



(51) International Patent Classification:

H04L 67/56 (2022.01) H04L 65/1045 (2022.01)
H04L 65/1016 (2022.01) H04L 65/1069 (2022.01)

(21) International Application Number:

PCT/IN2024/050961

(22) International Filing Date:

27 June 2024 (27.06.2024)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

202321045200 05 July 2023 (05.07.2023) IN

(71) Applicant: **JIO PLATFORMS LIMITED** [IN/IN]; Of-
fice-101, Saffron, Nr. Centre Point, Panchwati 5 Rasta, Am-
bawadi, Gujarat, Ahmedabad 380006 (IN).

(72) Inventors: **BHATNAGAR, Aayush**; Office-101, Saffron,
Nr. Centre Point, Panchwati 5 Rasta, Ambawadi, Gujarat,
Ahmedabad 380006 (IN). **JHA, Adityakar**; Office-101,
Saffron, Nr. Centre Point, Panchwati 5 Rasta, Ambawa-

di, Gujarat, Ahmedabad 380006 (IN). **SHAHID, Moham-
mad**; Office-101, Saffron, Nr. Centre Point, Panchwati 5
Rasta, Ambawadi, Gujarat, Ahmedabad 380006 (IN). **KU-
MAR, Ravi**; Office-101, Saffron, Nr. Centre Point, Panch-
wati 5 Rasta, Ambawadi, Gujarat, Ahmedabad 380006 (IN).
SENGUPTA, Swarup; Office-101, Saffron, Nr. Centre
Point, Panchwati 5 Rasta, Ambawadi, Gujarat, Ahmed-
abad 380006 (IN). **SHARMA, Vishal**; Office-101, Saffron,
Nr. Centre Point, Panchwati 5 Rasta, Ambawadi, Gujarat,
Ahmedabad 380006 (IN). **VASHISHTH, Yog**; Office-101,
Saffron, Nr. Centre Point, Panchwati 5 Rasta, Ambawadi,
Gujarat, Ahmedabad 380006 (IN).

(74) Agent: **JAPHET, Chinthan**; K Law (Krishnamurthy and
Co.), 4th Floor, Prestige Takt, No 23, Kasturba Road Cross,
Bangalore, Bangalore 560 001 (IN).

(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,

(54) Title: METHOD AND SYSTEM OF IMPLEMENTING A PROXY FOR COMMUNICATION BETWEEN DIFFERENT COM-
PONENTS IN A 5G CORE NODE

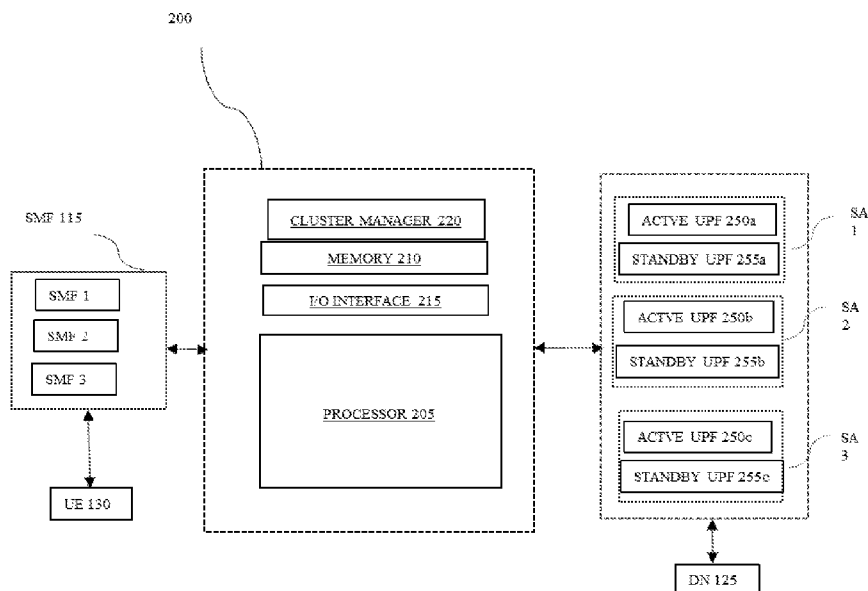


FIG. 2B

(57) Abstract: The present disclosure relates to a system (200) and a method (500) for implementing a proxy (225) between the 5G core nodes. The system (200) is configured to introduce the proxy (225) for masking the internal architecture of the User Plane Function (UPF) from other peer nodes. Thereby, the system (200) minimizes vulnerability of the UPF and handles the session management in an efficient manner. The method (500) includes various steps for implementing a proxy (225) between the 5G core nodes executed by the system (200).



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, 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))*

METHOD AND SYSTEM OF IMPLEMENTING A PROXY FOR
COMMUNICATION BETWEEN DIFFERENT COMPONENTS IN A 5G CORE
NODE

FIELD OF THE INVENTION

[0001] The present disclosure relates to network communication, and more particularly relates to a system and a method for implementing a proxy for communication between different components in a core node of a network.

BACKGROUND OF THE INVENTION

[0002] With increased consumer numbers, advancements in telecommunication networking are coming rapidly. To cater requirements, the network policies are ever changing. The 5G core node integration to provide better service is a part of this change. The 5G communication network architecture plays a crucial role which is a cluster architecture including a user plane and a control plane. The network architecture is a specific arrangement of various network components, in control plane and user plane, in order to regulate how data-packets from plurality of user devices will flow to the data network (DN) through an access network such as radio access network or a local access network etc.

[0003] In modern telecommunication networks, one of the crucial components in user plane is a User Plane Function (UPF) that plays a crucial role in packet processing and traffic management. The UPF is a key component of the Core Network defined by the 3rd Generation Partnership Project (3GPP). The 3GPP (Third Generation Partnership Project) is an international standards organization responsible for developing specifications for mobile communication systems. These specifications define the architecture, protocols, and functionalities of the mobile network infrastructure.

[0004] The UPF is responsible for processing user traffic in the Core Network based on signaling received over an N4 interface. As per 3GPP standard, the N4 interface facilitates communication between the UPF and the Session Management Function (SMF). The UPF performs various functions, including traffic classification, forwarding, quality of service enforcement, and usage reporting. Apart from the gateway user-plane functionality, an operator deploys an array of services in the user plane.

[0005] For optimal performance and reliable operation, various aspects, such as scalability, fault tolerance, FCAPS (Fault, Configuration, Accounting, Performance, and Security) functionality, as well as load balancing of PFCP (Packet Forwarding Control Protocol) session creation requests, are crucial.

[0006] Scale-in/Scale-out of the UPF DP Cluster: Conventionally, scaling the UPF Data Plane (DP) cluster to accommodate changing traffic demands has been a complex and resource-intensive process. The PFCP proxy enables seamless scale-in and scale-out of the UPF DP cluster based on real-time traffic requirements. By dynamically allocating and de-allocating resources, the system ensures optimal resource utilization and improved network performance.

[0007] Fault Tolerance of UPF DP Nodes: In the event of node failures within the UPF DP cluster, maintaining uninterrupted service and preventing data loss are paramount. The PFCP Proxy serves as a resilient intermediary that actively monitors the health and availability of UPF DP nodes. By leveraging fault tolerance mechanisms, such as redundancy and failover techniques, the system provides seamless failover and recovery capabilities, ensuring minimal disruption to network operations.

[0008] User Equipment (UE) Internet Protocol (IP) Allocation and Tunnel ID Allocation: Efficient and dynamic allocation of IP addresses and tunnel identifiers is crucial for managing network resources effectively. The PFCP Proxy acts as a central

authority that facilitates the allocation of unique IP addresses to User Equipment (UE) and assigns tunnel IDs to establish secure communication channels between the UE and the network infrastructure. This streamlined process enhances scalability and reduces overhead while providing secure and reliable connectivity to end-users.

[0009] FCAPS Functionality: The PFCP Proxy incorporates advanced FCAPS functionality, encompassing Fault Management, Configuration Management, Accounting Management, Performance Management, and Security Management. These comprehensive capabilities enable efficient monitoring, configuration, accounting, performance analysis, and security enforcement within the UPF DP cluster. By centralizing these management functions, the system simplifies network administration and enhances the overall performance and security of the network infrastructure.

[0010] Load Balancing of PFCP Session Creation Requests: To distribute PFCP session creation requests evenly across the UPF DP cluster, load balancing is imperative. The PFCP Proxy dynamically distributes these requests based on factors such as resource availability and load conditions. By optimizing the load distribution, the system ensures efficient resource utilization, minimizes response times, and enhances the overall user experience. The cluster architecture of the UPF is completely transparent to peer nodes, for example, to a Session Management Function (SMF). In the cluster architecture of UPF, there are active UPF instances and hot standby UPF instances. The hot standby UPF instance (if available) takes up the active role whenever an active UPF instance of a Service Availability (SA) Group fails (crashes/server restart etc.). Moreover, this failover procedure is transparent to the peer node i.e. SMF due to which there is minimal impact to the signaling/data traffic of the end user. When the failed node rejoins the cluster and it gets the hot standby role from cluster manager (CM), the proxy will restore the session context information on it so that it may take up the active role in future if the need arises. Therefore, it is required to implement a proxy component which will undertake the tasks other than processing of data packets.

[0011] Therefore, there is a need for a system and method configured to implement a proxy for communication between different components in a 5G core node of the network to improve operational efficiency and service quality.

BRIEF SUMMARY OF THE INVENTION

[0012] One or more embodiments of the present disclosure provide a system and a method for implementing a proxy for communication between different components in a 5G core node.

[0013] In one aspect of the present invention, a system for implementing a proxy for communication between different components in a 5G core node is disclosed. The system includes a masking module which is configured to mask a plurality of Session Management Functions (SMFs) from a plurality of User Plane Function (UPF) data plane instances by including a proxy component between the plurality of SMFs and the plurality of UPF data plane instances. The proxy component includes an active proxy instance and a plurality of standby proxy instances. The system further includes a synchronization module. The synchronization module is configured to sync the active proxy instance with the plurality of standby proxy instances of the proxy component. The system includes a transmission module that is configured to transmit at least one session initiated by at least one SMF to the active proxy instance. The system further includes a forwarding module configured to forward the at least one session from the at least one active proxy instance to the at least one UPF data plane instance to process the at least one session.

[0014] In an embodiment, for masking the plurality of SMFs from the plurality of UPF data plane instances, the masking module of the system is configured to terminate a first interface originating from the plurality of SMFs at the proxy component and terminate a second interface originating from the proxy component at the plurality of UPF data plane instances. The system includes the plurality of SMFs which are masked by the plurality of UPF data plane instances and allows horizontal scale up and scale down and transparent failovers of UPF data plane instances and allows horizontal scale up and scale down and transparent failovers of UPF data plane

instances, by masking the plurality of SMFs from the plurality of UPF data plane instances. The horizontal scale up includes adding at least one new UPF data plane instance to the existing plurality of UPF data plane instances. The horizontal scale down includes removing at least one UPF data plane instance from the existing plurality of UPF data plane instances.

[0015] In an embodiment, for syncing the active proxy instance with the plurality of standby proxy instances, the synchronization module of the system is configured to update the plurality of standby proxy instances with context of the at least one session initiated by the at least one SMF with the active proxy instance. The synchronization module is further configured to update the plurality of standby UPF data plane instances with context of the at least one session initiated by the at least one SMF with the active proxy instance, to process the at least one session. The synchronization module of the system is further configured to assign an active state to the proxy instance registered first with a cluster manager and assigns a standby state to the remaining plurality of proxy instances registered with the cluster manager.

[0016] In an embodiment, for transmitting the at least one session initiated by the at least one SMF, the transmission module of the system is configured to check information pertaining to whitelisted SMFs from the plurality of SMFs. The transmission module of the system is further configured to transmit the at least one session initiated by the at least one whitelisted SMF to the active proxy instance, in order to transmit the at least one session initiated by the at least one SMF.

[0017] In an embodiment, for forwarding the at least one session from the at least one active proxy instance to the at least one UPF data plane instance to process the at least one session, the forwarding module of the system is further configured to forward the at least one session to the at least one standby UPF data plane instance.

