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(54) Title: SYSTEM AND METHOD FOR PCF-SPR BYPASS IN COMMUNICATION NETWORK

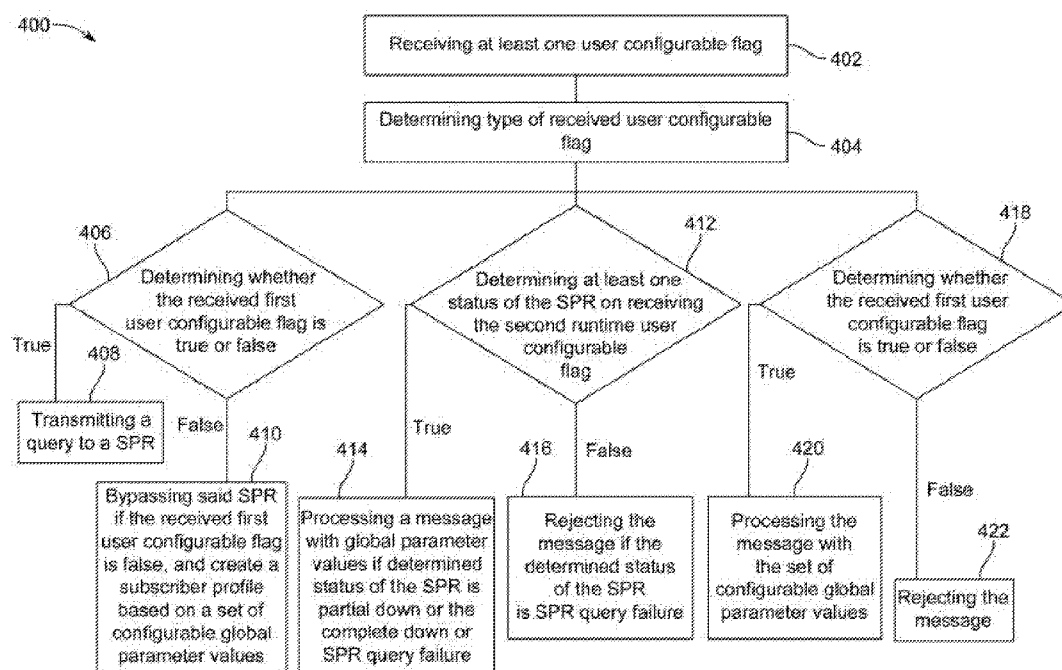


FIG. 4

(57) Abstract: The present disclosure provides a system (108) for Policy Control Function (PCF)- Subscriber Profile Repository (SPR) bypass in a communication network. The present disclosure enhances PCF and SPR to support bypass and subscribe/notify feature. The system includes a memory and a processing engine. The processing engine is configured to receive at least one user configurable flag from the PCF (110). The processing engine is configured to determine a state of the at least one received user configurable flag. The determined state is either a true state or a false state. The processing engine is configured to perform the at least one operation based on the determined state. The at least one operation includes at least one of bypassing the SPR (112), transmitting a query to the SPR, processing a message, and rejecting the message.

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SYSTEM AND METHOD FOR PCF-SPR BYPASS IN COMMUNICATION NETWORK

RESERVATION OF RIGHTS

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TECHNICAL FIELD

[002] The present disclosure relates to a field of a communication network, and specifically to a system and a method for Policy Control Function (PCF) -
15 Subscriber Profile Repository (SPR) bypass in a communication network.

BACKGROUND

[003] The following description of related art is intended to provide background information pertaining to the field of the disclosure. This section may include certain aspects of the art that may be related to various features of the
20 present disclosure. However, it should be appreciated that this section be used only to enhance the understanding of the reader with respect to the present disclosure, and not as admissions of prior art.

[004] Currently Policy Control Function (PCF) mandates Subscriber Profile Repository (SPR) lookup for Access Mobility (AM)/Session Management (SM) policy decision for initial AM policy control/SM policy control messages.
25 Once the SPR is looked up, subscriber SPR data object is stored by SM in cache so that any future lookup query is not sent again towards SPR. This cache object is deleted once all the session data for that specific subscriber is removed from PCF.

[005] In production environment, there may be negative scenarios that need to be handled by PCF including cases where SPR lookup needs to be turned off or SPR partially is unavailable or SPR lookup is failed (due to provisioning specific issues). Currently PCF application does not provide a way to handle the same.

[006] Similarly, when the subscriber profile is changed at SPR, there is no way that SPR currently sends the notification towards PCF given that SPR is just a database and has no trigger point to either send modified subscriber information for running session or knowledge of which PCF sends notification. Currently PCF does not have any way to handle the same as well.

[007] Thus, there is a need to provide a PCF-SPR bypass system by overcoming the deficiencies of the prior arts.

OBJECTS OF THE PRESENT DISCLOSURE

[008] It is an object of the present disclosure to provide a bypass system for Policy Control Function (PCF)-Subscriber Profile Repository (SPR) bypass in a communication network.

[009] It is an object of the present disclosure to enhance PCF and SPR to support bypass and subscribe/notify feature.

[0010] It is an object of the present disclosure to provide capability to act on notification received from SPR.

[0011] It is an object of the present disclosure to provide alarms, counters, vProbe codes, and logs for operational ease of feature.

SUMMARY

[0012] The present disclosure discloses a system for performing at least one operation in association with a policy control function (PCF) and a subscription profile repository (SPR) in a communication network. The system includes a

memory and a processing engine. The processing engine is configured to execute instructions including receiving at least one user configurable flag from the PCF. The processing engine is configured to determine a state of the at least one received user configurable flag, wherein the determined state is either a true state or a false state. The processing engine is configured to perform the at least one operation based on the determined state. The at least one operation includes at least one of bypassing the SPR, transmitting a query to the SPR, processing a message, and rejecting the message.

[0013] In an embodiment, the at least one user configurable flag is a first user configurable flag, a second runtime user configurable flag, or a third runtime user configurable flag.

[0014] In an embodiment, the processing engine is configured to transmit the query to the SPR if the determined state of the received first user configurable flag is the true state.

[0015] In an embodiment, the processing engine is configured to bypass the SPR if the determined state of the received first user configurable flag is the false state and creates a subscriber profile based on a set of configurable global parameter values.

[0016] In an embodiment, the processing engine is configured to determine at least one status of the SPR on receiving the second runtime user configurable flag. The at least one status includes a partial down, a complete down, a SPR query failure and a SPR query null. The processing engine is configured to process a message, received from a user equipment via an access management function (AMF), with a set of configurable global parameter values if the determined state of the received second runtime user configurable flag is the true state, and the determined status of the SPR is the partial down or the complete down. The processing engine is configured to reject the message if the determined state of the received second runtime user configurable flag is false state and the determined status of the SPR is the SPR query failure.

[0017] In an embodiment, the processing engine is configured to process the message with the set of configurable global parameter values if the determined state of the received third user configurable flag is the true state.

[0018] In an embodiment, the processing engine is configured to reject the message if the determined state of the received third user configurable flag is the false state.

[0019] In an embodiment, the set of configurable global parameter values includes identical field values as stored in the SPR corresponding to the subscriber profile.

10 [0020] In an embodiment, the SPR is configured to receive subscription information from a user indicating a change in at least one of the personal information, service plans, or services subscribed by the user and is further configured to update the subscriber profile to generate a modified subscriber profile.

15 [0021] In an embodiment, the processing engine is configured to detect a change in the subscription information associated with the user and send a notification to the PCF with the modified subscriber profile.

[0022] In an embodiment, the processing engine is configured to generate a unique identifier for each of a plurality of subscribe requests received for a
20 Subscription Permanent Identifier (SUPI) from a plurality of PCFs.

[0023] In an embodiment, the processing engine is configured to receive an unsubscribe message containing the unique identifier provided by the SPR and delete existing subscriptions from memory accordingly.

[0024] The present disclosure discloses a method for performing a number
25 of operations in association with a policy control function (PCF) and a subscriber profile repository (SPR) in a communication network. The method includes receiving at least one user configurable flag from the PCF. The method includes

determining a state of the at least one received user configurable flag. The determined state is either a true state or a false state. The method includes performing the at least one operation based on the determined state. The at least one operation includes at least one of bypassing the SPR, transmitting a query to the SPR, processing a message, and rejecting the message.

[0025] In an embodiment, the at least one user configurable flag is a first user configurable flag, a second runtime user configurable flag, or a third runtime user configurable flag.

[0026] In an embodiment, the method includes a step of transmitting, by the processing engine, the query to the SPR if the determined state of the received first user configurable flag is the true state.

[0027] In an embodiment, the method includes a step of bypassing, by the processing engine, the SPR if the determined state of the received first user configurable flag is the false state and creates a subscriber profile based on a set of configurable global parameter values.

[0028] In an embodiment, the method includes a step of determining, by the processing engine, at least one status of the SPR on receiving the second runtime user configurable flag, wherein the at least one status includes a partial down, a complete down, a SPR query failure and a SPR query null. The processing engine is further configured to process a message, received from a user equipment via an access management function (AMF), with a set of configurable global parameter values if the determined state of the received second runtime user configurable flag is the true state, and the determined status of the SPR is the partial down or the complete down. The processing engine reject the message if the determined state of the received second runtime user configurable flag is false state and the determined status of the SPR is the SPR query failure.

[0029] In an embodiment, the method includes a step of processing, by the processing engine, the message with a set of configurable global parameter values if the determined state of the received third user configurable flag is the true state.

5 [0030] In an embodiment, the method includes a step of rejecting, by the processing engine, the message if the determined state of the received third user configurable flag is the false state.

[0031] In an embodiment, the set of configurable global parameter values includes identical field values as stored in the SPR corresponding to the subscriber profile.

10 [0032] In an embodiment, the method includes a step of receiving, by the SPR, subscription information from a user indicating a change in at least one of the personal information, service plans, or services subscribed by the user and updating the subscriber profile to generate a modified subscriber profile.

15 [0033] In an embodiment, the method includes a step of detecting, by the processing engine, a change in the subscription information associated with the user and sending a notification to the PCF with the modified subscriber profile.

