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(54) **Intelligens P-GW áthelyezés SIPTO szolgáltatás folytonossága érdekében**

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(54) **INTELLIGENT P-GW RELOCATION FOR SIPTO SERVICE CONTINUITY**

INTELLIGENTE P-GW-VERLAGERUNG FÜR SIPTO-DIENSTKONTINUITÄT

DÉPLACEMENT INTELLIGENT DE PASSERELLE DE RÉSEAU DE DONNÉES PAR PAQUETS POUR ASSURER LA CONTINUITÉ D'UN SERVICE DE DÉLESTAGE DE TRAFIC DE PROTOCOLE INTERNET SÉLECTIONNÉ

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## Description

**[0001]** The following description relates to communication networks.

## BACKGROUND

**[0002]** Modem information networks are often combinations of data networks, including heterogeneous combinations. Often, a client device connected to a first network communicate with a second network (e.g., connect to services of the second network) via the first network. The two networks can use different protocols (e.g., addressing, framing, packetizing, etc.) to address devices or transmit data. Devices, such as network bridges or gateways, can be used to allow client devices to communicate from the first network (e.g., the network to which the client device is initially connected) by translating client device communications between the different protocols of the two networks.

**[0003]** In modem cellular networks, such as a networks adhering to the 3GPP Long Term Evolution Advanced (LTE-A) (e.g., 3GPP Long Term Evolution release 10, 3GPP standard 36.21X vb.x.x, release 11 and beyond) family of standards, user equipment (UE) (e.g., client devices such as cellular telephones, tablet computers, or other computing or communications devices) can initially connect to a cellular provider's core network for voice or data services. Through this core network, capable UEs can connect to packet data networks (PDNs), such as the Internet, for additional services. In LTE-A networks, the UE generally first interfaces with a serving gateway (S-GW) of the core network, and, based on this UE point of attachment, a PDN gateway (P-GW) is selected and associated with the UE. The UE's traffic is routed from the S-GW through the core network to the selected PDN gateway (P-GW) that then interfaces with the PDN. This process is known as selected internet protocol (IP) traffic offload (SIPTO).

**[0004]** WO 2011/034173 relates to an arrangement in which, when user equipment (UE) connects from an area, in which the user equipment currently exists, to an external network, the user equipment can reselect an optimum gateway. According to a communication method in LIPA/SIPTO architecture, the user equipment selects a gateway apparatus, which is physically or topologically near to a point to which the user equipment is attached, in accordance with a movement of the user equipment.

## SUMMARY

**[0005]** Aspects and embodiments are set out in the appended claims. According to some aspects and embodiments, network efficiency and/or session continuity may be improved relative to at least some prior arrangements.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0006]** In the drawings, which are not necessarily drawn to scale, like numerals may describe similar components in different views. Like numerals having different letter suffixes may represent different instances of similar components. The drawings illustrate generally, by way of example, but not by way of limitation, various embodiments discussed in the present document.

Fig. 1 illustrates an example system including an example network infrastructure component to perform intelligent P-GW relocation for SIPTO service continuity, according to one embodiment.

Figs. 2A-B illustrate two views of P-GW relocation for a UE physically moving in a core network at different points in time, according to one embodiment.

Fig. 3 illustrates example components of a UE to report network session state to a network infrastructure component, according to one embodiment.

Fig. 4 illustrates an example application catalog that can be used to facilitate intelligent P-GW relocation for SIPTO service continuity, according to one embodiment.

Fig. 5 illustrates a flowchart for an example method of intelligent P- GW relocation for SIPTO service continuity, according to one embodiment.

Fig. 6 illustrates a flowchart for an example method of determining a time period to meet an impact metric of network session continuity using an application catalog, according to one embodiment.

Fig. 7 illustrates a flowchart for an example method of determining a time period to meet an impact metric of network session continuity using information collected by the UE, according to one embodiment.

Fig. 8 illustrates a flowchart for an example method of monitoring UE network session state via network quality of service indicators.

Fig. 9 illustrates a block diagram illustrating an example machine upon which one or more embodiments can be implemented.

## DETAILED DESCRIPTION

**[0007]** For illustrative purposes the core network, UE, or system examples discussed below generally adhere to the LTE-A family of standards. However, the disclosed systems, apparatuses, or methods are not so limited and are applicable to other network configurations.

**[0008]** In networks that use the previously described S-GW and P-GW arrangement, the P-GW can assign one or more PDN characteristics to the UE. For example, to communicate with the internet, the UE can be assigned an IP address by the P-GW. In an example, changing the PDN characteristics can impact the network session continuity of an active PDN session. For example, changing the UE's IP address while a video is streaming to the UE can result in an interruption of the video. Maintaining

session continuity is a provider goal in order to meet customer expectations.

**[0009]** Maintaining an efficient core network is another goal for service providers. As a UE moves through space (e.g., as a mobile phone travels about a city with its operator) the UE can interface with different access points (e.g., a base station, eNb, wireless transmission points, etc.) during its travels. These access points can be associated with different S-GWs. If, for example, a PDN session were initiated at a first S-GW, a corresponding P-GW would be associated to the UE. As the UE moved and changed S-GWs, the provider may desire changing the P-GW to address its network efficiency concern because the original P-GW may be too distant from a current S-GW (e.g., in the number of network devices communications must pass through, physical distance, etc.) to be efficient. However, because PDN characteristics are assigned to the UE by the original P-GW, changing the P-GW during an active PDN session can lead to PDN session interruptions and negatively affect the provider's goal of maintaining session continuity. This issue can be exacerbated by the proliferation of UE always-on connectivity. Placing P-GWs deeper into the provider's core network (e.g., were a P-GW can serve more S-GWs with nearly equivalent efficiency) can abate some session continuity issues at the expense of efficiently offloading the PDN traffic from the core network.

**[0010]** Intelligent P-GW relocation (e.g., changing P-GWs) for SIPTO service continuity can address providers' dual goals of maintaining session continuity and maintaining an efficient core network. By monitoring, for example at a network infrastructure component of the core network, network session state for a UE and determining a transition window based on both that network session state and a session continuity impact metric, the UE can be associated with a new P-GW during the transition window in response to a determination that the current UE P-GW is less optimal, in at least one performance metric, than the new P-GW.

**[0011]** For example, given a UE application that can have active PDN sessions-such as when: transferring files using file transfer protocol (FTP); web browsing; downloading hypertext markup language (HTML); streaming video; using voice over IP (VOIP); video calling; and instant messaging among others-the UE application can have inactivity periods (e.g., time periods of no activity or of activity that can be quickly resumed by the application) where the PDN session can be interrupted (e.g., changing the UE's IP address) without any, or with minimal, interruption to the service continuity as perceived by the UE's user. Thus, a window can exist during these inactivity periods whereby transitioning from one P-GW to another, along with an IP address change for the UE, does not interrupt the service continuity. Accurate determination of these transition windows can lead to greater (e.g., more frequent) opportunities for the provider to change the P-GW associated with the UE. This can, in turn, allow the provider to locate the P-GWs closer to the S-GWs to efficiently offload PDN traffic from the core network without unduly impacting the service continuity goal of the provider.

**[0012]** Fig. 1 illustrates an example system 100 including an example network infrastructure component 105 to perform intelligent P-GW relocation for SIPTO service continuity, according to one embodiment. In an example, network infrastructure component 105 can be a mobility management entity (MME) as defined in the LTE-A family of standards.

**[0013]** In an example, the system 100 can include UE 120 and core network 140. In an example, the system 100 can include a PDN 160 (e.g., the Internet) or multiple PDNs. In an example, the core network 140 can include one or more S-GWs 145 and one or more P-GWs 150. In an example, the S-GW 145 can be configured to interface the application network traffic 125 of the UE 120 to the core network 140. In an example, the P-GW 150 can be configured to interface the application network traffic 125 to the PDN 160. In an example, the PDN 160 can include an application service provider 165 configured to provide data or other services to the application. In an example, the application network traffic 125 can include different layers (e.g., levels) of or protocols. In an example, the application network traffic 125 can include a network layer 130 (e.g., any one or more of layers one through six of the open systems interconnection model (OSI model)). In an example, the OSI model layers one through six can respectively include the physical layer, the data link layer, the network layer, the transport layer, the session layer, and the presentation layer. In an example, the application network traffic 125 can include an application layer 135. In an example, the application layer 135 can include the OSI layer seven.

**[0014]** The wireless infrastructure component 105 can include a UE application monitoring module 110 and a routing module 115 that are communicatively coupled to each other. In an example, the wireless infrastructure component 105 can also include an application catalog 155 communicatively coupled to the UE application monitoring module 110. In an example, the UE application monitoring module 110 can be communicatively coupled to any one or more of the UE 120, the application network traffic 125, the S-GW 145, the P-GW 150, or the application service provider 165.

**[0015]** The UE application monitoring module 110 can be configured to monitor a network session state for the UE 120. In an example, the network session state can include the session state of an application running on the UE.

**[0016]** In an example, the UE application monitoring module 110 can be configured to inspect the application network traffic 125 using deep packet inspection (DPI) to monitor the network session state for the UE 120. DPI (e.g., complete packet inspection or information extraction) can include analyzing the data or headers of the application network traffic 125 to determine the current state of the application. In an example, DPI is analysis

of the application layer 135. Using DPI, the UE application monitoring module 110 can determine what the application is or whether a PDN session can be interrupted without unduly impacting the service continuity of the application.

**[0017]** In an example, the UE application monitoring module 110 can be configured to identify the application service provider 165. For example, if the application is a social networking application, the application service provider 165 would be the service (e.g., available via a web site, web service, or other PDN service endpoint technologies) supporting the social network. In an example, to monitor the network session for the UE, the UE application monitoring module 110 can be configured to retrieve, receive, or both retrieve and receive an impact of the session state of the application for changing a PDN characteristic of the application network traffic 125 or UE 120 from the application service provider 165. In an example, the PDN characteristic can be an IP address of the UE 120 (e.g., a change in the PDN characteristic is an IP address change for the UE 120). In an example, the PDN characteristic can be other parameters provided to the UE 120 to operate on the PDN 160. These parameters could include such things as packet size, encryption keys, data control procedures, or any other parameter assigned to the UE 120 or the application network traffic 125 to allow the application network traffic 125 to operate from the core network 140 to the PDN 160. In an example, changing the PDN characteristic affects network session continuity of the application when there is an active PDN session for the application. In an example, one or more PDN characteristics (e.g., of the UE 120) are changed when the UE 120 is transitioned from a current P-GW 150 to a new P-GW.