[0018] In an embodiment, the system is further configured to replace in real time, the active proxy instance with at least one standby proxy instance upon detecting failure of the active proxy instance to complete processing the at least one session. The active proxy instance is replaced with at least one standby proxy instance upon detecting failure of the active proxy instance to complete processing the at least one

session, based on synced active proxy instance with the at least one standby proxy instance. The system is further configured to provide one or more control plane rules transmitted by the at least one SMF to the active proxy instance, to the at least one UPF data plane instance.

[0019] In an embodiment, the system is further configured to pre-allocate the at least one session to a unique Internet Protocol Version 6 (IPV6) address, as per configured IP pools. The system is further configured to monitor rate-limit of incoming traffic to the at least one active proxy instance from the at least one whitelisted SMF. The system is configured to indicate current load/overload level to the whitelisted SMFs via one of a Load Control Information (LCI) and an Overload Control Information (OCI) Information Element (IE). The system is configured to create or delete associations with one of the active UPF data plane instances and the standby data plane instances. The system is configured to balance the load by delegating incoming session establishment requests to the UPF data plane instances. The system is configured to modify local session context upon receiving session modification/session deletion requests from the whitelisted SMFs. The system is further configured to maintain session context version number pertaining to the UPF data plane instance as well as to delete local session context and retrieve the session context stored at the whitelisted SMFs deleted via Session Reporting Rules (SRR), in case of version mismatch reported by the UPF data plane instances via a proprietary error cause.

[0020] In another aspect of the present invention, a method for implementing a proxy for communication between different components in a 5G core node is disclosed. The method includes the step of masking by one or more processors a plurality of Session Management Functions (SMFs) from a plurality of User Plane Function (UPF) data plane instances by including a proxy component between the plurality of SMFs and the plurality of UPF data plane instances. The proxy component includes an active proxy instance and a plurality of standby proxy instances. The method includes the step of syncing by the one or more processors the active proxy instance with the plurality of standby proxy instances. The method further includes the step of transmitting by the one or more processors at least one session initiated by at

least one SMF to the active proxy instance. Thereafter the method includes the step of forwarding by the one or more processors the at least one session from the at least one active proxy instance to the at least one UPF data plane instance to process the at least one session.

[0021] In an embodiment, for masking the plurality of SMFs from the plurality of UPF data plane instances, the method includes the step of terminating by the one or more processors a first interface originating from the plurality of SMFs at the proxy component and a second interface originating from the proxy component at the plurality of UPF data plane instances. The proxy component is at least one of a Packet Forwarding Control Protocol (PFCP). The plurality of SMFs is masked by the plurality of UPF data plane instances and allows horizontal scale up and scale down and transparent failovers of UPF data plane instances. The horizontal scale up includes adding at least one new UPF data plane instance to the existing plurality of UPF data plane instances. The horizontal scale down includes removing at least one UPF data plane instance from the existing plurality of UPF data plane instances.

[0022] In an embodiment, for syncing the active proxy instance with the plurality of standby proxy instances, the method includes the step of updating by the one or more processors, the plurality of standby proxy instances with context of the at least one session initiated by the at least one SMF with the active proxy instance and the plurality of standby UPF data plane instances with context of the at least one session initiated by the at least one SMF with the active proxy instance, to process the at least one session. In an embodiment, the method includes step of assigning an active state to the proxy instance registered first with a cluster manager and assigns a standby state to the remaining plurality of proxy instances registered with the cluster manager, executed by the one or more processors. In an embodiment, the method further includes the step of replacing in real time by the one or more processors the active proxy instance with at least one standby proxy instance upon detecting failure of the active proxy instance to complete processing the at least one session. The method further comprises the step of providing by the one or more processors one or more control plane rules transmitted by the at least one SMF to the active proxy instance, to

the at least one UPF data plane instance. The active proxy instance is replaced with at least one standby proxy instance upon detecting failure of the active proxy instance to complete processing the at least one session, based on synced active proxy instance with the at least one standby proxy instance. In an embodiment, for forwarding the at least one session from the at least one active proxy instance to the at least one UPF data plane instance to process the at least one session, the method further includes the step of forwarding by the one or more processors, the at least one session to the at least one standby UPF data plane instance.

[0023] In an embodiment, for transmitting the at least one session initiated by at least one SMF, the method includes the steps of checking by the one or more processors, information pertaining to whitelisted SMFs from the plurality of SMFs and thereafter transmitting by the one or more processors, the at least one session initiated by the at least one whitelisted SMF to the active proxy instance.

[0024] In an embodiment, the method further includes the step of pre-allocating by the one or more processors, the at least one session to a unique Internet Protocol Version 6 (IPV6) address, as per configured IP pools. The method further includes the step of monitoring by the one or more processors, rate-limit of incoming traffic to the at least one active proxy instance from the at least one whitelisted SMF. The method further includes the step of indicating by the one or more processors, current load/overload level to the whitelisted SMFs via one of a Load Control Information (LCI) and an Overload Control Information (OCI) Information Element (IE). The method further includes the step of creating or deleting by the one or more processors associations with one of, active UPF data plane instances and standby data plane instances. The method further includes the step of load balancing by the one or more processors, incoming session establishment requests to the UPF data plane instances. The method further includes the step of modifying by the one or more processors, local session context upon receiving session modification/session deletion requests from the whitelisted SMFs. The method further includes the step of maintaining, by the one or more processors, session context version number pertaining to the UPF data plane instances. The method further includes the step of deleting by the one or more

processors, local session context and retrieve the session context stored at the whitelisted SMFs deleted via Session Reporting Rules (SRR), in case of version mismatch reported by the UPF data plane instances via a proprietary error cause.

[0025] 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

[0026] 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.

[0027] FIG. 1A is an exemplary 5G network architecture including 5G core nodes, according to various embodiments of the present invention;

[0028] FIG. 1B is an exemplary block diagram of an environment for implementing a proxy for communication between different components in a 5G core node, according to various embodiments of the present invention;

[0029] FIG. 2 is a block diagram of the system for implementing the proxy for communication between different components in a 5G core node, according to various embodiments of the present invention;

[0030] FIG. 3A is a schematic representation of the system of FIG. 1 for implementing the proxy for communication between different components in a 5G core node, according to various embodiments of the present invention;

[0031] FIG. 3B is a schematic representation of the system of FIG. 1 for implementing the proxy for communication between different components in a 5G core node, according to various embodiments of the present invention;

[0032] FIG. 4 shows of a schematic representation of the system of FIG. 1 for implementing the proxy for communication between different components in a 5G core node, according to various embodiments of the present invention;

[0033] FIG. 5 shows a flow diagram of a method for implementing the proxy for communication between different components in a 5G core node, according to various embodiments of the present invention; and

[0034] FIG. 6 shows a flow diagram of a method for masking a plurality of SMFs from UPF data-plane instances by utilizing the proxy, according to various embodiments of the present invention.

[0035] The foregoing shall be more apparent from the following detailed description of the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0036] 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.

[0037] 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.

[0038] 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.

[0039] As per various embodiments depicted, the present invention discloses a system and a method for implementing a proxy component for providing a masked communication between different core nodes in a 5G network architecture. The 5G core nodes are arranged in a control plane and a user plane of the 5G network architecture and are responsible for connecting a user device to a data network. The system and method is further intended for implementing the proxy that will mask the control plane core node from the user plane core node, more particularly to mask a plurality of Session Management Function (SMF) from User Plane Function (UPF) data-plane instances by utilizing the proxy. Further, the system and method are directed towards transmitting at least one session initiated by at least one SMF to the UPF data-plane instances by utilizing the proxy.

[0040] As per various embodiments described, the system and method aids in masking an internal cluster architecture of the UPF from peer nodes such as the SMF. As the internal cluster architecture of the UPF is completely transparent, utilizing the proxy component which is based on a Packet Forwarding Control Protocol (PFCP) is preferable. The PFCP refers to a protocol which enables communication between the

control plane and the user plane core nodes in the 5G network architecture. The PCF proxy abstracts the underlying data plane instances from the SMF and also undertakes non-packet processing tasks from the UPF.

[0041] FIG. 1A illustrates an exemplary 5G network architecture 100 including a plurality of 5G core nodes, according to various embodiments of the present invention. The illustrated 5G network architecture 100 is a cluster network architecture including a control plane and a user plane. The exemplary 5G network architecture 100 as illustrated in FIG.1A, includes the plurality of 5G core nodes such as but limited to, an Access and Mobility Management Function (AMF) 110, an Authentication Server Function (AUSF) 140, a Session Management Function (SMF) 115, a Network Slice Selection Function (NSSF) 145, a Network Exposure Function (NEF) 150, a NF (Network Functions) Repository Function (NRF) 155, a Policy Control function (PCF) 160, a Unified Data Management (UDM) 165, an Application Function (AF) 170, and a User plane Function (UPF) 120. The 5G core nodes are arranged in the control plane and the user plane of the 5G network architecture 100.

[0042] The 5G network architecture 100 also includes a data network 125 and a User Equipment (UE) 130. The UE 130 is connected to the data network 125 via the 5G core nodes.

[0043] In an embodiment, the UE 130 is one of, but not limited to, a wireless device including, by the way of example not limitation, a handheld wireless communication device (such as a mobile phone, a smart phone, and a phablet device), a wearable computer device (such as a head-mounted display computer device, a head-mounted camera device, and a wristwatch computer device), a Global Positioning System (GPS) device, a laptop computer, a tablet computer, or another type of portable computer, a media playing device, a portable gaming system, and/or any other type of computer device with wireless communication capabilities.

[0044] In an embodiment, UE 130 further includes one or more applications. The one or more applications are configured to interact with the data network 125 for executing activities such as, but not limited to, exchanging data-packets between the UE 130 and the data network 125.

[0045] The data network 125 is at least one 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.

[0046] The data network 125 includes, but is not limited to, a Third Generation (3G), a Fourth Generation (4G), a Fifth Generation (5G), a Sixth Generation (6G), and the like, which are capable of providing internet-based services to the UE 130.

[0047] The data network 125 further includes 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.

[0048] In an embodiment, the AMF 110 is configured to receive requests from the UE 130 to connect the UE 130 to the data network 125. The AMF 110 is configured to connect the UE 130 to the data network 125 via an access network 135 utilizing a N2 interface. The AMF 110 is further communicably coupled to the UE 130 directly via an N1 interface.

[0049] In an embodiment, the N2 interface supports control plane signaling to establish a communication in between the access network 135 and 5G core nodes such as AMF 110. The N2 interface is configured to transmit information pertaining to the UE 130 to the AMF 110. The N2 interface uses Stream Control Transmission Protocol (SCTP) to transport information pertaining to the UE 130 to the AMF 110. The N2 interface serves as a medium of communication between the access network 135 and the AMF 110. The N1 interface is configured to transmit non-radio signaling such as NAS in between the UE 130 and the AMF 110 without involving the access network 135.

[0050] In an embodiment, in order to establish a first connection with the AMF 110, the UE 130 is configured to include a Globally Unique AMF Identifier (GUAMI) of

the AMF 110 in a first Non-Access Stratum (NAS) message which is sent to the AMF 110, via the access network 135. The Globally Unique AMF Identifier (GUAMI) is a key element in Fifth Generation (5G) networks that uniquely identifies an Access and Mobility Management Function (AMF) across multiple network domains. The GUAMI facilitates mobility management and session continuity for the UE 130 as it moves between different service providers or roaming scenarios. The NAS is a higher layer of a control plane in a radio interface protocol stack. The NAS messages are exchanged between the UE 130 and the Core Network (CN) entities such as a Mobility Management Entity (MME) or the AMF in the 5G network.

[0051] The NAS message transmitted by the UE 130 is routed to the required AMF 110 by the Access Network 135, to establish a connection with the AMF 110. The AMF 110 is further configured to authenticate and register the UE 130 into the 5G network. The AMF 110 transmits an Authentication and Key Agreement (AKA) request to the UE 130 upon receiving the first NAS message, via the N2 interface. The AKA request is a specific type of message exchanged between the UE 130 and an authentication server or a Home Subscriber Server (HSS) in a cellular network. The AKA request is part of the authentication and security procedures used to establish a secure connection between the UE 130 and the data network 125. The N2 interface is a key interface defined in the 3rd Generation Partnership Project (3GPP) standards for the 5G mobile network architecture. The N2 interface facilitates communication and interaction between different network functions within the 5G core network.