[0034] In an embodiment, the method includes a step of generating, by the processing engine, a unique identifier to differentiate each of a plurality of subscribe requests received for a Subscription Permanent Identifier (SUPI) from a plurality
20 of PCFs.

[0035] In an embodiment, the method includes a step of receiving, by the processing engine, an unsubscribe message containing the unique identifier provided by the SPR and deleting existing subscriptions from memory accordingly.

[0036] The present disclosure discloses a user equipment (UE)
25 communicatively coupled with a system. The coupling comprises steps of receiving a connection request, sending an acknowledgment of the connection request to the

system, and transmitting a plurality of signals in response to the connection request. The system is a policy control function (PCF).

BRIEF DESCRIPTION OF THE DRAWINGS

5 [0037] In the figures, similar components and/or features may have the same reference label. Further, various components of the same type may be distinguished by following the reference label with a second label that distinguishes among the similar components. If only 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.

10 [0038] The diagrams are for illustration only, which thus is not a limitation of the present disclosure, and wherein:

[0039] FIG. 1 illustrates an exemplary network architecture for implementing a system, in accordance with an embodiment of the present disclosure.

15 [0040] FIG. 2 illustrates an exemplary block diagram of the system, in accordance with an embodiment of the present disclosure.

[0041] FIG. 3 is a flow chart depicting steps of a method for performing at least one operation in association with a policy control function (PCF) and a subscriber profile repository (SPR) in a communication network, in accordance
20 with an embodiment of the present disclosure.

[0042] FIG. 4 is a flow chart depicting steps performed by the system, in accordance with an embodiment of the present disclosure.

[0043] FIG. 5 is an illustration of a non-limiting example of details of computing hardware used in the system, in accordance with an embodiment of the
25 present disclosure.

LIST OF REFERENCE NUMERALS

- 100 – Network Architecture
- 102-1, 102-2...102-N – Users
- 104-1, 104-2...104-N – User Equipments
- 108 –System
- 5 110 – Policy Control Function (PCF)
- 112 – Subscription Profile Repository (SPR)
- 114 – Centralized Server
- 204 – Memory
- 206 – A Plurality of Interfaces
- 10 208 – Processing Engine
- 210 – Database
- 212 – Bypass Engine
- 214 – Subscription and Notification Engine
- 214 – Other Engine(s)
- 15 510 – External Storage Device
- 520 – Bus
- 530 – Main Memory
- 540 – Read Only Memory
- 550 – Mass Storage Device
- 20 560 – Communication Port
- 570 – Processor

DETAILED DESCRIPTION

- [0044] In the following description, for the purposes of explanation, various specific details are set forth in order to provide a thorough understanding of
- 25 embodiments of the present disclosure. It will be apparent, however, that embodiments of the present disclosure may be practiced without these specific details. Several features described hereafter can each be used independently of one another or with any combination of other features. An individual feature may not address any of the problems discussed above or might address only some of the
- 30 problems discussed above. Some of the problems discussed above might not be

fully addressed by any of the features described herein. Example embodiments of the present disclosure are described below, as illustrated in various drawings in which like reference numerals refer to the same parts throughout the different drawings.

- 5 **[0045]** The ensuing description provides exemplary embodiments only, and is not intended to limit the scope, applicability, or configuration of the disclosure. Rather, the ensuing description of the exemplary embodiments will provide those skilled in the art with an enabling description for implementing an exemplary embodiment. It should be understood that various changes may be made in the function and
10 arrangement of elements without departing from the spirit and scope of the disclosure as set forth.

[0046] Specific details are given in the following description to provide a thorough understanding of the embodiments. However, it will be understood by one of ordinary skill in the art that the embodiments may be practiced without these
15 specific details. For example, circuits, systems, networks, processes, and other components may be shown as components in block diagram form in order not to obscure the embodiments in unnecessary detail. In other instances, well-known circuits, processes, algorithms, structures, and techniques may be shown without unnecessary detail in order to avoid obscuring the embodiments.

- 20 **[0047]** Also, it is noted that individual embodiments may be described as a process that is depicted as a flowchart, a flow diagram, a data flow diagram, a structure diagram, or a block diagram. Although a flowchart may describe the operations as a sequential process, many of the operations can be performed in parallel or concurrently. In addition, the order of the operations may be re-arranged. A process
25 is terminated when its operations are completed but could have additional steps not included in a figure. A process may correspond to a method, a function, a procedure, a subroutine, a subprogram, etc. When a process corresponds to a function, its termination can correspond to a return of the function to the calling function or the main function.

- 30 **[0048]** The word “exemplary” and/or “demonstrative” is used herein to mean serving as an example, instance, or illustration. For the avoidance of doubt, the

subject matter disclosed herein is not limited by such examples. In addition, any aspect or design described herein as “exemplary” and/or “demonstrative” is not necessarily to be construed as preferred or advantageous over other aspects or designs, nor is it meant to preclude equivalent exemplary structures and techniques known to those of ordinary skill in the art. Furthermore, to the extent that the terms “includes,” “has,” “contains,” and other similar words are used in either the detailed description or the claims, such terms are intended to be inclusive like the term “comprising” as an open transition word without precluding any additional or other elements.

10 [0049] Reference throughout this specification to “one embodiment” or “an embodiment” or “an instance” or “one instance” means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment of the present disclosure. Thus, the appearances of the phrases “in one embodiment” or “in an embodiment” in various places throughout
15 this specification are not necessarily all referring to the same embodiment. Furthermore, the particular features, structures, or characteristics may be combined in any suitable manner in one or more embodiments.

[0050] The terminology used herein is to describe particular embodiments only and is not intended to be limiting the disclosure. As used herein, the singular forms “a”, “an”, and “the” are intended to include the plural forms as well, unless the context indicates otherwise. It will be further understood that the terms “comprises” and/or “comprising,” when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof. As used herein, the term “and/or” includes any combinations of one or more of the associated listed items. It should be noted that the terms “mobile device”, “user equipment”, “user device”, “communication device”, “device” and similar terms are used interchangeably for the purpose of describing the invention. These terms are not intended to limit the scope of the invention or imply any specific functionality or limitations on the described embodiments. The use of these terms is solely for convenience and clarity

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of description. The invention is not limited to any particular type of device or equipment, and it should be understood that other equivalent terms or variations thereof may be used interchangeably without departing from the scope of the invention as defined herein.

- 5 **[0051]** As used herein, an “electronic device”, or “portable electronic device”, or “user device” or “communication device” or “user equipment” or “device” refers to any electrical, electronic, electromechanical, and computing device. The user device is capable of receiving and/or transmitting one or parameters, performing function/s, communicating with other user devices, and transmitting data to the
- 10 other user devices. The user equipment may have a processor, a display, a memory, a battery, and an input-means such as a hard keypad and/or a soft keypad. The user equipment may be capable of operating on any radio access technology including but not limited to IP-enabled communication, Zig Bee, Bluetooth, Bluetooth Low Energy, Near Field Communication, Z-Wave, Wi-Fi, Wi-Fi direct, etc. For
- 15 instance, the user equipment may include, but not limited to, a mobile phone, smartphone, virtual reality (VR) devices, augmented reality (AR) devices, laptop, a general-purpose computer, desktop, personal digital assistant, tablet computer, mainframe computer, or any other device as may be obvious to a person skilled in the art for implementation of the features of the present disclosure.
- 20 **[0052]** Further, the user device may also comprise a “processor” or “processing unit” includes processing unit, wherein processor refers to any logic circuitry for processing instructions. The processor may be a general-purpose processor, a special purpose processor, a conventional processor, a digital signal processor, a plurality of microprocessors, one or more microprocessors in association with a
- 25 DSP core, a controller, a microcontroller, Application Specific Integrated Circuits, Field Programmable Gate Array circuits, any other type of integrated circuits, etc. The processor may perform signal coding data processing, input/output processing, and/or any other functionality that enables the working of the system according to the present disclosure. More specifically, the processor is a hardware processor.
- 30 **[0053]** As portable electronic devices and wireless technologies continue to improve and grow in popularity, the advancing wireless technologies for data

transfer are also expected to evolve and replace the older generations of technologies. In the field of wireless data communications, the dynamic advancement of various generations of cellular technology are also seen. The development, in this respect, has been incremental in the order of second generation
5 (2G), third generation (3G), fourth generation (4G), and now fifth generation (5G), and more such generations are expected to continue in the forthcoming time.

[0054] Radio Access Technology (RAT) refers to the technology used by mobile devices/ user equipment (UE) to connect to a cellular network. It refers to the specific protocol and standards that govern the way devices communicate with base
10 stations, which are responsible for providing the wireless connection. Further, each RAT has its own set of protocols and standards for communication, which define the frequency bands, modulation techniques, and other parameters used for transmitting and receiving data. Examples of RATs include GSM (Global System for Mobile Communications), CDMA (Code Division Multiple Access), UMTS
15 (Universal Mobile Telecommunications System), LTE (Long-Term Evolution), and 5G. The choice of RAT depends on a variety of factors, including the network infrastructure, the available spectrum, and the mobile device's/device's capabilities. Mobile devices often support multiple RATs, allowing them to connect to different types of networks and provide optimal performance based on the available network
20 resources.

[0055] While considerable emphasis has been placed herein on the components and component parts of the preferred embodiments, it will be appreciated that many embodiments can be made and that many changes can be made in the preferred
25 embodiments without departing from the principles of the disclosure. These and other changes in the preferred embodiment as well as other embodiments of the disclosure will be apparent to those skilled in the art from the disclosure herein, whereby it is to be distinctly understood that the foregoing descriptive matter is to be interpreted merely as illustrative of the disclosure and not as a limitation.

[0056] Policy Control Function (PCF) and Subscriber Profile Repository (SPR) are
30 both key components in the architecture of telecommunications networks, particularly in the realm of mobile networks such as LTE (Long-Term Evolution)

and 5G. PCF is a network entity responsible for controlling and managing policies related to the quality of service (QoS), traffic management, and charging within the network. PCF plays a crucial role in ensuring that the network resources are utilized efficiently while meeting the service quality requirements of different applications and users. PCF interacts with other network elements such as the Policy and Charging Rules Function (PCRF), User Equipment (UE), and Session Management Function (SMF) to enforce policies and make dynamic decisions based on factors like subscriber profiles, network conditions, and service requirements.

