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(54) **METHOD AND APPARATUS FOR HOME NETWORK ACCESS USING A REMOTE MOBILE DEVICE**

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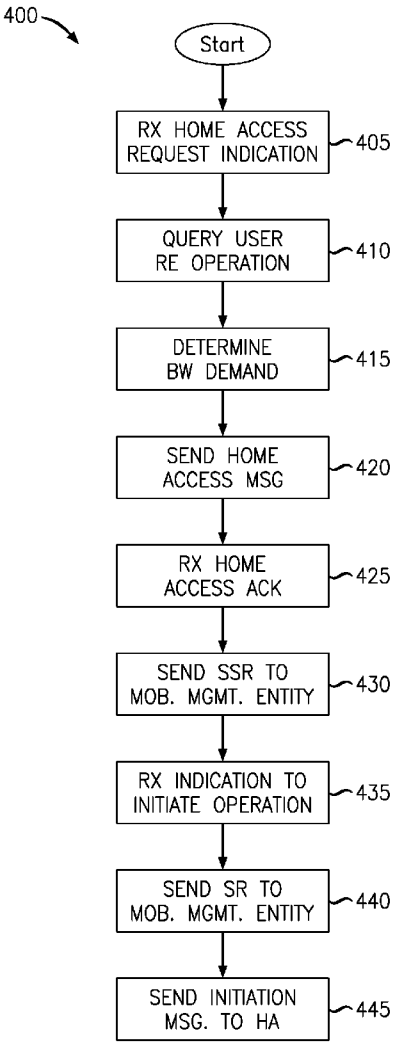
(57) **ABSTRACT**

A manner of facilitating access to a home network having an HA by a remote mobile device, such as a smartphone, having an FA that is or may be registered with the HA. A secure tunnel or similar communication path is established between the FA and an HA of a home network, and an SSR (specialized service request) is transmitted to the mobile network though which the mobile device is communicating, providing advance notification that a bandwidth intensive operation is anticipated so that the mobile network may take preparatory action. The SSR is preferably sent by the FA after a tunnel to the HA has been established, but prior to the user selecting a particular bandwidth intensive application for execution. The user may be queried in advance to determine which operation might be anticipated.