[0052] The access network 135 is one of, but not limited to, Radio Access Network (RAN), wired Local Access Network (LAN), wireless LAN, ethernet, next-generation RAN(NG-RAN), non-3GPP WLAN and Asymmetric Digital Subscriber Line (ADSL). The ADSL is a type of digital subscriber line (DSL) technology used for transmitting digital data over traditional telephone lines. The ADSL is asymmetric which allows for higher downstream data rates (from the internet to the user) compared to upstream rates (from the user to the internet). The access network is configured to transfer information pertaining to the UE 130 to the AMF 110 via the N2 interface.

The information pertaining to UE 130 includes one of details of connection, network mobility and user session details.

[0053] The AMF 110 receives connection and session related information from the UE 130 based on the connection request. The AMF 110 is configured to handle connection and mobility management tasks. Upon receiving the connection request from UE 130, the AMF 110 is configured to relay the information pertaining to the UE 130, to the SMF 115 via a N11 interface. The N11 interface is utilized to send a trigger to the SMF 115 to add, modify or delete a Packet Data Unit (PDU) session across the user plane of the 5G network architecture 100.

[0054] In an embodiment, the SMF 115 is configured to interact with the decoupled data plane, creating, updating and removing PDU sessions and managing session context with the UPF 120. The SMF 115 is further configured to keep track of the PDU sessions and Quality of Service (QoS) Flows in the 5G core network architecture 100 for the plurality of UEs 130 and make sure their states and status are coordinated between the core nodes arranged in the control plane and the user plane. The SMF 115 sends messages to the UPF 120 over a N4 interface using the Packet Forwarding Control Protocol (PFCP).

[0055] The N4 interface is configured to serve as a medium of communication in between the SMF 115 and the UPF 120. The N4 interface is utilized to exchange information pertaining to data routing, session management, and policy control to ensure efficient data transfer and management within the 5G network architecture 100.

[0056] The SMF 115 is further configured to receive Policy and Charging Control (PCC) rules from the PCF 160 for establishment, modification and release of the QoS Flows. The PCC rules are set by a network operator. The PDU session is the process of establishing a data path between the plurality of UE 130 and the 5G core nodes of the 5G network architecture 100. The PDU session is a logical connection between the UE 130 and the data network 125, such as the internet or a private network. The QoS flow pertains to the performance characteristics of a network or service experienced by its users and corresponds to parameters of the 5G network architecture 100 including one of reliability, availability, latency, throughput, and prioritization of

traffic. The present disclosure will be explained in terms of SMF 115 which includes a plurality of SMFs.

[0057] The PCF 160 is a core node in the control plane and is communicably connected to the AMF 110 and the SMF 115. The PCF 160 is configured to store policy subscription information and policy rules set by the network operator, in a User Data Repository (UDR). The UDR is a key component in modern telecommunications networks, especially within the 5G architectures defined by the 3GPP. The UDR is responsible for storing and managing subscriber-related data, which can be accessed and utilized by various network functions to provide personalized services and ensure efficient network operation. The policy rules include one of an access and mobility policy and a session management policy. The PCF 160 is configured to interact with the AMF 110 for transmitting the access and mobility policy. The PCF 160 transmits the session management policy to the SMF 115.

[0058] In an embodiment, the UPF 120 is a part of the user plane of the 5G network architecture 100 unlike the AMF 110 and the SMF 115 which are part of control plane of the 5G network architecture 100. The UPF 120 is configured to establish a session to connect the plurality of UE 130 to the data network 125 upon receiving information pertaining the session and the UE 130 which initiates the session to connect to the data network 125, from SMF 115 via the N4 interface. The UPF 120 includes a plurality of UPF data plane instances to establish the session. The plurality of UPF data plane instances refer to specific instances or implementations of the UPF user plane functionality. The UPF is a key network function responsible for managing and processing user data traffic in 5G networks, including data forwarding, traffic shaping, QoS enforcement, and routing.

[0059] The UPF 120 is configured to interconnect the UE 130 initiating the session and the data network 125 via a N6 interface by utilizing a GPRS Tunnelling Protocol for the user plane (GTP-U). The GTP-U is a protocol used in mobile networks to facilitate the transmission of user data, and also includes the GTP for a control plane (GTP-C). The GTP-U specifically handles the encapsulation and transportation of user data packets between network nodes in both 2G/3G ((General Packet Radio Service

(GPRS), Universal Mobile Telecommunications System (UMTS)), 4G (Long Term Evolution (LTE)) networks, and 5G networks. The UPF 120 is configured to route and forward data packets from the UE 130 to the data network 125 based on traffic filters set by the network operator. The traffic filters correspond to criteria for differentiating the data packets traversing in the 5G network and includes but not limited to, one of a layer filtering based on Deep Packet Inspection (DPI), and filtering based on the data packets flow including an uplink and a downlink flow. The DPI is a form of network packet filtering that examines a data part (for an example, a header) of a packet as it passes an inspection point. The DPI is used to monitor, manage, and secure network traffic by analyzing the content of the packets for specific data, patterns, or protocols.

[0060] The N6 interface serves as a medium to transmit data pertaining to the session from the UPF to the data network 125 thereby establishing a flow for connecting the UE 130 and the data network 125. The GTP-U includes one or more communications protocols used to carry the GPRS in the 5G network.

[0061] The UPF 120 is further configured to perform application detection using a Service Data Flow (SDF) traffic filter templates or 3-tuple protocol, server-side Internet Protocol (IP) address and port number Packet Flow Description (PFD) received from the SMF 115. The SDF describes a flow of data packets that are treated as a single entity for the purposes of Quality of Service (QoS) and policy enforcement. The SDF typically consists of all packets that belong to a specific service or application, such as a voice call, video stream, or web browsing session. The 3-tuple protocol refers to identifying and classifying network traffic based on source IP address, destination IP address, and a protocol type of the packet. The PFD pertains to information on how data packets from the UE 130 or the data network 125 are processed, forwarded, and modified in the 5G network architecture. The SDF corresponds to a data flow within the 5G network.

[0062] The AUSF 140 is configured to receive an authentication request from the AMF 110 when the UE 130 sends the NAS message to be registered into the 5G network. The AUSF 140 is a key component in the 5G core network architecture responsible for handling authentication procedures for users and devices. The AUSF

140 ensures that only legitimate subscribers can access the data network 125 and its services. The AUSF 140 interacts with other network functions to perform its tasks effectively. The AUSF 140 is configured to interact with the UDM 165 to obtain authentication vectors for processing the AKA authentication of the UE 130 and validates network responses to determine whether or not the authentication was successful. The authentication vectors include at least one of an authentication response parameter containing the response (RES) value, an expected response (XRES) token, and a subscription permanent identifier (SUPI).

[0063] The UDM 165 is a core node in 5G network architecture arranged in the control plane. The UDM 165 is configured to generate authentication credentials used during the authentication process for UE 130 which is initiated by the AMF 110. The UDM 165 is further configured to authorize network access and roaming based on user subscriptions, after the UE 130 is registered into the 5G network after successful authentication.

[0064] The NSSF 145 is a core node in the control plane of the 5G network architecture. The NSSF 145 is a key component in 5G networks, facilitates in managing network slicing. The network slicing is a form of virtual network architecture that allows multiple logical networks to be created on top of a common physical infrastructure. Each slice can be tailored to meet specific needs, such as latency, throughput, or reliability, The NSSF 145 is configured to enable the AMF 110 to establish the session based on a session request received from the UE 130 in order to connect to the data network 125. The NSSF 145 is further configured to perform network slicing to ensure uninterrupted QoS flow by selecting network slicing instance (NSI) comprising one or more network slices for performing a desired function initiated by the one or more application of the UE 130. The NSSF 145 is further configured to allocate an NSI ID to the selected NSI. The NSI ID is a unique identifier used in network slicing to identify each network slice created. The NSSF 145 is further configured to provide information corresponding to the NSI ID to AMF 110 which utilizes the said information for the session establishment procedure. The NSSF 145

is further configured to interact with the NRF 155 in order to allow specific 5G core node services to be used during the UE 130 registration request.

[0065] The NRF 155 is a core component of the 5G network architecture 100 arranged in the control plane. The NRF 155 is a centralized network entity in 5G architecture that maintains a repository of available NFs and their profiles, providing registration, discovery, and status management services for the NFs. The NRF 155 enables NFs to discover and interact with each other and supports the flexibility and scalability of 5G networks. The NRF 155 is configured to work as a centralized repository for all 5G network functions (NFs) in the operator's network. The NRF allows 5G NFs to register and discover each other via a standard application programming interface (API). The standard API is an interface enabling interconnection of various components of the 5G network including core nodes.

[0066] The NEF 150 is communicably connected to the AMF 110, the NSSF 145 and the NRF 155 of the control plane of the 5G network architecture. The NEF 150 is a crucial component in the 5G network architecture, designed to provide secure and standardized access to network services and capabilities. The NEF 150 exposes network services and capabilities to external applications and third-party service providers in a controlled and secure manner, enabling new business models and enhancing service innovation. The NEF 150 is configured to securely expose the network services and capabilities to either third-party applications or the internal Application Functions (AFs) over standard API.

[0067] The AF 170 is a core node of the 5G network architecture which to provide service-related information to the network operator. The AF 170 is a network entity in 5G architecture that offers application services and interacts with the 5G core network to influence network policies and behaviors. The AF 170 is used to provide value-added services, enforce policies, and optimize network performance for specific applications. The AF 170 is configured to access the NEF 150 for retrieving resource related information. The AF 170 is further configured to interact with the PCF 160 in order to enable policy control. The AF 170 is configured to perform session traffic routing.

[0068] For further explanation of the present disclosure the core nodes that would be considered are the AMF 110, the SMF 115 and the UPF 120, however, this should not be considered limiting to the scope of the present disclosure.

[0069] FIG. 1B illustrates a block diagram of the exemplary 5G network architecture 100 for implementing the proxy for communication between different components in the 5G core nodes, according to various embodiments of the present invention. The exemplary 5G network architecture 100 includes the UE 130, connected to the data network 125 via the 5G core nodes. The UE 130 is capable of sending data-packets to and receiving data-packets from the data network 125 via the various core elements of the 5G network architecture 100.

[0070] The exemplary 5G network architecture 100 further includes a system 200 communicably coupled to the SMF 115 arranged in the control plane and the UPF 120 arranged in the user plane of the 5G network architecture 100. The system 200 is indirectly connected to the data network 125 and the UE 130 in order to establish a communication pathway between the UE 130 and the data network 125. Operational and construction features of the system 200 will be explained in detail with respect to the following figures.

[0071] Referring to FIG. 2A, FIG. 2A illustrates a block diagram of the system 200 for implementing a proxy for communication between different components in the 5G core nodes, according to various embodiments of the present invention.

[0072] As per the illustrated embodiment, the system 200 includes one or more processors 205, a memory 210, and an input/output interface unit 215. The processor 205 is further connected to a cluster manager 220. The cluster manager 220 is configured to maintain records on information pertaining to a status of all 5G core nodes involved in the session processing, including the SMF 115 and the UPF 120, as well as various timer values, various UE counter values, a Data Network Name (DNN) and a UE IP Pool information for each of the UE 130 registered into the 5G network architecture 100. The status of all core nodes corresponds to one of a working and idle state of the core nodes.

[0073] The processor 205 is indirectly connected with the UE 130 and the Data Network 125. The one or more processors 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.

[0074] As per the illustrated embodiment, 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.

[0075] 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 200 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 200 and the processing resource. In other examples, the processor 205 may be implemented by electronic circuitry.

[0076] In an embodiment, the input/output (I/O) interface unit 215 may be one of a first I/O interface 215a, a second I/O interface 215b and a third I/O interface 215c. The

I/O interface unit 215 facilitates communication of the system 200 and the components of the 5G core node. Examples of such components include, but are not limited to, the SMF 115 and the UPF 120. The I/O interface unit 215 further enables communication of the system 200 with the network operator.

