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(54) Title: METHOD FOR DECIDING TO HANDOVER USER EQUIPMENT IN A MOBILE COMMUNICATON NETWORK

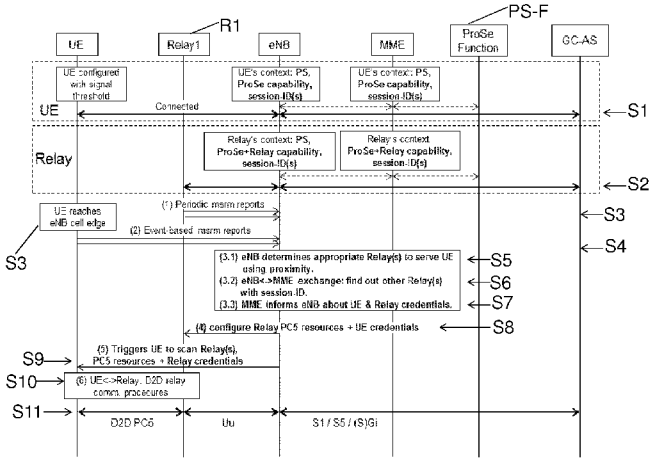


Fig. 5

(57) Abstract: The present invention relates to a method for deciding to handover a user equipment in a mobile communication network, wherein the mobile communication network comprises an access network and a core network, wherein the access network comprises a plurality of base stations, wherein at least one of the base stations is connected to one or more proximity service relays providing proximity service functionality like device-to-device communication, and wherein said user equipment is directly and/or indirectly via one of said proximity service relays, connected to one of the base stations, comprising the steps of a) Storing context information of said user equipment and said one or more proximity service relays in one or more core network entities and/or access network entities, b) Determining the location of said user equipment based on measurement reports of said user equipment, c) Checking whether one or more of the proximity service relays connected to the same and/or to another, preferably neighboring, base station can provide a proximity service connection for said user equipment based on the stored context information and/or based on available connection parameters, d) Matching the locations of said user equipment and one or more of said proximity service relays based on measurement reports of said one or more proximity service relays, e) Determining whether said user equipment can be served by one or more of the proximity service relays with a higher communication quality, and f) Deciding to handover the user equipment to one of the proximity service relays based on the results of steps c)-e) for establishing a proximity service connection between said proximity service relay and said user equipment.

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METHOD FOR DECIDING TO HANDOVER USER EQUIPMENT IN A MOBILE COMMUNICATION NETWORK

The present invention relates to a method for deciding to handover a user equipment in a mobile communication network, wherein the mobile communication network comprises an access network and a core network, wherein the access network comprises a plurality of base stations, wherein at least one of the base stations is connected to one or more proximity service relays providing proximity service functionality like device-to-device communication, and wherein said user equipment is directly and/or indirectly via one of said proximity service relays connected to one of the base stations.

The present invention further relates to a mobile communication network for deciding to handover a user equipment, preferably for performing with a method according to one of the claims 1-30, wherein the mobile communication network comprises an access network and a core network, wherein the access network comprises a plurality of base stations, wherein at least one of the base stations is connected to one or more proximity service relays providing proximity service functionality like device-to-device communication, and wherein said user equipment is directly and/or indirectly via one of said proximity service relays connected to one of the base stations.

Although applicable to proximity services in general the present invention will be described with regard to proximity services for public safety, in particular to public safety communication.

Although applicable in general to any kind or type of communication the present invention will be described with regard to group communication.

Although applicable in general to any kind of radio access network technology, the present invention will be described with regard to LTE as radio access network technology.

Current public safety communication between members of police, fire brigade, ambulance, etc. is usually performed over a radio network and a network infrastructure dedicated for the purpose like TETRA or P.25. To lower the costs of maintaining these specialized networks, authorities of some countries decided to reuse existing commercial mobile communication networks. Especially LTE-based access networks have been considered as candidates for deploying public safety services since LTE offers adequate capacity, for example for video-calls. Also the corresponding user terminals for LTE can be used with extensions to support the requirements of public safety communication easily.

One of the main requirements to commercial mobile communication networks in order to provide public safety services is to support group communication and communication when a user equipment is out-of-coverage, i.e. out of the cellular coverage, i.e. in particular out of macrocell coverage of a base station of a mobile communication network. In 3GPP TR 23.768 v0.2.0, "Study on architecture enhancements to support Group Communication System Enablers for LTE (GCSE_LTE)" v0.1.0, June 2013 this problem is addressed by supporting public safety services like push-to-talks, conferencing and distribution of different content like voice/video media, files, maps, etc. to a group of devices.

According to 3GPP TR 23.768 the communication between a group communication service enabler application server, in the following abbreviated with GC-AS and a user terminal can be modeled in two layers, namely an communication in an application layer AL that may also include a service capability layer and a transport layer TL, which is shown in Fig. 1. Details of Fig. 1 are described below.

A further conventional mobile communication network architecture is shown in Fig. 2 considering user equipment relays R. Details of Fig. 2 are described below.

To make sure that a user equipment UE is not out of coverage, the user equipment UE can be served by a user equipment-relay node R and the user equipment-relay R is here considered to be used for public safety application. One example of such a user equipment-relay R can be a police car or a fire brigade

truck that is parked outside the building and provides connectivity to user equipment UE which are inside the building and do not have macrocell coverage of a base station, in Fig. 2 the evolved node B eNB. In such cases the user equipment UE would connect to the user equipment-relay R which forwards the traffic of the user equipment UE to the core network of the mobile communication network.

Further it is possible that a public safety proximity service enabled user equipment which is not served by the radio access network may take part in a group communication of one or more group communication service enabler groups for which it is authorized via a proximity service user equipment-to-network relay as shown in 3GPP TR 23.768. Further the procedures of a proximity service user equipment-to-network relay R and its interaction with the mobile communication network at the transport layer TL is shown in 3GPP TR 23.703 v0.4.1 “Study on architecture enhancements to support Proximity Services (ProSe)”, June 2013 .

A proximity service functional architecture according to 3GPP TR 23.703 is shown in Fig. 3, which details are described below. Similar to the multipoint service function MuSe in Fig. 2 the proximity service function provides proximity services in a similar manner. The same applies for the corresponding proximity service application server PS-AS respectively GC-AS in Fig. 2.

A problem occurs, when a user equipment looses the coverage area of its base station or its communication quality decreases to a level which is not matching quality of experience levels of a user. A proximity service enabled user equipment then tries to find a user equipment relay for a proximity service connection and performs a proximity service discovery procedure. Within the proximity service direct discovery procedure the user equipment can have an announcing role and in this case the user equipment permanently announces an expression code which describes the services or interest of the user equipment. To determine the position of a user equipment and therefore if it will loose the coverage area network based positioning of user equipment based on measurement reports can be used as for example shown in 3GPP TR 36.839, v11.0.0, “Evolved Universal Terrestrial Radio

Access (E-UTRA); Mobility enhancements in heterogeneous networks", January 2013.

However, this has inter alia the following disadvantages: radio resources, for example the dedicated resources for discovery are used, battery drain of the user equipment may arise due to permanent announcement/broadcasting of the afore-mentioned expression codes and malicious users can easily identify that public safety users like police or fire brigades are in their proximity. The latter increases the risk that non-public safety resources belonging to a particular group can identify, for example via the proximity service direct discovery announcement that public safety users are in their vicinity.

It is therefore an objective of the present invention to provide a method for deciding to handover a user equipment in a mobile communication network and a mobile communication network which reduce the usage of resources in particular of the corresponding user equipment.

It is a further objective of the present invention to provide a method for deciding to handover a user equipment in a mobile communication network and a mobile communication network enabling a handover of the user equipment to a proximity service relay without reducing the security.

It is an even further objective of the present invention to provide a method for deciding to handover a user equipment in a mobile communication network and a mobile communication network enabling a faster handover of the user equipment to a proximity service relay.

It is an even further objective of the present invention to provide a method for deciding to handover a user equipment in a mobile communication network and a mobile communication network which enable enhanced flexibility in particular in terms of user equipment.

It is an even further objective of the present invention to provide a method for deciding to handover a user equipment in a mobile communication network and a

mobile communication network enabling an easy implementation into existing mobile communication networks.

There aforementioned objectives are accomplished by a method of claim 1 and a mobile communication network of claim 31.

In claim 1 a method for deciding to handover a user equipment in a mobile communication network, wherein the mobile communication network comprises an access network and a core network, wherein the access network comprises a plurality of base stations, wherein at least one of the base stations is connected to one or more proximity service relays providing proximity service functionality like device-to-device communication, and wherein said user equipment is directly and/or indirectly via one of said proximity service relays, connected to one of the base stations is defined.

According to claim 1 the method is characterized by the steps of

a) Storing context information of said user equipment and said one or more proximity service relays in one or more core network entities and/or access network entities,
b) Determining the location of said user equipment based on measurement reports of said user equipment,
c) Checking whether one or more of the proximity service relays connected to the same and/or to another, preferably neighboring, base station can provide a proximity service connection for said user equipment based on the stored context information and/or based on available connection parameters,
d) Matching the locations of said user equipment and one or more of said proximity service relays based on measurement reports of said one or more proximity service relays,
e) Determining whether said user equipment can be served by one or more of the proximity service relays with a higher communication quality, and
f) Deciding to handover the user equipment to one of the proximity service relays based on the results of steps c)-e) for establishing a proximity service connection between said proximity service relay and said user equipment.

In claim 31 a mobile communication network for deciding to handover a user equipment, preferably for performing with a method according to one of the claims 1 to 30, wherein the mobile communication network comprises an access network and a core network, wherein the access network comprises a plurality of base stations, wherein at least one of the base stations is connected to one or more proximity service relays providing proximity service functionality like device-to-device communication, and wherein said user equipment is directly and/or indirectly via one of said proximity service relays, connected to one of the base stations is defined.

According to claim 31 the mobile communication network is characterized by means operable to perform the following steps

a) Storing context information of said user equipment and said one or more proximity service relays in one or more core network entities and/or access network entities,

b) Determining the location of said user equipment based on measurement reports of said user equipment,

c) Checking whether one or more of the proximity service relays connected to the same and/or to another, preferably neighboring, base station can provide a proximity service connection for said user equipment based on the stored context information and/or based on available connection parameters,

d) Matching the locations of said user equipment and one or more of said proximity service relays based on measurement reports of said one or more proximity service relays,

e) Determining whether said user equipment can be served by one or more of the proximity service relays with a higher communication quality, and

f) Deciding to handover the user equipment to one of the proximity service relays based on the results of steps c)-e) for establishing a proximity service connection between said proximity service relay and said user equipment.

The term “proximity service relay” can be interchangeably used with the term “ProSe user equipment-to-network relay”, “device-to-device relay” or “ProSe user

equipment-to-user-equipment relay" in the description, preferably in the claims. Two types of a proximity service relay, a proximity service user equipment-to-network relay and a proximity service user equipment-to-user equipment relay are described in more detail in 3GPP TS 22.278 v12.0.0, "Service requirements for the Evolved Packet System (EPS)", March 2013.

According to the invention it has been recognized that when the handover decision to handover the user equipment to a proximity service relay has been taken, a proximity service discovery procedure can be avoided since in particular network enabled determination of handover of the user equipment to the proximity service relay based on measurements report is enabled.

According to the invention it has been further recognized that security is enhanced: No regular announcements of user equipment to find a potential proximity service relays are necessary since the network, for example the base stations, is aware about the user equipment and its capabilities.

According to the invention it has been even further recognized that flexibility is enhanced since, for example not only devices or user equipment supporting proximity service discovery procedures can be used but also user equipment which are only able to perform or provide proximity service connections.

According to the invention it has been even further recognized that an easy implementation is enabled in existing mobile communication networks. For example a simple software update or the like can be used for an implementation.

Further features, advantages and preferred embodiments are described or become apparent in the following sub-claims.

According to a preferred embodiment for step b) the location of said user equipment within the cell of said base station is determined using radio fingerprint information and/or observed time difference of arrival. This enables a network to determine approximately but precisely enough the location of said user equipment. The term "approximately" means here that the location can be determined in such

a way that the uncertainty of the location is tolerable. Radio fingerprints could be a list of macro cell IDs and their corresponding signal strength RSRP values using which the serving macro cell can estimate the approximate location of the user equipment or the proximity of the user equipment to a proximity service relay based on comparison between measurement report of the user equipment as well as the proximity service relay. For example a possible fingerprint database comprising cell IDs and Reference Signal Received Power RSRP values indicating the signal strength in the proximity of a small cell can be used. Preferably for a mobile communication network in form of a 3GPP Advanced network requirements for network-based positioning or locating are shown in 3GPP TS 36.111 v1.1.1, "Location Measurement Unit (LMU) performance specification; Network Based Positioning Systems in E-UTRAN", June 2013.

According to a further preferred embodiment proximity service direct discovery support information, proximity service support information, relay communication allowance information and/or group communication allowance information are included into the context information of said user equipment and/or of a proximity service relay. Proximity service direct discovery support information indicates that a user equipment has the capability to perform a proximity service direct discovery procedure. Proximity service support information indicates that the user equipment supports proximity services. Proximity service relay communication allowance information indicate if a user equipment is allowed for proximity service communication over a relay and group communication allowance information indicates if the user equipment is allowed for group communication preferably including broadcast communication or the like. The same applies correspondingly to the proximity service relay where proximity service direct discovery support information indicates whether a relay is can provide proximity services and capabilities. This allows in an efficient way to store only the information necessary for avoiding a proximity service discovery procedure. Further flexibility is enhanced since in case a user equipment can still perform a direct discovery procedure if false or incomplete context information of a relay is provided by a mobility management entity for example, the user equipment may still perform a direct discovery procedure.

According to a preferred embodiment relay information including capability information of acting as user equipment-to-network relay or as a user equipment-to-user equipment relay are included into the context information of a proximity service relay. This enables to store the relevant capability information of a proximity service relay preferably additionally to the context information of a user equipment enabling an efficient storage of context information.

According to further preferred embodiment relay activation status information and/or relay activation authorization information is included into the context information of a proximity service relay. This enables for example core network entities in the mobile communication network to identify entities which are able to activate or deactivate a proximity service relay and in which status the proximity service relay is and therefore a controlled but flexible handling of activation/deactivation of a proximity service relay and provided restricted access to a proximity service relay is enabled.

According to further preferred embodiment one or more preference parameters are included into the context information. This further enhances the flexibility. For example a proximity service relay can be capable of acting as a user equipment-to-network relay and also as a user equipment-to-user equipment relay but can have a preference for a user equipment-to-network relay. Similarly context information of a user equipment may include that the user equipment supports proximity service direct communication with another user equipment and the user equipment is allowed for proximity service communication over a proximity service relay but the preference can be that the user equipment prefers proximity service communication over a proximity service relay.

According to a further preferred embodiment when establishing a communication session, a session identifier is indicated to a core network entity, preferably a mobility management entity and/or to an access network entity, preferably a base station, and stored therein for the duration of said communication session. This enables to easily identify a communication session by access network or core network entities. Examples of a session ID can be an access point name APN used for example for the packet data network connection/bearer establishment or

an App-level group communication ID GC-ID or other packet data network gateway PDN/packet data protocol PDP connection IDs or other identifiers or names of sessions.

According to a further preferred embodiment the session identifier is linked with one or more transport bearer identifiers like EPS bearer identifiers. This enables in an easy way to identify the transport bearers which are used for transporting the signaling and/or data for this communication session. Thus a mapping of potential user equipment and proximity service relays that may establish, allow to establish or are interested to establish proximity service communication is enabled.

According to a further preferred embodiment a proximity service relay indicates its context information only when a user equipment attaches to it. This could be performed for example by the proximity service relay performing a dedicated bearer request procedure preferably as described in 3GPP TS 23.401 for each attached user equipment or a modify bearer request preferably according to 3GGP TS 23.401 once a user equipment attaches or leaves the proximity service relay. In case the modify bearer procedure is used the proximity service relay may mark the flows in a similar manner as described above of each of the user equipment with a different session ID and/or may use another identifier understood at the packet data network PGW to map for example the flow to the right destination and also in the downlink direction. This session identifier could be also user equipment related, for example its TMSI, IMSI, IMEI, SIP URI, IMPU, etc. This enables an efficient use of network resources since only when a user equipment attaches or leaves a proximity service relay the corresponding context information are stored or updated.

According to a further preferred embodiment the same quality parameters, preferably quality of service parameters, of a communication session to the proximity service relay and user equipment connected to said proximity service relay are configured. This ensures that after handover no modifications of the bearers of the proximity service relay over the Uu-interface for example and further over the S1/S5-interface for example are needed. If for example the quality parameters are different, for example when the user equipment uses a video call

transmission in the uplink whereas the proximity service relay only listens/receives data in the downlink, modifications may be needed.