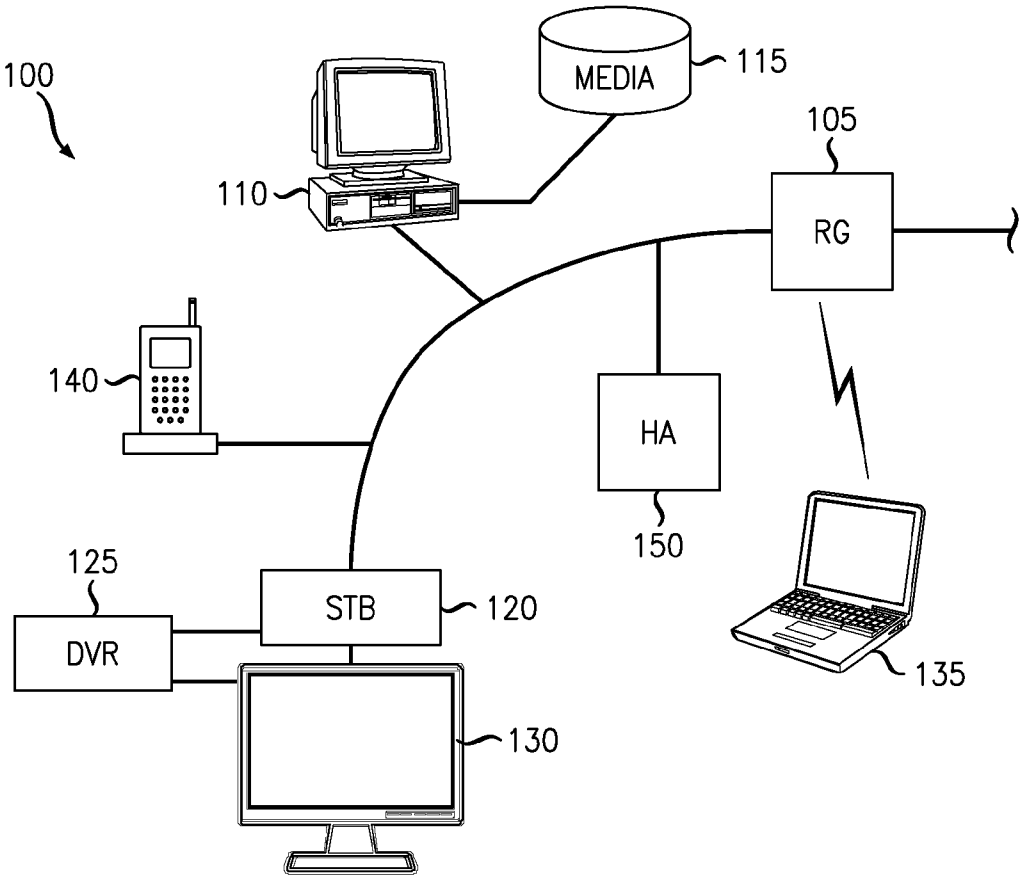


FIG. 1

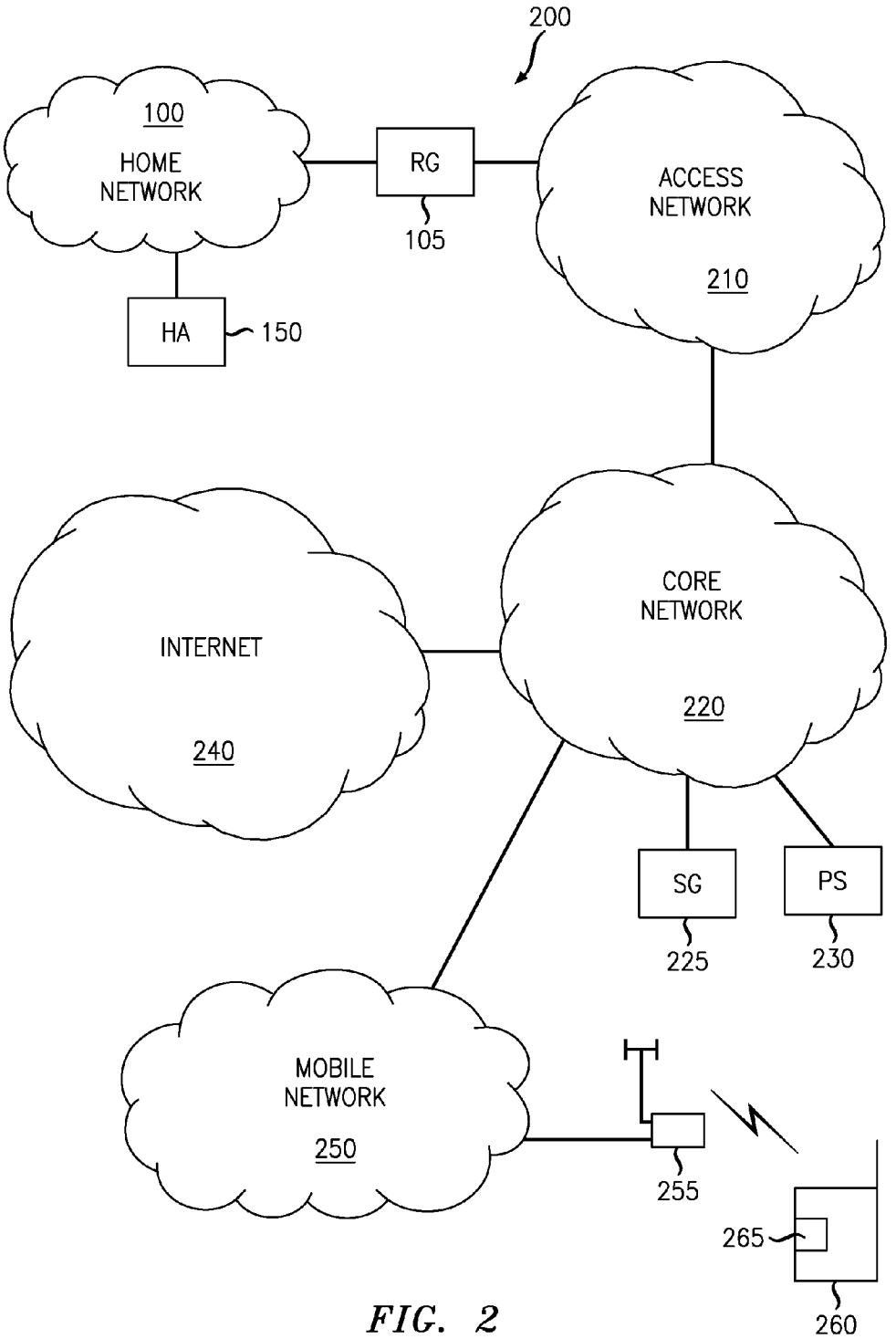

200
100
HOME NETWORK
RG
105
ACCESS NETWORK
210
HA
150
INTERNET
240
CORE NETWORK
220
SG
225
PS
230
MOBILE NETWORK
250
255
265
260

