



(51) International Patent Classification:

H04W 8/18 (2009.01) H04L 65/1016 (2022.01)
H04M 3/42 (2006.01) H04L 67/51 (2022.01)

(21) International Application Number:

PCT/IN2024/050950

(22) International Filing Date:

27 June 2024 (27.06.2024)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

202321044347 03 July 2023 (03.07.2023) IN

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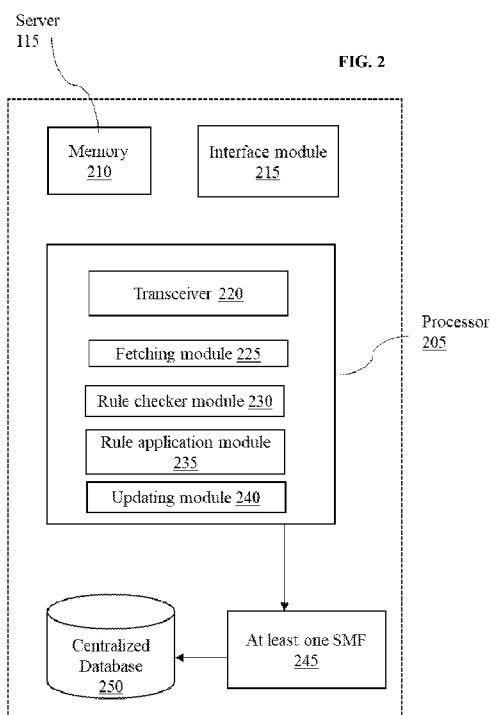
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(81) Designated States (unless otherwise indicated, for every
kind of national protection available): AE, AG, AL, AM,
AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ,
CA, CH, CL, CN, CO, CR, CU, CV, CZ, DE, DJ, DK, DM,
DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT,
HN, HR, HU, ID, IL, IN, IQ, IR, IS, IT, JM, JO, JP, KE, KG,
KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY,
MA, MD, MG, MK, MN, MU, MW, MX, MY, MZ, NA,
NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO,
RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH,
TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS,
ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every
kind of regional protection available): ARIPO (BW, CV,
GH, GM, KE, LR, LS, MW, MZ, NA, RW, SC, SD, SL, ST,

(54) Title: METHOD AND SYSTEM FOR BARRING AND UNBARRING OF AN ATLEAST ONE SERVICE RELATED TO SUBSCRIBERS



(57) Abstract: The present disclosure relates to a system (125) and a method (600) for barring and unbarring of an at least one service related to subscribers. The system (125) includes a transceiver (220) to receive a request from a network operator via an interface module. The system (125) includes a fetching module (225) to fetch relevant data from a database (250). The system (125) includes a rule checker module (230) to check whether predefined rules are pre-associated to the subscribers. The transceiver (220) transmits the request to at least one active Session Management Function (SMF) (245) when the predefined rules are independent of an association with the subscribers. The system (125) includes a rule application module (235) to apply the rules for the subscribers. The system (125) further includes an updating module (240) configured to update the rules for the subscribers.

SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, ME, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *of inventorship (Rule 4.17(iv))*

Published:

- *with international search report (Art. 21(3))*
- *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*
- *in black and white; the international application as filed contained color or greyscale and is available for download from PATENTSCOPE*

METHOD AND SYSTEM FOR BARRING AND UNBARRING OF AN
ATLEAST ONE SERVICE RELATED TO SUBSCRIBERS

FIELD OF THE INVENTION

[0001] The present invention generally relates to wireless communication systems, and more particularly relates to optimizing barring and unbarring of subscribers.

BACKGROUND OF THE INVENTION

[0002] The barring and unbarring of users in specific areas is a common practice in the communication services field. Due to recent statutory enactments enshrining user's rights and changes in regulatory requirements, data usage for users are disabled for a particular area, spanning approximately few kilometers. This area may consist of multiple towers, with each tower having multiple Tracking Area Codes (TACs). In order to enforce the barring and unbarring of users in these TAC areas, it is essential to maintain data about user's location based on the TACs in the application.

[0003] To accomplish this, a conventional method is being used, which involves maintaining a list of subscribers associated with each TAC. Since there could be thousands of users attached to the TACs in the specified area, it becomes necessary to bar these users from accessing data services. However, this approach presents certain challenges. Firstly, the memory size of the application increases significantly as a result of storing the TAC-Subscriber list. Additionally, contentious issues arise when multiple threads concurrently access the same data, leading to increased CPU utilization. Moreover, the data needs to be maintained in both active and standby servers, further complicating the process.

[0004] Considering the potential for future features and requirements, it is anticipated that additional data may need to be stored based on different parameters such as VID (Virtual ID), PLMN (Public Land Mobile Network) data, or other custom

parameters. Storing data based on multiple keys to accommodate varying application requirements would further contribute to the increased size of the application.

[0005] Therefore, there is a need for an advancement for a system and method that can overcome at least one of the above shortcomings, particularly to manage the storage during fault handling.

BRIEF SUMMARY OF THE INVENTION

[0006] One or more embodiments of the present disclosure provide a system and method for barring and unbarring of an at least one service related to subscribers.

[0007] In one aspect of the present invention, the system for barring and unbarring of an at least one service related to the subscribers is disclosed. The system includes a transceiver configured to receive a request from a network operator via an interface module for barring or unbarring of the at least one service related to subscribers. The system includes a fetching module configured to fetch the relevant data corresponding to the request from a centralized database. The system further includes a rule checker module configured to check whether one or more predefined rules are pre-associated to the subscribers based on the fetched data from the centralized database corresponding to the request. In an embodiment, the one or more predefined rules represent the at least one service related to the subscribers which is required to be barred or unbarred based on the request. The system includes the transceiver module configured to transmit the request to at least one active Session Management Function (SMF) for barring or unbarring of the at least one service related to subscribers when the one or more predefined rules are independent of an association with the subscribers. The system further includes a rule application module configured to apply via the at least one active SMF the one or more predefined rules for barring or unbarring the at least one service related to the respective subscribers. The system further includes an updating module configured to update via the at least one active

SMF the one or more predefined rules applied for barring or unbarring the at least one service related to the respective subscribers at the centralized database.

[0008] In an embodiment, the request received from the network operator for barring or unbarring of subscribers includes at least one of, Tracking Area Codes (TAC) List, Public Land Mobile Network (PLMN), and rule IDs representing the one or more predefined rules to be applied to the subscribers.

[0009] In another embodiment, the relevant data is at least one of subscriber IDs and pre-configured rule IDs associated with the specified TAC list or the PLMN.

[0010] In yet another embodiment, the one or more pre-defined rules are represented as rule IDs pertaining to barring or unbarring of the at least one service related to a specific subscription plan of the subscribers.

[0011] In yet another embodiment, the fetching module is further configured to extract data pertaining to specified Tracking Area Codes (TAC) list and Public Land Mobile Network (PLMN) from the request. The fetching module is configured to retrieve from the centralized database relevant data pertaining to subscriber IDs and associated pre-configured rule IDs based on the extracted TAC list and the PLMN.

[0012] In yet another embodiment, the rule checker module is further configured to compare rule IDs pertaining to the one or more pre-defined rules with pre-configured rule IDs for the respective subscribers. Further, the rule checker module is further configured to infer availability or non-availability of the one or more pre-defined rules pre-associated to the subscribers based on comparing the one or more rule IDs with the pre-configured rule IDs for the respective subscribers.

[0013] In yet another embodiment, the transceiver module is configured to transmit the request to the at least one active SMF for barring or unbarring of the at least one service related to subscribers when one or more predefined rules are independent of an association with the subscribers. Further, the transceiver module is configured to

identify the at least one active SMF responsible for handling the respective subscribers at a pre-defined rate. The transceiver module is configured to transmit the request to the identified active SMF.

[0014] In yet another embodiment, the rule application module is further configured to apply the one or more predefined rules to subscriber sessions related to the respective subscribers for barring or unbarring the at least one service via the at least one active SMF.

[0015] In yet another embodiment, the updating module of the system is further configured to update at least one network element including at least one of, a Policy Control Function (PCF) to enforce the one or more predefined rules applied to the respective subscribers. The updating module is further configured to synchronize the updated at least one network element with the centralized database to maintain consistency with the updated data related to the one or more predefined rules applied to the subscribers.

[0016] In yet another embodiment, the updating module of the system is further configured to update the centralized database with the TAC list subsequent to at least one of, Protocol Data Unit (PDU) establishment or handover of a new Subscriber Equipment (SE) with an existing network and PDU release of existing SE from the existing network.

[0017] In another aspect of the present invention, a method for barring and unbarring of at least one service related to subscribers is disclosed. The method includes the steps of receiving a request from a network operator via an interface module for barring or unbarring of the at least one service related to subscribers. The method includes the step of fetching the relevant data corresponding to the request from a centralized database. The method further includes checking whether one or more predefined rules are pre-associated to the subscribers based on the fetched data from the centralized database corresponding to the request. The one or more predefined rules represent the

at least one service related to the subscribers which is required to be barred or unbarred based on the request. Further, the method includes the step of transmitting the request to an at least one active Session Management Function (SMF) for barring or unbarring of the at least one service related to subscribers when the one or more predefined rules are independent of an association with the subscribers. The method further includes the step of applying via the at least one active SMF the one or more predefined rules for barring or unbarring the at least one service related to the respective subscribers. Thereafter the method includes the step of updating via the at least one active SMF the one or more predefined rules applied for barring or unbarring the at least one service related to the respective subscribers at the centralized database.

[0018] In one embodiment, the request received from the network operator for barring or unbarring of subscribers includes at least one of, Tracking Area Codes (TAC) List, Public Land Mobile Network (PLMN), and one or more rule IDs representing the one or more predefined rules to be applied to the subscribers.

[0019] In another embodiment, the relevant data fetched by the one or more processor from the centralized database in response to the request received from the network operator is at least one of subscriber IDs and pre-configured rule IDs associated with the specified TAC list or the PLMN.

[0020] In yet another embodiment, the one or more pre-defined rules are represented as one or more rule IDs pertaining to barring or unbarring of the at least one service related to a specific subscription plan of the subscribers.

[0021] In yet another embodiment, the method further the step of fetching the relevant data corresponding to the request from the centralized database. The method includes the step of extracting data pertaining to specified Tracking Area Codes (TAC) list and Public Land Mobile Network (PLMN) from the request. The method includes the step of retrieving from the centralized database relevant data pertaining to

subscriber IDs and associated pre-configured rule IDs based on the extracted TAC list and the PLMN.

[0022] In yet another embodiment, the method further includes the step of checking whether one or more pre-defined rules are pre-associated to the subscribers based on the fetched data from the centralized database. The method includes the step of comparing one or more rule IDs pertaining to the one or more pre-defined rules with pre-configured rule IDs for the respective subscribers. The method includes the step of inferring availability or non-availability of the one or more pre-defined rules pre-associated to the subscribers based on comparing the one or more rule IDs with the pre-configured rule IDs for the respective subscribers.

