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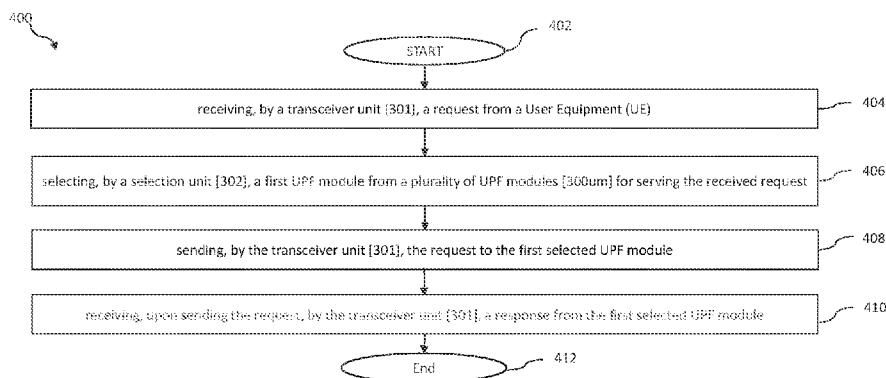


FIG. 4

(57) Abstract: The present disclosure relates to a method and a system for establishing packet data unit (PDU) session with user plane function (UPF). The disclosure encompasses receiving, a request for obtaining a plurality of network resources; selecting a first UPF module from a plurality of UPF modules [306] for serving the received request; sending the request to the first selected UPF module; and receiving a response from the first selected UPF module for one of an acceptance and a rejection of serving of said request.

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METHOD AND SYSTEM FOR ESTABLISHING PDU SESSION WITH UPF**TECHNICAL FIELD**

5 [0001] Embodiments of the present disclosure generally relate to wireless communication systems. More particularly, embodiments of the present disclosure relate to establishing packet data unit (PDU) session with user plane function (UPF).

BACKGROUND

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[0002] The following description of the related art is intended to provide background information pertaining to the field of the disclosure. This section may include certain aspects of the art that may be related to various features of the present disclosure. However, it should be appreciated that this section is used only to enhance the understanding of the reader with respect to the present
15 disclosure, and not as admissions of the prior art.

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

30 [0004] In a communication network (typically a 5G communication network) the session establishment takes place through steps of access and registration; session management; configuration of policy to be followed, setting up of quality of service (QoS), resource allocation; and finally, the transmission of the data over the network. In the session management, once the user equipment (UE) requests for protocol data unit (PDU) session, the Access and Mobility
35 Management Function (AMF) sends the session management request to the Session Management

Function (SMF). The AMF is a 5G core network function that manages access and mobility including but not limited to UE registration, connection, mobility management procedures like handovers and paging. The SMF, also a 5G core network function caters to the role of managing, establishing, modifying, and releasing sessions by way of network resources allocation and configuration of the User Plane Function (UPF). It coordinates with the UPF for data forwarding and handles IP address allocation and QoS enforcement. The UPF is responsible for handling user data traffic and routing it appropriately. Since, there are multiple user plane functions (UPFs) available in the communication network, the SMF decides which UPFs to link to. This is done on the basis of various parameters such as but not limited to Public Land Mobile Network (PLMN), slice, data network name (DNN), and tracking area code (TAC), etc.

[0005] In some uncertain situations, although the SMF selects the UPF, the UPF may reject to handle the request, for reason such as but not limited to lack of network resources available with the UPF. In said uncertain situations, the SMF then rejects to serve the request from user equipment (UE). The UE will then re-send the request and keep on re-sending the requests to the SMF till the UPF accepts the request of the UE during the setup of a PDU session. This may lead to a lot of signalling network resources being wasted in the tedious process of assigning/ selecting the UPF by the SMF and then completing establishment of a PDU session in case of a rejection for an originally selected UPF by the SMF. This aggravates further rejection by the SMF for the UE, and the UE eventually attempts again to make a request for network access in the communication network.

[0006] Thus, there exists an imperative need in the art to provide a method and system for re-trying the same or different user plane functions (UPFs) by the SMF for packet data unit (PDU) session establishment that saves signalling resources, processing power, and time, which the present disclosure aims to address.

SUMMARY OF THE DISCLOSURE

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

[0008] An aspect of the present disclosure may relate to a method for establishing packet data unit (PDU) session with user plane function (UPF). The method comprises receiving, by a transceiver

unit, a request from a User Equipment (UE). It is to be noted that the request is for obtaining a plurality of network resources. The method further comprises selecting, by a selection unit, a first UPF module from a plurality of UPF modules for serving the received request. It is to be noted that serving the received request comprises assigning the requested plurality of network resources to said UE. The method further comprises sending, by the transceiver unit, the request to the first selected UPF module. And, the method further comprises, upon sending the request, receiving, by the transceiver unit, a response from the first selected UPF module. It is to be noted that the response comprises one of an acceptance and a rejection of serving of said request.

[0009] In an exemplary aspect of the present disclosure, in the disclosed method, the selection of the UPF module, by the selection unit, is based on checking of one or more configuration parameters associated with the UPF module. It is to be noted that the one or more configuration parameters comprise at least one of a Public Land Mobile Network (PLMN), Slice, Data Network Name (DNN), and Tracking Area Code (TAC).

[0010] In an exemplary aspect of the present disclosure, in the disclosed method, the request is accepted by the first selected UPF module in an event when a number of available network resources with the first UPF module is greater than or equal to the number of requested plurality of network resources for serving the request.

[0011] In an exemplary aspect of the present disclosure, in the disclosed method, the request is rejected by the first selected UPF module in an event when the number of available network resources with the first UPF module is less than the number of requested plurality of network resources for serving the request.

[0012] In an exemplary aspect of the present disclosure, the method further comprises, upon receiving a rejection response, performing, by the selection unit, selection of another UPF module to serve said request received from the UE. The method further comprises transmitting, by the transceiver unit, the request to another selected UPF module.

[0013] In an exemplary aspect of the present disclosure, the method further comprises, upon receiving the rejection response, performing, by the selection unit, the selection of another UPF module, to serve said request, for a pre-defined number of times.

[0014] In an exemplary aspect of the present disclosure, in the disclosed method, the pre-defined number of times is based on a weightage associated with said another UPF module.

5 [0015] In an exemplary aspect of the present disclosure, the method further comprises, upon receiving the rejection response, selecting by the selection unit, another UPF module, to serve said request, for a pre-defined amount of time.

10 [0016] In an exemplary aspect of the present disclosure, the method further comprises, upon receiving a rejection response from the first UPF module, performing, by an analysis unit, a secondary analysis of the rejection response. It is to be noted that the secondary analysis comprises assessing a reason of the rejection of the request by the first UPF module; based on the analysis, generating a report; and causing to store the generated report in a data repository.