FIG. 2

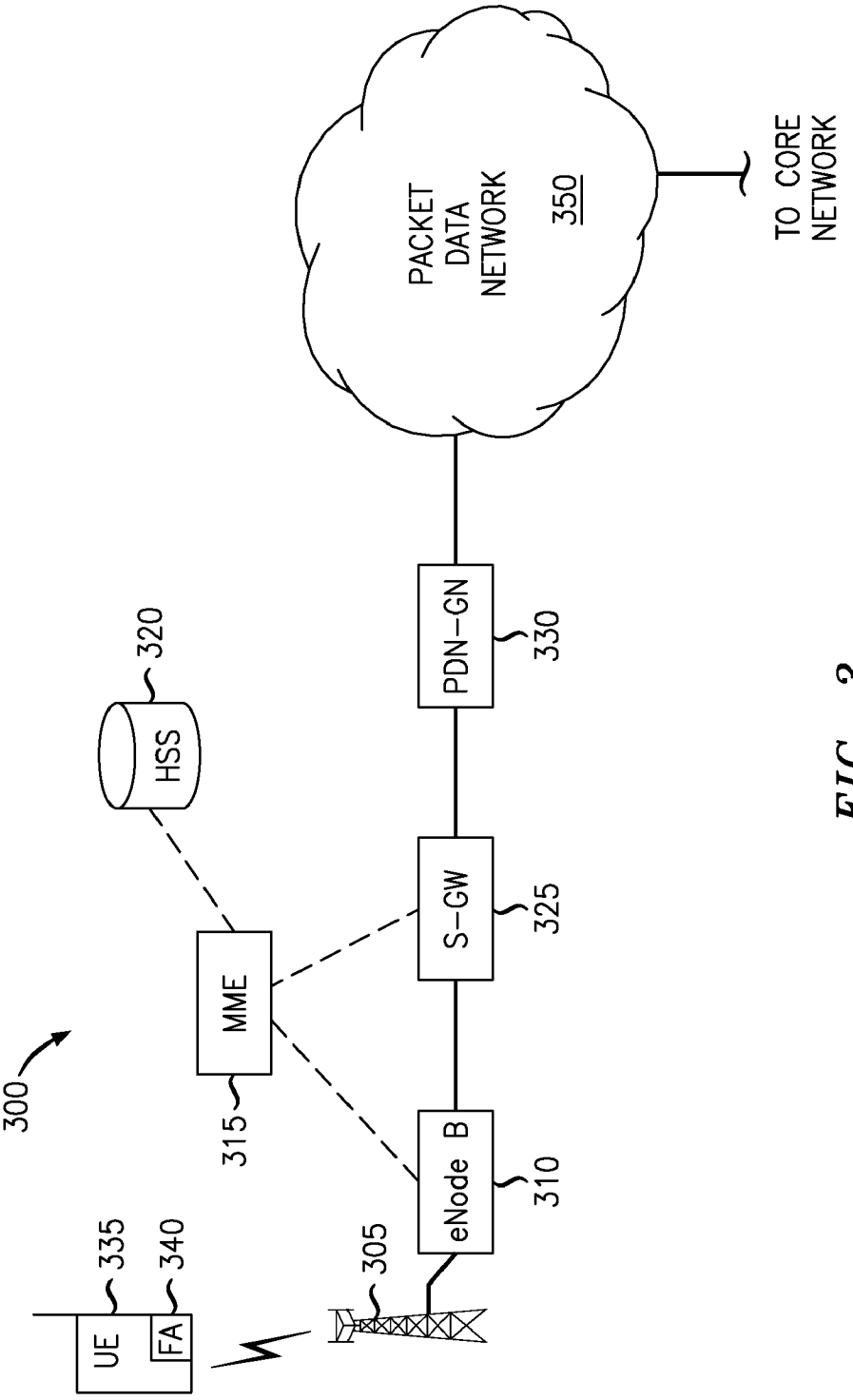

PACKET DATA NETWORK
350
TO CORE NETWORK
PDN-GN
330
320
HSS
S-GW
325
MME
315
300
eNode B
310
305
335
340
UE
FA

FIG. 3

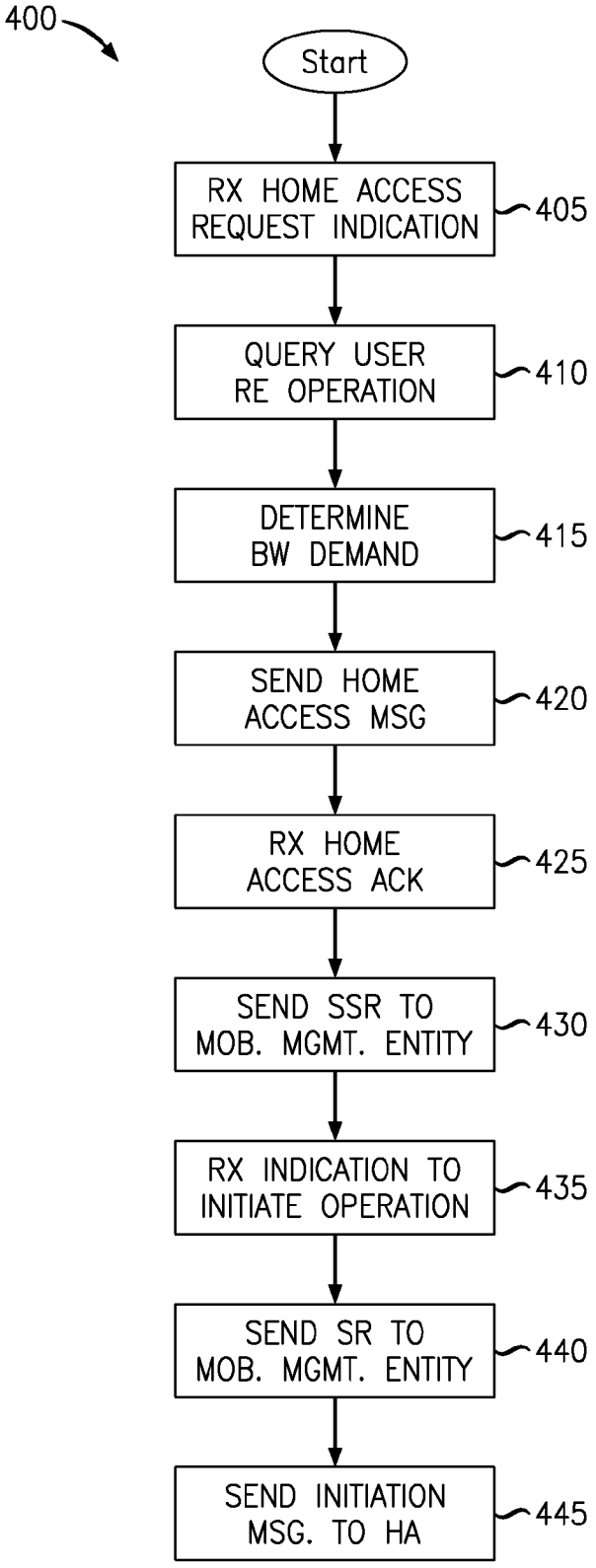

400
Start
RX HOME ACCESS REQUEST INDICATION
405
QUERY USER RE OPERATION
410
DETERMINE BW DEMAND
415
SEND HOME ACCESS MSG
420
RX HOME ACCESS ACK
425
SEND SSR TO MOB. MGMT. ENTITY
430
RX INDICATION TO INITIATE OPERATION
435
SEND SR TO MOB. MGMT. ENTITY
440
SEND INITIATION MSG. TO HA
445

FIG. 4

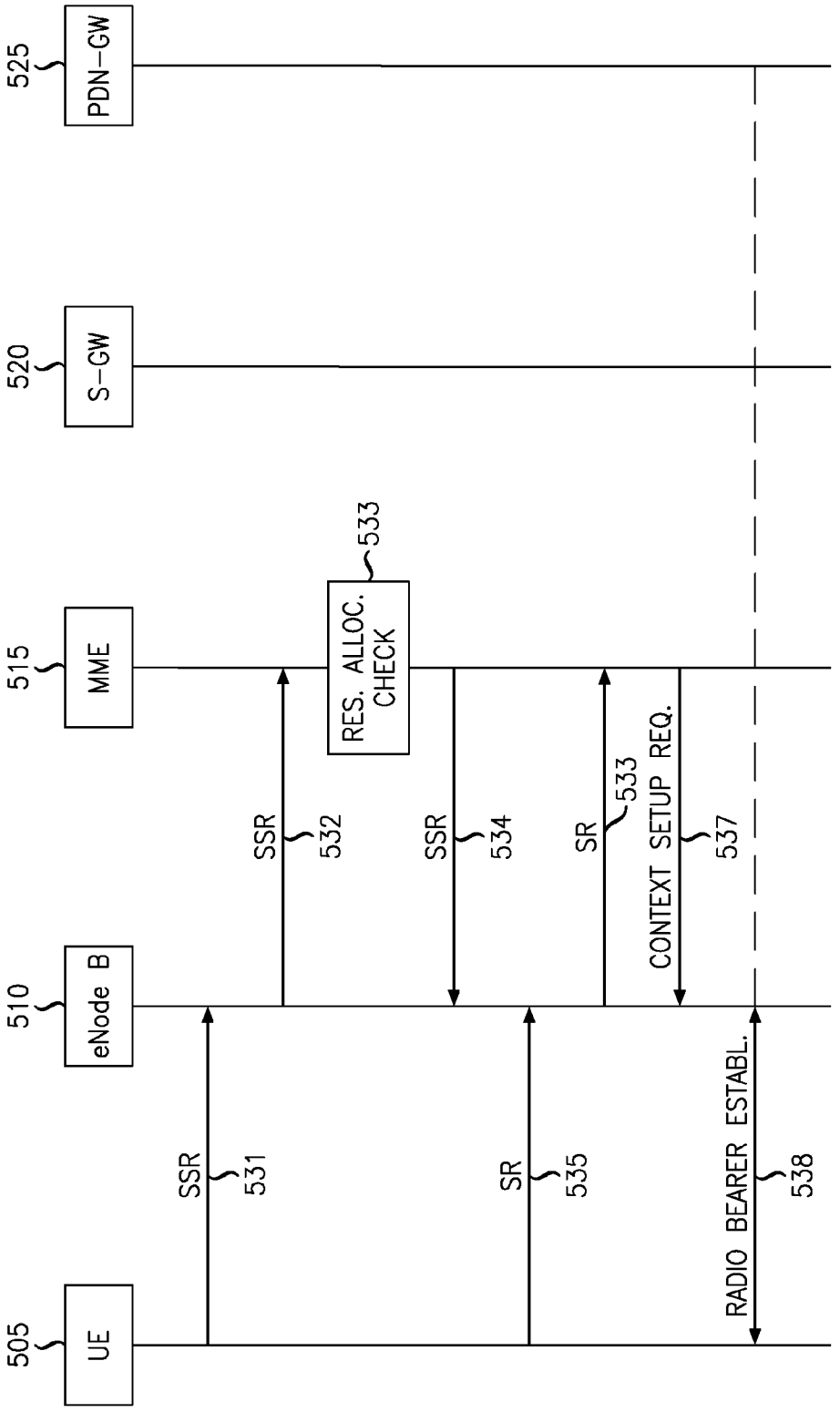

525
PDN-GW
520
S-GW
515
MME
510
eNode B
505
UE
RES. ALLOC. CHECK
533
SSR
532
SSR
534
SR
533
CONTEXT SETUP REQ.
537
SSR
531
SR
535
RADIO BEARER ESTABL.
538