[0057] SPR serves as a centralized repository for storing subscriber-related information and profiles within the network. SPR contains detailed information about subscribers such as their service subscriptions, authentication credentials, service preferences, usage patterns, and QoS requirements. SPR provides a centralized source of subscriber data that various network functions and entities can access for authentication, authorization, charging, and policy enforcement purposes. SPR enables the network to personalize services, enforce policies, and deliver a consistent user experience across different access networks and service domains.

[0058] The PCF requires an SPR lookup for access mobility (AM) and session management (SM) policy decisions for initial AM/SM policy control messages. Once the SPR is looked up, a subscriber data object (having a subscriber information) is stored corresponding to a session for a specific subscriber in a cache object associated with the PCF, so that any future lookup query is not sent again toward the SPR. The cache object is deleted once all the session data for that specific subscriber is removed from PCF. In a production environment, there may be scenarios that need to be handled by PCF, including cases where SPR lookup needs to be turned off, or SPR is partially unavailable, or SPR lookup failed (due to provisioning-specific issues). Currently, the PCF does not provide a way to handle these scenarios. Similarly, when the subscriber information is changed at SPR, there is no way for SPR to send a notification to PCF, given that SPR is a database only and has no trigger point to either send modified subscriber

information for running sessions. Currently, PCF does not have any way to handle these situations as well.

[0059] The present disclosure provides a system for PCF-SPR in a communication network. The present disclosure enhances features associated with the PCF and SPR. The present disclosure provides a capability to PCF to act on the notification received from SPR. The present disclosure provides the following functionalities:

- enables the PCF and SPR to implement bypass mechanisms, allowing certain types of traffic or transactions to skip the normal processing flow. This could be useful for time-sensitive or critical operations where latency needs to be minimized.
- introduces a mechanism for entities within the network to subscribe to specific events or changes in the subscriber profiles stored in the SPR. This enables real-time updates and notifications, ensuring that network elements stay synchronized with the latest subscriber information.
- provides the capability for network functions, including the PCF, to act upon receiving notifications from the SPR. This could involve dynamically adjusting policy decisions, allocating resources, or triggering specific service activations or deactivations based on the updated subscriber profiles.
- facilitates operational management and troubleshooting by including features such as alarms, counters, vProbe codes, and logs. These tools provide insights into the system's performance, usage patterns, and potential issues, making it easier for network operators to monitor and maintain the PCF-SPR system.

[0060] The described system enhances the capabilities of PCF and SPR within the communication network, offering improved flexibility, real-time

responsiveness, and operational efficiency through bypass support, subscribe/notify features, and comprehensive management tools.

[0061] The various embodiments of the present disclosure will be explained in detail with reference to FIG. 1 to FIG. 5.

5 **[0062]** FIG. 1 illustrates an exemplary network architecture (100) for implementing a system (108), in accordance with an embodiment of the present disclosure.

[0063] Referring to FIG. 1, the network architecture (100) includes one or more computing devices or user equipments (104-1, 104-2...104-N) associated
10 with one or more users (102-1, 102-2...102-N), the system (108), and a centralized server (114) in an environment. A person of ordinary skill in the art will understand that one or more users (102-1, 102-2...102-N) may be individually referred to as the user (102) and collectively referred to as the users (102). Similarly, a person of ordinary skill in the art will understand that one or more user equipments (104-1,
15 104-2...104-N) may be individually referred to as the user equipment (104) and collectively referred to as the user equipment (104). A person of ordinary skill in the art will appreciate that the terms “computing device(s)” and “user equipment” may be used interchangeably throughout the disclosure. Although three user equipments (104) are depicted in FIG. 1, however any number of the user
20 equipments (104) may be included without departing from the scope of the ongoing description.

[0064] In an embodiment, the user equipment (104) may include smart devices operating in a smart environment, for example, an Internet of Things (IoT) system. In such an embodiment, the user equipment (104) may include, but is not
25 limited to, smart phones, smart watches, smart sensors (e.g., mechanical, thermal, electrical, magnetic, etc.), networked appliances, networked peripheral devices, networked lighting system, communication devices, networked vehicle accessories, networked vehicular devices, smart accessories, tablets, smart television (TV), computers, smart security system, smart home system, other devices for monitoring
30 or interacting with or for the users (102) and/or entities, or any combination thereof.

A person of ordinary skill in the art will appreciate that the user equipment (104) may include, but is not limited to, intelligent, multi-sensing, network-connected devices, that can integrate seamlessly with each other and/or with a central server or a cloud-computing system or any other device that is network-connected.

5 **[0065]** In an embodiment, the user equipment (104) may include, but is not limited to, a handheld wireless communication device (e.g., a mobile phone, a smart phone, a phablet device, and so on), a wearable computer device(e.g., a head-mounted display computer device, a head-mounted camera device, a wristwatch computer device, and so on), a Global Positioning System (GPS) device, a laptop
10 computer, a tablet computer, or another type of portable computer, a media playing device, a portable gaming system, and/or any other type of computer device with wireless communication capabilities, and the like. In an embodiment, the user equipment (104) may include, but is not limited to, any electrical, electronic, electro-mechanical, or an equipment, or a combination of one or more of the above
15 devices such as virtual reality (VR) devices, augmented reality (AR) devices, laptop, a general-purpose computer, desktop, personal digital assistant, tablet computer, mainframe computer, or any other computing device, wherein the user equipment (104) may include one or more in-built or externally coupled accessories including, but not limited to, a visual aid device such as a camera, an audio aid, a
20 microphone, a keyboard, and input devices for receiving input from the user (102) or the entity such as touch pad, touch enabled screen, electronic pen, and the like. A person of ordinary skill in the art will appreciate that the user equipment (104) may not be restricted to the mentioned devices and various other devices may be used.

25 **[0066]** Referring to FIG. 1, the user equipment (104) is configured to communicate with the system (108), through a communication network (106). The system (108) is commutatively coupled to a policy control function (PCF) (110) and a subscription profile repository (SPR) (112) in the communication network (106). In an embodiment, the system (108) may be assembled with the PCF (110)
30 and the SPR (112) to provide an enhancement in various capabilities (support the bypass and subscribe/notify features) of the PCF and the SPR. In an aspect, the

communication network (106) may include a multiple PCFs, a plurality of access management functions (AMFs), and multiple SPR as per requirements. In an embodiment, the communication network (106) is a fifth generation (5G) network, 6G network, fifth generation (5G) standalone (SA) network, 5G non-standalone (NSA) network, fourth generation (4G) network, a combination of 5G to 4G network, wireless fidelity (Wi-Fi) network or other non 3GPP (third generation partnership project) access network. The communication network (106) enables the user equipment (104) to communicate with other devices in the network architecture (100) and/or with the system (108). The communication network (106) may include a wireless card or some other transceiver connection to facilitate this communication. In another embodiment, the communication network (106) may be implemented as or include any of a variety of different communication technologies such as a wide area network (WAN), a local area network (LAN), a wireless network, a mobile network, a Virtual Private Network (VPN), the Internet, the Public Switched Telephone Network (PSTN), or the like.

[0067] In another exemplary embodiment, the centralized server (114) may include or comprise, by way of example but not limitation, one or more of: a stand-alone server, a server blade, a server rack, a bank of servers, a server farm, hardware supporting a part of a cloud service or system, a home server, hardware running a virtualized server, one or more processors executing code to function as a server, one or more machines performing server-side functionality as described herein, at least a portion of any of the above, some combination thereof.

[0068] In accordance with embodiments of the present disclosure, the system (108) (also referred as “PCF-SPR bypass system (108)”) is configured for enhancing capabilities of the PCF and the SPR to support the bypass and subscribe/notify features. In addition, the system (108) is configured to provide the capability to act on the notifications received from SPR. Also, the system (108) is configured to provide alarms, counters, vProbe codes, logs for operational ease of feature.

[0069] The system includes a memory and a processing engine (as shown in FIG. 2). Under a set of operative instructions, the processing engine is configured

to receive at least one user configurable flag from the PCF. In an embodiment, the at least one user configurable flag is a first user configurable flag (SPRLookupEnable), a second runtime user configurable flag (SPRFailProcess), or a third runtime user configurable flag (SPRNullProcess). On receiving the runtime user configurable flag, the system (108) is configured to determine a type of the received runtime user configurable flag. The processing engine is configured to determine a state of the received user configurable flag. In an example, the determined state is either a true state or a false state. The processing engine is configured to perform the at least one operation based on the determined state. In an aspect, the at least one operation includes bypassing the SPR, transmitting a query to the SPR, processing a message, or rejecting the message.

[0070] After determining, the type of the received runtime user configurable flag (for example, the received runtime user configurable flag is the first user configurable flag), the system (108) is configured to determine whether the determined state of the received first user configurable flag is the true state or the false state. If the determined state of the received first user configurable flag is the true state, the system (108) is configured to transmit a query to the SPR. If the determined state of the received first user configurable flag is the false state, the system (108) is configured to bypass the SPR and create a subscriber profile based on a set of configurable global parameter values. In an example, the set of configurable global parameter values includes identical field values as stored in the SPR corresponding to a subscriber profile. The subscriber profile includes a range of details such as unique subscriber identities like International mobile subscriber identity (IMSI) or Subscriber Identity Module (SIM) information, subscribed services data, voice, and messaging plans, along with associated service profiles defining parameters like QoS and call forwarding settings.

[0071] If the received runtime user configurable flag is the second user configurable flag, then the system (108) is configured to determine at least one status of the SPR. The at least one status includes a partial down, a complete down, a SPR query failure and a SPR query null. If the determined state of the received second runtime user configurable flag is the true state and the determined status of

the SPR is partial down or the complete down, the system (108) is configured to process a message, received from the user equipment via an access management function (AMF), with the set of configurable global parameter values. If the determined state of the received second runtime user configurable flag is the false state and the determined status of the SPR is the SPR query failure, then the system (108) is configured to reject the received message.

