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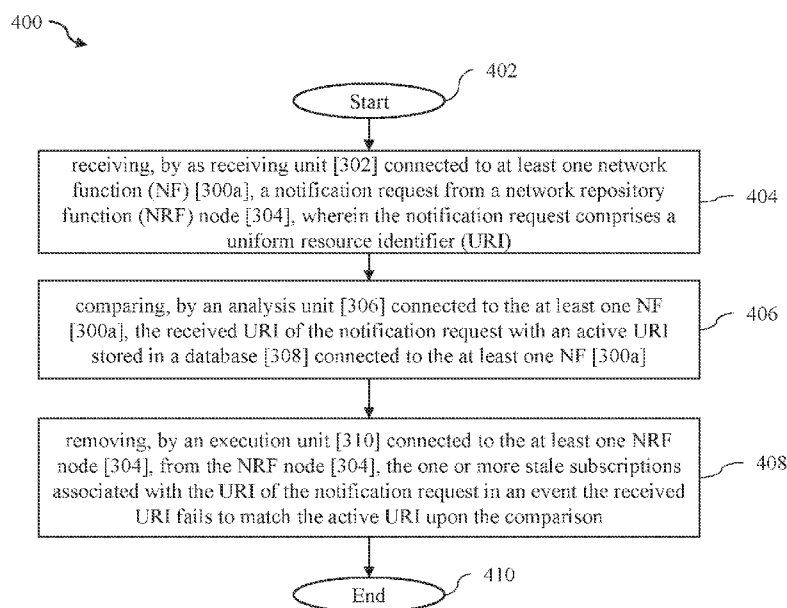


FIG. 4

(57) Abstract: The present disclosure relates to a method and a system for managing one or more stale subscriptions. The method encompasses receiving, by a receiving unit [302] connected to at least one network function (NF) [300a], a notification request from the NRF node [304], wherein the notification request comprises a uniform resource identifier (URI); comparing, by an analysis unit [306] connected to the at least one NF [300a], the received URI of the notification request with an active URI stored in a database [308] of the at least one NF [300a]; removing, by an execution unit [310] connected at least to the one NRF node [304] from the NRF node [304], the one or more stale subscriptions associated with the URI of the notification request in an event the received URI fails to match the active URI upon the comparison.

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METHOD AND SYSTEM FOR MANAGING STALE SUBSCRIPTIONS**FIELD OF THE DISCLOSURE**

5 **[0001]** The present disclosure generally relates to the field of wireless communication systems. More particularly, embodiments of the present disclosure relate to a method and system for managing stale subscriptions.

BACKGROUND

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[0002] The following description of the 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 present disclosure. However, it should be appreciated that this section is used only to enhance the understanding of the reader with respect
15 to the present disclosure, and not as admissions of the prior art.

[0003] Wireless communication technology has rapidly evolved over the past few decades, with each generation bringing significant improvements and advancements. The first generation of wireless communication technology was based on analog technology and offered only voice
20 services. However, with the advent of the second-generation (2G) technology, digital communication and data services became possible, and text messaging was introduced. 3G technology marked the introduction of high-speed internet access, mobile video calling, and location-based services. The fourth-generation (4G) technology revolutionized wireless communication with faster data speeds, better network coverage, and improved security.
25 Currently, the fifth-generation (5G) technology is being deployed, promising even faster data speeds, low latency, and the ability to connect multiple devices simultaneously. With each generation, wireless communication technology has become more advanced, sophisticated, and capable of delivering more services to its users.

30 **[0004]** In conventional network implementation, a network function (NF) discovers another network function and establishes a communication channel for data transfer therebetween. Here, one NF is designated to be a microservice consumer and the other NF is designated to be a microservice producer. Examples of microservice consumers and microservice producers can be an AMF or an SMF.

[0005] However, after a certain period of time, the discovered data about peer NFs expires and is required to be re-discovered. However, to get the changes about the discovered data in between the consecutive discoveries a subscription is registered with Network Repository Function (NRF). Once a subscription is registered with NRF, any changes in the status of one NF (e.g., a first NF) is notified to the other NF (e.g., a second NF). Here, the first NF may be designated to be the microservice consumer, and the second NF may be designated to be the microservice producer. In conventional approaches, when the second NF shuts down abruptly, the corresponding subscription is not removed from the NRF server. Hence, once the second NF is back online, it registers a new subscription with the NRF server. Therefore, with the same second NF, the NRF can have multiple subscriptions, wherein one of the subscriptions is redundant. The redundant subscriptions are called stale subscriptions. As a result, any change in the status of the second NF is notified multiple times to the first NF, by the NRF server. This results in utilization of NRF server resources in notifying the same information multiple times to the other NF. Moreover, the first NF needs to process the same information multiple times, leading to utilization of resources for redundant tasks, which is undesirable for efficient working of the first NF. Furthermore, in conventional approaches, the number of stale subscriptions can become so prohibitively high that it can choke the network and affect user experience.

[0006] Thus, there exists an imperative need in the art for managing one or more stale subscriptions.

SUMMARY

[0007] This section is provided to introduce certain aspects of the present disclosure in a simplified form that are further described below in the detailed description. This summary is not intended to identify the key features or the scope of the claimed subject matter.

[0008] An aspect of the present disclosure relates to a method for managing one or more stale subscriptions from a network repository function (NRF) node. The method includes receiving, by a receiving unit of at least one network function (NF), a notification request from the NRF node, wherein the notification request comprises a uniform resource identifier (URI). The method further includes comparing, by an analysis unit of the at least one NF, the received URI of the notification request with an active URI stored in a database of the at least one NF. The method further includes

removing, by an execution unit of the at least one NF from the NRF node, the one or more stale subscriptions associated with the URI of the notification request in an event the received URI fails to match the active URI upon the comparison.

5 **[0009]** In an exemplary aspect of the present disclosure, the at least one network function comprises one of an authentication and management function (AMF) and a session management function (SMF).

10 **[0010]** In an exemplary aspect of the present disclosure, the at least one NF receives a notification from the NRF node in case of an occurrence of a change in the profile of a peer network function associated with an active subscription.

15 **[0011]** In an exemplary aspect of the present disclosure, the method further comprises transmitting, by a transmitting unit of the at least one NF, a notification acceptance response to NRF node after successful matching of the URI of the notification request with the active URI upon the comparison.

20 **[0012]** In an exemplary aspect of the present disclosure, the method further comprises receiving the notification request from the NRF node is performed upon transmission of a subscription request from the at least one NF to the NRF node.

25 **[0013]** In an exemplary aspect of the present disclosure, receiving the notification request from the NRF node is performed upon transmission of a subscription request from the at least one NF to the NRF node.

30 **[0014]** In an exemplary aspect of the present disclosure, the active URI of the at least one NF is a unique URI that is created each time the at least one NF restarts for each of the subscriptions with the NRF node.

30 **[0015]** Another aspect of the present disclosure relates to a system for managing one or more stale subscriptions in a network repository function (NRF) node. The system comprises a receiving unit of at least one network function (NF). The receiving unit is configured to receive a notification request from the NRF node, wherein the notification request comprises a uniform resource identifier (URI). The system further comprises an analysis unit connected to the at least one NF

connected at least with the receiving unit. The analysis unit is configured to compare the received URI of the notification request with an active URI stored in a database of the at least one NF. The system further comprises an execution unit connected to the at least one NF connected at least with the analysis unit, wherein the execution unit is configured to remove, from the NRF node, the one or more stale subscriptions associated with the URI of the notification request in an event the received URI fails to match the active URI upon the comparison.