**[0018]** The impact of the session state of the application, for example retrieved from the application service provider 165, can provide information to the UE application monitoring module 110 on the current state of the PDN session. For example, the impact of the session state of the application could be a numerical report indicating the level of severity of changing the PDN characteristic. In an example, the report could report the impact via the state, such as by providing an 'idle' indication when the PDN can be interrupted without a network session continuity impact; a 'minimal' indication when the impact would be minor (e.g., an instant chat application reconnecting to the application service provider 165 between transmissions); or severe when the impact would lead to more serious interruptions (e.g., a video streaming application that, when interrupted, would require the user to start the video over after reconnection to the application service provider 165).

**[0019]** In an example, the UE application monitoring module 110 and the application service provider 165 can be configured to use Interworking between Mobile Operators using the Evolved Packet System, and Data Application Providers (MOSAP) as provided in the LTE-A family of standards. These configurations can include architectural adaptions (e.g., application interfaces, authentication or communications protocols, etc.). In an example, the core network 140 can provide authentication for applications. In an example, the core network 140 can provide and enforce policy interactions for the core network's 140 services or for the application service provider 165.

**[0020]** In an example, the UE application monitoring module 110, in order to monitor the network session state for the UE, can be configured to receive, retrieve, or both receive and retrieve the impact of the session state of the application for changing the PDN characteristic (e.g., as discussed above) from the UE 120. For example, similar to the UE application monitoring module's 110 interaction(s) with the application service provider 165 discussed above, this information can be gathered from the UE 120. Further examples are discussed below with respect to Fig. 3.

**[0021]** In an example, UE application monitoring module 110, in order to monitor the network session state for the UE, can be configured to determine a network quality of service (QOS) indicator for the application network traffic 125 and associate the network QOS indicator to an impact of the network session continuity for changing the PDN characteristic. For example, the UE application monitoring module 110 can observe network layer 130 traffic, interface with routers or switches, or otherwise obtain a QOS level for application network traffic 125. QOS levels can be numerical or symbolic and correspond to various network based procedures for handling traffic at a specific QOS level. For example, a given QOS levels of high and low priority, high priority traffic may be delivered before low priority traffic. Other types of QOS levels could specific, for example, a guaranteed delivery, or specify that an undelivered piece of data should not be re-transmitted. These QOS levels can be associated with various impacts of the network session continuity. For example, high priority traffic can be associated with a severe impact of the network session continuity whereas low priority traffic can be associated with a minor (e.g., easily recoverable) impact of the network session continuity. In an example, the QOS levels can include active TCP sessions (e.g., an active TCP session is associated to one QOS level and an inactive TCP session is associated to a different QOS level). In an example, QOS levels can include UE 120 connectivity information (e.g., active or inactive data sessions, UE 120 idle state, etc.) obtained via radio resource control (RRC) signaling of a LTE-A network, for example from a base station.

**[0022]** Monitoring the network session state for the UE 120, by the UE application monitoring module 110, can include direct monitoring of the application network traffic 125 (e.g., via DPI or network QOS levels as described above), retrieving or receiving information from application service provider 165 of the application (e.g., as described above), receiving information from the UE 120 (e.g., as described above), or any combination thereof. For direct monitoring of the application network traffic

125, the application network traffic 125 can be observed at a core network 140 component (e.g., a router, bridge, gateway, etc.), the application network traffic 125 can be routed through the network infrastructure component 105, or some or all of the application network traffic 125 can be copied and directed to the network infrastructure component 105.

**[0023]** In addition to being configured to monitor the network session state for the UE 120, the UE application monitoring module 110 can be configured to determine a transition window based on both the network session state and a session continuity impact metric. In an example, the session continuity impact metric can be a degree of service interruption for the application perceived by a user of the UE 120. For example, given degree's zero, one, and two, degree zero could be an interruption that the user cannot perceive (e.g., changing an IP address between HTTP requests), degree one could be a minor interruption perceived by the user (e.g., playing music stutters), and degree two could be a major interruption (e.g., the service is interrupted and the user must log back onto the service). The degree of service interruption can be expressed numerically, symbolically, or via more complex data structures.

**[0024]** In an example, by comparing the current network session state to the session continuity impact metric, the UE application monitoring module 110 can identify PDN session periods whereby changing the PDN characteristic won't disrupt the PDN session more that the session continuity impact metric. Thus, the provider can establish periods in which a new P-GW can be assigned to the UE 120 while still maintaining the desired user experienced continuity.

**[0025]** In an example, in order to determine the transition window, the UE application monitoring module 110 can be configured to determine a time period in which changing the PDN characteristic would not affect network session continuity of the application to a degree greater that the session continuity impact metric. For example, given a three degree level of the session continuity impact metric starting at zero, if the session continuity impact metric is one, changing the PDN characteristic during the determined time period would result in a network session continuity impact of degree zero or one. Thus, the core network 140 provider can set the level session continuity via the session continuity impact metric.

**[0026]** In an example, given the retrieval or receipt of an impact of the session state of the application (e.g., via DPI, the application service provider 165, the UE 120, or associating network QOS indicators as described above), the UE application monitoring module 110 can be configured to identify a beginning of the time period in response to matching the impact metric of the network session continuity to the retrieved or received impact of the session state of the application. In an example, the UE application monitoring module 110 can be configured to identify a beginning of the time period by matching a network traffic marker

**[0027]** (described below with respect to Fig. 4) to the session continuity impact metric. Thus, in a stream, of data, when the UE application monitoring module 110 first observes that the impact of changing the PDN characteristic on the PDN session is less than or equal to the session continuity impact metric, the time of that first observation marks the beginning of the time period. In an example, the end of the time period can correspond to a fixed time offset from the beginning of the time period (e.g., 10ms). In an example, the time period can continue until the UE application monitoring module 110 observes the impact of the session state of the application becoming greater than the session continuity impact metric.

**[0028]** The routing module 115 can be configured to associate a new P-GW to the UE 120 during the transition window (e.g., as determined by the UE application monitoring module 110) in response to a determination that the current P-GW 150 of the UE 120 is less optimal, in at least one performance metric, than the new P-GW. In an example, associating a new P-GW to the UE 120 changes at least one PDN characteristic (e.g., IP address) for the UE 120. In an example, the routing module 115 can be configured to make the determination that the current P-GW 150 of the UE 120 is less optimal than the new P-GW. In an example, the routing module 115 can be configured to receive the determination that the current P-GW 150 of the UE 120 is less optimal than the new P-GW.

**[0029]** In an example, the performance metric corresponds to a measurable aspect of a P-GW's 150 efficiency in the core network 140. For example, the performance metric can measure physical distance (e.g., between S-GW 145 and P-GW 150), logical distance (e.g., the number of network devices application network traffic 125 passes through between S-GW 145 and P-GW 150), load (e.g., number of UEs served by the P-GW 150), etc.

**[0030]** Figs. 2A-B illustrate two views of P-GW relocation for a UE 120 physically moving in a core network 140 at different points in time, according to one embodiment. Fig. 2A illustrates an initial P-GW A 150A associated with UE 120 via S-GW A 145A. In this example, P-GW A 150A was chosen because it had was more optimal than P-GW B 150B with respect to S-GW A 145A when a PDN session was initiated. As the UE 120 moves (e.g., in a car traveling between cities)
the UE 120 can also be associated with other S-GWs, such as S-GW B 145B as illustrated in Fig. 2B. Fig. 2B also illustrates that, although UE 120 is still associated with P-GW A 150A, P-GW B 150B is more optimal with respect to the new S-GW B 145B. Thus, transitioning UE 120 from P-GW A 150A to P-GW B 150B is desirable for the core network 140 provider to maintain core network 140 efficiency by offloading the SIPTO traffic sooner. By performing this transition during the transition window determined by the UE application monitoring module 110, the core network 140 provider can also maintain its desired level of session continuity for the UE 120.

**[0031]** Fig. 3 illustrates example components of a UE

120 to report network session state to a network infrastructure component 105, according to one embodiment. UE 120 can include a UE platform 305. The UE platform 305 can include software or hardware to support voice or data operations of the UE 120. For example, the UE platform 305 can include an UE operating system 310, a UE service module 320, or an application 315. In an example, the application 315 is the application discussed above with respect to Fig. 1. In an example, the application 315 and the UE service module 320 can run on, or within, the UE operating system 310. In an example, one or more of the UE operating system 310, the application 315, and the UE service module 320 can be communicatively coupled to the network infrastructure component 105. In an example, the UE operating system 310, the application 315, and the UE service module 320 can be communicatively coupled to each other in any combination of the three.

**[0032]** The UE service module 320 can be configured to query the application 315 to determine the impact of the session state of the application and transmit the impact of the session state of the application to the UE application monitoring module 110. In an example, the UE service module 320 can observe application network traffic 125 originating from the application 315 to determine the impact of the session state of the application. In an example, the UE service module 320 can register with the application 315 and receive the impact of the session state of the application from the application 315 (e.g., periodically or when the impact of the session state of the application changes). In an example, the UE service module 320 is a component of the network infrastructure component 105 (e.g., a software program transferred and executed on the UE 120). In an example, the UE service module 320 is configured to transmit the impact of the session state of the application in response to a request from the UE application monitoring module 110. In an example, the application 315 can be configured to determine the impact of the session state of the application and transmit it to the UE application monitoring module 110. In an example, the UE operating system 310 can be configured to determine the impact of the session state of the application and transmit it to the UE application monitoring module 110.

