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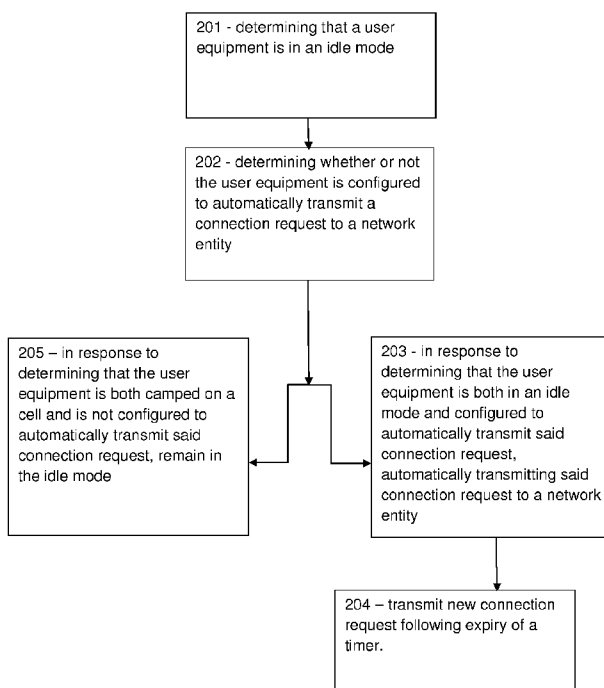


FIG. 2

(57) Abstract: There is provided a method comprising: determining that a user equipment is in an idle mode; determining whether or not the user equipment is configured to automatically transmit a connection request to a network entity; and in response to determining that the user equipment is both in an idle mode and configured to automatically transmit said connection request, automatically transmitting said connection request to the network entity.



DESCRIPTION

TITLE

COMMUNICATION SYSTEM

5

FIELD

[0001] The present application relates to methods and apparatus for use in a communication system.

BACKGROUND

10 [0002] In developing communication systems for future use, there is a need to reduce communication latencies between user equipment and network-based apparatus. This is not only desirable for massive mobile broadband services, but also for reliable machine-type-communications, such as ultra-reliable machine-type-communications (uMTC), massive machine-type-communications (mMTC), in addition to other communication types for which
15 low latency is desirable.

[0003] In Long Term Evolution (LTE) communication standards, recent progress in user equipment (UE) and UE application behaviours has introduced a phenomena in which UEs attempt to establish Radio Resource Control (RRC) connections very frequently, transferring only a small amount of application data with each new RRC connection, before returning to
20 an idle mode. As this sequence of actions is repeated frequently, and by many UEs, significant signalling load may be added to the radio network systems by this behaviour. Also, frequently establishing connections to a network entity can drain the batteries of the UEs.

SUMMARY

25 [0004] Although there have been various proposals to address problems associated with a user equipment configured to make frequent small transmissions, the inventors have realised

that such proposals have not also addressed issues of backward compatibility or the existing framework in which the user equipment operates.

[0005] According to a first aspect, there is provided

[0006] A method comprising: determining that a user equipment is in an idle mode;

5 determining whether or not the user equipment is configured to automatically transmit a connection request to a network entity; and in response to determining that the user equipment is both in an idle mode and configured to automatically transmit said connection request, automatically transmitting said connection request to the network entity.

[0007] The method may further comprise: starting a timer when the request for connection is
10 automatically transmitted; and in response to the expiry of the timer without a connection being established with the network entity, automatically transmitting another request for connection.

[0008] The method may further comprise remaining in the idle mode in response to determining that the user equipment is both in an idle mode and is not configured to automatically transmit said connection request.

15 [0009] The determining whether or not the user equipment is configured to automatically transmit a connection request to a network entity may comprise: determining the type of user equipment; and determining that the user equipment is configured to automatically transmit a connection request to a network entity if the type is one of a predetermined type of user equipment. The predetermined type of user equipment may be a machine-type-
20 communication device and/or a customer premises equipment.

[0010] The determining whether or not the user equipment is configured to automatically transmit a connection request to a network entity may comprise: determining whether or not the network supports a user equipment that automatically transmits said connection request.

[0011] The determining whether or not the user equipment is configured to automatically
25 transmit a connection request to a network entity may comprise: determining whether the type of public land mobile network, PLMN, of the network entity is a home PLMN, an equivalent

home PLMN or a visitor PLMN; and determining the user equipment is configured to automatically transmit a connection request to a network entity only if the PLMN is an equivalent home PLMN or a home PLMN.