[0016] Yet another aspect of the present disclosure may relate to a non-transitory computer readable storage medium storing instructions for managing one or more stale subscriptions in a network repository function (NRF) node, the instructions include executable code which, when executed by one or more units of a system, causes a receiving unit connected to at least one network function (NF), to receive a notification request from the NRF node, wherein the notification request comprises a uniform resource identifier (URI). The instruction when executed further causes an analysis unit connected to at least one network function (NF), to compare the received URI of the notification request with an active URI stored in a database of the at least one NF. The instructions when executed further causes an execution unit connected to at least one network function (NF), to remove, from the NRF node, the one or more stale subscriptions associated with the URI of the notification request in an event the received URI fails to match the active URI upon the comparison.

OBJECTS OF THE INVENTION

[0017] Some of the objects of the present disclosure, which at least one embodiment disclosed herein satisfies are listed herein below.

[0018] It is an object of the present disclosure to provide a system and a method for detection and removal of stale subscriptions from the NRF server.

[0019] It is yet another object of the present disclosure to provide a solution that reduces a number of notifications processed at a microservice providing server.

[0020] It is yet another object of the present disclosure to provide a solution that prevents the network from choking due to a high number of stale subscriptions.

DESCRIPTION OF THE DRAWINGS

[0021] 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. Also, the embodiments shown in the figures are not to be construed as limiting the disclosure, but the possible variants of the method and system according to the disclosure are illustrated herein to highlight the advantages of the disclosure. It will be appreciated by those skilled in the art that disclosure of such drawings includes disclosure of electrical components or circuitry commonly used to implement such components.

[0022] FIG. 1 illustrates an exemplary block diagram representation of 5th generation core (5GC) network architecture.

[0023] FIG. 2 illustrates an exemplary block diagram of a computing device upon which the features of the present disclosure may be implemented in accordance with exemplary implementation of the present disclosure.

[0024] FIG. 3 illustrates an exemplary block diagram of a system for managing one or more stale subscriptions, in accordance with exemplary implementations of the present disclosure.

[0025] FIG. 4 illustrates a method flow diagram for managing one or more stale subscriptions, in accordance with exemplary implementations of the present disclosure.

[0026] FIG. 5a illustrates a process flow diagram for managing one or more stale subscriptions, in accordance with exemplary implementations of the present disclosure.

[0027] FIG. 5b illustrates a process flow diagram for managing one or more stale subscriptions, in accordance with exemplary implementations of the present disclosure.

[0028] The foregoing shall be more apparent from the following more detailed description of the disclosure.

DETAILED DESCRIPTION

[0029] In the following description, for the purposes of explanation, various specific details are set forth in order to provide a thorough understanding of 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 may 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 problems discussed above.

[0030] 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 arrangement of elements without departing from the spirit and scope of the disclosure as set forth.

[0031] 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 specific details. For example, circuits, systems, processes, and other components may be shown as components in block diagram form in order not to obscure the embodiments in unnecessary detail.

[0032] Also, it is noted that individual embodiments may be described as a process which 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 may be performed in parallel or concurrently. In addition, the order of the operations may be re-arranged. A process is terminated when its operations are completed but could have additional steps not included in a figure.

[0033] 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—in a manner similar to the term “comprising” as an open transition word—without precluding any additional or other elements.

[0034] As used herein, a “processing unit” or “processor” or “operating processor” includes one or more processors, wherein processor refers to any logic circuitry for processing instructions. A 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 (Digital Signal Processing) 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 or processing unit is a hardware processor.

[0035] As used herein, “a user equipment”, “a user device”, “a smart-user-device”, “a smart-device”, “an electronic device”, “a mobile device”, “a handheld device”, “a wireless communication device”, “a mobile communication device”, “a communication device” may be any electrical, electronic and/or computing device or equipment, capable of implementing the features of the present disclosure. The user equipment/device may include, but is not limited to, a mobile phone, smart phone, laptop, a general-purpose computer, desktop, personal digital assistant, tablet computer, wearable device or any other computing device which is capable of implementing the features of the present disclosure. Also, the user device may contain at least one input means configured to receive an input from at least one of a transceiver unit, a processing unit, a storage unit, a detection unit and any other such unit(s) which are required to implement the features of the present disclosure.

[0036] As used herein, “storage unit” or “memory unit” refers to a machine or computer-readable medium including any mechanism for storing information in a form readable by a computer or similar machine. For example, a computer-readable medium includes read-only memory (“ROM”), random access memory (“RAM”), magnetic disk storage media, optical storage media, flash memory devices or other types of machine-accessible storage media. The

storage unit stores at least the data that may be required by one or more units of the system to perform their respective functions.

[0037] As used herein “interface” or “user interface” refers to a shared boundary across which two or more separate components of a system exchange information or data. The interface may also refer to a set of rules or protocols that define communication or interaction of one or more modules or one or more units with each other, which also includes the methods, functions, or procedures that may be called.

[0038] All modules, units, components used herein, unless explicitly excluded herein, may be software modules or hardware processors, the processors being a general-purpose processor, a special purpose processor, a conventional processor, a digital signal processor (DSP), a plurality of microprocessors, one or more microprocessors in association with a DSP core, a controller, a microcontroller, Application Specific Integrated Circuits (ASIC), Field Programmable Gate Array circuits (FPGA), any other type of integrated circuits, etc.

[0039] As used herein, the transceiver unit includes at least one receiver and at least one transmitter configured respectively for receiving and transmitting data, signals, information, or a combination thereof between units/components within the system and/or connected with the system.

[0040] As used herein, the Uniform Resource Identifier (URI) uniquely identifies an abstract or physical resource on the web. Internet protocols use these series of characters to pick apart multiple resources and enable interactions among them. The standard web address, the Uniform Resource Locator (URL), is one of the most well-known instances of URIs. It helps identify exact websites, though other URIs can identify images, electronic documents, and other resources. These resources do not necessarily connect to the Internet, either.

[0041] As discussed in the background section, the current known solutions have several shortcomings. The present disclosure aims to overcome the above-mentioned and other existing problems in this field of technology by providing a method and system for managing one or more stale subscriptions.

[0042] FIG. 1 illustrates an exemplary block diagram representation of 5th generation core (5GC) network architecture, in accordance with exemplary implementation of the present disclosure. As shown in FIG. 1, the 5GC network architecture [100] includes a user equipment (UE) [102], a radio access network (RAN) [104], an access and mobility management function (AMF) [106], a Session Management Function (SMF) [108], a Service Communication Proxy (SCP) [110], an Authentication Server Function (AUSF) [112], a Network Slice Specific Authentication and Authorization Function (NSSAAF) [114], a Network Slice Selection Function (NSSF) [116], a Network Exposure Function (NEF) [118], a Network Repository Function (NRF) [120], a Policy Control Function (PCF) [122], a Unified Data Management (UDM) [124], an application function (AF) [126], a User Plane Function (UPF) [128], a data network (DN) [130], wherein all the components are assumed to be connected to each other in a manner as obvious to the person skilled in the art for implementing features of the present disclosure.

[0043] Radio Access Network (RAN) [104] is the part of a mobile telecommunications system that connects user equipment (UE) [102] to the core network (CN) and provides access to different types of networks (e.g., 5G network). It consists of radio base stations and the radio access technologies that enable wireless communication.

[0044] Access and Mobility Management Function (AMF) [106] is a 5G core network function responsible for managing access and mobility aspects, such as UE registration, connection, and reachability. It also handles mobility management procedures like handovers and paging.

[0045] Session Management Function (SMF) [108] is a 5G core network function responsible for managing session-related aspects, such as establishing, modifying, and releasing sessions. It coordinates with the User Plane Function (UPF) for data forwarding and handles IP address allocation and QoS enforcement.

[0046] Service Communication Proxy (SCP) [110] is a network function in the 5G core network that facilitates communication between other network functions by providing a secure and efficient messaging service. It acts as a mediator for service-based interfaces.