[0023] In yet another embodiment, the method further includes the step of transmitting the request to an at least one active SMF for barring or unbarring of the at least one service related to subscribers when one or more predefined rules are independent of an association with the subscribers. The method includes the step of identifying the at least one active SMF responsible for handling the respective subscribers at a pre-defined rate. The method includes the step of transmitting the request to the identified active SMF.

[0024] In yet another embodiment, the method further includes the step of applying the one or more predefined rules for barring or unbarring the at least one service related to the respective subscribers. The method includes the step of applying via the at least one active SMF the one or more predefined rules to subscriber sessions related to the respective subscribers for barring or unbarring the at least one service.

[0025] In yet another embodiment, the method further includes the step of updating via the at least one active SMF the one or more predefined rules applied for barring or unbarring the at least one service related to the respective subscribers at the centralized database. The method includes the step of updating at least one network element including at least one of, a Policy Control Function (PCF) to enforce the one or more

predefined rules applied to the respective subscribers. The method includes the step of synchronizing the updated at least one network element with the centralized database to maintain consistency with the updated data related to the one or more predefined rules applied to the subscribers.

[0026] In yet another aspect of the present invention, a Subscriber Equipment (SE) includes one or more primary processors. The one or more primary processors communicatively coupled to one or more processors and a memory. The memory stores instructions which when executed by the one or more primary processors causes the SE to transmit location coordinates of respective subscriber to a network operator database based on a current location of the respective subscriber and transmit a Tracking Area Code (TAC) to the network operator database.

[0027] In yet another aspect of the present invention, a non-transitory computer-readable medium having stored thereon computer-readable instructions. The computer-readable instructions are executed by a processor. The processor is configured to receive a request from a network operator via an interface module for barring or unbarring of the at least one service related to subscribers. The processor is further configured to fetch the relevant data corresponding to the request from a centralized database. The processor is further configured to check whether one or more predefined rules are pre-associated to the subscribers based on the fetched data from the centralized database corresponding to the request. The one or more predefined rules represent the at least one service related to the subscribers which is required to be barred or unbarred based on the request. The processor is further configured to transmit the request to at least one active Session Management Function (SMF) for barring or unbarring of the at least one service related to subscribers when the one or more predefined rules are independent of an association with the subscribers. The processor is further configured to apply via the at least one active SMF the one or more predefined rules for barring or unbarring the at least one service related to the respective subscribers. The processor is further configured to update via the at least one active SMF, the one or more predefined rules applied for barring or unbarring the

at least one service related to the respective subscribers at the centralized database, thereby barring and unbarring of at least one service related to the subscribers.

[0028] Other features and aspects of this invention will be apparent from the following description and the accompanying drawings. The features and advantages described in this summary and in the following detailed description are not all-inclusive, and particularly, many additional features and advantages will be apparent to one of ordinary skill in the relevant art, in view of the drawings, specification, and claims hereof. Moreover, it should be noted that the language used in the specification has been principally selected for readability and instructional purposes and may not have been selected to delineate or circumscribe the inventive subject matter, resort to the claims being necessary to determine such inventive subject matter.

BRIEF DESCRIPTION OF THE DRAWINGS

[0029] The accompanying drawings, which are incorporated herein, and constitute a part of this disclosure, illustrate exemplary embodiments of the disclosed methods and systems in which like reference numerals refer to the same parts throughout the different drawings. Components in the drawings are not necessarily to scale, emphasis instead being placed upon clearly illustrating the principles of the present disclosure. Some drawings may indicate the components using block diagrams and may not represent the internal circuitry of each component. It will be appreciated by those skilled in the art that disclosure of such drawings includes disclosure of electrical components, electronic components or circuitry commonly used to implement such components.

[0030] **FIG. 1** is an exemplary block diagram of a communication system for barring and unbarring of at least one service related to subscribers, according to one or more embodiments of the present invention;

[0031] **FIG. 2** is a block diagram of a system for barring and unbarring of at least one service related to subscribers, according to the one or more embodiments of the present invention;

[0032] **FIG. 3** is a schematic representation of the present system of **FIG. 1** workflow, according to the one or more embodiments of the present invention;

[0033] **FIG. 4** is a schematic representation of the system for barring and unbarring of at least one service related to subscribers, according to the one or more embodiments of the present invention;

[0034] **FIG. 5** is a signaling flow diagram of barring or unbarring of at least one service to the subscribers, according to the one or more embodiments of the present invention; and

[0035] **FIG. 6** illustrates a flow diagram of a method for barring and unbarring of at least one service related to subscribers, according to the one or more embodiments of the present invention.

[0036] The foregoing shall be more apparent from the following detailed description of the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0037] Some embodiments of the present disclosure, illustrating all its features, will now be discussed in detail. It must also be noted that as used herein and in the appended claims, the singular forms "a", "an" and "the" include plural references unless the context clearly dictates otherwise.

[0038] Various modifications to the embodiment will be readily apparent to those skilled in the art and the generic principles herein may be applied to other embodiments. However, one of ordinary skill in the art will readily recognize that the present disclosure including the definitions listed here below are not intended to be

limited to the embodiments illustrated but is to be accorded the widest scope consistent with the principles and features described herein.

[0039] A person of ordinary skill in the art will readily ascertain that the illustrated steps detailed in the figures and here below are set out to explain the exemplary embodiments shown, and it should be anticipated that ongoing technological development will change the manner in which particular functions are performed. These examples are presented herein for purposes of illustration, and not limitation. Further, the boundaries of the functional building blocks have been arbitrarily defined herein for the convenience of the description. Alternative boundaries can be defined so long as the specified functions and relationships thereof are appropriately performed. Alternatives (including equivalents, extensions, variations, deviations, etc., of those described herein) will be apparent to persons skilled in the relevant art(s) based on the teachings contained herein. Such alternatives fall within the scope and spirit of the disclosed embodiments.

[0040] As per various embodiments depicted, the present invention discloses the system and method for optimizing barring and unbarring of subscribers in different Tracking Area Codes (TACs) to maintain and store data in a centralized database to reduce overload of memory and ensure optimization of memory usage.

[0041] Referring to **FIG. 1**, **FIG. 1** illustrates an exemplary block diagram of a communication system **100** for barring and unbarring of at least one service related to subscribers, according to one or more embodiments of the present invention. The communication system **100** includes a Subscriber Equipment (SE) **105**, a network **110**, a server **115**, and a system **125**. The SE **105** aids subscribers to interact with the system **125** for transmitting location coordinates of the SE **105** of the respective subscriber and a Tracking Area Code (TAC) of the SE **105** to a network operator database. The SE **105** is configured to allow the subscribers to interact with the network **110** to perform one or more functions. The one or more functions include one of, but not

limited to, accessing the internet, making phone calls, and sending Short Message Service (SMS).

[0042] For the purpose of description and explanation, the description will be explained with respect to one or more SEs **105**, or to be more specific will be explained with respect to a first SE **105a**, a second SE **105b**, and a third SE **105c**, and should nowhere be construed as limiting the scope of the present disclosure. In one embodiment, each of the first SE **105a**, the second SE **105b**, and the third SE **105c** is one of, but are not limited to, any electrical, electronic, electro-mechanical or an equipment and a combination of one or more of the above 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. A person skilled in the art will appreciate that the computer system may include more than one processor and communication ports. The communication port(s) may be any of an 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(s) may be chosen depending on a network **110**, such as, but not limited to, a Local Area Network **110** (LAN), a Wide Area Network **110** (WAN), or any of the network **110** to which the computer system connects.

[0043] The network **110** includes, by way of example but not limitation, one or more of a wireless network, a wired network, an internet, an intranet, a public network, a private network, a packet-switched network, a circuit-switched network, an ad hoc network, an infrastructure network, a Public-Switched Telephone Network (PSTN), a cable network, a cellular network, a satellite network, a fiber optic network, or some combination thereof. The network **110** may include, but is not limited to, a Third Generation (3G), a Fourth Generation (4G), a Fifth Generation (5G), a Sixth Generation (6G), a New Radio (NR), a Narrow Band Internet of Things (NB-IoT), an Open Radio Access Network (O-RAN), and the like.

[0044] The server **115** may include by way of example but not limitation, one or more of a standalone 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. In an embodiment, the entity may include, but is not limited to, a vendor, a network operator, a company, an organization, a university, a lab facility, a business enterprise, a defence facility, or any other facility that provides content.

[0045] The communication system **100** further includes the system **125** communicably coupled to the server **115** and each of the first SE **105a**, the second SE **105b**, and the third SE **105c** via the network **110**. The system **125** is configured for barring and unbarring of at least one service related to the subscribers.

[0046] In various embodiments, the system **125** may be generic in nature and may be integrated with any application including a System Management Facility (SMF), an Access and Mobility Management Function (AMF), a Business Telephony Application Server (BTAS), a Converged Telephony Application Server (CTAS), any SIP (Session Initiation Protocol) Application Server which interacts with core Internet Protocol Multimedia Subsystem(IMS) on Industrial Control System (ISC) interface as defined by 3GPP to host a wide array of cloud telephony enterprise services, a System Information Blocks (SIB)/ and a Mobility Management Entity (MME).

[0047] Operational and construction features of the system **125** will be explained in detail with respect to the following figures.

[0048] Referring to **FIG. 2**, **FIG. 2** illustrates a block diagram of the system **125** for barring and unbarring of at least one service related to the subscribers, according to one or more embodiments of the present invention. The system **125** is adapted to be embedded within the server **115** or is embedded as the individual entity, as per multiple

embodiments of the present invention. However, for the purpose of description, the system **125** is described as an integral part of the server **115**, without deviating from the scope and limiting the scope of the present disclosure.

[0049] As per the illustrated embodiment, the system **125** includes one or more processors **205**, a memory **210**, and an interface module **215**. The one or more processor **205**, hereinafter referred to as the processor **205** may be implemented as one or more microprocessors, microcomputers, microcontrollers, digital signal processors, central processing units, state machines, logic circuitries, single board computers, and/or any devices that manipulate signals based on operational instructions. As per the illustrated embodiment, the system **125** includes one processor **205**. However, it is to be noted that the system **125** may include multiple processors as per the requirement and without deviating from the scope of the present disclosure. Among other capabilities, the processor **205** is configured to fetch and execute computer-readable instructions stored in the memory **210**. The memory **210** may be configured to store one or more computer-readable instructions or routines in a non-transitory computer-readable storage medium, which may be fetched and executed to create or share data packets over a network service. The memory **210** may include any non-transitory storage device including, for example, volatile memory such as RAM, or non-volatile memory such as EPROM, flash memory, and the like.

[0050] In an embodiment, the interface module **215** includes a variety of interfaces, for example, interfaces for data input and output devices, referred to as Input/Output (I/O) devices, storage devices, and the like. The interface module **215** facilitates communication of the system **125**. In one embodiment, the interface module **215** provides a communication pathway for one or more components of the system **125**. Examples of such components include, but are not limited to, the SE **105** and a centralized database **250**.