[0012] The method may further comprise: transmitting to the network entity an indication that the user equipment is able to automatically transmit said connection request.

[0013] The method may further comprising: receiving from the network entity an indication that the network entity does not allow the automatic transmission of said connection request.

[0014] Determining that a user equipment is in an idle mode may comprise determining that the user equipment is in one of: a camped normally state; and a camped on any cell state.

[0015] According to a second aspect, there is provided an apparatus comprising: at least one processor and at least one memory including computer program code, the at least one memory and the computer program code being configured to, with the at least one processor, cause the apparatus to: determine that a user equipment is in an idle mode; determine whether or not the user equipment is configured to automatically transmit a connection request to a network entity; and in response to determining that the user equipment is both in an idle mode and configured to automatically transmit said connection request, automatically transmitting said connection request to the network entity.

[0016] The at least one memory and the computer program code may be configured to, with the at least one processor, cause the apparatus to: start a timer when the request for connection is automatically transmitted; and in response to the expiry of the timer without a connection being established with the network entity, automatically transmit another request for connection.

[0017] The at least one memory and the computer program code may be configured to, with the at least one processor, cause the apparatus to remain in the idle mode in response to determining that the user equipment is both in an idle mode and is not configured to automatically transmit said connection request.

[0018] The at least one memory and the computer program code may be configured to, with the at least one processor, cause the apparatus to determine whether or not the user equipment is configured to automatically transmit a connection request to a network entity by: determining the type of user equipment; and determining that the user equipment is configured to automatically transmit a connection request to a network entity if the type is one of a predetermined type of user equipment.

[0019] The predetermined type of user equipment may be a machine-type-communication device and/or a customer premises equipment.

[0020] The at least one memory and the computer program code may be configured to, with the at least one processor, cause the apparatus to determine whether or not the user equipment is configured to automatically transmit a connection request to a network entity comprises: determining whether or not the network entity supports a user equipment that automatically transmits said connection request.

[0021] The at least one memory and the computer program code may be configured to, with the at least one processor, cause the apparatus to determine whether or not the user equipment is configured to automatically transmit a connection request to a network entity by: determining whether the type of public land mobile network, PLMN, of the network entity is a home PLMN, an equivalent home PLMN or a visitor PLMN; and determining the user equipment is configured to automatically transmit a connection request to a network entity only if the PLMN is an equivalent home PLMN or a home PLMN.

[0022] The at least one memory and the computer program code may be configured to, with the at least one processor, further cause the apparatus to: transmitting to the network entity an indication that the user equipment is able to automatically transmit said connection request.

[0023] The at least one memory and the computer program code may be configured to, with the at least one processor, cause the apparatus to: receive from the network entity an

indication that the network entity does not allow the automatic transmission of said connection request.

[0024] The at least one memory and the computer program code may be configured to, with the at least one processor, cause the apparatus to determine that the user equipment is in an idle mode when the user equipment is in one of: a camped normally state; and a camped on any cell state.

[0025] According to a third aspect, there is provided a computer program comprising computer executable instructions, which when executed by a computer, cause the computer to perform each of the method steps of any of claims 1 to 10.

[0026] According to a fourth aspect, there is provided a method comprising: receiving, by a network entity, a connection request from a user equipment; determining, by the network entity, that the connection request was transmitted automatically by the user equipment when the user equipment was in an idle mode; and in response to the determination, prioritising by the network element said connection request after connection requests that were determined to not have been transmitted automatically by respective user equipment.

[0027] According to a fifth aspect, there is provided an apparatus comprising: means for determining that a user equipment is in an idle mode; means for determining whether or not the user equipment is configured to automatically transmit a connection request to a network entity; and means for, in response to determining that the user equipment is both in an idle mode and configured to automatically transmit said connection request, automatically transmitting said connection request to a network entity.

FIGURES

[0028] Some embodiments are described below, by way of example only, with reference to the accompanying drawings, in which:

[0029] Figure 1 is a schematic illustration of a network;

[0030] Figure 2 is a flow chart illustrating potential actions performed by a user equipment;

[0031] Figure 3 illustrates various states a user equipment may enter;

[0032] Figure 4 is a flow chart illustrating potential actions performed by a network entity;

[0033] Figure 5 is a schematic illustration of some of the components of the network entity

5 operating in accordance with Figure 4; and

[0034] Figure 6 is a schematic illustration of some of the components of the user equipment operating in accordance with at least 201 to 203 any of Figure 2.