15 [0017] In an exemplary aspect of the present disclosure, the method further comprises, upon receiving a rejection response from each of the plurality of UPF modules, transmitting, by the transceiver unit, a request rejection acknowledgement to the UE.

20 [0018] Another aspect of the present disclosure may relate to a system for establishing packet data unit (PDU) session with user plane function (UPF). The system comprises a transceiver unit configured to receive a request from a User Equipment (UE). It is to be noted that the request is for obtaining a plurality of network resources. The system further comprises a selection unit configured to select a first UPF module from a plurality of UPF modules for serving the received request. It is to be noted that the serving the received request comprises assigning the requested plurality of network resources to said UE. The transceiver unit is further configured to send the request to the first selected UPF module. Upon sending the request, the transceiver unit is further configured to receive a response from the first selected UPF module. It is to be noted that the response comprises one of an acceptance and a rejection of serving of said request.

30 [0019] Yet another aspect of the present disclosure may relate to a non-transitory computer readable storage medium storing instruction for establishing packet data unit (PDU) session with user plane function (UPF), the instructions include executable code which, when executed by a one or more units of a system, causes: a transceiver unit to receive a request from a User Equipment (UE). It is to be noted that the request is for obtaining a plurality of network resources. The instructions further cause a selection unit to select a first UPF module from a plurality of UPF modules for serving the received request. It is to be noted that serving the received request

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comprises assigning the requested plurality of network resources to said UE. The instructions further cause the transceiver unit to send the request to the first selected UPF module; and upon sending the request, receive a response from the first selected UPF module. It is to be noted that the response comprises one of an acceptance and a rejection of serving of said request.

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[0020] Yet another aspect of the present disclosure may relate to a user equipment (UE) that comprises a transceiver unit configured to transmit a request for obtaining a plurality of network resources. The transceiver unit is further configured to receive one of a request acceptance acknowledgement and a request rejection acknowledgement. It is to be noted that the request
10 acceptance acknowledgement is received based on an acceptance of serving of said request by a first user plane function (UPF) module from a plurality of UPF modules. It is further noted that the first UPF module is selected from the plurality of UPF modules based on a comparison of a number of available network resources with the first UPF module and a number of the requested plurality of network resources. It is furthermore noted that the number of available network
15 resources with the first UPF module is greater than or equal to the number of the requested plurality of network resources.

OBJECTS OF THE DISCLOSURE

20 [0021] Some of the objects of the present disclosure, which at least one embodiment disclosed herein satisfies are listed herein below.

[0022] It is an object of the present disclosure to provide a system and a method for re-trying a request for user plane functions (UPFs) for packet data unit (PDU) session establishment that saves
25 signaling resources.

[0023] It is another object of the present disclosure to provide a solution for re-trying for user plane functions (UPFs) for packet data unit (PDU) session establishment that saves processing power and time.

30

DESCRIPTION OF THE DRAWINGS

[0024] 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
35 reference numerals refer to the same parts throughout the different drawings. Components in the

drawings are not necessarily to scale, emphasis instead being placed upon clearly illustrating the principles of the present disclosure. Also, the embodiments shown in the figures are not to be construed as limiting the disclosure, but the possible variants of the method and system according to the disclosure are illustrated herein to highlight the advantages of the disclosure. It will be appreciated by those skilled in the art that disclosure of such drawings includes disclosure of electrical components or circuitry commonly used to implement such components.

[0025] FIG. 1 illustrates an exemplary block diagram representation of 5th generation core (5GC) network architecture.

[0026] FIG. 2 illustrates an exemplary block diagram of a computing device upon which the features of the present disclosure may be implemented in accordance with exemplary implementation of the present disclosure.

[0027] Fig. 3 illustrates an exemplary block diagram of a system for establishing packet data unit (PDU) session with user plane function (UPF), in accordance with exemplary implementations of the present disclosure.

[0028] Fig. 4 illustrates a method flow diagram for establishing packet data unit (PDU) session with user plane function (UPF) in accordance with exemplary implementations of the present disclosure.

[0029] Fig. 5 illustrates another method flow diagram for session establishment with user plane function (UPF) in accordance with exemplary implementations of the present disclosure.

[0030] The foregoing shall be more apparent from the following more detailed description of the disclosure.

DETAILED DESCRIPTION

[0031] In the following description, for the purposes of explanation, various specific details are set forth in order to provide a thorough understanding of embodiments of the present disclosure. It will be apparent, however, that embodiments of the present disclosure may be practiced without these specific details. Several features described hereafter may each be used independently of one

another or with any combination of other features. An individual feature may not address any of the problems discussed above or might address only some of the problems discussed above.

[0032] The ensuing description provides exemplary embodiments only, and is not intended to limit the scope, applicability, or configuration of the disclosure. Rather, the ensuing description of the exemplary embodiments will provide those skilled in the art with an enabling description for implementing an exemplary embodiment. It should be understood that various changes may be made in the function and arrangement of elements without departing from the spirit and scope of the disclosure as set forth.

[0033] Specific details are given in the following description to provide a thorough understanding of the embodiments. However, it will be understood by one of ordinary skill in the art that the embodiments may be practiced without these specific details. For example, circuits, systems, processes, and other components may be shown as components in block diagram form in order not to obscure the embodiments in unnecessary detail.

[0034] Also, it is noted that individual embodiments may be described as a process which is depicted as a flowchart, a flow diagram, a data flow diagram, a structure diagram, or a block diagram. Although a flowchart may describe the operations as a sequential process, many of the operations may be performed in parallel or concurrently. In addition, the order of the operations may be re-arranged. A process is terminated when its operations are completed but could have additional steps not included in a figure.

[0035] The word “exemplary” and/or “demonstrative” is used herein to mean serving as an example, instance, or illustration. For the avoidance of doubt, the subject matter disclosed herein is not limited by such examples. In addition, any aspect or design described herein as “exemplary” and/or “demonstrative” is not necessarily to be construed as preferred or advantageous over other aspects or designs, nor is it meant to preclude equivalent exemplary structures and techniques known to those of ordinary skill in the art. Furthermore, to the extent that the terms “includes,” “has,” “contains,” and other similar words are used in either the detailed description or the claims, such terms are intended to be inclusive—in a manner similar to the term “comprising” as an open transition word—without precluding any additional or other elements.

[0036] As used herein, a “processing unit” or “processor” or “operating processor” includes one or more processors, wherein processor refers to any logic circuitry for processing instructions. A

processor may be a general-purpose processor, a special purpose processor, a conventional processor, a digital signal processor, a plurality of microprocessors, one or more microprocessors in association with a (Digital Signal Processing) DSP core, a controller, a microcontroller, Application Specific Integrated Circuits, Field Programmable Gate Array circuits, any other type of integrated circuits, etc. The processor may perform signal coding data processing, input/output processing, and/or any other functionality that enables the working of the system according to the present disclosure. More specifically, the processor or processing unit is a hardware processor.