[0077] The first I/O interface 215a may be a northbound N4 interface. The northbound N4 interface is the standard API that allows a lower-level or user plane 5G network node to communicate with a higher level or control plane core nodes. The second I/O interface 215b may be a southbound N4 interface. The southbound N4 interface is the standard API that allows the higher-level control plane core nodes to send commands to lower-level or user plane network nodes.

[0078] In an embodiment, the processor 205 is further configured to act as proxy to serve as a mediator in between the SMF 115 and the UPF 120. More particularly, the processor 205 is configured to act as an abstraction layer in between the SMF 115 and the UPF 120.

[0079] In an embodiment, the processor 205 is configured to receive a session request from the SMF 115 via the first I/O interface 215a, when the UE 130 intends to transmit the data-packets to the data network 125 via the access network 135. The session request may be a session initiation, a session modification or a session deletion request. The processor 205, upon receiving the session request, checks the status of the SMF 115 by utilizing the cluster manager 220. When the SMF 115 is determined to be whitelisted, the processor 205 transmits the session request to the UPF 120. The whitelisted SMF pertains to SMF 115 that is active and functioning.

[0080] The processor 205 of the system 200, is configured to transmit the at least one session along with relevant information to the UPF 120, via the second I/O interface 215b. The relevant information pertains to, but not limited to, an Internet Protocol (IP) address of the UE 130 and one or more control plane rules transmitted by the SMF 115.

[0081] FIG. 2B shows the block diagram of the system 200 in communication with the SMF 115 and the UPF 120, according to various embodiment of the present invention.

[0082] In an embodiment, the UPF 120 includes a plurality of UPF data plane instances including at least one of an active UPF data plane instance 250 and a plurality of standby UPF data plane instances 255. The UPF 120 further includes a plurality of Service Availability (SA) group. The plurality of SA group ensures to enhance the reliability and availability of services by grouping multiple network elements or instances that can provide the same service. Further, the plurality of SA group is to ensure continuous service availability even in the event of failures or maintenance activities. The plurality of SA group includes at least a SA 1, a SA 2 and a SA 3. However, it is to be noted that the plurality of SA should not be limited to only the SA 1, the SA 2 and the SA 3.

[0083] In an embodiment, the plurality of UPF data plane instances arranged in the plurality of SA Group. Each of the SA 1, the SA 2, and the SA 3 include at least one of the active UPF data plane instance 250 and at least one of the plurality of standby UPF data plane instance 255.

[0084] In an embodiment, the SMF 115 further includes plurality of SMF instances such as a SMF 115a, a SMF 115b and a SMF 115c. Each of the SMF 115a, the SMF 115b and the SMF 115c is configured to receive the session request from the UE 130. It is to be noted that the above are utilized for explanation purposes only and should not be considered limiting to the present disclosure.

[0085] In an embodiment, the processor 205 of the system 200 includes the plurality of SMFs 115 are masked by the plurality of UPF data plane instances. . The system 200 includes the plurality of SMFs 115 is at least one of horizontal scale up and scale down of the plurality of UPF data plane instances. The horizontal scale up pertains to adding at least one new UPF data plane instance to the existing plurality of UPF data plane instances and the horizontal scale down pertains to removing at least one UPF data plane instance from the existing plurality of UPF data plane instances. The horizontal scale up of the UPF data plane instances is performed when there is an overload. The horizontal scale down is performed when the load is low and there is a need to reduce resource consumption. The resource includes running storage

requirement including one of a Central Processing Unit (CPU) storage, Random Access Memory (RAM) storage and Read Only Memory (ROM) storage.

[0086] The processor 205 is configured to relay the session requests from the at least one of the SMF 115a, the SMF 115b and the SMF 115c to the active UPF plane instances 250 for further processing. However, in case the active UPF plane instance 250 fails or stops functioning then the processor 205 is configured to relay the session request to one of the standby UPF data plane instances 255 which is in the same SA group as the active UPF data plane instance 250. The processor 205 abstracts the UPF data plane instances of the UPF 120 therefore, the at least one SMF 115 sending the session request remains ignorant of the UPF data plane failover. In other words, abstracting by the processor 205 indicates that the SMF 115 only knows that UPF data plane instances of the UPF 120 are operating, the SMF 115 does not know whether the active UPF data plane instance 250 is operating or the standby UPF data plane instances 255 is operating. Thus, processor 205 of the system 200 is configured to hide failovers of the plurality of UPF data plane instances, i.e., switch over from the active UPF data plane instance 250 to the standby UPF data plane instance 255, from the plurality of SMFs.

[0087] FIG. 3A illustrates an embodiment of the system 200, according to various embodiments of the preset invention. The processor 205 is configured to integrate an additional component as a proxy 300 rather than serving as the proxy itself. In order for the system 200 to provide masked communication between the core nodes, more particularly between the SMF 115a, the SMF 115b and the SMF 115c the plurality of UPF plane instances of the UPF 120 arranged in the SA 1, the SA 2 and the SA 3 service availability group, the processor 205 is configured to integrate the proxy component 300 to serve as a communication medium.

[0088] The proxy component 300 includes a plurality of proxy instances. The plurality of proxy instances of the proxy component 300 includes at least one of an active proxy instance 305 and a plurality of standby proxy instance 310 based on a generalized incoming session request rate. The generalized incoming session request

rate pertains to an average of the number of session requests calculated within a predefined time period set by the network operator.

[0089] In an embodiment, the processor 205 is communicably coupled with the cluster manager 220 to register the proxy component in the cluster manager 220. The processor 205 is configured to register the plurality of proxy instances of the proxy component 300 into the cluster manager 220 in a predefined order. Depending on the registration order with the cluster manager 220, the processor 205 is configured to assign a first proxy instance from the plurality of proxy instances, registered with the cluster manager 220, as the active proxy instance 305. The processor 205 is configured to assign rest of the proxy instances registered with the cluster manager 220 as of the standby proxy instance 310. The predefined order is set by the network operator via the third I/O interface 215c.

[0090] In an embodiment, the active proxy instance 305 is configured to receive the session request from one of the SMF 115a, the SMF 115b and the SMF 115c via the first I/O interface 215a. The active proxy instance 305 upon receiving the session request, checks the status of the SMF 115a, the SMF 115b and the SMF 115c from which the session request came from. The status of the SMF 115 pertains to whether the SMF 115 is a whitelisted one or not. The active proxy instance 305 determines the status of the SMF 115 by enquiring the cluster manager 220. Upon confirming that the SMF 115 is whitelisted, the active proxy instance 305 is configured to extract the relevant information pertaining to IP address of the UE 130 and one or more control plane rules transmitted by the SMF 115. The active proxy instance 305 afterwards checks the status of the plurality of UPF 120 plane instances arranged in the SA 1, the SA 2 and the SA 3 from the cluster manager 220 and forwards the session request to the available UPF 120 plane instance via the second I/O interface 215b.

[0091] FIG. 3B is a schematic representation of the system 200 for implementing the proxy for communication between different components in the 5G core node, according to an embodiment of the present invention. More particularly, FIG. 3B illustrates the components of the active proxy instance 305 in communication with the standby proxy instance 310, according to an embodiment of the present disclosure.

The active proxy instance 305 includes a Packet Forwarding Control Protocol (PFCP) component 315, a High Availability (HA) component 320, a Data plane (DP) HA component 325, and a Fault, Configuration, Accounting, Performance, and Security (FCAPS) component 330 communicably connected to each other. The PFCP component 315 is a communication protocol used in 5G networks to manage and control the forwarding of user data packets between network elements, such as the UPF and the control plane entities. The PFCP enables dynamic session management, Quality of Service (QoS) control, and policy enforcement in 5G networks.

[0092] The PFCP component 315 of the active proxy instance 305 is communicably connected to the SMF 115a, the SMF 115b and the SMF 115c to receive the session request. The PFCP component 315 is further configured to obtain the information from the cluster manager 220 on the SMF 115, the UPF data plane instances 120, the various timer values, the DNN and the UE IP Pool information for each of the UE 130 registered into the 5G network architecture 100, when the active proxy instance 305 is registered into the cluster manager 220. The PFCP component 315 is configured to pre-allocate the sessions a unique IPv6 address when the session is initiated as per the UE IP pool info. The PFCP component 315 of the active proxy instance 305 is further configured to monitor the plurality of UPF plane instances of the UPF 120 arranged in the SA 1, the SA 2 and the SA 3 and the incoming session requests, and the incoming session request traffic according to a rate limit.

[0093] The rate-limit is a predefined number of session requests received at the at least one active proxy instance 305 in a predefined time-period. The rate-limit and the predefined time-period are defined by the network operator via the third I/O interface 215c. If the number of the incoming session requests is greater than the rate-limit, then the PFCP component 315 is configured to relay the information pertaining to the load level to the SMF 115. The PFCP component 315 is further configured to create associations with one of, active UPF data plane instances and standby data plane instances to delegate the session requests for further processing. The PFCP component 315 is further configured prompt the UPF 120 to add new UPF plane instances to handle the overload situation by delegating incoming session requests to the newly

added UPF plane instances. When the overload is subsided with reduction in the number of the session requests is reduced to be under the rate limit, the PFCP component 315 is configured to prompt the UPF 120 to delete the created UPF plane instances.

[0094] The PFCP component 315 sends information pertaining to the current load level or overload level to the SMF 115 via an information element (IE) which may be one of a Load Control Information (LCI) and an Overload Control Information (OCI). The LCI is configured to manage and control the load on various network resources. The LCI is used to ensure that the data network 125 can handle the traffic demands placed upon it without degradation of service or performance. The LCI typically includes the data related to the current load status of network elements, such as base stations, core network components, and links, allowing the data network 125 to make informed decisions about load balancing, resource allocation, and congestion management.

[0095] As per the one embodiment, the OCI is a specific type of the information element (IE) used to manage and mitigate situations where the network elements are experiencing or are at risk of experiencing overload conditions. The OCI provides mechanisms for controlling and alleviating the overload by adjusting the network behavior, such as throttling traffic, rerouting sessions, or temporarily denying service requests. The OCI aids to maintain network stability and service quality even under high load conditions.

[0096] For example: the rate-limit is predefined as maximum of number of session request from one SMF within a predefined time period. The rate limit is set at 100 and the predefined time-period is set at 10 seconds. This indicates that if the number of session requests received within 10 seconds can be forwarded for further processing at an active UPF instance. However, when the number of session request received within the predefined time-period of 10 seconds is 150, the PFCP component 315 of the active proxy instances 305 determines that there is an overload. In one embodiment, the PFCP component 315 is configured to prompt the UPF 120 to create a new UPF data-plane to handle additional session requests. When the number of

session requests subsides to be under the rate-limit, then the PFCP component 315 may prompt the UPF 120 to delete the newly created UPF data-plane. Thereby, the PFCP component reduces the memory 210 usage of the system 200.

[0097] In an embodiment, the PFCP component 315 of the active proxy instance 305 is further configured to modify a local session context upon receiving the session modification request from the SMF 115 during an ongoing session.

[0098] In an embodiment, the PFCP component 315 of the active proxy instance 305 is further configured to delete the local session context upon receiving at least one session deletion request from the SMF 115.

[0099] In an embodiment, the PFCP component 315 of the active proxy instance 305 is further configured to maintain, modify and delete a local record of the session context in terms of versions. For example: the PFCP component 315 maintains the local record of the session initiated by the SMF 115 in the memory 210 of the system 200. The PFCP component 315 further saves any modifications that is made to the said session by the SMF 115. In an embodiment, the PFCP component 315 of the active proxy instance 305 is further configured to retrieve the session context stored at the SMF 115 via utilization of a Session Reporting Rules (SRR), in case of version mismatch is observed or reported by the UPF data plane instances via a proprietary error cause. The SRR are guidelines or policies established within the data network 125 to control how session-related information is reported or managed. The SRR relates to define criteria, triggers, and actions related to reporting on various aspects of sessions within the data network 125. In order to this, the sessions refer to communication sessions, data sessions, or any other defined period of interaction between network entities. The SRR pertains to information on the session. The proprietary error cause relates to an error caused due to unsuccessful authorization.