[0051] The centralized database **250** is one of, but is not limited to, one of a centralized database, a cloud-based database, a commercial database, an open-source

database, a distributed database, an end-user database, a graphical database, a No-Structured Query Language (NoSQL) database, an object-oriented database, a personal database, an in-memory database, a document-based database, a time series database, a wide column database, a key value database, a search database, a cache databases, and so forth. The foregoing examples of centralized database **250** types are non-limiting and may not be mutually exclusive e.g., a database can be both commercial and cloud-based, or both relational and open-source, etc.

[0052] Further, the processor **205**, in an embodiment, may be implemented as a combination of hardware and programming (for example, programmable instructions) to implement one or more functionalities of the processor **205**. In the examples described herein, such combinations of hardware and programming may be implemented in several different ways. For example, the programming for the processor **205** may be processor-executable instructions stored on a non-transitory machine-readable storage medium and the hardware for processor **205** may comprise a processing resource (for example, one or more processors), to execute such instructions. In the present examples, the memory **210** may store instructions that, when executed by the processing resource, implement the processor **205**. In such examples, the system **125** may comprise the memory **210** storing the instructions and the processing resource to execute the instructions, or the memory **210** may be separate but accessible to the system **125** and the processing resource. In other examples, the processor **205** may be implemented by electronic circuitry.

[0053] In order for the system **125** to bar and unbar at least one service related to the subscribers, the processor **205** includes a transceiver module **220**, a fetching module **225**, a rule checker module **230**, a rule application module **235**, and an updating module **240** communicably coupled to each other.

[0054] The transceiver module **220** of the processor **205** is communicably connected to each of the first SE **105a**, the second SE **105b**, and the third SE **105c** via the network **110**. Accordingly, the transceiver module **220** is configured to receive a request from

a network operator via an interface module **215** for barring or unbarring of the at least one service related to subscribers. The interface module **215** enables communication between different network elements and is responsible for managing communication between different protocols or standards used within the network. In one embodiment, the interface module **215** may include, but not limited to, a diameter interface module, a Short Message Peer-to-Peer (SMPP) module, a Representational State Transfer (RESTful) API interface module, a Remote Authentication Dial-In User Service (RADIUS) interface module, and a Session Initiation Protocol (SIP) interface module.

[0055] In one embodiment, the request received from the network operator for barring or unbarring of subscribers includes at least one of, Tracking Area Codes (TAC) List, Public Land Mobile Network (PLMN), and one or more rule IDs representing one or more predefined rules to be applied to the subscribers from the centralized database **250** to the SE **105**. In one embodiment, the predefined rules are defined by the network operator. Further, in one embodiment, the one or more predefined rules correspond to the one or more rule IDs pertaining to barring or unbarring of the at least one service related to a specific subscription plan of the subscribers. In one embodiment, a set of the one or more predefined rules are defined for the barring of the subscribers and a different set of the one or more predefined rules are defined for the unbarring of the subscribers. For example, if the subscribers are within a home network region, the one or more predefined rules allows the subscribers to use internet. Further, if the subscribers are not within a home network region and are in roaming region, the one or more predefined rules bars the subscribers from using the internet.

[0056] In one embodiment, the subscription plan of the subscribers includes, at least one of, but not limited to, a mobile phone plan, such as unlimited or limited talk time, text messages, and high-speed data usage, and a streaming services plan. As used herein, the Tracking Area (TA) is a logical concept of an area where the subscriber can move around without updating a Mobile Management Entity (MME). The network allocates a list with one or more TAs to the subscriber. In certain operation modes, the

SE **105** may move freely in all TAs of the list without updating the MME. The PLMN is identified by a globally unique PLMN code, which consists of a Mobile Country Code (MCC) and a Mobile Network Code (MNC). Hence, the PLMN code is a five-to-six-digit number identifying a country, and a mobile network operator in that country.

[0057] The processor **205** includes the fetching module **225** in communication with the transceiver module **220**. More specifically, the fetching module **225** is communicably coupled with the transceiver module **225** to fetch relevant subscriber data from the centralized database **250** to a network operator database corresponding to the request received from the network operator. In one embodiment, the relevant subscriber data may include, at least one of, location coordinates of respective subscriber along with subscriber IDs and pre-configured rule IDs associated with the specified TAC list and the PLMN from the centralized database **250**.

[0058] Further, as per one or more embodiments, the fetching module **225** is configured to extract the subscriber data pertaining to the specified TAC list and the PLMN based on the request received from the network operator. Subsequently, the fetching module **225** is configured to retrieve the relevant subscriber data pertaining to the subscriber IDs and the pre-configured rule IDs based on the extracted TAC list and the PLMN from the centralized database **250**.

[0059] The rule checker module **230** of the processor **205** is communicably connected to the fetching module **225**. The rule checker module **230** is configured to check whether the one or more predefined rules are pre-associated to the subscribers based on the fetched data from the centralized database **250** corresponding to the request. In one embodiment, the one or more predefined rules represent the at least one service related to the subscribers which is required to be barred or unbarred based on the request. For example, for each subscriber identified in the fetched data, the rule checker module checks whether the Rule IDs R1 and R2 are already applied or not. In one embodiment, the rule checker module **230** is configured to compare the rule IDs

pertaining to the one or more predefined rules with pre-configured rule IDs of the respective subscribers of each of the first, the second and the third SE **105a**, **105b**, **105c**.

[0060] Further, the rule checker module **230** is configured to infer availability or non-availability of the one or more predefined rules pre-associated to the subscribers. In order to do so, the rule checker module **230** is configured to compare the one or more rule IDs with the pre-configured rule IDs for the respective subscribers of each of the first, the second and the third SE **105a**, **105b**, **105c**.

[0061] In a preferred embodiment, the rule checker module **230** eliminates unnecessary processing of the subscriber data when the one or more predefined rules are pre-associated to the respective subscriber before receiving barring input query/command. In this scenario, the respective subscriber is not counted in the list of subscribers to be barred. After finishing the pre-checking process, the rule checker module **230** forwards the relevant barring or unbarring requests to the at least one active SMF **245** for handling the respective subscriber. The distribution of requests helps to distribute the workload and thereby improves processing efficiency of the processor **205** and reduces load on the memory **210**.

[0062] The processor **205** further includes the transceiver module **220**. The transceiver module **220** is configured to transmit the request to at least one active Session Management Function (SMF) **245** for barring or unbarring of the at least one service related to respective subscribers of the SE **105** when the one or more predefined rules are independent of an association with the respective subscribers. The at least one active SMF **245** is a network element responsible for controlling and managing multimedia sessions in an IP Multimedia Subsystem (IMS) network. The at least one active SMF **245** is involved in initiation, modification, and termination process of multimedia sessions and determines an appropriate routing of multimedia sessions based on policies, rules, user preferences, or network conditions.

[0063] In a preferred embodiment, the transceiver module **220** is configured for identifying the at least one active SMF **245** responsible for handling the respective subscribers of each of the first, the second and the third SE **105a**, **105b**, **105c** at a pre-defined rate when the one or more predefined rules are independent of an association with the subscribers. For example, the pre-defined rate may be barring or unbarring of the at least one service which is done by the at least one active SMF **245** for multiple subscribers within a particular time. For example, the at least one active SMF **245** may be configured to perform barring or unbarring process at rate of 800 subscribers per second. Further, the transceiver module **220** is configured for transmitting the request to the identified active SMF **245** when the one or more predefined rules are independent of an association with the respective subscribers.

[0064] The rule application module **235** is configured to apply the one or more predefined rules via the at least one active SMF **245** for barring or unbarring the at least one service related to the respective subscribers when the one or more predefined rules are independent of an association with the respective subscribers. Further, the rule application module **235** is configured to apply the one or more predefined rules to subscriber sessions related to the respective subscribers for barring or unbarring the at least one service via the at least one active SMF **245**.

[0065] The updating module **240** of the processor **205** is configured to update the one or more predefined rules applied for barring or unbarring the at least one service related to the respective subscribers at the centralized database **250** via the at least one active SMF **245**. The updating module **240** is further configured to update the centralized database **250** with the TAC list subsequent to at least one of, Protocol Data Unit (PDU) establishment or handover of a new Subscriber Equipment (SE) with an existing network and PDU release of existing SEs from the existing network. In an embodiment, the new SE is associated with the subscribers.

[0066] On updating the centralized database **250** with the TAC list, the updating module **240** is configured to update the one or more predefined rules applied for

barring or unbarring the at least one service related to the respective subscribers via the at least one active SMF **245** using the at least one network element. The at least one network element may include at least one of, but not limited to, a Policy Charging Function (PCF) and a User Plane Function (UPF) to enforce the one or more predefined rules applied to the respective subscribers.

[0067] The updating module **240** is further configured to synchronize the subscriber's data with the centralized database **250** to maintain consistency across the system **125** when the one or more pre-defined rules applied for barring or unbarring the at least one service related to the respective subscribers is successfully updated the at least one network element. By doing so, the system **125** is configured to provide data availability in the event of the at least one active SMF **245** failover and switchover of standby SMF **248**, optimization of memory usage, optimization of CPU, compliance with regulatory guidelines, and scalability.

[0068] Referring to **FIG. 3**, **FIG. 3** describes a preferred embodiment of the system **125**, according to one or more embodiments of the present invention. It is to be noted that the embodiment with respect to **FIG. 3** will be explained with respect to the first SE **105a** for the purpose of description and illustration and should nowhere be construed as limited to the scope of the present disclosure.

[0069] As mentioned earlier in **FIG.1**, the first SE **105a** the second SE **105b**, and the third SE **105c** is a computer system which may include an external storage device, a bus, a main memory, a read-only memory, a mass storage device, communication port(s), and a processor. In one exemplary embodiment, the first SE **105a** will be explained. The first SE **105a** includes one or more primary processors **305** communicably coupled to the one or more processors **205** of the system **125**. The one or more primary processors **305** are coupled with a memory **310** storing instructions which are executed by the one or more primary processors **305**. Execution of the stored instructions by the one or more primary processors **305** enables the first SE **105a** to transmit location coordinates of respective subscriber to a network operator database

based on a current location of the respective subscriber. The execution of the stored instructions by the one or more primary processors **305** further enables the first SE **105a** to transmit a Tracking Area Code (TAC) to the network operator database.

[0070] As mentioned earlier in the **FIG. 2**, the processor **205** of the system **125** is configured for barring and unbarring of at least one service related to the subscribers. The transceiver module **220** is communicably connected to each of the first SE **105a**, the second SE **105b**, and the third SE **105c** via the network **110**. Accordingly, the transceiver module **220** is configured to receive the request from the network operator via the interface module **215** for barring or unbarring of the at least one service related to subscribers. The interface module **215** enables communication between different network elements and is responsible for managing communication between different protocols or standards used within the network. In one embodiment, the interface module **215** may include, but not limited to, the diameter interface module, the Short Message Peer-to-Peer (SMPP) module, the Representational State Transfer (RESTful) API interface module, the Remote Authentication Dial-In User Service (RADIUS) interface module, and the Session Initiation Protocol (SIP) interface module.

