **315** may reject the establishment of the PDU Session.

[0109] To invoke an NEF service operation, at **345**, the SMF **315** may perform NEF selection and may select the NEF **325** based on the NEF **325** supporting AA for the first service. For instance, the SMF **315** may identify the NEF **325** based on local configuration or by NEF discovery procedure using DNN/S-NSSAI and/or the authentication server address provided by the UE **115**-*b* or stored in the subscription information (e.g., AF address).

[0110] At **350**, the SMF **315** may output or obtain one or more messages with the NEF **325** to authenticate and authorize the UE **115**-*b* for the first service based on the indicator of the first service. For instance, the SMF **315** may output an Nnef_Auth request to the NEF **325** to authenticate and authorize the UE **115**-*b* for the first service based on the indicator of the first service. Additionally, the SMF **315** may output or obtain one or more messages with the NEF **325** to authenticate and authorize the UE **115**-*b* for the second service based on the indicator of the second service.

[0111] The SMF **315** may invoke Nnef_Authentication_AuthenticateAuthorize service operation, including the service level user identity, a DNN, S-NSSAI, the authentication server address (e.g., the AF address), the service-level AA payload if it was provided by the UE, a GPSI, and the UE IP Address, if available. The NEF **325** may select an AF **330** based on either the service level user identity or the authentication server address (e.g., AF address) being received. In some examples, the SMF **315** may also provide a Notification Endpoint to the NEF **325**, so that the SMF **315** is implicitly subscribed to be notified of re-authentication, update authorization data or revocation of service-level AA from the NEF **325**, if the service-level AA result is successful.

[0112] At **350**, the NEF **325** may obtain, from the SMF **315**, a request to authenticate and authorize the UE **115**-*b* for the first service or the second service or both. Such request may include an indicator of the first service of a set of multiple services or an indicator of the second service of the set of multiple services or both. The indicator in the request may be a service identifier, a service name, a server address, or a combination thereof.

[0113] At **355**, the NEF **325** may perform AF selection and may select the AF **330** based on the AF **330** supporting AA for the first service. Additionally, or alternatively, the NEF **325** may select a second AF **330** based on the second AF **330** supporting AA for the second service. At **360**, the NEF **325**

may obtain an authentication response from the AF **330**. In some examples, multiple round-trip messages may be implemented by the authentication method used by the AF **330**. This step may be performed if the Naf_Authentication_AuthenticateAuthorize response message from the AF **330** in step **360** does not include a service-level AA result (indicating success or failure). In some examples, the Naf_Authentication_AuthenticateAuthorize response message (in **360**) from the AF **330** may include GPSI and may include an authentication message based on an authentication method used that is forwarded transparently to UE **115**-*b* over NAS mobility management (MM) transport messages.

[0114] At **365**, the SMF **315**, the NEF **325**, and the AF **330** may exchange signaling (e.g., output or obtain one or more messages) as part of an AA procedure (e.g., Nnef_Auth and Naf_Auth) to authenticate and authorize the UE **115**-*b* for the first service or the second service or both. In some examples, the AF **330** may send Naf_Authentication_AuthenticateAuthorize response to the NEF **325** with the AA result containing the service-level AA result (indicating success or failure) and the requested policy information (e.g., within the service-level AA authorization payload). The requested policy information from AF **330** may include a data network (DN) authorization profile index and/or a DN authorized session aggregate maximum bit rate (AMBR), or traffic filter(s) that is enabled on the protocol data unit session or that enables any traffic for the protocol data unit session. In some examples, the NEF **325** may confirm the successful service-level AA of the protocol data unit session. The NEF **325** may store the service-level AA result together with the service level user identity and an external identifier. The NEF **325** may also forward the service-level AA result, a service level user identity and the service-level AA payload, if received from the AF **330**, to the SMF **315**.

[0115] At **370**, the UE **115**-*b*, the AMF **310**, and the SMF **315** may exchange signaling (e.g., output or obtain one or more messages) as part of an SM NAS service-level AA procedure to authenticate and authorize the UE **115**-*b* for the first service or the second service or both. The SM NAS service-level AA procedure may be invoked if a Naf_Authentication_AuthenticateAuthorize response message in **360** does not indicate an authorization result.

[0116] At **375**, the UE **115**-*b*, the AMF **310**, the SMF **315**, and the UPF **320** may exchange signaling (e.g., output or obtain one or more messages) for protocol data unit session establishment completion or protocol data unit session modification completion. For example, the SMF **315** may establish a protocol data unit session with the set of traffic filters in accordance with the first request (for the first service). Upon receiving the second request, the SMF **315** may modify the protocol data unit session based on the second request (instead of establishing a new session), where modifying the protocol data unit session may include modifying at least one traffic filter of the set of traffic filters. If both services are authenticated by their respective AFs, then the UE **115**-*b*, the AMF **310**, and the SMF **315** may exchange signaling (e.g., output or obtain one or more messages) for protocol data unit session establishment completion or protocol data unit session modification completion for both services. If one of the services is not authenticated (service-level AA is unsuccessful or timed out), then the UE **115**-*b*, the AMF **310**, and the SMF **315** may exchange signaling (e.g., output or obtain one or more messages) for protocol data unit session establishment completion or protocol data unit session modification completion for the remaining service (the identifier of the unsuccessful service is removed from the protocol data unit session establishment). In some examples, if the SMF **315** receives traffic filter(s) from the AF **330**, then the SMF **315** may send traffic filter(s) to a policy control function (PCF) to inform the UPF **320** of the allowed traffic for the protocol data unit session by the AF **330**. The UPF **320** may implement one or more updated filters for the protocol data unit session in accordance with the traffic filters received from the AF **330**.

[0117] FIG. **4** shows a diagram **400** of a device **405** that supports techniques to use service-level AA for multiple applications in accordance with one or more aspects of the present disclosure. The device **405** may be an example of aspects of a network entity **105** as described herein. The device **405** may include a receiver **410**, a transmitter **415**, and a communications manager **420**. The device **405**, or one or more components of the device **405** (e.g., the receiver **410**, the transmitter **415**, the communications manager **420**), may include at least one processor, which may be coupled with at least one memory, to, individually or collectively, support or enable the described techniques. Each of these components may be in communication with one another (e.g., via one or more buses).