[0047] Authentication Server Function (AUSF) [112] is a network function in the 5G core responsible for authenticating UEs during registration and providing security services. It generates and verifies authentication vectors and tokens.

5 **[0048]** Network Slice Specific Authentication and Authorization Function (NSSAAF) [114] is a network function that provides authentication and authorization services specific to network slices. It ensures that UEs can access only the slices for which they are authorized.

10 **[0049]** Network Slice Selection Function (NSSF) [116] is a network function responsible for selecting the appropriate network slice for a UE based on factors such as subscription, requested services, and network policies.

15 **[0050]** Network Exposure Function (NEF) [118] is a network function that exposes capabilities and services of the 5G network to external applications, enabling integration with third-party services and applications.

20 **[0051]** Network Repository Function (NRF) [120] is a network function that acts as a central repository for information about available network functions and services. It facilitates the discovery and dynamic registration of network functions.

[0052] Policy Control Function (PCF) [122] is a network function responsible for policy control decisions, such as QoS, charging, and access control, based on subscriber information and network policies.

25 **[0053]** Unified Data Management (UDM) [124] is a network function that centralizes the management of subscriber data, including authentication, authorization, and subscription information.

30 **[0054]** Application Function (AF) [126] is a network function that represents external applications interfacing with the 5G core network to access network capabilities and services.

[0055] User Plane Function (UPF) [128] is a network function responsible for handling user data traffic, including packet routing, forwarding, and QoS enforcement.

[0056] Data Network (DN) [130] refers to a network that provides data services to user equipment (UE) in a telecommunications system. The data services may include but are not limited to Internet services, private data network related services.

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[0057] FIG. 2 illustrates an exemplary block diagram of a computing device [200] (also referred to herein as computer system [200]) upon which the features of the present disclosure may be implemented in accordance with exemplary implementation of the present disclosure. In an implementation, the computing device [200] may also implement a method for managing one or more stale subscriptions utilising the system. In another implementation, the computing device
10 [200] itself implements the method for managing one or more stale subscriptions using one or more units configured within the computing device [200], wherein said one or more units are capable of implementing the features as disclosed in the present disclosure.

[0058] The computing device [200] may include a bus [202] or other communication mechanism for communicating information, and a hardware processor [204] coupled with bus [202] for processing information. The hardware processor [204] may be, for example, a general-purpose microprocessor. The computing device [200] may also include a main memory [206], such as a random-access memory (RAM), or other dynamic storage device, coupled to the bus
20 [202] for storing information and instructions to be executed by the processor [204]. The main memory [206] also may be used for storing temporary variables or other intermediate information during execution of the instructions to be executed by the processor [204]. Such instructions, when stored in non-transitory storage media accessible to the processor [204], render the computing device [200] into a special-purpose machine that is customized to perform the operations specified
25 in the instructions. The computing device [200] further includes a read only memory (ROM) [208] or other static storage device coupled to the bus [202] for storing static information and instructions for the processor [204].

[0059] A storage device [210], such as a magnetic disk, optical disk, or solid-state drive is
30 provided and coupled to the bus [202] for storing information and instructions. The computing device [200] may be coupled via the bus [202] to a display [212], such as a cathode ray tube (CRT), Liquid crystal Display (LCD), Light Emitting Diode (LED) display, Organic LED (OLED) display, etc. for displaying information to a computer user. An input device [214], including alphanumeric and other keys, touch screen input means, etc. may be coupled to the bus [202] for

communicating information and command selections to the processor [204]. Another type of user input device may be a cursor controller [216], such as a mouse, a trackball, or cursor direction keys, for communicating direction information and command selections to the processor [204], and for controlling cursor movement on the display [212]. This input device typically has two
5 degrees of freedom in two axes, a first axis (e.g., x) and a second axis (e.g., y), that allow the device to specify positions in a plane.

[0060] The computing device [200] may implement the techniques described herein using customized hard-wired logic, one or more ASICs or FPGAs, firmware, and/or program logic which
10 in combination with the computing device [200] causes or programs the computing device [200] to be a special-purpose machine. According to one implementation, the techniques herein are performed by the computing device [200] in response to the processor [204] executing one or more sequences of one or more instructions contained in the main memory [206]. Such instructions may be read into the main memory [206] from another storage medium, such as the storage device
15 [210]. Execution of the sequences of instructions contained in the main memory [206] causes the processor [204] to perform the process steps described herein. In alternative implementations of the present disclosure, hard-wired circuitry may be used in place of or in combination with software instructions.

[0061] The computing device [200] also may include a communication interface [218] coupled to the bus [202]. The communication interface [218] provides a two-way data communication coupling to a network link [220] that is connected to a local network [222]. For example, the communication interface [218] may be an integrated services digital network (ISDN) card, cable modem, satellite modem, or a modem to provide a data communication connection to
25 a corresponding type of telephone line. As another example, the communication interface [218] may be a local area network (LAN) card to provide a data communication connection to a compatible LAN. Wireless links may also be implemented. In any such implementation, the communication interface [218] sends and receives electrical, electromagnetic, or optical signals that carry digital data streams representing various types of information.

[0062] The computing device [200] can send messages and receive data, including program code, through the network(s), the network link [220] and the communication interface [218]. In the Internet example, a server [230] might transmit a requested code for an application program through the Internet [228], the ISP [226], the local network [222], host [224] and the
30

communication interface [218]. The received code may be executed by the processor [204] as it is received, and/or stored in the storage device [210], or other non-volatile storage for later execution.

[0063] The computing device [200] encompasses a wide range of electronic devices capable of processing data and performing computations. Examples of the computing device [200] include, but are not limited only to, personal computers, laptops, tablets, smartphones, servers, and embedded systems. The devices may operate independently or as part of a network and can perform a variety of tasks such as data storage, retrieval, and analysis. Additionally, the computing device [200] may include peripheral devices, such as monitors, keyboards, and printers, as well as integrated components within larger electronic systems, showcasing their versatility in various technological applications.

[0064] FIG. 3 illustrates an exemplary block diagram of a system [300] for managing one or more stale subscriptions, in accordance with the exemplary implementations of the present disclosure. The system [300] comprises at least one network function [300a], at least one receiving unit [302], at least one NRF node [304], at least one analysis unit [306], at least one database [308], at least one execution unit [310] and at least one transmitting unit [312]. Also, all of the components/ units of the system [300] are assumed to be connected to each other unless otherwise indicated below. As shown in the figures all units shown within the system should also be assumed to be connected to each other. Also, in FIG. 3 only a few units are shown, however, the system [300] may comprise multiple such units or the system [300] may comprise any such numbers of said units, as required to implement the features of the present disclosure. Further, in an implementation, the system [300] may be present in a user device to implement the features of the present disclosure. The system [300] may be a part of the user device / or may be independent of but in communication with the user device (may also referred herein as a UE). In another implementation, the system [300] may reside in a server or a network entity. In yet another implementation, the system [300] may reside partly in the server/ network entity and partly in the user device.

[0065] The system [300] is configured for managing one or more stale subscriptions, with the help of the interconnection between the components/units of the system [300].

[0066] The system [300] comprises a receiving unit [302] connected to at least one network function (NF) [300a]. The receiving unit [302] is configured to receive a notification request from

the NRF node [304], wherein the notification request comprises a uniform resource identifier (URI).

[0067] The receiving unit [302] connected to at least network function [300a] receives the notification request from the NRF node [304]. The notification request includes the uniform resource identifier (URI) that is related to a particular subscription. In an exemplary aspect, the notification request notifies the receiving unit [302] to identify which subscription needs to be checked for further processing, analysis, and removal of the stale subscriptions.