[0037] As used herein, “a user equipment”, “a user device”, “a smart-user-device”, “a smart-device”, “an electronic device”, “a mobile device”, “a handheld device”, “a wireless communication device”, “a mobile communication device”, “a communication device” may be any electrical, electronic and/or computing device or equipment, capable of implementing the features of the present disclosure. The user equipment/device may include, but is not limited to, a mobile phone, smart phone, laptop, a general-purpose computer, desktop, personal digital assistant, tablet computer, wearable device or any other computing device which may implement the features of the present disclosure. Also, the user device may contain at least one input means configured to receive an input from at least one of a transceiver unit, a processing unit, a storage unit, a detection unit and any other such unit(s) which are required to implement the features of the present disclosure.

[0038] As used herein, “storage unit” or “memory unit” refers to a machine or computer-readable medium including any mechanism for storing information in a form readable by a computer or similar machine. For example, a computer-readable medium includes read-only memory (“ROM”), random access memory (“RAM”), magnetic disk storage media, optical storage media, flash memory devices or other types of machine-accessible storage media. The storage unit stores at least the data that may be required by one or more units of the system to perform their respective functions.

[0039] As used herein “interface” or “user interface refers to a shared boundary across which two or more separate components of a system exchange information or data. The interface may also be referred to a set of rules or protocols that define communication or interaction of one or more modules or one or more units with each other, which also includes the methods, functions, or procedures that may be called.

[0040] All modules, units, components used herein, unless explicitly excluded herein, may be software modules or hardware processors, the processors being a general-purpose processor, a special purpose processor, a conventional processor, a digital signal processor (DSP), a plurality of microprocessors, one or more microprocessors in association with a DSP core, a controller, a microcontroller, Application Specific Integrated Circuits (ASIC), Field Programmable Gate Array circuits (FPGA), any other type of integrated circuits, etc.

[0041] As used herein the transceiver unit include at least one receiver and at least one transmitter configured respectively for receiving and transmitting data, signals, information or a combination thereof between units/components within the system and/or connected with the system.

[0042] As discussed in the background section, the current known solutions have several shortcomings. The present disclosure aims to overcome the above-mentioned and other existing problems in this field of technology by providing method and system for establishing packet data unit (PDU) session with user plane function (UPF).

[0043] FIG. 1 illustrates an exemplary block diagram representation of 5th generation core (5GC) network architecture, in accordance with exemplary implementation of the present disclosure. As shown in FIG. 1, the 5GC network architecture [100] includes a user equipment (UE) [102], a radio access network (RAN) [104], an access and mobility management function (AMF) [106], a Session Management Function (SMF) [108], a Service Communication Proxy (SCP) [110], an Authentication Server Function (AUSF) [112], a Network Slice Specific Authentication and Authorization Function (NSSAAF) [114], a Network Slice Selection Function (NSSF) [116], a Network Exposure Function (NEF) [118], a Network Repository Function (NRF) [120], a Policy Control Function (PCF) [122], a Unified Data Management (UDM) [124], an application function (AF) [126], a User Plane Function (UPF) [128], a data network (DN) [130], wherein all the components are assumed to be connected to each other in a manner as obvious to the person skilled in the art for implementing features of the present disclosure.

[0044] The Radio Access Network (RAN) [104] is the part of a mobile telecommunications system that connects user equipment (UE) [102] to the core network (CN) and provides access to different types of networks (e.g., 5G network). It consists of radio base stations and the radio access technologies that enable wireless communication.

[0045] The Access and Mobility Management Function (AMF) [106] is a 5G core network function responsible for managing access and mobility aspects, such as UE registration, connection, and reachability. It also handles mobility management procedures like handovers and paging.

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[0046] The Session Management Function (SMF) [108] is a 5G core network function responsible for managing session-related aspects, such as establishing, modifying, and releasing sessions. It coordinates with the User Plane Function (UPF) for data forwarding and handles IP address allocation and QoS enforcement.

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[0047] The Service Communication Proxy (SCP) [110] is a network function in the 5G core network that facilitates communication between other network functions by providing a secure and efficient messaging service. It acts as a mediator for service-based interfaces.

15 [0048] The Authentication Server Function (AUSF) [112] is a network function in the 5G core responsible for authenticating UEs during registration and providing security services. It generates and verifies authentication vectors and tokens.

[0049] The Network Slice Specific Authentication and Authorization Function (NSSAAF) [114] is a network function that provides authentication and authorization services specific to network slices. It ensures that UEs can access only the slices for which they are authorized.

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[0050] The Network Slice Selection Function (NSSF) [116] is a network function responsible for selecting the appropriate network slice for a UE based on factors such as subscription, requested services, and network policies.

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[0051] The Network Exposure Function (NEF) [118] is a network function that exposes capabilities and services of the 5G network to external applications, enabling integration with third-party services and applications.

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[0052] The Network Repository Function (NRF) [120] is a network function that acts as a central repository for information about available network functions and services. It facilitates the discovery and dynamic registration of network functions.

[0053] The Policy Control Function (PCF) [122] is a network function responsible for policy control decisions, such as QoS, charging, and access control, based on subscriber information and network policies.

5 [0054] The Unified Data Management (UDM) [124] is a network function that centralizes the management of subscriber data, including authentication, authorization, and subscription information.

10 [0055] The Application Function (AF) [126] is a network function that represents external applications interfacing with the 5G core network to access network capabilities and services.

[0056] The User Plane Function (UPF) [128] is a network function responsible for handling user data traffic, including packet routing, forwarding, and QoS enforcement.

15 [0057] The Data Network (DN) [130] refers to a network that provides data services to user equipment (UE) in a telecommunications system. The data services may include but are not limited to Internet services, private data network related services.

20 [0058] FIG. 2 illustrates an exemplary block diagram of a computing device [200] upon which the features of the present disclosure may be implemented in accordance with exemplary implementation of the present disclosure. In an implementation, the computing device [200] may also implement a method for establishing packet data unit (PDU) session with user plane function (UPF) utilising the system. In another implementation, the computing device [200] itself implements the method for establishing packet data unit (PDU) session with user plane function
25 (UPF) using one or more units configured within the computing device [200], wherein said one or more units are capable of implementing the features as disclosed in the present disclosure.

[0059] The computing device [200] may include a bus [202] or other communication mechanism for communicating information, and a hardware processor [204] coupled with bus [202] for
30 processing information. The hardware processor [204] may be, for example, a general-purpose microprocessor. The computing device [200] may also include a main memory [206], such as a random-access memory (RAM), or other dynamic storage device, coupled to the bus [202] for storing information and instructions to be executed by the processor [204]. The main memory [206] also may be used for storing temporary variables or other intermediate information during
35 execution of the instructions to be executed by the processor [204]. Such instructions, when stored

in non-transitory storage media accessible to the processor [204], render the computing device [200] into a special-purpose machine that is customized to perform the operations specified in the instructions. The computing device [200] further includes a read only memory (ROM) [208] or other static storage device coupled to the bus [202] for storing static information and instructions
5 for the processor [204].