[0118] The receiver **410** may provide a means for obtaining (e.g., receiving, determining, identifying) information such as user data, control information, or any combination thereof (e.g., I/Q samples, symbols, packets, protocol data units, service data units) associated with various channels (e.g., control channels, data channels, information channels, channels associated with a protocol stack). Information may be passed on to other components of the device **405**. In some examples, the receiver **410** may support obtaining information by receiving signals via one or more antennas. Additionally, or alternatively, the receiver **410** may support obtaining information by receiving signals via one or more wired (e.g., electrical, fiber optic) interfaces, wireless interfaces, or any combination thereof.

[0119] The transmitter **415** may provide a means for outputting (e.g., transmitting, providing, conveying, sending) information generated by other components of the device **405**. For example, the transmitter **415** may output information such as user data, control information, or any combination thereof (e.g., I/Q samples, symbols, packets, protocol data units, service data units) associated with various channels (e.g., control channels, data channels, information channels, channels associated with a protocol stack). In some examples, the transmitter **415** may support outputting information by transmitting signals via one or more antennas. Additionally, or alternatively, the transmitter **415** may support outputting information by transmitting signals via one or more wired (e.g., electrical, fiber optic) interfaces, wireless interfaces, or any combination thereof. In some examples, the transmitter **415** and the receiver **410** may be co-located in a transceiver, which may include or be coupled with a modem.

[0120] The communications manager **420**, the receiver **410**, the transmitter **415**, or various combinations or components thereof may be examples of means for performing various aspects of techniques to use service-level AA for multiple applications as described herein. For example, the communications manager **420**, the receiver **410**, the transmitter **415**, or various combinations or components thereof may be capable of performing one or more of the functions described herein.

[0121] In some examples, the communications manager **420**, the receiver **410**, the transmitter **415**, or various combinations or components thereof may be implemented in hardware (e.g., in communications management circuitry). The hardware may include at least one of a processor, a DSP, a CPU, an ASIC, an FPGA or other programmable logic device, a microcontroller, discrete gate or transistor logic, discrete hardware components, or any combination thereof configured as or otherwise supporting, individually or collectively, a means for performing the functions described in the present disclosure. In some examples, at least one processor and at least one memory coupled with the at least one processor may be configured to perform one or more of the functions described herein (e.g., by one or more processors, individually or collectively, executing instructions stored in the at least one memory).

[0122] Additionally, or alternatively, the communications manager **420**, the receiver **410**, the transmitter **415**, or various combinations or components thereof may be implemented in code (e.g., as communications management software or firmware) executed by at least one processor (e.g., referred to as a processor-executable code). If implemented in code executed by at least one processor, the functions of the communications manager **420**, the receiver **410**, the transmitter **415**, or various combinations or components thereof may be performed by a general-purpose processor, a DSP, a CPU, an ASIC, an FPGA, a microcontroller, or any combination of these or other programmable logic devices (e.g., configured as or otherwise supporting, individually or collectively, a means for performing the functions described in the present disclosure).

[0123] In some examples, the communications manager **420** may be configured to perform various operations (e.g., receiving, obtaining, monitoring, outputting, transmitting) using or otherwise in cooperation with the receiver **410**, the transmitter **415**, or both. For example, the communications manager **420** may receive information from the receiver **410**, send information to the transmitter **415**, or be integrated in combination with the receiver **410**, the transmitter **415**, or both to obtain information, output information, or perform various other operations as described herein.

[0124] For example, the communications manager **420** is capable of, configured to, or operable to support a means for obtaining a first request to validate a first service for a UE, the first request including an indicator of the first service. The communications manager **420** is capable of, configured to, or operable to support a means for establishing a protocol data unit session with a set of traffic filters in accordance with the first request. The communications manager **420** is capable of, configured to, or operable to support a means for obtaining a second request to validate a second service for the UE, the second request including an indicator of the second service. The communications manager **420** is capable of, configured to, or operable to support a means for modifying the protocol data unit session based on the second request, where modifying the protocol data unit session includes modifying at least one traffic filter of the set of traffic filters.

[0125] By including or configuring the communications manager **420** in accordance with examples as described herein, the device **405** (e.g., at least one processor controlling or otherwise coupled with the receiver **410**, the transmitter **415**, the communications manager **420**, or a combination thereof) may support techniques for reduced processing, reduced power consumption, and more efficient utilization of communication resources.

[0126] FIG. **5** shows a diagram **500** of a device **505** that supports techniques to use service-level AA for multiple applications in accordance with one or more aspects of the present disclosure. The device **505** may be an example of aspects of a device **405** or a network entity **105** as described herein. The device **505** may include a receiver **510**, a transmitter **515**, and a communications manager **520**. The device **505**, or one or more components of the device **505** (e.g., the receiver **510**, the transmitter **515**, the communications manager **520**), may include at least one processor, which may be coupled with at least one memory, to support the described techniques. Each of these components may be in communication with one another (e.g., via one or more buses).

[0127] The receiver **510** may provide a means for obtaining (e.g., receiving, determining, identifying) information such as user data, control information, or any combination thereof (e.g., I/Q samples, symbols, packets, protocol data units, service data units) associated with various channels (e.g., control channels, data channels, information channels, channels associated with a protocol stack). Information may be passed on to other components of the device **505**. In some examples, the receiver **510** may support obtaining information by receiving signals via one or more antennas. Additionally, or alternatively, the receiver **510** may support obtaining information by receiving signals via one or more wired (e.g., electrical, fiber optic) interfaces, wireless interfaces, or any combination thereof.

[0128] The transmitter **515** may provide a means for outputting (e.g., transmitting, providing, conveying, sending) information generated by other components of the device **505**. For example, the transmitter **515** may output information such as user data, control information, or any combination thereof (e.g., I/Q samples, symbols, packets, protocol data units, service data units) associated with various channels (e.g., control channels, data channels, information channels, channels associated with a protocol stack). In some examples, the transmitter **515** may support outputting information by transmitting signals via one or more antennas. Additionally, or alternatively, the transmitter **515** may support outputting information by transmitting signals via one or more wired (e.g., electrical, fiber optic) interfaces, wireless interfaces, or any combination thereof. In some examples, the transmitter **515** and the receiver **510** may be co-located in a transceiver, which may include or be coupled with a modem.