**[0033]** Fig. 4 illustrates an example application catalog 155 that can be used to facilitate intelligent P-GW relocation for SIPTO service continuity, according to one embodiment. The application catalog 155 can include one or more entries 405 (e.g., entry A 405A and entry B 405B) corresponding to one or more applications. In an example, an entry 405 (e.g., entry A 405A) can include an index 410 and a network traffic marker 420. In an example, the index 410 can identify the application corresponding to the entry 405. In an example, a single index 410 can be associated with multiple network traffic markers 420. In an example, the index 410 is absent from the entry A 405A.

**[0034]** In an example, the network traffic marker 420 can be observable (e.g., by the UE application monitoring module 110) via DPI. In an example, the network traffic marker 420 can correspond to a point in a network session for the application. In an example, the network traffic marker 420 can include the impact of the network session for changing the PDN characteristic at the point. For example, the network traffic marker 420 could be a bit stream pattern corresponding to a transaction ending operation in the application. The application could quickly recover from a PDN characteristic change immediately following the operation, but the user may perceive the interruption (e.g., a minor interruption as described above). Thus, the network traffic marker 420 would include the minor character of interrupting the network session after the marker (e.g., the bit stream pattern) is observed.

**[0035]** In an example, when the application catalog 155 described here is employed, the UE application monitoring module 110 can be configured to retrieve, for example the entry A 405A, based on matching the impact on the network session continuity, from the network traffic marker 420, to the session continuity impact metric. Thus, the entries 405 can be filtered by those that would permit a P-GW relocation given a session continuity impact metric.

**[0036]** The example methods described below can use any combination of components described above in Figs. 1-4 or other components to perform the described operations. Thus, although specific components may be used below for illustrative purposes, the described methods are not limited to running on those components.

**[0037]** Fig. 5 illustrates a flowchart for an example method 500 of intelligent P-GW relocation for SIPTO service continuity, according to one embodiment.

**[0038]** At operation 505 a determination that a current P-GW 150 of the UE 120 is less optimal, in at least one performance metric, than the new P-GW can be made (e.g., by the UE application monitoring module 110). This determination can be made as described above with respect to Figs. 1 and 2. In an example, operation 505 can occur before or after any of operations 510-520. That is, operation 505 is not dependent upon (e.g., is independent of) any other operation describe in Fig. 5.

**[0039]** At operation 510 the network session state for a UE 120 can be monitored (e.g., at UE application monitoring module 110). In an example, the network session state can include the session state of an application 315 running on the UE 120. In an example, monitoring the network session state for the UE can include inspecting the network traffic of the application using deep packet inspection. In an example, the monitoring can include identifying an application service provider 165 (e.g., a service vendor) for the application 315 and retrieve, from the application service provider 165, an impact of the session state of the application 315 for changing the PDN characteristic.

**[0040]** At operation 515 a transition window based on both the network session state and a session continuity

impact metric can be determined. In an example, determining the transition window includes determining a time period in which changing the PDN characteristic would not affect network session continuity of the application 315 to a degree greater than the session continuity impact metric. In an example, changing the PDN characteristic can include changing an IP address for the UE 120. In an example, the session continuity impact metric is a degree of service interruption for the application 315 perceived by a user of the UE 120. In an example, the degree of service interruption is zero (e.g., the user perceives no interruption). In an example, when monitoring of operation 505 includes retrieving an impact of the session state from the application service provider 165, determining the time period can include identifying a beginning of the time period in response to matching the session continuity impact metric to the retrieved impact of the session state of the application.

**[0041]** At operation 520 a new P-GW can be associated to the UE 120 during the transition window. In an example, associating the new P-GW to the UE 120 can include changing the PDN characteristic of the UE120. In an example, changing the PDN characteristic can affect network session continuity of the application.

**[0042]** Fig. 6 illustrates a flowchart for an example method 600 of determining a time period to meet an impact metric of network session continuity using an application catalog (e.g., as described in operation 515 of Fig. 5), according to one embodiment. Method 600 can be performed with the application catalog 155 (e.g., as described above with respect to Figs. 1 and 4) including entries 405, each entry 420 including a network traffic marker 420. The network traffic marker 420 can be observable (e.g., by the UE application monitoring module 110) via DPI, can correspond to a point in a network session for the application 315, and can include the impact on the network session for changing the PDN characteristic at the point in the network session for the application 315.

**[0043]** At operation 605 an entry corresponding to the application 315 can be retrieved (e.g., by the UE application monitoring module 110) based on matching the impact on the network session continuity, from the network traffic marker 420 of the entry (e.g., entry A 405A), to the session continuity impact metric.

**[0044]** At operation 610 the beginning of the time period can be identified based on matching the network traffic marker 420 to the session state of the application determined by DPI (e.g., by the UE application monitoring module 110).

**[0045]** Fig. 7 illustrates a flowchart for an example method 700 of determining a time period to meet an impact metric of network session continuity using information collected by the UE 120, according to one embodiment. Method 700 can be performed when monitoring the network session state for the UE 120 (e.g., as described in operation 510 of Fig. 5) includes receiving the impact of the session state of the application 315 for changing the PDN characteristic from the UE 120. Further, when determining the time period (e.g., as described in operation 515 of Fig. 5) includes identifying the beginning of the time period in response to matching the session continuity impact metric to the received impact of the session state of the application 315. In an example, one or both of operations 705 and 710 can be performed on, or by, the UE 120 or components of the UE 120.

**[0046]** At operation 705 the application 315 can be queried (e.g., by the UE service module 320) to determine the impact of the session state of the application 315 (e.g., as described above with respect to Figs. 1 and 3).

**[0047]** At operation 710 the impact of the session state of the application 315 (e.g., as determined at operation 705) can be transmitted to the core network 140 (e.g., to the UE application monitoring module 110). In an example, the impact of the session state of the application 315 can be transmitted in response to a request from the core network 140 (e.g., UE application monitoring module 110).

**[0048]** Fig. 8 illustrates a flowchart for an example method 800 of monitoring UE network session state (as described in operation 510 of Fig. 5) via network QOS indicators.

**[0049]** At operation 805 the network QOS indicator of the application network traffic 125 can be determined (e.g., by the UE application monitoring module 110). In an example, the determination can be performed as described above with respect to Fig. 1.

**[0050]** At operation 810 the network QOS indicator (e.g., as determined at operation 805) can be associated to an impact on the network session for changing the PDN characteristic. In an example, the association can be performed as described above with respect to Fig. 1.

**[0051]** After the association of operation 810 is made, operation 510, specifically determining the time period, can be modified to include identifying the beginning of the time period in response to matching the session continuity impact metric to the impact of the session state of the application 315.

**[0052]** Fig. 9 illustrates a block diagram of an example machine 900 upon which any one or more of the techniques (e.g., methodologies) discussed herein can perform. In alternative embodiments, the machine 900 can operate as a standalone device or can be connected (e.g., networked) to other machines. In a networked deployment, the machine 900 can operate in the capacity of a server machine, a client machine, or both in server-client network environments. In an example, the machine 900 can act as a peer machine in peer-to-peer (P2P) (or other distributed) network environment. The machine 900 can be a personal computer (PC), a tablet PC, a set-top box (STB), a Personal Digital Assistant (PDA), a mobile telephone, a web appliance, a network router, switch or bridge, or any machine capable of executing instructions (sequential or otherwise) that specify actions to be taken by that machine. Further, while only a single ma-

chine is illustrated, the term "machine" shall also be taken to include any collection of machines that individually or jointly execute a set (or multiple sets) of instructions to perform any one or more of the methodologies discussed herein, such as cloud computing, software as a service (SaaS), other computer cluster configurations.

**[0053]** Examples, as described herein, can include, or can operate on, logic or a number of components, modules, or mechanisms. Modules are tangible entities capable of performing specified operations and can be configured or arranged in a certain manner. In an example, circuits can be arranged (e.g., internally or with respect to external entities such as other circuits) in a specified manner as a module. In an example, the whole or part of one or more computer systems (e.g., a standalone, client or server computer system) or one or more hardware processors can be configured by firmware or software (e.g., instructions, an application portion, or an application) as a module that operates to perform specified operations. In an example, the software can reside (1) on a non-transitory machine-readable medium or (2) in a transmission signal. In an example, the software, when executed by the underlying hardware of the module, causes the hardware to perform the specified operations.

**[0054]** Accordingly, the term "module" is understood to encompass a tangible entity, be that an entity that is physically constructed, specifically configured (e.g., hardwired), or temporarily (e.g., transitorily) configured (e.g., programmed) to operate in a specified manner or to perform part or all of any operation described herein. Considering examples in which modules are temporarily configured, each of the modules need not be instantiated at any one moment in time. For example, where the modules comprise a general-purpose hardware processor configured using software, the general-purpose hardware processor can be configured as respective different modules at different times. Software can accordingly configure a hardware processor, for example, to constitute a particular module at one instance of time and to constitute a different module at a different instance of time.

**[0055]** Machine (e.g., computer system) 900 can include a hardware processor 902 (e.g., a central processing unit (CPU), a graphics processing unit (GPU), a hardware processor core, or any combination thereof), a main memory 904 and a static memory 906, some or all of which can communicate with each other via a bus 908. The machine 900 can further include a display unit 910, an alphanumeric input device 912 (e.g., a keyboard), and a user interface (UI) navigation device 911 (e.g., a mouse). In an example, the display unit 910, input device 917 and UI navigation device 914 can be a touch screen display. The machine 900 can additionally include a storage device (e.g., drive unit) 916, a signal generation device 918 (e.g., a speaker), a network interface device 920, and one or more sensors 921, such as a global positioning system (GPS) sensor, compass, accelerometer, or other sensor. The machine 900 can include an output controller 928, such as a serial (e.g., universal serial bus (USB), parallel, or other wired or wireless (e.g., infrared(IR)) connection to communicate or control one or more peripheral devices (e.g., a printer, card reader, etc.).