FIG. 5

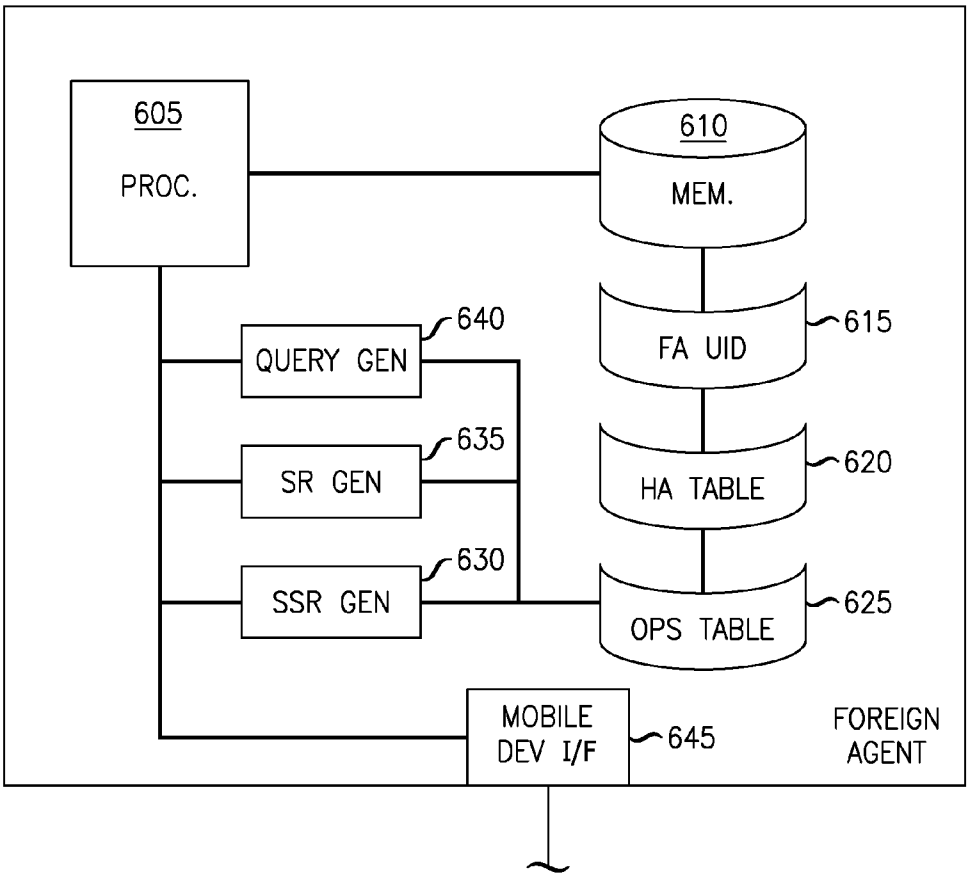

605
PROC.
610
MEM.
FA UID
615
640
QUERY GEN
635
SR GEN
HA TABLE
620
630
SSR GEN
OPS TABLE
625
MOBILE
DEV I/F
645
FOREIGN
AGENT

FIG. 6

METHOD AND APPARATUS FOR HOME NETWORK ACCESS USING A REMOTE MOBILE DEVICE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present disclosure is related to and claims priority from U.S. Provisional Patent Application Ser. No. 61/316,553, entitled Extending the In-Home Layer 2 Network and filed on 23 Mar. 2010, the entire contents of which are incorporated by reference herein.

[0002] The present invention is related to the U.S. patent application Ser. No. 12/985,730, entitled Method and Apparatus for Home Network Access, filed on 6 Jan. 2011, the entire contents of which are incorporated by reference herein.

TECHNICAL FIELD

[0003] The present invention relates generally to the field of communication networks, and, more particularly, to a method and apparatus for facilitating remote access by a subscriber to an in-home communication network using a mobile device in communication with an access network.

BACKGROUND

[0004] Introductory information will here be provided. Note, however, that the apparatus, techniques, or schemes described herein as existing or possible are presented as background for describing the present invention, and no admission is intended thereby that these were heretofore commercialized or known to others beside the inventors.

[0005] Selected abbreviations are herewith defined, at least some of which are referred to within the following description of the state-of-the-art and the present invention.

[0006] ASIC Application Specific Integrated Circuit
[0007] DSL Digital Subscriber Line
[0008] DVR Digital Video Recorder
[0009] HA Home Agent
[0010] FA Foreign Agent
[0011] IP Internet Protocol
[0012] ISP Internet Service Provider
[0013] LTE Long Term Evolution
[0014] MME Mobility Management Entity
[0015] NAT Network Address Translation
[0016] OS Operating System
[0017] PC Personal Computer
[0018] PDN Packet Data Network
[0019] PDN-GW PDN Gateway
[0020] PKI Public Key Infrastructure
[0021] PS Proxy Server
[0022] RG Residential Gateway
[0023] SG Signaling Gateway
[0024] S-GW Serving Gateway
[0025] QCI QoS Class Identifier
[0026] QoS Quality of Service
[0027] TCP Transmission Control Protocol
[0028] UE User Equipment
[0029] UID Unique Identifier

[0030] Consumer electronics have progressed a great deal in the recent past. Not only are they more capable than they were a short time ago, they are also far more prevalent. Many homes, for example, have more than one personal computer and video storage device, along with many similar devices. These devices are often connected together to form a network, and through the network are capable of communicating with other devices outside of the home. The use of email and telephone services that are available through such networks is very common, and the downloading of, for example, software applications and multimedia transmissions is becoming more frequent.

[0031] A home network benefits users in a number of ways. Even if there is no connection to others outside of the home, the home network allows a user to, for example, print from a printer that is not connected directly to the computer in use. Files such as documents, pictures, and videos may be retrieved or sent to another device within the home. Modern data storage units are capable of saving a large amount of audio or video data, and the network permits this content to be retrieved and played on any device connected to the network. Multiple users may participate in a game over the network.