[0071] The processor **205** includes the fetching module **225** in communication with the transceiver module **220**. More specifically, the fetching module **225** is communicably coupled with the transceiver module **225** to fetch relevant subscriber data from the centralized database **250** to the network operator database corresponding to the request received from the network operator. In one embodiment, the relevant subscriber data may include, at least one of, location coordinates of respective subscriber along with subscriber IDs and pre-configured rule IDs associated with the specified TAC list and the PLMN from the centralized database **250**.

[0072] The rule checker module **230** is communicably connected to the fetching module **225**. The rule checker module **230** is configured to check whether the one or more predefined rules are pre-associated to the subscribers based on the fetched data from the centralized database **250** corresponding to the request. In one embodiment,

the one or more predefined rules represent the at least one service related to the subscribers which is required to be barred or unbarred based on the request. For example, for each subscriber identified in the fetched data, the rule checker module checks whether the Rule IDs R1 and R2 are already applied or not. In one embodiment, the rule checker module **230** is configured to compare the rule IDs pertaining to the one or more pre-defined rules with pre-configured rule IDs for the respective subscribers of each of the first, the second and the third SE **105a**, **105b**, **105c**.

[0073] In the preferred embodiment, the rule checker module **230** eliminates unnecessary processing of the subscriber data when the one or more predefined rules are pre-associated to the respective subscriber before receiving barring input query/command. In this scenario, the respective subscriber is not counted in the list of subscribers to be barred. After finishing the pre-checks, the rule checker module **230** forwards the relevant barring or unbarring requests to the at least one active SMF **245** for handling the respective subscriber. The distribution of requests helps to distribute the workload and thereby improves processing efficiency of the processor **205** and reduces load on the memory **210**.

[0074] The processor **205** further includes the transceiver module **220**. The transceiver module **220** is configured to transmit the request to at least one active Session Management Function (SMF) **245** for barring or unbarring of the at least one service related to the respective subscribers of the SE **105** when the one or more predefined rules are independent of an association with the respective subscribers. The at least one active SMF **245** is the network element responsible for controlling and managing multimedia sessions in an IP Multimedia Subsystem (IMS) network. The at least one active SMF **245** is involved in initiation, modification, and termination process of multimedia sessions and also determines an appropriate routing of multimedia sessions based on policies, rules, user preferences, or network conditions.

[0075] The rule application module **235** is configured to apply the one or more predefined rules via the at least one active SMF **245** for barring or unbarring the at

least one service related to the respective subscribers when the one or more predefined rules are independent of an association with the respective subscribers. Further, the rule application module **235** is configured to apply the one or more predefined rules to subscriber sessions related to the respective subscribers for barring or unbarring the at least one service via the at least one active SMF **245**.

[0076] The updating module **240** of the processor **205** is configured to update the one or more predefined rules applied for barring or unbarring the at least one service related to the respective subscribers at the centralized database **250** via the at least one active SMF **245**. The updating module **240** is further configured to update the centralized database **250** with the TAC list subsequent to at least one of, Protocol Data Unit (PDU) establishment or handover of a new Subscriber Equipment (SE) with an existing network and PDU release of existing SEs from the existing network. The new SE is associated with the subscribers. On updating the centralized database **250** with the TAC list, the updating module **240** is configured to update the one or more predefined rules applied for barring or unbarring the at least one service related to the respective subscribers via the at least one active SMF **245** using the at least one network element. The at least one network element may include at least one of the Policy Charging Function (PCF) and the User Plane Function (UPF) to enforce the one or more predefined rules applied to the respective subscribers.

[0077] The updating module **240** is further configured to synchronize the subscriber's data with the centralized database **250** to maintain consistency across the system **125** when the one or more pre-defined rules applied for barring or unbarring the at least one service related to the respective subscribers is successfully updated in the at least one network element. By doing so, the system **125** is configured to provide data availability in the event of the at least one active SMF **245** failover and switchover of standby SMF **248**, optimization of memory usage, optimization of CPU, compliance with regulatory guidelines, and scalability.

[0078] Hence, for the sake of brevity, similar description related to the working and operation of the system **125** as illustrated in **FIG. 2** has been omitted to avoid repetition. The limited description provided for the system **125** in **FIG. 3**, should be read with the description as provided for the system **125** in the **FIG. 2** above.

[0079] **FIG. 4** is a schematic representation of the system for barring and unbarring of at least one service related to subscribers, according to one or more embodiments of the present invention.

[0080] The system includes, but may not be limited to, the interface module **215**, the server **115**, the centralized database **250**, communicatively coupled to the server **115**, and the network **110**. The server **115** is configured to communicate with the centralized database **250** and the at least one SMF **245**.

[0081] In one embodiment, the network operator input is received by the server **115** through the interface module **215**. In one embodiment, the network operator input for this query may include at least one of the TAC lists, the PLMN, and the pre-configured Rule IDs. The inputs define the specific TACs and PLMN where the barring or unbarring actions need to be applied. The pre-configured Rule IDs represent the specific rules that are to be enforced on the subscribers. In an exemplary embodiment, the network operator input includes TAC list: [12345, 67890], PLMN: "XYZ", and Rule IDs: [R1, R2].

[0082] When the network operator input is received, the data is retrieved by the server **115** from the centralized database **250**. The server **115** retrieves the subscriber ID (IMSI) and Rule IDs associated with the specified TACs and the PLMN from the centralized database **250**. This retrieval ensures that only the relevant subscribers in that PLMN and TAC list information are fetched.

[0083] In one embodiment, the system **125** is configured for pre-checking of existing barring and unbarring rules. Before proceeding with the barring or unbarring actions, the system **125** pre-checks to determine whether the one or more predefined

rules are already applied to the subscribers so as to avoid redundant processing by the at least one active SMF **245**. For example, for each subscriber identified in the fetched data, the system **125** checks whether Rule IDs R1 and R2 are already applied. If the subscriber is already barred or unbarred based on the one or more predefined rules, the specific subscribers are excluded from further processing.

[0084] In another embodiment, the subscribers on which the barring and unbarring rules are not yet imposed are forwarded to the at least one active SMF **245**. After the pre-checks, the server **115** forwards the relevant barring or unbarring requests to the at least one active SMF **245** responsible for handling the respective subscriber. The requests are forwarded based on the pre-defined rate to the at least one active SMF **245** so that the at least one active SMF **245** performs barring or unbarring activity as per pre-configured rate. For example, the at least one SMF **245** may be configured to perform barring or unbarring activity at the rate of 800 subscribers per second.

[0085] In one embodiment, the at least one SMF **245** updates the at least one network element, such as the Policy Charging Function and the User Plane Function, to enforce the one or more predefined rules for barring or unbarring of at least one of the services to the subscribers. After successful update of the at least one network element, the data is synchronized with the centralized database **250** to ensure consistency across the system **125**. The subscriber's data, including the applied one or more predefined rules, is then updated in the centralized database **250**. Any policy change or change in the subscriber data (such as updated service policy) are also updated in the centralized database **250**.

[0086] **FIG. 5** is a signaling flow diagram of barring or unbarring of at least one service to the subscribers, according to the one or more embodiments of the present invention.

[0087] In one example, the SE **105** can be connected to the network **110**. In one embodiment, the SE **105** can be a mobile device. A PDU establishment request, for

creating/updating/removing the subscribers TAC list in the centralized database **250**, availing at least one service to the subscribers. The PDU establishment request is processed by the at least one active SMF **245** in accordance with a standard procedure, and if the PDU establishment request is successfully processed, a PDU accept response is sent to the SE **105** by the at least one active SMF **245**. The PDU release request is processed by the at least one active SMF **245** when the subscriber data is already fetched, so the respective subscriber data is removed from the TAC list. The PDU establishment request and PDU release request are processed as per 3GPP defined standard procedures and corresponding signaling messages.

[0088] At step **502**, the PDU session establishment request is forwarded to the server **115** for creating/updating/removing subscribers TAC in the centralized database **250**. When a regulatory requirement arises to bar or unbar subscribers in specific TACs, the system **125** retrieves the required subscriber data from the centralized database **250**. Different subscribers present in multiple TACs need to be barred/unbarred by the network operator based on the regulatory requirement.

[0089] At step **504**, the server **115** fetches the subscriber IDs (IMSI) and rule IDs present in the particular TAC/PLMN, from the centralized database **250**. After successful fetching of the subscriber IDs and the rule IDs, the rule check module **230** in the server **115** pre-checks whether the barring/unbarring is already applied or not.

[0090] In a first scenario, at step **506**, the server **115** forwards the request to the at least one active SMF **245** for handling the respective subscriber when the one or more predefined rules of the barring and unbarring is not applied.

[0091] Further, the at least one active SMF **245** applies the one or more predefined rules in the at least one network element such as, the Policy Charging Function and the User Plane Function at step **508**. The subscriber's data is synchronized with the centralized database **250** when the one or more pre-defined rules applied for barring

or unbarring the at least one service related to the respective subscribers is successfully updated at the at least one network element.

[0092] The at least one active SMF **245** updates the one or more predefined rules applied for barring or unbarring the at least one service related to the respective subscribers at the centralized database **250** at step **508**. The at least one active SMF **245** transmits the PDU session accept acknowledgement to the SE **105** when the one or more predefined rules applied for barring or unbarring the at least one service related to the respective subscribers at the centralized database **250**.

[0093] In a second scenario: the system **125** is configured for pre-checking of existing of the one or more predefined rules of barring or unbarring of subscribers. Before proceeding with the one or more predefined rules, the system **125** performs pre-checking process to determine whether the one or more predefined rules are already applied to the subscribers, which helps to avoid redundant processing by the at least one active SMF **245**. The respective subscriber will be excluded from further processing when the respective subscriber is already barred or unbarred based on the one or more predefined rules. Further, the respective subscriber is removed from the TAC list when the PDU release request is established.

[0094] **FIG. 6** is a flow diagram of a method **600** for barring and unbarring of at least one service related to subscribers, according to the one or more embodiments of the present invention. The method **600** is adapted to perform barring and unbarring of at least one service related to subscribers. More specifically, the method further utilizes the at least one active SMF **245** to update the barring and unbarring of at least one service related to subscribers. For the purpose of description, the method **600** is described with the embodiments as illustrated in **FIG. 2** and should nowhere be construed as limiting the scope of the present disclosure.