**[0056]** The storage device 916 can include a machine-readable medium 922 on which is stored one or more sets of data structures or instructions 924 (e.g., software) embodying or utilized by any one or more of the techniques or functions described herein. The instructions 924 can also reside, completely or at least partially, within the main memory 904, within static memory 906, or within the hardware processor 902 during execution thereof by the machine 900. In an example, one or any combination of the hardware processor 902, the main memory 904, the static memory 906, or the storage device 916 can constitute machine readable media.

**[0057]** While the machine-readable medium 922 is illustrated as a single medium, the term "machine readable medium" can include a single medium or multiple media (e.g., a centralized or distributed database, and/or associated caches and servers) that configured to store the one or more instructions 924.

**[0058]** The term "machine-readable medium" can include any tangible medium that is capable of storing, encoding, or carrying instructions for execution by the machine 900 and that cause the machine 900 to perform any one or more of the techniques of the present disclosure, or that is capable of storing, encoding or carrying data structures used by or associated with such instructions. Non-limiting machine-readable medium examples can include solid-state memories, and optical and magnetic media. Specific examples of machine-readable media can include: non-volatile memory, such as semiconductor memory devices (e.g., Electrically Programmable Read-Only Memory (EPROM), Electrically Erasable Programmable Read-Only Memory (EEPROM)) and flash memory devices; magnetic disks, such as internal hard disks and removable disks; magneto-optical disks; and CD-ROM and DVD-ROM disks.

**[0059]** The instructions 924 can further be transmitted or received over a communications network 926 using a transmission medium via the network interface device 920 utilizing any one of a number of transfer protocols (e.g., frame relay, internet protocol (IP), transmission control protocol (TCP), user datagram protocol (UDP), hypertext transfer protocol (HTTP), etc.). Example communication networks can include a local area network (LAN), a wide area network (WAN), a packet data network (e.g., the Internet), mobile telephone networks (e.g., cellular networks), Plain Old Telephone (POTS) networks, and wireless data networks (e.g., Institute of Electrical and Electronics Engineers (IEEE) 802.11 family of standards known as Wi-Fi®, IEEE 802.16 family of standards known as WiMax®), peer-to-peer (P2P) networks, among others. In an example, the network interface device 920 can include one or more physical jacks (e.g., Ethernet, coaxial, or phone jacks) or one or more antennas to connect to the communications network 926. In

an example, the network interface device 920 can include a plurality of antennas to wirelessly communicate using at least one of single-input multiple-output (SIMO), multiple-input multiple- output (MEVIO), or multiple-input single-output (MISO) techniques. The term "transmission medium" shall be taken to include any intangible medium that is capable of storing, encoding or carrying instructions for execution by the machine 900, and includes digital or analog communications signals or other intangible medium to facilitate communication of such software.

**[0060]** The above description is intended to be illustrative, and not restrictive. For example, the above-described examples (or one or more aspects thereof) may be used in combination with each other. Other embodiments can be used, such as by one of ordinary skill in the art upon reviewing the above description. The Abstract is submitted with the understanding that it will not be used to interpret or limit the scope or meaning of the claims. Also, in the above Detailed Description, various features may be grouped together to streamline the disclosure. This should not be interpreted as intending that an unclaimed disclosed feature is essential to any claim. Rather, inventive subject matter may lie in less than all features of a particular disclosed embodiment. Thus, the following claims each stands on its own as a separate embodiment. The scope of the invention should be determined with reference to the appended claims, along with the full scope to which such claims are entitled.

## Claims

1. A network infrastructure component (105) configured to:

   receive information, the information at least one of:

   information provided by an application service provider (165) via Mobile Operators using the Evolved Packet System, and Data Application Providers, MOSAP,
   information from deep packet inspection, DPI, or
   quality of service, QOS, information;

   determine, based on the received information, a degree of service interruption perceived by a user of a user equipment, UE, (120) if packet data network gateway, P-GW, (150) relocation is performed; and
   associate a new packet data network gateway, P-GW, (150B) to the UE (120) based on the determination.

2. The network infrastructure component (105) of claim 1, wherein the received information includes a session state of an application (315) running on the UE (120).

3. The network infrastructure component (105) of claim 1 or claim 2, wherein the change in the PDN characteristic is an internet protocol, IP, address change for the UE (120).

4. The network infrastructure component (105) of any one of claims 1 to 3, wherein the network infrastructure component (105) is configured to inspect the network traffic of an application (315) using deep packet inspection in order to receive the information from deep packet inspection.

5. The network infrastructure component (105) of any one of claims 1 to 4, wherein the network infrastructure component (105) is configured to determine a network quality of service, QOS, indicator of the network traffic of an application (315) to receive the QOS information.

6. The network infrastructure component (105) of any one of claims 1 to 5, wherein the network infrastructure component (105) is included in a mobility management entity, MME, of a network according to a 3GPP LTE-A family of standards.

7. A method performed by a network infrastructure component (105) for packet data network, PDN, gateway, P-GW, (150) relocation, the method comprising:

   receiving information, the information at least one of:

   information provided by an application service provider (165) via Mobile Operators using the Evolved Packet System, and Data Application Providers, MOSAP,
   information from deep packet inspection, DPI, or
   quality of service, QOS, information;

   determining, based on the received information, a degree of service interruption perceived by a user of a user equipment, UE, (120) if P-GW (150) relocation is performed; and
   associating a new P-GW (150B) to the UE (120) based on the determination.

8. The method of claim 7, wherein the received information includes a session state of an application (315) running on the UE (120).

9. The method of claim 7 or claim 8, wherein the network infrastructure component (105) is included in a mobility management entity, MME, of a network according to a 3GPP LTE-A family of standards.

10. A machine readable medium including instructions that, when executed by a machine, cause the machine to perform any one or more of the methods of claims 7 to 9.

**Patentansprüche**

1. Netzinfrastrukturkomponente (105), die konfiguriert ist, um:

   Informationen zu empfangen, wobei die Informationen:

   Informationen, die durch einen Anwendungsdienstanbieter (165) über Mobilfunkbetreiber unter Nutzung des Evolved Packet System und Datenanwendungsanbieter, MOSAP, bereitgestellt werden, und/oder
   Informationen aus der Deep Packet Inspection, DPI, und/oder
   Informationen zur Dienstgüte, QOS;

   einen Grad einer von einem Benutzer eines Benutzerendgeräts, UE, (120) wahrgenommenen Dienstunterbrechung, falls eine Verlagerung eines Gateways eines Paketdatennetzes, P-GW, (150) durchgeführt wird, basierend auf den empfangenen Informationen zu bestimmen; und
   basierend auf der Bestimmung ein neues Gateway eines Paketdatennetzes, P-GW, (150B) mit dem UE (120) zu assoziieren.

2. Netzinfrastrukturkomponente (105) nach Anspruch 1, wobei die empfangenen Informationen einen Sitzungsstatus einer auf dem UE (120) laufenden Anwendung (315) enthalten.

3. Netzinfrastrukturkomponente (105) nach Anspruch 1 oder Anspruch 2, wobei die PDN-Eigenschaftsänderung eine Änderung der Internetprotokoll(IP)-Adresse für das UE (120) ist.

4. Netzinfrastrukturkomponente (105) nach einem der Ansprüche 1 bis 3, wobei die Netzinfrastrukturkomponente (105) konfiguriert ist, um den Netzverkehr einer Anwendung (315) unter Nutzung der Deep Packet Inspection zu überwachen, um die Informationen aus der Deep Packet Inspection zu empfangen.

5. Netzinfrastrukturkomponente (105) nach einem der Ansprüche 1 bis 4, wobei die Netzinfrastrukturkomponente (105) konfiguriert ist, um einen Indikator der Netzdienstgüte, QOS, des Netzverkehrs einer Anwendung (315) zum Empfangen der QOS-Informationen zu bestimmen.

6. Netzinfrastrukturkomponente (105) nach einem der Ansprüche 1 bis 5, wobei die Netzinfrastrukturkomponente (105) in einer Mobility Management Entity, MME, eines Netzes gemäß einer 3GPP-LTE-A-Normenfamilie enthalten ist.

7. Verfahren, das von einer Netzinfrastrukturkomponente (105) zur Verlagerung eines Gateways eines Paketdatennetzes, PDN, P-GW, (150) durchgeführt wird, wobei das Verfahren Folgendes umfasst:

   Empfangen von Informationen, wobei die Informationen:

   Informationen, die durch einen Anwendungsdienstanbieter (165) über Mobilfunkbetreiber unter Nutzung des Evolved Packet System und Datenanwendungsanbieter, MOSAP, bereitgestellt werden, und/oder
   Informationen aus der Deep Packet Inspection, DPI, und/oder
   Informationen zur Dienstgüte, QOS;

   Bestimmen eines Grads einer von einem Benutzer eines Benutzerendgeräts, UE, (120) wahrgenommenen Dienstunterbrechung, falls eine Verlagerung eines P-GW (150) durchgeführt wird, basierend auf den empfangenen Informationen; und
   Assoziieren eines neuen P-GW (150B) mit dem UE (120) basierend auf der Bestimmung.

8. Verfahren nach Anspruch 7, wobei die empfangenen Informationen einen Sitzungsstatus einer auf dem UE (120) laufenden Anwendung (315) enthalten.

9. Verfahren nach Anspruch 7 oder Anspruch 8, wobei die Netzinfrastrukturkomponente (105) in einer Mobility Management Entity, MME, eines Netzes gemäß einer 3GPP-LTE-A-Normenfamilie enthalten ist.

10. Maschinenlesbares Medium, das Befehle enthält, die, wenn sie von einer Maschine ausgeführt werden, bewirken, dass die Maschine eines oder mehrere der Verfahren nach den Ansprüchen 7 bis 9 durchführt.