[0129] The device **505**, or various components thereof, may be an example of means for performing various aspects of techniques to use service-level AA for multiple applications as described herein. For example, the communications manager **520** may include a validation request component **525**, a session establishment component **530**, a session modification component **535**, or any combination thereof. The communications manager **520** may be an example of aspects of a communications manager **420** as described herein. In some examples, the communications manager **520**, or various components thereof, may be configured to perform various operations (e.g., receiving, obtaining, monitoring, outputting, transmitting) using or otherwise in cooperation with the receiver **510**, the transmitter **515**, or both. For example, the communications manager **520** may receive information from the receiver **510**, send information to the transmitter **515**, or be integrated in combination with the receiver **510**, the transmitter **515**, or both to obtain information, output information, or perform various other operations as described herein.

[0130] The validation request component **525** is capable of, configured to, or operable to support a means for obtaining a first request to validate a first service for a UE, the first request including an indicator of the first service. The session establishment component **530** is capable of, configured to, or operable to support a means for establishing a protocol data unit session with a set of traffic filters in accordance with the first request. The validation request component **525** is capable of, configured to, or operable to support a means for obtaining a second request to validate a second service for the UE, the second request including an indicator of the second service. The session modification component **535** is capable of, configured to, or operable to support a means for modifying the protocol data unit session based on the second request, where modifying the protocol data unit session includes modifying at least one traffic filter of the set of traffic filters.

[0131] FIG. **6** shows a diagram **600** of a communications manager **620** that supports techniques to use service-level AA for multiple applications in accordance with one or more aspects of the present disclosure. The communications manager **620** may be an example of aspects of a communications manager **420**, a communications manager **520**, or both, as described herein. The communications manager **620**, or various components thereof, may be an example of means for performing various aspects of techniques to use service-level AA for multiple applications as described herein. For example, the communications manager **620** may include a validation request component **625**, a session establishment component **630**, a session modification component **635**, a service-level validation component **640**, a traffic filter component **645**, a session release component **650**, or any combination thereof. Each of these components, or components or subcomponents thereof (e.g., one or more processors, one or more memories), may communicate, directly or indirectly, with one another (e.g., via one or more buses). The communications may include communications within a protocol layer of a protocol stack, communications associated with a logical channel of a protocol stack (e.g., between protocol layers of a protocol stack, within a device, component, or virtualized component associated with a network entity **105**, between devices, components, or virtualized components associated with a network entity **105**), or any combination thereof.

[0132] The validation request component **625** is capable of, configured to, or operable to support a means for obtaining a first request to validate a first service for a UE, the first request including an indicator of the first service. The session establishment component **630** is capable of, configured to, or operable to support a means for establishing a protocol data unit session with a set of traffic filters in accordance with the first request. In some examples, the validation request component **625** is capable of, configured to, or operable to support a means for obtaining a second request to validate a second service for the UE, the second request including an indicator of the second service. The session modification component **635** is capable of, configured to, or operable to support a means for modifying the protocol data unit session based on the second request, where modifying the protocol data unit session includes modifying at least one traffic filter of the set of traffic filters.

[0133] In some examples, the service-level validation component **640** is capable of, configured to, or operable to support a means for initiating, based on obtaining the first request, a first service-level validation of the first service, where the first service is validated by a first AF. In some examples, the service-level validation component **640** is capable of, configured to, or operable to support a means for initiating, based on obtaining the second request, a second service-level validation of the second service, where the second service is validated by a second AF different from the first AF.

[0134] In some examples, the set of traffic filters enable a first flow of traffic associated with the first service based on the first service-level validation of the first service being successful and the set of traffic filters including the modified at least one traffic filter enable a second flow of traffic associated with the second service based on the second service-level validation of the second service being successful.

[0135] In some examples, the first AF and the second AF are external to the network entity. In some examples, the network entity communicates with the first AF and the second AF via a network exposure function.

[0136] In some examples, the session release component **650** is capable of, configured to, or operable to support a means for releasing the protocol data unit session based on determining that the first service-level validation of the first service and the second service-level validation of the second service are not complete within a threshold time period.

[0137] In some examples, the traffic filter component **645** is capable of, configured to, or operable to support a means for obtaining the set of traffic filters to identify a flow of traffic associated with the first service based on the first service-level validation of the first service being successful.

[0138] In some examples, the service-level validation component **640** is capable of, configured to, or operable to support a means for outputting an indication of a capability to support a service-level validation of services supported by the UE, where obtaining the first request and the second request is based on outputting the indication of the capability.

[0139] In some examples, the service-level validation component **640** is capable of, configured to, or operable to support a means for obtaining an indication of revocation of validation of the first service. In some examples, the traffic filter component **645** is capable of, configured to, or operable to support a means for removing a traffic filter from the set of traffic filters in response to obtaining the indication, where the traffic filter corresponds to the first service.

[0140] In some examples, the traffic filter component **645** is capable of, configured to, or operable to support a means for determining that the set of traffic filters is exclusive of active traffic filters for the protocol data unit session. In some examples, the session release component **650** is capable of, configured to, or operable to support a means for releasing the protocol data unit session in response to determining that the set of traffic filters is exclusive of active traffic filters for the protocol data unit session.

[0141] In some examples, the session release component **650** is capable of, configured to, or operable to support a means for releasing the protocol data unit session upon expiration of a timer, where the timer is initiated upon determining that set of traffic filters is exclusive of active traffic filters for the protocol data unit session.

[0142] In some examples, establishing the protocol data unit session is based on a subscription data, the indicator of the first service, or both. In some examples, the subscription data indicates that the protocol data unit session is associated with a service-level validation of the UE.

[0143] In some examples, the set of traffic filters enable flow of traffic not subject to service-level validation, traffic associated with a successful service-level validation, or both. In some examples, the indicator of the first service includes a service level indicator. In some examples, the network entity includes a session management function.

[0144] FIG. **7** shows a diagram of a system **700** including a device **705** that supports techniques to use service-level AA for multiple applications in accordance with one or more aspects of the present disclosure. The device **705** may be an example of or include components of a device **405**, a device **505**, or a network entity **105** as described herein. The device **705** may communicate with other network devices or network equipment such as one or more of the network entities **105**, UEs **115**, or any combination thereof. The communications may include communications over one or more wired interfaces, over one or more wireless interfaces, or any combination thereof. The device **705** may include components that support outputting and obtaining communications, such as a communications manager **720**, a transceiver **710**, one or more antennas **715**, at least one memory **725**, code **730**, and at least one processor **735**. These components may be in electronic communication or otherwise coupled (e.g., operatively, communicatively, functionally, electronically, electrically) via one or more buses (e.g., a bus **740**).