DETAILED DESCRIPTION

10 [0035] In general, the following relates to a mechanism for avoiding connection setup signalling delay and increased signalling load resulting from user equipments frequently requesting connection establishment, which is compatible with existing systems.

[0036] In embodiments of the following, which are examples only, a user equipment is configured to initiate (or otherwise trigger) the transmission of a connection request (e.g. a
15 radio resource control connection request) automatically when the user equipment determines itself to be in an idle mode. The user equipment may further determine whether or not it is configured to transmit the automatic connection request (configuration may be originated via either the user equipment or via a network entity) before making the automatic transmission, with the automatic transmission only being made if the user equipment is configured to make
20 the automatic transmission. If the user equipment is not configured to make the automatic transmission, the user equipment is configured to remain in the idle mode without making the automatic connection request. It is understood that an application level protocol in the user equipment may still cause a regular connection request to be sent in this latter case, when there is application level data to send.

25 [0037] By having an RRC connection automatically opened, the user equipment may also be automatically configured with security context, and basic user and control plane connectivity.

This can be used to increase the speed at which application data is transmitted when it is available, as a new connection/new connectivity information does not have to be determined. The connectivity information may be only for control plane connection, or both or both downlink and uplink control and user plane connection. Thus when there is downlink data activity, the network entity may address the user equipment directly without the core network initiating paging. Similarly in the case of uplink data, the user equipment may transmit uplink data via contention based channel or the user equipment may request resources in an uplink transmission grant request. Further, as the user equipment would have dedicated control channels available, user equipment specific configuration may be provided for session and mobility management. The user equipment is configured to act to remain in the connected state once a connection with the network entity has been established. This helps to minimise the signalling load across the network for devices that make frequent small data transmissions.

[0038] The following embodiments are only examples. Although the specification may refer to “an”, “one”, or “some” embodiment(s) in several locations, this does not necessarily mean that each such reference is to the same embodiment(s), or that the feature only applies to a single embodiment. Single features of different embodiments may also be combined to provide other embodiments. Furthermore, words “comprising” and “including” should be understood as not limiting the described embodiments to consist of only those features that have been mentioned and such embodiments may also contain also features, structures, units, modules etc. that have not been specifically mentioned.

[0039] Embodiments are applicable to any user equipment, as well as to any network element, relay node, server, node, corresponding component, and/or to any communication system or any combination of different communication systems that support required functionalities. The communication system may be a wireless communication system or a communication system utilizing both fixed networks and wireless networks. The protocols used, the specifications of communication systems, apparatuses, such as servers and user

equipments, especially in wireless communication, develop rapidly. Such development may require extra changes to an embodiment. Therefore, all words and expressions should be interpreted broadly and they are intended to illustrate, not to restrict, embodiments.

[0040] In the following, different exemplifying embodiments will be described using, as an
5 example of an access architecture to which the embodiments may be applied, a radio access architecture based on long term evolution advanced (LTE Advanced, LTE-A), without restricting the embodiments to such an architecture, however. It is obvious for a person skilled in the art that the embodiments may also be applied to other kinds of communications networks having suitable means by adjusting parameters and procedures appropriately. Some
10 examples of other options for suitable systems are 5G, the universal mobile telecommunications system (UMTS) radio access network (UTRAN or E-UTRAN), long term evolution (LTE, the same as E-UTRA), wireless local area network (WLAN or WiFi), worldwide interoperability for microwave access (WiMAX), Bluetooth®, personal communications services (PCS), ZigBee®, wideband code division multiple access (WCDMA), systems using
15 ultra-wideband (UWB) technology, sensor networks, mobile ad-hoc networks (MANETs) and Internet Protocol multimedia subsystems (IMS) or any combination thereof.

[0041] Figure 1 depicts examples of simplified system architectures only showing some elements and functional entities, all being logical units, whose implementation may differ from what is shown. The connections shown in Figure 1 are logical connections; the actual physical
20 connections may be different. It is apparent to a person skilled in the art that the system typically comprises also other functions and structures than those shown in Figure 1.

[0042] The embodiments are not, however, restricted to the system given as an example but a person skilled in the art may apply the solution to other communication systems provided with necessary properties. Another example of a suitable communications system is the 5G
25 concept. It is assumed that radio network architecture in 5G may be quite similar to that of the LTE-advanced. 5G is likely to use multiple input – multiple output (MIMO) antennas, many

more base stations or nodes than the LTE (a so-called small cell concept), including macro sites operating in co-operation with smaller stations and perhaps also employing a variety of radio technologies for better coverage and enhanced data rates. 5G will likely be comprised of more than one radio access technology (RAT), each optimized for certain use cases and/or spectrum. 5G mobile communications will have a wider range of use cases and related applications including video streaming, augmented reality, different ways of data sharing and various forms of machine type applications, including vehicular safety, different sensors and real-time control.