**Revendications**

1. Composant d'infrastructure de réseau (105) configuré pour :

   recevoir des informations, les informations au moins l'une :

d'informations fournies par un fournisseur de services d'application (165) par l'intermédiaire d'opérateurs mobiles utilisant le système par paquets évolué, et des fournisseurs d'applications de données, MOSAP, d'informations provenant d'une inspection approfondie de paquets, DPI, ou d'informations de qualité de service, QOS ;

déterminer, en fonction des informations reçues, un degré d'interruption de service perçu par un utilisateur d'un équipement utilisateur, UE, (120) si un repositionnement de passerelle de réseau de données par paquets, P-GW, (150) est effectué ; et
associer une nouvelle passerelle de réseau de données par paquets, P-GW, (150B) à l'équipement UE (120) en fonction de la détermination.

**2.** Composant d'infrastructure de réseau (105) selon la revendication 1, dans lequel les informations reçues comportent un état de session d'une application (315) exécutée sur l'équipement UE (120) .

**3.** Composant d'infrastructure de réseau (105) selon la revendication 1 ou la revendication 2, dans lequel le changement de la caractéristique de réseau PDN est un changement d'adresse de protocole internet, IP, de l'UE (120).

**4.** Composant d'infrastructure de réseau (105) selon l'une quelconque des revendications 1 à 3, le composant d'infrastructure de réseau (105) étant configuré pour inspecter le trafic de réseau d'une application (315) en utilisant une inspection approfondie des paquets afin de recevoir les informations de l'inspection approfondie des paquets.

**5.** Composant d'infrastructure de réseau (105) selon l'une quelconque des revendications 1 à 4, le composant d'infrastructure de réseau (105) étant configuré pour déterminer un indicateur de qualité de service, QOS, de réseau du trafic de réseau d'une application (315) pour recevoir les informations QOS.

**6.** Composant d'infrastructure de réseau (105) selon l'une quelconque des revendications 1 à 5, le composant d'infrastructure de réseau (105) étant inclus dans une entité de gestion de mobilité, MME, d'un réseau conformément à une famille de normes LTE-A 3GPP.

**7.** Procédé exécuté par un composant d'infrastructure de réseau (105) pour un repositionnement de passerelle de réseau de données par paquets PDN, P-GW, (150), le procédé comprenant :

la réception d'informations, les informations au moins l'une :

d'informations fournies par un fournisseur de services d'application (165) par l'intermédiaire d'opérateurs mobiles utilisant le système par paquets évolué, et des fournisseurs d'applications de données, MOSAP, d'informations provenant d'une inspection approfondie de paquets, DPI, ou d'informations de qualité de service, QOS ;

la détermination, en fonction des informations reçues, d'un degré d'interruption de service perçu par un utilisateur d'un équipement utilisateur, UE, (120) si un repositionnement de passerelle P-GW (150) est effectué ; et
l'association d'une nouvelle passerelle P-GW (150B) à l'équipement UE (120) en fonction de la détermination.

**8.** Procédé selon la revendication 7, dans lequel les informations reçues comportent un état de session d'une application (315) exécutée sur l'équipement UE (120).

**9.** Procédé selon la revendication 7 ou la revendication 8, dans lequel le composant d'infrastructure de réseau (105) est inclus dans une entité de gestion de mobilité, MME, d'un réseau conformément à une famille de normes LTE-A 3GPP.

**10.** Support lisible par machine comportant des instructions qui, à leur exécution dans une machine, amène la machine à exécuter n'importe lequel ou lesquels des procédés selon les revendications 7 à 9.

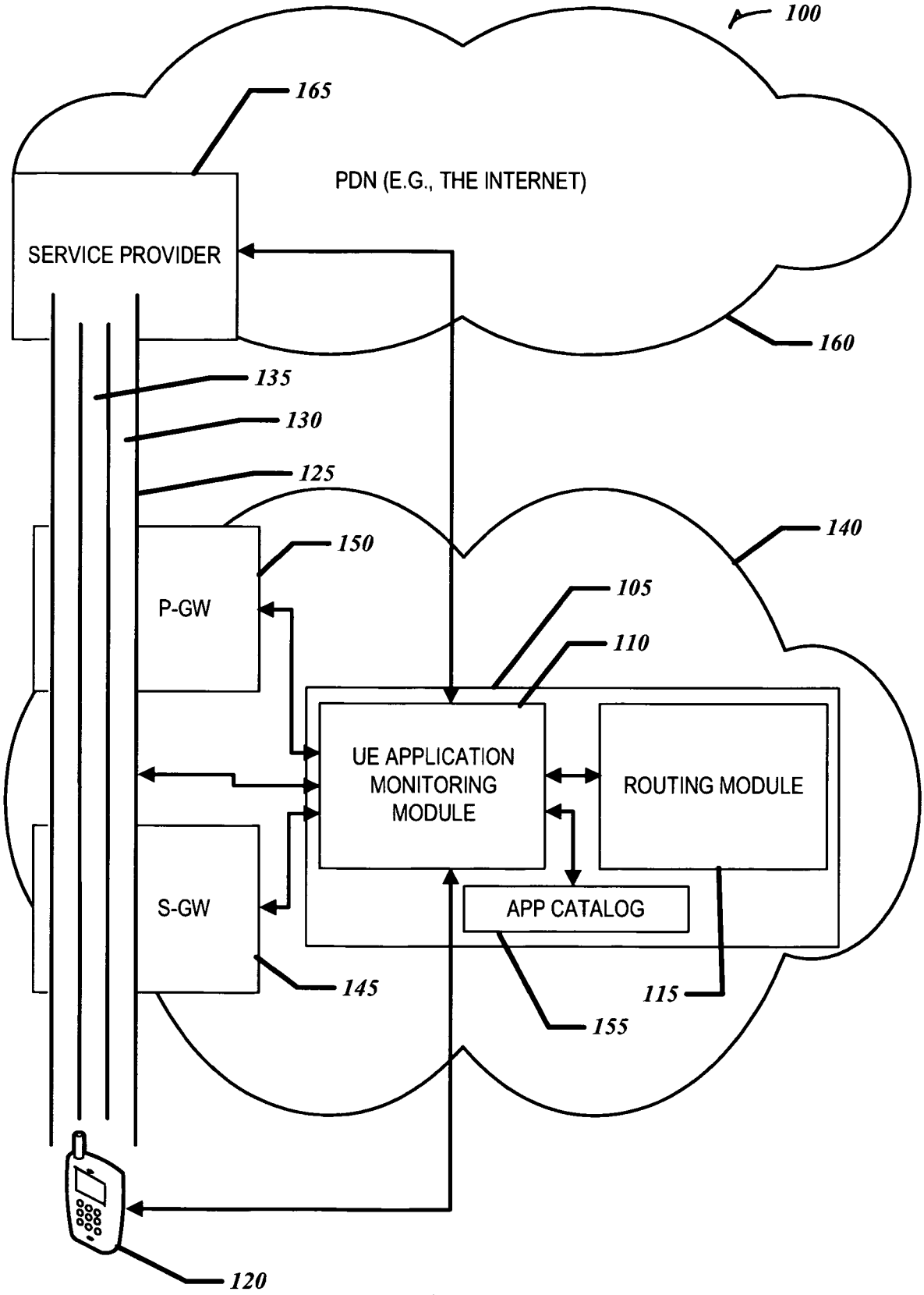
100
165
PDN (E.G., THE INTERNET)
SERVICE PROVIDER
160
135
130
125
140
150
P-GW
105
110
UE APPLICATION MONITORING MODULE
ROUTING MODULE
S-GW
APP CATALOG
145
115
155
120

*Fig. 1*

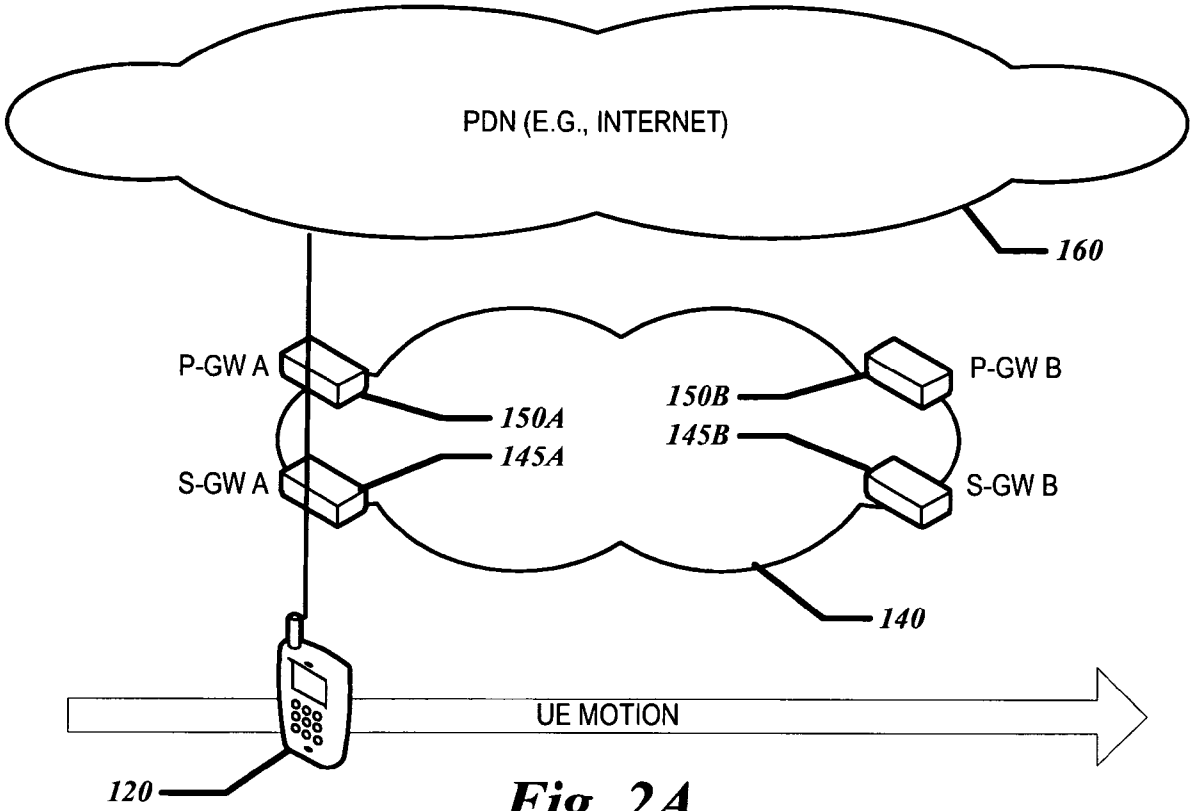
PDN (E.G., INTERNET)
160
P-GW A
150A
145A
S-GW A
150B
145B
P-GW B
S-GW B
140
UE MOTION
120