[0095] At step **605**, the method **600** includes the step of receiving, by one or more processors **205**, a request from a network operator via an interface module **215** for

barring or unbarring of the at least one service related to subscribers by using the transceiver module **220**. The interface module **215** enables communication between different network elements and is responsible for managing communication between different protocols or standards used within the network. In one embodiment, the interface module **215** may include, but not limited to, a diameter interface module, a Short Message Peer-to-Peer (SMPP) module, a Representational State Transfer (RESTful) API interface module, a Remote Authentication Dial-In User Service (RADIUS) interface module, and Session Initiation Protocol (SIP) interface module. In one embodiment, the request received from the network operator for barring or unbarring of subscribers includes at least one of, Tracking Area Codes (TAC) List, Public Land Mobile Network (PLMN), and rule IDs representing the one or more predefined rules to be applied to the subscribers. In one embodiment, the one or more pre-defined rules are represented as rule IDs pertaining to barring or unbarring of the at least one service related to a specific subscription plan of the subscribers.

[0096] In one embodiment, the request received from the network operator for barring or unbarring of subscribers includes at least one of, Tracking Area Codes (TAC) List, Public Land Mobile Network (PLMN), and rule IDs representing the one or more predefined rules to be applied to the subscribers. In one embodiment, the one or more pre-defined rules are defined by the network operator. In one embodiment, the one or more pre-defined rules are represented as rule IDs pertaining to barring or unbarring of the at least one service related to the specific subscription plan of the subscribers. In one embodiment, the subscription plan of the subscribers may include, at least one of, the mobile phone plan, such as unlimited or limited talk time, text messages, and high-speed data usage, and the streaming services plan.

[0097] At step **610**, the method **600** includes the step of fetching, by one or more processors **205**, relevant subscriber data from a centralized database **250** to a network operator database corresponding to the request received from the network operator. In one embodiment, the relevant subscriber data may include, at least one of, location coordinates of respective subscriber along with subscriber IDs and pre-configured rule

IDs associated with the specified TAC list and the PLMN from the centralized database **250**.

[0098] Further, as per one or more embodiments, the fetching module **225** is configured to extract the subscriber data pertaining to the specified TAC list and the PLMN based on the request received from the network operator. Subsequently, the fetching module **225** is configured to retrieve the relevant subscriber data pertaining to the subscriber IDs and the pre-configured rule IDs based on the extracted TAC list and the PLMN from the centralized database **250**.

[0099] At step **615**, the method **600** includes the step of checking, by the one or more processors **205**, whether the one or more predefined rules are pre-associated to the subscribers based on the fetched data from the centralized database **250** corresponding to the request by using a rule checker module **230**. In one embodiment, the one or more predefined rules represent the at least one service related to the subscribers which is required to be barred or unbarred based on the request. For example, for each subscriber identified in the fetched data, the rule checker module checks whether the Rule IDs R1 and R2 are already applied or not. In one embodiment, the rule checker module **230** is configured to compare the rule IDs pertaining to the one or more pre-defined rules with pre-configured rule IDs for the respective subscribers of each of the first, the second and the third SE **105a**, **105b**, **105c**.

[00100] Further, the rule checker module **230** is configured to infer availability or non-availability of the one or more pre-defined rules pre-associated to the subscribers. In order to do so, the rule checker module **230** is configured to compare the one or more rule IDs with the pre-configured rule IDs for the respective subscribers of each of the first, the second and the third SE **105a**, **105b**, **105c**.

[00101] In a preferred embodiment, the rule checker module **230** eliminates unnecessary processing of the subscriber data when the one or more predefined rules are pre-associated to the respective subscriber before receiving barring input

query/command. In this scenario, the respective subscriber is not counted in the list of subscribers to be barred. After finishing the pre-checks, the rule checker module **230** forwards the relevant barring or unbarring requests to an active Session Management Function (SMF) **245** for handling the respective subscriber. The distribution of requests helps to distribute the workload and thereby improves processing efficiency of the processor **205** and reduces load on the memory **210**.

[00102] At step **620**, the method **600** includes the step of transmitting, by the one or more processors **205**, the request to an at least one active SMF **245** for barring or unbarring of the at least one service related to the respective subscribers when the one or more predefined rules are independent of an association with the respective subscribers by the transceiver module **220**. The at least one active SMF **245** is a network element responsible for controlling and managing multimedia sessions in an IP Multimedia Subsystem (IMS) network. The at least one active SMF **245** is involved in initiation, modification, and termination process of multimedia sessions. The at least one active SMF **245** may also determine an appropriate routing of multimedia sessions based on policies, rules, user preferences, or network conditions.

[00103] Further, the transceiver module **220** is configured for identifying the at least one active SMF **245** responsible for handling the respective subscribers at a pre-defined rate when the one or more predefined rules are independent of an association with the subscribers. Further, the transceiver module **220** is configured for transmitting the request to the identified active SMF **245** when the one or more predefined rules are independent of an association with the subscribers so that the at least one SMF **245** performs barring or unbarring activity as the per-defined rate. For example, the at least one SMF **245** may be configured to perform barring or unbarring activity at rate of 800 subscribers per second.

[00104] At step **625**, the method **600** includes the step of applying, by the one or more processors **205**, via the at least one active SMF **245** the one or more predefined rules for barring or unbarring the at least one service related to the respective

subscribers by a rule application module **235**. Further, the rule application module **235** is configured to apply the one or more predefined rules to subscriber sessions related to the respective subscribers for barring or unbarring the at least one service via the at least one active SMF **245**.

[00105] At step **630**, the method **600** includes the step of updating, by the one or more processors **205**, update the one or more predefined rules applied for barring or unbarring the at least one service related to the respective subscribers at the centralized database via the at least one active SMF **245** by the updating module **240**. The updating module **240** is further configured to update the centralized database with the TAC list subsequent to at least one of, Protocol Data Unit (PDU) establishment or handover of a new Subscriber Equipment (SE) **105** with an existing network and PDU release of existing SEs **105** from the existing network. The new SE is associated with the subscribers. On updating the centralized database **250** with the TAC list, the updating module **240** is configured to update via the at least one active SMF **245** the one or more pre-defined rules applied for barring or unbarring the at least one service related to the respective subscribers using the at least one network element. The at least one network element may include, at least one of the Policy Charging Function (PCF) and the User Plane Function (UPF). The updating module **240** is configured to update at least one network element to enforce the one or more predefined rules applied to the respective subscribers. Further, the updating module **240** is configured to synchronize the updated network element with the centralized database **250** to maintain consistency with updated data related to the one or more predefined rules applied to the subscribers. By doing so, the method **600** is configured to provide optimization of memory usage, optimization of CPU, and scalability.

[00106] The present invention further discloses a non-transitory computer-readable medium having stored thereon computer-readable instructions. The computer-readable instructions are executed by a processor **205**. The processor **205** is configured to receive a request from a network operator via an interface module **215** for barring or unbarring of the at least one service related to subscribers. The processor

205 is further configured to fetch the relevant data corresponding to the request from a centralized database **250**. The processor **205** is further configured to check whether one or more predefined rules are pre-associated to the subscribers based on the fetched data from the centralized database **250** corresponding to the request. The one or more predefined rules represent the at least one service related to the subscribers which is required to be barred or unbarred based on the request. The processor **205** is further configured to transmit the request to at least one active Session Management Function (SMF) **245** for barring or unbarring of the at least one service related to subscribers when the one or more predefined rules are independent of an association with the subscribers. The processor **205** is further configured to apply via the at least one active SMF **245** the one or more predefined rules for barring or unbarring the at least one service related to the respective subscribers. The processor **205** is further configured to update via the at least one active SMF **245**, the one or more predefined rules applied for barring or unbarring the at least one service related to the respective subscribers at the centralized database **250**, thereby barring and unbarring of at least one service related to the subscribers.

[00107] A person of ordinary skill in the art will readily ascertain that the illustrated embodiments and steps in description and drawings (FIG.1-6) are set out to explain the exemplary embodiments shown, and it should be anticipated that ongoing technological development will change the manner in which particular functions are performed. These examples are presented herein for purposes of illustration, and not limitation. Further, the boundaries of the functional building blocks have been arbitrarily defined herein for the convenience of the description. Alternative boundaries can be defined so long as the specified functions and relationships thereof are appropriately performed. Alternatives (including equivalents, extensions, variations, deviations, etc., of those described herein) will be apparent to persons skilled in the relevant art(s) based on the teachings contained herein. Such alternatives fall within the scope and spirit of the disclosed embodiments.

[00108] Advantages of the present embodiment may be as described below:

[00109] Data availability even in the event of at least one SMF **245** failovers/switchovers: By storing the subscriber data in the centralized database **250**, the system **125** ensures data availability and accessibility even during failovers or switchovers of SMF **245** application processes. This enhances the overall reliability and continuity of subscriber services.

[00110] Optimization of memory usage: Storing the subscriber data in the centralized database **250** reduces memory footprint of the at least one SMF **245**. This optimization allows for efficient memory allocation and utilization, leading to improved system performance and stability.

[00111] Optimization of CPU: With the offloading of data fetching and analysis to the server **115**, the burden on the CPU of the application is reduced. This optimization results in better CPU utilization, enabling faster processing of other critical tasks within the system. CPU occupancy is greatly reduced due to data access contention avoidance implementation design.

[00112] Compliance with regulatory guidelines: The dynamic barring and unbarring process ensures compliance with regulatory guidelines by accurately applying or removing the specified rules on subscribers and eliminates the possibility of subscribers remaining barred or unbarred unintentionally, ensuring adherence to regulatory requirements.

[00113] Scalability: The implemented method offers scalability, allowing the system to accommodate future similar features or requirements. The centralized database and application architecture can accommodate additional functionalities, ensuring the system remains robust and adaptable to evolving network demands.

[00114] The present disclosure incorporates technical advancement of storing subscriber data in the centralized database **250** to reduce memory size of the at least one SMF application. The updated subscriber data is also fetched in the centralized database **250**, which distributes the updated data to the multiple SMFs **245** at a pre-

defined rate to avoid overload in the CPU. Therefore, the system **125** and method **600** are configured to enhance overall reliability and continuity of subscriber services.

[00115] The present invention offers multiple advantages over the prior art and the above listed are a few examples to emphasize on some of the advantageous features. The listed advantages are to be read in a non-limiting manner.

REFERENCE NUMERALS

- [00116] Communication system - 100;
- [00117] Subscriber Equipment - 105;
- [00118] Network – 110;
- [00119] Server – 115;
- [00120] System -125;
- [00121] One or more processor -205;
- [00122] Memory – 210;
- [00123] Interface Module – 215;
- [00124] Transceiver Module- 220;
- [00125] Fetching Module - 225;
- [00126] Rule Checker Module - 230;
- [00127] Rule Application Module - 235;
- [00128] Updating Module- 240;
- [00129] At least one SMF- 245;
- [00130] Centralized database – 250;
- [00131] Primary processor– 305;
- [00132] Memory unit- 310.