[0032] Connections outside of the home are often facilitated by some type of device that serves as an interface to whatever network service is providing access. Such a device may take the form, for example, of a wireless router connecting multiple computers to the Internet, or a set-top box that receives video and television programming for display on a television or other video display device. Many if not most home networks are connected to an access network, which provides a link between a subscriber's home and a core network capable of handling large amounts of communication traffic and providing gateways for communicating through other networks as well.

[0033] When the home network is connected to an access network, communications such as email and Internet access are permitted; video and audio content may be downloaded. In addition, recent advances in technology have enlarged the amount of data that may be uploaded, or sent from the home network to others through the access network. In some cases, for example a movie or other video may be sent to another at nearly the speed at which it was downloaded, at least from the user's perception.

[0034] This may be of great advantage to the user of a mobile device. As used herein, a mobile device is one capable of accessing a mobile network using radio communications. Mobile devices are very popular because of their mobility; a user may conveniently carry the device with them and use it anywhere a mobile network may be contacted. Mobile network providers have signed up thousands of subscribers and built up networks that cover large geographic areas. In many locations, if a subscriber cannot access their own mobile network, they may use another network as a visitor. Mobile networks are often based on a cell system, where mobile devices communicate with a nearby base station and handover protocols allow them to travel from one cell (base station) to another without significant interruption of an ongoing communication session.

[0035] Access may also be possible directly to the home network though a mobile network using protocols such as MobileIP. In such an arrangement it is contemplated that the mobile device embodies a foreign agent (FA) that establishes a communication session with a home agent (HA) embodied on one of the devices that makes up the home network. Access to a home network may be provided for selected FAs, for example in accordance with the solution presented in U.S. patent application Ser. No. 12/985,730 (referred to above), for the purpose of using home network resources, controlling network functions, and transferring or viewing content stored there to or at the mobile device.

[0036] Unfortunately, large amounts of streaming multimedia content may overwhelm the mobile network. Although the mobile device may be granted access to the home network and allowed to retrieve content stored there, in order to display it on the mobile device it must pass through the mobile network and the air interface between the mobile network and the mobile device.

[0037] In an attempt to avoid transmission problems, the mobile network allocates bearer resources to carry the traffic associated with the mobile device when the device requests that a call be set up. The needs of the call and its priority are determined so that appropriate resources can be reserved. With mobile access of a home network, however, the resources needed may appear to be very modest when the call is set up.

[0038] In accordance with the access scheme employed here, initial communications involve only communicating with, for example, a signaling gateway to gain access to the home network and then browsing a media storage device located there to select content. Once the content is selected and retrieval begins, however, the bandwidth requirements may rise quickly and significantly. The mobile network faces with this sudden demand may simply decline to pass along the transmission or terminate the communication session entirely.

[0039] In the face of such difficulties, there is a need for a way to improve the process of retrieving content stored on a home network and, specifically, of attempting to reserve sufficient mobile-network resources for the transmission. Accordingly, there has been and still is a need to address the aforementioned shortcomings and other shortcomings associated with remote access of a home network. These needs and other needs are satisfied by the present invention.

SUMMARY

[0040] The present invention is directed to a manner of facilitating access to a home network having an HA by a remote mobile device, such as a smartphone, having an FA that is or may be registered with the HA. In one aspect, the present invention is a method for accessing the home network using a mobile device including requesting via a mobile network that a communication session with the home network be established, sending an SSR (specialized service request) to the mobile network indicating an anticipated operation, and sending an SR (service request) to the mobile network requesting that a bearer be established for the anticipated operation. In some embodiments, the FA sends a query to the user of the mobile device to assist in the determination of the nature of the anticipated operation and whether it is bandwidth intensive. In some embodiments, the SSR may not be sent if no bandwidth intensive operations are anticipated while in others, an SSR indicating this may be sent. In still other embodiments, all anticipated operations are processed the same regardless of the amount of bandwidth to be required.

[0041] In this aspect, the SSR is usually but not necessarily sent after a communication path between the FA and the HA has been established, and the SR is sent once an operation has actually been selected for execution. Unless the operation is declined, it may then be executed. In an LTE environment, the SSR is sent to an MME of the mobility network via an eNodeB. In some embodiments, the SSR includes an indication of the bandwidth requirements for the anticipated operation and a requested QoS.

[0042] In another aspect, the present invention is an FA (foreign agent) for use by a mobile device, including a processor, a memory device accessible to the processor, an SSR generator for generating an SSR indicating an anticipated operation, and a mobile device interface for sending the SSR to a mobile network via the mobile device. The FA may be embodied in or connectable to the mobile device. The FA may further include an operations table for maintaining a list of operations that may be requested by a user and their anticipated bandwidth demand and a query generator for generating a query to the user to determine an anticipated operation.

[0043] Additional aspects of the invention will be set forth, in part, in the detailed description, figures and any claims which follow, and in part will be derived from the detailed description, or can be learned by practice of the invention. It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory only and are not restrictive of the invention as disclosed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0044] A more complete understanding of the present invention may be obtained by reference to the following detailed description when taken in conjunction with the accompanying drawings wherein:

[0045] FIG. **1** is a simplified schematic diagram illustrating selected components of a home network according to an embodiment of the invention;

[0046] FIG. **2** is a simplified schematic diagram illustrating selected components of a communication network according to an embodiment of the present invention;

[0047] FIG. **3** is a simplified schematic diagram illustrating selected components of a broadband wireless network according to an embodiment of the present invention;

[0048] FIG. **4** is a flow diagram illustrating a method according to an embodiment of the present invention;

[0049] FIG. **5** is a message flow diagram illustrating a method according to and embodiment of the presentation; and

[0050] FIG. **6** is a simplified schematic diagram illustrating selected components of an FA according to an embodiment of the present invention.

DETAILED DESCRIPTION

[0051] FIG. **1** is a simplified schematic diagram illustrating selected components of a home network **100** according to an embodiment of the invention. Note that the home network is so-called because the components used are suitable to acquisition and use in-home by a subscriber, but the same system could just as easily be installed in, for example, a small business, school, or church office setting. For convenience, such a network will be referred to as a home network regardless of whether it is installed in the residence of a single subscriber or in another location.

[0052] The various components of a home network could communicate only among themselves—within the home (or other installed location), but this is typically not the case. Communication with outside devices is often one of the reasons for which the home network was established. In the embodiment of FIG. **1**, home network **100** includes an RG (residential gateway) **105**. RG **105** facilitates communications between home network **100** and an access network (not shown in FIG. **1**). The access network in turn provides a

conduit to a core communication network and then to other networks and devices (see, for example, FIG. **2**).