[00100] The HA component 320 is connected to the PFCP component 315 to receive update pertaining to the UPF data plane instances. The HA component 320 is communicably connected to the standby proxy instance 310 to restore a session context on the standby proxy instance 310 when it comes up. The HA component 320 may be further configured to checkpoint association and session related messages on

the standby proxy instance 310 in order to keep the context at standby proxy in sync with that at active proxy instance 305.

[00101] The HA component 320 is further communicably connected to the DP HA component 320 of the active proxy instances 305. The DP HA component 320 is configured to receive the updates pertaining to the session, SMF 115. The DP HA component 320 is communicably connected to the active UPF data plane instance executing/processing the session request which is received from the SMF 115 and to the standby UPF plane instances in the same SA group of the active UPF plane instance. The DP HA component 325 is configured to synchronize all information pertaining to the active session request including the details pertaining to the UPF data plane instance of the UPF 120, the SMF 115 and the IP address of the UE 130, among the active and standby UPF plane instances in the same SA group.

[00102] The Fault, Configuration, Accounting, Performance, and Security (FCAPS) component 330 is a network management framework used to categorize and organize various aspects of managing and maintaining telecommunications and networking systems. The FCAPS component 330 of the active proxy instance 305 is communicably connected to each of the PFCP component 315, the HA component 320, the DP HA component 325 of the active proxy instance 305. The FCAPS component 330 of the active proxy instance 305 is configured to obtain information pertaining to the SMF 115, UPF data plane 120 and ongoing and incoming session requests. The FCAPS component 330 of the active proxy instance 305 is further configured to monitor the overall performance of the active proxy instance 305.

[00103] The FCAPS component 330 may be further configured to maintain a record of performance counters and report performance counters to the network operator. The performance counter pertains to one of an overall packet transmission rate, a transfer latency, and a packet discard rate of 5G network architecture 100. The FCAPS component 330 may be further configured to raise alarms on occurrence of events like an association creation with the UPF data plane instances of the UPF 120, deletion of the UPF data plane instances of the UPF 120, breach of overload levels for

the incoming session requests, breach of configured levels of 5G network architecture 100, data plane session available capacity, any I/O interface 215 going down/up.

[00104] The FCAPS component 330 may be further configured to dynamically whitelist the SMF 115 based on the performance of the SMF 115. The FCAPS component 330 may be further configured to update the cluster manager 220 records by dynamically configuring the various timers, the various UE counters, adding the DNN and the UE IP pools information for each of the UE 130 registered into the 5G network architecture 100. The FCAPS component 330 may be further configured to report diagnostic information related to application context and current cluster manager 220 status exposed via the third I/O interface 215c to the network operator.

[00105] The HA component 320 and the FCAPS component 330 of the active proxy instance 305 are connected to the standby proxy instance 310 for synchronization and ease of failover when the active proxy instance 305 fails.

[00106] In an embodiment, each time the information is relayed from the SMF 115 to the UPF data plane instances 120, the active proxy instance 305 and the plurality of standby proxy instances 310 are synchronized by the processor 205. The processor 205 is configured to update the plurality of standby proxy instances 310 with context of the at least one session initiated by the SMF 115 with the active proxy instance 305. Thereby, the processor 205 enables ease of switching over when the active proxy instances 305 face failure or stops functioning.

[00107] In an embodiment, the processor 205 is configured to replace the active proxy instance 305 with at least one standby proxy instance 310 upon detecting failure of the active proxy instance to complete processing the at least one session. The processor 205 is configured to perform the switch over of the at least one standby proxy instance 310 in real time.

[00108] Referring to FIG. 4, FIG. 4 describes an embodiment of the system 200 for providing communication between different components in the 5G core node of the 5G network architecture 100, according to various embodiments of the present invention. In this embodiment, the processor 205 includes a masking module 405, a

transmission module 410, a forwarding module 415 and a synchronization module 420, communicably connected to each other.

[00109] In the preferred embodiment, the masking module 405 of the processor 205 is communicably connected to the plurality of SMFs 115 via the first I/O interface 215a. The masking module 405 is configured to receive the session request from the plurality of SMFs 115. The session request is one of the session establishment request, the session modification request, and the session deletion request.

[00110] The masking module 405 acts as the abstraction layer for the plurality of UPF data plane instances of the UPF 120 to hide the internal architecture of the UPF data plane instances of the UPF 120 from the SMF 115. The masking module 405 is connected to the cluster manager 220 of the system 200 to receive information pertaining to the SMF 115, whether the SMF 115 is whitelisted or not. Upon confirming that SMF 115 is whitelisted, the masking module 405 is configured to extract relevant information of the session such as IP address of the UE 130 and the one or more control plane rules transmitted by the SMF 115 from the received session request.

[00111] The transmission module 410 of the processor 205 is connected to the masking module 405 and is configured to receive the relevant information from the masking module 405. The transmission module 410 is configured to transmit the relevant information received from the masking module 405, to the UPF data plane instances of the UPF 120 for further processing via the second I/O interface 215b.

[00112] In an embodiment, the forwarding module 415 of the processor 205 is connected to the transmission module 410. The forwarding module 415 is configured to receive the session request and the relevant information pertaining to the IP address of the UE 130 and the one or more control plane rules transmitted by the SMF 115, from the transmission module 410. The forwarding module 415 is configured to forward the session request and the relevant information to one of the active UPF data plane instances 250 and the standby UPF data plane instances 255 by utilizing one of the active proxy instances 305 and the standby proxy instances 310, to establish, modify or delete the at least one session as per the received request.

[00113] The synchronization module 420 of the processor 205 is connected to the transmission module 410 and the forwarding module 415 in order to receive updates on the status of the session request, the SMF 115, the UPF data plane instances of the UPF 120, the active proxy instances 305 and the standby proxy instances 310. The synchronization module 415 is further configured to synchronize the active proxy instances 305 and the standby proxy instances 310, to facilitate easy switch over.

[00114] FIG. 5 illustrates a flow chart of the method 500 for implementing the proxy for communication between different components in the 5G core node. More particularly, the method 500 is for implementing a proxy component 300 in between the SMF 115 and the plurality of UPF data plane instances of the UPF 120. The method 500 is described with respect to FIG. 2. according to various embodiments of the present invention.

[00115] At step 505, the method 500 includes the step masking by one or more processors 205, the plurality of SMF 115 from the plurality of UPF data plane instances of the UPF 120 by including the proxy 300 between the plurality of SMFs 115 and the plurality of UPF data plane instances of the UPF 120. The proxy 300 includes the active proxy instance 305 and the plurality of standby proxy instances 310.

[00116] At step 510, the method 500 includes the step of synchronizing by the one or more processors 205, the active proxy instance 305 with the plurality of standby proxy instances 305. The synchronization enables information distribution among the active proxy instance 305 and the plurality of standby proxy instances 310 to ensure easy take over when the active proxy instance 310 fails.

[00117] The method 500 further updates the plurality of standby proxy instances 310 with context of the at least one session initiated by the at least one SMF 115 with the active proxy instance 305 and the plurality of standby UPF data plane instances of the UPF 120 with context of the at least one session initiated by the at least one SMF 115 with the active proxy instance 305, to process the at least one session, by the one or more processors 205.

[00118] At step 515, the method 500 includes the step of transmitting by the one or more processors 205, at least one session initiated by at least one SMF to the active proxy instance 305.

[00119] At step 520, the method 500 includes the step of forwarding by the one or more processors 205, the at least one session from the at least one active proxy instance 305 to the at least one UPF data plane instance of the UPF 120 to process the at least one session.

[00120] FIG. 6 shows a flow diagram of a method 600 for masking a plurality of SMFs 115 from UPF data-plane instances of the UPF 120 by utilizing the proxy, according to various embodiments of the present invention.

[00121] At step 605, the method 600 includes the step of terminating, by the one or more processors 205, a first interface 215a originating from the plurality of SMFs 115 at the proxy component 300.

[00122] At step 610, the method 600 includes the step of terminating, by the one or more processors 205, a second interface 215b originating from the proxy component 300 at the plurality of UPF data plane instances of the UPF 120.

[00123] The plurality of SMFs 115 are masked by the plurality of UPF 120 data plane instances including horizontal scale up and scale down and transparent failovers of the UPF data plane instances of the UPF 120. The horizontal scale up is adding the new UPF data plane instances to the already existing UPF data plane instance of the UPF 120. The horizontal scale down includes deleting the existing UPF data plane from the UPF data plane instance of the UPF 120. The failovers of UPF data plane instances of the UPF 120 includes switching over of the standby UPF data plane instance 255 when the active UPF data plane instance 250 fails.

[00124] In an embodiment, 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 mask the plurality of SMFs from a plurality of UPF data plane instances by including the proxy component 300 between the plurality of SMFs and the plurality of UPF data plane instances. The proxy component 300

includes an active proxy instance 305 and a plurality of standby proxy instances 310. The processor 205 is further configured to synchronize the active proxy instance 305 with the plurality of standby proxy instances 305. The processor 205 is further configured to transmit at least one session initiated by at least one SMF to the active proxy instance and forward, the at least one session from the at least one active proxy instance to the at least one UPF data plane instance to process the at least one session.

[00125] A person of ordinary skill in the art will readily ascertain that the illustrated embodiments and steps in description and drawings (FIG.1-7) 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 function is 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.

[00126] 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

[00127]	5G network architecture - 100;
[00128]	AMF-110;
[00129]	SMF-115;
[00130]	UPF-120;
[00131]	Data network - 125;
[00132]	User Equipment-130;
[00133]	Access Network-135;
[00134]	AUSF- 140;
[00135]	NSSF-145;
[00136]	NEF-150;
[00137]	NRF-155;
[00138]	PCF-160;
[00139]	UDN-165;
[00140]	AF-170;
[00141]	System-200;
[00142]	One or more processor -205;
[00143]	Memory - 210;
[00144]	I/O interface -215
[00145]	Cluster Manager- 220;
[00146]	Active UPF-250a, 250b, 250c;
[00147]	Standby UPF-255a, 255b, 255c;
[00148]	Active proxy instance - 305;

- [00149] Standby proxy instance- 310;
- [00150] PFCP component-315;
- [00151] HA component-320;
- [00152] DP HA component-325;
- [00153] FCAPS component-330;
- [00154] Masking Module - 405;
- [00155] Transmission Module - 410;
- [00156] Forwarding Module - 415;
- [00157] Synchronization Module - 420.

We Claim:

1. A method (500) of implementing a proxy for communication between different components in a 5G core node, the method comprises the steps of:
 - masking (505), by one or more processors (205), a plurality of Session Management Functions (SMFs) (115) from a plurality of User Plane Function (UPF) (120) data plane instances by including a proxy component (300) between the plurality of SMFs and the plurality of UPF (120) data plane instances, wherein the proxy component (300) includes an active proxy instance (305) and a plurality of standby proxy instances (310);
 - syncing (510), by the one or more processors (205), the active proxy instance (305) with the plurality of standby proxy instances (310);
 - transmitting (515), by the one or more processors (205), at least one session initiated by at least one SMF (115) to the active proxy instance (305);
 - and
 - forwarding (520), by the one or more processors (205), the at least one session from the at least one active proxy instance (305) to the at least one UPF (120) data plane instance to process the at least one session.
2. The method (500) as claimed in claim 1, wherein the step of masking, the plurality of SMFs (115) from the plurality of UPF (120) data plane instances by including the proxy component (300) between the plurality of SMFs (115) and the plurality of UPF (120) data plane instances, includes the steps of:
 - terminating (605), by the one or more processors (205), a first interface (215a) originating from the plurality of SMFs (115) at the proxy component (300); and
 - terminating (610), by the one or more processors (205), a second interface (215b) originating from the proxy component (300) at the plurality of UPF (120) data plane instances.