[0072] If the received runtime user configurable flag is the third user configurable flag, then the system (108) is configured to determine whether the state of the received third user configurable flag is the true state or the false state.

10 In an embodiment, the system (108) is configured to determine at least one status of the SPR on receiving the third runtime user configurable flag. If the determined state of the received third user configurable flag is the true state, the system (108) is configured to process the message with the set of configurable global parameter values. If the determined state of the received third user configurable flag is the false state, and the determined status of the SPR is SPR query null, then the system (108) is configured to reject the message.

[0073] In an embodiment, the SPR is configured to receive subscription information from a user indicating a change in at least one of the personal information, service plans, or services subscribed by the user. On receiving the subscription information from the user, the SPR is further configured to update the subscriber profile according to the change to generate a modified subscriber profile.

[0074] The processing engine is configured to detect a change in the subscription information, performed by the SPR, associated with the user, and send a notification to the PCF with the modified subscriber profile. In an embodiment, the SPR is configured to receive a subscription message from the PCF and store subscription information for the modified subscriber profile.

[0075] The processing engine is configured to generate a unique identifier for each of a plurality of subscribe requests received for a Subscription Permanent Identifier (SUPI) from a plurality of PCFs. Further, the processing engine is configured to receive an unsubscribe message containing the unique identifier provided by the SPR and delete existing subscriptions from memory accordingly.

[0076] In an embodiment, the system (108) is configured to generate a unique subscriber identity module provider identifier (SUPI) value to differentiate between a subscribe request for same SUPI from multiple PCFs. In an example, the system (108) is configured to generate the unique SUPI values by adding some randomly generated values.

[0077] In an embodiment, the system (108) is configured to detect a change in subscription information and send a notification towards a uniform resource identifier (URI) with updated subscriber profile.

[0078] Although FIG. 1 shows exemplary components of the network architecture (100), in other embodiments, the network architecture (100) may include fewer components, different components, differently arranged components, or additional functional components than depicted in FIG. 1. Additionally, or alternatively, one or more components of the network architecture (100) may perform functions described as being performed by one or more other components of the network architecture (100).

[0079] In an overall aspect, the system is configured to facilitate various operations as described:

- Handling User Configurable Flags:

The processing engine receives a set of user configurable flags from the PCF, indicating certain conditions or preferences. In an example, the set of user configurable flags can be of different types, such as runtime user configurable flags or specific flags indicating system states.

- Operation Based on Flag States:

The processing engine determines the state of each received flag (true or false). Based on these states, the processing engine performs various operations, including bypassing the SPR, transmitting queries to the SPR, processing messages, or rejecting messages.

- Different flags trigger different actions. For instance:

The first user configurable flag determines whether to transmit a query to the SPR or bypass it.

The second runtime user configurable flag is used to determine the status of the SPR and influence message processing.

The third user configurable flag affects message processing directly.

- Handling SPR Subscription Information:

5 The SPR receives subscription information from users, indicating changes in personal details, service plans, or subscribed services. The SPR updates subscriber profiles accordingly to reflect modified subscription details.

- Notification and Subscription Management:

10 The processing engine detects changes in subscription information and notifies the PCF with the modified subscriber profile. The processing engine also generates unique identifiers for subscribe requests and handles unsubscribe messages, accordingly, deleting subscriptions from memory.

[0080] In summary, the disclosed system enhances the functionalities of the PCF and SPR within the communication network by providing flexible handling of user configurable flags, efficient operation based on flag states, and effective management of subscriber profiles and subscriptions.

[0081] FIG. 2 illustrates an exemplary block diagram (200) of the system (108), in accordance with an embodiment of the present disclosure. In an aspect, the system (108) includes a memory (204), a plurality of interfaces (206), a processing engine (208), and a database (210). The processing engine (208) is configured to fetch and execute computer-readable instructions stored in the memory. The processing engine (208) is configured to execute a sequence of instructions of the method for performing a number of operations in association with the PCF and the SPR, which may be embodied in a program or software. The instructions can be directed to the processing unit, which may subsequently program or otherwise be configured to implement the methods of the present disclosure. In some examples, the processing engine (208) is configured to control and/or communicate with large databases, perform high-volume transaction processing, and generate reports from large databases. The processing engine (208) may be implemented as one or more microprocessors, microcomputers, microcontrollers, digital signal processors, central processing units, state machines,

logic circuitries, and/or any devices that manipulate signals based on operational instructions. The memory (204) is configured to store program instructions and data corresponding to a plurality of messages received from the PCF and the SCR. The program instructions include a program that implements a method for enhancing a
5 number of functionalities of the connected PCF and the SPR in accordance with embodiments of the present disclosure and may implement other embodiments described in this specification. The memory (204) may include any computer-readable medium known in the art including, for example, volatile memory, such as Static Random Access Memory (SRAM) and Dynamic Random Access Memory
10 (DRAM), and/or non-volatile memory, such as Read Only Memory (ROM), erasable programmable ROM, flash memories, hard disks, optical disks, and magnetic tapes.

[0082] The plurality of interfaces (206) includes a variety of interfaces, for example, interfaces for data input and output devices, referred to as I/O devices,
15 storage devices, and the like. The plurality of interfaces (206) is configured to facilitate communication of the system (108). The plurality of interfaces (206) also provides a communication pathway for one or more components of the system (108).

[0083] The processing engine (208) (processing unit) may be implemented
20 as a combination of hardware and programming (for example, programmable instructions) to implement one or more functionalities of the processing engine (208). In examples described herein, such combinations of hardware and programming may be implemented in several different ways. For example, the programming for the processing engine (208) may be processor-executable
25 instructions stored on a non-transitory machine-readable storage medium and the hardware for the processing engine (208) may comprise a processing resource (for example, one or more processors), to execute such instructions. In the present examples, the machine-readable storage medium may store instructions that, when executed by the processing resource, implement the processing engine (208). In
30 such examples, the system (108) may include the machine-readable storage medium storing the instructions and the processing resource to execute the

instructions, or the machine-readable storage medium may be separate but accessible to the system (108) and the processing resource. In other examples, the processing engine(s) (208) may be implemented by an electronic circuitry. In an embodiment, the processing engine (208) may include a bypass engine (212), a
5 subscription and notification engine (214), and other engines (216).

[0084] After receiving the first user configurable flag, the bypass engine (212) of the system (108) is configured to perform the following steps:

- a. receive runtime user configurable flag “SPRLookupEnable” with value true/false (default value as true) from the PCF. When the value is true, the
10 PCF is configured to query SPR, via the system (108). The SPR is configured to provide the subscribe information (subscribe profile). When “SPRLookupEnable” is set to true, PCF operates in its standard mode for subscribers, engaging in communication with the SPR to access necessary subscriber information. Moreover, the PCF also initiates a subscription to
15 the Subscription Permanent Identifier (SUPI) from SPR, enabling bidirectional communication by sharing a notification URI with SPR to facilitate the transmission of notifications back to PCF. Conversely, when “SPRLookupEnable” is set to false, the PCF adjusts its operational behaviour accordingly. The PCF refrains from executing SPR lookup
20 procedures and abstains from subscribing to SUPI. In an aspect, the PCF, in association with the system (108), is configured to define a set of configurable global parameter values. The set of configurable global parameter values has similar fields to what is provided by the SPR. The system (108) is configured to use those global parameter values for making
25 decisions for session establishment/session completion. To monitor and track the flow of messages exchanged between PCF and SPR, a counter mechanism is implemented. This counter records both the messages sent to SPR and those bypassed, offering insights into the overall communication dynamics between the two entities. By maintaining this count, PCF can
30 effectively manage and optimize its interactions with SPR while ensuring the integrity and efficiency of the system's policy control mechanisms.

- b. In an aspect, for an inroamer (refers to a subscriber who is roaming on a foreign network while still maintaining their home network subscription) (or subscribers not associated with a current network), the access mobility and management function (AMF) is configured to forward messages received from the user equipment to the local PCF within the same Public Land Mobile Network (PLMN). Once the Authentication Management (AM) query reaches the PCF, the SPR lookup process is bypassed for decision-making purposes. Conversely, for outroamer subscribers, the AM Policy query will not be directed to the local PCF. On landing the AM query lands to the PCF, the system (108) is configured to bypass the SPR lookup for decision making. For outroamer, AM policy query did not land on the PCF. In an embodiment, the PCF in cooperation with the system (108), is further analyse a user equipment (UE) policy message as well for the inroamer where no SPR lookup has been done. In an example, the system (108) is configured to provide a configurable option to connect with a home PCF for forwarding the UE policy message. For the outroamer, the system (108) is configured to provide the UE policy message via a V-PCF (virtual PCF) to the home PCF (h-PCF). For Session Management (SM) policy, SM policy for inroamer is not received at PCF and for outroamer local SMF is configured to connect with the PCF. The SMF is configured to handle all sessions corresponding to the same SUPI that are landed to the same PCF. In an embodiment, the SMF is configured to operate in all cases including 5G SA or NSA, 4G, 5G to 4G or 4G to 5G handover (HO), Wireless-Fidelity (Wi-Fi) or other Non 3gpp access etc. In an embodiment, the system (108) is configured to provide a counter for individual interfaces for inroamers and outroamers (v-PCF to h-PCF communication). Further, the system (108) is configured to record logging data for failed messages for the inroamer/ outroamer.
- c. The system (108) is configured to receive the second runtime user configurable flag (SPRFailProcess) with the value true/false (default value as true) from the PCF. The second runtime user configurable flag is used

when the SPR is partially or completely down, which may also result in a timeout of queries. If the SPR query fails as the user request (Client) cannot reach SPR (SPR is unavailable partially or completely), the value of the second runtime user configurable flag decides if the message is processed or not. In case the flag value is true, then even in case of SPR query failure, the system (108) is configured to process the message with the set of configurable global parameter values and the SPR is bypassed. In case the flag value is false, and the SPR query fails, then the system (108) is configured to reject the message. This processing is for messages where SPR lookup is being done. In an embodiment, the system (108) is configured to provide a counter for the number of messages passed/failed based on the second runtime user configurable flag.

d. The system (108) is configured to receive the third runtime user configurable flag (SPRNullProcess) with the value true/ false (default value as false) from the PCF. The third runtime user configurable flag (SPRNullProcess) is used when SPR is up and returns the null result for the query, i.e., no record is found in SPR. This flag is not used for timeout/SPR unavailable cases. In case the flag value is true, then even in case the SPR query is null, the system (108) is configured to process the message with the set of configurable global parameter values and considered as a case where SPR is bypassed. If flag value is false and SPR query is null, then the system (108) is configured to reject the message. In an embodiment, the system (108) is configured to provide a counter that may be available for a number of messages passed/failed based on the third runtime user configurable flag.