[0053] In the embodiment of FIG. **1**, RG **105** may also act as a router to receive communications from outside and transmit them to the various components of network **100**. In this embodiment, these components include a PC **110** and associated media storage device **115**. Telephone service is also available through home network **100**, as represented by telephone **140**. A set-top box **120** is also part of home network **100** and is associated with DVR **125**. In this embodiment, network **100** also includes a telephone **130** and laptop computer **135**. As indicated in FIG. **1**, many components of network **100** are connected by a cable to RG **105**, while the laptop **135** uses a wireless interface. Of course, this particular combination of components, while not uncommon, is exemplary and other home networks may be configured differently.

[0054] Home network **100** also includes an HA (home agent) **150**, which is typically implemented as a physical processor executing instructions stored as software in a non-transitory medium. In other embodiments, the HA may be implemented as a combination of executable software and hardware such as an ASIC. The HA may be a standalone device or incorporated in a multifunction apparatus that performs other duties as well. In some implementations it may, for example, be implemented in RG **105** or PC **110**.

[0055] In accordance with this embodiment of the present invention, the HA **150** is used for communication sessions involving an FA authorized to remotely access the home network. An FA used for this purpose is typically embodied in a mobile device. Like the HA, the FA (not shown in FIG. **1**) is typically implemented as a physical processor executing instructions stored as software in a non-transitory medium. In other embodiments, however, the FA may be implemented as a combination of executable software and hardware such as an ASIC. A secure communication link, or tunnel, is established between the FA and the HA when, for example, a subscriber wishes to view content stored on the home network.

[0056] FIG. **2** is a simplified schematic diagram illustrating selected components of a communication network **200** according to an embodiment of the present invention. Note that communication network **200** actually includes several networks (or, more accurately, components within those networks, which components are not shown separately). For example, home network **100** is illustrated as a cloud (though shown in more detail in FIG. **1**), except that HA **150** is also depicted in FIG. **2**, as is RG **105**. RG **105** connects the home network **100** to access network **210**. Access network may, for example, be a DSL implementation in a PSTN or a PON (passive optical network). Access network **210** in turns provides a connection to core network **220**. In general, core network **220** is a large capacity packet data network that routes communications between many different entities, including home network **100** via access network **210**.

[0057] In this embodiment, for example, the core network **220** is in communication with the Internet **240**, providing home network **100** with Internet access. Again, there may be one or more gateway devices used at the interface, though for simplicity these components are not shown individually in FIG. **2**. Separately shown, however, are signaling gateway (SG) **225** and proxy server (PS) **230**. Each (or both) of these devices could be software executing on a single physical unit or could be implemented using multiple physical devices working cooperatively. The operation of these components in accordance with the present invention will be described below.

[0058] In the embodiment of FIG. **2**, core network **220** is also connected to mobile network **250**. Mobile network **250** typically includes a number of geographically dispersed base stations, each with their own antenna, for communicating with mobile devices in their local area. Antenna/base station **255** is depicted for purposes of illustration. Antenna/base station **255** may include, for example, an eNodeB. Mobile device **260** is also shown and is capable of radio communications with antenna/base station **255** to set up a communication session through mobile network **250**. Although only one is shown, a mobile network ordinarily includes a large number of antenna/base stations and employs a protocol for handing over a communication session from one antenna/base station to another when the mobile device relocates.

[0059] In this embodiment of the present invention, mobile device **260** includes a FA (foreign agent) **265**, which may register with HA **150** in order to access home network **100**. In accordance with the present invention a secure communication path, or tunnel, is established between FA **265** of mobile device **260** and HA **150** of home network **100** though SG **225**. In most cases, the setting up of this link will be initiated by the FA **265** as it contacts the SG **225**. Once a communication session between FA **265** and SG **225** is set up, SG **225** contacts HA **150** and provides information about the FA **265** (presuming the HA **150** has already registered with SG **225**).

[0060] The HA **150** will confirm that FA **265** should be allowed access, but than access will be permitted within applicable limitations. The secure tunnels between HA **150** and SG **225** and between SG **225** and FA **265** are linked by SG **225**, and the user may begin browsing the home network (presuming this is within the access granted) and, for example, select content to be retrieved. Note that for large transmissions, such as streaming multimedia, the secure link may be transferred to proxy server **230**. In accordance with the present invention, mobile network will already have been alerted that a large transmission directed at mobile device **260**. This process will now be described in more detail.

[0061] Note that the strategy of the present invention may be implemented for a variety of mobile networks. One such mobile network is a broadband LTE (Long Term Evolution) network, and increasing popular network for handling the demands of modern mobile traffic. FIG. **3** is a simplified schematic diagram illustrating selected components of a broadband wireless network **300** according to an embodiment of the present invention. Network **300** is, generally speaking, part of an LTE network, but again the embodiment of FIG. **3** is exemplary and many variations may be possible within the scope of the present invention.

[0062] In this embodiment, the base station is referred to as an eNodeB—here eNodeB **310**. As mentioned above, there could be and typically are a large number of geographically-dispersed network eNodeBs, which may be interconnected with each other in addition to the connections to the network **300** shown in FIG. **3**. In this context a mobile device is often referred to as a UE (user equipment). When the subscriber associated with UE **335** places or receives a call, a communication channel is established with eNodeB **310** via antenna **305**. In most if not all wireless communication networks, protocols are in place to handover communications to another

eNodeB if UE **335** relocates (or the need arises for another reason, for example heavy traffic conditions or an equipment outage).

[0063] In the embodiment of FIG. **3**, communications from UE **335** to one or more other callers are routed through S-GW (serving gateway) **325**, which among other things acts as a mobility anchor so that communications to and from UE **335**, for example, can if necessary be handed over to another eNodeB (not shown) as the UE relocates or as dictated by traffic conditions. From S-GW **325**, calls are routed to a PDN (packet data network) **350** via PDN-GW **330** for communication to the other party or parties to a communication session. In this exemplary embodiment, PDN **350** is in communication with core network **220** (shown in FIG. **2**) although in another embodiment they may in fact form a single network.

[0064] The MME **315** is a call control unit that communicates with both the eNodeB **310** and the S-GW **325** and its duties include handling authentication and signaling for connection and mobility management. The MME **315** is in communication with HSS **320**, which maintains user profiles that may include, for example, location and subscription information related to DE **335** and other subscriber devices.

[0065] In this embodiment, MME **315** interfaces with both eNodeB **310** and S-GW **325**. MME **315** also has access to HSS **320**, where subscriber data such as user profiles and location information may be stored. In FIG. **3**, interfaces illustrated with a solid line indicate communication channels for user traffic, while the broken line reflects interfaces for control signaling.