We Claim:

1. A method (600) for barring and unbarring of an at least one service related to subscribers, the method (600) comprises the steps of:
 - receiving, by one or more processors (205), a request from a network operator via an interface module (215) for barring or unbarring of the at least one service related to subscribers;
 - fetching, by the one or more processors (205), the relevant data corresponding to the request from a centralized database (250);
 - checking, by the one or more processors (205), whether one or more predefined rules are pre-associated to the subscribers based on the fetched data from the centralized database (250) corresponding to the request, wherein the one or more predefined rules represent the at least one service related to the subscribers which is required to be barred or unbarred based on the request;
 - transmitting, by the one or more processors (205), the request to an at least one active Session Management Function (SMF) (245) for barring or unbarring of the at least one service related to the subscribers when the one or more predefined rules are independent of an association with the subscribers;
 - applying, by the one or more processors (205), via the at least one active SMF (245), the one or more predefined rules for barring or unbarring the at least one service related to the respective subscribers; and
 - updating, by the one or more processors (205), via the at least one active SMF (245), the one or more predefined rules applied for barring or unbarring the at least one service related to the respective subscribers at the centralized database (250).
2. The method (600) as claimed in claim 1, wherein the request received from the network operator for barring or unbarring of the subscribers includes at least one of, Tracking Area Code (TAC) List, Public Land Mobile Network (PLMN), and one or more rule IDs representing the one or more predefined rules to be applied to the subscribers.

3. The method (600) as claimed in claim 1, wherein the relevant data fetched by the one or more processors (205) from the centralized database (250) in response to the request received from the network operator, is at least one of, subscriber IDs and pre-configured rule IDs associated with the specified TAC list or the PLMN.
4. The method (600) as claimed in claim 1, wherein the one or more pre-defined rules are represented as one or more rule IDs pertaining to barring or unbarring of the at least one service related to a specific subscription plan of the subscribers..
5. The method (600) as claimed in claim 1, wherein the step of fetching, the relevant data corresponding to the request from the centralized database (250), includes the steps of:
 - extracting, by the one or more processors (205), data pertaining to the specified TAC list and the PLMN from the request; and
 - retrieving, by the one or more processors (205), from the centralized database (250), the relevant data pertaining to the subscriber IDs and associated pre-configured rule IDs based on the extracted TAC list and the PLMN.
6. The method (600) as claimed in claim 1, wherein the step of, checking, whether the one or more pre-defined rules are pre-associated to the subscribers based on the fetched data from the centralized database (250), includes the steps of:
 - comparing, by the one or more processors (205), the one or more rule IDs pertaining to the one or more pre-defined rules with the pre-configured rule IDs for the respective subscribers; and
 - inferring, by the one or more processors (205), availability or non-availability of the one or more pre-defined rules pre-associated to the

subscribers based on comparing the one or more rule IDs with the pre-configured rule IDs for the respective subscribers.

7. The method (600) as claimed in claim 1, wherein the step of, transmitting, the request to the at least one active SMF (245) for barring or unbarring of the at least one service related to the subscribers when the one or more predefined rules are independent of an association with the subscribers includes the steps of:

identifying, by the one or more processors (205), the at least one active SMF (245) responsible for handling the respective subscribers at a pre-defined rate; and

transmitting, by the one or more processors (205), the request to the identified active SMF (245).

8. The method (600) as claimed in claim 1, wherein the step of applying, the one or more predefined rules for barring or unbarring the at least one service related to the respective subscribers, includes the step of:

applying, by the one or more processors (205), via the at least one active SMF (245), the one or more predefined rules to subscriber sessions related to the respective subscribers for barring or unbarring the at least one service.

9. The method (600) as claimed in claim 1, wherein the step of, updating, via the at least one active SMF (245), the one or more predefined rules applied for barring or unbarring the at least one service related to the respective subscribers at the centralized database (250), further includes the steps of:

updating, by the one or more processors (205), an at least one network element including at least one of, a Policy Control Function (PCF) to enforce the one or more predefined rules applied to the respective subscribers; and

synchronizing, by the one or more processors (205), the updated at least one network element with the centralized database (250) to maintain consistency with the updated data related to the one or more predefined rules applied to the subscribers.

10. A system (125) for barring and unbarring of an at least one service related to the subscribers, the system (125) comprising:

a transceiver module (220) configured to, receive, a request from a network operator via an interface module (215) for barring or unbarring of the at least one service related to subscribers;

a fetching module (225) configured to, fetch, the relevant data corresponding to the request from a centralized database (250);

a rule checker module (230) configured to, check, whether one or more predefined rules are pre-associated to the subscribers based on the fetched data from the centralized database (250) corresponding to the request, wherein the one or more predefined rules represent the at least one service related to the subscribers which is required to be barred or unbarred based on the request;

the transceiver module (220) configured to, transmit, the request to an at least one active Session Management Function (SMF) (245) for barring or unbarring of the at least one service related to the subscribers when the one or more predefined rules are independent of an association with the subscribers;

a rule application module (235) configured to, apply, via the at least one active SMF (245), the one or more predefined rules for barring or unbarring the at least one service related to the respective subscribers; and

an updating module (240) configured to, update, via the active SMF (245), the one or more predefined rules applied for barring or unbarring the at least one service related to the respective subscribers at the centralized database (250).

11. The system (125) as claimed in claim 10, wherein the request received from the network operator for barring or unbarring of the subscribers includes at least one of, Tracking Area Code (TAC) List, Public Land Mobile Network (PLMN), and one or more rule IDs representing the one or more predefined rules to be applied to the subscribers.
12. The system (125) as claimed in claim 10, wherein the relevant data is at least one of, subscriber IDs and pre-configured rule IDs associated with the specified TAC list or the PLMN.
13. The system (125) as claimed in claim 10, wherein the one or more pre-defined rules are represented as the one or more rule IDs pertaining to barring or unbarring of the at least one service related to a specific subscription plan of the subscribers.
14. The system (125) as claimed in claim 10, wherein the fetching module (225) is further configured to:
 - extract, data pertaining to the specified TAC list and the PLMN from the request; and
 - retrieve, from the centralized database (250), the relevant data pertaining to the subscriber IDs and associated pre-configured rule IDs based on the extracted TAC list and the PLMN.
15. The system (125) as claimed in claim 10, wherein the rule checker module (230) is further configured to:
 - compare, one or more rule IDs pertaining to the one or more pre-defined rules with the pre-configured rule IDs for the respective subscribers;
 - and

infer, availability or non-availability of the one or more pre-defined rules pre-associated to the subscribers based on comparing the one or more rule IDs with the pre-configured rule IDs for the respective subscribers.

16. The system (125) as claimed in claim 10, wherein on transmitting the request to the at least one active SMF (245) for barring or unbarring of the at least one service related to the subscribers when the one or more predefined rules are independent of an association with the subscribers, the transceiver module (220) is further configured to:

identify, the at least one active SMF (245) responsible for handling the respective subscribers at a pre-defined rate; and

transmit, the request to the identified active SMF (245).

17. The system (125) as claimed in claim 10, wherein the rule application module (235) is further configured to:

apply, via the at least one active SMF (245), the one or more predefined rules to subscriber sessions related to the respective subscribers for barring or unbarring the at least one service.

18. The system (125) as claimed in claim 10, wherein the updating module (240) of the system (125) is further configured to:

update, at least one network element including at least one of, a Policy Control Function (PCF) to enforce the one or more predefined rules applied to the respective subscribers; and

synchronize, the updated at least one network element with the centralized database (250) to maintain consistency with the updated data related to the one or more predefined rules applied to the subscribers.

19. The system (125) as claimed in claim 10, wherein the updating module (240) of the system (125) is further configured to update, the centralized database

(250) with the TAC list subsequent to at least one of, Protocol Data Unit (PDU) establishment or handover of a new Subscriber Equipment (SE) (105) with an existing network and PDU release of existing SE (105) from the existing network.

20. A Subscriber Equipment (SE) (105), comprising:

one or more primary processors (305) communicatively coupled to one or more processors (205), the one or more primary processors (305) coupled with a memory (310), wherein said memory (310) stores instructions which when executed by the one or more primary processors (305) causes the SE (105) to:

transmit, location coordinates of respective subscribers to a network operator database, based on a current location of the respective subscribers; and

transmit, a Tracking Area Code (TAC) to the network operator database; wherein, the processor is further configured to perform the steps as claimed in claim 1.

21. A non-transitory computer-readable medium having stored thereon computer-readable instructions that, when executed by a processor (205), causes the processor (205) to:

receive, a request from a network operator via an interface module (215) for barring or unbarring of the at least one service related to subscribers;

fetch, the relevant data corresponding to the request from a centralized database (250);

check, whether one or more predefined rules are pre-associated to the subscribers based on the fetched data from the centralized database (250) corresponding to the request, wherein the one or more predefined rules represent the at least one service related to the subscribers which is required to be barred or unbarred based on the request;

transmit, the request to an at least one active Session Management Function (SMF) (245) for barring or unbarring of the at least one service related to the subscribers when the one or more predefined rules are independent of an association with the subscribers;

apply, via the at least one active SMF (245), the one or more predefined rules for barring or unbarring the at least one service related to the respective subscribers; and

update, via the at least one active SMF (245), the one or more predefined rules applied for barring or unbarring the at least one service related to the respective subscribers at the centralized database (250), thereby barring and unbarring of the at least one service related to the subscribers.