According to a further preferred embodiment the base station to which said user equipment is connected performs steps b) to f). This enables to perform the steps b) to f) by the "edge" of the mobile communication network, i.e. the entity which is in terms of network location close to both the user equipment and the proximity service relay avoiding unnecessary traffic from the base station to and in the further access network and the core network.

According to a further preferred embodiment after step f) said user equipment and the proximity service relay to which said user equipment will be handed over are configured with radio parameters and/or security information for a proximity service communication and/or proximity service start information and/or proximity service discovery information. This enables a fast and reliable handover of the user equipment.

According to a further preferred embodiment providing measurement reports, preferably configured on the proximity service relay and/or on the user equipment is initiated by the base station to which they are connected. This enables in a flexible way that the base station requests for example measurement reports either of the proximity service relay or the user equipment or both when needed so that a waste of resources for example unnecessary data traffic is avoided.

According to a further preferred embodiment measurement reports are provided periodically and/or event-based. For example an evolved node B eNB can configure the proximity service relay for periodic measurement reports. In particular the provision of the measurement reports may depend on battery consumption in the proximity service relay, available radio resources in the macro cell in the uplink of the base station, etc. The periodic reception of measurement reports enables the base station to know the proximity relay location and/or fingerprint within its cell. Event-based measurement reports are preferably used by the user equipment avoiding a waste of user equipment resources, preferably unnecessary traffic since the user equipment only provides measurement reports

when for example the radio conditions of the user equipment due to its movement are getting worse so that communication over a proximity service relay may become attractive to ensure connectivity of the user equipment.

According to a further preferred embodiment for performing step c) only proximity service relays being part of the same communication session as the user equipment are considered. For example these proximity service relays may be identified by the same session identification information. This even further enhances the reliability and a quick handover of the user equipment to a proximity service relay. For instance the proximity service relay to which said user equipment is connected then may use the same application as said user equipment for participating in the same communication session. This enables that the proximity service relay may act as a user equipment from application point of view, i.e. from a group communication service enabler application server GC-AS and from the network point of view. For example the proximity service relay can be implemented in a police car or bus where there is installed a car phone so that the policeman driving in the car can use the phone.

According to a further preferred embodiment for performing step c) actual and/or future resource information, preferably load and/or bandwidth, of said one or more proximity service relays are determined and evaluated. For example alternatively or additionally along with a consideration of locations and/or fingerprints of the user equipment and the proximity service relay, for example a base station, like an evolved node B, can consider the traffic load of a proximity service relay when deciding about a proper proximity service relay for handover. For example the base station may know that there are several user equipments connected over this proximity service relay and no more user equipment can be attached to it. Also the data radio bearers of the proximity service relay can be utilized close to the maximum and no more bandwidth can be allocated to the bearers of the proximity service relay so that no more new user equipment can be connected to it. Alternatively or additionally other conditions for the decision of a handover to a proper proximity service relay can be taken into account for example policy information or the like.

According to a further preferred embodiment context information of a proximity service relay for performing step c) is requested by a base station from a core network entity. This allows for example a base station to determine a possible proper proximity service relays when the base station does not have the context information of the proximity service relay. The base station for example contacts the mobility management entity to request information for particular proximity service relays using for example session identification information and the location of the proximity service relays in the cell of the base station. The base station, for example an evolved node B, may then determine one or more possible proper proximity service relays for the user equipment and the base station can then request from the mobility management entity for example security credentials for the proximity service relay and the user equipment needed for the secure proximity service direct communication between the user equipment and the proximity service relay. The core network entity in form of the mobility management entity then responds with the needed security credentials.

According to a further preferred embodiment after step f) for establishing the proximity service communication with a proximity service relay a new bearer establishment procedure or a bearer modification procedure is performed, wherein the latter procedure can be performed before or during the establishment of the proximity service communication. For example when a base station already knows parameters of the established bearers of a user equipment then the base station can compare those parameters with parameters of bearers of a proximity service relay. If the base station determines that the bearer of the proximity service relay need to be updated, for example increased, because the bearer parameters of the user equipment are higher, for example higher guaranteed bit rate or higher AMBR or lower delay or the like, the base station can initiate a bearer update procedure. Optionally, the base station can also inform a proximity service relay about the new required bearer parameters so that the relay can initiate a bearer modification procedure. Even further, the base station may indicate to a core network entity, for example a mobility management entity, in particular via a S1-MME interface, about the required bearer modification. Therefore, after the user equipment and the proximity service relay have established a proximity service direct communication link, for example the PC5 interface establishment is completed, the currently used

proximity services by the user equipment can – as mentioned above – perform a new bearer establishment procedure or a bearer modification procedure for the bearers of the proximity service relay. An advantage is that the user equipment is allowed to continue using its service without interruption. For example the base station can determine a matching between the bearers of the user equipment and the proximity service relay based on the session identification parameters which are preferably stored in the context information of the user equipment and the proximity service relay, in particular in the base station.

According to a further preferred embodiment for performing step c) first proximity service relays within the cell of the base station to which the user equipment is connected, are checked and if the result is negative, then proximity service relays connected to neighboring base stations are checked. This enables a more flexible while fast making of a decision to handover. Proximity service relays which are too far away are not considered for being a proper proximity service relay for handover.

According to a further preferred embodiment for determining a next neighboring base station the location of said user equipment is determined and matched to the location of said base station. This allows in an easy way to determine neighboring base stations.

According to a further preferred embodiment neighboring base stations exchange proximity relay coverage information, preferably obtained by coverage estimation. Then a very fast determination of the location of neighboring base stations can be performed if next neighboring base stations preferably a priori exchange relay-specific coverage information about overlapping proximity service relay nodes preferably based on relay coverage estimation methods.

According to a further preferred embodiment when in at least one of the steps c)-e) a possible proximity service relay for handover is found, the X2-interface is used between the base station to which said user equipment is connected and the base station to which said possible proximity service relay is connected for requesting proximity relay location information. Using the X2-interface between the base

stations provide fast and efficient transfer of proximity relay location information to the base station which the user equipment is connected at the moment. The possible proximity service relay responds with its proximity service relay location information upon receiving a corresponding request of the X2-interface.

According to a further preferred embodiment when receiving multicast delivery of data by the user equipment in case of a received trigger for handover either

a) the user equipment requests unicast delivery of said data and after receiving unicast delivery perform handover to the proximity service relay to establish proximity service communication, or

b) the proximity service relay joins the multicast delivery service providing said data, receives said data and forwards said data to the user equipment.

This ensures that when the user equipment is handed over to a proximity service relay service continuity of the services received via multicast distribution. For example after obtaining a trigger from a base station about a handover to a proximity service relay, a user equipment can first request unicast delivery from an application server like a group communication service enabler application server GC-AS, i.e. the user equipment attempts to switch from multicast to unicast data delivery. After the group communication service enabler application server GC-AS starts unicast delivery, the user equipment can proceed with proximity service direct communication establishment with the proximity service relay.

Another possibility is that the user equipment keeps receiving the data via multicast delivery when connected to the proximity service relay. In such cases, the proximity service relay received the multicast data and forwards it to the user equipment. For this purpose the proximity service relay preferably joins for example an (e)MBMS bearer service broadcasted in the macro cell of the base station. A possibility to configure the proximity service relay to join the (e)MBMS bearer service is that user equipment indicates the (e)MBMS bearer service identification, for example TMGI to the proximity service relay. Another possibility is that the network, for example the base station via RRC signaling or the multimedia management entity MME via NAS signaling, informs the proximity

service relay to join the (e)MBMS bearer service for example by indicating the TMGI.

According to a further preferred embodiment a proximity service relay measures the communication quality of said user equipment after obtaining uplink resource information of said user equipment for performing step e). One of the advantages is, that the proximity service relay can then compute whether proximity service direct communication can be established with good quality. When a conclusion has been drawn there may be different options how to proceed further:

a) The proximity service relay can indicate to the base station its conclusion about possible proximity service link quality. Then the base station takes decision whether to trigger the user equipment and proximity service relay to establish proximity service direct communication, assigns the needed radio resources and provides resource information to the user equipment and proximity service relay along with other needed parameters like security credentials and IDs.

b) The proximity service relay decides to initiate proximity service direct communication and the proximity service relay assigns radio resources. The proximity service relay can indicate to the base station to trigger the user equipment to use the proximity service relay's resources to initiate proximity service direct communication establishment.

According to a further preferred embodiment a user triggers performing of steps c) to f) by providing triggering information in a measurement report. This enhances the flexibility since a user may trigger by itself a possible handover. For example the user of the user equipment may wish to trigger a device-to-device communication by button-push. In such a case preferably the user equipment application layer which is user operated, indicates to lower 3GPP layers, i.e. AS/NAS, that a device-to-device communication is preferred. Then the user equipment signals to the network, i.e. to a base station or a mobility management entity or an evolved node B, a request for device-to-device communication. This can be also provided additionally or outside regular measurement reports.

According to a further preferred embodiment interference between one or more proximity service relays and the base stations is minimized, preferably by using different frequency bands. This reduces the interference between the one or more proximity service relays, i.e. neighboring proximity service relays do not cause interference for user equipment camping at close locations. Further the throughput in these radio resources, where the proximity service direct communication is performed, is not decreased due to the interference.

According to a further preferred embodiment interference is determined upon activation and/or configuration of a proximity service relay. Then such interference conditions are predetermined, i.e. once a proximity service relay is configured and/or activated to act as a proximity service relay, the network, i.e. a network entity like a base station or mobility management entity provides information about frequencies and/or radio recourses that can be used or could change the radio resources by exchanging information via base stations. Further a network entity may be able to reconfigure the radio resources where proximity service direct communication is performed. For example the base station like an evolved node B can re-allocate resources between different proximity service relays in order to fulfill traffic quality of service requirements of the user equipment connected to those proximity service relays.

According to a further preferred embodiment the traffic of a user equipment connected to a proximity service relay is separated by the base station and/or said proximity service relay, preferably using a packet identifier to separate packets of the attached user equipment like a session ID or an application level group communication identifier. This enhances the flexibility, since for example such a user equipment traffic separation can be helpful in order to apply different traffic policies, accounting and/or other treatments on user equipment packets in the radio access network like E-UTRAN or in the core (EPC) network. In all embodiments here the interface, preferably the LTE Uu interface, between the proximity service relay and a base station, preferably an evolved node B, can be configured in such a way in the that the base station, here the evolved node B in the uplink and proximity service relay in the downlink is able to differentiate the

traffic coming from a particular user equipment connected to the proximity service relay via proximity service direct communication:

In the uplink, for example this can be achieved if the proximity service relay includes a session ID to separate the packets of the attached user equipment or another identifier, e.g. an access point name APN used e.g. for the packet data network PDN connection/bearer establishment, an App-level Group Communication ID GC-ID, other packet data network PDN/ packet data protocol PDP connection ID, and/or user equipment's identifiers e.g. TMSI, IMSI, IMEI, SIP URI, IMPU, etc..

In the downlink, for example this can be achieved if the base station, here an evolved node B includes a session ID to separate the packets of the attached user equipment or another identifier, an access point name APN used e.g. for the packet data network PDN connection/bearer establishment, an App-level Group Communication ID GC-ID, other packet data network PDN/ packet data protocol PDP connection ID, and/or user equipment's identifiers e.g. TMSI, IMSI, IMEI, SIP URI, IMPU, etc..

Such a different treatment or separation of different user equipment's traffic is not possible in the conventional model of tethering.

According to a further preferred embodiment the proximity service relay is provided in form of a second user equipment having proximity service functionality. For example this allows to discover user equipment which are close to each other preferably in a same cell of a base station. When the user equipment is attached to the network or performed a proximity service request procedure or is handed over to a base station, then the user equipment indicating their proximity service capability as well as their group identification and/or session or service identification to which group or session/service they are belonging to. Then the base station receives for example measurement reports from both user equipment and then may detect their location. When a decision for handing over is made, then they are close to each other and may perform a proximity service direct connection with each other.

According to a further preferred embodiment step c) – f) are performed when the user equipment looses or will lose soon a coverage of a cell of a base station to which the user equipment is connected to. This enables for example a continuous data connection of the user equipment in particular in public safety communications enhancing the reliability of the connection to a great extent.

There are several ways how to design and further develop the teaching of the present invention in an advantageous way. To this end it is to be referred to the patent claims subordinate to patent claim 1 on the one hand and to the following explanation of preferred embodiments of the invention by way of example, illustrated by the figure on the other hand. In connection with the explanation of the preferred embodiments of the invention by the aid of the figure, generally preferred embodiments and further developments of the teaching will be explained.

In the drawings

Fig. 1 shows a conventional network architecture for group communication;

Fig. 2 shows a conventional functional architecture for group communication with a relay;

Fig. 3 shows a conventional proximity service functional architecture with a conventional mobile communication network;

Fig. 4 shows a conventional mobile communication network for performing with embodiments of a method according to the present invention;

Fig. 5 shows part of steps of a method according to a first embodiment of the present invention;

Fig. 6 shows part of steps of a method according to a second embodiment of the present invention;

Fig. 7 shows a proximity scenario between two user equipment;

Fig. 8 shows part of steps of a method according to a third embodiment of the present invention;

Fig. 9 shows a proximity scenario between two user equipment camped on different macrocells; and

Fig. 10 shows part of steps of a method according to a forth embodiment of the present invention;

Fig. 1 shows a conventional network architecture for group communication.

In Fig. 1 a layered architecture for group communication service enabler used for public safety is shown.

According to 3GPP TR 23.768 the communication between a group communication service enabler application server, in the following abbreviated with GC-AS and a user terminal can be modeled in two layers, namely communication in an application layer AL that may also include a service capability layer and a transport layer TL, which is shown in Fig. 1. In Fig. 1 it is further assumed that a 3GPP mobile communication network is shown, so that the network transport layer TL includes 3GPP technologies, for example evolved packet core EPC in the core network CN and LTE in the radio access network RAN. One of the newer 3GPP based mobile communication networks is the so-called evolved packet system EPS including multiple radio access networks and evolved packet core in the core network.

The mobile communication network based on the evolved packet system EPS also includes user subscription, policy control and other functional entities as specified in 3GPP TS 23.401 and it may include apart or whole of a service capability layer,

for example the IMS service capability platform in case of an IP multimedia subsystem IMS. However, this is not explicitly shown in Fig. 1.

In more detail in Fig. 1 a public safety terminal PST provides an application A like an IMS client on an application layer AL which communicates via a service capability layer SCLC with a transport layer TL for transporting data of the application A in an application layer AL. The transport layer TL uses the mobile network MN to communicate with a public safety agency PSA on the transport layer TL. The public safety agency PSA also communicates via a service capability layer SCLC to provide the transported data to a group communication service enabler application server GCSE-AS like a dispatcher, floor chair or an IMS application server.

Fig. 2 shows a conventional functional architecture for group communication with a relay.

In Fig. 2 a group communication service enabler functional architecture considering user equipment-relays according to 3GPP TR 23.768 is shown.

A further conventional mobile communication network architecture is shown in Fig. 2 considering user equipment relays R. In more detail Fig. 2 shows a user equipment UE having a group communication service enabler application GC-A running on the corresponding user equipment UE. Further the user equipment UE has established a proximity service communication via a PC5 interface to a user equipment-relay R on which also a group communication service enabler application GC-A is running. The user equipment-relay R is connected via a Uu interface to an evolved node B eNB. The evolved node B eNB is connected via a GC3 interface to a multipoint service MuSe which is in turn connected via a GC2 interface to the group communication service enabler application server GC-AS. The group communication service enabler application server GC-AS may use the SGi interface for transmission of the data to the packet data network gateway P-GW. The packet data network gateway P-GW has established unicast EPS bearers to the user equipment UE and the group communication GC data is conveyed over the corresponding EPS bearers.

However, if the group communication service enabler application server GC-AS decides to send the data via a multicast to a group of user equipment UE or to a specific area, the group communication service enabler application server GC-AS may use the GC2 interface to the multipoint service functional entity MuSe providing multipoint services. The multipoint service entity MuSe decides how to distribute the data to the group of user equipment UE. The GC2 interface between the multipoint service entity MuSe and the group communication service enabler application server GC-AS may be used for both control plane signaling and/or user plane data.

In Fig. 2 the interfaces or reference points GC1-GC5 are defined in more detail as follows:

GC1 is reference point between the group communication service enabler application in the user equipment UE and in the group communication service enabler application server GC-AS. It is used to define application level signaling requirements to enable multipoint functionality for GCSE_LTE, and possibly for session establishment and floor control usages, etc..

GC2 is reference point between the group communication service enabler application server GC-AS and the MuSe function. It is used to define the interaction between group communication service enabler application server GC-AS and MuSe functionality provided by the 3GPP EPS layer.

GC3 is reference point between the E-UTRAN and MuSe function. It is used to define the interaction between E-UTRAN and MuSe function in order to achieve multipoint functionality provided by the 3GPP EPS layer.