[0043] It should be appreciated that future networks will most probably utilise network functions virtualization (NFV) which is a network architecture concept that proposes virtualizing network node functions into “building blocks” or entities that may be operationally connected or linked together to provide services. A virtualized network function (VNF) may comprise one or more virtual machines running computer program codes using standard or general type servers instead of customized hardware. Cloud computing or data storage may also be utilized. In radio communications this may mean node operations to be carried out, at least partly, in a server, host or node operationally coupled to a remote radio head. It is also possible that node operations will be distributed among a plurality of servers, nodes or hosts. It should also be understood that the distribution of labour between core network operations and base station operations may differ from that of the LTE or even be non-existent. Some other technology advancements probably to be used are Software-Defined Networking (SDN), Big Data, and all-IP, which may change the way networks are being constructed and managed.

[0044] Figure 1 shows a part of a radio access network based on E-UTRA, LTE, LTE-Advanced (LTE-A) or LTE/EPC (EPC = evolved packet core, EPC is enhancement of packet switched technology to cope with faster data rates and growth of Internet protocol traffic). E-UTRA is an air interface of LTE Release 8 (UTRA= UMTS terrestrial radio access, UMTS=

universal mobile telecommunications system). Some advantages obtainable by LTE (or E-UTRA) are a possibility to use plug and play devices, and Frequency Division Duplex (FDD) and Time Division Duplex (TDD) in the same platform.

[0045] Figure 1 shows user equipments 100 and 102 configured to be in a wireless connection on one or more communication channels 104 and 106 in a cell with a (e)NodeB 108 providing the cell. The physical link from a user equipment to a (e)NodeB is called uplink or reverse link and the physical link from the (e)NodeB to the user equipment is called downlink or forward link.

[0046] Two other nodes (eNodeBs) are also provided, namely 114 and 116 which may have communications channels 118 and 120 to eNode B 108. The nodes may belong to the network of a same operator or to the networks of different operators. It should be appreciated that the number of nodes may vary, as well as the number of networks. User equipments communicating with nodes 114 and 116 are not shown due to the sake of clarity. The nodes may have connections to other networks, as well.

[0047] The NodeB, or advanced evolved node B (eNodeB, eNB) in LTE-Advanced, is a computing device configured to control the radio resources of communication system it is coupled to. The (e)NodeB may also be referred to as a base station, an access point or any other type of interfacing device including a relay station capable of operating in a wireless environment.

[0048] The (e)NodeB includes or is coupled to transceivers. From the transceivers of the (e)NodeB, a connection is provided to an antenna unit that establishes bi-directional radio links to user equipments. The antenna unit may comprise a plurality of antennas or antenna elements. The (e)NodeB is further connected to core network 110 (CN). Depending on the system, the counterpart on the CN side can be a serving gateway (S-GW, routing and forwarding user data packets), packet data network gateway (P-GW), for providing connectivity of user equipments (UEs) to external packet data networks, user gateway (uGW),

routing and forwarding user data packets and for providing connectivity of UEs to external packet data networks, or mobile management entity (MME), etc.

[0049] A communications system typically comprises more than one (e)NodeB in which case the (e)NodeBs may also be configured to communicate with one another over links, wired or
5 wireless, designed for the purpose. These links may be used for signalling purposes.

[0050] The communication system is also able to communicate with other networks, such as a public switched telephone network or the Internet 112. The communication network may also be able to support the usage of cloud services. It should be appreciated that (e)NodeBs or their functionalities may be implemented by using any node, host, server or access point
10 etc. entity suitable for such a usage.

[0051] The communication system may also comprise a central control entity, or a like, providing facilities for networks of different operators to cooperate for example in spectrum sharing.

[0052] The user equipment (also called UE, user equipment, user terminal, terminal device,
15 etc.) illustrates one type of an apparatus to which resources on the air interface are allocated and assigned, and thus any feature described herein with a user equipment may be implemented with a corresponding apparatus, such as a relay node. Disclosures relating to a user equipment thus also encompass those features being performed by a corresponding apparatus. An example of such a relay node is a layer 3 relay (self-backhauling relay) towards
20 the base station.