[0145] The transceiver **710** may support bi-directional communications via wired links, wireless links, or both as described herein. In some examples, the transceiver **710** may include a wired transceiver and may communicate bi-directionally with another wired transceiver. Additionally, or alternatively, in some examples, the transceiver **710** may include a wireless transceiver and may communicate bi-directionally with another wireless transceiver. In some examples, the device **705** may include one or more antennas **715**, which may be capable of transmitting or receiving wireless transmissions (e.g., concurrently). The transceiver **710** may also include a modem to modulate signals, to provide the modulated signals for transmission (e.g., by one or more antennas **715**, by a wired transmitter), to receive modulated signals (e.g., from one or more antennas **715**, from a wired receiver), and to demodulate signals. In some implementations, the transceiver **710** may include one or more interfaces, such as one or more interfaces coupled with the one or more antennas **715** that are configured to support various receiving or obtaining operations, or one or more interfaces coupled with the one or more antennas **715** that are configured to support various transmitting or outputting operations, or a combination thereof. In some implementations, the transceiver **710** may include or be configured for coupling with one or more processors or one or more memory components that are operable to perform or support operations based on received or obtained information or signals, or to generate information or other signals for transmission or other outputting, or any combination thereof. In some implementations, the transceiver **710**, or the transceiver **710** and the one or more antennas **715**, or the transceiver **710** and the one or more antennas **715** and one or more processors or one or more memory components (e.g., the at least one processor **735**, the at least one memory **725**, or both), may be included in a chip or chip assembly that is installed in the device **705**. In some examples, the transceiver **710** may be operable to support communications via one or more communications links (e.g., communication link(s) **125**, backhaul communication link(s) **120**, a midhaul communication link **162**, a fronthaul communication link **168**).

[0146] The at least one memory **725** may include RAM, ROM, or any combination thereof. The at least one memory **725** may store computer-readable, computer-executable, or processor-executable code, such as the code **730**. The code **730** may include instructions that, when executed by one or more of the at least one processor **735**, cause the device **705** to perform various functions described herein. The code **730** may be stored in a non-transitory computer-readable medium such as system memory or another type of memory. In some cases, the code **730** may not be directly executable by a processor of the at least one processor **735** but may cause a computer (e.g., when compiled and executed) to perform functions described herein. In some cases, the at least one memory **725** may include, among other things, a BIOS which may control basic hardware or software operation such as the interaction with peripheral components or devices. In some examples, the at least one processor **735** may include multiple processors and the at least one memory **725** may include multiple memories. One or more of the multiple processors may be coupled with one or more of the multiple memories which may, individually or collectively, be configured to perform various functions herein (for example, as part of a processing system).

[0147] The at least one processor **735** may include one or more intelligent hardware devices (e.g., one or more general-purpose processors, one or more DSPs, one or more central processing units (CPUs), one or more graphics processing units (GPUs), one or more neural processing units (NPUs) (also referred to as neural network processors or deep learning processors (DLPs)), one or more microcontrollers, one or more ASICs, one or more FPGAs, one or more programmable logic devices, discrete gate or transistor logic, one or more discrete hardware components, or any combination thereof). In some cases, the at least one processor **735** may be configured to operate a memory array using a memory controller. In some other cases, a memory controller may be integrated into one or more of the at least one processor **735**. The at least one processor **735** may be configured to execute computer-readable instructions stored in a memory (e.g., one or more of the at least one memory **725**) to cause the device **705** to perform various functions (e.g., functions or tasks supporting techniques to use service-level AA for multiple applications). For example, the device **705** or a component of the device **705** may include at least one processor **735** and at least one memory **725** coupled with one or more of the at least one processor **735**, the at least one processor **735** and the at least one memory **725** configured to perform various functions described herein. The at least one processor **735** may be an example of a cloud-computing platform (e.g., one or more physical nodes and supporting software such as operating systems, virtual machines, or container instances) that may host the functions (e.g., by executing code **730**) to perform the functions of the device **705**. The at least one processor **735** may be any one or more suitable processors capable of executing scripts or instructions of one or more software programs stored in the device **705** (such as within one or more of the at least one memory **725**). In some examples, the at least one processor **735** may include multiple processors and the at least one memory **725** may include multiple memories. One or more of the multiple processors may be coupled with one or more of the multiple memories, which may, individually or collectively, be configured to perform various functions herein. In some examples, the at least one processor **735** may be a component of a processing system, which may refer to a system (such as a series) of machines, circuitry (including, for example, one or both of processor circuitry (which may include the at least one processor **735**) and memory circuitry (which may include the at least one memory **725**)), or components, that receives or obtains inputs and processes the inputs to produce, generate, or obtain a set of outputs. The processing system may be configured to perform one or more of the functions described herein. For example, the at least one processor **735** or a processing system including the at least one processor **735** may be configured to, configurable to, or operable to cause the device **705** to perform one or more of the functions described herein. Further, as described herein, being "configured to," being "configurable to," and being "operable to" may be used interchangeably and may be associated with a capability, when executing code stored in the at least one memory **725** or otherwise, to perform one or more of the functions described herein.

[0148] In some examples, a bus **740** may support communications of (e.g., within) a protocol layer of a protocol stack. In some examples, a bus **740** may support communications associated with a logical channel of a protocol stack (e.g., between protocol layers of a protocol stack), which may include communications performed within a component of the device **705**, or between different components of the device **705** that may be co-located or located in different locations (e.g., where the device **705** may refer to a system in which one or more of the communications manager **720**, the transceiver **710**, the at least one memory **725**, the code **730**, and the at least one processor **735** may be located in one of the different components or divided between different components).

[0149] In some examples, the communications manager **720** may manage aspects of communications with a core network **130** (e.g., via one or more wired or wireless backhaul links). For example, the communications manager **720** may manage the transfer of data communications for client devices, such as one or more UEs **115**. In some examples, the communications manager **720** may manage communications with one or more other network devices **105**, and may include a controller or scheduler for controlling communications with UEs **115** (e.g., in cooperation with the one or more other network devices). In some examples, the communications manager **720** may support an X2 interface within an LTE/LTE-A wireless communications network technology to provide communication between network entities **105**.

[0150] For example, the communications manager **720** is capable of, configured to, or operable to support a means for obtaining a first request to validate a first service for a UE, the first request including an indicator of the first service. The communications manager **720** is capable of, configured to, or operable to support a means for establishing a protocol data unit session with a set of traffic filters in accordance with the first request. The communications manager **720** is capable of, configured to, or operable to support a means for obtaining a second request to validate a second service for the UE, the second request including an indicator of the second service. The communications manager **720** is capable of, configured to, or operable to support a means for modifying the protocol data unit session based on the second request, where modifying the protocol data unit session includes modifying at least one traffic filter of the set of traffic filters.