GC4 is reference point between the mobility management entity MME and MuSe function. It is used to define the interaction between mobility management entity MME and MuSe function in order to achieve multipoint functionality provided by the 3GPP EPS layer.

GC5 is reference point between the packet data network gateway P-GW and MuSe function. It is used to provide data link DL unicast service by MuSe.

To make sure that a user equipment UE is not out of coverage, the user equipment UE can be served by a user equipment-relay node R as mentioned before and the user equipment-relay R is here considered to be used for public safety application. One example of such a user equipment-relay R can be a police car or a fire brigade truck that is parked outside the building and provides connectivity to user equipment UE which are inside the building and do not have macrocell coverage of a base station, in Fig. 2 the evolved node B eNB. In such cases the user equipment UE would connect to the user equipment-relay R which forwards the traffic of the user equipment UE to the core network of the mobile communication network.

Further it is possible that a public safety proximity service enabled user equipment which is not served by the radio access network may take part in a group communication of one or more group communication service enabler groups for which it is authorized via a proximity service user equipment-to-network relay as shown in 3GPP TR 23.768, key issue #2 “GCSE_LTE interaction with ProSe UE-to-Network Relays”

Further the procedures of a proximity service user equipment-to-network relay R and its interaction with the mobile communication network at the transport layer TL is shown in 3GPP TR 23.703.

Fig. 3 shows a conventional proximity service functional architecture with a conventional mobile communication network.

In Fig. 3 a proximity service functional architecture according to 3GPP TR 23.703 is shown.

Similar to the multipoint service function MuSe in Fig. 2 the proximity service function provides proximity services in a similar manner. The same applies for the

corresponding proximity service application server PS-AS respectively GC-AS in Fig. 2.

The interfaces shown in Fig. 3 are defined as follows:

PC1 is reference point between the proximity service application PS-A in the user equipment UE and in the proximity service application server PS-AS. It is used to define application level signaling requirements.

PC2 is reference point between the proximity service application server PS-AS and the proximity service ProSe Function. It is used to define the interaction between proximity service application server PS-AS and proximity service functionality provided by the 3GPP EPS via the proximity service ProSe function. One example may be for application data updates for a proximity service database in the ProSe Function. Another example may be data for use by a proximity service application server PS-AS in interworking between 3GPP functionality and application data, e.g. name translation.

PC3 is the reference point between the user equipment UE and the ProSe Function. It is used to define the interaction between user equipment UE and the ProSe function. An example may be to use for configuration for proximity service discovery and communication.

PC4 is the reference point between the evolved packet core EPC and the ProSe Function. It is used to define the interaction between evolved packet core EPC and the ProSe Function. Possible use cases may be when setting up a one-to-one communication path between user equipment UE or when validating proximity service services (authorization) for session management or mobility management in real time.

PC5 is reference point between user equipment UE to user equipment UE used for control and user plane for discovery and communication, for relay and one-to-one communication between user equipment UE directly and between user equipment over the LTE-Uu interface.

In addition to the relevant functions defined in TS 29.061 via SGi, the SGi interface or reference point may be used for application data and application level control information exchange.

The interface between the user equipment and user equipment relay R in Fig. 2 and the PC5 interface between the first and second user equipment UE1, UE2 is the same.

Fig. 4 shows a conventional mobile communication network for performing with embodiments of a method according to the present invention.

In Fig. 4 a scenario, i.e. an underlying architecture for performing with a method according to an embodiment is shown. The base station in form of an evolved node B eNB1 is connected via a Uu interface to a first relay R1. Two user equipment UE1, UE2 are connected via a PC5-interface to perform device-to-device communication to the first relay R1. Both user equipment UE1, UE2 are within the cell of the first base station eNB1, wherein the cell is depicted with a circular broken line. A second base station in form of an evolved node B eNB2 is connected via an X2-interface to the first base station eNB1. A second relay R2 is connected via a Uu-interface to the second base station eNB2. The first base station eNB1 is further connected via a S1-MME interface to a mobility management entity MME and via S1-U interface to a serving gateway SGW /packet data network gateway PGW which is in turn connected via a SGi interface to a group communication service enabler application server GCSE-AS. On both user equipment UE1, UE2 as well as on the first relay R1 a group communication server enabler application GSCE App is running which communicates with the corresponding group communication service enabler applications GCSE App via a GC1 interface.

In Fig. 4 it is assumed that the user equipment UE1, UE2 are within network coverage which is also known as “in-coverage” at the start of a communication session. For this purpose the user equipment UE1, UE2 are attached to the network via E-UTRAN and have set up the needed EPS and radio bearers for the

communication session. The user equipment UE1, UE2 may use individual communication to an application server but the user equipment UE1, UE2 can also be part of a group communication GC session, so individual unicast communication as well as group communication is possible.

Due to the movement of a user equipment UE1, UE2, a public safety user equipment UE1, UE2 can potentially move out of the macrocell coverage which is denoted as "out-of-coverage" scenario. To avoid the case where the user equipment UE1, UE2 is out-of-coverage and/or its communication quality decreases, the user equipment UE1, UE2 is handed over to an appropriate device-to-device relay R1. Such device-to-device relays or proximity service relays R1 are different from conventional relay nodes. The main difference is that the proximity service relay R1 considered for public safety or proximity service direct communication do not support broadcasting of system information SIB as done by conventional 3GPP small cell or pico cells and relay nodes. Between a base station and a proximity service relay there is no X2 interface functionality. The interface between a user equipment UE1, UE2 and a proximity service relay R1, R2 is based on device-to-device or proximity service defined as PC5 interface. The interface shown in Fig. 4 between the proximity service relay R1, R2 and the corresponding base station eNB1, eNB2 is here based on the LTE Uu interface.

Further in Fig. 4 it is assumed that there is no interference between the coverage range of the corresponding proximity service relay R1, R2 which is also known as broadcasting range or proximity service relay cell and the cell of the corresponding base station eNB1, eNB2. For unicast traffic the user equipment UE1, UE2 connected to the first proximity service relay R1 can be considered as a tethered device and the proximity service relay R1 acts as "IP router" to this user equipment UE1, UE2.

Further in Fig. 4 it is assumed that different radio resources are used for proximity service direct communication over the PC5 interface than from E-UTRAN resources used in the macrocell of the corresponding base station eNB1, eNB2.

The device-to-device relays R1, R2 are considered to be semi-mobile, i.e. not moving much while the user equipment-relay R1, R2 operates as a proximity service relay. User equipment UE1, UE2 and proximity service relay R1 may communicate on the application level via the GC1 interface as it is shown in Fig. 4. When one of the user equipments UE1, UE2 has poor radio conditions or no coverage from a macrocell provided by the base stations eNB1, eNB2 a connection between a user equipment UE1, UE2 and one of the relays R1, R2 based on proximity service direct communication may be established without using proximity service discovery procedures. In particular a radio access network entity for example the base station or a core network entity controls the session continuity when the user equipment UE1, UE2 experiences poor or no coverage and therefore a handover to a proximity service relay/device-to-device relay is needed.

When a user equipment UE1, UE2 capable of both proximity service communication and relay functionality - for simplicity called "D2D proximity service relay capable" here - i.e. user equipment UE1, UE2 implementing proximity service UE-to-Network proximity service relay capability attaches to the network, it indicates its capabilities to the network, e.g. to mobility management entity MME via NAS signaling. From the network such a device is considered as user equipment UE having a special capability/functionality that may be activated or de-activated. Such a user equipment UE1, UE2 is also registered and authorized with the proximity service function as proximity service-and-proximity service relay-capable user equipment UE. This can be for example according the network architecture shown in Fig. 3.

Alternatively the mobility management entity MME can learn about the proximity service and relay capabilities from the proximity service ProSe function. The relay function in such a user equipment UE1, UE2 may not be permanently activated, but rather can be activated on demand when needed by the network, e.g. by the proximity service ProSe function, or by the mobility management entity MME or by evolved node B eNB.

Further, the user equipment's context in the network represented preferably by the mobility management entity MME or evolved node B eNB, but also in the subscription home subscriber server HSS/home location server HLR or in the proximity service ProSe function may include the following parameters:

1) A parameter indicating whether a user equipment UE1, UE2 supports proximity service direct communication,
2) a parameter indicating whether a user equipment UE1, UE2 supports proximity service ProSe direct discovery,
3) a parameter indicating whether the user equipment UE1, UE2 is allowed for proximity service ProSe communication over a proximity service relay, and/or
4) a parameter whether the user equipment UE1, UE2 is allowed for group communication including broadcast communication, and other parameters.

Similarly, the relay's context in the network represented preferably by the mobility management entity MME or evolved node B eNB, but also in the subscription home subscriber server HSS/ home location server HLR or in the proximity service ProSe function may include the above list of parameters for user equipment UE1, UE2 and additionally

1) a parameter indicating whether a user equipment UE1, UE2 and/or proximity service relay R1 is capable to act as a user equipment-to-Network proximity service relay,
2) if a user equipment UE1, UE2 and/or proximity service relay R1 is capable to act as a user equipment-to-user equipment relay, and other parameters.

The above parameters for user equipment UE1, UE2 and proximity service relay R1 are more-or-less capability parameters. Additionally the user equipment's UE1, UE2 and proximity service relay's context in the network can store preference parameters which e.g. can be based on the above parameters. For example, a proximity service relay R1 can be capable of acting or providing a user equipment-

to-network relay and user equipment-to-user equipment-relay, but can have a preference for acting as user equipment-to-network relay. Similarly, a user equipment's UE1, UE2 context can include that the user equipment UE1, UE2 supports proximity service ProSe direct communication and the user equipment UE1, UE2 is allowed for proximity service ProSe communication over a proximity service relay R1, but the preference can be that the user equipment UE1, UE2 prefers proximity service ProSe communication over a proximity service relay.

When such D2D, i.e. a device-to-device or proximity service relay capable user equipment UE1, UE2 establishes a communication session for public safety, the user equipment UE1, UE2 may indicate a communication session identifier, i.e. a session-ID to the network, i.e. another entity in the radio access or core network, which can include mobility management entity MME or evolved node B eNB or proximity service ProSe function. Such a session-ID is then stored in the network entity/entities for the duration of the session. The session-ID can be linked with the EPS bearer(s) ID which are used to transport the signaling and data for this session.

Examples of a session-ID are an access point name APN used e.g. for the packet data network PDN connection/bearer establishment, an App-level Group Communication ID GC-ID or other packet data network PDN/packet data protocol PDP connection IDs, or other identifiers or names of sessions.

With other words, the session-ID is used as parameter/identifier to map the potential user equipment UE1, UE2 and proximity service relays that may establish or are allowed to establish or are interested to establish proximity service ProSe communication.

Alternatively the user equipment UE1, UE2 capable proximity service relay or short ”relay” only indicates its relay capabilities once a user equipment UE1, UE2 attaches to the proximity service relay and uses its resources towards the network. This could be done e.g. that the proximity service relay performs a Dedicated Bearer Request procedure as described in 3GPP TS 23.401 for each attached user equipment UE1, UE2 or with a Modify Bearer Request as described in 3GPP

TS 23.401 once a user equipment UE1, UE2 attaches or leaves the proximity service relay. In case the Modify Bearer Request procedure is used, the proximity service relay would mark in a similar manner as described above the flows of each of the user equipment UE1, UE2 with a different session ID or would use another identifier understood at the packet data network gateway PGW to map the flow to the right destination and also in the downlink direction. This identifier could be also user equipment UE1, UE2 related e.g. its TMSI, IMSI, IMEI, SIP URI, IMPU, etc.

The proximity service relay also known as user equipment-proximity service relay, D2D proximity service relay, proximity service user equipment-to-Network relay, user equipment-to-user equipment proximity service relay, etc. can implement the same application as the user equipment UE1, UE2 and can participate the same communication session as the user equipment UE1, UE2, and thus, the proximity service relay acts as a user equipment UE1, UE2 from application GC-A point of view and from network point of view.

For example the proximity service relay can be implemented in a police car/bus where there is installed car phone, so that the policeman driving in the car can use the phone. In such a case, it is possible that in downlink the bearer setup to proximity service relay and user equipment UE1, UE2 have the same Quality of Service QoS/QCI parameters. Therefore after a handover no modifications of the proximity service relay bearers over Uu-link and further the S1/S5 link are needed. However, if the bearer parameters are different, e.g. the user equipment UE1, UE2 may use a video call transmission in the uplink, whereas the proximity service relay only listens/receives data in the downlink, bearer modifications are needed. This is described in further detail in step 6 in Fig. 5.

Fig. 5 shows part of steps of a method according to a first embodiment of the present invention.

In Fig. 5 a steps for a handover procedure between a user equipment UE and a proximity service relay within the same macrocell of a base station eNB are shown.

In a first step S1 the user equipment UE and the proximity service relay R1 are attached to the network in a CONNECTED state as indicated. The network i.e. here the evolved node B and the mobility management entity MME store the context information of the user equipment UE and the proximity service relay R1 about their capability/preferences and/or functionalities, for example public safety devices proximity service communication capability, relay functionality, and/or session ID in case that the user equipment UE and the proximity service relay R1 already use a particular communication session. The user equipment UE is configured with a signal threshold, i.e. quality of service parameters so that in case the communication quality decreases, a handover to the proximity service relay R1 may be decided.

The proximity service relay R1 is in a second step S2 also connected to the evolved node B eNB and further to a group communication service enabler application server GC-AS which is also performed for the user equipment UE.

The evolved node B eNB receives measurement reports of the user equipment which is indicated in the fourth step S4. These measurement reports are event based, but can be also periodically transmitted, and the base station eNB determines if the user equipment UE will loose macrocell coverage soon (step S3') and the location of the user equipment UE in the cell of the base station eNB and/or if the user equipment UE can be served with a higher guaranteed communication quality by the proximity service relay R1.

In a fifth step S5 the base station eNB determines the location and fingerprint of the proximity service relay R1 according to provided measurement reports of the proximity service relay R1 to the base station eNB in a third step S3 and matches the locations of the user equipment UE and the proximity service relay R1. Matching means that in a sixth step S6 the base station eNB contacts for example the mobility management entity MME to find out if other proximity service relays with the same session ID are present for a handover of the user equipment UE. Here in Fig. 5 it is assumed that proximity service relay R1 matches the location with the user equipment UE.

Then in a seventh step S7 the mobility management entity MME informs the base station eNB about the credentials of the user equipment and the proximity service relay R1. The base station eNB then takes the decision in an eighth step S8 which is the proper proximity service relay – here proximity service relay R1 – and configures the corresponding proximity service relay R1 and the user equipment UE with certain radio parameters for a device-to-device communication and security credentials for the proximity service connection between the user equipment UE and the proximity service relay R1 in a ninth step S9. The base station eNB triggers the user equipment to scan for the corresponding proximity service relay R1 and provides the PC5 resources and proximity service relay credentials.

In a tenth step S10 between the user equipment UE and the proximity service relay R1 the device-to-device relay communication procedures are performed and in an eleventh step S11 the user equipment UE is connected to the proximity service relay R1 via a device-to-device PC5 communication and the proximity service relay R1 is connected via a Uu-interface to the base station eNB which in turn is connected via a S1/S5/(S)Gi interface to a group communication service enabler application server GC-AS.

In more detail the box "UE" shows the procedure(s) for attaching the user equipment UE to the network via macro cell (eNB) and possible establishment of communication session corresponding to a bearer service to an application server shown as group communication service enabler application server GC-AS, but it can be also assumed to be a proximity service server ProSe Server e.g. from Fig. 3. The network, i.e. base station eNB and/or MME, but also HSS/HLR and proximity service server ProSe Function stores user equipment UE's context information about user equipment UE capabilities/functionalities, e.g. public safety device, proximity service server ProSe communication (D2D) capability, and/or session-ID in case that the devices already use a particular communication session. A more complete list of user equipment UE's capabilities and preferences that can be stored in the network is described above.

Here it is assumed that the user equipment UE is in CONNECTED state and has ongoing communication with the group communication service enabler application server GC-AS for public safety. As the user equipment UE is proximity service server ProSe communication capable, the user equipment UE may register with proximity service server ProSe function e.g. as shown in Fig. 3. The arrows shown with dotted lines between base station eNB and the mobility management entity MME and the mobility management entity MME and ProSe function express signaling exchange between these entities. This signaling exchange provides user equipment UE's capabilities and functionalities in the user equipment UE's context in the base station eNB and the mobility management entity MME.

User equipment UE's context in base station eNB includes authorization for communication over a proximity service relay and optionally the session-ID parameter, which allows the base station eNB to map the used bearer with a particular session. In the particular case where the user equipment UE uses group communication for public safety and is ProSe communication capable, the corresponding group communication service enabler application server GC-AS and ProSe server can be implemented in the same entity, but can be also in different physical nodes. This means that the user equipment UE would have PC1 and GC1 interfaces to the same or different nodes.