[0068] For example, the notification request may be received from a network function [300a] relating to a change in a current profile of the network function [300a]. The change in profile may include, without limitations, addition, or removal of instances associated with the network function [300a]. A record of an instance of the network function [300a] may be stored in the NRF node [304], and a notification of the corresponding change in the profile of the network function [300a] may be transmitted to the NRF node [304] to update the record. In some cases, another network function or microservice (such as, without limitations, an AMF [106], an SMF [108], etc.) may send a request to the NRF node [304] for information related to a record of the network function [300a]. However, if the request pertains to a network function [300a] whose profile is currently changed, there may be a mismatch between the request and the record of the subscription in the NRF node [304]. The present system [300] provides a means to overcome such a case, particularly, when the NRF node [304] may receive a plurality of such requests.

[0069] In an exemplary aspect, network function [300a] is connected to the system [300] and the NRF node [304].

[0070] In an exemplary aspect, the URI may include, without limitations, a unique identifier, metadata, and other information about the subscription, including details about the subscriber, the service or resource, and the status of the subscription. It is crucial for tracking, managing, and validating subscriptions within a network or service environment.

[0071] In an exemplary aspect, the at least one network function [300a] may also include policy control function (PCF) [122], unified data management (UDM) [124], etc. In an exemplary implementation, the at least one network function [300a] comprises one of an authentication and management function (AMF) [106] or a session management function (SMF) [108]. In an

exemplary aspect, the AMF [106] or the SMF [108] receives the notification request from the NRF node [304]. In an exemplary aspect, the network repository function (NRF) [120] provides information about available network functions and services. It facilitates the discovery and dynamic registration of network functions.

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[0072] In an exemplary aspect, the at least one NF [300a] receives a notification from the NRF node [304] in case of an occurrence of a change in a profile of a peer network function associated with an active subscription. In an exemplary aspect, the network function (NF) [300a] receives notifications from the NRF node [304] whenever there is a change in the profile of a peer network function associated with an active subscription. This ensures that the NF [300a] remains up to date with relevant changes, which is crucial for maintaining consistent and efficient network operations.

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[0073] In an exemplary aspect, the receiving unit [302] receives the notification request from the NRF node [304] upon transmission of a subscription request from the at least one NF [300a] to the NRF node [304].

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[0074] In an exemplary aspect, the network function (NF) [300a] transmits the subscription request to the NRF node [304], and in response, the receiving unit [302] of the NF [300a] receives a notification request from the NRF node [304]. This notification request acts as a follow-up to the subscription request and includes information regarding the subscription status or updates. This ensures that the network function (NF) [300a] is kept informed and can respond appropriately to changes or confirmations related to the subscription.

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[0075] The system [300] further comprises an analysis unit [306] of the at least one NF [300a] connected at least with the receiving unit [302]. The analysis unit [306] is configured to compare the received URI of the notification request with an active URI stored in a database [308] of the at least one NF [300a].

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[0076] The analysis unit [306] compares the received URI of the notification request that was sent by the NRF node [304] with an active URI stored in the database [308] connected to the at least one NF [300a]. In an exemplary aspect, the database [308] connected to the network function (NF) [300a] maintains a list of active URIs. These URIs represent subscriptions that are currently active or valid. By comparing the incoming URIs with the active URIs in the database [308], the

30

analysis unit [306] may identify which subscriptions are outdated and need to be addressed, thereby ensuring the NRF node [304] remains up-to-date and accurate.

[0077] In an exemplary aspect, the active URI of the at least one NF [300a] is a unique URI that is created each time the at least one NF [300a] restarts for each of the subscriptions with the NRF node [304]. The active URI stored in the database [308] is a unique identifier that is generated each time the NF [300a] restarts. This ensures that each subscription with the NRF node [304] is associated with a fresh, unique URI, which helps in maintaining accurate subscription records, avoiding conflicts, and enhancing the overall management of subscriptions.

[0078] The system [300] comprises a transmitting unit [312] connected to the at least one NF [300a] and to at least the analysis unit [306]. The transmitting unit [312] is configured to transmit a notification acceptance response to the NRF node [304] after successful matching of the URI of the notification request with the active URI upon the comparison.

[0079] After the analysis unit [306] confirms that the URI in a notification request matches an active URI in the database [308], the transmitting unit [312] sends a notification acceptance response to the NRF node [304]. This response indicates that the notification has been successfully processed and that the subscription associated with the URI is valid. This ensures accurate and reliable communication between the NF [300a] and the NRF node [304], supporting efficient subscription management.

[0080] In an exemplary aspect, if there is no match of the incoming URI from the NRF node [304] with an active URI stored in the database [308], the transmitting unit [312] sends a 404 error (Not Found) response to the NRF node [304] i.e. NRF [120], which then facilitates the removal of the stale subscription from its records. By avoiding the processing of stale notifications, the network function [300a] such as the AMF [106] and the (SMF) [108] experience lower computational resource overhead which prevents unnecessary growth of subscriptions.

[0081] The system [300] comprises an execution unit [310] connected to the at least one NF [300a], and to at least the analysis unit [306], and to the NRF node [304]. The execution unit [310] is configured to remove, from the NRF node [304], the one or more stale subscriptions associated with the URI of the notification request in an event the received URI fails to match the active URI upon the comparison.

[0082] In an embodiment, to remove the stale subscription in the NRF node [304], the transmitting unit [312] connected at least to the execution unit [310], in response to receiving the error response, is further configured to transmit a request to the NRF node [304] to remove the identified stale subscription. The execution unit [310] is further configured to delete the stale subscription in the NRF node [304]. Deletion of the stale subscription may include deleting a record of the identified stale subscription. In an embodiment, once the stale subscription is deleted, the transmitting unit [312] through the NRF node [304], may generate an acknowledgement indicative of successful deletion of the stale subscription.

[0083] In an exemplary aspect, after the analysis unit [306] compares the received URI from the NRF node [304] with the active URI stored in the database [308], the execution unit [310] removes the one or more stale subscriptions associated with the URI, in an event the received URI fails to match the active URI upon the comparison. This ensures that the network function [300a] operates more efficiently with fewer unnecessary notifications, leading to cleaner subscription records, which improves overall network efficiency.

[0084] FIG. 4 illustrates an exemplary flow diagram of a method [400] for managing one or more stale subscriptions, in accordance with exemplary implementations of the present disclosure is shown. In an implementation the method [400] is performed by the system [300]. Further, in an implementation, the system [300] may be present in a server device to implement the features of the present disclosure. Also, as shown in FIG. 4, the method [400] starts at step [402].

[0085] At step 404, the method [400] comprises receiving, by a receiving unit [302] connected to at least one network function (NF) [300a], a notification request from the NRF node [304], wherein the notification request comprises a uniform resource identifier (URI).

[0086] The receiving unit [302] connected to at least network function [300a] receives the notification request from the NRF node [304]. These requests include the uniform resource identifier (URI) that are related to a particular subscription. In an exemplary aspect, URI provides the necessary information to the receiving unit [302] for taking appropriate action on the subscription referenced by that said URI. In an exemplary aspect, these requests notify the receiving unit [302] to identify which subscriptions need to be checked for further processing, analysis, and removal of the stale subscriptions.

[0087] In an exemplary aspect, at least one network function [300a] comprises one of an authentication and management function (AMF) [106] or a session management function (SMF) [108]. In an exemplary aspect, the AMF [106] or the SMF [108] receives the notification request
5 from the NRF node [304].

[0088] In an exemplary aspect, the at least one NF [300a] receives a notification from the NRF node [304] in case of an occurrence of a change in the profile of a peer network function associated with an active subscription. In an exemplary aspect, the network function (NF) [300a]
10 receives notifications from the NRF node [304] whenever there is a change in the profile of a peer network function associated with an active subscription. This ensures that the NF [300a] remains up to date with relevant changes, which is crucial for maintaining consistent and efficient network operations.