[0060] A storage device [210], such as a magnetic disk, optical disk, or solid-state drive is provided and coupled to the bus [202] for storing information and instructions. The computing device [200] may be coupled via the bus [202] to a display [212], such as a cathode ray tube (CRT),
10 Liquid crystal Display (LCD), Light Emitting Diode (LED) display, Organic LED (OLED) display, etc. for displaying information to a computer user. An input device [214], including alphanumeric and other keys, touch screen input means, etc. may be coupled to the bus [202] for communicating information and command selections to the processor [204]. Another type of user input device may be a cursor controller [216], such as a mouse, a trackball, or cursor direction
15 keys, for communicating direction information and command selections to the processor [204], and for controlling cursor movement on the display [212]. The input device typically has two degrees of freedom in two axes, a first axis (e.g., x) and a second axis (e.g., y), that allow the device to specify positions in a plane.

[0061] The computing device [200] may implement the techniques described herein using customized hard-wired logic, one or more ASICs or FPGAs, firmware and/or program logic which in combination with the computing device [200] causes or programs the computing device [200] to be a special-purpose machine. According to one implementation, the techniques herein are performed by the computing device [200] in response to the processor [204] executing one or more
25 sequences of one or more instructions contained in the main memory [206]. Such instructions may be read into the main memory [206] from another storage medium, such as the storage device [210]. Execution of the sequences of instructions contained in the main memory [206] causes the processor [204] to perform the process steps described herein. In alternative implementations of the present disclosure, hard-wired circuitry may be used in place of or in combination with
30 software instructions.

[0062] The computing device [200] also may include a communication interface [218] coupled to the bus [202]. The communication interface [218] provides a two-way data communication coupling to a network link [220] that is connected to a local network [222]. For example, the
35 communication interface [218] may be an integrated services digital network (ISDN) card, cable

modem, satellite modem, or a modem to provide a data communication connection to a corresponding type of telephone line. As another example, the communication interface [218] may be a local area network (LAN) card to provide a data communication connection to a compatible LAN. Wireless links may also be implemented. In any such implementation, the communication
5 interface [218] sends and receives electrical, electromagnetic or optical signals that carry digital data streams representing various types of information.

[0063] The computing device [200] can send messages and receive data, including program code, through the network(s), the network link [220] and the communication interface [218]. In the
10 Internet example, a server [230] might transmit a requested code for an application program through the Internet [228], the ISP [226], the host [224], the local network [222] and the communication interface [218]. The received code may be executed by the processor [204] as it is received, and/or stored in the storage device [210], or other non-volatile storage for later execution.

[0064] The present disclosure is implemented by a system [300] (as shown in FIG. 3). In an implementation, the system [300] may include the computing device [200] (as shown in FIG. 2). It is further noted that the computing device [200] is able to perform the steps of a method [400] (as shown in FIG. 4).

[0065] Referring to FIG. 3, an exemplary block diagram of a system [300] for establishing packet data unit (PDU) session with user plane function (UPF), is shown, in accordance with the exemplary implementations of the present disclosure. The system [300] comprises at least one transceiver unit [301], at least one selection unit [302] at least one data repository [303] and at least one analysis unit [304]. Also, all of the components/ units of the system [300] are assumed
25 to be connected to each other unless otherwise indicated below. As shown in the figures all units shown within the system should also be assumed to be connected to each other. Also, in FIG. 3 only a few units are shown, however, the system [300] may comprise multiple such units or the system [300] may comprise any such numbers of said units, as required to implement the features of the present disclosure. Further, in an implementation, the system [300] may be present in a user
30 device/ equipment to implement the features of the present disclosure. The system [300] may be a part of the user device / or may be independent of but in communication with the user device (may also referred herein as a UE). In another implementation, the system [300] may reside in a server or a network entity. In another implementation, the system [300] may be in communication with at least a plurality of UPF modules [306] and the UE.

[0066] The system [300] is configured for establishing packet data unit (PDU) session with user plane function (UPF), with the help of the interconnection between the components/units of the system [300].

5 [0067] The transceiver unit [301] is configured to receive a request from the User Equipment (UE). It is to be noted that the request is for obtaining a plurality of network resources. The plurality of network resources may correspond to resources associated with the plurality of UPF modules [306].

10 [0068] The selection unit [302] is configured to select a first UPF module from the plurality of UPF modules [306] for serving the received request. It is to be noted that the serving the received request comprises assigning the requested plurality of network resources to said UE.

15 [0069] The transceiver unit [301] is further configured to send the request to the first selected UPF module. Upon sending the request, the transceiver unit [301] is further configured to receive a response from the first selected UPF module. It is to be noted that the response comprises one of an acceptance and a rejection of serving of said request.

20 [0070] In an implementation of the present disclosure, the selection unit [302] is configured to select the UPF module based on checking of one or more configuration parameters associated with the UPF module. It is to be noted that the one or more configuration parameters comprise at least one of a Public Land Mobile Network (PLMN), Slice, Data Network Name (DNN), and Tracking Area Code (TAC).

25 [0071] In an implementation of the present disclosure, the request is accepted by the first selected UPF module in an event when a number of available network resources with the first UPF module is greater than or equal to the number of requested plurality of network resources for serving the request.

30 [0072] In an implementation of the present disclosure, the request is rejected by the first selected UPF module in an event when the number of available network resources with the first UPF module is less than the number of requested plurality of network resources for serving the request.

35 [0073] In an implementation of the present disclosure, the selection unit [302], upon receiving a rejection response, is further configured to perform selection of another UPF module to serve said

request received from the UE. And the transceiver unit [301] is further configured to transmit the request to another selected UPF module.

5 [0074] In an implementation of the present disclosure, the selection unit [302] is further configured to, upon receiving the rejection response, perform the selection of another UPF module to serve said request for a pre-defined number of times. It is important to note that the pre-defined number of times includes but is not limited to the number of attempts of performing the selection of UPF module, upon receiving a rejection response from the selected UPF. Generally, the value or magnitude of the number of times/attempts is based on the type of network design and operating policies in the communication network which may govern the selection process. For e.g.,
10 performing of the selection of the UPF module can be for a pre-defined number of 5 attempts, when the first attempt to select the UPF fails due to network congestion, unavailability, etc.

15 [0075] In an implementation of the present disclosure, the pre-defined number of times is based on a weightage associated with said another UPF module. It is important to note that the weightage here refers to a priority or a preference in selecting a particular UPF module. The weightage may relate to but is not limited to amount of network resources present with the UPF module, load balancing capability of the SMF which is selecting the UPF module, etc.