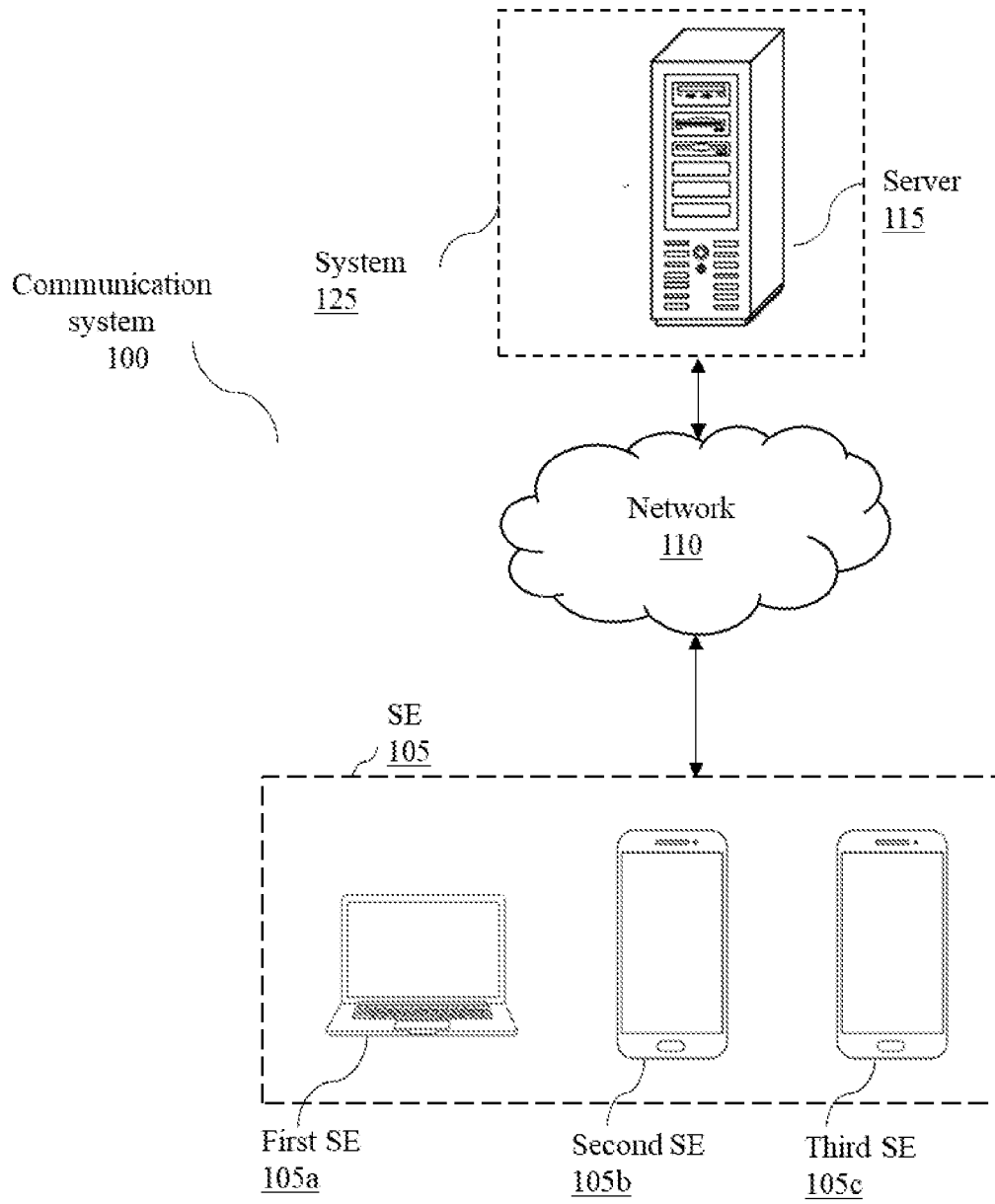


FIG. 1

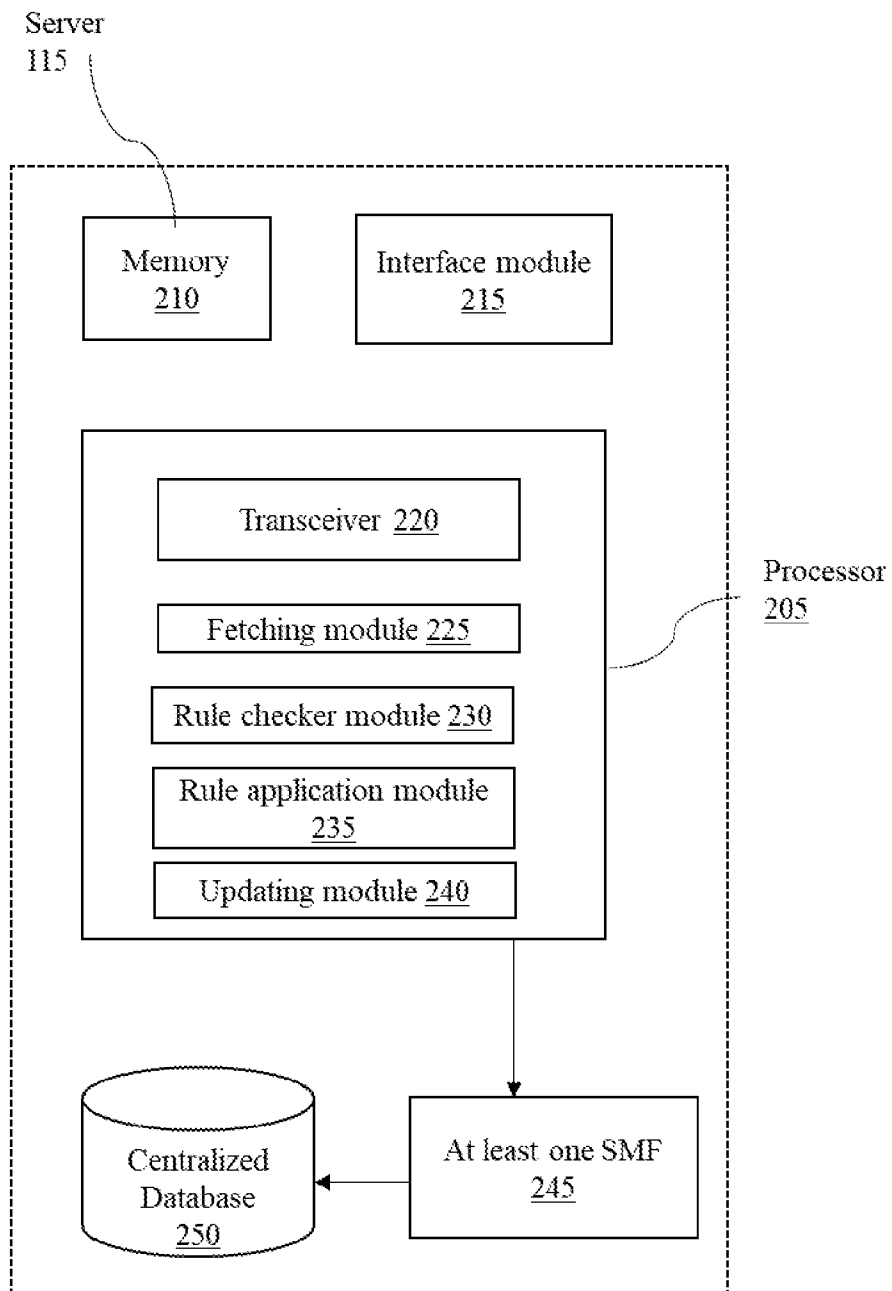


FIG. 2

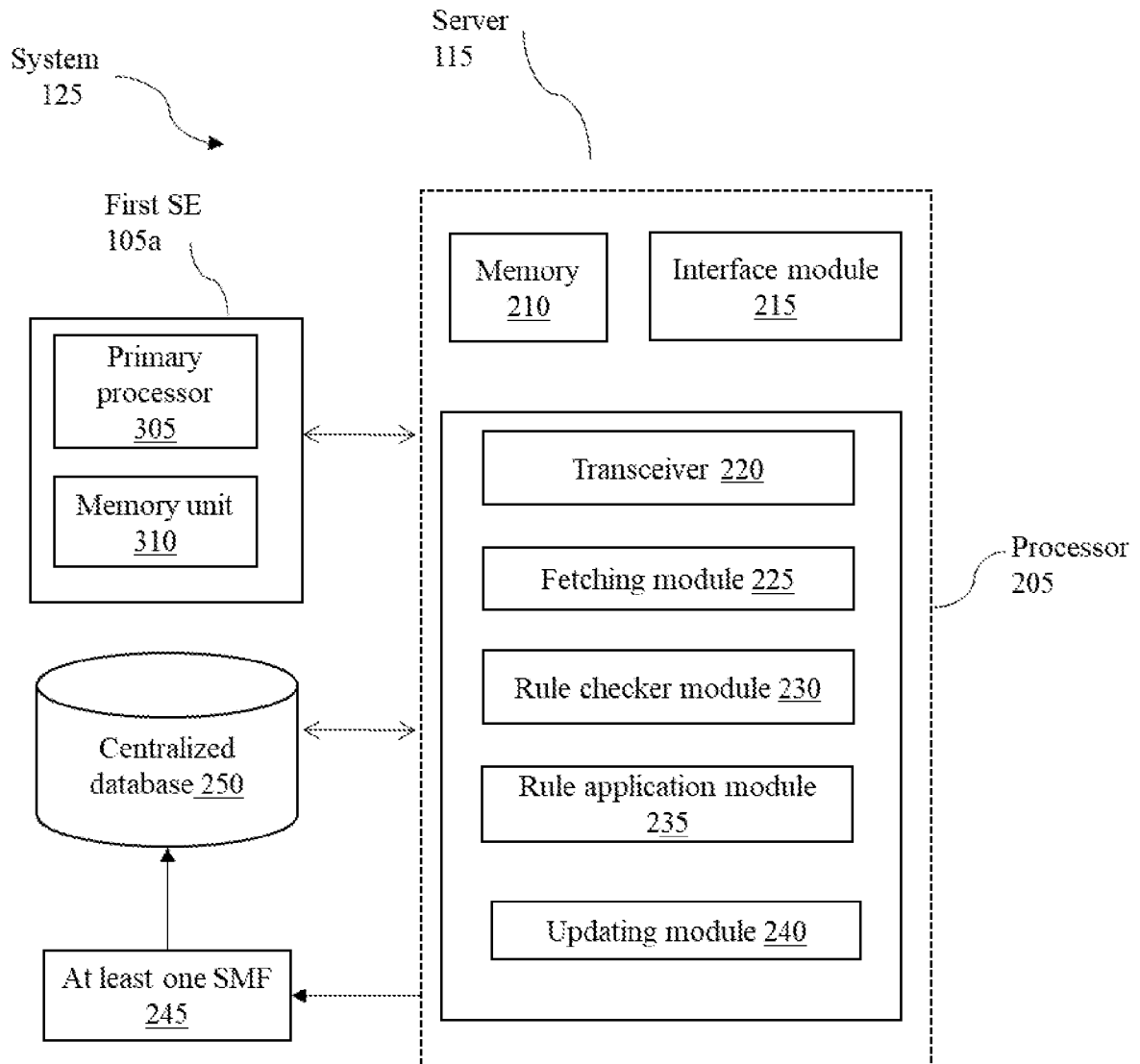


FIG. 3

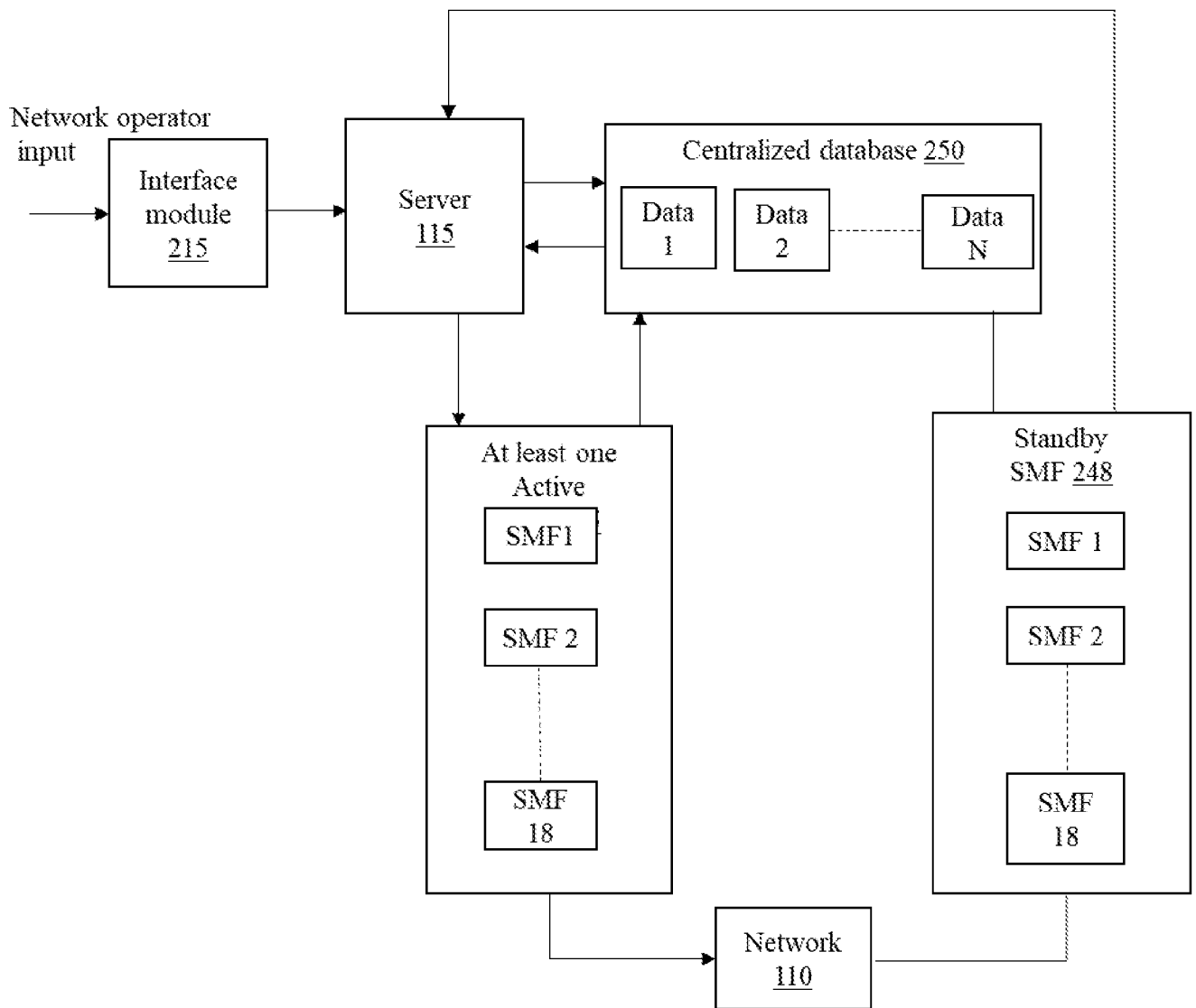


FIG. 4

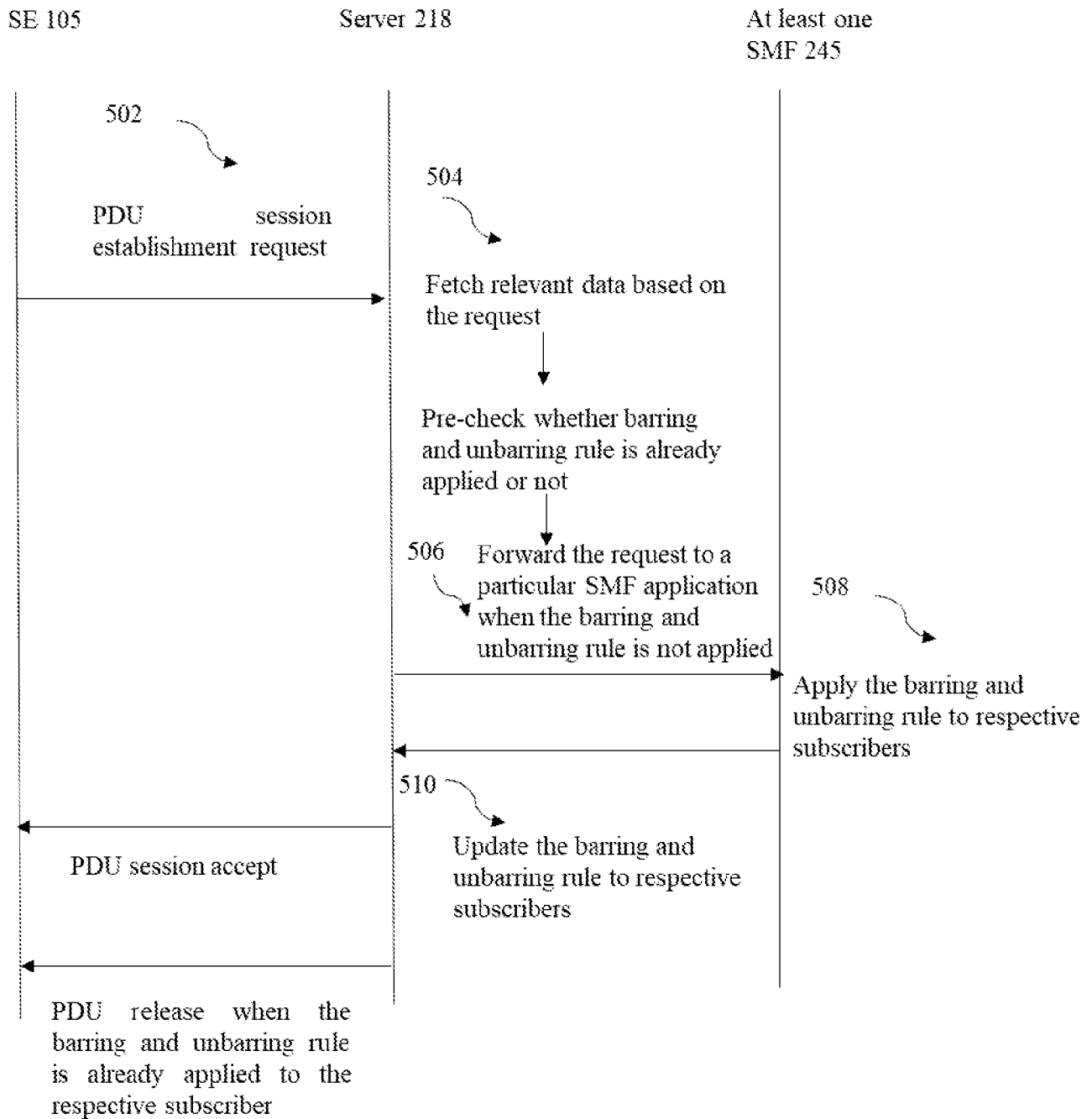


FIG. 5

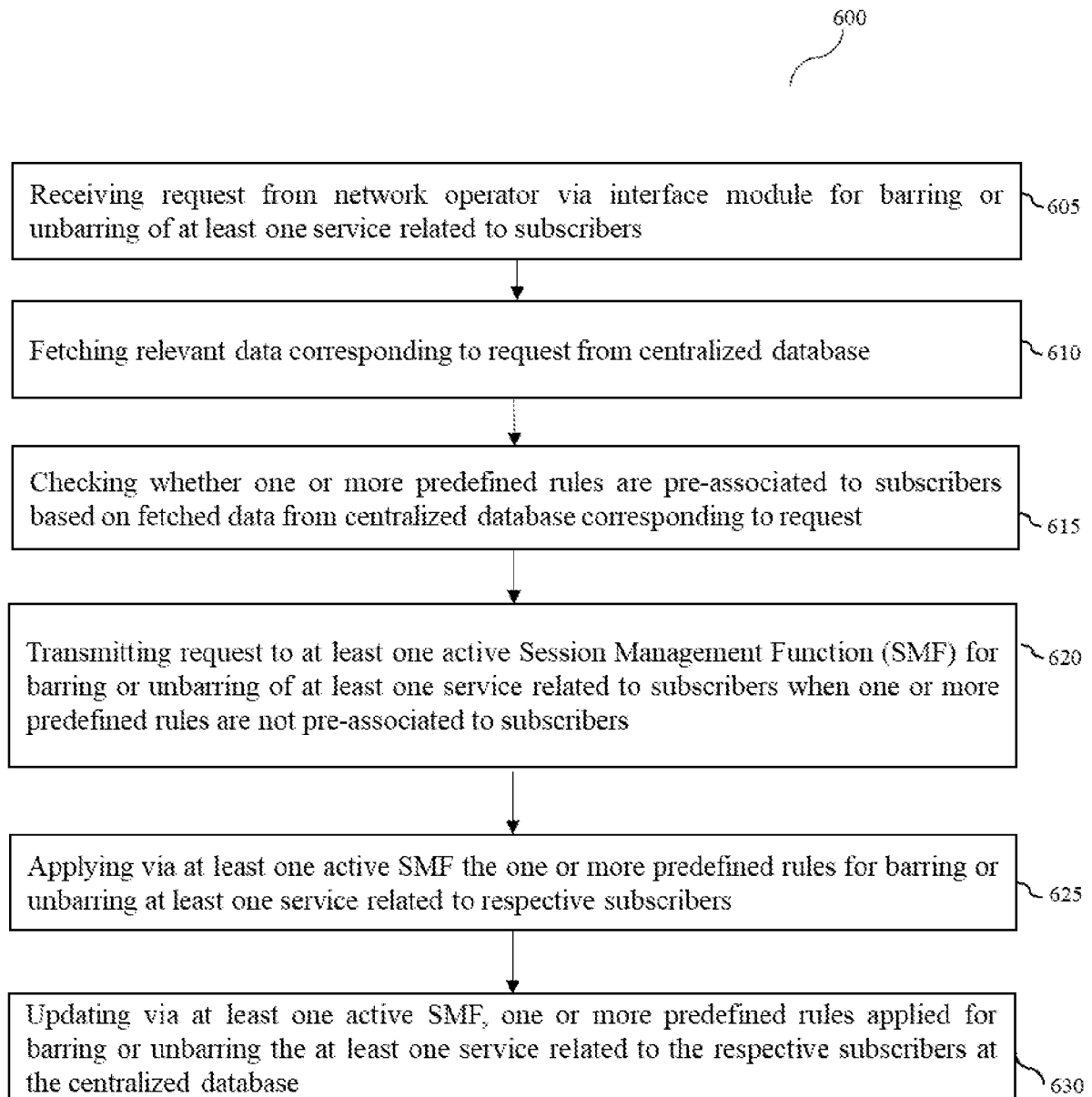


FIG. 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IN2024/050950

A. CLASSIFICATION OF SUBJECT MATTER

H04W8/18, H04M3/42, H04L65/1016, H04L67/51 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; H04M;

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

Keywords: centralized database, service management, session management;

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US20100046730A1 (Telefonaktiebolaget LM Ericsson AB) 25.02.2010 (25 Feb 2010) Abstract; Description;	1-21



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

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

"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

30-10-2024

Date of mailing of the international search report

30-10-2024

Name and mailing address of the ISA/

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IN2024/050950

Citation	Pub.Date	Family	Pub.Date
US 2010046730 A1	25-02-2010	EP 2062425 A1	27-05-2009
		WO 2008033026 A1	20-03-2008