[0066] In accordance with the present invention, UE **335** includes FA **340** for communicating with an HA such as HA **150** in home network **100** (shown in FIG. **1**). When UE **335** communicates with eNodeB **210** for this purpose, a bearer is set up from the UE to network **350**. At this time a QoS class may be assigned, which dictates among other things the priority of the call and the acceptable loss and delay. A minimum guaranteed bit rate may be applied, but frequently is not. While the assigned class may be adequate for the minimal communications often needed for access of the home network and even browsing content stored there, it may be wholly inadequate for retrieving large files or streaming video. To address this problem, in accordance with the present invention, the US **335** sends a specialized service request. In the LTE environment, this will typically be a NAS (non-access stratum) protocol message. Ideally, this message will be sent after the FA has gained access to the home network but prior to actually requesting service for the high bandwidth transmission.

[0067] FIG. **4** is a flow diagram illustrating a method **400** according to an embodiment of the present invention. At START it is presumed that the components necessary to performing the method are available and operational according to the present invention. Method **400** may be implemented, for example, in the context of a user with a mobile device who wishes to remotely access a home network. In this embodiment, the user indicates this by selecting an option to launch the home access application, which is an FA resident on the mobile device. In alternate embodiments, the home access application and the FA may be separate but cooperating applications, and one or both may reside on a separate physical device, for example a USB device or a card inserted into or otherwise connected with the mobile device for this operation.

[0068] In the embodiment of FIG. **4**, the process then begins when the FA receives an indication from the user (step **405**) that home access is desired. This indication may, for example, occur by the opening of an FA application or by selecting an option from an already open application. The FA then queries the user (step **410**) as to what operation or operations are anticipated when a communication path to the home network has been established. A determination is then made (step **415**) as to whether the anticipated operations are bandwidth intensive. Note that this determination is the (or an) object of the query of step **410**, which may be omitted if the determination can be otherwise made. For example, in some implementations the user may actually have selected an icon associated with "program home video recorder" or "view home network video" to initiate the process. Note also that in some embodiments, all home network access requests will simply be treated in similar fashion regardless of how bandwidth intensive they are, in which case this step may be omitted as well. Finally, note that the determination at step **415** presumes two levels, that is, either an operation is bandwidth intensive or it is not. In another embodiment, there may be multiple levels defined and associated with particular operations. (The actual bandwidth associated with each level may be specified by, for example, the network operator or the FA or eNodeB manufacturer.)

[0069] In this embodiment, if the anticipated operation is determined at step **415** to be bandwidth intensive, a message is sent (step **420**) to an SG to initiate the home access. This will of course begin with a transmission to the eNodeB or other mobile network base station (see, for example, FIG. **3**). As mentioned above, a bearer associated with a QCI will be established for purposes of this session. The SG will make the necessary communications with the HA to determine of access will be permitted and, if it will, the secure communication path will be established (not shown). Of course, the request for access may be denied, but in this embodiment it is presumed to be permitted.

[0070] In the embodiment of FIG. **4**, when the FA receives a message (step **425**) acknowledging that the link to the HA is established, an SSR (specialized service request) is send to the MME or other mobility management entity (step **430**). The SSR includes an indication to the MME that a bandwidth intensive request is anticipated. The SSR may also indicate a more precise estimate of the anticipated bandwidth or other information relating to the request. It may also include a requested QoS. The estimated time when the transmission will begin may also be included, and a time out period provided, that is, an indication that the SSR may be ignored a certain amount of time after it was sent if the anticipated transmission has taken place. In this case, SSRs may be repeated or renewed periodically if additional time is required, for example if indicated in response to a query sent to the user (not shown).

[0071] The SSR, when received by the mobility management entity, provides additional time for the network to respond to the (anticipated) user request. A determination can be made by the MME as to whether adequate resources are available and, if not, preparatory action may be taken. For example, sessions involving UE that could also be handled by a different base station may be handed over, or the channels and resource blocks available to the network may be tuned to handle the anticipated load. In some networks the user may be offered a service upgrade to provide faster service, or given some options for different levels of service. In some cases, if

it appears that the request cannot be accommodated even with these measures, an early rejection message may be sent, perhaps with an offer to reserve a time for the operation at some point in the future. If the anticipated resources are available no such action is required, although depending on the preferences of the network operator it may be taken anyway to conserve resources for possible future requests. Of course, the specific action taken in response to the SSR is generally within the discretion of the network operator. It is anticipated, however, that the resources for the anticipated operation indicated in the SSR will not actually be reserved to avoid tying up the resources unnecessarily.

[0072] When the FA receives an indication (step **435**) that the user has selected content for retrieval, or otherwise initiates the bandwidth intensive operation, the FA sends (step **440**) an SR (service request) to the mobility management entity that a bearer be created for this transmission. The SR may contain a reference to the previously sent SSR, but in some implementations the mobility management entity may simply recognize that it is from the same mobile device. It is noted that the FA cannot typically control operation of the MME or other mobility management entity, but it is expected that in at least some cases action taken by the MME in response to the SSR increases the likelihood that the resources necessary for satisfactory transmission will be made available. There is no guarantee, of course, that all FA service requests will be granted. In this embodiment, however, it is presumed for convenience that a bearer is established in response to the SR. The FA then sends a message (step **445**) to the HA of the home network to initiate the desired operation.

[0073] In the embodiment of FIG. **4**, if it is determined at step **415** that the application is not bandwidth intensive, the FA simply proceeds to request home network access and the SSR may be omitted (not shown). Again, this is an exemplary embodiment and in other embodiments all home network access requests may be treated the same (for example, by sending an SSR to the MME). In addition, it is noted that in other embodiments additional operations may be added, or in some cases removed (regardless of whether they are indicated above as optional). The sequence of operations is also exemplary, and unless otherwise recited in a particular embodiment, the operations may be performed in any logically-consistent order.

[0074] FIG. **5** is a message flow diagram illustrating a method **500** according to and embodiment of the presentation. This embodiment is presented in the LTE environment, but may in many implementations be translated into different environments as well. it is also noted that the method **500** of FIG. **5** is similar in part though not necessarily identical to the sequence of operations illustrated in FIG. **4**. Represented in FIG. **5** is UE **505**, which is presumed to include an FA according to an embodiment of the present invention. Also shown are eNodeB **510**, MME **515**, S-GW **520**, and PDN-GW **525**, which may be presumed to be arranged as represented in FIG. **3**, or in a similar fashion.