[0053] The user equipment typically refers to a portable computing device that includes wireless mobile communication devices operating with or without a subscriber identification module (SIM), including, but not limited to, the following types of devices: a mobile station (mobile phone), smartphone, personal digital assistant (PDA), handset, device using a
25 wireless modem (alarm or measurement device, etc.), laptop and/or touch screen computer, tablet, game console, notebook, and multimedia device. It should be appreciated that a user

equipment may also be a nearly exclusive uplink only device, of which an example is a camera or video camera loading images or video clips to a network. A user equipment may also be a device having capability to operate in Internet of Things (IoT) network which is a scenario in which objects are provided with the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. A user equipment may also be a device operating in a cyber-physical system (CPS) which is a system of collaborating computational elements controlling physical entities.

[0054] The user equipment (or in some embodiments a layer 3 relay node or a self-backhauling node) is configured to perform one or more of user equipment functionalities. The user equipment may also be called a subscriber unit, mobile station, remote terminal, access terminal, user terminal or user equipment (UE) just to mention but a few names or apparatuses.

[0055] It should be understood that, in Figure 1, user equipments are depicted to include 2 antennas only for the sake of clarity. The number of reception and/or transmission antennas may naturally vary according to a current implementation.

[0056] Additionally, although the apparatuses have been depicted as single entities, different units, processors and/or memory units (not all shown in Figure 1) may be implemented.

[0057] It is obvious for a person skilled in the art that the depicted system is only an example of a part of a radio access system and in practise, the system may comprise a plurality of (e)NodeBs, the user equipment may have an access to a plurality of radio cells and the system may comprise also other apparatuses, such as physical layer relay nodes or other network elements, etc. At least one of the NodeBs or eNodeBs may be a Home(e)nodeB. Additionally, in a geographical area of a radio communication system a plurality of different kinds of radio cells as well as a plurality of radio cells may be provided. Radio cells may be macro cells (or umbrella cells) which are large cells, usually having a diameter of up to tens of kilometres, or smaller cells such as micro-, femto- or picocells. The (e)NodeBs of Figure 1 may provide any

kind of these cells. A cellular radio system may be implemented as a multilayer network including several kinds of cells. Typically, in multilayer networks, one node B provides one kind of a cell or cells, and thus a plurality of (e) Node Bs are required to provide such a network structure.

5 [0058] For fulfilling the need for improving the deployment and performance of communication systems, the concept of “plug-and-play” (e)NodeBs has been introduced. Typically, a network which is able to use “plug-and-play” (e)Node Bs, includes, in addition to Home (e)NodeBs (H(e)nodeBs), a home node B gateway, or HNB-GW (not shown in Figure 1). A HNB Gateway (HNB-GW), which is typically installed within an operator’s network may
10 aggregate traffic from a large number of HNBs back to a core network.

[0059] The following, described in relation to Figure 2, illustrates potential actions that may be performed by a user equipment interacting with a network entity of a cell in accordance with the present teachings. The network entity may be any entity/apparatus acting as part of the network infrastructure for providing services to the user equipment. An example network
15 entity is an eNodeB.

[0060] At 201, the user equipment is configured to determine that it is in an idle mode. Prior to entering said idle mode, the user equipment may be configured to perform an initial cell selection for finding a suitable cell. The user equipment may enter the idle mode from an RRC connected mode, after switching on the user equipment, following the addition of a USIM to
20 the user equipment and/or after a user equipment selecting a public landline mobile network (PLMN). An example idle mode/state is the “Camped normally” state, which is illustrated in Figure 5.2.2-1 of TS 36.304 (reproduced in Figure 3). A user equipment enters a state called “Camped normally” after selecting a suitable cell on which to camp. When a user equipment is camped on a cell, it is registered with the cell but is in an idle mode in which there is no
25 active connection between the user equipment and a network element of the cell. As shown in Figure 3, the “Camped normally” state may be entered either after an initial cell selection

has been performed, or following a retrieval of cell information stored in the mobile terminal. In the camped state, the user equipment is configured to perform several different functions. For example, the user equipment is configured to select and monitor selected paging channels of the cell, monitor relevant System Information, perform measurements for cell reselection evaluation procedures and execute cell reselection evaluation process following either a UE
5 internal trigger or an external trigger. In general, the UE in camped mode may be considered to listen for information relating to the camped cell and to execute evaluations of whether or not to camp on a new cell, but does not have any active and/or open connections. For simplicity, the following examples will consider the idle mode as being the camped normally
10 state. It is useful to apply the present techniques to the camped normally state as in this state, a suitable cell has been found for connection (e.g. the cell is not used for other purposes, the cell has a particular quality, etc.). However, it is understood that the present techniques may be applied to other idle modes of the user equipment. Another example other idle mode would be when the user equipment is in the “Camped on any cell” state illustrated in Figure 3. This
15 mode would have especial relevance when entering a connected mode for making emergency calls (e.g. to the police and/or fire department and/or some specific network configuration in the event of an emergency). The state/mode of a user equipment may be stored in the user equipment.