20 [0076] In an implementation of the present disclosure, the selection unit [302] is further configured to, upon receiving the rejection response, select another UPF module, to serve said request, for a pre-defined amount of time. It is important to note that the pre-defined amount of time may include but is not limited to an interval of time for which, the iterative selecting of another UPF module will take place. For e.g., the selection of another UPF module may be performed for a pre-defined
25 amount of time interval of 5-10 seconds/minutes, when the initial attempt to select the UPF fails. The pre-defined amount of time, as configured, may be based on the type of network design and operating policies in the communication network which may govern the selection process.

30 [0077] In an implementation of the present disclosure, an analysis unit [304] is further configured to, upon receiving a rejection response from the first UPF module, perform a secondary analysis of the rejection response. The secondary analysis comprises assessing a reason of the rejection of the request by the first UPF module. It further includes generating a report based on the analysis and storing the generated report in a data repository [303].

[0078] In an implementation of the present disclosure, the transceiver unit [301] is further configured to, upon receiving a rejection response from each of the plurality of UPF modules [306], transmit request rejection acknowledgement to the UE.

5 [0079] Referring to FIG. 4, an exemplary method flow diagram [400] for establishing packet data unit (PDU) session with user plane function (UPF), in accordance with exemplary implementations of the present disclosure is shown. In an implementation, the method [400] is performed by the system [300]. Further, in an implementation, the system [300] may be present in a server device to implement the features of the present disclosure. Also, as shown in FIG. 4, the
10 method [400] starts at step [402].

[0080] At step [404], the method [400] comprises receiving, by a transceiver unit [301], a request from a User Equipment (UE). It is to be noted that the request is for obtaining a plurality of network resources.

15

[0081] At step [406], the method [400] comprises selecting, by a selection unit [302], a first UPF module from a plurality of UPF modules [306] for serving the received request. It is to be noted that serving the received request comprises assigning the requested plurality of network resources to said UE.

20

[0082] In an exemplary aspect of the present disclosure, in the disclosed method [400], the selection of the UPF module, by the selection unit [302], is based on checking of one or more configuration parameters associated with the UPF module. It is to be noted that the one or more configuration parameters comprise at least one of a Public Land Mobile Network (PLMN), Slice, Data Network Name (DNN), and Tracking Area Code (TAC).
25

[0083] In an exemplary aspect of the present disclosure, in the disclosed method [400], the request is accepted by the first selected UPF module in an event when a number of available network resources with the first UPF module is greater than or equal to the number of requested plurality
30 of network resources for serving the request.

[0084] In an exemplary aspect of the present disclosure, in the disclosed method [400], the request is rejected by the first selected UPF module in an event when the number of available network resources with the first UPF module is less than the number of requested plurality of network
35 resources for serving the request.

[0085] At step [408], the method [400] comprises sending, by the transceiver unit [301], the request to the first selected UPF module.

- 5 [0086] At step [410], the method [400] comprises, upon sending the request, receiving, by the transceiver unit [301], a response from the first selected UPF module. It is to be noted that the response comprises one of an acceptance and a rejection of serving of said request.

10 [0087] In an exemplary aspect of the present disclosure, the method [400] further comprises, upon receiving a rejection response, performing, by the selection unit [302], selection of another UPF module to serve said request received from the UE. The method [400] further comprises, transmitting, by the transceiver unit [301], the request to another selected UPF module.

15 [0088] In an exemplary aspect of the present disclosure, the method [400] further comprises, upon receiving the rejection response, performing, by the selection unit [302], the selection of another UPF module, to serve said request, for a pre-defined number of times. It is important to note that the pre-defined number of times includes but is not limited to the number of attempts of performing the selection of UPF module, upon receiving a rejection response from the selected UPF. Generally, the value or magnitude of the number of times/attempts is based on the type of network
20 design and operating policies in the communication network which may govern the selection process. For e.g., performing of the selection of the UPF module can be for a pre-defined number of 5 attempts, when the first attempt to select the UPF fails due to network congestion, unavailability, etc.

25 [0089] In an exemplary aspect of the present disclosure, in the disclosed method [400], the pre-defined number of times is based on a weightage associated with said another UPF module. It is important to note that the weightage here refers to a priority or a preference in selecting a particular UPF module. The weightage may relate to but is not limited to amount of network resources present with the UPF module, load balancing capability of the SMF which is selecting the UPF
30 module, etc. The load balancing capability may be based upon the type of hardware capacity. For e.g., based on the hardware capacity, a value (weightage in other words) is given to the particular UPF module. Let's say a value of 10 is given to UPF-1 module and value of 20 to UPF-2. This indicates that the UPF-2 has twice the handling capacity of UPF-1. Thus, UPF-2 is prioritized/preferred over the UPF-1 for diverting the network traffic for more users/ subscribers. In other
35 words, the UPF-2 will be chosen for 20 subscribers as compared to the UPF-1.

[0090] In an exemplary aspect of the present disclosure, the method [400] further comprises, upon receiving the rejection response, selecting by the selection unit [302], another UPF module, to serve said request, for a pre-defined amount of time. It is important to note that the pre-defined amount of time may include but not limited to an interval of time for which, the iterative selecting of another UPF module will take place. For e.g., the selection of another UPF module may be performed for a pre-defined amount of time interval of 5-10 seconds/minutes, when the initial attempt to select the UPF fails. The pre-defined amount of time, as configured, may be based on the type of network design and operating policies in the communication network which may govern the selection process.

[0091] In an exemplary aspect of the present disclosure, the method [400] further comprises, upon receiving a rejection response from the first UPF module, performing, by an analysis unit [304], a secondary analysis of the rejection response. It is to be noted that the secondary analysis comprises assessing a reason of the rejection of the request by the first UPF module; and based on the analysis, generating a report; and causing to store the generated report in a data repository [303].

[0092] In an exemplary aspect of the present disclosure, the method [400] further comprises, upon receiving a rejection response from each of the plurality of UPF modules [306], transmitting, by the transceiver unit [301], a request rejection acknowledgement to the UE.

[0093] Thereafter, the method [400] terminates at step [412].

[0094] Referring to FIG. 5, an exemplary flow diagram [500], for session establishment with user plane function (UPF), in accordance with exemplary implementations of the present disclosure is shown.

[0095] As shown in flow diagram [500], at step [502], the AMF sends PDU establishment request to the SMF.

[0096] At step [504], the SMF sends Session Establishment Request (SER) to the User Plane Function (UPF)-1 for the selection of UPF. It is to be noted that the UPF-1 and the UPF-2 belonging to a pool, such as the plurality of UPF modules [306], as shown in FIG. 3. In an embodiment, the Session Establishment Request (SER) pertains to request sent by the SMF for establishing a data pathway between the UE and the core functions of the communication network.