The box "Relay" shows the procedure(s) for attaching the proximity service relay R to the network via macro cell (base station eNB). Optionally it is shown that the proximity service relay participates a communication session with corresponding to a bearer service to an application server shown as group communication service enabler application server GC-AS which is the same server to which the user equipment UE is communicating. The network, i.e. base station eNB and/or mobility management entity MME stores proximity service relay's context information about proximity service relay capabilities/functionalities, e.g. public safety device, proximity service server ProSe communication (D2D) capability, and/or session-ID in case that the devices already use a particular communication session. A more complete list of proximity service relay's capabilities and preferences that can be stored in the network is described above. Here it is assumed that the user equipment UE is in CONNECTED state and has ongoing

communication with the group communication service enabler application server GC-AS for public safety.

The proximity service relay's context stored in the base station eNB or in the mobility management entity MME includes information whether the proximity service relay functionality is activated or deactivated and also authorization to activate/deactivate the proximity service relay function by the base station eNB. The arrows shown with dotted lines between base station eNB and mobility management entity MME and the mobility management entity MME and the proximity service ProSe function express signaling exchange between these entities. This signaling exchange provides proximity service relay's capabilities and functionalities in the proximity service relay's context in base station eNB and mobility management entity MME. In the particular case where the proximity service relay uses group communication for public safety and is proximity service server ProSe communication capable, the corresponding group communication service enabler application server GC-AS and proximity service server ProSe Server can be same entity, but can be also in different physical nodes. This means that the proximity service relay would have PC1 and GC1 interfaces to the same or different nodes. The base station eNB can configure the proximity service relay for periodic measurement reports. The periodicity of the measurement reports depends on factors like battery consumption in the proximity service relay, available radio resources in the macro cell in the uplink, etc. The periodic reception of measurement reports allows the base station eNB to know proximity service relay's location/fingerprint within the cell.

In a third step S3 the proximity service relay R1 can send periodic measurement reports, which may be configured accordingly. This allows the base station eNB to know proximity service relay's location/fingerprint within the cell of the base station eNB. However, the proximity service relay R1 may also not be configured to send periodic measurement reports in order to save radio/battery resources. In such a case, if needed, the base station eNB should configure the proximity service relay R1, e.g. via RRC signaling messages to start periodic measurement reports. For example such a situation can occur when police car capable of proximity service relay functionality start moving towards an incident. In case when the police car is

parked in front of the police station, the periodic measurement report can be avoided, i.e. deactivated.

In a fourth step S4 the user equipment UE reports radio measurements to the base station eNB. Such measurements can be periodic or event based. In Fig. 5 it is assumed that the user equipment UE's measurement reports are event based. Due to movement the user equipment UE radio conditions gets worse and then the user equipment UE reports measurements to the base station eNB.

The next, fifth step S5 is internally performed by the base station eNB. In this step it is assumed that base station eNB has the required proximity service relay's context in order to determine the possible proper proximity service relay. The base station eNB determines the bad radio conditions of the user equipment UE. Based on the measurement reports, the base station eNB can determine the location which is also known under the term "fingerprint" of the user equipment UE within the cell. Depending on the configuration e.g. of E-UTRAN, the base station eNB can be able to determine the UE's location with the proximity of 10-20 meters or even up to 5 m. The base station eNB determines also the proximity service relay's location (fingerprint) based on the measurement reports received from the proximity service relay R1. Based on the proximity service relay R1 and UE capabilities and/or preferences in the user equipment UE's and proximity service relay's contexts, and after receiving the user equipment UE and proximity service relay measurements, the base station eNB can start procedure to determine whether the user equipment UE shall switch to communicate over the proximity service relay R1. The base station eNB can match the location of the UE to the location of known proximity service relays, e.g. a user equipment UE capable of proximity service relay functionality.

For this matching the base station eNB can consider all proximity service relays, or optionally only such proximity service relays that are part of the same communication session, e.g. based on session-ID as the user equipment UE. Alternatively or additionally, along with consider the user equipment UE and proximity service relay locations/fingerprints, the base station eNB can consider the traffic load of the proximity service relay R1 when deciding about the proper

proximity service relay. For example the base station eNB can know that there are already several user equipment UE connected over this proximity service relay R1 and no more user equipment UE can be attached to it. Also, the proximity service relay's data radio bearers DRB can be utilized close to the maximum and no more bandwidth can be allocated to proximity service relay's bearers, so that no more new user equipment UE can be connected to it.

Alternatively other conditions for the decision of the proper proximity service relay can be taken into account, which are of course but not limited to them, e.g. policy information, etc.

As a further option to initiate a handover the base station eNB may send a handover HO trigger to user equipment UE including “target proximity service relay” info resources like frequency, time sync, IDs, etc. and credentials

In a further alternative the base station eNB can send handover HO trigger to the user equipment UE including a “proximity service relay” indication. Then the user equipment UE exchanges signaling e.g. with the mobility management entity MME and/or possibly with proximity service server ProSe Function and/or group communication service enabler application server GC-AS to obtain information about available proximity service relays R1 in the same cell or in the vicinity.

The sixth step S6 is an optional step for the case where base station eNB does not have the needed proximity service relay's context in order to the determine the possible proper proximity service relay R1. The base station eNB contacts the mobility management entity MME to request information for particular proximity service relays R1 using session-ID and located in the base station eNB cell.

In a seventh step S7 a signaling between the base station eNB and the mobility management entity MME is shown. After the base station eNB determines the possible proper proximity service relay R1 for the user equipment UE, the base station eNB can request from the mobility management entity MME the security credentials for the proximity service relay R1 and user equipment UE needed for the secure ProSe direct communication between user equipment UE and proximity

service relay R1. The mobility management entity MME responds with the needed security credentials.

In an eighth step S8 after determining the proper proximity service relay R1 based on all facets or results of steps S5-S7, the base station eNB instructs the proximity service relay R1 about the needed proximity service server ProSe direct communication with the user equipment UE. For this purpose the base station eNB indicates to the proximity service relay R1 one or several of the following indications/parameters/information elements:

- information about the start of proximity service server ProSe direct communication with the user equipment UE. This can optionally include an indication to start proximity service server ProSe direct discovery announcement.
- radio communication parameters, e.g. frequency band, synchronization timer(s), etc. to establish the PC5 proximity service server ProSe direct communication with the user equipment UE.
- security credentials of the user equipment UE in order to establish secure communication.

In a ninth step S9 the base station eNB instructs the user equipment UE about the needed proximity service server ProSe direct communication with the proximity service relay R1 in order to allow session continuity. For this purpose the base station eNB indicates to the user equipment UE one or several of the following indications/parameters/information elements:

- information about the start of proximity service server ProSe direct communication with the proximity service relay R1. This can optionally include indication to start proximity service server ProSe direct discovery announcement.
- radio communication parameters, e.g. frequency band, synchronization timer(s), etc. to establish the PC5 proximity service server ProSe direct communication with the proximity service relay R1.

- security credentials of the proximity service relay R1 in order to establish secure proximity service server ProSe communication with the proximity service relay R1.

A tenth step S10 is based on the proximity service server ProSe direct communication establishment procedure(s) that are preferably defined in 3GPP TR 23.703. After the proximity service relay and UE are indicated by the base station eNB that a proximity service server ProSe direct communication can be performed and with communication parameters, the proximity service relay R1 and user equipment UE can start the proximity service server ProSe direct communication establishment without direct or EPC based discovery procedure.

In an eleventh step S11 a D2D communication of the user equipment UE via the proximity service relay R1 to the group communication service enabler application server GC-AS.

The bottom of Fig. 5 shows the solid line bold arrows which denote the data transmission path between the user equipment UE and group communication service enabler application server GC-AS. The proximity service relay R1 should act as a router or tethering device in order to forward user equipment UE's data in uplink and downlink.

After the user equipment UE and proximity service relay have established the ProSe direct communication link, i.e. the PC5 interface establishment is completed, depending on the user equipment UE's currently used services either a new bearer establishment or a bearer modification procedure needs to be performed for the proximity service relay's bearers. This should allow the user equipment UE to continue using its service(s). The base station eNB can determine the matching between the user equipment UE's and proximity service relay's bearers based on the session-ID parameter stored in the user equipment UE's and proximity service relay's context in the base station eNB.

If the user equipment UE configures a new IP address over the proximity service server ProSe direct communication link with the proximity service relay R1, i.e. the

proximity service relay R1 acts here as a router and advertises a new IP prefix to the user equipment UE, the user equipment UE may register its new address with the application server, here a group communication service enabler application server GC-AS for unicast delivery of the application data.

Regarding the bearer modification procedure described in the tenth step S10, it can be performed before or during the user equipment UE establishes the proximity service server ProSe direct communication link with the proximity service relay R1. For example, the base station eNB already knows the parameters of user equipment UE's established bearers and the base station eNB can compare those parameters with the proximity service relay's bearer parameters. If the base station eNB determines that proximity service relay's bearer parameters need to be updated, i.e. increased, because user equipment UE's bearer parameters are higher, e.g. higher guaranteed bit rate, or higher AMBR or lower delay, the base station eNB can initiate the bearer update.

Optionally the base station eNB can inform the proximity service relay R1 about the new required bearer parameters, so that the proximity service relay R1 can initiate the bearer modification procedure. Yet another option is that the base station eNB can indicate to the mobility management entity MME via S1-MME interface about the required bearer modification.

Throughout the description, preferably in the claims it is considered that the user equipment UE is able to perform dual connectivity with a base station, e.g. an evolved node B eNB and a D2D proximity service relay R1. In other words the user equipment UE is able to establish D2D PC5 connection, i.e. a ProSe direct communication link to proximity service relay R1 while the user equipment UE is connected via a LTE Uu interface to the base station eNB. The traffic is sent either over the D2D link to the proximity service relay R1 or over the Uu interface to the base station eNB, however the connections to both proximity service relay and base station eNB can be maintained for short time during/after the handover or transition procedure.

Alternatively, when the user equipment UE and proximity service relay R1 first need to apply a proximity service ProSe direct discovery procedure before they proceed with the proximity service ProSe direct communication establishment, then in steps S8 and S9 the base station eNB indicates the parameters for proximity service server ProSe direct discovery instead of proximity service ProSe direct communication. It is also possible that the base station eNB indicates common parameters for proximity service ProSe direct discovery and proximity service ProSe direct communication.

One essential advantage of the solution according to Fig. 5 is that the network, here e.g. in form of a base station eNB and/or a mobility management entity MME knows the existence of a particular user equipment UE which is connected to a proximity service relay R1 using a proximity service ProSe direct communication.

Here it is assumed that the user equipment UE can be connected via the proximity service relay R1 where the proximity service relay R1 uses tethering, i.e. the user equipment UE is connected seamlessly to the network and the network cannot identify this user equipment UE. When the network knows about the user equipment UE connected via a proximity service relay R1, the network knows about user equipment UE's bearer requirements, e.g. QoS class, video or audio, bit rate or the like, the network can correspondingly establish or modify the proximity service relay's bearers in order to fulfill the user equipment UE's traffic/bearer requirements.

Fig. 6 shows part of steps of a method according to a second embodiment of the present invention.

In Fig. 6 a handover procedure between a user equipment UE and a second relay R2 connected to a neighbor base station eNB2 is shown.

For Fig. 6 it is assumed that the current base station eNB1 to which the user equipment UE is currently connected cannot determine a proper proximity service relay/device-to-device relay R2 for a possible handover in the current cell of the base station eNB1. The current base station eNB1 contacts then neighbor cells of

base stations eNB2 in order to determine if there are proper proximity service relays/device-to-device relays R2 in the neighbor cell.

In Fig. 6 the base station eNB1 determines that the user equipment UE will loose coverage, soon, however the base station eNB1 cannot determine a proper proximity service relay in its macrocell, for example when the user equipment UE reaches the cell edge of the evolved node B eNB1 depicted in step T3'. The base station eNB1 then gathers location of other relays – here in Fig. 6 relay R2 – from the neighbor cells according to the current location of the user equipment UE, i.e. from the neighbor cell or cells to which the user equipment can possibly perform a macro handover, which is depicted in Fig. 6 with reference sign T5.

Neighboring base stations eNB1, eNB2 may a priori exchange relay-specific coverage information about overlapping proximity service relay nodes based on relay coverage estimation methods. One of the base stations for example eNB1 or eNB2 take the decision which is the proper proximity service relay R2, depicted with reference signs T6 and T7. The second base station eNB2 then configures (reference sign T8) the second relay R2 for handover and the first base station eNB1 configures (reference sign T9) the user equipment UE with certain radio parameters for proximity service communication and user equipment credentials for user equipment relay device-to-device connection. The first base station eNB1 may obtain the credentials from the mobility management entity MME.

In more detail the Box "UE" shows the procedure(s) for attaching the user equipment UE to the network. This step T1 is the same as the Box "UE" - step S1 – in Fig. 5.

The Box "proximity service relay" shows the procedure(s) for attaching the relay to the network. This step T2 is the same as the Box "Relay" - step S2 - in Fig. 5.

The third step T3 is the same as the step S3 in Fig. 5.

The fourth step T4 is the same step as the step S4 in Fig. 5.

The fifth step T5 is based on the measurement reports from the user equipment UE. The base station eNB1 determines the location of the user equipment UE in the macro cell and base station eNB1 may not discover a proper proximity service relay R2 in the vicinity of the user equipment UE. Based on the user equipment UE capabilities and/or preferences in the user equipment UE's context, and after receiving the user equipment UE and proximity service relay measurements, the base station eNB1 can start a procedure to determine whether the user equipment UE shall switch to communicate over a proximity service relay R2. In such a case the base station eNB1 needs to determine if there are proximity service relays R2 available in the neighbor cells of neighbor base stations. For this purpose the base station eNB1 requests from the mobility management entity MME information about possible proximity service relays R2 in the neighbor cell(s) to which the user equipment UE is located. In a particular example this could be the cell of base station eNB2. The mobility management entity MME responds to the base station eNB1 with information about the proximity service relay(s) R2 connected to base station eNB2 and optionally the mobility management entity MME may take into consideration the session-ID used by the user equipment UE.

Further additionally a core network entity like the mobility management entity MME may send the user equipment UE and proximity service relay(s) R2 credentials for establishing the proximity service ProSe direct communication link.

It should be noted that the fifth step T5 is performed internally on the base station eNB1, i.e. is internally handled and signaling id exchanged between base station eNB1 and the mobility management entity MME.

In a sixth step T6 after obtaining the possible proximity service relay(s) information from the mobility management entity MME, the base station eNB1 requests the proximity service relay(s) location information from base station eNB2. For this purpose the base station eNB1 can use X2-interface procedures. The base station eNB2 responds with the proximity service relay(s) location information. The base station eNB1 determines if there is a proper proximity service relay R2 that can serve the user equipment UE.

After taking a decision, the base station eNB1 informs the base station eNB2 to trigger the proper proximity service relay R2 to establish a proximity service ProSe direct communication with the user equipment UE. The base station eNB1 includes also the ID of the user equipment UE and the UE's credentials in the signaling to the base station eNB2. Upon reception of the trigger from base station eNB1, the base station eNB2 proceeds with an eighth step T8.

Alternatively the base station eNB1 can determine the proper proximity service relay R2 from the neighbor cell without contacting the mobility management entity MME. The base station eNB1 gathers proximity service relays' location from the neighbor cell(s) according to the current location of the user equipment UE, i.e. from the neighbor cell(s) to which the user equipment UE can possibly perform a macro handover. Then the base station eNB1 determines if there is a proper proximity service relay R2 that can serve the user equipment UE and communicates with the base station eNB2 according to the already described procedure above in the sixth step T6.

The next seventh step T7 is an alternative step to the sixth step from above. The base station eNB1 sends the location/fingerprint and session-ID of the user equipment UE to the neighbor cell, here the base station eNB2. The base station eNB2 determines based on the location of the user equipment and the location of the proximity service relay(s) in its macro cell, if there is a proper proximity service relay R2 in base station eNB2 cell that can server the user equipment UE. The base station eNB2 can determine that proximity service relay R2 can serve the user equipment UE. The base station eNB2 then sends a trigger to the proximity service relay R2 to establish proximity service ProSe direct communication with the user equipment UE including the needed user equipment ID and parameters and credentials of the user equipment.

After taking this decision, the base station eNB2 informs base station eNB1 to trigger the user equipment UE to establish a proximity service ProSe direct communication with the proximity service relay R2. The base station eNB2 includes also proximity service relay's ID and proximity service relay's credentials in the signaling to the base station eNB1.

In an eighth step T8 the base station eNB2 triggers proximity service relay R2 to establish proximity service ProSe direct communication with the user equipment UE including the needed parameters and credentials of the user equipment UE.