*Fig. 2A*

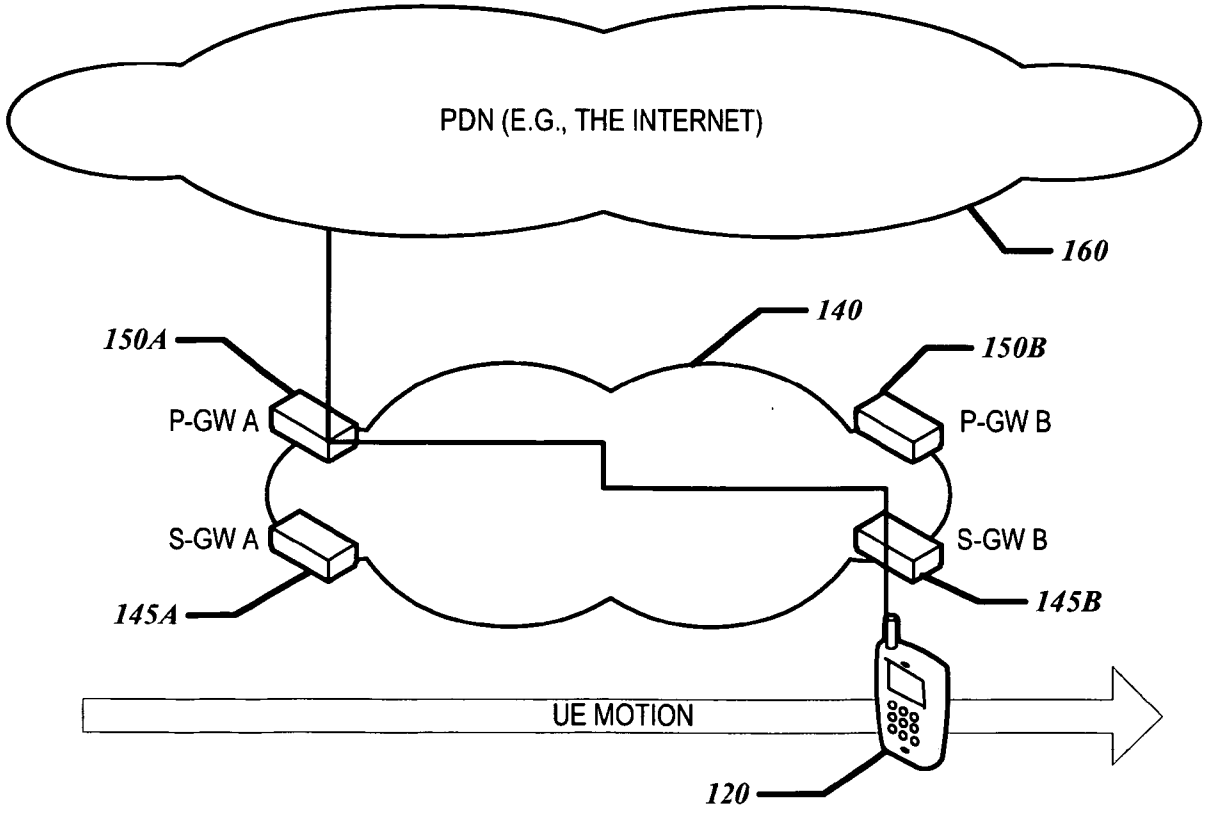
PDN (E.G., THE INTERNET)
160
140
150A
150B
P-GW A
P-GW B
S-GW A
S-GW B
145A
145B
UE MOTION
120