[0097] At steps [506], the UPF-1 sends the negative Session Establishment (SE) response back to the SMF along with the number of resources available. It is to be noted that the negative Session Establishment (SE) response is sent back when the UPF-1 is unable to provide success response to the SER. This is due to reasons such as but not limited to an internal error in the core network function or resource limitations.

[0098] At steps [508], the SMF resends the SER to the UPF-2 for reselection of the UPF. Here, the UPF-2 refers to another UPF selected from the plurality of UPF modules [306] (as shown in Fig. 3), which gets selected when the request of first UPF i.e., UPF-1 gets rejected i.e., the SMF receives negative response from the UPF-1.

[0099] At steps [510], the UPF-2 sends the successful SE response back to the SMF.

[0100] At steps [512], the PDU session establishment request is concluded after being accepted by the SMF.

[0101] The present disclosure further discloses a non-transitory computer readable storage medium storing instruction for establishing packet data unit (PDU) session with user plane function (UPF) [300U], the instructions include executable code which, when executed by a one or more units of a system, causes: a transceiver unit [301] to receive a request from a User Equipment (UE). It is to be noted that the request is for obtaining a plurality of network resources. The instructions further cause a selection unit [302], connected to at least the transceiver unit [301], to select a first UPF module from a plurality of UPF modules [306] for serving the received request. It is to be noted that serving the received request comprises assigning the requested plurality of network resources to said UE. The instructions further cause the transceiver unit [301] to send the request to the first selected UPF module; and upon sending the request, receive a response from the first selected UPF module. It is to be noted that the response comprises one of an acceptance and a rejection of serving of said request.

[0102] Yet another aspect of the present disclosure may relate to a user equipment (UE) that comprises a transceiver unit [301] configured to transmit a request for obtaining a plurality of network resources. The transceiver unit [301] is further configured to receive one of a request acceptance acknowledgement and a request rejection acknowledgement. It is to be noted that the request acceptance acknowledgement is received based on an acceptance of serving of said request

by a first user plane function (UPF) module from a plurality of UPF modules [306]. It is further noted that the first UPF module is selected from the plurality of UPF modules [306] based on a comparison of a number of available network resources with the first UPF module and a number of the requested plurality of network resources. It is furthermore noted that the number of available
5 network resources with the first UPF module is greater than or equal to the number of the requested plurality of network resources.

[0103] Further, in accordance with the present disclosure, it is to be acknowledged that the functionality described for the various the components/units can be implemented interchangeably.

10 While specific embodiments may disclose a particular functionality of these units for clarity, it is recognized that various configurations and combinations thereof are within the scope of the disclosure. The functionality of specific units as disclosed in the disclosure should not be construed as limiting the scope of the present disclosure. Consequently, alternative arrangements and substitutions of units, provided they achieve the intended functionality described herein, are
15 considered to be encompassed within the scope of the present disclosure.

[0104] As is evident from the above, the present disclosure provides a technically advanced solution for establishing packet data unit (PDU) session with user plane function (UPF). The present solution provides for re-trying for user plane functions (UPFs) for packet data unit (PDU)
20 establishment. By implementing the features of the present invention, signalling resources are saved by enabling the SMF to re-try for the same or different UPFs in case the UPF selected by the SMF rejects serving the request of the user device. Further, implementing the features of the present invention will also save processing power and time by not sending a rejection indication to the user device in case of rejection received from the selected UPF by the SMF for serving the
25 request of the user device.

[0105] While considerable emphasis has been placed herein on the disclosed implementations, it will be appreciated that many implementations can be made and that many changes can be made to the implementations without departing from the principles of the present disclosure. These and
30 other changes in the implementations of the present disclosure will be apparent to those skilled in the art, whereby it is to be understood that the foregoing descriptive matter to be implemented is illustrative and non-limiting.

We Claim:

1. A method [400] for establishing packet data unit (PDU) session with user plane function (UPF), the method [400] comprising:

receiving, by a transceiver unit [301], a request from a User Equipment (UE),
5 wherein the request is for obtaining a plurality of network resources;

selecting, by a selection unit [302], a first UPF module from a plurality of UPF modules [306] for serving the received request, wherein serving the received request comprises assigning the requested plurality of network resources to said UE;

10 sending, by the transceiver unit [301], the request to the first selected UPF module; and

upon sending the request, receiving, by the transceiver unit [301], a response from the first selected UPF module, wherein the response comprises one of an acceptance and a rejection of serving of said request.

- 15 2. The method [400] as claimed in claim 1, wherein the selection of the first UPF module, by the selection unit [302], is based on checking of one or more configuration parameters associated with the UPF module, wherein the one or more configuration parameters comprise at least one of a Public Land Mobile Network (PLMN), Slice, Data Network Name (DNN), and Tracking Area Code (TAC).

- 20 3. The method [400] as claimed in claim 1, wherein the request is accepted by the first selected UPF module in an event when a number of available network resources with the first UPF module is greater than or equal to the number of requested plurality of network resources for serving the request.

- 25 4. The method [400] as claimed in claim 3, wherein the request is rejected by the first selected UPF module in an event when the number of available network resources with the first UPF module is less than the number of requested plurality of network resources for serving the request.

- 30 5. The method [400] as claimed in claim 4, further comprising:

upon receiving a rejection response, performing, by the selection unit [302], selection of another UPF module to serve said request received from the UE; and

transmit, by the transceiver unit [301], the request to the another selected UPF module.

6. The method [400] as claimed in claim 5, further comprising:
upon receiving the rejection response, performing, by the selection unit [302], the selection of another UPF module, to serve said request, for a pre-defined number of times.
- 5 7. The method [400] as claimed in claim 6, wherein the pre-defined number of times is based on a weightage associated with said another UPF module.
8. The method [400] as claimed in claim 5, further comprising:
upon receiving the rejection response, selecting by the selection unit [302], another UPF
10 module, to serve said request, for a pre-defined amount of time.
9. The method [400] as claimed in claim 4, further comprising:
upon receiving a rejection response from the first UPF module, performing, by an analysis unit [304], a secondary analysis of the rejection response, wherein the secondary analysis
15 comprises assessing a reason of the rejection of the request by the first UPF module;
based on the analysis, generating a report; and
causing to store the generated report in a data repository [303].
10. The method [400] as claimed in claim 5, further comprising:
20 upon receiving a rejection response from each of the plurality of UPF modules [306], transmitting, by the transceiver unit [301], a request rejection acknowledgement to the UE.
11. A system [300] for establishing packet data unit (PDU) session with user plane function (UPF), the system [300] comprising:
25 a transceiver unit [301] configured to:
receive a request from a User Equipment (UE), wherein the request is for obtaining a plurality of network resources;
a selection unit [302], connected to at least the transceiver unit [301], the selection unit [302] configured to:
30 select a first UPF module from a plurality of UPF modules [306] for serving the received request, wherein serving the received request comprises assigning the requested plurality of network resources to said UE;
wherein the transceiver unit [301] is further configured to:
send the request to the first selected UPF module; and

upon sending the request, receive a response from the first selected UPF module, wherein the response comprises one of an acceptance and a rejection of serving of said request.