[0061] At 202, the user equipment determines whether or not the user equipment is
20 configured to automatically transmit a connection request to a network entity of said cell in which the user equipment is in idle mode. This may be achieved in a variety of ways by each of the user equipment and the network entity. Examples of the various ways in which this may be determined are detailed below.

[0062] At 203, in response to determining that the user equipment is both in an idle mode
25 and is configured to automatically transmit said connection request, automatically transmitting said connection request to the network entity.

[0063] The connection request may comprise an indication that this connection request has been transmitted automatically. This is useful as it may be that there is no application-level data to transfer at the time at which the user equipment automatically transmits the connection request. Therefore, the indication may be used by the network entity to prioritise which connection requests to respond to first, in the event there are multiple. The network entity may in addition or in the alternate use this indication to put the user equipment into an energy efficient configuration/state, such as an inactive state. This state may be different to the idle state that the user equipment was in when making the automatic transmission of the connection request. The network entity may prioritise connection requests so that connection requests that are indicated as being transmitted automatically (in accordance with the above) are processed subsequent to connection requests received by the network entity that do not comprise such an indication. The network entity may prioritise connection requests so that connection requests that are indicated as being transmitted automatically (in accordance with the above) are processed prior to connection requests received by the network entity that do not comprise such an indication.

[0064] A connection request, transmitted to a network that the user equipment wishes to use for communications, informs the network of the user equipment's service needs. The information in the message may vary, but in principle, information needed by the network for resource configuration is provided. The information on service may be a service identity (ID) and/or an application identity (ID). These identities may be standardized, informed as a part of random access or a corresponding procedure (unicast or multicast), informed in broadcasts an access node providing a cell transmits, negotiated between service providers, etc. They may be in the form of a list or table, for example. In 5G, it has been proposed that cells advertise more actively available services. Therefore a user equipment may request a service that provides the closest match to its capability and/or needs. The information on service may also comprise a mobility status of the user equipment. The mobility status information may be

based on location or tracking information (such as using Global Position System or range detection) and/or information obtained from speed sensors or radars, for example.

[0065] Information on service may also comprise indication of resources dedicated to the service. This is useful information in network slicing, wherein a machine-type-communication
5 device may indicate to a network which network slice is applicable to the device or service.

[0066] A connection request may comprise information on user equipment's capabilities or a separate message comprising the information may be transmitted. For example, capabilities of a smart phone may vary from model to model. A connection request may also comprise information on user equipment's power saving configuration or a power saving request. For
10 example, a certain service or application may have dedicated power saving settings or a power saving mode. A connection request may be transmitted after a random access procedure or a like using the resources reserved or configured for a connection request.

[0067] At step 204, the user equipment optionally starts a timer when automatically transmitting the connection request of step 203. If the timer expires without a connection being
15 established with the network entity, the user equipment is configured to automatically transmit another connection request.

[0068] For completeness, it is noted that the network entity may respond to the connection request of the user equipment by transmitting, configuration information is received in response to the connection request, and a connection between the user equipment and the
20 network entity may be established based on the configuration information.

[0069] As a response to the connection request, a network sends a confirmation or setup message or the like, wherein resources or configuration for the connection are provided to the user equipment. A user equipment establishes a connection to the network based on this information.

[0070] Step 205 applies when it is determined that the user equipment is both camped on a
25 cell (more generally, is in an idle mode) and is not configured to automatically transmit said

connection request. In response to these determinations, the user equipment remains in the idle mode (e.g. remains camped in the cell).

[0071] In the above, step 202 comprised determining whether or not the user equipment is configured to automatically transmit a connection request to a network entity of said cell. Some

5 of the ways in which this may be done are now discussed.

[0072] The different ways may be broadly separated into two types: user equipment controlled and network controlled. It is understood that these different ways (and types) may be implemented separately or in combination with each other, depending on the system implemented by the skilled person. It may be that only some of these different ways are

10 implanted, depending on the system.

[0073] User equipment controlled configuration is considered first. In a first example, a user equipment is configured to always be configured to automatically transmit a connection request to a network entity of said cell. This automatic transmission may therefore be independent of any properties of the user equipment/communications being made.