In a ninth step T9 the base station eNB1 triggers the user equipment UE to establish a proximity service ProSe direct communication with the proximity service relay R2 including the needed parameters, e.g. proximity service relay's ID, link radio parameters and proximity service relay's credentials.

The next tenth and eleventh steps T10 and T11 are the same as the steps S10 and S11 in Fig. 5.

One further use case applicable to the embodiments described in Fig. 5. and Fig. 6 above is when the user equipment UE uses multicast delivery of the application data, e.g. by using a (e)MBMS bearer service, while connected to the macro cell of a base station. When the user equipment UE is handed over to the proximity service relay R2, the service continuity of the services received via multicast distribution should be preserved.

In the following there are several possible procedures ensuring the service continuity for a user equipment:

After obtaining a trigger from the base station eNB about the handover to the proximity service relay R2, the user equipment UE can first request unicast delivery from the group communication service enabler application server GC-AS, i.e. the user equipment UE attempts to switch from multicast to unicast data delivery. After the group communication service enabler application server GC-AS starts unicast delivery, the user equipment UE can proceed with proximity service ProSe direct communication establishment with the proximity service relay R2.

Another option is the following: The user equipment UE keeps receiving the data via multicast delivery when connected to the proximity service relay R2. Here the proximity service relay R2 needs to receive the multicast data and forward it to the

user equipment UE. For this purpose the proximity service relay R2 needs to join the (e)MBMS bearer service broadcasted in the macro cell. One possibility to configure the proximity service relay to join the (e)MBMS bearer service is that user equipment UE indicates the (e)MBMS bearer service ID, e.g. TMGI to the proximity service relay R2. Another possibility is that the network, e.g. the base station eNB via RRC signaling or the mobility management entity MME via NAS signaling, informs the proximity service relay R2 to join the (e)MBMS bearer service by e.g. indicating the TMGI.

Even further the proximity service relay R2 can be informed by the base station eNB with the uplink resources of the user equipment UE, so that the proximity service relay R2 can measure the signal strength and/or quality of the user equipment UE.

Based on such measurements, the proximity service relay R2 can conclude whether a proximity service ProSe direct communication can be established with good quality. There are several options how to proceed further:

The proximity service relay R2 can indicate to the base station eNB its conclusion about possible proximity service ProSe link quality. Then the base station eNB takes decision whether to trigger the user equipment UE and proximity service relay R2 to establish proximity service ProSe direct communication, assigns the needed radio resources and informs resources to the user equipment UE and proximity service relay R2 along with other needed parameters like security credentials and IDs.

Another option is that the proximity service relay R2 decides to initiate proximity service ProSe direct communication and proximity service relay R2 assigns radio resources. The proximity service relay R2 can indicate to the base station eNB to trigger the user equipment UE to use the proximity service relay's resources to initiate proximity service ProSe direct communication establishment.

The user equipment UE's user may also wish to trigger a D2D communication by button-push (button/switch "D2D communication"). In such case the user

equipment UE App layer, which is user operated, may indicate to lower 3GPP layers, i.e. AS or NAS that D2D/proximity service communication is required. Then the user equipment UE signals to the network, i.e. a base station eNB or a mobility management entity MME for instance, a request for D2D/proximity service communication. This functionality can be for example an alternative to the forth step S4 in Fig. 5 where the user equipment UE sends such indication to base station eNB and/or mobility management entity MME instead of sending measurement reports. The other steps are similar to the corresponding steps as described in Fig. 5. or Fig. 6.

Fig. 7 shows a proximity scenario between two user equipment.

In Fig. 7 a scenario for proximity of two user equipment UE A and UE B in one cell of a base station eNB is shown.

Embodiments of the invention enable to discover proximity service enabled user equipments UE A, UE B that are close to each other in the same cell C. In Fig. 7 the two proximity service enabled user equipment UE A, UE B are in CONNECTED state that are moving around within the cell of the base station eNB.

When the user equipment UE A, UE B is attached to the network or performed a Service Request procedure or handed over to the base station eNB, the user equipment UE A, UE B indicated their proximity service ProSe capability as well as the group ID and/or session/Service ID to which group or session/Service they are belonging to. Also, the user equipment UE A, UE B context may further include information as described in the description, e.g. about proximity service ProSe discovery and communication capabilities, preferences and functionalities. Additionally the user equipment UE A, UE B should have information in their context in the network about the identifiers of other user equipment UE that they wish to discover.

Fig. 8 shows part of steps of a method according to a third embodiment of the present invention

In Fig. 8 proximity detection within one cell for two user equipment UE A, UE B being in CONNECTED mode/state are shown.

In detail the following steps are performed for detecting a proximity:

In a first step V1 the user equipment UE A connects to the base station eNB.

In a second step V2 the user equipment UE B connects to the same base station base station eNB.

In a third step V3 the user equipment UE B is sending periodic Measurement Reports to the base station eNB.

In a fourth step V4 user equipment UE A is sending periodic Measurement Reports to the base station eNB.

Then in a fifth step V5the user equipment UE A is moving into the proximity of the user equipment UE B.

In a sixth step V6 the base station eNB continuously compares the fingerprints from the measurement reports of the user equipment UE A, UE B of the same group.
In a seventh step V7 the base station eNB detects based on the comparison in sixth step V6 that the user equipment UE A and user equipment UE B are close to each other.

In an eighth step V8 the base station eNB sends a notification message to the user equipment UE B with the credentials to configure the PC5 resources.

In a ninth step V9 the base station eNB sends a notification message to the user equipment UE A with the credentials to configure the PC5 resources. This step V9 and the previous step V8 may occur in parallel. The message used in these steps V8, V9 may be a Radio Resource Control RRC message or any other lower layer protocol between the base station eNB and user equipment UE A, UE B.

In tenth step V10 the user equipment UE A and the user equipment UE B turn on D2D direct discovery and setup their D2D connection for direct communication.

In an eleventh step V11 the user equipment UE A and the user equipment UE B are being connected by a D2D PC5 proximity service connection.

The steps of the embodiment described above considers only one cell, i.e. both user equipment UE A, UE B that discover themselves are in the same cell at the same base station eNB.

Fig. 9 shows a proximity scenario between two user equipment camped on different macrocells.

In Fig. 9 the proximity of two user equipment UE A, UE B over two cells of different base station eNB A, eNB B are shown.

User equipment UE A belongs to the cell of base station eNB A and user equipment UE B to the cell of base station eNB B, but both of them are in proximity of each other. In such a case, the measurement reports from user equipment UE A already show a weak signal from base station eNB A and a stronger signal from base station eNB B. Depending on the moving direction of user equipment UE A, the base station eNB A may decide at one point in time to handover the user equipment UE A to the other base station eNB B, but not necessarily.

The procedure is similar to the one where both user equipment UE A, UE B are located in the same cell with the difference that the base station eNB does not receive the measurement reports from user equipment not being attached to it.

Fig. 10 shows part of steps of a method according to a forth embodiment of the present invention.

In Fig. 10 a proximity detection procedure for two user equipment UE A, UE B being in CONNECTED mode in two neighbor cells of different base stations eNB A, eNB B are shown.

In detail the following steps are performed:

In a first step W1 the user equipment UE A connects to the first base station eNB A.

In a second step W2 the user equipment UE B connects to the second base station eNB B.

In a third step W3 the user equipment UE B is sending periodic measurement reports to the base station eNB B.

In a forth step W4 the user equipment UE A is sending periodic Measurement Reports to the base station eNB A.

In a fifth step W5 the user equipment UE A is moving into the proximity of the user equipment UE B.

In a sixth step W6 the base station eNB A continuously compares the fingerprints from the measurement reports of the user equipment UE A, UE B of the same group.

In a seventh step W7 the base station eNB A detects based on the measurement reports in the sixth step W6 that the user equipment UE A is close to base station eNB B.

In an eighth step W8 the base station eNB A sends a Proximity Evaluation Request with the measurement report from user equipment UE A and its group ID to the base station eNB B. This message may be a S1-AP or X2-AP message or any other suitable protocol message between base station eNBs.

In a ninth step W9 the base station eNB B detects based on the received measurement reports from the user equipment UE A that the user equipment UE A is close to the user equipment UE B.

In a tenth step W10 the base station eNB B sends a Proximity Evaluation Report to the base station eNB A with the PC5 resources and user equipment UE credentials.

In an eleventh step W11 the base station eNB B sends a notification message to the user equipment UE B with the credentials to configure the PC5 resources.

In a twelfth step W12 the base station eNB A sends a notification message to the user equipment UE A with the credentials to configure the PC5 resources. Step 7 and 8 may occur in parallel. The message used in steps W11 and W12 may be a Radio Resource Control message or any other lower layer protocol between base station eNB and user equipment UE.

In a thirteenth step W13 the user equipment UE A and user equipment UE B turn on D2D direct discovery and setup their D2D connection for direct communication.

In a fourteenth step W14 a D2D PC5 communication between user equipment UE A and user equipment UE B is established.

The proximity evaluation request could be an extension of currently defined X2 interface messages or any newly defined message which does this function.

In all embodiments of the present invention it can be assumed that proximity service relays use a different frequency band than the base station eNB, however it is possible that all relays use the same frequency band. In such case it has to make sure that neighboring relays do not cause interference for user equipment UE camping at close locations. Further the throughput in this radio resources where the proximity service ProSe direct communication is performed can be decreased due to interference. Such conditions could be predetermined, i.e. once the proximity service relay is configured/activated to act as proximity service relay,

the network provides info about frequencies or radio resources that can be used, or could change the radio resources by exchanging information via base stations eNBs.

Further, the network, e.g. the base station eNB may be able to re-configure the radio resources where the proximity service ProSe direct communication is performed. For example, the base station eNB can re-allocate resources between different proximity service relays in order to fulfill the traffic Quality of Service requirements of the user equipment UE connected to those proximity service relays.

In all embodiments of the present invention, the LTE Uu interface between a proximity service relay and a base station eNB can be configured in such a way in the that the base station eNB in the uplink and the proximity service relay in the downlink is able to differentiate the traffic coming from a particular user equipment UE connected to the proximity service relay via proximity service ProSe direct communication:

In the uplink, for example this can be achieved if the proximity service relay includes a session ID to separate the packets of the attached user equipment UEs or another identifier, Access Point Name APN used e.g. for the PDN connection/bearer establishment, an App-level Group Communication ID GC-ID, other PDN/PDP connection ID, or user equipment UE's identifiers e.g. TMSI, IMSI, IMEI, SIP URI, IMPU, etc.

In the downlink, for example this can be achieved if the base station eNB includes a session ID to separate the packets of the attached user equipment UE or another identifier, Access Point Name APN used e.g. for the PDN connection/bearer establishment, an App-level Group Communication ID GC-ID, other PDN/PDP connection ID, or user equipment UE's identifiers e.g. TMSI, IMSI, IMEI, SIP URI, IMPU, etc.

For example, between the proximity service relay and base station eNB a particular bearer over the LTE Uu interface can be used to transmit the traffic of

several user equipment UE, as the separation of the user equipment UE's traffic is possible. Such user equipment UE traffic separation can be helpful in order to apply different traffic policies, accounting and/or other treatments on the user equipment UE's packets in the RAN (E-UTRAN) or Core (EPC) network.

Such a different treatment or separation of different user equipment UE's traffic is not possible with conventional tethering.

In summary the present invention provides preferably a method for avoiding the proximity service ProSe discovery procedure where (E)UTRAN, e.g. base station eNB decides to trigger handover of a user equipment UE to particular proximity service relay(s) where base station eNB determines user equipment UE and proximity service relay proximity based on received radio measurements, considering multiple cells.

The steps for this decision preferably include:

- a base station eNB stores user equipment UE and proximity service relay capabilities, preferences and functionalities related to public safety, direct communication and session ID(s); and/or
- the base station eNB takes into account the utilization of the user equipment UE and proximity service relay bearers; and/or
- the base station eNB configures user equipment UE and relay with proximity service ProSe communication parameters and security credentials.
- The proximity service relay includes a session ID to separate the packets of the attached user equipment UE or another identifier, an APN, i.e. Access Point Name used e.g. for the PDN connection/bearer establishment, an App-level Group Communication ID (GC-ID), other PDN/PDP connection ID, TMSI, IMSI, IMEI, SIP URI, IMPU, etc.

Even further the present invention enables a method in which the network, i.e. network entities like base station eNB and/or mobility management entity MME takes before or during triggering a handover of the user equipment UE to the

proximity service relay into consideration the proximity service relay bearer parameters, and if needed, adjusts those bearer parameters to utilize the user equipment UE's current traffic requirements in order to assure seamless session continuity of the user equipment UE's services.

The proximity service relay reserves dedicated bearers per attached user equipment UE in the network or modifies the bearer of the relay accordingly to the number and QoS requirements of the attached user equipment UEs.

Even further the present invention enables a method in the network (base station eNB) to determine the proximity of two or more user equipment UE A, UE B based on radio measurements and on user equipment UE preferences to discover each other, where the following steps are performed:

- The network, preferably a base station eNB, informs these user equipment UE A, UE B about their proximity; and/or
- the network, preferably base station eNB, informs these user equipment UE A, UE B about radio resource parameters configuration like security, physical layer/lower layer parameters, frequency bands etc. where they can discover or communicate with each other; and/or
- the user equipment UE A, UE B turn on their proximity service ProSe direct discovery mechanism; and/or
- the user equipment UE A, UE B turn on their proximity service ProSe direct communication mechanisms.
- In case of different base stations eNBs involved the (E)UTRAN (e)NB that determines the proximity to another cell queries the neighbor (E)UTRAN (e)NB whether there is any proximity to a user equipment UE in the neighbor cell using the same subscribed proximity service/group ID etc.

The present invention enables that proximity service discovery procedures using E-UTRAN, preferably in form of a base station eNB, is avoided.

The present invention further enables a determination of handover of a user equipment to a proximity service relay based on measurement reports and other conditions considering multiple cells.

Further the present invention enables base stations to trigger user equipment and proximity service relays to perform proximity service direct communication procedures and to inform them with all needed parameters.

The present invention has inter alia the following advantages: The present invention avoids proximity service discovery procedures and does not reveal the existence of public safety relays to malicious users.

Further the present invention enables the network to being aware about user equipment even if user equipment is connected via a proximity service direct communication with a proximity service relay.

Even further the present invention can be applied to devices that do not support any proximity services either EPC-based or direct discovery procedures but do support proximity service direct communication so flexibility is enhanced and an easy implementation is provided.

Many modifications and other embodiments of the invention set forth herein will come to mind the one skilled in the art to which the invention pertains having the benefit of the teachings presented in the foregoing description and the associated drawings. Therefore, it is to be understood that the invention is not to be limited to the specific embodiments disclosed and that modifications and other embodiments are intended to be included within the scope of the appended claims. Although specific terms are employed herein, they are used in a generic and descriptive sense only and not for purposes of limitation.

Claims

1. A method for deciding to handover a user equipment (UE, UE1, UE2) in a mobile communication network (1), wherein the mobile communication network (1) comprises an access network (AN) and a core network (CN), wherein the access network (AN) comprises a plurality of base stations (eNB, eNB1, eNB2), wherein at least one of the base stations (eNB, eNB1, eNB2) is connected to one or more proximity service relays (R1, R2, UE1, UE2) providing proximity service functionality like device-to-device communication, and wherein said user equipment (UE, UE1, UE2) is directly and/or indirectly via one of said proximity service relays (R1, R2, UE1, UE2), connected to one of the base stations (eNB, eNB1, eNB2),

characterized by the steps of

a) Storing context information of said user equipment (UE, UE1, UE2) and said one or more proximity service relays (R1, R2, UE1, UE2) in one or more core network entities (MME) and/or access network entities (eNB, eNB1, eNB2),

b) Determining the location of said user equipment (UE, UE1, UE2) based on measurement reports of said user equipment (UE, UE1, UE2),

c) Checking whether one or more of the proximity service relays (R1, R2, UE1, UE2) connected to the same and/or to another, preferably neighboring, base station (eNB, eNB1, eNB2), can provide a proximity service connection for said user equipment (UE, UE1, UE2) based on the stored context information and/or based on available connection parameters,

d) Matching the locations of said user equipment (UE, UE1, UE2) and one or more of said proximity service relays (R1, R2, UE1, UE2) based on measurement reports of said one or more proximity service relays (R1, R2, UE1, UE2),

e) Determining whether said user equipment (UE, UE1, UE2) can be served by one or more of the proximity service relays (R1, R2, UE, UE1, UE2) with a higher communication quality, and

f) Deciding to handover the user equipment (UE, UE1, UE2) to one of the proximity service relays (R1, R2, UE1, UE2) based on the results of steps c)-e) for establishing a proximity service connection between said proximity service relay (R1, R2, UE1, UE2) and said user equipment (UE, UE1, UE2).