- 5 **12.** The system [300] as claimed in claim 11, wherein the selection unit [302] is configured to select the first UPF module based on checking of one or more configuration parameters associated with the UPF module, wherein the one or more configuration parameters comprise at least one of a Public Land Mobile Network (PLMN), Slice, Data Network Name (DNN), and Tracking Area Code (TAC).
- 10
- 13.** The system [300] as claimed in claim 11, wherein the request is accepted by the first selected UPF module in an event when a number of available network resources with the first UPF module is greater than or equal to the number of requested plurality of network resources for serving the request.
- 15
- 14.** The system [300] as claimed in claim 13, wherein the request is rejected by the first selected UPF module in an event when the number of available network resources with the first UPF module is less than the number of requested plurality of network resources for serving the request.
- 20
- 15.** The system [300] as claimed in claim 14, wherein the selection unit [302] is to further:
 upon receiving a rejection response, perform selection of another UPF module to serve said request received from the UE; and
 the transceiver unit [301] is further configured to transmit the request to the another
25 selected UPF module.
- 16.** The system [300] as claimed in claim 15, wherein the selection unit [302] is to further:
 upon receiving the rejection response, perform the selection of another UPF
module, to serve said request, for a pre-defined number of times.
- 30
- 17.** The system [300] as claimed in claim 16, wherein the pre-defined number of times is based on a weightage associated with said another UPF module.
- 18.** The system [300] as claimed in claim 15, wherein the selection unit [302] is to further:

upon receiving the rejection response, select another UPF module, to serve said request, for a pre-defined amount of time.

- 5 **19.** The system [300] as claimed in claim 14, wherein an analysis unit [304] is to further:
 upon receiving a rejection response from the first UPF module, perform a secondary analysis of the rejection response, wherein the secondary analysis comprises assessing a reason of the rejection of the request by the first UPF module;
 based on the analysis, generate a report; and
 store the generated report in a data repository [303].

- 10 **20.** The system [300] as claimed in claim 15, wherein the transceiver unit [301] is to further:
 upon receiving a rejection response from each of the plurality of UPF modules [306], transmit request rejection acknowledgement to the UE.

- 15 **21.** A user equipment (UE) comprising:
 - a transceiver unit [301] configured to
 o transmit a request for obtaining a plurality of network resources; and
 o receive one of a request acceptance acknowledgement and a request rejection acknowledgement,
 wherein, the request acceptance acknowledgement is received based on an acceptance of serving of said request by a first user plane function (UPF) module from a plurality of UPF modules [306],
 wherein the first UPF module is selected from the plurality of UPF modules
20 [306] based on a comparison of a number of available network resources with the first UPF module and a number of the requested plurality of network resources, and
 wherein the number of available network resources with the first UPF module is greater than or equal to the number of the requested plurality of network resources.

- 25 **22.** A non-transitory computer-readable storage medium storing instructions for establishing packet data unit (PDU) session with user plane function (UPF), the storage medium comprising executable code which, when executed by one or more units of a system, causes:
30

a transceiver unit [301] to receive a request from a User Equipment (UE), wherein the request is for obtaining a plurality of network resources;

a selection unit [302] to select a first UPF module from a plurality of UPF modules [306] for serving the received request, wherein serving the received request comprises assigning the requested plurality of network resources [300N] to said UE;

the transceiver unit [301] to send the request to the first selected UPF module; and upon sending the request, the transceiver unit [301] to receive a response from the first selected UPF module, wherein the response comprises one of an acceptance and a rejection of serving of said request.

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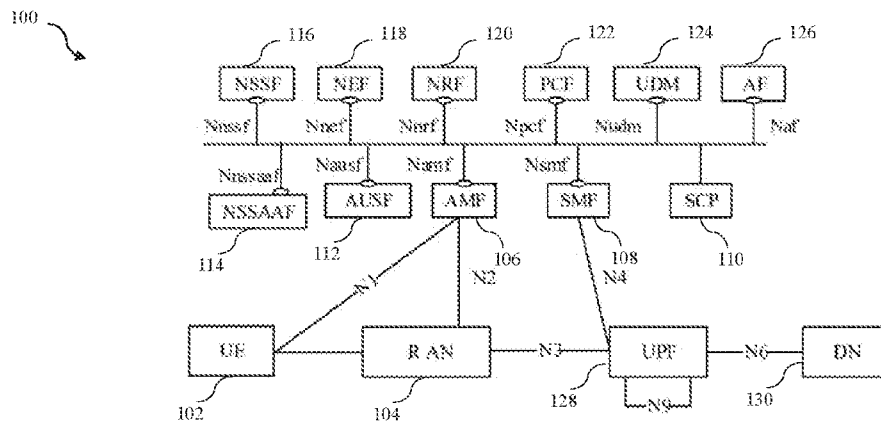