[0151] By including or configuring the communications manager **720** in accordance with examples as described herein, the device **705** may support techniques for improved communication reliability, reduced latency, improved user experience related to reduced processing, reduced power consumption, more efficient utilization of communication resources, improved coordination between devices, and improved utilization of processing capability.

[0152] In some examples, the communications manager **720** may be configured to perform various operations (e.g., receiving, obtaining, monitoring, outputting, transmitting) using or otherwise in cooperation with the transceiver **710**, the one or more antennas **715** (e.g., where applicable), or any combination thereof. Although the communications manager **720** is illustrated as a separate component, in some examples, one or more functions described with reference to the communications manager **720** may be supported by or performed by the transceiver **710**, one or more of the at least one processor **735**, one or more of the at least one memory **725**, the code **730**, or any combination thereof (for example, by a processing system including at least a portion of the at least one processor **735**, the at least one memory **725**, the code **730**, or any combination thereof). For example, the code **730** may include instructions executable by one or more of the at least one processor **735** to cause the device **705** to perform various aspects of techniques to use service-level AA for multiple applications as described herein, or the at least one processor **735** and the at least one memory **725** may be otherwise configured to, individually or collectively, perform or support such operations.

[0153] FIG. **8** shows a flowchart illustrating a method **800** that supports techniques to use service-level AA for multiple applications in accordance with one or more aspects of the present disclosure. The operations of the method **800** may be implemented by a network entity or its components as described herein. For example, the operations of the method **800** may be performed by a network entity as described with reference to FIGS. **1** through **7**. In some examples, a network entity may execute a set of instructions to control the functional elements of the network entity to perform the described functions. Additionally, or alternatively, the network entity may perform aspects of the described functions using special-purpose hardware.

[0154] At **805**, the method may include obtaining a first request to validate a first service for a UE, the first request including an indicator of the first service. The operations of **805** may be performed in accordance with examples as disclosed herein. In some examples, aspects of the operations of **805** may be performed by a validation request component **625** as described with reference to FIG. **6**.

[0155] At **810**, the method may include establishing a protocol data unit session with a set of traffic filters in accordance with the first request. The operations of **810** may be performed in accordance with examples as disclosed herein. In some examples, aspects of the operations of **810** may be performed by a session establishment component **630** as described with reference to FIG. **6**.

[0156] At **815**, the method may include obtaining a second request to validate a second service for the UE, the second request including an indicator of the second service. The operations of **815** may be performed in accordance with examples as disclosed herein. In some examples, aspects of the operations of **815** may be performed by a validation request component **625** as described with reference to FIG. **6**.

[0157] At **820**, the method may include modifying the protocol data unit session based on the second request, where modifying the protocol data unit session includes modifying at least one traffic filter of the set of traffic filters. The operations of **820** may be performed in accordance with examples as disclosed herein. In some examples, aspects of the operations of **820** may be performed by a session modification component **635** as described with reference to FIG. **6**.

[0158] FIG. **9** shows a flowchart illustrating a method **900** that supports techniques to use service-level AA for multiple applications in accordance with one or more aspects of the present disclosure. The operations of the method **900** may be implemented by a network entity or its components as described herein. For example, the operations of the method **900** may be performed by a network entity as described with reference to FIGS. **1** through **7**. In some examples, a network entity may execute a set of instructions to control the functional elements of the network entity to perform the described functions. Additionally, or alternatively, the network entity may perform aspects of the described functions using special-purpose hardware.

[0159] At **905**, the method may include obtaining a first request to validate a first service for a UE, the first request including an indicator of the first service. The operations of **905** may be performed in accordance with examples as disclosed herein. In some examples, aspects of the operations of **905** may be performed by a validation request component **625** as described with reference to FIG. **6**.

[0160] At **910**, the method may include establishing a protocol data unit session with a set of traffic filters in accordance with the first request. The operations of **910** may be performed in accordance with examples as disclosed herein. In some examples, aspects of the operations of **910** may be performed by a session establishment component **630** as described with reference to FIG. **6**.

[0161] At **915**, the method may include initiating, based on obtaining the first request, a first service-level validation of the first service, where the first service is validated by a first AF. The operations of **915** may be performed in accordance with examples as disclosed herein. In some examples, aspects of the operations of **915** may be performed by a service-level validation component **640** as described with reference to FIG. **6**.

[0162] At **920**, the method may include obtaining a second request to validate a second service for the UE, the second request including an indicator of the second service. The operations of **920** may be performed in accordance with examples as disclosed herein. In some examples, aspects of the operations of **920** may be performed by a validation request component **625** as described with reference to FIG. **6**.

[0163] At **925**, the method may include modifying the protocol data unit session based on the second request, where modifying the protocol data unit session includes modifying at least one traffic filter of the set of traffic filters. The operations of **925** may be performed in accordance with examples as disclosed herein. In some examples, aspects of the operations of **925** may be performed by a session modification component **635** as described with reference to FIG. **6**.

[0164] At **930**, the method may include initiating, based on obtaining the second request, a second service-level validation of the second service, where the second service is validated by a second AF different from the first AF. The operations of **930** may be performed in accordance with examples as disclosed herein. In some examples, aspects of the operations of **930** may be performed by a service-level validation component **640** as described with reference to FIG. **6**.

[0165] FIG. **10** shows a flowchart illustrating a method **1000** that supports techniques to use service-level AA for multiple applications in accordance with one or more aspects of the present disclosure. The operations of the method **1000** may be implemented by a network entity or its components as described herein. For example, the operations of the method **1000** may be performed by a network entity as described with reference to FIGS. **1** through **7**. In some examples, a network entity may execute a set of instructions to control the functional elements of the network entity to perform the described functions. Additionally, or alternatively, the network entity may perform aspects of the described functions using special-purpose hardware.

[0166] At **1005**, the method may include obtaining a first request to validate a first service for a UE, the first request including an indicator of the first service. The operations of **1005** may be performed in accordance with examples as disclosed herein. In some examples, aspects of the operations of **1005** may be performed by a validation request component **625** as described with reference to FIG. **6**.

[0167] At **1010**, the method may include establishing a protocol data unit session with a set of traffic filters in accordance with the first request. The operations of **1010** may be performed in accordance with examples as disclosed herein. In some examples, aspects of the operations of **1010** may be performed by a session establishment component **630** as described with reference to FIG. **6**.