15 [0074] Another example of user equipment controlled configuration depends on the properties of the user equipment itself. In this case, the user equipment may determine what type of user equipment it is; and to determine that it is configured to automatically transmit a connection request to a network entity of said cell if the type is one of a predetermined type of user equipment. The predetermined type of user equipment may be programmed into the user equipment and/or be received from the network. For example, one type of such user equipment may be a machine-type-communication device, such as the above-mentioned mMTC and/or uMTC. Another type of user equipment may be a customer premises equipment (CPE), such as CPE used to provide internet access to normal subscriber devices (e.g. phones, laptops, TV, setup boxes, etc.). In particular, the present system is usefully applied to

20 systems in which low latency communications are used (e.g. in factory automation). Therefore, the type of device may be defined with respect to the types of communication that are expected

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from it. For example, the system may be only applied to those devices that are expected to transmit low latency communications and/or that frequently transmit small data items. Furthermore, the established connection may be used to establish whether or not the user equipment is fully operational. Thus, in an example, if the connection request fails to establish
5 a connection (or the connection otherwise fails), this may be used to initiate a “safe mode” for the user equipment without a connection.

[0075] In another example, the user equipment controlled configuration depends on the user equipment determining a network capability of a public land mobile network (PLMN) that is accessible through an access point to the PLMN. Each access point to the network (such as
10 a base station/eNB) may be configured to serve multiple PLMNs. The total number of PLMNs served by a base station depends on the structure of the network. Therefore, the user equipment is configured to distinguish between different PLMNs provided via such a network entity. The user equipment may be configured to determine a network capability of each PLMN that it may access through such a base station. For example, the user equipment may
15 determine what services it may access through each available PLMN and/or what quality of services it may access through each available PLMN. The user equipment may use the determined network capability to determine whether or not to automatically transmit the connection request. For example, the user equipment may be configured to automatically transmit the connection request only if the service is of a particular type and/or has a minimum
20 guaranteed quality greater than a threshold value and/or it is explicitly permitted for a given PLMN.

[0076] Another example of user equipment controlled configuration depends on the user equipment determining if it is in a particular mode. For example, if the user equipment is camping for limited services in a “Camped on Any Cell Selection” state, the user equipment
25 will only request a connection to be set up when the data to be transmitted relates to emergency services. In this case, a determination that the user equipment is in such a state

would lead to a negative decision of whether or not the user equipment is configured to automatically transmit the connection request. As mentioned above, the "Camped on any cell" mode is entered when the user equipment does not find a suitable cell and thus cannot enter the "Camped normally" state. When the user equipment is in "Camping on any cell", the user equipment may be configured to remain in that idle mode and to only automatic connection requests to the network for emergency call purposes. It should be noted that in this case, the user equipment is not registered to a network thus cannot receive any mobile terminated calls.

[0077] The user equipment controlled configuration may be signalled to a network at various times. For example, the user equipment may transmit to the network entity an indication that the user equipment is able to automatically transmit said connection request prior to the user equipment being camped on a cell. Such an indication may instead (and/or in addition) be transmitted by the user equipment as part of the connection request.

[0078] Network controlled configuration is considered next. In one example, an indication of whether or not a user equipment is configured to automatically transmit the connection request is dependent on receipt of an indication of this from the network. The indication may be dependent on whether or not the network entity of the cell with which the user equipment is communicating and/or the network as a whole (e.g. a PLMN) can support this functionality, and can be sent via different methods, depending on the entity in the network that does not support the automatic transmission. For example, the indication may be transmitted between the core network and the user equipment using any of: Session Initiation Protocol (SIP) signalling, access stratum (AS) signalling, non-access stratum (NAS) signalling, and dedicated signalling (following, e.g., a Random Access Channel message from the user equipment).

[0079] In an example of network controlled configuration, the core network may indicate to the user equipment that the user equipment is configured to automatically transmit the connection request depending on the type of network to which the user equipment would be

connected to via the connection request. For example, the user equipment may be configured to automatically transmit the connection request when the PLMN to which it would be connecting is a home PLMN (or an equivalent home PLMN), but may be configured to abstain from automatically transmitting the connection request when the PLMN to which it would be connecting is a visitor PLMN. This configuration of the user equipment may be configured by a network entity. As another example, an identifier of a network to which the user equipment would be transmitting the automatic connection request may be used to determine whether or not to automatically transmit the connection request. For example, network identifiers associated with, e.g., home and/or work networks may be used to determine whether or not to automatically transmit the connection request. A tracking area identifier (i.e. an identifier to provide an approximate location for the user equipment in its idle mode whilst in the cell) may also be used to determine whether or not to automatically transmit the connection request.