*Fig. 2B*

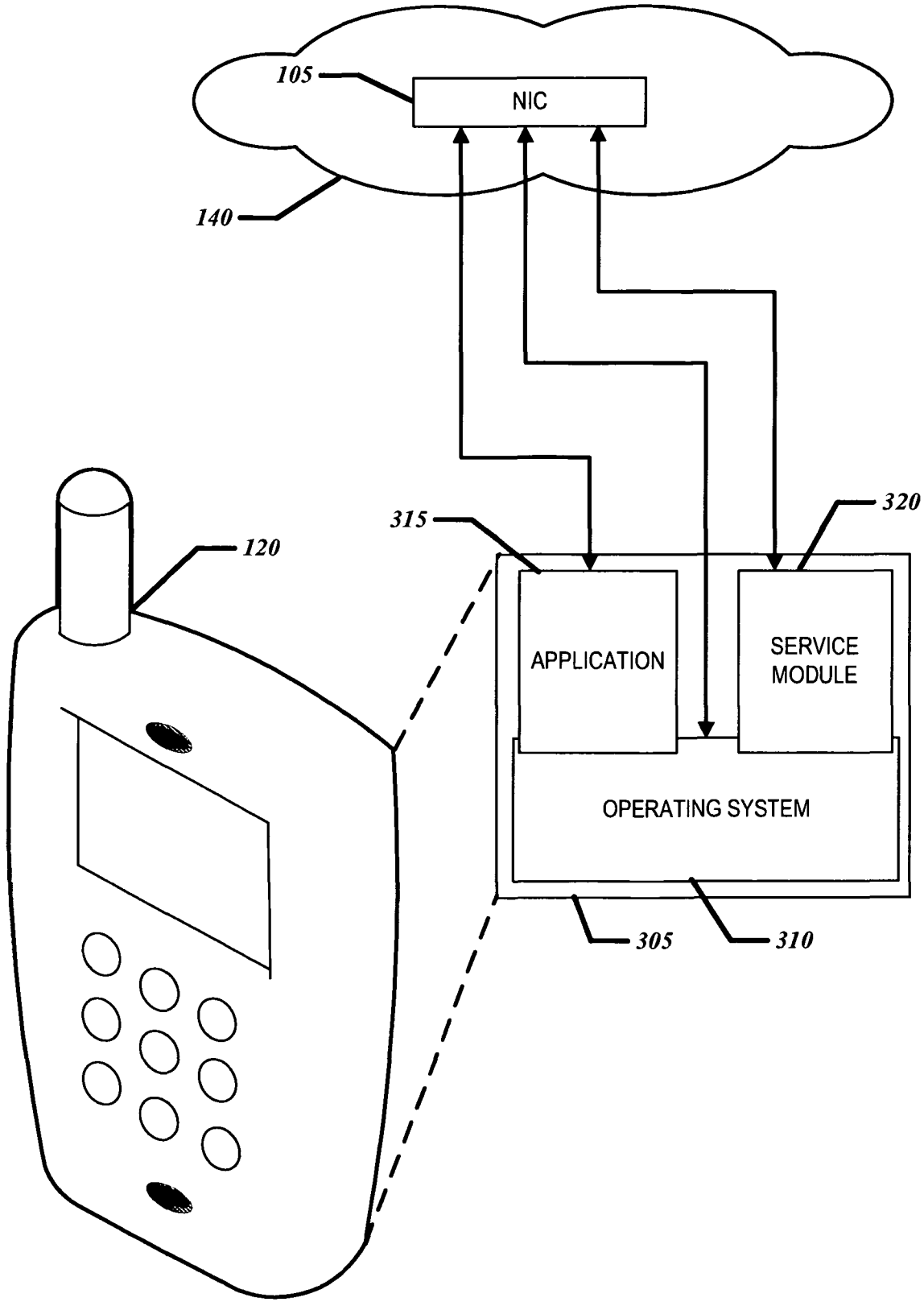
105
NIC
140
315
320
120
APPLICATION
SERVICE MODULE
OPERATING SYSTEM
305
310

*Fig. 3*

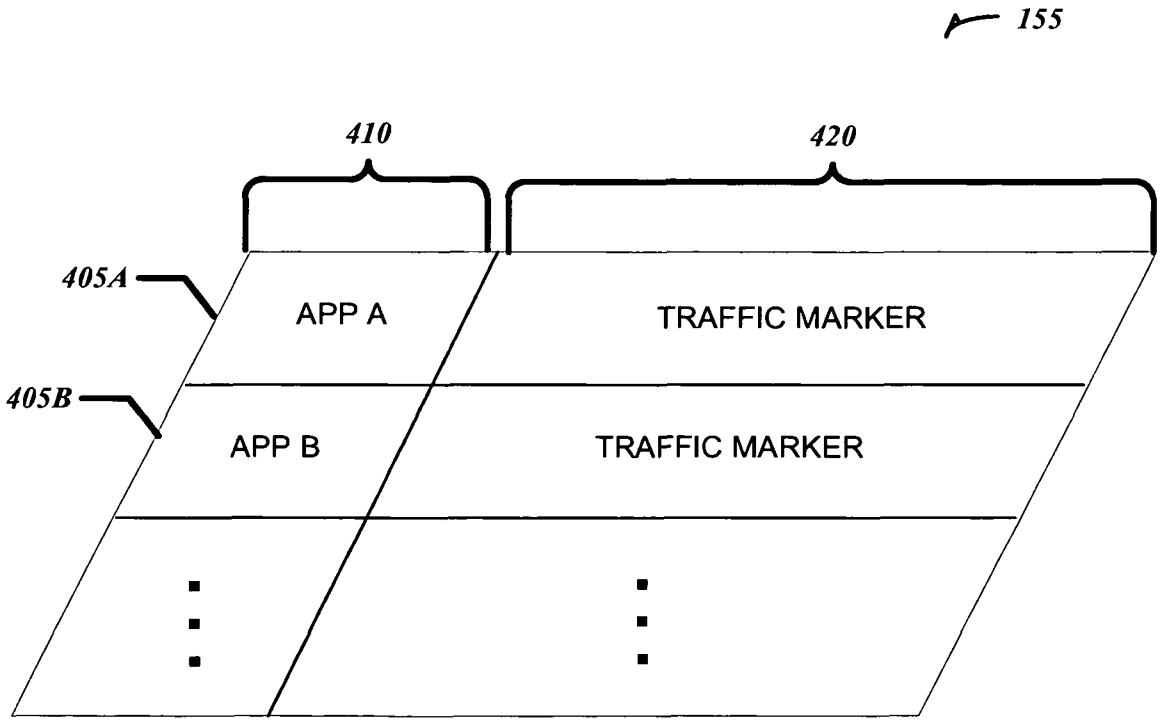
155
410
420
405A
APP A
TRAFFIC MARKER
405B
APP B
TRAFFIC MARKER

*Fig. 4*

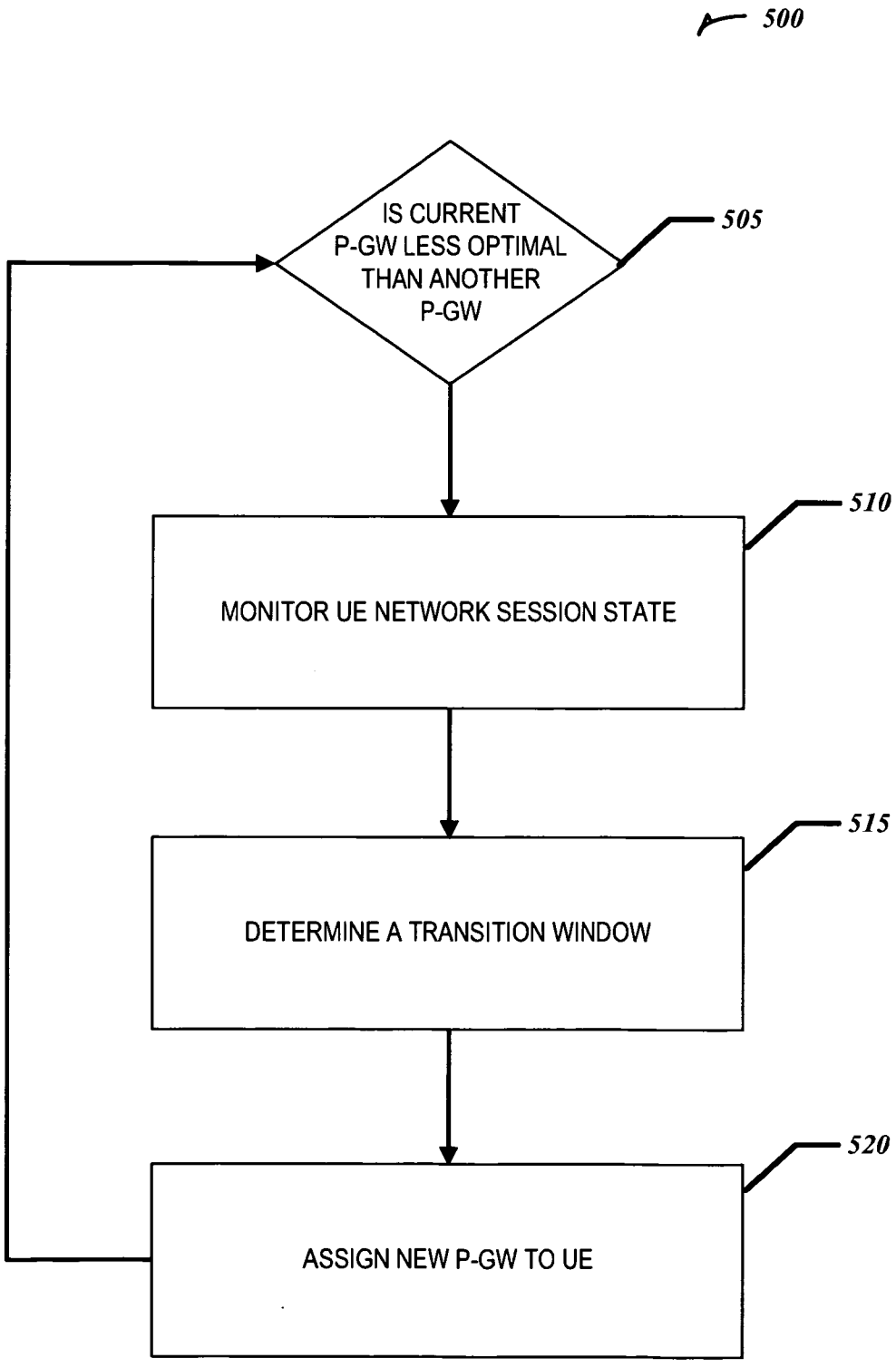
500
IS CURRENT P-GW LESS OPTIMAL THAN ANOTHER P-GW
505
MONITOR UE NETWORK SESSION STATE
510
DETERMINE A TRANSITION WINDOW
515
ASSIGN NEW P-GW TO UE
520

*Fig. 5*

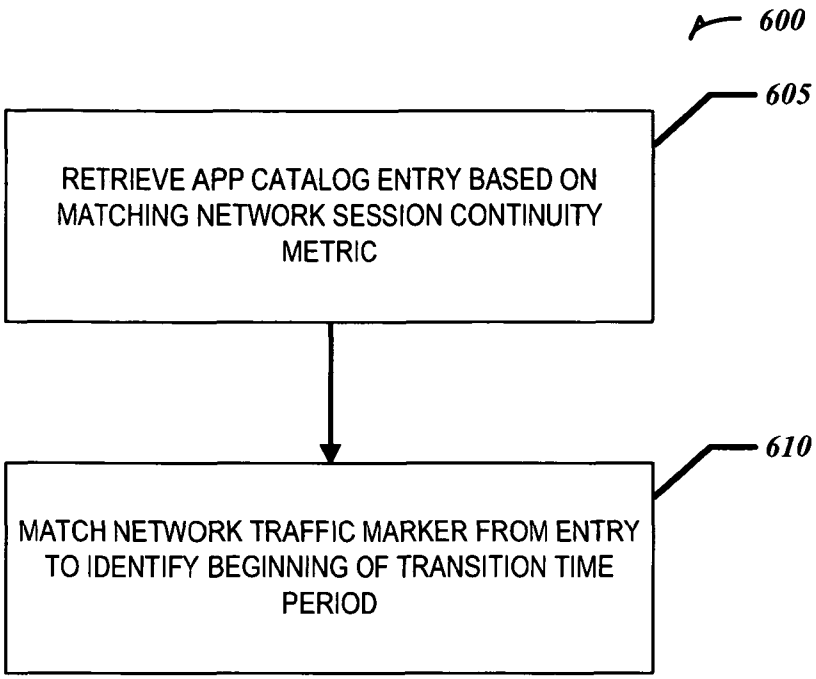
600
605
RETRIEVE APP CATALOG ENTRY BASED ON MATCHING NETWORK SESSION CONTINUITY METRIC
610
MATCH NETWORK TRAFFIC MARKER FROM ENTRY TO IDENTIFY BEGINNING OF TRANSITION TIME PERIOD

*Fig. 6*

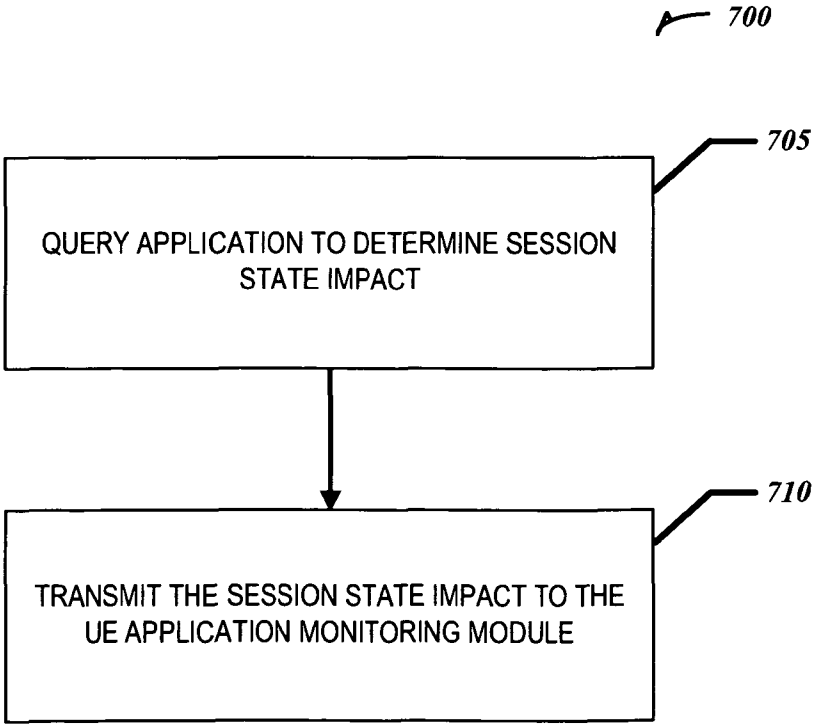
700
705
QUERY APPLICATION TO DETERMINE SESSION STATE IMPACT
710
TRANSMIT THE SESSION STATE IMPACT TO THE UE APPLICATION MONITORING MODULE