2. The method according to claim 1, characterized in that
for step b) the location of said user equipment (UE, UE1, UE2) within the cell of said base station (eNB, eNB1, eNB2) is determined using radio fingerprint information and/or observed time difference of arrival.

3. The method according to one of the claims 1 to 2, characterized in that
proximity service direct discovery support information,
proximity service support information,
relay communication allowance information, and/or
group communication allowance information
are included into the context information of said user equipment (UE, UE1, UE2) and/or of a proximity service relay (R1, R2, UE1, UE2).

4. The method according to one of the claims 1 to 3, characterized in that
relay information including capability information of acting as user equipment-to-network relay and/or as a user equipment-to-user equipment relay are included into the context information of a proximity service relay (R1, R2, UE1, UE2).

5. The method according to one of the claims 1 to 4, characterized in that
relay activation status information and/or relay activation authorization information is included into the context information of a proximity service relay (R1, R2, UE1, UE2).

6. The method according to one of the claims 1 to 5, characterized in that
one or more preference parameters are included into the context information.

7. The method according to one of the claims 1 to 6, characterized in that

when establishing a communication session, a session identifier is indicated to a core network entity, preferably a multimedia management entity, and/or to an access network entity, preferably a base station, and stored therein for the duration of the communication session.

8. The method according to one claim 7, characterized in that the session identifier is linked with one or more transport bearer identifiers like EPS bearer identifiers.

9. The method according to one of the claims 1 to 8, characterized in that a proximity service relay (R1, R2, UE1, UE2) indicates its context information only when a user equipment (UE, UE1, UE2) attaches to it.

10. The method according to one of the claims 1 to 9, characterized in that the same quality parameters, preferably quality of service parameters, of a communication session to the proximity service relay (R1, R2, UE1, UE2) and user equipment (UE, UE1, UE2) connected to said proximity service relay (R1, R2, UE1, UE2) are configured.

11. The method according to one of the claims 1 to 10, characterized in that the base station (eNB, eNB1, eNB2) to which said user equipment (UE, UE1, UE2) is connected performs steps b) to f).

12. The method according to one of the claims 1 to 11, characterized in that after step f) said user equipment (UE, UE1, UE2) and the proximity service relay (R1, R2, UE1, UE2) to which said user equipment (UE, UE1, UE2) will be handed over are configured with radio parameters and/or security information for a proximity service communication and/or proximity service start information and/or proximity service discovery information.

13. The method according to one of the claims 1 to 12, characterized in that providing measurement reports, preferably configured on the proximity service relay and/or on the user equipment is initiated by the base station (eNB, eNB1, eNB2) to which they are connected.

14. The method according to one of the claims 1 to 13, characterized in that measurement reports are provided periodically and/or event-based.

15. The method according to one of the claims 1 to 14, characterized in that for performing step c) only proximity service relays (R1, R2, UE1, UE2) being part of the same communication session as the user equipment (UE, UE1, UE2) are considered.

16. The method according to one of the claims 1 to 15, characterized in that for performing step c) actual and/or future resource information, preferably load and/or bandwidth, of said one or more proximity service relays (R1, R2, UE1, UE2) are evaluated.

17. The method according to one of the claims 1 to 16, characterized in that context information of a proximity service relay (R1, R2, UE1, UE2) for performing step c) is requested by a base station from a core network entity (MME).

18. The method according to one of the claims 1 to 17, characterized in that after step f) for establishing the proximity service communication with a proximity service relay (R1, R2, UE1, UE2) a new bearer establishment procedure or a bearer modification procedure is performed, wherein the latter procedure can be performed before or during the establishment of the proximity service communication.

19. The method according to one of the claims 1 to 18, characterized in that for performing step c) first proximity service relays (R1, R2, UE1, UE2) within the cell of the base station (eNB, eNB1, eNB2) to which the user equipment (UE, UE1, UE2) is connected, are checked and if the result is negative, then

proximity service relays (R1, R2, UE1, UE2) connected to neighboring base stations (eNB, eNB1, eNB2) are checked.

20. The method according to claim 19, characterized in that for determining a next neighboring base station (eNB, eNB1, eNB2) the location of said user equipment (UE, UE1, UE2) is determined and matched to the location of said base station (eNB, eNB1, eNB2).

21. The method according to one of the claims 19 to 20, characterized in that neighboring base stations (eNB, eNB1, eNB2) exchange proximity relay coverage information, preferably obtained by coverage estimation.

22. The method according to one of the claims 1 to 21, characterized in that when in at least one of the steps c)-e) a possible proximity service relay (R1, R2, UE1, UE2) for handover is found, the X2-interface is used between the base station (eNB, eNB1, eNB2) which said user equipment (UE, UE1, UE2) is connected and the base station (eNB, eNB1, eNB2) to which said possible proximity service relay (R1, R2, UE1, UE2) is connected for requesting proximity relay location information.

23. The method according to one of the claims 1 to 22, characterized in that when receiving multicast delivery of data by the user equipment (UE, UE1, UE2) in case of a received trigger for handover either

a) the user equipment (UE, UE1, UE2) requests unicast delivery of said data and after receiving unicast delivery perform handover to the proximity service relay (R1, R2, UE1, UE2) to establish proximity service communication, or

b) the proximity service relay (R1, R2, UE1, UE2) joins the multicast delivery service providing said data, receives said data and forwards said data to the user equipment (UE, UE1, UE2).

24. The method according to one of the claims 1 to 23, characterized in that a proximity service relay (R1, R2, UE1, UE2) measures the communication quality of said user equipment (UE, UE1, UE2) after obtaining uplink resource information of said user equipment (UE, UE1, UE2) for performing step e).

25. The method according to one of the claims 1 to 24, characterized in that a user triggers performing of steps c) to f) by providing triggering information in a measurement report.

26. The method according to one of the claims 1 to 25, characterized in that interference between one or more proximity service relays (R1, R2, UE1, UE2) and the base stations (eNB, eNB1, eNB2) is minimized, preferably by using different frequency bands.

27. The method according to claim 26, characterized in that interference is determined upon activation and/or configuration of a proximity service relay (R1, R2, UE1, UE2).

28. The method according to one of the claims 1 to 27, characterized in that the traffic of a user equipment (UE, UE1, UE2) connected to a proximity service relay (R1, R2, UE1, UE2) is separated by the base station (eNB, eNB1, eNB2) and/or said proximity service relay (R1, R2, UE1, UE2), preferably using a packet identifier to separate packets of the attached user equipment (UE, UE1, UE2) like a session id or an application level group communication identifier.

29. The method according to one of the claims 1 to 28, characterized in that the proximity service relay (R1, R2, UE1, UE2) is provided in form of a second user equipment (UE, UE1, UE2) having proximity service functionality.

30. The method according to one of the claims 1 to 29, characterized in that steps c) to f) are performed when the user equipment (UE, UE1, UE2) looses or will loose soon a coverage of a cell of the base station (eNB, eNB1, eNB2) to which the user equipment (UE, UE1, UE2) is connected to.

31. A mobile communication network (1) for deciding to handover a user equipment (UE, UE1, UE2), preferably for performing with a method according to one of the claims 1 to 30, wherein the mobile communication network (1) comprises an access network (AN) and a core network (CN), wherein the access network (AN) comprises a plurality of base stations (eNB, eNB1, eNB2), wherein at least one of the base stations (eNB, eNB1, eNB2) is connected to one or more proximity service relays (R1, R2, UE1, UE2) providing proximity service functionality like device-to-device communication, and wherein said user equipment (UE, UE1, UE2) is directly and/or indirectly via one of said proximity service relays (R1, R2, UE1, UE2), connected to one of the base stations (eNB, eNB1, eNB2),
characterized by
means operable to perform the following steps

a) Storing context information of said user equipment and said one or more proximity service relays (R1, R2, UE1, UE2) in one or more core network entities (MME) and/or access network entities (eNB, eNB1, eNB2),

b) Determining the location of said user equipment (UE, UE1, UE2) based on measurement reports of said user equipment (UE, UE1, UE2),

c) Checking whether one or more of the proximity service relays (R1, R2, UE1, UE2) connected to the same and/or to another, preferably neighboring, base station (eNB, eNB1, eNB2), can provide a proximity service connection for said user equipment (UE, UE1, UE2) based on the stored context information and/or based on available connection parameters,

d) Matching the locations of said user equipment (UE, UE1, UE2) and one

or more of said proximity service relays (R1, R2, UE1, UE2) based on measurement reports of said one or more proximity service relays (R1, R2, UE1, UE2),

e) Determining whether said user equipment (UE, UE1, UE2) can be served by one or more of the proximity service relays (R1, R2, UE, UE1, UE2) with a higher communication quality, and

f) Deciding to handover the user equipment (UE, UE1, UE2) to one of the proximity service relays (R1, R2, UE1, UE2) based on the results of steps c)-e) for establishing a proximity service connection between said proximity service relay (R1, R2, UE1, UE2) and said user equipment (UE, UE1, UE2).

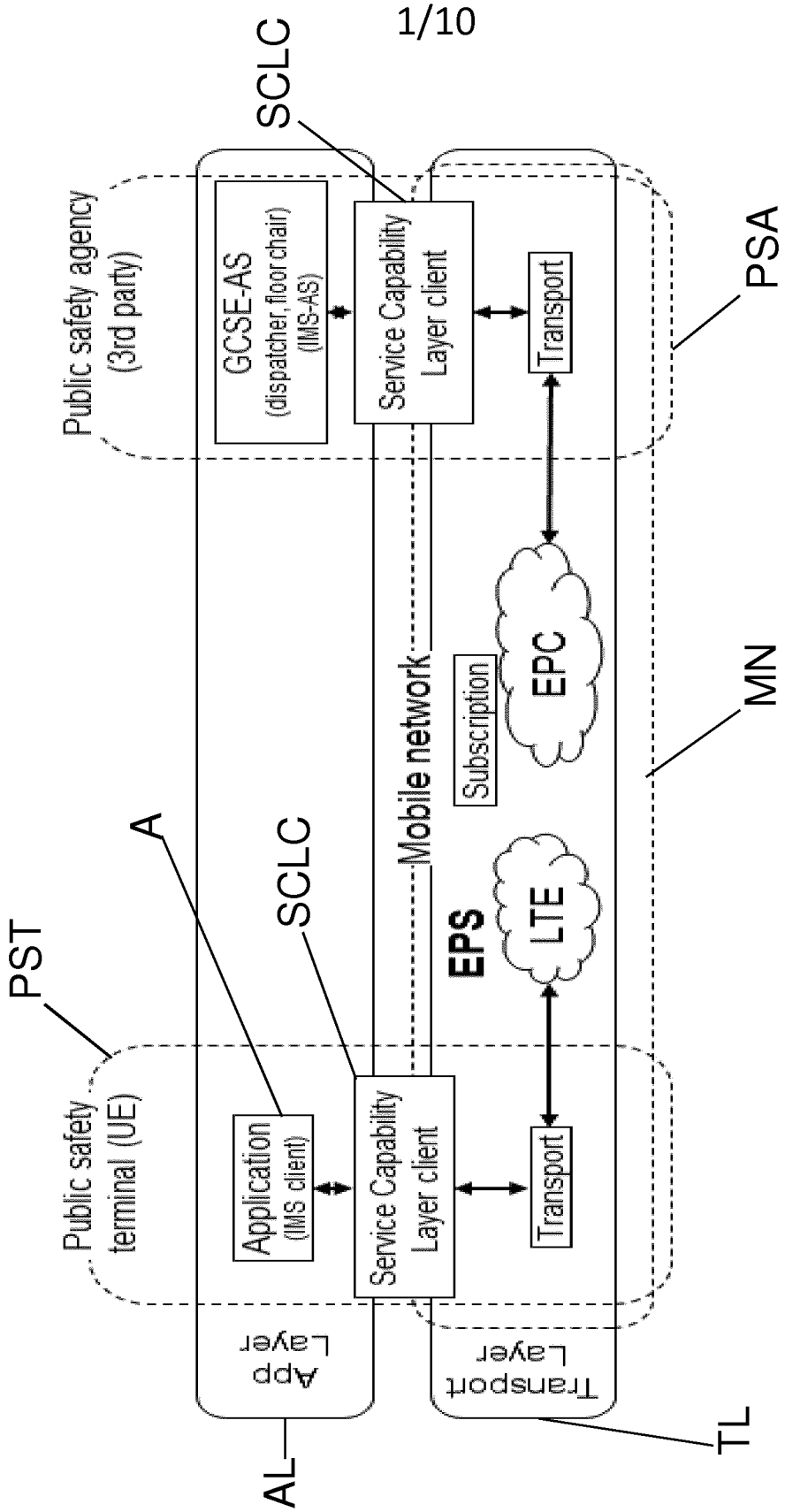

SCLC
Public safety agency (3rd party)
GCSE-AS (dispatcher, floor chair) (IMS-AS)
Service Capability Layer client
Transport
PSA
Mobile network
Subscription
EPC
MN
EPS
LTE
A
SCLC
PST
Public safety terminal (UE)
Application (IMS client)
Service Capability Layer client
Transport
App Layer
Transport Layer
AL
TL

Fig. 1

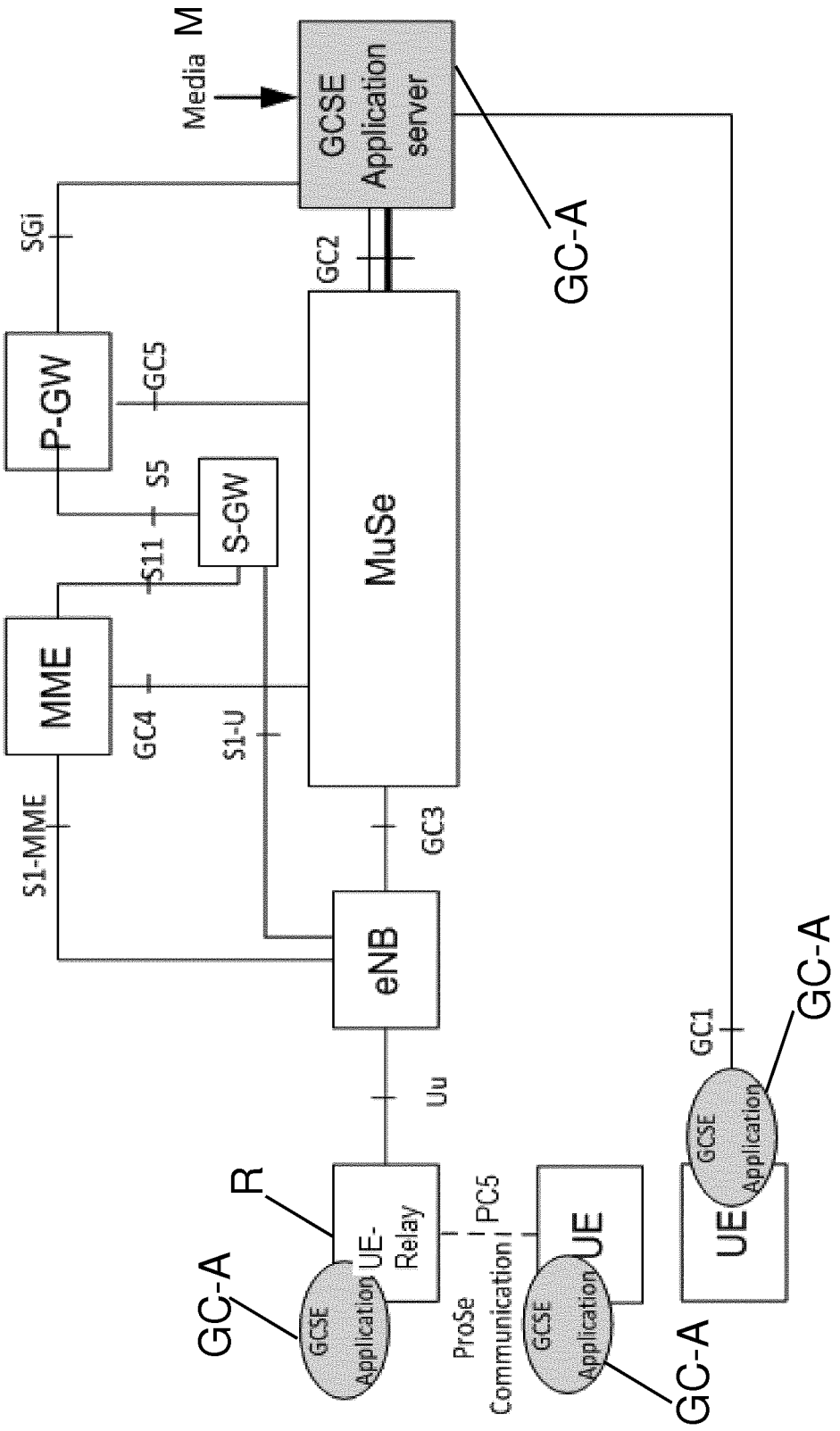

Media M
GCSE Application server
GC-A
SGi
GC2
P-GW
GC5
S5
S-GW
S11
MuSe
MME
GC4
S1-U
S1-MME
GC3
eNB
Uu
R
UE-Relay
PC5
ProSe Communication
UE
GC1
GC-A
GCSE Application
GC-A
GCSE Application
GC-A
GCSE Application
UE