[0075] In the embodiment of FIG. **5**, it is presumed that the FA of the UE has already requested a communication session with the HA (not shown) of a home network, though in other embodiments, the message flow **500** may commence simultaneously with or even before such a request has been made. In this embodiment, an SSR is sent (**531**) from the UE **505** to the eNodeB **510**. As with method **400** of FIG. **4**, it is expected in the LTE environment that service requests will be sent in accordance with an NAS protocol. The SSR is then forwarded (**532**) to the MME **515**.

[0076] In this embodiment, when the MME **515** receives the SSR, it performs (**533**) a resource allocation check, where it is determined whether resources are available for the anticipated operation indicated by the SSR and whether any reallocation or other action should be taken. If so, a resource allocation message (or series of messages) is sent (**534**) to the eNodeB **510** indicating the actions to be taken. If no action is necessary, the resource allocation may be sent indicating this, or in some embodiments it may simply not be sent at all. In this embodiment, no resources are actually reserved for the anticipated operation at this time, nor a separate bearer established, though in other embodiments one or both of these actions may be taken.

[0077] In the embodiment of FIG. **5**, it is also presumed that the user of the UE **505** has selected content to be streamed to the UE **505** (or some other bandwidth intensive operation) and indicated this to the FA. (In some cases, content retrieval or similar operations may be initiated automatically, so user input is not strictly required, and is not a requirement of the invention unless recited in a particular embodiment.) The UE then sends (**535**) an SR to the eNodeB **510**, which forwards (**536**) it to the MME **515**. Presuming sufficient resources to be available, the MME **515** returns (**537**) an initial context setup request to the eNodeB **510**. Radio bearer establishment (**538**) may then occur, and the operation may commence (not shown). (Of course, a bearer is established from the UE to the PDN-GW (as represented by the broken line), but the air interface is often the most resource intensive and so it emphasized here.)

[0078] It is noted that at any time, a determination may be made that the anticipated (or actually requested operation may not be accommodated, and in that case the UE will probably be notified (not shown in FIG. **5**). It is also noted that in the typical case, other messaging will be conducted according to standard protocol for setting up the appropriate communication link from the UE to the home network, and this description of the present invention does not intend to imply otherwise.

[0079] FIG. **6** is a simplified schematic diagram illustrating selected components of an FA **600** according to an embodiment of the present invention. In this embodiment, the FA **600** includes a processor **605** for controlling the other components of FA **600** and a memory device **610**, which stores both data and program instructions for controlling the Ha **600**. Memory device, as used herein, connotes a physical, non-transitory apparatus. Shown separately is a UID memory device **615** for storing the UID of the FA when it is acquired, preferably in encrypted form. An HA registration table **620** maintains a registry of HAs with which FA **600** had registered, including their respective UIDs and authentication certificates. An operations table **625** maintains a list of operations that may be requested by a user and their anticipated bandwidth demand. In some embodiments a referred QoS for each operation is also included so that it may be included in SSRs sent to the mobile network.

[0080] In the embodiment of FIG. **6**, also present in FA **600** is an SSR generator **630** for generating SSRs indicating anticipated operations to a mobility manager of the mobile network and an SR generator **635** for generating standard SRs when an anticipated operation is selected for initiation. A user query generator **640** may be present for generating queries to

for presentation to the user by the mobile device. FA **600** is preferably resident on a mobile device, such as a UE, but may also be embodied on a separate physical device connectable to the mobile device. In either case, FA **600** includes a mobile device interface **645** for interfacing with the mobile device, for example to send and receive messages and to query the user.

[0081] In this manner the present invention facilitates access to a home network using an HA by a remote mobile device, such as a smartphone, having an FA that is or may be registered with the HA. When a secure tunnel or similar communication path is or is to be established between the FA and an HA of a home network, the mobile network though which the mobile device is communicating is notified in advance that a bandwidth intensive operation is anticipated so that the mobile network may take preparatory action. In this way it is hoped that the number of requests that must be declined due to insufficient resources may be significantly reduced.

[0082] Although multiple embodiments of the present invention have been illustrated in the accompanying Drawings and described in the foregoing Detailed Description, it should be understood that the present invention is not limited to the disclosed embodiments, but is capable of numerous rearrangements, modifications and substitutions without departing from the invention as set forth and defined by the following claims.

1. A method for accessing a home network comprising a home agent by a mobile device comprising a foreign agent, said method comprising:
- requesting via a mobile network that a communication session with the home network be established;
- sending an SSR (specialized service request) to the mobile network indicating an anticipated operation; and
- sending an SR (service request) to the mobile network requesting that a bearer be established for the anticipated operation.

2. The method of claim **1**, further comprising executing the anticipated operation.

3. The method of claim **2**, wherein the anticipated operation comprises the transmission of streaming video from a storage device in the home network to the mobile device.

4. The method of claim **1**, wherein the mobile network is an LTE network and the SSR is sent to an MME of the mobility network via an eNodeB.

5. The method of claim **1**, wherein the SSR comprises an indication of the bandwidth requirements for the anticipated operation.

6. The method of claim **1**, wherein the SSR comprises a requested QoS.

7. The method of claim **1**, wherein the SSR comprises an indication of the expected start of the anticipated operation.

8. The method of claim **1**, further comprising resending the SSR.

9. The method of claim **8**, wherein the resent SSR is different than the original SSR.

10. The method of claim **1**, further comprising determining whether the anticipated operation is a bandwidth intensive operation.

11. The method of claim **10**, wherein the SSR is sent only if the anticipated operation is a bandwidth intensive operation.

12. The method of claim **10**, wherein determining whether the anticipated operation is bandwidth intensive comprises querying the user of the mobile device.

13. The method of claim **1**, further comprising receiving an indication that a secure communication path between the FA and the HA has been established.

14. The method of claim **13**, wherein the SSR is sent only after receiving the indication that a secure communication path between the FA and the HA has been established.

15. The method of claim **13**, wherein the SSR is sent only after requesting that a communication session with the home network be established.

16. An FA (foreign agent) for use by a mobile device, comprising:
- a processor;
- a memory device accessible to the processor;
- an SSR generator for generating an SSR indicating an anticipated operation; and
- a mobile device interface for sending the SSR to a mobile network via the mobile device.

17. The FA of claim **16**, further comprising an operations table for maintaining a list of operations that may be requested by a user and their anticipated bandwidth demand.

18. The FA of claim **16**, further comprising a user query generator for generating a query to the user to determine an anticipated operation.

19. A mobile device comprising an FA, the FA comprising:
- a processor;
- a memory device accessible to the processor;
- an SSR generator for generating an SSR indicating an anticipated operation; and
- a mobile device interface for sending the SSR to a mobile network via the mobile device.

20. The mobile device of claim **19**, wherein the mobile device is a smartphone.

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