3. The method (500) as claimed in claim 1, wherein the step of, syncing, the active proxy instance (305) with the plurality of standby proxy instances (310), includes the step of:
 - updating, by the one or more processors (205), the plurality of standby proxy instances (310) with context of the at least one session initiated by the at least one SMF (115) with the active proxy instance (305); and
 - updating, by the one or more processors (205), the plurality of standby UPF (120) data plane instances with context of the at least one session initiated by the at least one SMF (115) with the active proxy instance (305), to process the at least one session.
4. The method (500) as claimed in claim 1, wherein the plurality of SMFs (115) are masked by the plurality of UPF (120) data plane instances and allows horizontal scale up and scale down and transparent failovers of UPF (120) data plane instances.
5. The method (500) as claimed in claim 4, wherein the horizontal scale up includes adding at least one new UPF data plane instance to the existing plurality of UPF (120) data plane instances.
6. The method (500) as claimed in claim 4, wherein the horizontal scale down includes removing at least one UPF data plane instance from the existing plurality of UPF (120) data plane instances.
7. The method (500) as claimed in claim 1, wherein the one or more processors (205), assigns an active state to the proxy instance registered first with a cluster manager (220) and assigns a standby state to the remaining plurality of proxy instances registered with the cluster manager (220).
8. The method (500) as claimed in claim 1, wherein the step of transmitting, at least one session initiated by at least one SMF (115) includes the steps of:

checking, by the one or more processors (205), information pertaining to whitelisted SMFs from the plurality of SMFs (115); and

transmitting, by the one or more processors (205), the at least one session initiated by the at least one whitelisted SMF to the active proxy instance (305).

9. The method (500) as claimed in claim 1, wherein the method further comprises the step of:

replacing in real time, by the one or more processors (205), the active proxy instance (305) with at least one standby proxy instance (310) upon detecting failure of the active proxy instance (310) to complete processing the at least one session.

10. The method (500) as claimed in claim 1, wherein the method further comprises the step of:

providing, by the one or more processors (205), one or more control plane rules transmitted by the at least one SMF to the active proxy instance, to the at least one UPF data plane instance.

11. The method (500) as claimed in claim 1, wherein the active proxy instance is replaced with at least one standby proxy instance upon detecting failure of the active proxy instance to complete processing the at least one session, based on synced active proxy instance with the at least one standby proxy instance.

12. The method (500) as claimed in claim 1, wherein the step of, forwarding, the at least one session from the at least one active proxy instance to the at least one UPF data plane instance to process the at least one session, further includes the step of:

forwarding, by the one or more processors (205), the at least one session to the at least one standby UPF data plane instance.

13. The method (500) as claimed in claim 1, wherein the method further comprises at least one of the steps of:
- pre-allocating, by the one or more processors (205), the at least one session to a unique Internet Protocol Version 6 (IPv6) address, as per configured IP pools;
 - monitoring, by the one or more processors (205), rate-limit of incoming traffic to the at least one active proxy instance (305) from the at least one whitelisted SMF (115);
 - indicating, by the one or more processors (205), current load/overload level to the whitelisted SMFs (115) via one of a Load Control Information (LCI) and an Overload Control Information (OCI) Information Element (IE);
 - creating or deleting, by the one or more processors (205), associations with one of, active UPF data plane instances (250) and standby data plane instances (255);
 - load balancing, by the one or more processors (205), incoming session establishment requests to the UPF (120) data plane instances;
 - modifying, by the one or more processors (205), local session context upon receiving session modification/session deletion requests from the whitelisted SMFs (115);
 - maintaining, by the one or more processors (205), session context version number pertaining to the UPF (120) data plane instances; and
 - deleting, by the one or more processors (205), local session context and retrieve the session context stored at the whitelisted SMFs (115) deleted via Session Reporting Rules (SRR), in case of version mismatch reported by the UPF (120) data plane instances via a proprietary error cause.
14. The method (500) as claimed in claim 1, wherein the proxy component (300) is at least one of, a Packet Forwarding Control Protocol (PFCP).

15. A system (200) of implementing a proxy for communication between different components in a 5G core node, the system (200) comprising of:
- a masking module (405) configured to mask, a plurality of Session Management Functions (SMFs) (115) from a plurality of User Plane Function (UPF) (120) data plane instances by including a proxy component (300) between the plurality of SMFs (115) and the plurality of UPF (120) data plane instances, wherein the proxy component (300) including an active proxy instance (305) and a plurality of standby proxy instances (310);
 - a synchronization module (420) configured to sync, the active proxy instance (305) with the plurality of standby proxy instances (310);
 - a transmission module (410) configured to transmit, at least one session initiated by at least one SMF (115) to the active proxy instance (305); and
 - a forwarding module (415) configured to forward, the at least one session from the at least one active proxy instance (305) to the at least one UPF (120) data plane instance to process the at least one session.
16. The system (200) as claimed in claim 15, wherein for masking, the plurality of SMFs (115) from the plurality of UPF (120) data plane instances by including the proxy component (300) between the plurality of SMFs (115) and the plurality of UPF (120) data plane instances, the masking module (405) is configured to:
- terminate, a first interface (215a) originating from the plurality of SMFs (115) at the proxy component (300); and
 - terminate, a second interface (215b) originating from the proxy component (300) at the plurality of UPF (120) data plane instances.
17. The system (200) as claimed in claim 15, wherein for syncing, the active proxy instance with the plurality of standby proxy instances, the synchronization module (420) is configured to:

update, the plurality of standby proxy instances (310) with context of the at least one session initiated by the at least one SMF (115) with the active proxy instance (305); and

update, the plurality of standby UPF (120) data plane instances with context of the at least one session initiated by the at least one SMF (115) with the active proxy instance (305), to process the at least one session.

18. The system (200) as claimed in claim 15, wherein the plurality of SMFs (115) are masked by the plurality of UPF (120) data plane instances and allows horizontal scale up and scale down and transparent failovers of UPF (120) data plane instances.
19. The system (200) as claimed in claim 18, wherein the horizontal scale up includes adding at least one new UPF data plane instance to the existing plurality of UPF (120) data plane instances.
20. The system (200) as claimed in claim 18, wherein the horizontal scale down includes removing at least one UPF data plane instance from the existing plurality of UPF (120) data plane instances.
21. The system (200) as claimed in claim 15, wherein the synchronization module (420) is configured to assign an active state to the proxy instance registered first with a cluster manager (220) and assigns a standby state to the remaining plurality of proxy instances registered with the cluster manager (220).
22. The system (200) as claimed in claim 15, wherein for transmitting, the at least one session initiated by the at least one SMF, the transmission module (410) is configured to:

check, information pertaining to whitelisted SMFs from the plurality of SMFs (115); and

transmit, the at least one session initiated by the at least one whitelisted SMF to the active proxy instance (305).

23. The system (200) as claimed in claim 15, wherein the system (200) is further configured to:

replace in real time, the active proxy instance (305) with at least one standby proxy instance (310) upon detecting failure of the active proxy instance (305) to complete processing the at least one session.

24. The system (200) as claimed in claim 15, wherein the system (200) is further configured to:

provide, one or more control plane rules transmitted by the at least one SMF (115) to the active proxy instance (305), to the at least one UPF (120) data plane instance.

25. The system (200) as claimed in claim 15, wherein the active proxy instance (305) is replaced with at least one standby proxy instance (310) upon detecting failure of the active proxy instance (305) to complete processing the at least one session, based on synced active proxy instance (305) with the at least one standby proxy instance (310).

26. The system (200) as claimed in claim 15, wherein for forwarding, the at least one session from the at least one active proxy instance to the at least one UPF data plane instance to process the at least one session, the forwarding module (415) is further configured to:

forward, the at least one session to the at least one standby UPF (120) data plane instance.

27. The system (200) as claimed in claim 15, wherein the wherein the system (200) is further configured to:

pre-allocate, the at least one session to a unique Internet Protocol Version 6 (IPv6) address, as per configured IP pools;

monitor, rate-limit of incoming traffic to the at least one active proxy instance (305) from the at least one whitelisted SMF (115);

indicate, current load/overload level to the whitelisted SMFs (115) via one of a Load Control Information (LCI) and an Overload Control Information (OCI) Information Element (IE);

create or delete, associations with one of, active UPF data plane instances (250) and standby data plane instances (255);

balance, the load by delegating incoming session establishment requests to the UPF (120) data plane instances;

modify, local session context upon receiving session modification/session deletion requests from the whitelisted SMFs (115);

maintain, session context version number pertaining to the UPF (120) data plane instances; and

delete, local session context and retrieve the session context stored at the whitelisted SMFs (115) deleted via Session Reporting Rules (SRR), in case of version mismatch reported by the UPF data plane instances via a proprietary error cause.

28. The system (200) as claimed in claim 15, wherein the proxy component is at least one of, a Packet Forwarding Control Protocol (PFCP).

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

mask, a plurality of Session Management Functions (SMFs) (115) from a plurality of UPF data plane instances by including a proxy component (300) between the plurality of SMFs and the plurality of UPF data plane instances,

wherein the proxy component including an active proxy instance and a plurality of standby proxy instances;

sync, the active proxy instance (305) with the plurality of standby proxy instances (310);

transmit, at least one session initiated by at least one SMF (115) to the active proxy instance (305); and

forward, the at least one session from the at least one active proxy instance (305) to the at least one UPF data plane instance to process the at least one session.