[0085] In an aspect, currently SPR acts as a database (DB) towards which PCF is communicating with a DB client. In association with the system (108), the SPR (using the subscription and notification engine (214)) is configured to:

- a. provide subscriber lookup as it is being done and to provide an SPR bypass feature.
- b. provide an application (SPR notification) where the application accepts the subscription messages from the PCF and stores the subscription

- information. Further, the application is configured to send notifications to the same PCF for subscriber identity module provider identifier (SUPI) when subscriber information changes in SPR. The application provides a unique identifier (not only SUPI value but added on some random number to differentiate between subscribed requests for the same SUPI from multiple PCFs). Also, the application (SPR notification) is configured to process all the incoming provisioning requests (message requests). In an embodiment, the application is configured to keep checking for SUPI values that have been subscribed by the PCF. If this application detects that subscription information has been changed, a notification is sent to a uniform resource identifier (URI) provided by PCF with the updated subscriber profile. In an embodiment, the system (108) is configured to provide counters and logs for each operation.
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- c. in an operative aspect, the application (SPR notification application) is configured to accept the subscription update messages from PCF. The PCF sends update to subscribe with an update of notification URI (In case of switchovers). PCF include subscription ID assigned earlier for such case to uniquely identify the subscription to be updated. The SPR notification application updates the subscription information accordingly.
 - d. In another operative aspect, the system (108) is configured to support unsubscribe operations requested from the PCF. In this case, the PCF sends the unique identifier provided by the SPR notification application during subscribe. When SPR, in association with the system (108) (108), receives this unsubscribe message with unique subscription ID, any existing subscriptions is deleted. In an embodiment, the system (108) is configured to provide counters and logs for unsubscribed operations.
 - e. In another operative aspect, the system (108) is configured to maintain multiple sessions for same SUPI. In an aspect, the system (108) is configured to provide a unique application to PCF and different PCF may be used for Access Mobility (AM) vs Session Management (SM).

- 5 f. For instances where an unsubscribe message is missed by the system (108), this application is configured to provide two approaches to handle such a scenario. In the first approach, when the SPR Notification application sends the notification to PCF, PCF may not find the subscription ID, thus rejecting the message. Based on the rejection code received, the SPR notification application is configured to delete the subscription. In the second approach, the SPR notification application provides long timers (in weeks) for individual subscription IDs. Once that subscription timer expires, that subscription may be deleted. To further strengthen this approach, PCF is
10 configured to have an update timer (runtime configurable) equivalent to heartbeat (HB), after which PCF may send updates to the SPR notification application.
- 15 g. At the PCF side, the system (108) in combination with the PCF is configured to define the SPR notification application IP/port/context etc. needed for communication between PCF and SPR notification application. The PCF also considers the backup scenario for this. Further, whenever PCF is doing SPR lookup, the PCF sends subscribe message towards the SPR notification application. In an example, the subscribe message includes at least SUPI
20 details, notification URI that may be used by SPR notification application for sending the notify. The SPR notification application responds with success and unique subscription ID stored by PCF for any future update or unsubscribe or notify handling. In case of failure, PCF writes log and increment counter with support for conditional alert.
- 25 h. In case of switchover, context change, etc., PCF sends notification with the updated notification URI and with the unique subscription ID provided during subscribe operation earlier. In an embodiment, the update is sent after predefined time intervals (user-configured time) as heartbeat messages. In an aspect, the system (108) is configured to provide counters and logs (separate for HB vs. actual Updates) along with success and failure
30 counts.

- 5 i. When all session data for a specific SUPI is removed from the PCF, the PCF sends an unsubscribe message to the SPR notification application with the unique subscription ID. The system (108) removes this subscription data from the database at that time. In case even a single session is present (or creation is being processed at that time), unsubscribing may not be done to avoid the race-around condition. In an aspect, the system (108) is configured to provide counters and logs for total, passed or failed messages.
- 10 j. In case notification from the SPR notification application, the system (108) sends the notification towards notification URI sent in subscribe along with unique subscription ID assigned earlier during subscribe operation. The PCF updates the SPR data for the subscriber based on notification and keeps a copy of old data, which is used for comparison purposes. Further, the system (108) provides an SPR analysis engine that uses a trigger (notification message from SPR with fields as old and new data or only new data) to take various actions. In an aspect, the various actions include sending new Policy and Charging Control (PCC) Rule towards SM/Modify PCC Rule/ Notify Terminate/Notify Update/Updated Session Aggregate Maximum Bit Rate (AMBR)/Modify Session Rule/Update AM Data/Update Radio Access Technology (RAT) frequency selection priority (RFSP)/Update UE Route Selection Policy (URSP)/Terminate AM Session Notification/Rx Random Access Response (RAR) or ASR message/Request Physical Cell Identifier (PCID) from CHF/Sd Session modification/Termination etc. In an aspect, the system (108) is configured to provide counters and logs for specific SPR rule being triggered.
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- 25 **[0086]** Although FIG. 2 shows an exemplary block diagram (200) of the PCF-SPR bypass system (108), in other embodiments, the PCF-SPR bypass system (108) may include fewer components, different components, differently arranged components, or additional functional components than depicted in FIG. 2. Additionally, or alternatively, one or more components of the PCF-SPR bypass system (108) may perform functions described as being performed by one or more other components of the PCF-SPR bypass system (108).
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[0087] FIG. 3 is a flow chart depicting steps involved in a method (300) for performing at least one operation in association with the PCF and the SPR in the communication network, in accordance with an embodiment of the present disclosure.

5 [0088] At step (302), the processing engine (208) of the system (108) is configured to receive the at least one user configurable flag from the PCF (110). In an example, the at least one user configurable flag is a first user configurable flag, a second runtime user configurable flag, or a third runtime user configurable flag.

[0089] At step (304), the processing engine (208) is configured to determine
10 a state of each of the received user configurable flag. In an example, the determined state is a true state or a false state.

[0090] At step (306), the processing engine (208) is configured to perform the at least one operation based on the determined state. For example, the at least one operation includes bypassing the SPR (112), transmitting a query to the SPR
15 (112), processing a message, or rejecting the message.

[0091] In an operative aspect, the method includes a step of transmitting, by the processing engine (208), the query to the SPR (112) if the determined state of the received first user configurable flag is the true state.

[0092] In another operative aspect, the method includes a step of bypassing,
20 by the processing engine (208), the SPR (112) if the determined state of the received first user configurable flag is the false state and creating a subscriber profile based on a set of configurable global parameter values.

[0093] In an aspect, the method includes a step of determining, by the processing engine (208), at least one status of the SPR (112) on receiving the second
25 runtime user configurable flag. In an example, the at least one status includes a partial down, a complete down, a SPR query failure and a SPR query null. The processing engine (208) is further configured to process a message, received from a user equipment via an access management function (AMF), with the set of configurable global parameter values if the determined state of the received second
30 runtime user configurable flag is the true state, and the determined status of the SPR (112) is the partial down or the complete down. The set of configurable global

parameter values includes identical field values as stored in the SPR (112) corresponding to the subscriber profile. The processing engine is further configured to reject the message if the determined state of the received second runtime user configurable flag is false state and the determined status of the SPR (112) is the
5 SPR query failure.

[0094] In an embodiment, the method includes a step of processing, by the processing engine (208), the message with the set of configurable global parameter values if the determined state of the received third user configurable flag is the true state. The processing engine (208) is configured to reject the message if the
10 determined state of the received third user configurable flag is the false state.

[0095] In an embodiment, the method includes a step of receiving, by the SPR (112), subscription information from a user indicating a change in at least one of the personal information, service plans, or services subscribed by the user and updating the subscriber profile to generate a modified subscriber profile.

15 [0096] In an embodiment, the method includes a step of detecting, by the processing engine (208), a change in the subscription information associated with the user and sending a notification to the PCF (110) with the modified subscriber profile.

[0097] In an embodiment, the method includes a step of generating, by the
20 processing engine (208), a unique identifier to differentiate each of a plurality of subscribe requests received for a Subscription Permanent Identifier (SUPI) from a plurality of PCFs.

[0098] In an embodiment, the method includes a step of receiving, by the processing engine (208), an unsubscribe message containing the unique identifier
25 provided by the SPR (112) and deleting existing subscriptions from memory accordingly.

[0099] FIG. 4 is a flow chart depicting steps performed by the system (108), in accordance with an embodiment of the present disclosure.

[00100] Step (402) includes receiving at least one user configurable flag from
30 the PCF.

[00101] Step (404) includes determining a type of received user configurable flag. In an example, the received user configurable flag may be the first user configurable flag, the second user configurable flag or the third user configurable flag.

5 [00102] Step (406) includes determining whether the received first user configurable flag is true or false.

[00103] Step (408) includes transmitting a query to the SPR if the received first user configurable flag is true.

10 [00104] Step (410) includes bypassing the SPR if the received first user configurable flag is false and creating a subscriber profile based on a set of configurable global parameter values (having similar value as stored in SPR).

[00105] Step (412) includes determining at least one status of the SPR on receiving the second runtime user configurable flag. The at least one status includes a partial down, a complete down, a SPR query failure and a SPR query null.

15 [00106] Step (414) includes processing a message, received from the user equipment via the access management function (AMF), with the set of global parameter values if the received second runtime user configurable flag is true and determined status of the SPR is partial down or the complete down.

20 [00107] Step (416) includes rejecting the message if the received second runtime user configurable flag is false and the determined status of the SPR is the SPR query failure.

[00108] Step (418) includes determining whether the received third user configurable flag is true or false.

25 [00109] Step (420) includes processing the message with the set of configurable global parameter values if the received first user configurable flag is true.