[0168] At **1015**, the method may include initiating, based on obtaining the first request, a first service-level validation of the first service, where the first service is validated by a first AF. The operations of **1015** may be performed in accordance with examples as disclosed herein. In some examples, aspects of the operations of **1015** may be performed by a service-level validation component **640** as described with reference to FIG. **6**.

[0169] At **1020**, the method may include obtaining a second request to validate a second service for the UE, the second request including an indicator of the second service. The operations of **1020** may be performed in accordance with examples as disclosed herein. In some examples, aspects of the operations of **1020** may be performed by a validation request component **625** as described with reference to FIG. **6**.

[0170] At **1025**, the method may include modifying the protocol data unit session based on the second request, where modifying the protocol data unit session includes modifying at least one traffic filter of the set of traffic filters. The operations of **1025** may be performed in accordance with examples as disclosed herein. In some examples, aspects of the operations of **1025** may be performed by a session modification component **635** as described with reference to FIG. **6**.

[0171] At **1030**, the method may include initiating, based on obtaining the second request, a second service-level validation of the second service, where the second service is validated by a second AF different from the first AF. The operations of **1030** may be performed in accordance with examples as disclosed herein. In some examples, aspects of the operations of **1030** may be performed by a service-level validation component **640** as described with reference to FIG. **6**.

[0172] At **1035**, the method may include releasing the protocol data unit session based on determining that the first service-level validation of the first service and the second service-level validation of the second service are not complete within a threshold time period. The operations of **1035** may be performed in accordance with examples as disclosed herein. In some examples, aspects of the operations of **1035** may be performed by a session release component **650** as described with reference to FIG. **6**.

[0173] The following provides an overview of aspects of the present disclosure:

[0174] Aspect 1: A method for wireless communications at a network entity, comprising: obtaining a first request to validate a first service for a UE, the first request comprising an indicator of the first service; establishing a protocol data unit session with a set of traffic filters in accordance with the first request; obtaining a second request to validate a second service for the UE, the second request comprising an indicator of the second service; and modifying the protocol data unit session based at least in part on the second request, wherein modifying the protocol data unit session comprises modifying at least one traffic filter of the set of traffic filters.

[0175] Aspect 2: The method of aspect 1, further comprising: initiating, based at least in part on obtaining the first request, a first service-level validation of the first service, wherein the first service is validated by a first application function; and initiating, based at least in part on obtaining the second request, a second service-level validation of the second service, wherein the second service is validated by a second application function different from the first application function.

[0176] Aspect 3: The method of aspect 2, wherein the set of traffic filters enable a first flow of traffic associated with the first service based at least in part on the first service-level validation of the first service being successful and the set of traffic filters comprising the modified at least one traffic filter enable a second flow of traffic associated with the second service based at least in part on the second service-level validation of the second service being successful.

[0177] Aspect 4: The method of any of aspects 2 through 3, wherein the first application function and the second application function are external to the network entity.

[0178] Aspect 5: The method of aspect 4, wherein the network entity communicates with the first application function and the second application function via a network exposure function.

[0179] Aspect 6: The method of any of aspects 2 through 5, further comprising: releasing the protocol data unit session based at least in part on determining that the first service-level validation of the first service and the second service-level validation of the second service are not complete within a threshold time period.

[0180] Aspect 7: The method of any of aspects 2 through 6, further comprising: obtaining the set of traffic filters to identify a flow of traffic associated with the first service based at least in part on the first service-level validation of the first service being successful.

[0181] Aspect 8: The method of any of aspects 1 through 7, further comprising: outputting an indication of a capability to support a service-level validation of services supported by the UE, wherein obtaining the first request and the second request is based at least in part on outputting the indication of the capability.

[0182] Aspect 9: The method of any of aspects 1 through 8, further comprising: obtaining an indication of revocation of validation of the first service; and removing a traffic filter from the set of traffic filters in response to obtaining the indication, wherein the traffic filter corresponds to the first service.

[0183] Aspect 10: The method of any of aspects 1 through 9, further comprising: determining that the set of traffic filters is exclusive of active traffic filters for the protocol data unit session; and releasing the protocol data unit session in response to determining that the set of traffic filters is exclusive of active traffic filters for the protocol data unit session.

[0184] Aspect 11: The method of aspect 10, further comprising: releasing the protocol data unit session comprising releasing the protocol data unit session upon expiration of a timer, wherein the timer is initiated upon determining that set of traffic filters is exclusive of active traffic filters for the protocol data unit session.

[0185] Aspect 12: The method of any of aspects 1 through 11, wherein establishing the protocol data unit session is based at least in part on a subscription data, the indicator of the first service, or both, the subscription data indicates that the protocol data unit session is associated with a service-level validation of the UE.

[0186] Aspect 13: The method of any of aspects 1 through 12, wherein the set of traffic filters enable flow of traffic not subject to service-level validation, traffic associated with a successful service-level validation, or both.

[0187] Aspect 14: The method of any of aspects 1 through 13, wherein the indicator of the first service comprises a service level indicator.

[0188] Aspect 15: The method of any of aspects 1 through 14, wherein the network entity comprises a session management function.

[0189] Aspect 16: A network entity comprising one or more memories storing processor-executable code, and one or more processors coupled with the one or more memories and individually or collectively operable to execute the code to cause the network entity to perform a method of any of aspects 1 through 15.

[0190] Aspect 17: A network entity comprising at least one means for performing a method of any of aspects 1 through 15.

[0191] Aspect 18: A non-transitory computer-readable medium storing code the code comprising instructions executable by one or more processors to perform a method of any of aspects 1 through 15.

[0192] It should be noted that the methods described herein describe possible implementations. The operations and the steps may be rearranged or otherwise modified and other implementations are possible. Further, aspects from two or more of the methods may be combined.

[0193] Although aspects of an LTE, LTE-A, LTE-A Pro, or NR system may be described for purposes of example, and LTE, LTE-A, LTE-A Pro, or NR terminology may be used in much of the description, the techniques described herein are applicable beyond LTE, LTE-A, LTE-A Pro, or NR networks. For example, the described techniques may be applicable to various other wireless communications systems such as Ultra Mobile Broadband (UMB), Institute of Electrical and Electronics Engineers (IEEE) 802.11 (Wi-Fi), IEEE 802.16 (WiMAX), IEEE 802.20, Flash-OFDM, as well as other systems and radio technologies not explicitly mentioned herein.