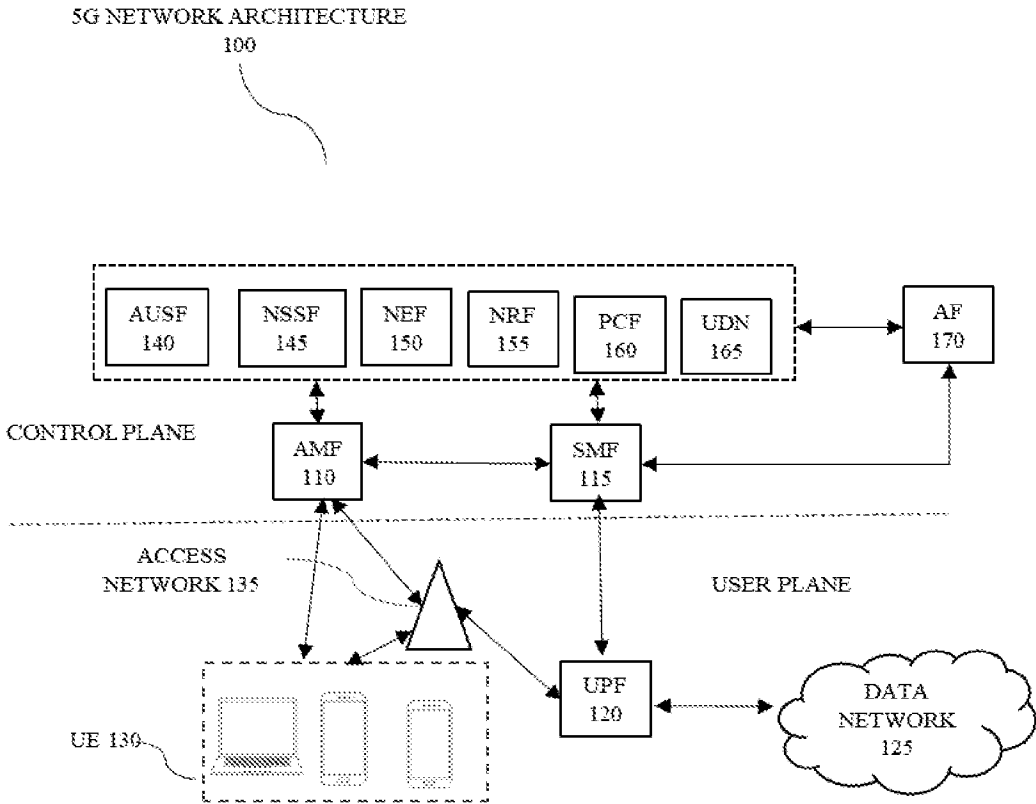


FIG. 1A

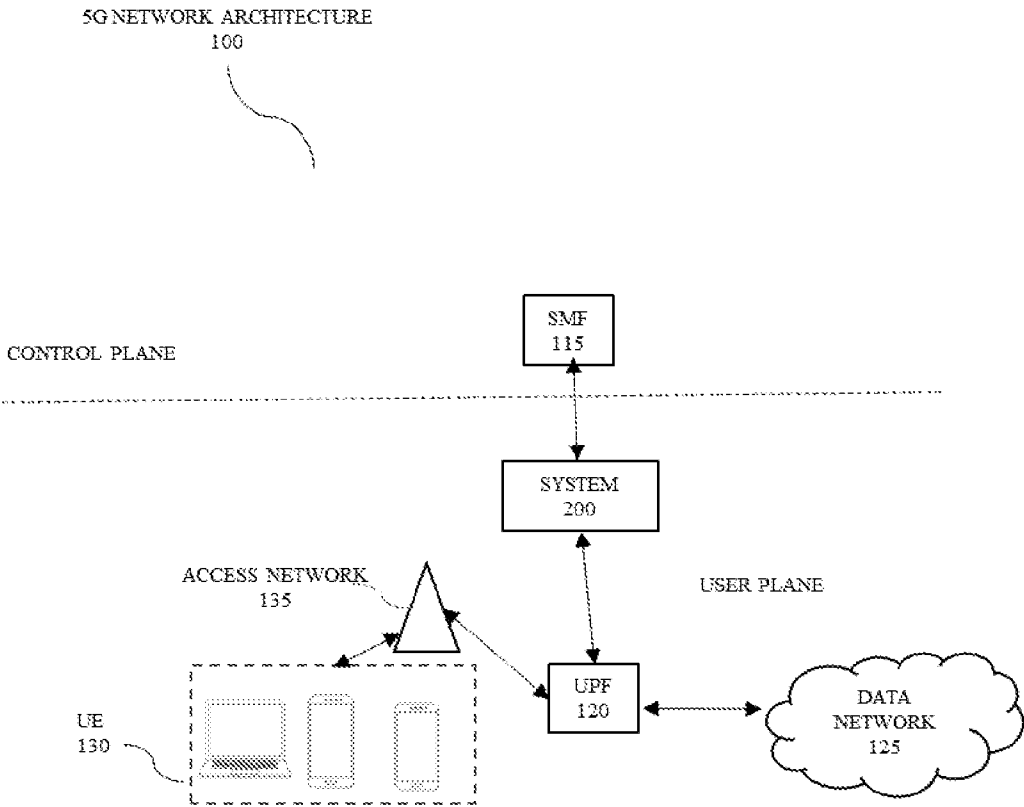


FIG. 1B

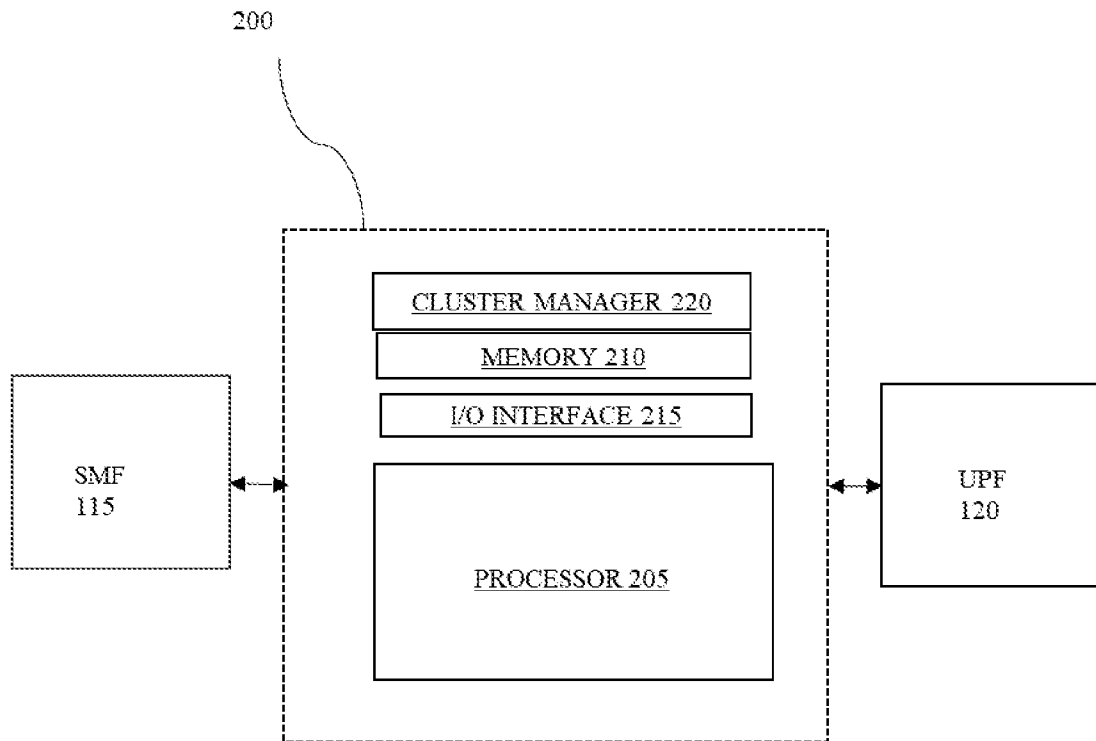


FIG. 2A

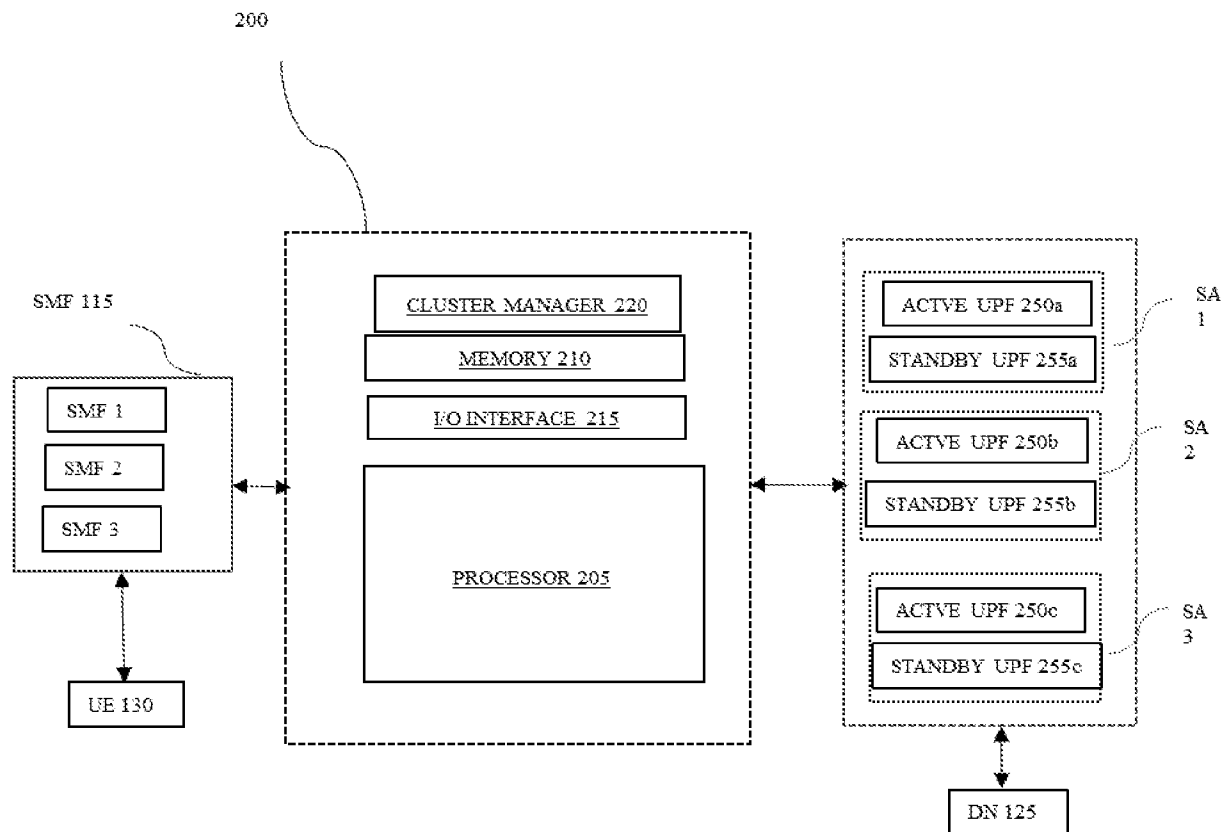


FIG. 2B

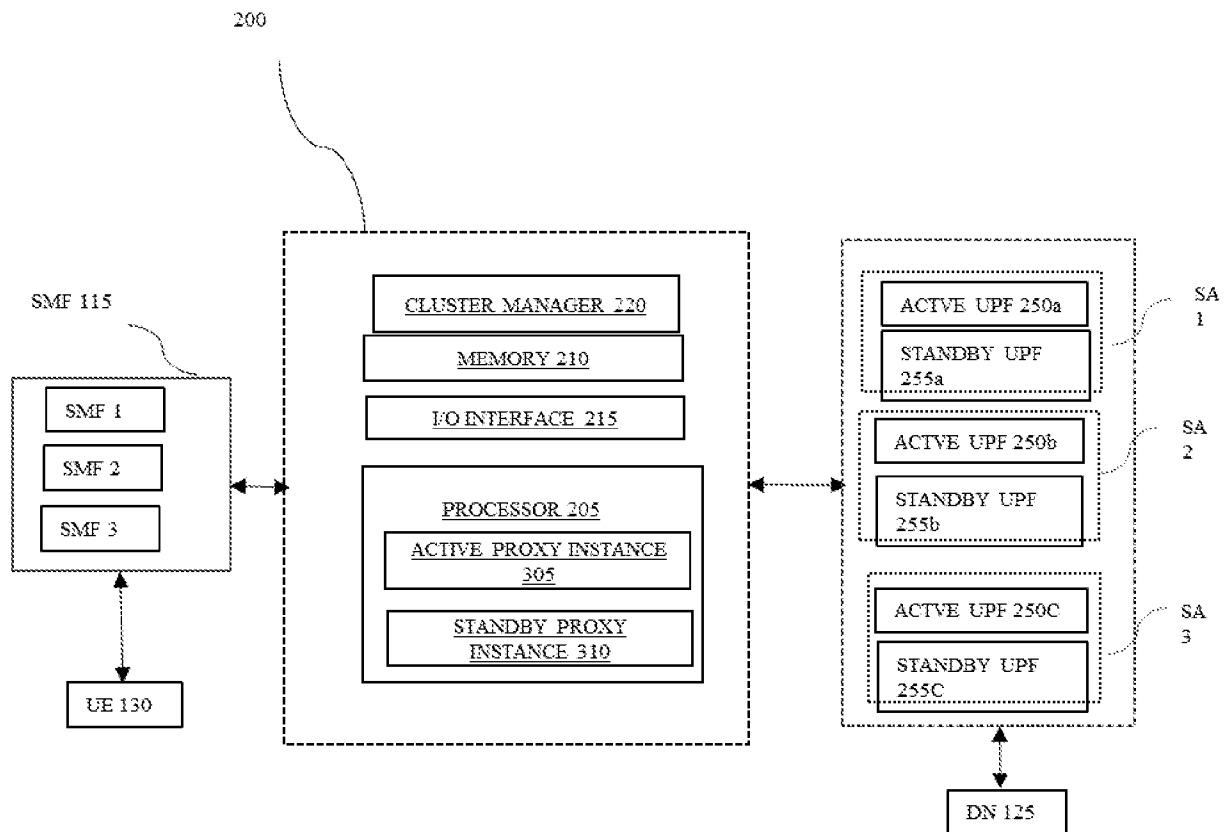


FIG. 3A

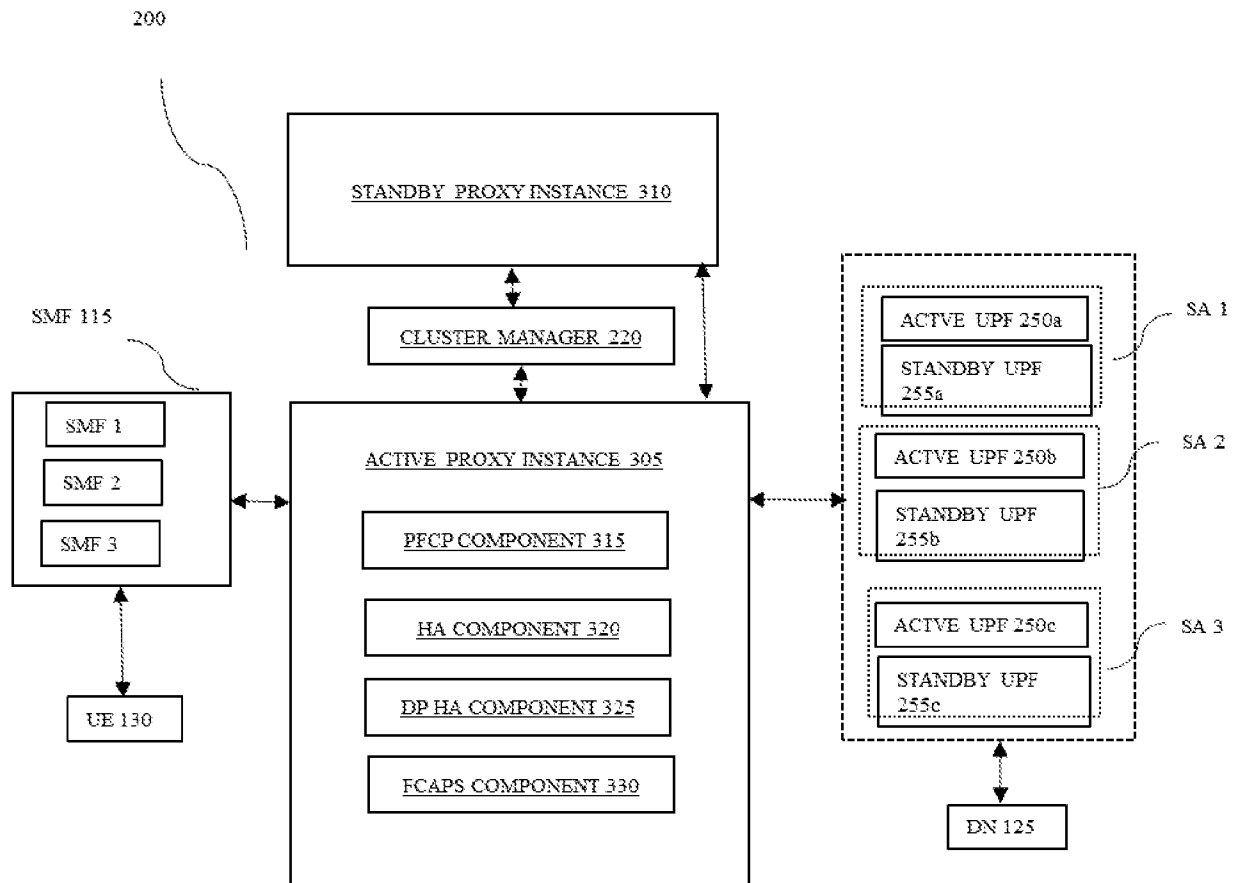


FIG. 3B

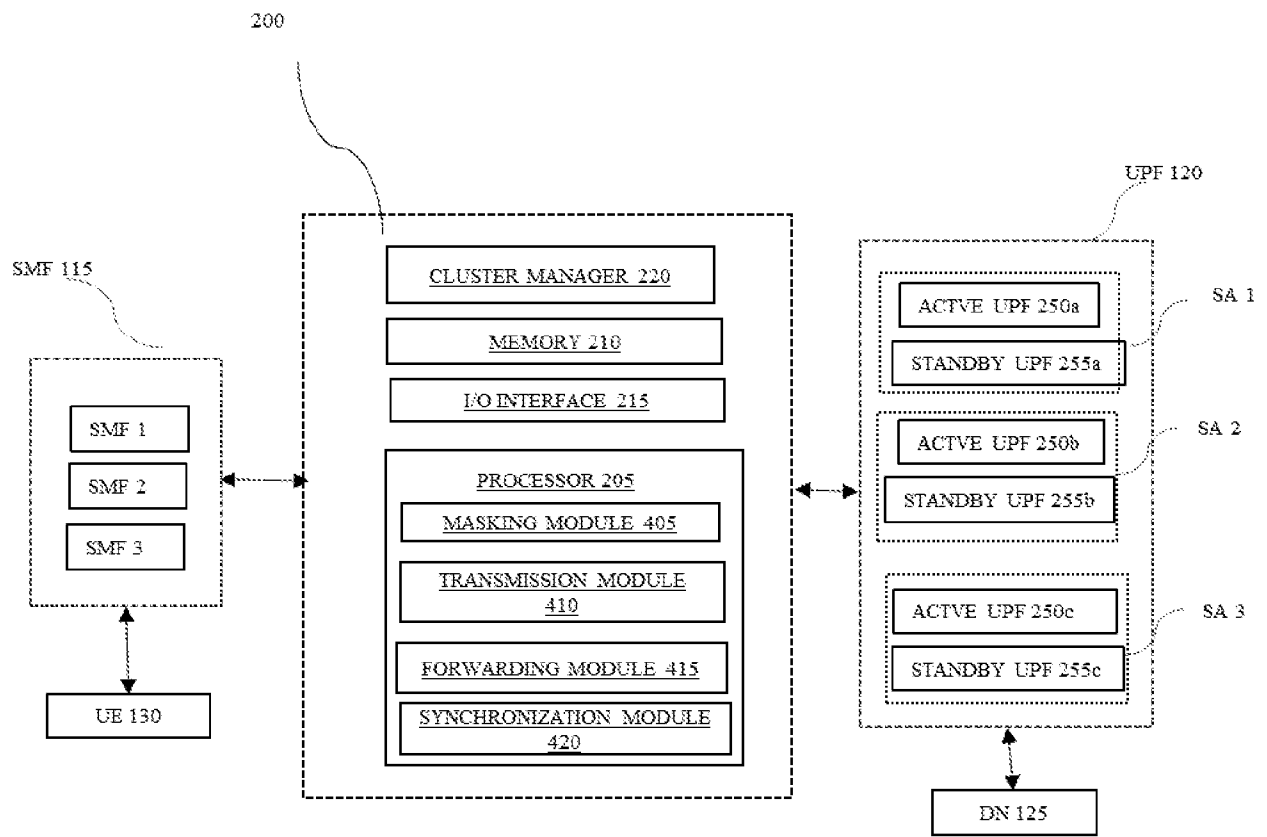


FIG. 4

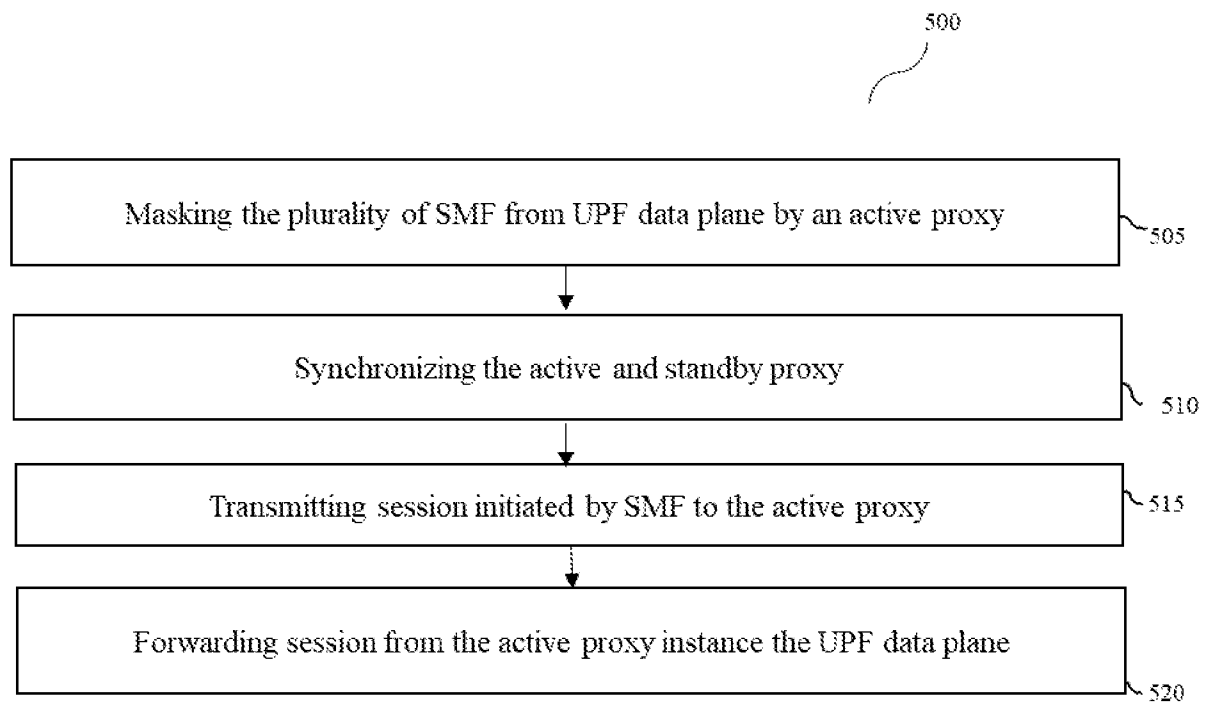


FIG. 5

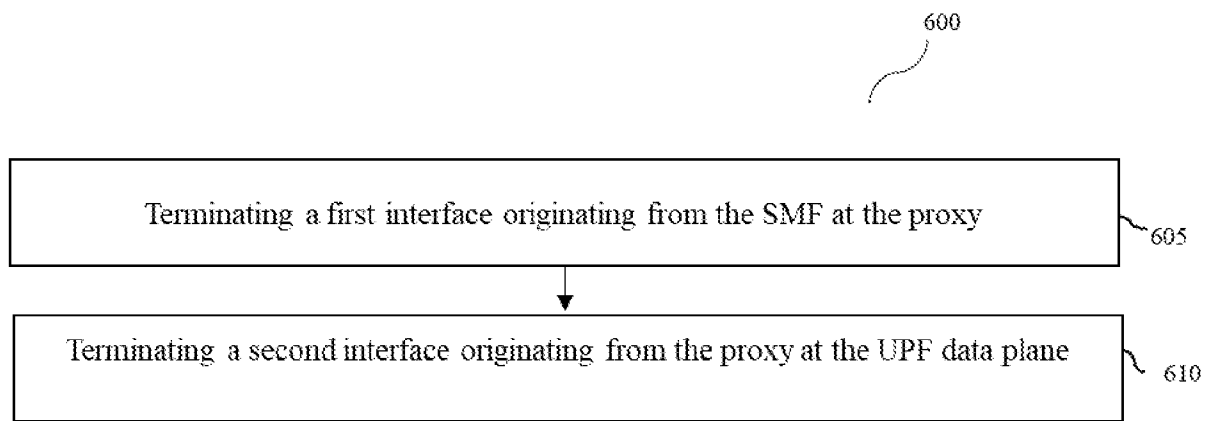


FIG. 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IN2024/050961

A. CLASSIFICATION OF SUBJECT MATTER

H04L67/56, H04L65/1016, H04L65/1045, H04L65/1069 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)

H04L

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

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

PatSeer, IPO Internal Database

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	CN114465948A, (CHINA TELECOM CORP. LTD.), 10 May 2022 (10-05-2022) [description] (English translation from Google Patents)	1-29
Y	CN113347739A, (TENCENT TECHNOLOGY SHENZHEN CO. LTD.), 03 September 2021 (03-09-2021) [Description] [Fig.2] [Fig. 3] (English translation from Google Patents)	1-29



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"D" document cited by the applicant in the international application

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

"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

22-10-2024

Date of mailing of the international search report

22-10-2024

Name and mailing address of the ISA/

Indian Patent Office
Plot No.32, Sector 14, Dwarka, New Delhi-110075
Facsimile No.

Authorized officer

Ajay Kumar Paswan

Telephone No. +91-1125300200