[00110] Step (422) includes rejecting the message if the received second runtime user configurable flag is false.

30 [00111] In an embodiment, the method (400) includes detecting a change in subscription information and sending a notification to a uniform resource identifier (URI) with the updated subscriber profile.

[00112] In an embodiment, the SPR is configured to receive a subscription message from the PCF and store subscription information for the modified subscriber profile.

[00113] In an embodiment, the method (400) includes a step of generating a
5 unique subscriber identity module provider identifier (SUPI) value to differentiate between a subscribe request for the same SUPI from multiple PCFs.

[00114] FIG. 5 illustrates an exemplary block diagram of a computer system (500) in which or with which embodiments of the present disclosure may be implemented. As shown in FIG. 5, the system (500) may include an external storage
10 device (510), a bus (520), a main memory (530), a read only memory (540), a mass storage device (550), a communication port (560), and a processor (570). A person skilled in the art will appreciate that the system (500) may include more than one processor (570) and communication ports (560). Processor (570) may include various modules associated with embodiments of the present disclosure.

[00115] In an embodiment, the communication port (560) may be any of an
15 RS-232 port for use with a modem-based dialup connection, a 10/100 Ethernet port, a Gigabit or 10 Gigabit port using copper or fiber, a serial port, a parallel port, or other existing or future ports. The communication port (560) may be chosen depending on a network, such a Local Area Network (LAN), Wide Area Network
20 (WAN), or any network to which the computer system (500) connects.

[00116] In an embodiment, the memory (530) may be Random Access Memory (RAM), or any other dynamic storage device commonly known in the art. Read-only memory (540) may be any static storage device(s) e.g., but not limited to, a Programmable Read Only Memory (PROM) chips for storing static
25 information e.g., start-up or Basic Input/Output System (BIOS) instructions for the processor (570).

[00117] In an embodiment, the mass storage device (550) may be any current or future mass storage solution, which may be used to store information and/or instructions. Exemplary mass storage solutions include, but are not limited to,
30 Parallel Advanced Technology Attachment (PATA) or Serial Advanced Technology Attachment (SATA) hard disk drives or solid-state drives (internal or

external, e.g., having Universal Serial Bus (USB) and/or Firewire interfaces), one or more optical discs, Redundant Array of Independent Disks (RAID) storage, e.g., an array of disks (e.g., SATA arrays).

[00118] In an embodiment, the bus (520) communicatively couples the processor(s) (570) with the other memory, storage, and communication blocks. The bus (520) may be, e.g., a Peripheral Component Interconnect (PCI)/PCI Extended (PCI-X) bus, Small Computer System Interface (SCSI), Universal Serial Bus (USB) or the like, for connecting expansion cards, drives and other subsystems as well as other buses, such a front side bus (FSB), which connects the processor (570) to the computer system (500).

[00119] In an exemplary aspect, the present disclosure discloses a user equipment (UE) communicatively coupled with the system (108). The coupling comprises steps of receiving a connection request, sending an acknowledgment of the connection request to the system; and transmitting a plurality of signals in response to the connection request. The system is a policy control function (PCF).

[00120] Optionally, operator and administrative interfaces, e.g., a display, keyboard, joystick, and a cursor control device, may also be coupled to the bus (520) to support direct operator interaction with the computer system (500). Other operator and administrative interfaces may be provided through network connections connected through the communication port (560). Components described above are meant only to exemplify various possibilities. In no way should the aforementioned exemplary computer system (500) limit the scope of the present disclosure.

[00121] The present disclosure is configured to provide an enhancement to the PCF such that the enhanced PCF can support the feature to skip the SPR query lookup, thereby increasing the performance of a communication network. In a production environment, various scenarios may arise that require handling by PCF. These scenarios include situations where SPR lookup needs to be disabled, SPR is partially unavailable, or SPR lookup fails due to provisioning-specific issues. The current system employed in PCF can effectively handle these situations. The present disclosure is applicable to a wide range of applications that require real-

time operation, including generating alarms, generating counters, providing vProbe codes, and generating logs for operational ease. The present disclosure is configured to be employed in a communication system related to update the policy subscription information store in a memory (database) to provide policy rules to
5 network functions (SMF/AMF) to enhance the processing of the communication system.

[00122] The method and system of the present disclosure may be implemented in a number of ways. For example, the methods and systems of the present disclosure may be implemented by software, hardware, firmware, or any
10 combination of software, hardware, and firmware. The above-described order for the steps of the method is for illustration only, and the steps of the method of the present disclosure are not limited to the order specifically described above unless specifically stated otherwise. Further, in some embodiments, the present disclosure may also be embodied as programs recorded in a recording medium, the programs
15 including machine-readable instructions for implementing the methods according to the present disclosure. Thus, the present disclosure also covers a recording medium storing a program for executing the method according to the present disclosure.

[00123] While the foregoing describes various embodiments of the present
20 disclosure, other and further embodiments of the present disclosure may be devised without departing from the basic scope thereof. The scope of the present disclosure is determined by the claims that follow. The present disclosure is not limited to the described embodiments, versions, or examples, which are included to enable a person having ordinary skill in the art to make and use the present disclosure when
25 combined with information and knowledge available to the person having ordinary skill in the art.

ADVANTAGES OF THE PRESENT DISCLOSURE

[00124] The present disclosure provides a system for policy control function
30 (PCF)-subscriber profile repository (SPR) in a communication network.

[00125] The present disclosure enhances PCF and SPR to support bypass and subscribe/notify feature.

[00126] The present disclosure provides capability to act on notification received from SPR.

- 5 [00127] The present disclosure provides alarms, counters, vProbe codes, and logs for operational ease of feature.

CLAIMS

1. A system (108) for performing at least one operation in association with a policy control function (PCF) (110), and a subscription profile repository (SPR) (112) in a communication network, the system (108) comprising:
 - 5 a memory (204); and
 - a processing engine (208) configured to execute instructions comprising:
 - receive at least one user configurable flag from the PCF (110);
 - 10 determine a state of the at least one received user configurable flag, wherein the determined state is either a true state or a false state; and
 - perform the at least one operation based on the determined state, wherein the at least one operation includes at least one of
 - 15 bypassing the SPR (112), transmitting a query to the SPR (112), processing a message, rejecting the message, and creating a subscriber profile based on a set of configurable global parameter values.
- 20 2. The system (108) as claimed in claim 1, wherein the at least one user configurable flag is a first user configurable flag, a second runtime user configurable flag, or a third runtime user configurable flag.
3. The system (108) as claimed in claim 2, wherein the processing engine (208) is configured to:
 - 25 transmit the query to the SPR (112) if the determined state of the received first user configurable flag is the true state; and
 - bypass the SPR (112) if the determined state of the received first user configurable flag is the false state and create the subscriber profile based on the set of configurable global parameter values.

4. The system (108) as claimed in claim 3, wherein the processing engine (208) is configured to:

determine at least one status of the SPR (112) on receiving the second runtime user configurable flag, wherein the at least one status includes a partial down, a complete down, a SPR query failure and a SPR (112) query null;

process a message received from a user equipment via an access management function (AMF), with the set of configurable global parameter values if the determined state of the received second runtime user configurable flag is the true state, and the determined status of the SPR (112) is the partial down or the complete down; and

reject the message if the determined state of the received second runtime user configurable flag is the false state and the determined status of the SPR (112) is the SPR query failure.

5. The system (108) as claimed in claim 2, wherein the processing engine (208) is configured to:

process the message with the set of configurable global parameter values if the determined state of the received third user configurable flag is the true state; and

reject the message if the determined state of the received third user configurable flag is the false state.

6. The system (108) as claimed in claim 4, wherein the set of configurable global parameter values includes identical field values as stored in the SPR (112) corresponding to the subscriber profile.

7. The system (108), as claimed in claim 1, wherein the SPR (112) is configured to receive subscription information from a user indicating a change in at least one of personal information, service plans, or services

subscribed by the user and is further configured to update the subscriber profile to generate a modified subscriber profile.

5 8. The system (108), as claimed in claim 7, wherein the processing engine (208) is configured to detect a change in the subscription information associated with the user and send a notification to the PCF (110) with the modified subscriber profile.

10 9. The system (108), as claimed in claim 1, wherein the processing engine (208) is configured to generate a unique identifier for each of a plurality of subscribe requests received for a Subscription Permanent Identifier (SUPI) from a plurality of PCFs (110).

10. The system (108), as claimed in claim 9, wherein the processing engine (208) is configured to receive an unsubscribe message containing the unique identifier provided by the SPR (112) and delete existing subscriptions from the memory accordingly.

15 11. A method (300) for performing at least one operation in association with a policy control function (PCF) (110) and a subscriber profile repository (SPR) (112) in a communication network, the method (300) comprising:

receiving (302), by a processing engine (208), at least one user configurable flag from the PCF (110);

20 determining (304), by the processing engine (208), a state of the at least one received user configurable flag, wherein the determined state is either a true state or a false state; and

performing (306), by the processing engine (208), the at least one operation based on the determined state, wherein the at least one operation includes at least one of bypassing the SPR (112), transmitting a query to the SPR (112), processing a message, rejecting the message, and creating a subscriber profile based on a set of configurable global parameter values.

25

12. The method (300) as claimed in claim 11, wherein the at least one user configurable flag is a first user configurable flag, a second runtime user configurable flag, or a third runtime user configurable flag.
13. The method (300) as claimed in claim 12, further comprising transmitting,
5 by the processing engine (208), the query to the SPR (112) if the determined state of the received first user configurable flag is the true state.
14. The method (300) as claimed in claim 12, further comprising bypassing, by
the processing engine (208), the SPR (112) if the determined state of the
received first user configurable flag is the false state and creating the
10 subscriber profile based on the set of configurable global parameter values.
15. The method (300) as claimed in claim 14, further comprising determining,
by the processing engine (208), at least one status of the SPR on receiving
the second runtime user configurable flag, wherein the at least one status
includes a partial down, a complete down, a SPR query failure and a SPR
15 query null; and is further includes steps of:
processing a message, received from a user equipment via an access
management function (AMF), with the set of configurable global parameter
values if the determined state of the received second runtime user
configurable flag is the true state, and the determined status of the SPR (112)
20 is the partial down or the complete down; and
rejecting the message if the determined state of the received second
runtime user configurable flag is the false state and the determined status of
the SPR (112) is the SPR query failure.
- 25 16. The method (300) as claimed in claim 12, further comprising processing, by
the processing engine (208), the message with the set of configurable global
parameter values if the determined state of the received third user
configurable flag is the true state.