[0194] Information and signals described herein may be represented using any of a variety of different technologies and techniques. For example, data, instructions, commands, information, signals, bits, symbols, and chips that may be referenced throughout the description may be represented by voltages, currents, electromagnetic waves, magnetic fields or particles, optical fields or particles, or any combination thereof.

[0195] The various illustrative blocks and components described in connection with the disclosure herein may be implemented or performed using a general-purpose processor, a DSP, an ASIC, a CPU, a graphics processing unit (GPU), a neural processing unit (NPU), an FPGA or other programmable logic device, discrete gate or transistor logic, discrete hardware components, or any combination thereof designed to perform the functions described herein. A general-purpose processor may be a microprocessor but, in the alternative, the processor may be any processor, controller, microcontroller, or state machine. A processor may also be implemented as a combination of computing devices (e.g., a combination of a DSP and a microprocessor, multiple microprocessors, one or more microprocessors in conjunction with a DSP core, or any other such configuration). Any functions or operations described herein as being capable of being performed by a processor may be performed by multiple processors that, individually or collectively, are capable of performing the described functions or operations.

[0196] The functions described herein may be implemented in hardware, software executed by a processor, firmware, or any combination thereof. If implemented in software executed by a processor, the functions may be stored on or transmitted over as one or more instructions or code on a computer-readable medium. Other examples and implementations are within the scope and spirit of the disclosure and appended claims. For example, due to the nature of software, functions described above can be implemented using software executed by a processor, hardware, firmware, hardwiring, or combinations of any of these. Features implementing functions may also be physically located at various positions, including being distributed such that portions of functions are implemented at different physical locations. As used herein, including in the claims, the term "and/or," when used in a list of two or more items, means that any one of the listed items can be employed by itself, or any combination of two or more of the listed items can be employed. For example, if a composition is described as containing components A, B, and/or C, the composition can contain A alone; B alone; C alone; A and B in combination; A and C in combination; B and C in combination; or A, B, and C in combination. Also, as used herein, including in the claims, "or" as used in a list of items (for example, a list of items prefaced by a phrase such as "at least one of" or "one or more of") indicates a disjunctive list such that, for example, a list of "at least one of A, B, or C" means A or B or C or AB or AC or BC or ABC (i.e., A and B and C).

[0197] Computer-readable media includes both non-transitory computer storage media and communication media including any medium that facilitates transfer of a computer program from one location to another. A non-transitory storage medium may be any available medium that may be accessed by a general-purpose or special-purpose computer. By way of example, and not limitation, non-transitory computer-readable media may include RAM, ROM, electrically erasable programmable ROM (EEPROM), flash memory, compact disk (CD) ROM or other optical disk storage, magnetic disk storage or other magnetic storage devices, or any other non-transitory medium that may be used to carry or store desired program code means in the form of instructions or data structures and that may be accessed by a general-purpose or special-purpose computer or a general-purpose or special-purpose processor. Also, any connection is properly termed a computer-readable medium. For example, if the software is transmitted from a website, server, or other remote source using a coaxial cable, fiber optic cable, twisted pair, digital subscriber line (DSL), or wireless technologies such as infrared, radio, and microwave, then the coaxial cable, fiber optic cable, twisted pair, DSL, or wireless technologies such as infrared, radio, and microwave are included in the definition of computer-readable medium. Disk and disc, as used herein, include CD, laser disc, optical disc, digital versatile disc (DVD), floppy disk, and Blu-ray disc. Disks may reproduce data magnetically, and discs may reproduce data optically using lasers. Combinations of the above are also included within the scope of computer-readable media. Any functions or operations described herein as being capable of being performed by a memory may be performed by multiple memories that, individually or collectively, are capable of performing the described functions or operations.

[0198] As used herein, including in the claims, "or" as used in a list of items (e.g., a list of items prefaced by a phrase such as "at least one of" or "one or more of") indicates an inclusive list such that, for example, a list of at least one of A, B, or C means A or B or C or AB or AC or BC or ABC (i.e., A and B and C). Also, as used herein, the phrase "based on" shall not be construed as a reference to a closed set of conditions. For example, an example step that is described as "based on condition A" may be based on both a condition A and a condition B without departing from the scope of the present disclosure. In other words, as used herein, the phrase "based on" shall be construed in the same manner as the phrase "based at least in part on."

[0199] As used herein, including in the claims, the article "a" before a noun is open-ended and understood to refer to "at least one" of those nouns or "one or more" of those nouns. Thus, the terms "a," "at least one," "one or more," and "at least one of one or more" may be interchangeable. For example, if a claim recites "a component" that performs one or more functions, each of the individual functions may be performed by a single component or by any combination of multiple components. Thus, the term "a component" having characteristics or performing functions may refer to "at least one of one or more components" having a particular characteristic or performing a particular function. Subsequent reference to a component introduced with the article "a" using the terms "the" or "said" may refer to any or all of the one or more components. For example, a component introduced with the article "a" may be understood to mean "one or more components," and referring to "the component" subsequently in the claims may be understood to be equivalent to referring to "at least one of the one or more components." Similarly, subsequent reference to a component introduced as "one or more components" using the terms "the" or "said" may refer to any or all of the one or more components. For example, referring to "the one or more components" subsequently in the claims may be understood to be equivalent to referring to "at least one of the one or more components."

[0200] The term "determine" or "determining" encompasses a variety of actions and, therefore, "determining" can include calculating, computing, processing, deriving, investigating, looking up (such as via looking up in a table, a database, or another data structure), ascertaining, and the like. Also, "determining" can include receiving (e.g., receiving information), accessing (e.g., accessing data stored in memory), and the like. Also, "determining" can include resolving, obtaining, selecting, choosing, establishing, and other such similar actions.

[0201] In the appended figures, similar components or features may have the same reference label. Further, various components of the same type may be distinguished by following the reference label by a dash and a second label that distinguishes among the similar components. If just the first reference label is used in the specification, the description is applicable to any one of the similar components having the same first reference label irrespective of the second reference label or other subsequent reference label.

[0202] The description set forth herein, in connection with the appended drawings, describes example configurations and does not represent all the examples that may be implemented or that are within the scope of the claims. The term "example" used herein means "serving as an example, instance, or illustration" and not "preferred" or "advantageous over other examples." The detailed description includes specific details for the purpose of providing an understanding of the described techniques. These techniques, however, may be practiced without these specific details. In some figures, known structures and devices are shown in diagram form in order to avoid obscuring the concepts of the described examples.