Fig. 2

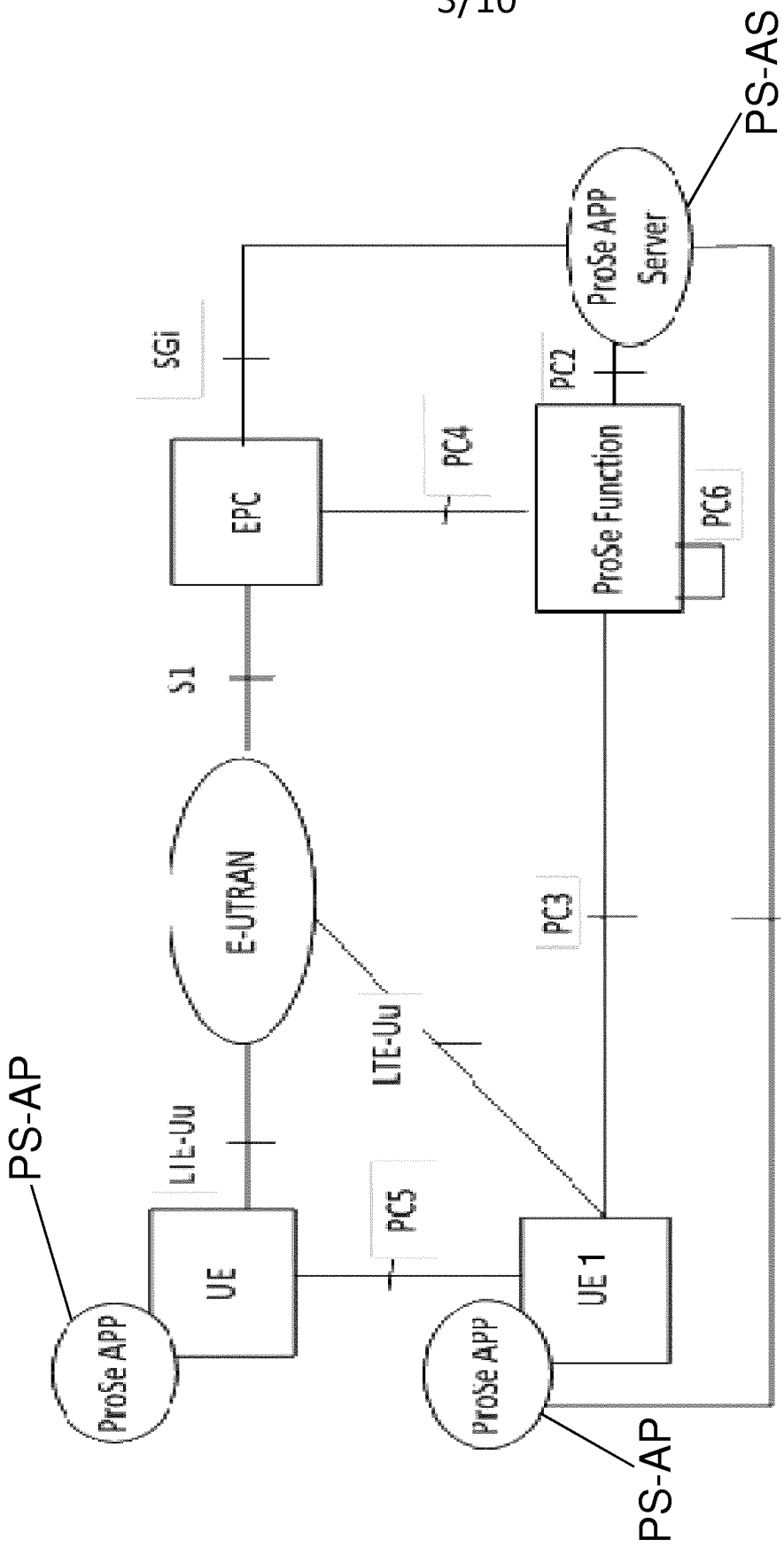

PS-AS
ProSe APP Server
SGi
PC2
PC4
EPC
ProSe Function
PC6
S1
E-UTRAN
PC3
PC1
LTE-Uu
PS-AP
LTE-Uu
PC5
UE
UE 1
ProSe APP
ProSe APP
PS-AP

Fig. 3

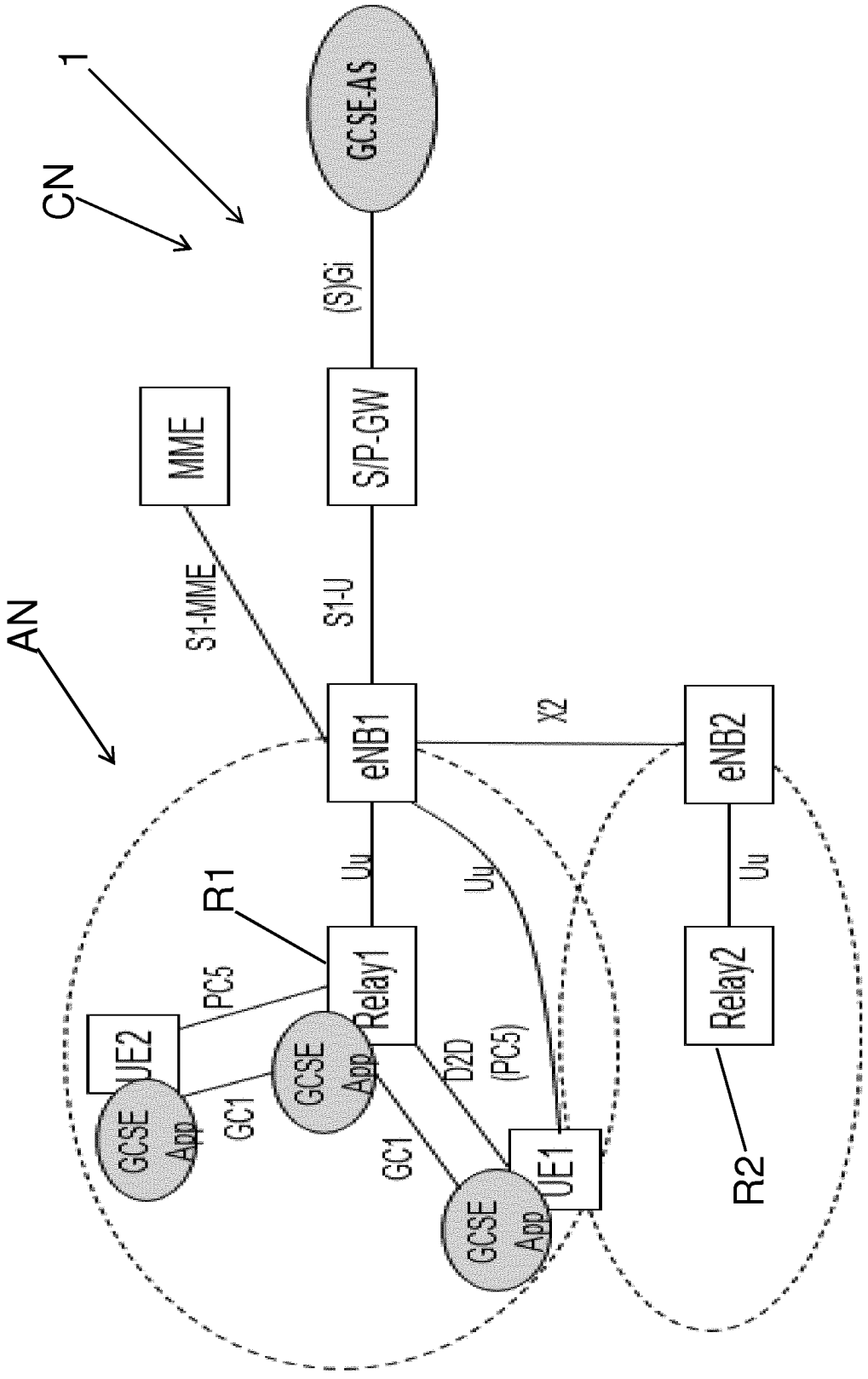

1
CN
GCSE-AS
(S)Gi
MME
S/P-GW
S1-MME
S1-U
AN
eNB1
X2
eNB2
Uu
Uu
Uu
R1
PC5
Relay1
Relay2
UE2
GCSE App
GC1
GCSE App
D2D (PC5)
GC1
UE1
GCSE App
R2

Fig. 4

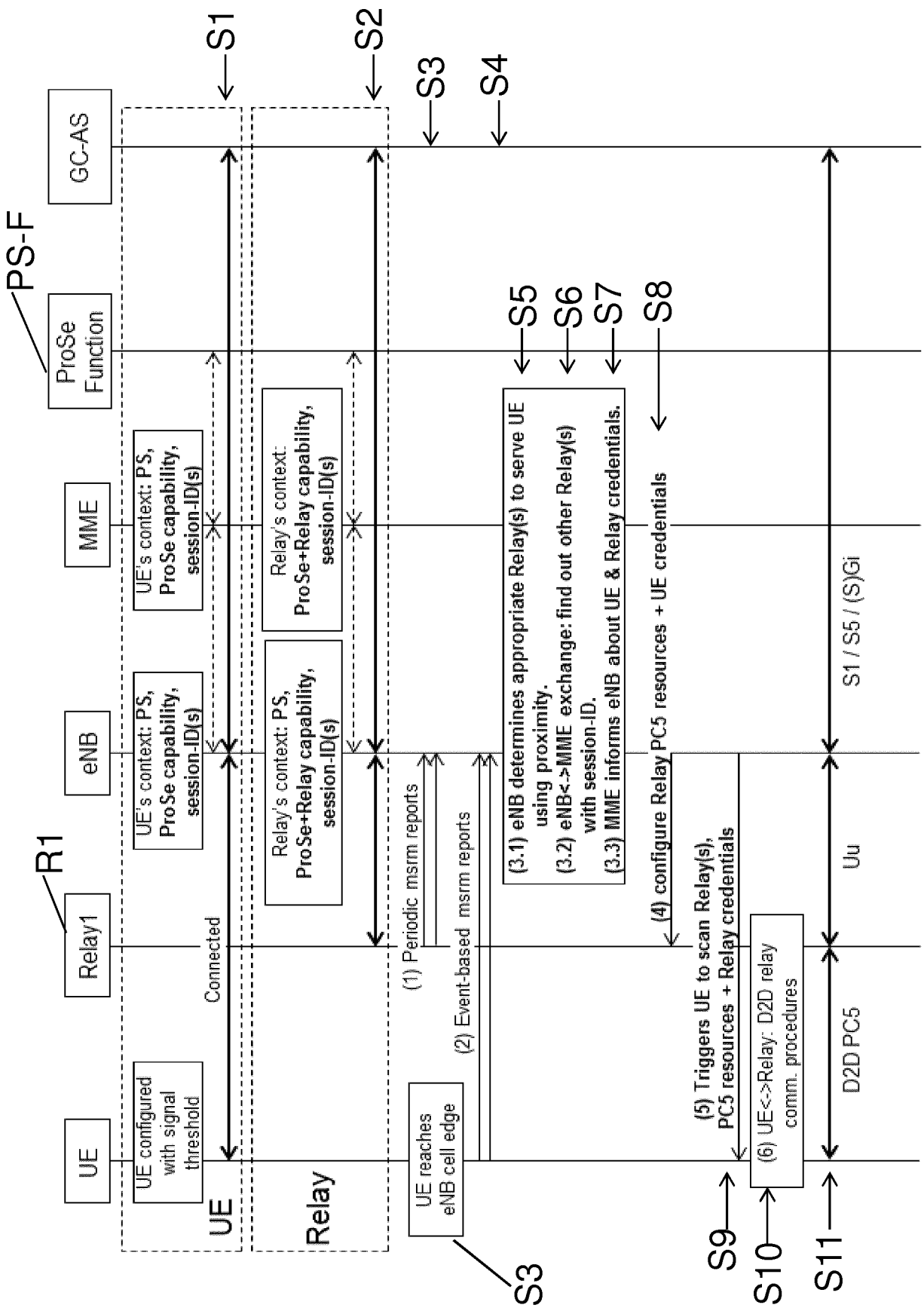

S1
S2
S3
S4
S5
S6
S7
S8
PS-F
GC-AS
ProSe Function
MME
eNB
R1
Relay1
UE
UE configured with signal threshold
UE's context: PS, ProSe capability, session-ID(s)
Relay's context: PS, ProSe+Relay capability, session-ID(s)
Connected
UE
Relay
UE reaches eNB cell edge
(1) Periodic msrm reports
(2) Event-based msrm reports
(3.1) eNB determines appropriate Relay(s) to serve UE using proximity.
(3.2) eNB<->MME exchange: find out other Relay(s) with session-ID.
(3.3) MME informs eNB about UE & Relay credentials.
(4) configure Relay PC5 resources + UE credentials
(5) Triggers UE to scan Relay(s), PC5 resources + Relay credentials
(6) UE<->Relay: D2D relay comm. procedures
S1 / S5 / (S)Gi
Uu
D2D PC5
S3
S9
S10
S11

Fig. 5

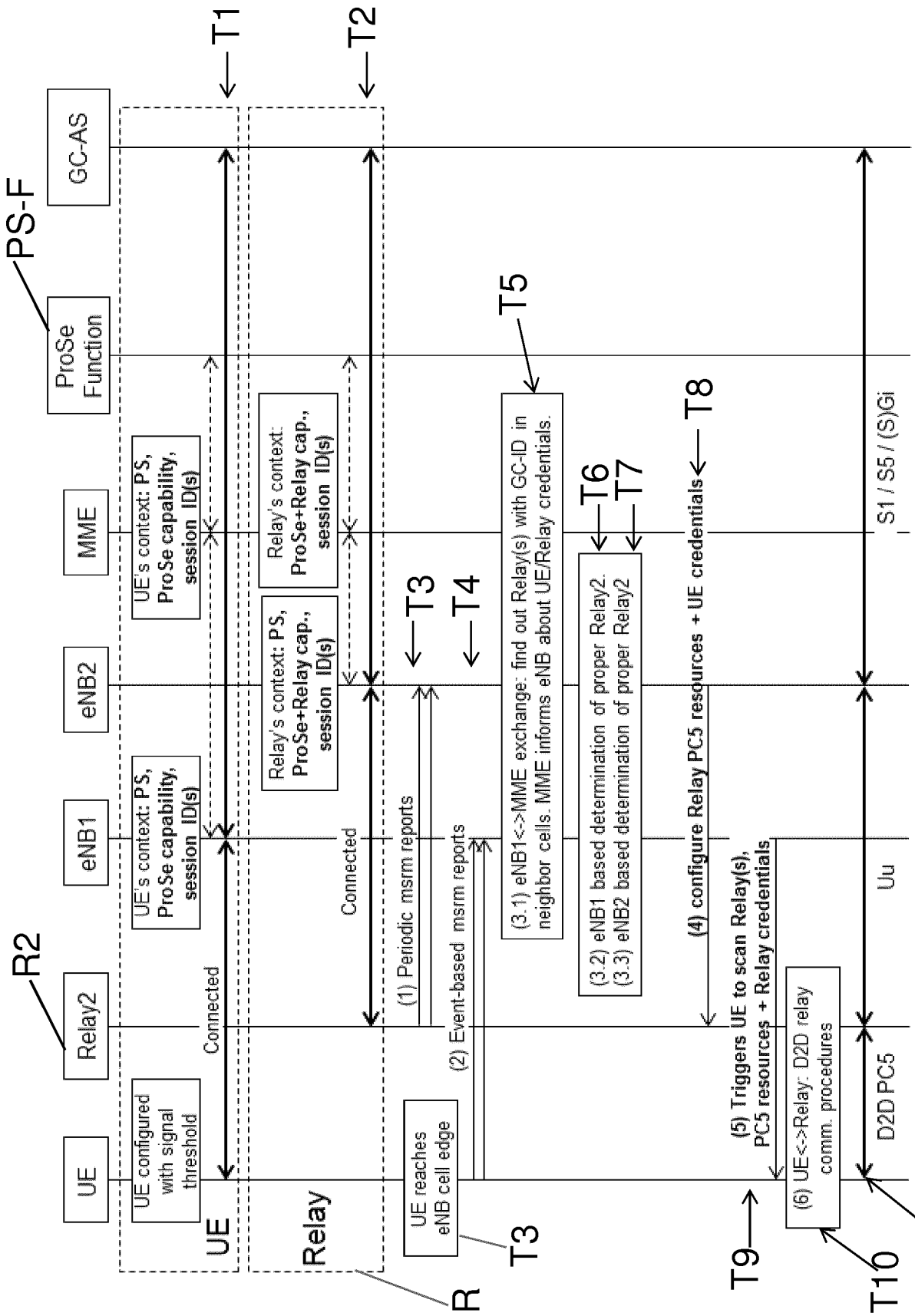
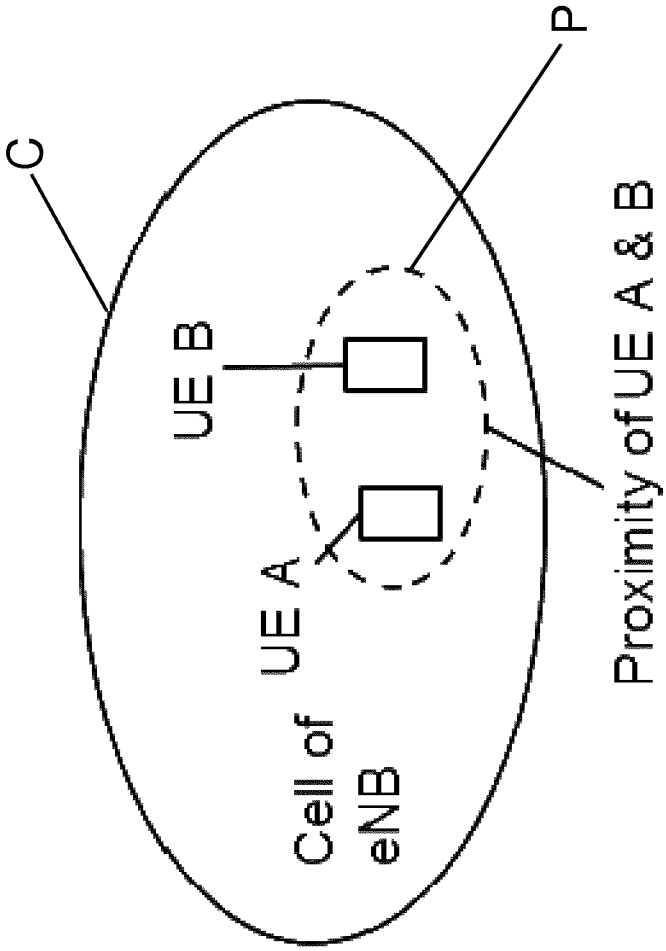