[0089] The receiving the notification request from the NRF node [304] is performed upon transmission of a subscription request from the at least one NF [300a] to the NRF node [304].
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[0090] In an exemplary aspect, the network function (NF) [300a] transmits the subscription request to the NRF node [304], the receiving unit [302] of the NF [300a] receives a notification
20 request from the NRF node [304]. This notification request acts as a follow-up to the subscription request and includes crucial information regarding the subscription status or updates. This ensures that the network function (NF) [300a] is kept informed and can respond appropriately to changes or confirmations related to the subscription.

[0091] At step 406, the method [400] comprises comparing, by an analysis unit [306] connected to the at least one NF [300a], the received URI of the notification request with an active
25 URI stored in a database [308] connected to the at least one NF [300a].

[0092] The analysis unit [306] compares the received URI of the notification request that was
30 sent by the NRF node [304] with an active URI stored in the database [308] of the at least one NF [300a]. In an exemplary aspect, the database [308] within the network function (NF) [300a] maintains the list of active URIs. These URIs represent subscriptions that are currently active or valid. By comparing the incoming URIs with the active URIs in the database [308], the analysis

unit [306] may identify which subscriptions are outdated and need to be addressed, thereby ensuring the NRF node [304] remains up-to-date and accurate.

[0093] In an exemplary aspect, the active URI of the at least one NF [300a] is a unique URI that is created each time the at least one NF [300a] restarts for each of the subscriptions with the NRF node [304]. The active URI stored in the database [308] of the network function (NF) [300a] is a unique identifier that is generated each time the NF [300a] restarts. This ensures that each subscription with the NRF node [304] is associated with a fresh, unique URI, which helps in maintaining accurate subscription records, avoiding conflicts, and enhancing the overall management of subscriptions.

[0094] The method further comprises transmitting, by a transmitting unit [312] connected to the at least one NF [300a], a notification acceptance response to the NRF node [304] after successful matching of the URI of the notification request with the active URI upon the comparison.

[0095] After the analysis unit [306] confirms that the URI in a notification request matches an active URI in the database [308], the transmitting unit [312] sends a notification acceptance response to the NRF node [304]. This response indicates that the notification has been successfully processed and that the subscription associated with the URI is valid. This ensures accurate and reliable communication between the NF [300a] and the NRF node [304], supporting efficient subscription management.

[0096] In an exemplary aspect, if there is no match of the incoming URI from the NRF node [304] with an active URI stored in the database [308], the transmitting unit [312] sends a 404 error (Not Found) response to the NRF node i.e. NRF [120], which then facilitates the removal of the stale subscription from its records. By avoiding the processing of stale notifications, the network function [300a] such as the AMF [106] and the (SMF) [108] experience lower computational resource overhead which prevents unnecessary growth of subscriptions.

[0097] At step 408, the method [400] comprises removing, by an execution unit [310] connected to the at least one NRF [304], from the NRF node [304], the one or more stale subscriptions associated with the URI of the notification request in an event the received URI fails to match the active URI upon the comparison.

[0098] In an exemplary aspect, after the analysis unit [306] compares the received URI from the NRF node [304] with the active URI stored in the database [308], the execution unit [310] removes the one or more stale subscriptions associated with the URI of in an event the received
5 URI fails to match the active URI upon the comparison. This ensures that the network function [300a] operates more efficiently with fewer unnecessary notifications leading to cleaner subscription records, which improves overall network efficiency.

[0099] At step 410, the method [400] terminates.

10 [0100] FIGs. 5a and 5b illustrate an exemplary process flow diagrams [500a, 500b] for managing one or more stale subscriptions, in accordance with exemplary implementations of the present disclosure.

15 [0101] Referring to FIGs. 3, 5a, and 5b, at step S1, AMF [106]/SMF [108], sends a subscription request to the NRF [120].

[0102] At step S2, the NRF [120] sends back a subscription response to the AMF [106] /SMF [108].

20 [0103] At step S3, the AMF [106]/SMF [108] receives a notification request from the NRF [120]. In an exemplary aspect, the receiving unit [302] connected to at least network function [300a] (i.e., AMF [106] / SMF [108]) receives the notification request from the NRF [120]. The notification requests include a uniform resource identifier (URI) that is related to a particular
25 subscription of the network function [300a] in the NRF [120]. In an exemplary aspect, the URI provides the necessary information to the receiving unit [302] for taking appropriate action on the subscription referenced by that said URI. In an exemplary aspect, the notification request notifies the receiving unit [302] to identify which subscriptions need to be checked for further processing, analysis, and removal of the stale subscriptions.

30 [0104] In an exemplary aspect, the analysis unit [306] compares the received URI of notification request that was sent by the NRF [120] with an active URI stored in the database [308] connected to the at least one NF [300a]. In an exemplary aspect, the database [308] within the network function (NF) [300a] maintains the list of active URIs. These URIs represent subscriptions

that are currently active or valid. By comparing the incoming URIs with the active URIs in the database [308], the analysis unit [306] may identify which subscriptions are outdated and need to be addressed, thereby ensuring the NRF [120] remains up-to-date and accurate.

5 **[0105]** At step S4, the AMF [106]/SMF [108] sends back a notification response to the NRF [120]. After the analysis unit [306] confirms that the URI in the notification request matches an active URI in the database [308], the transmitting unit [312] sends a notification acceptance response to the NRF [120]. This response indicates that the notification has been successfully processed and the subscription associated with the URI is valid. This ensures accurate and reliable
10 communication between the NF [300a] and the NRF [120], supporting efficient subscription management.

[0106] In another embodiment, in an event that the analysis unit [306] determined that the URI in the notification request does not match with an active URI in the database [308], the
15 transmitting unit [312] is configured to send an error notification to the NRF [120]. This response indicated that the subscription is stale. In response to the invalid subscription, the execution unit [310] connected to the NRF [120] may facilitate removal of the stale subscription from the NRF [120].

20 **[0107]** The present disclosure further discloses a non-transitory computer readable storage medium storing instructions for detecting and removing one or more stale subscriptions at a network repository function node (NRF) node [304], the instructions include executable code which, when executed by one or more units of a system, causes: a receiving unit [302] connected to at least one network function (NF) [300a], to receive a notification request from the NRF node
25 [304] , wherein the notification request comprises a uniform resource identifier (URI). The instructions when executed further causes an analysis unit [306] connected to at least one network function (NF) [300a], to compare the received URI of the notification request with an active URI stored in a database [308] connected to the at least one NF [300a]. The instructions when executed further causes an execution unit [310] connected to at least one network function (NF) [300a], to
30 remove, from the NRF node [304], the one or more stale subscriptions associated with the URI of the notification request in an event the received URI fails to match the active URI upon the comparison.

[0108] As is evident from the above, the present disclosure provides a technically advanced solution for managing one or more stale subscriptions. The invention disclosed in the present disclosure reduces the number of stale subscriptions registered with the central NRF server. This results in reduced number of notifications dispatched by NRF server and reduced number of notifications processed at a microservice providing server, thereby reducing wastage of resources that would otherwise be spent on redundant activities. The invention disclosed in the present disclosure also prevents the network from choking due to a high number of stale subscriptions.

[0109] Further, in accordance with the present disclosure, it is to be acknowledged that the functionality described for the various components/units can be implemented interchangeably. While specific embodiments may disclose a particular functionality of these units for clarity, it is recognized that various configurations and combinations thereof are within the scope of the disclosure. The functionality of specific units as disclosed in the disclosure should not be construed as limiting the scope of the present disclosure. Consequently, alternative arrangements and substitutions of units, provided they achieve the intended functionality described herein, are considered to be encompassed within the scope of the present disclosure.