*Fig. 7*

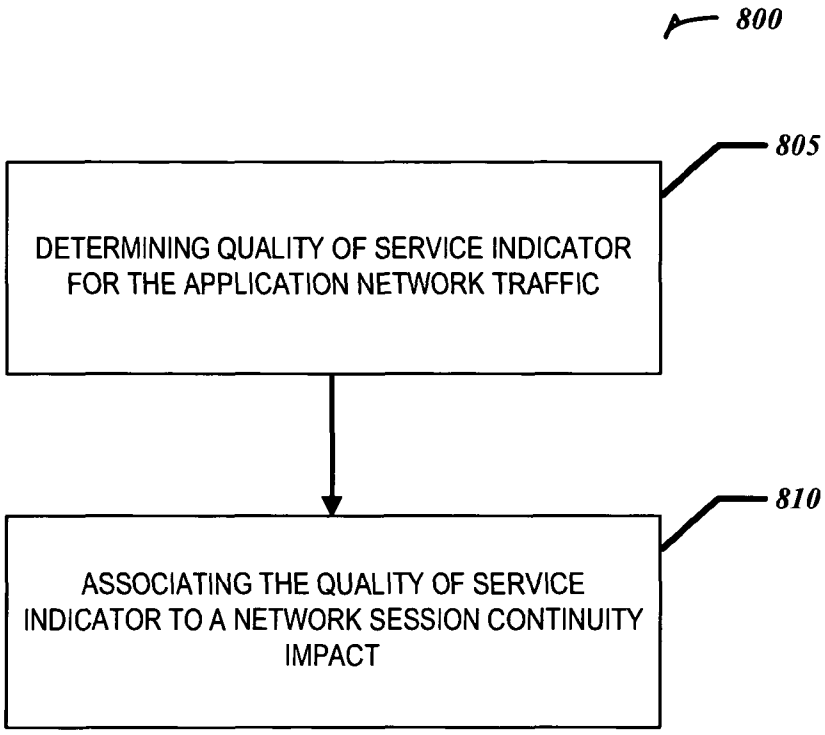
800
805
DETERMINING QUALITY OF SERVICE INDICATOR FOR THE APPLICATION NETWORK TRAFFIC
810
ASSOCIATING THE QUALITY OF SERVICE INDICATOR TO A NETWORK SESSION CONTINUITY IMPACT

*Fig. 8*

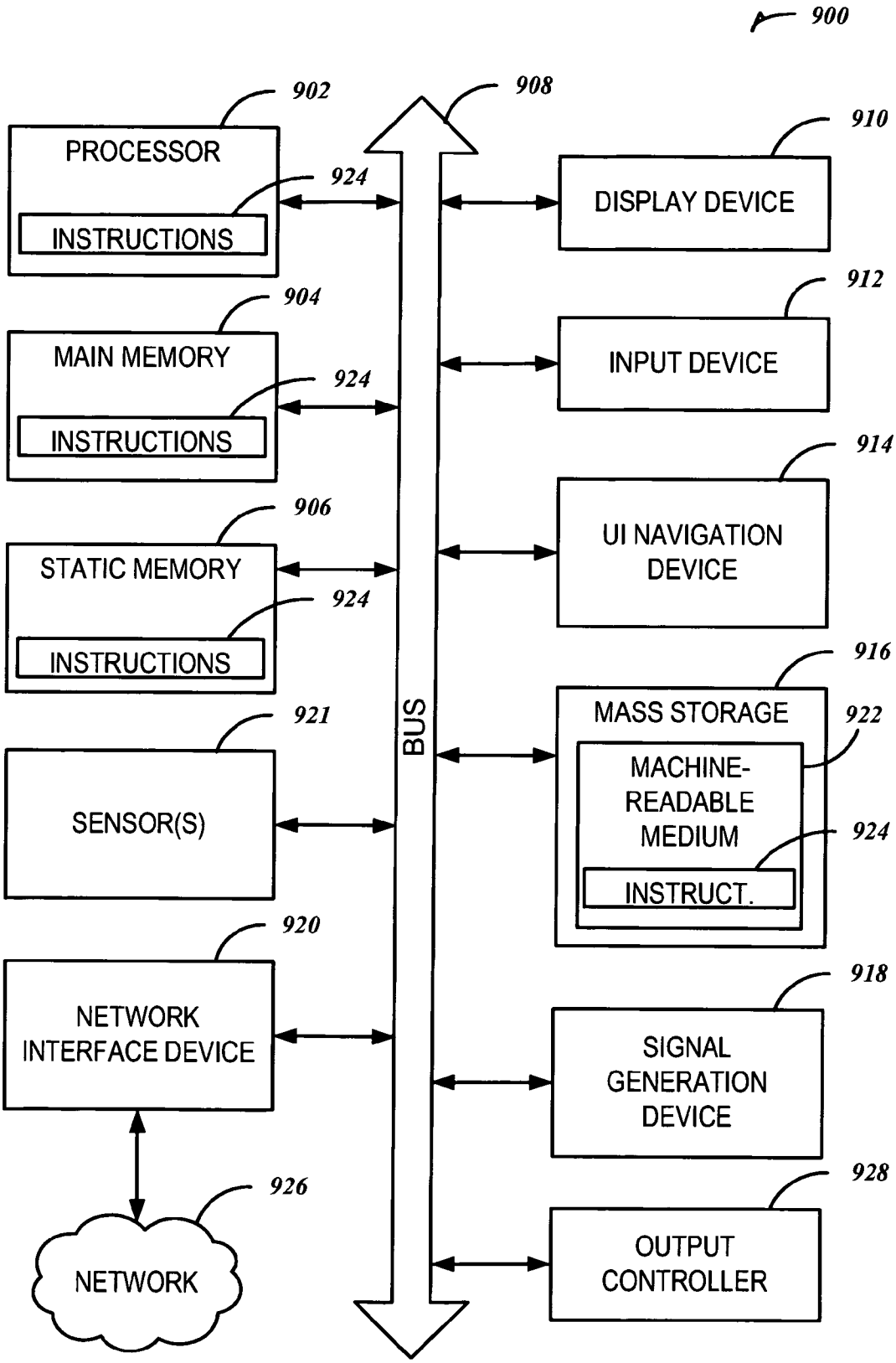
900
902
PROCESSOR
924
INSTRUCTIONS
904
MAIN MEMORY
924
INSTRUCTIONS
906
STATIC MEMORY
924
INSTRUCTIONS
921
SENSOR(S)
920
NETWORK INTERFACE DEVICE
926
NETWORK
908
BUS
910
DISPLAY DEVICE
912
INPUT DEVICE
914
UI NAVIGATION DEVICE
916
MASS STORAGE
922
MACHINE-READABLE MEDIUM
924
INSTRUCT.
918
SIGNAL GENERATION DEVICE
928
OUTPUT CONTROLLER

*Fig. 9*

## REFERENCES CITED IN THE DESCRIPTION

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### Patent documents cited in the description


- WO 2011034173 A **[0004]**

**Intelligens P-GW áthelyezés SIPTO szolgáltatás folytonossága érdekében**

**Szabadalmi igénypontok**

1. Hálózati infrastruktúra komponens (105), amely úgy van konfigurálva, hogy:

információt vegyen, ahol az információ a következők legalább egyike:

egy alkalmazás szolgáltató (165) által Evolved Packet System rendszert használó mobil operátorokon és Data Application Providers, MOSAP, szolgáltatókon keresztül nyújtott információ,

mély csomagvizsgálatból (Deep Packet Inspection), DPI, származó információ, vagy

szolgáltatási minőség, QOS információ;

a vett információ alapján meghatározza egy felhasználói készülék, UE (120) felhasználója által észlelt szolgáltatás megszakadás mértékét, ha adatcsomag hálózati átjáró, P-GW (150) áthelyezést hajtottak végre; és

a meghatározás alapján egy új adatcsomag hálózati átjáró, P-GW (150B) rendeljen az UE-hoz (120).

2. Az 1. igénypont szerinti hálózati infrastruktúra komponens (105), ahol a vett információ az UE-n (120) futó alkalmazás (315) szekció állapotát foglalja magában.

3. Az 1. vagy 2. igénypont szerinti hálózati infrastruktúra komponens, ahol a PDN karakterisztikában bekövetkező változás egy internet protokoll, IP, cím változás az UE (120) számára.

4. Az 1-3. igénypontok bármelyike szerinti hálózati infrastruktúra komponens, ahol a hálózati infrastruktúra komponens (105) úgy van konfigurálva, hogy egy alkalmazás (315) hálózati forgalmát felügyelje, mély csomagvizsgálat használatával, hogy megkapja az információt a mély csomagvizsgálattól.

5. Az 1-4. igénypontok bármelyike szerinti hálózati infrastruktúra komponens, ahol a hálózati infrastruktúra komponens (105) úgy van konfigurálva, hogy meghatározza egy alkalmazás (315) hálózati forgalmának egy hálózati szolgáltatási minőség, QOS indikátorát, hogy vegye a QOS információt.

6. Az 1-5. igénypontok bármelyike szerinti hálózati infrastruktúra komponens, ahol a hálózati infrastruktúra komponens (105) egy 3GPP LTE-A szabvány család szerinti hálózat egy mobilitás menedzselő entitásában (MME) található.

7. Eljárás, amelyet egy hálózati infrastruktúra komponens (105) hajt végre adatcsomag hálózat, PDN, átjáró, P-GW (150) áthelyezéséhez, az eljárás tartalmazza:

információ vételét, ahol az információ a következők legalább egyike:

egy alkalmazás szolgáltató (165) által Evolved Packet System rendszert használó mobil operátorokon és Data Application Providers, MOSAP, szolgáltatókon keresztül nyújtott információ,

mély csomagvizsgálatból (Deep Packet Inspection), DPI, származó információ, vagy

szolgáltatási minőség, QOS információ;

a vett információ alapján egy felhasználói készülék, UE (120) felhasználója által észlelt szolgáltatás megszakadás mértékének meghatározását, ha adatcsomag hálózati átjáró, P-GW (150) áthelyezést hajtottak végre; és

a meghatározás alapján egy új adatcsomag hálózati átjáró, P-GW (150B) hozzárendelését az UE-hoz (120).

8. A 7. igénypont szerinti eljárás, ahol a vett információ az UE-n (120) futó alkalmazás (315) szekció állapotát foglalja magában.

9. A 7. vagy 8. igénypont szerinti eljárás, ahol a hálózati infrastruktúra komponens (105) egy 3GPP LTE-A szabvány család szerinti hálózat egy mobilitás menedzselő entitásában (MME) található.

10. Géppel olvasható közeg, amely utasításokat tartalmaz, amelyek egy géppel végrehajtva a gépet a 7-9. igénypontok bármelyike szerinti eljárás végrehajtására késztetik.