[0203] The description herein is provided to enable a person having ordinary skill in the art to make or use the disclosure. Various modifications to the disclosure will be apparent to a person having ordinary skill in the art, and the generic principles defined herein may be applied to other variations without departing from the scope of the disclosure. Thus, the disclosure is not limited to the examples and designs described herein but is to be accorded the broadest scope consistent with the principles and novel features disclosed herein.

What is claimed is:

1. A network entity, comprising:

one or more memories storing processor-executable code; and

one or more processors coupled with the one or more memories and individually or collectively operable to execute the code to cause the network entity to:

obtain a first request to validate a first service for a user equipment (UE), the first request comprising an indicator of the first service;

establish a protocol data unit session with a set of traffic filters in accordance with the first request;

obtain a second request to validate a second service for the UE, the second request comprising an indicator of the second service; and

modify the protocol data unit session based at least in part on the second request, wherein modifying the protocol data unit session comprises modifying at least one traffic filter of the set of traffic filters.

2. The network entity of claim **1**, wherein the one or more processors are individually or collectively further operable to execute the code to cause the network entity to:

initiate, based at least in part on obtaining the first request, a first service-level validation of the first service, wherein the first service is validated by a first application function; and

initiate, based at least in part on obtaining the second request, a second service-level validation of the second service, wherein the second service is validated by a second application function different from the first application function.

3. The network entity of claim **2**, wherein the set of traffic filters enable a first flow of traffic associated with the first service based at least in part on the first service-level validation of the first service being successful and the set of traffic filters comprising the modified at least one traffic filter enable a second flow of traffic associated with the second service based at least in part on the second service-level validation of the second service being successful.

4. The network entity of claim **2**, wherein the first application function and the second application function are external to the network entity, and wherein the network entity communicates with the first application function and the second application function via a network exposure function.

5. The network entity of claim **2**, wherein the one or more processors are individually or collectively further operable to execute the code to cause the network entity to:

release the protocol data unit session based at least in part on determining that the first service-level validation of the first service and the second service-level validation of the second service are not complete within a threshold time period.

6. The network entity of claim **2**, wherein the one or more processors are individually or collectively further operable to execute the code to cause the network entity to:

obtain the set of traffic filters to identify a flow of traffic associated with the first service based at least in part on the first service-level validation of the first service being successful.

7. The network entity of claim 1, wherein the one or more processors are individually or collectively further operable to execute the code to cause the network entity to:

output an indication of a capability to support a service-level validation of services supported by the UE, wherein obtaining the first request and the second request is based at least in part on outputting the indication of the capability.

8. The network entity of claim 1, wherein the one or more processors are individually or collectively further operable to execute the code to cause the network entity to:

obtain an indication of revocation of validation of the first service; and

remove a traffic filter from the set of traffic filters in response to obtaining the indication, wherein the traffic filter corresponds to the first service.

9. The network entity of claim 1, wherein the one or more processors are individually or collectively further operable to execute the code to cause the network entity to:

determine that the set of traffic filters is exclusive of active traffic filters for the protocol data unit session; and

release the protocol data unit session in response to determining that the set of traffic filters is exclusive of active traffic filters for the protocol data unit session.

10. The network entity of claim 9, wherein the one or more processors are individually or collectively further operable to execute the code to cause the network entity to:

release the protocol data unit session upon expiration of a timer, wherein the timer is initiated upon determining that the set of traffic filters is exclusive of active traffic filters for the protocol data unit session.

11. The network entity of claim 1, wherein:

establishing the protocol data unit session is based at least in part on a subscription data, the indicator of the first service, or both; and

the subscription data indicates that the protocol data unit session is associated with a service-level validation of the UE.

12. The network entity of claim 1, wherein the set of traffic filters enable flow of traffic not subject to service-level validation, traffic associated with a successful service-level validation, or both.

13. The network entity of claim 1, wherein the indicator of the first service comprises a service level indicator, and wherein the network entity comprises a session management function.

14. A network entity, comprising:

one or more memories storing processor-executable code; and

one or more processors coupled with the one or more memories and individually or collectively operable to execute the code to cause the network entity to:

obtain an indication to validate a first service for a user equipment (UE);

obtain, from an application function that is selected based at least in part on the indication of the first service, an indication of authentication and authorization of the UE for the first service;

obtain, from the application function, a set of traffic filters associated with the first service;

forward, to a session management function, the indication of the authentication and authorization of the UE for the first service; and

forward, to the session management function, the set of traffic filters obtained from the application function for establishment of a protocol data unit session with the UE.

15. The network entity of claim 14, wherein the one or more processors are individually or collectively further operable to execute the code to cause the network entity to:

obtain an indication to validate a second service for the UE;

obtain, from a second application function that is selected based at least in part on the indication to validate the second service, a second indication of authentication and authorization of the UE for the second service;

obtain, from the application function, a second set of traffic filters associated with the second service; and

forward, to the session management function for modification of at least one traffic filter of the set of traffic filters of the protocol data unit session, the second set of traffic filters and the second indication of authentication and authorization.

16. The network entity of claim 14, wherein the one or more processors are individually or collectively further operable to execute the code to cause the network entity to:

receive a second indication of authentication and authorization of the UE for the first service, wherein the second indication comprises a revocation of validation; and

remove the set of traffic filters associated with the first service from an allowed traffic filter list associated with the UE based at least in part on the revocation of validation.

17. The network entity of claim 16, wherein the one or more processors are individually or collectively further operable to execute the code to cause the network entity to:

release the protocol data unit session associated with the UE based at least in part on the revocation of validation associated with the first service and the first service being a last service associated with the UE.

18. The network entity of claim 14, wherein the network entity comprises a network exposure function.

19. A method for wireless communications at a network entity, comprising:

obtaining a first request to validate a first service for a user equipment (UE), the first request comprising an indicator of the first service;

establishing a protocol data unit session with a set of traffic filters in accordance with the first request;

obtaining a second request to validate a second service for the UE, the second request comprising an indicator of the second service; and

modifying the protocol data unit session based at least in part on the second request, wherein modifying the protocol data unit session comprises modifying at least one traffic filter of the set of traffic filters.

20. The method of claim 19, further comprising:

initiating, based at least in part on obtaining the first request, a first service-level validation of the first service, wherein the first service is validated by a first application function; and

initiating, based at least in part on obtaining the second request, a second service-level validation of the second service, wherein the second service is validated by a second application function different from the first application function.

* * * * *