17. The method (300) as claimed in claim 12, further comprising rejecting, by the processing engine (208), the message if the determined state of the received third user configurable flag is the false state.
18. The method (300) as claimed in claim 15, wherein the set of configurable global parameter values includes identical field values as stored in the SPR (112) corresponding to the subscriber profile.
19. The method (300) as claimed in claim 11, further comprising receiving, by the SPR (112), subscription information from a user indicating a change in at least one of personal information, service plans, or services subscribed by the user and updating the subscriber profile to generate a modified subscriber profile.
20. The method (300) as claimed in claim 19, further comprising detecting, by the processing engine (208), a change in the subscription information associated with the user and sending a notification to the PCF (110) with the modified subscriber profile.
21. The method (300) as claimed in claim 11, further comprising generating, by the processing engine (208), a unique identifier to differentiate each of a plurality of subscribe requests received for a Subscription Permanent Identifier (SUPI) from a plurality of PCFs (110).
22. The method (300) as claimed in claim 21, further comprising receiving, by the processing engine (208), an unsubscribe message containing the unique identifier provided by the SPR (112) and deleting existing subscriptions from memory accordingly.
23. A computer program product comprising a non-transitory computer-readable medium comprising instructions that, when executed by one or more processors, cause the one or more processors to:

receive at least one user configurable flag from a policy control function (PCF) (110);

determine a state of the received user configurable flag, wherein the determined state is either a true state or a false state; and

5 perform at least one operation based on the determined state, wherein the at least one operation includes at least one of bypassing a subscription profile repository (SPR) (112), transmitting a query to the SPR (112), processing a message, rejecting the message, and creating a subscriber profile based on a set of configurable global parameter values.

10

24. A user equipment (UE) communicatively coupled with a system (108), the coupling comprises steps of:

receiving a connection request from the system (108);

15 sending an acknowledgment of the connection request to the system (108);

transmitting a plurality of signals in response to the connection request, wherein the system (108) is a policy control function (PCF) (110) as claimed in claim 1.

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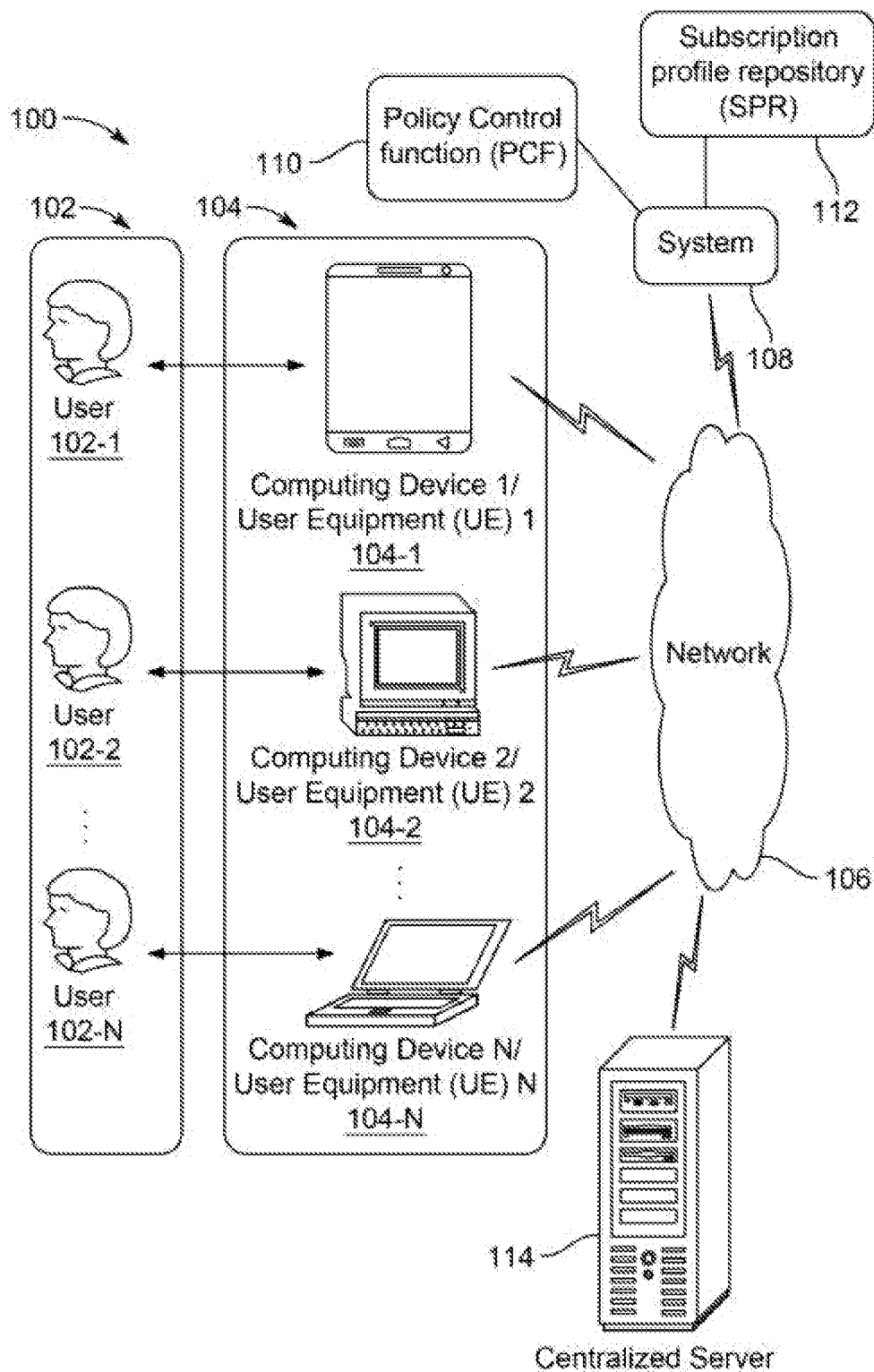


FIG. 1

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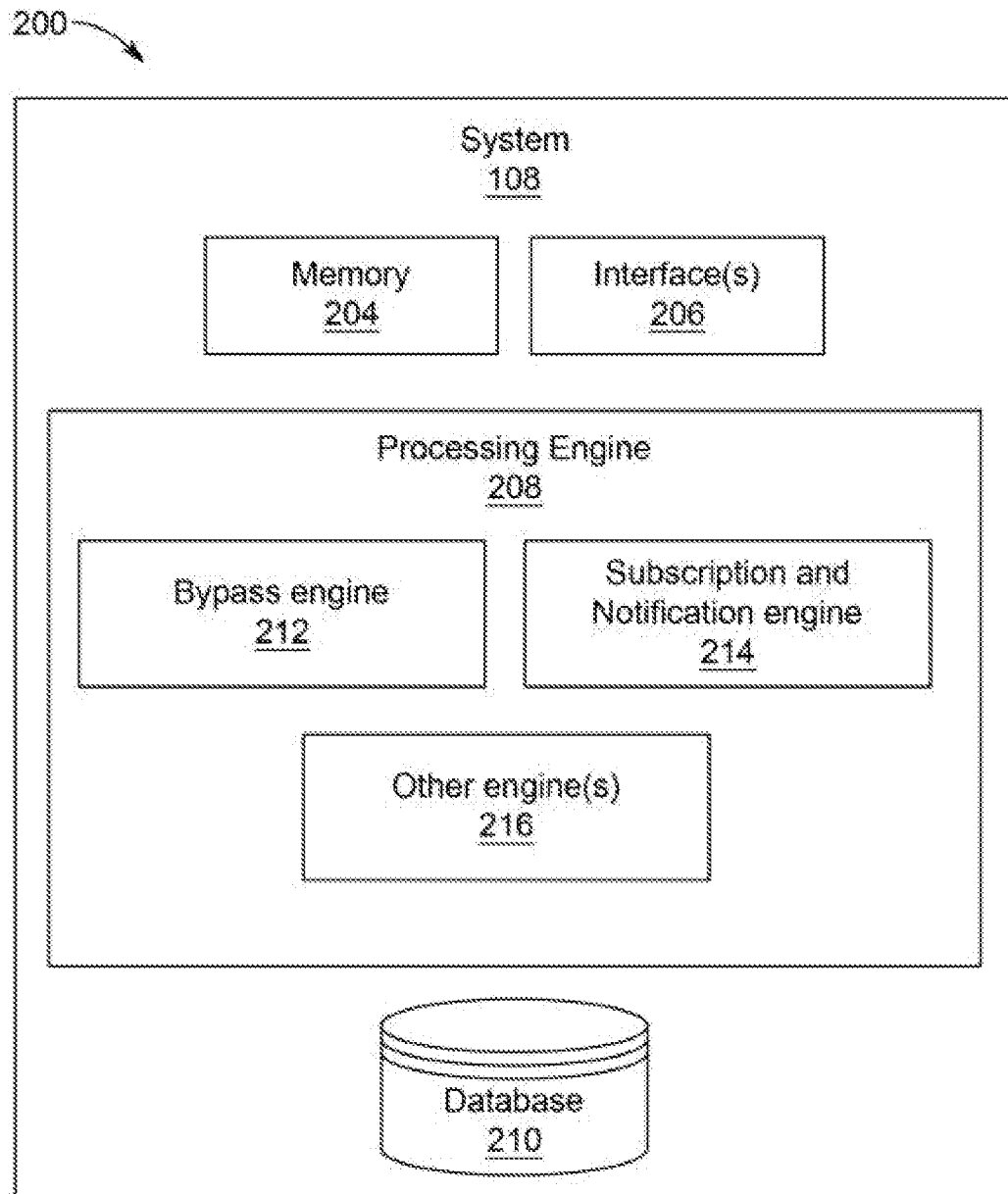