FIG. 1

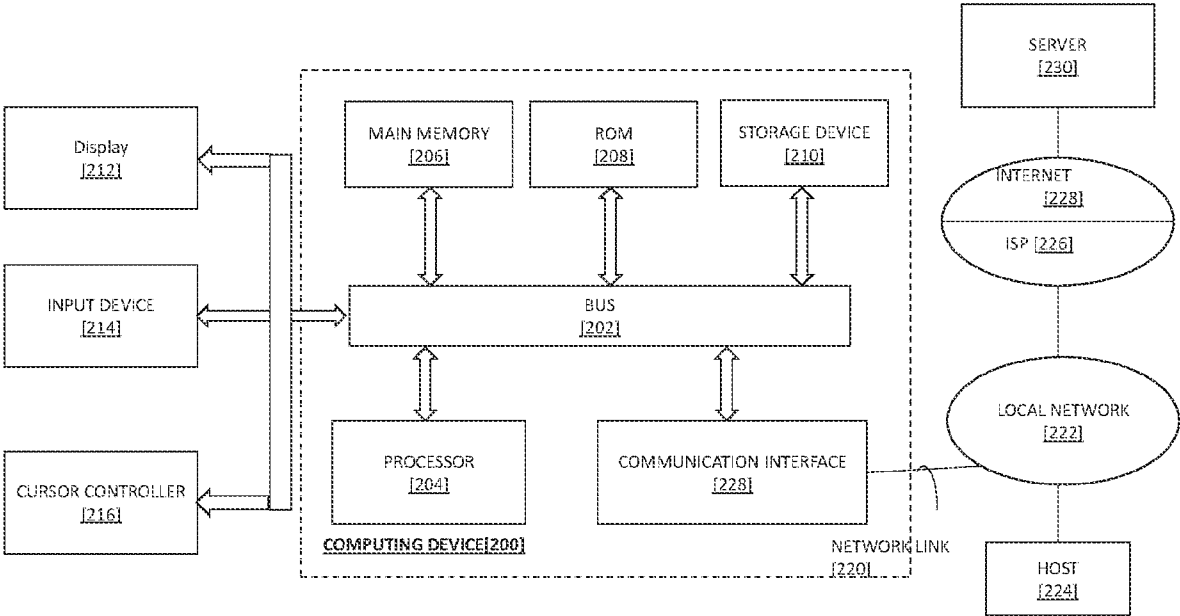


FIG. 2

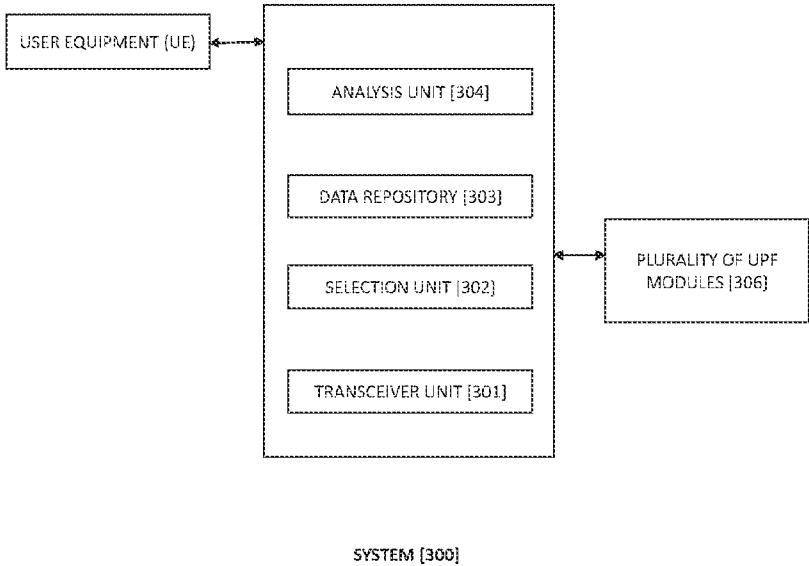


FIG. 3

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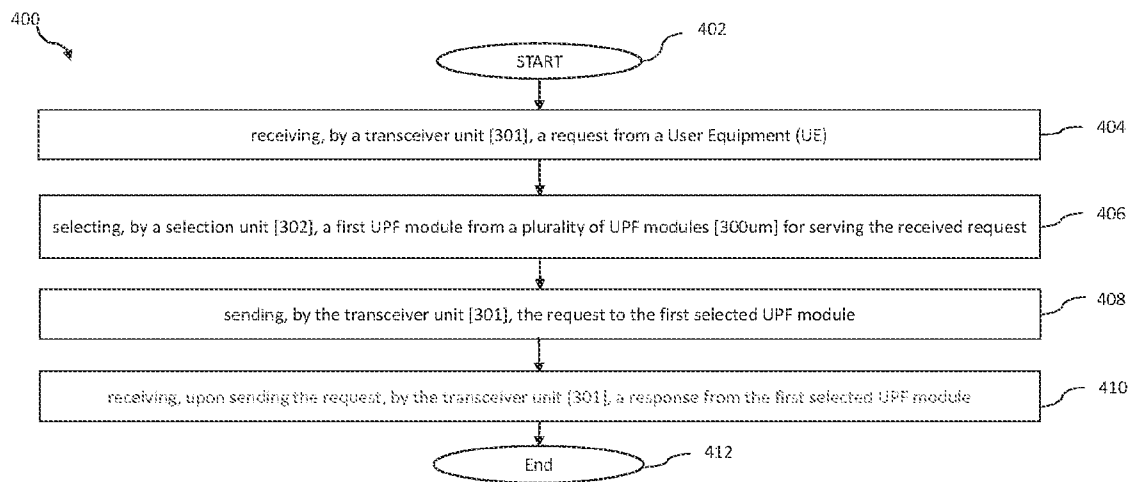


FIG. 4

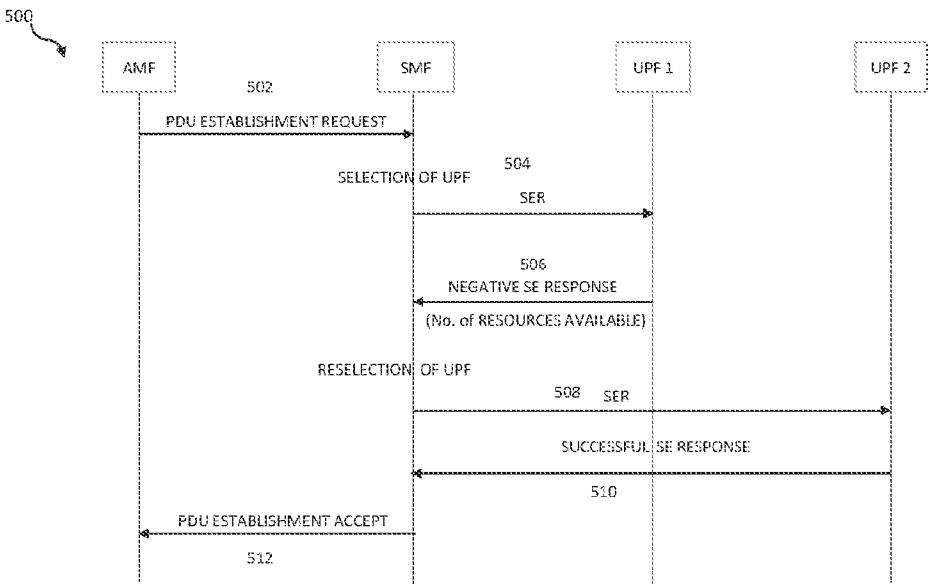


FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.

PCT/IN2024/050877

A. CLASSIFICATION OF SUBJECT MATTER

H04W76/12, H04W80/10 Version=2024.01

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H04W

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)

Databases: PatSeer, IPO Internal Database

Keywords: UPF, PDU session, 5G

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US11191088B2 (TELEFONAKTIEBOLAGET LM ERICSSON AB), 30 November 2021 (30-11-2021) Whole document	1-22

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

* Special categories of cited documents:

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

"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)

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"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

14-10-2024

Date of mailing of the international search report

14-10-2024

Name and mailing address of the ISA/

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/IN2024/050877

Citation	Pub.Date	Family	Pub.Date
US 11191088 B2	30-11-2021	US 20200068587 A1	27-02-2020