[0110] While considerable emphasis has been placed herein on the disclosed implementations, it will be appreciated that many implementations can be made and that many changes can be made to the implementations without departing from the principles of the present disclosure. These and other changes in the implementations of the present disclosure will be apparent to those skilled in the art, whereby it is to be understood that the foregoing descriptive matter to be implemented is illustrative and non-limiting.

We Claim:

1. A method for managing one or more stale subscriptions, the method comprising:
 - receiving, by a receiving unit [302] connected to at least one network function (NF) [300a],
5 a notification request from a network repository function (NRF) node [304], wherein the notification request comprises a uniform resource identifier (URI);
 - comparing, by an analysis unit [306] connected to the at least one NF [300a], the received URI of the notification request with an active URI stored in a database [308] connected to the at least one NF [300a];
 - 10 - removing, by an execution unit [310] connected at least to the one NRF node [304], from the NRF node [304], the one or more stale subscriptions associated with the URI of the notification request in an event the received URI fails to match the active URI upon the comparison.
- 15 2. The method as claimed in claim 1, wherein the at least one network function (NF) [300a] comprises one of an authentication and management function (AMF) [106] or a session management function (SMF) [108].
3. The method as claimed in claim 1, wherein the at least one NF [300a] receives a notification
20 from the NRF node [304] in case of an occurrence of a change in a profile of a peer network function [300a] associated with an active subscription.
4. The method as claimed in claim 1, wherein the method further comprises:
 - transmitting, by a transmitting unit [312] connected to the at least one NF [300a], a
25 notification acceptance response to the NRF node [304] after successful matching of the URI of the notification request with the active URI upon the comparison.
5. The method as claimed in claim 1, wherein receiving the notification request from the NRF
30 node [304] is performed upon transmission of a subscription request from the at least one NF [300a] to the NRF node [304].

6. The method as claimed in claim 1, wherein the active URI of the at least one NF [300a] is a unique URI that is created each time the at least one NF [300a] restarts for each of the subscriptions with the NRF node [304].
- 5 7. A system for managing one or more stale subscriptions, the system comprising:
- a receiving unit [302] connected to at least one network function (NF) [300a], the receiving unit [302] is configured to:
 - o receive a notification request from a network repository function (NRF) node [304], wherein the notification request comprises a uniform resource identifier (URI);
 - 10 - an analysis unit [306] connected to the at least one NF [300a] and at least with the receiving unit [302], wherein the analysis unit [306] is configured to:
 - o compare the received URI of the notification request with an active URI stored in a database [308] connected to the at least one NF [300a];
 - an execution unit [310] connected at least to the one NRF node [304] and at least with
15 the analysis unit [306], wherein the execution unit [310] is configured to:
 - o remove, from the NRF node [304], the one or more stale subscriptions associated with the URI of the notification request in an event the received URI fails to match the active URI upon the comparison.
- 20 8. The system as claimed in claim 7, wherein the at least one network function [300a] comprises one of an authentication and management function (AMF) [106] or a session management function (SMF) [108].
9. The system as claimed in claim 7, wherein the at least one NF [300a] receives a notification
25 from the NRF node [304] in case of an occurrence of a change in a profile of a peer network function associated with an active subscription.
10. The system as claimed in claim 7 further comprises a transmitting unit [312] connected to
30 the at least one NF [300a] connected at least with the analysis unit [306], the transmitting unit [312] is configured to transmit a notification acceptance response to the NRF node [304] after successful matching of the URI of the notification request with the active URI upon the comparison.

11. The system as claimed in claim 7, wherein the receiving unit [302] receives the notification request from the NRF node [304] upon transmission of a subscription request from the at least one NF [300a] to the NRF node [304].

5 12. The system as claimed in claim 7, wherein the active URI of the at least one NF [300a] is a unique URI that is created each time the at least one NF [300a] restarts for each of the subscriptions with the NRF node [304].

10 13. A non-transitory computer-readable storage medium, storing instructions for managing one or more stale subscriptions, the storage medium comprising executable code which, when executed by one or more units of a system, causes:

- a receiving unit [302] connected to at least one network function (NF) [300a], to receive a notification request from a network repository function (NRF) node [304], wherein the notification request comprises a uniform resource identifier (URI);
- 15 - an analysis unit [306] to compare the received URI of the notification request with an active URI stored in a database [308] connected to the at least one NF [300a];
- an execution unit [310] to remove, from the NRF node [304], the one or more stale subscriptions associated with the URI of the notification request in an event the received URI fails to match the active URI upon the comparison.

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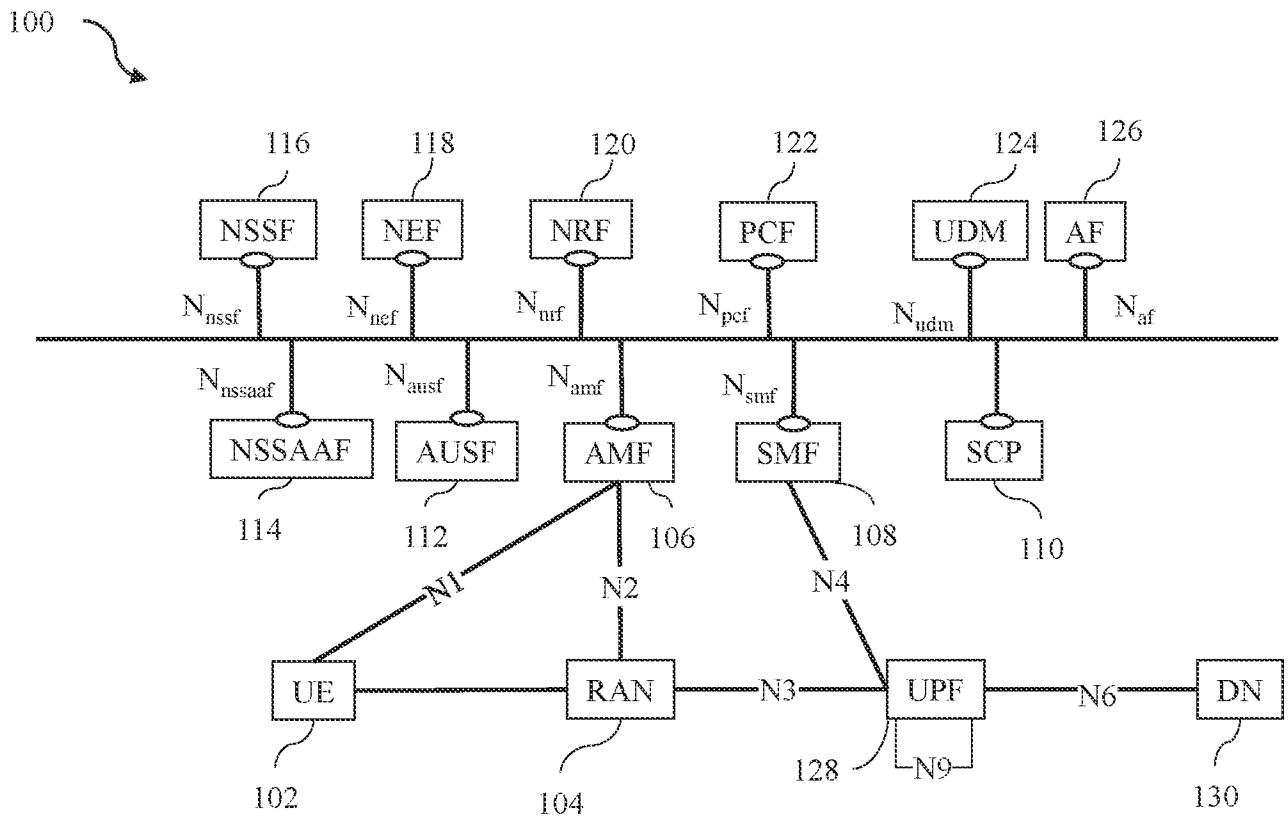