FIG. 2

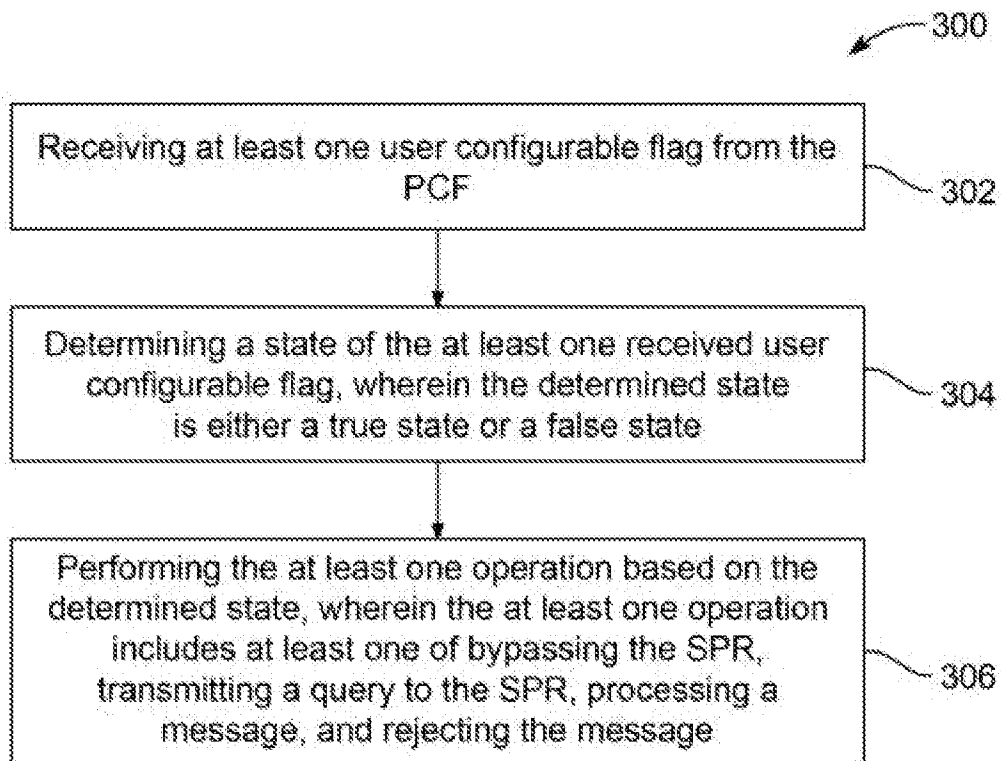


FIG. 3

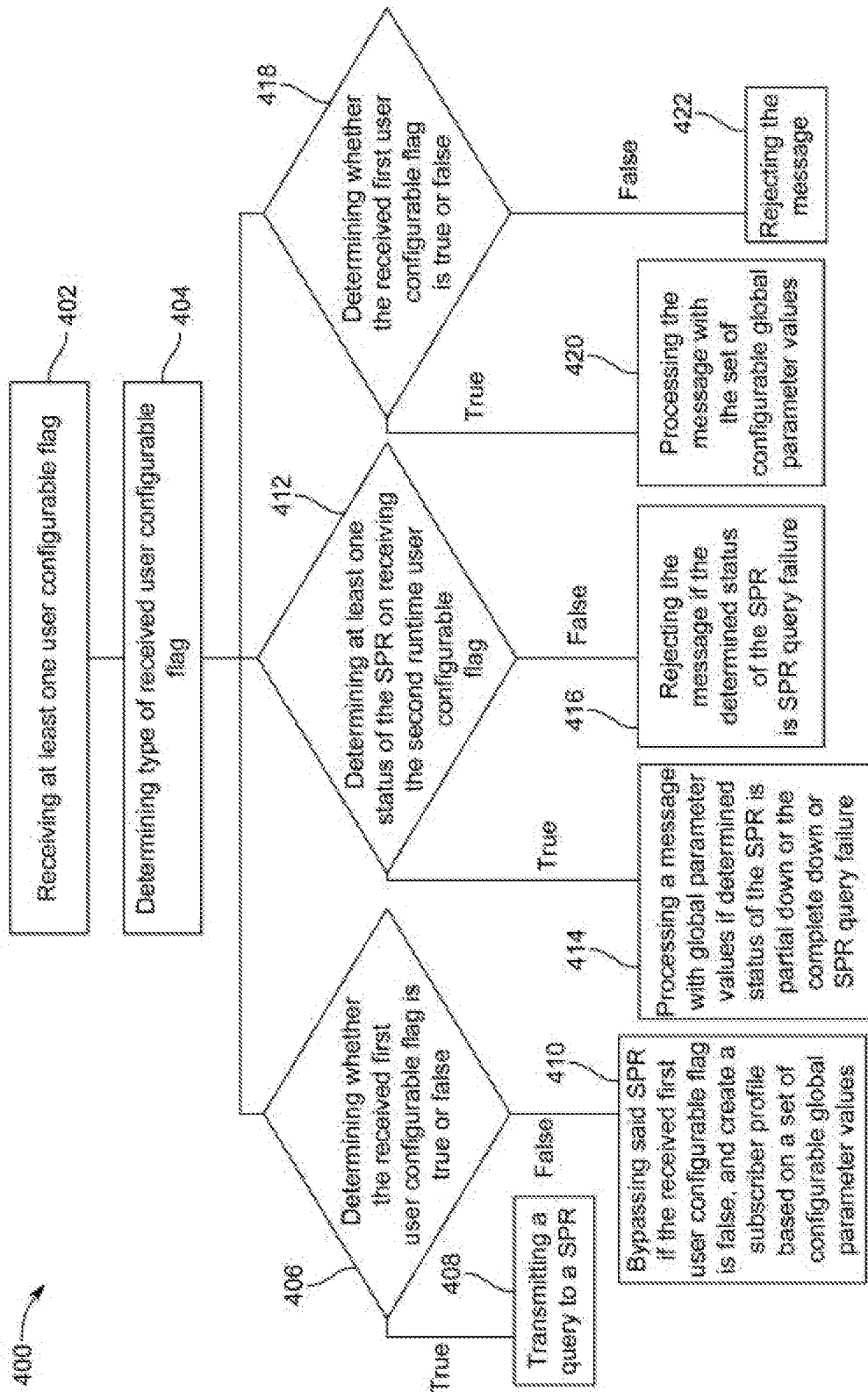


FIG. 4

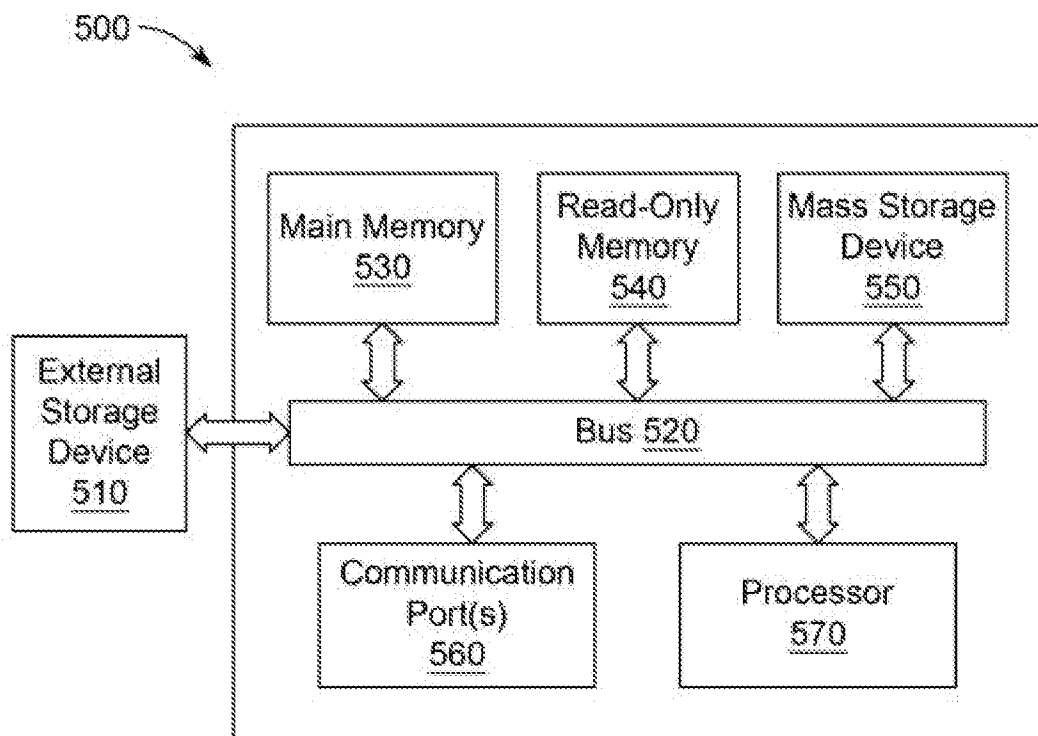


FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IN2024/050678

A. CLASSIFICATION OF SUBJECT MATTER

H04W24/02, H04W72/50, H04W80/10, H04L67/141 Version=2024.01

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H04W, H04L

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

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

PatSeer, IPO Internal Database

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	IN202011038535 A (STERLITE TECHNOLOGIES LIMITED [IN]) 11 March 2022 (11-03-2022) Fig. 5, Para [0070]–[0072]	1–24
Y	EP2678983 B1 (ALCATEL LUCENT SAS [FR]) 01 July 2015 (01-07-2015) Para [0034]–[0035]	1–24
Y	EP3072286 B1 (ORACLE INTERNATIONAL CORP [US]) 29 August 2018 (29-08-2018) Para [0011]	2, 4–10, 12, 15–22

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:

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

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

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

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

“&” document member of the same patent family

Date of the actual completion of the international search

13-09-2024

Date of mailing of the international search report

13-09-2024

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IN2024/050678

Citation	Pub.Date	Family	Pub.Date
EP 2678983 B1	01-07-2015	US 8838791 B2	16-09-2014
		CN 103404078 B	02-03-2016
		WO 2012113077 A2	30-08-2012
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		JP 6480934 B2	13-03-2019