UE
Relay2
eNB1
eNB2
MME
ProSe Function
GC-AS
R2
PS-F
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
T11
UE configured with signal threshold
UE's context: PS, ProSe capability, session ID(s)
Connected
Relay's context: PS, ProSe+Relay cap., session ID(s)
Relay's context: ProSe+Relay cap., session ID(s)
(1) Periodic msrm reports
(2) Event-based msrm reports
UE reaches eNB cell edge
(3.1) eNB1<->MME exchange: find out Relay(s) with GC-ID in neighbor cells. MME informs eNB about UE/Relay credentials.
(3.2) eNB1 based determination of proper Relay2.
(3.3) eNB2 based determination of proper Relay2
(4) configure Relay PC5 resources + UE credentials
(5) Triggers UE to scan Relay(s), PC5 resources + Relay credentials
(6) UE<->Relay: D2D relay comm. procedures
S1 / S5 / (S)Gi
Uu
D2D PC5
UE
Relay
R

Fig. 6

Fig. 7



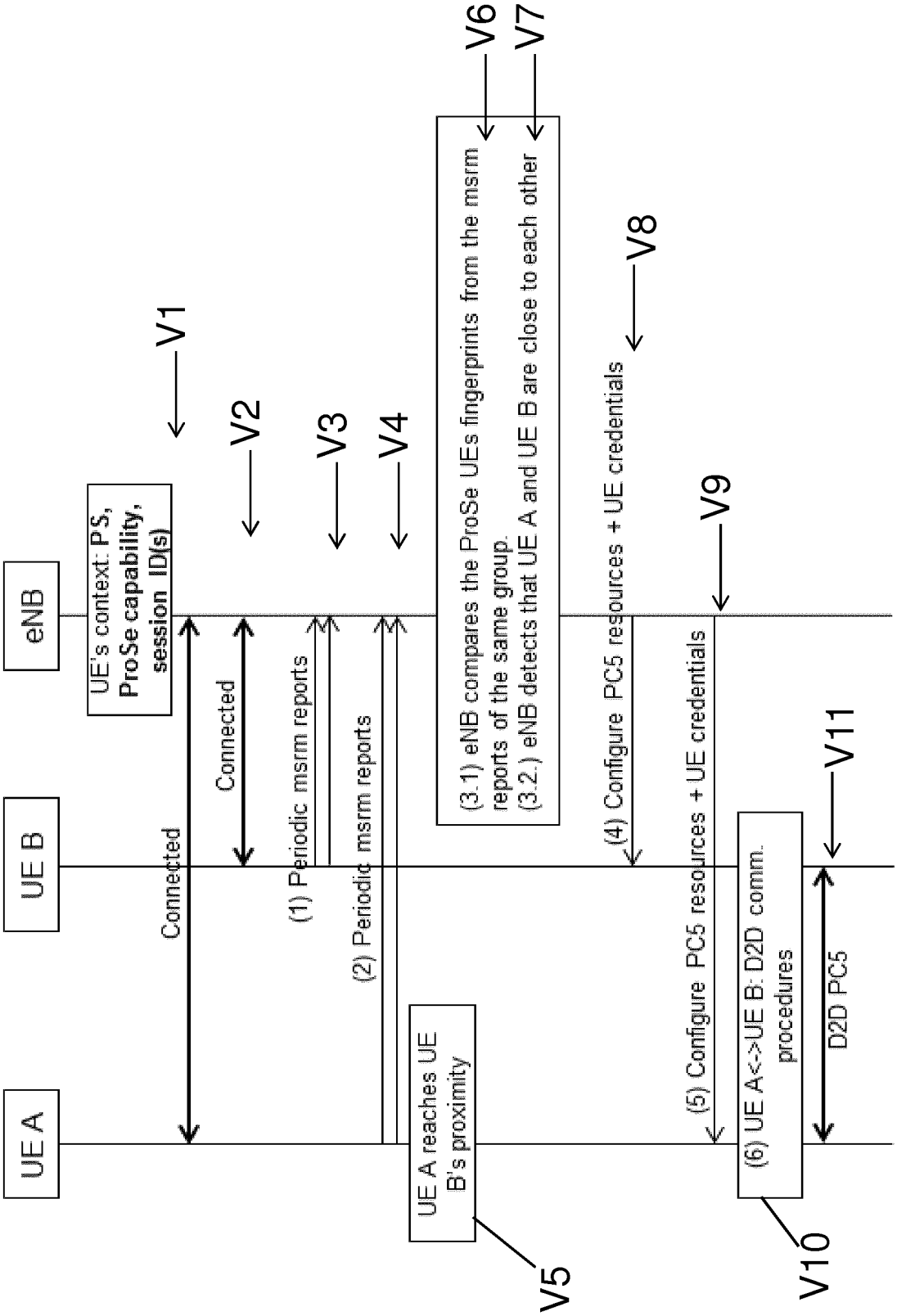
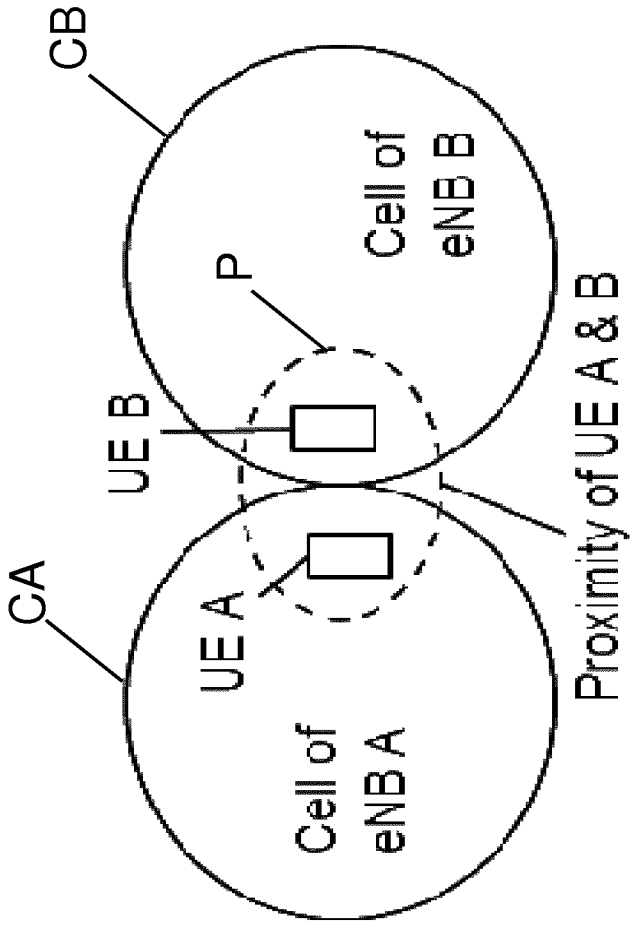

UE A
UE B
eNB
UE's context: PS, ProSe capability, session ID(s)
V1
V2
V3
V4
V5
V6
V7
V8
V9
V10
V11
Connected
Connected
(1) Periodic msrm reports
(2) Periodic msrm reports
UE A reaches UE B's proximity
(3.1) eNB compares the ProSe UEs fingerprints from the msrm reports of the same group.
(3.2.) eNB detects that UE A and UE B are close to each other
(4) Configure PC5 resources + UE credentials
(5) Configure PC5 resources + UE credentials
(6) UE A<->UE B: D2D comm. procedures
D2D PC5

Fig. 8

Fig. 9



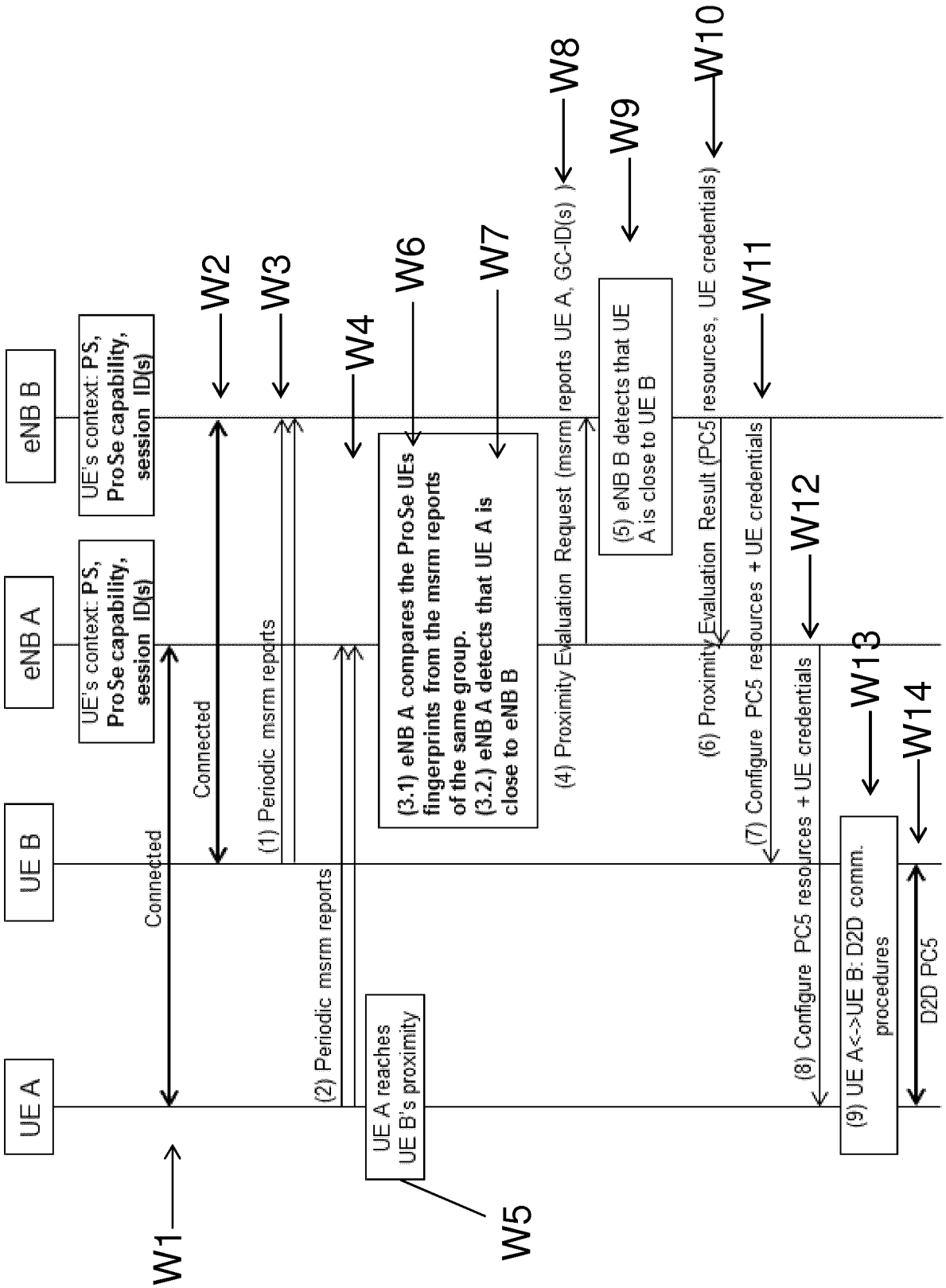

UE A
UE B
eNB A
eNB B
W1
Connected
UE's context: PS, ProSe capability, session ID(s)
UE's context: PS, ProSe capability, session ID(s)
W2
Connected
(1) Periodic msrm reports
W3
(2) Periodic msrm reports
W4
UE A reaches UE B's proximity
W5
(3.1) eNB A compares the ProSe UEs fingerprints from the msrm reports of the same group.
(3.2.) eNB A detects that UE A is close to eNB B
W6
W7
(4) Proximity Evaluation Request (msrm reports UE A, GC-ID(s))
W8
(5) eNB B detects that UE A is close to UE B
W9
(6) Proximity Evaluation Result (PC5 resources, UE credentials)
W10
(7) Configure PC5 resources + UE credentials
W11
(8) Configure PC5 resources + UE credentials
W12
(9) UE A<->UE B: D2D comm. procedures
W13
D2D PC5
W14

Fig. 10

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2014/064624

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04W36/00 H04W36/08 H04W64/00 H04W84/04 H04W88/04
ADD.

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H04W

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2012/044836 A1 (SIVAVAKEESAR SIVAPATHALINGHAM [GB] ET AL) 23 February 2012 (2012-02-23) paragraph [0021] paragraph [0047] paragraph [0067] - paragraph [0069] paragraph [0072] paragraph [0091] - paragraph [0123] paragraph [0126] - paragraph [0127] paragraph [0133] - paragraph [0142] paragraph [0146] paragraph [0149] paragraph [0156] paragraph [0159] - paragraph [0161] paragraph [0174] - paragraph [0175] paragraph [0177] paragraph [0180] paragraph [0187] ----- -/--	1-31

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

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

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

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

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

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18 November 2014	26/11/2014

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Moreno-Solana, S

1

Form PCT/ISA/210 (second sheet) (April 2005)

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2010/167743 A1 (PALANKI RAVI [US] ET AL) 1 July 2010 (2010-07-01) paragraph [0027] - paragraph [0030] paragraph [0038] paragraph [0046] paragraph [0048] paragraph [0071] -----	1-31
A	INTERDIGITAL COMMUNICATIONS: "Analysis of ProSe and GCSE-LTE service level requirements and evaluation of commonalities and assumptions for ProSe stage 2", 3GPP DRAFT; S2-132142_REV1902_GCSE_PROSE_COMPARISON_REV1, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE , vol. SA WG2, no. Busan, South Korea; 20130527 - 20130531 31 May 2013 (2013-05-31), XP050709302, Retrieved from the Internet: URL:http://www.3gpp.org/ftp/tsg_sa/WG2_Arch/TSGS2_97_Busan/Docs/ [retrieved on 2013-05-31] the whole document -----	1-31
A	NEC: "ProSe IMS Architecture", 3GPP DRAFT; S2-132160, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE , vol. SA WG2, no. Busan, South Korea; 20130527 - 20130531 31 May 2013 (2013-05-31), XP050709314, Retrieved from the Internet: URL:http://www.3gpp.org/ftp/tsg_sa/WG2_Arch/TSGS2_97_Busan/Docs/ [retrieved on 2013-05-31] the whole document -----	1-31

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2014/064624

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US 2012044836 A1	23-02-2012	JP 2012525720 A	22-10-2012
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		WO 2010078210 A1	08-07-2010