FIG. 1

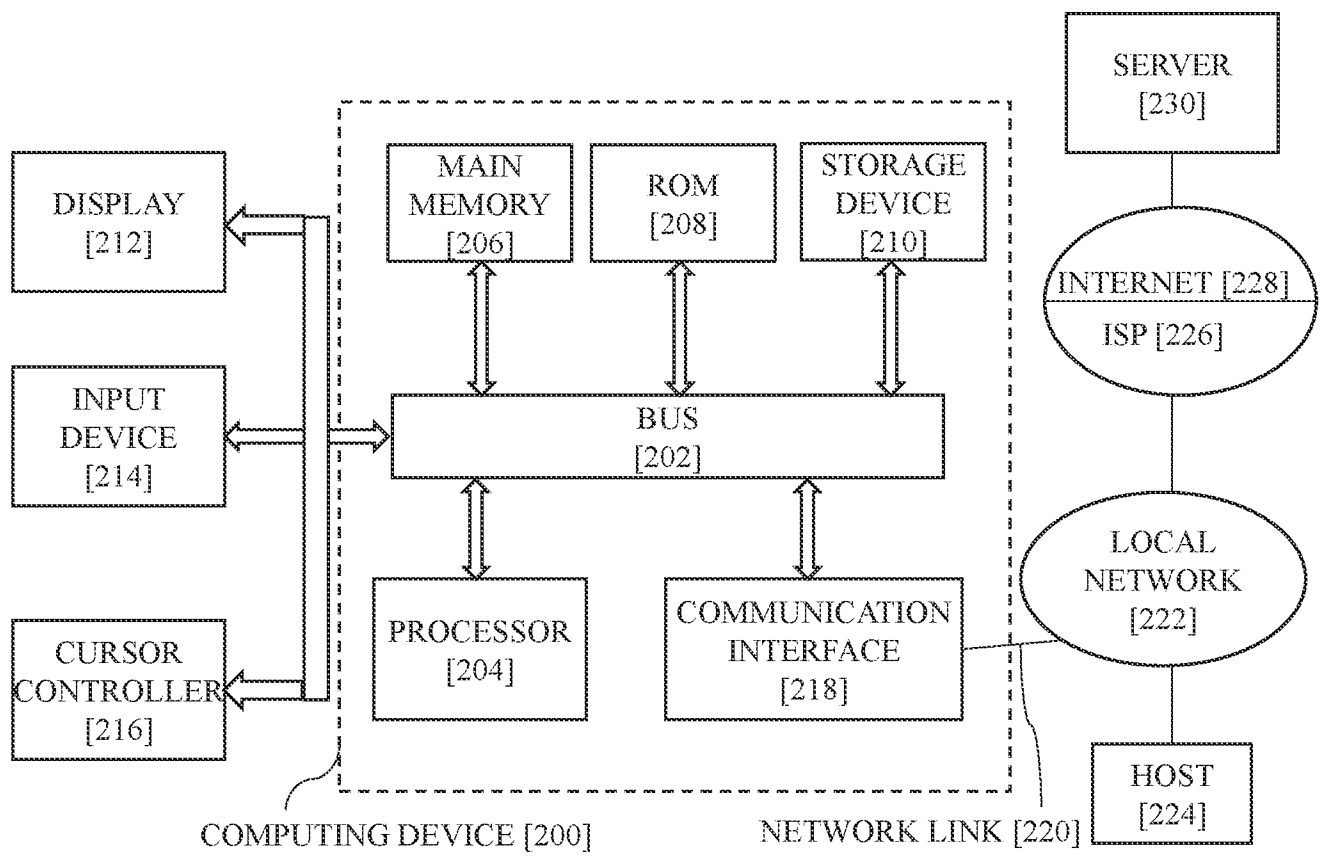


FIG. 2

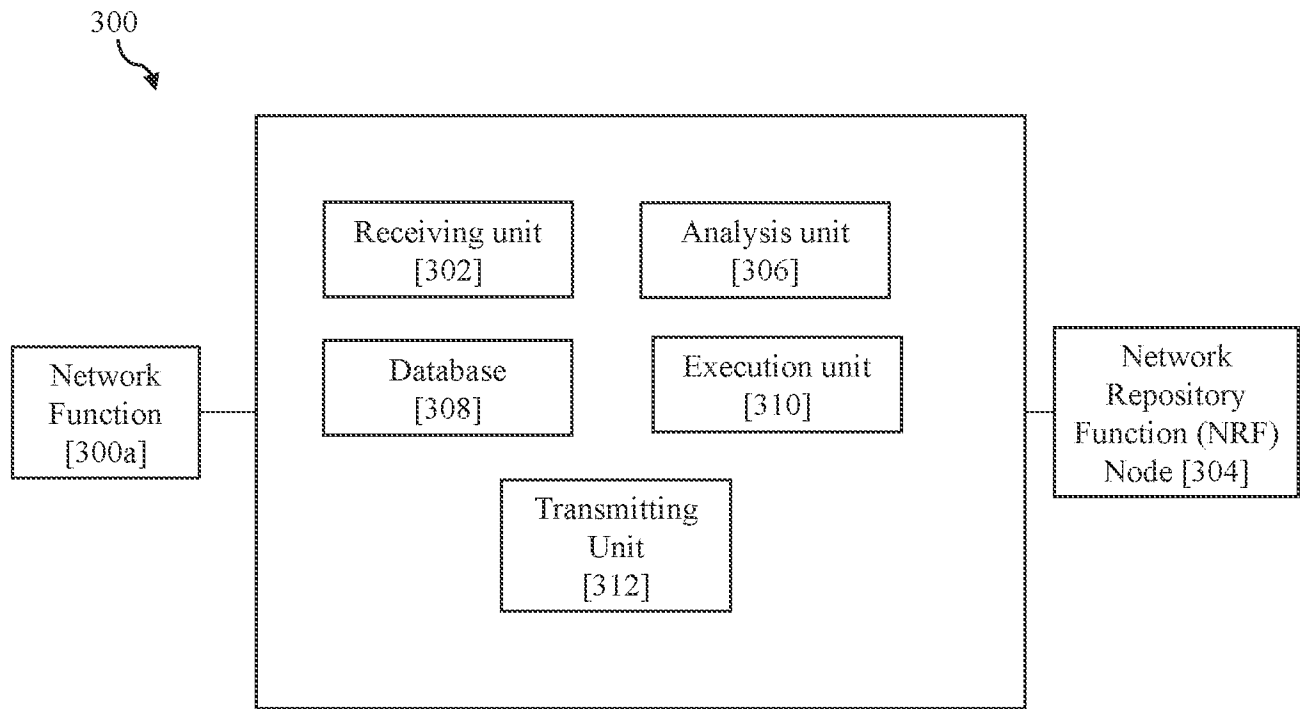


FIG. 3

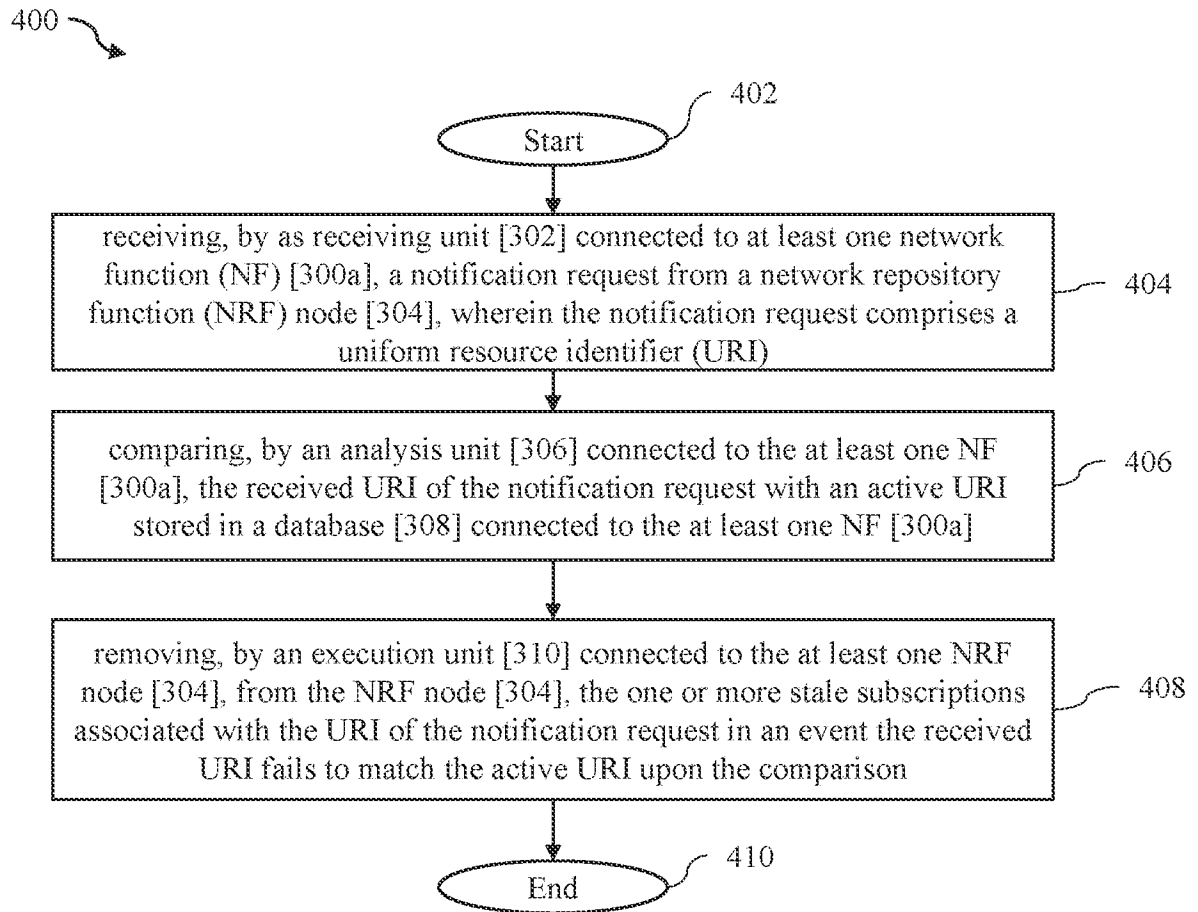


FIG. 4

500a

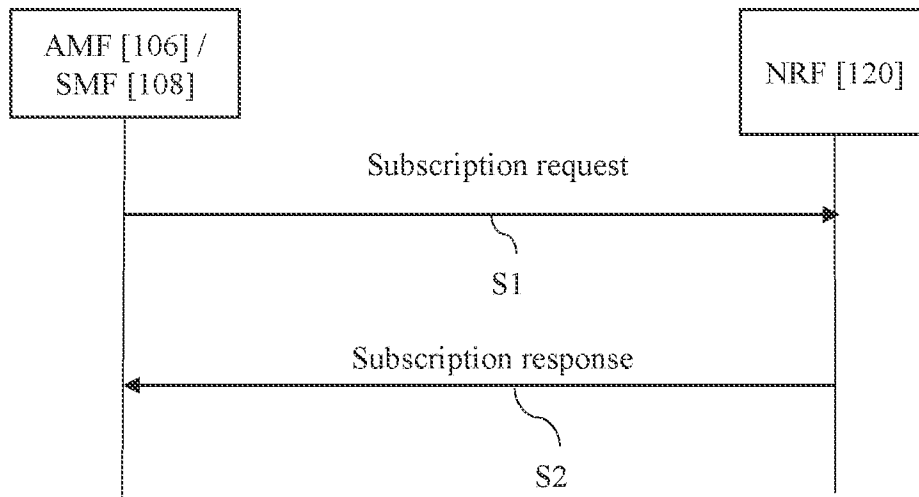


FIG. 5a

500b →

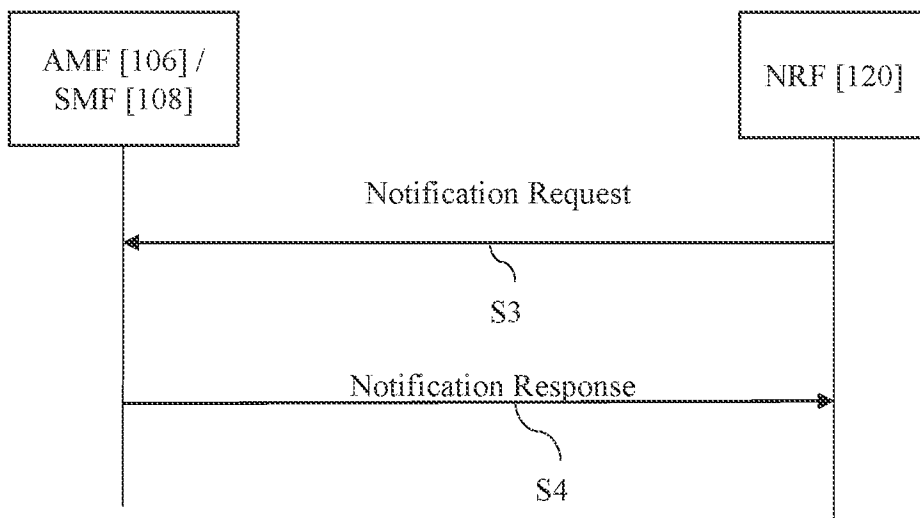


FIG. 5b

INTERNATIONAL SEARCH REPORT

International application No.

PCT/IN2024/051589

A. CLASSIFICATION OF SUBJECT MATTER

H04W8/18, H04L67/51, H04W8/20 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, Keywords (Synonyms): NF, NRF, URI, Subscription, compare, active, stale, removes, fail, match, AMF, SMF

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO2023131495A1 (TELEFONAKTIEBOLAGET LM ERICSSON (PUBL)) 13 JULY 2023 (13-07-2023) Abstract, Page no. 2, Claims 1, 15-17	1-13
Y	WO2020108507A1 (HUAWEI TECHNOLOGIES CO LTD) 04 JUNE 2020 (04-06-2020) (English Translation Copy from Google Patents) Abstract, Description, Fig. 2	1-13
Y	JP2023512957A (TELEFONAKTIEBOLAGET LM ERICSSON AB) 30 MARCH 2023 (30-03-2023) (English Translation Copy from Google Patents) Abstract, Paragraph no. [0014], [0032], [0134], [0152], Claims 5-6, 17	1-13



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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"E" earlier application or patent but published on or after the international filing date

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

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

"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

20-12-2024

Date of mailing of the international search report

20-12-2024

Name and mailing address of the ISA/

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IN2024/051589

Citation	Pub.Date	Family	Pub.Date
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WO 2020108507 A1	04-06-2020	CN 111263409 A	09-06-2020
		EP 3843341 A1	30-06-2021
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		EP 4104470 A1	21-12-2022
		CN 115152256 A	04-10-2022
		WO 2021160547 A1	19-08-2021
		US 20230080510 A1	16-03-2023