[0080] As another example, the core network may signal an indication to the user equipment regarding whether or not the core network allows for automatic connection request transmission. This may be signalled to the user equipment using NAS layer signalling to trigger the automatic transmission of the signalling. If the indication indicates that the automatic connection requests are not permitted by the core network, the user equipment does not automatically transmit a connection request (e.g. without having application-level data). If the indication indicates that the automatic connection requests are permitted by the core network, the user equipment does automatically transmit a connection request. The indication may be an explicit indication (e.g. signalled via at least one bit designated for that purpose).

[0081] As another example, the operator may signal an indication to the user equipment regarding whether or not the core network allows for automatic connection request transmission. The signalling may be sent to a USIM of the user equipment. If the indication indicates that the automatic connection requests are not permitted by the operator, the user equipment does not automatically transmit a connection request (e.g. without having

application-level data). If the indication indicates that the automatic connection requests are permitted by the operator, the user equipment does automatically transmit a connection request. The indication may be an explicit indication (e.g. signalled via at least one bit designated for that purpose).

5 **[0082]** The network controlled configuration may be signalled to the user equipment at various times. For example, the network entity of the cell may transmit to the user equipment an indication that the user equipment is able (or not) to automatically transmit said connection request prior to the user equipment being camped on the cell. Such an indication may instead (and/or in addition) be transmitted by the network entity as part of the connection request.

10 **[0083]** As detailed above, the network entity may also have interactions with the user equipment described in relation to Figure 2. Some of these interactions are described in the following, with reference to Figure 4.

15 **[0084]** At 401, the network entity receives a connection request from a user equipment. This connection request may be the connection request transmitted in step 203, or may be a connection request transmitted at a later time (e.g. following the expiration of the timer in the example of step 205).

20 **[0085]** At 402, the network entity determines that the connection request was transmitted automatically by the user equipment when the user equipment was in an idle mode. This determination may be performed in a variety of ways. For example, the user equipment may explicitly signal this to the network entity in the connection request. The determination may utilise information provided by the user equipment in the connection request. The determination may infer that the transmission has been automatically transmitted given a determined time difference (e.g. determined by the network entity) between when user equipment has entered an idle mode and when the connection request is received.

25 **[0086]** At 403, in response to the determination that the connection request was transmitted automatically by the user equipment when the user equipment was in an idle mode, the

network entity is configured to prioritise said connection request after connection requests that the network entity has determined to not have been transmitted automatically by respective user equipment. By this, it is meant that the network entity is configured to respond to the automatic connection request after responding to any non-automatic connection requests received. To this effect, the network entity may delay responding to the automatic connection request for a predetermined time, to allow for receipt of any non-automatic connection requests. The predetermined time delay may not be applied to the non-automatic connection requests.

[0087] If the network entity rejects the automatic connection request, or any established connection is subsequently lost, the network entity may provide the user equipment with carrier information and/or physical cell ID information that the user equipment should attempt to camp on in a cell that does allow the user equipment to be configured to transmit the automatic connection request.

[0088] Figure 5 illustrates several components in an apparatus 500 that may be configured to execute the example method as described with reference to Figure 4.

[0089] Figure 5 illustrates a simplified block diagram of an apparatus according to an embodiment in relation to Figure 3. The apparatus may be an access point, node, host or server or any suitable apparatus to carry out processes described above in relation to Figure 3.

[0090] As an example of an apparatus according to an embodiment, it is shown apparatus 500 including facilities in control unit 504 (including one or more processors, for example) to carry out functions of embodiments according to Figure 3. The facilities may be software, hardware or combinations thereof as described in further detail below.

[0091] In Figure 5, block 506 includes parts/units/modules needed for reception and transmission, usually called a radio front end, RF-parts, radio parts, remote radio head, etc. The parts/units/modules needed for reception and transmission may be comprised in the

apparatus or they may be located outside the apparatus the apparatus being operationally coupled to them. The apparatus may also include or be coupled to one or more internal or external memory units.

[0092] Another example of apparatus 500 may include at least one processor 504 and at least one memory 502 including a computer program code, the at least one memory and the computer program code configured to, with the at least one processor, cause the apparatus at least to: receive a connection request from a user equipment; determine that the connection request was transmitted automatically by the user equipment when the user equipment was in an idle mode; and in response to the determination, prioritise by the network element said connection request after connection requests that were determined to not have been transmitted automatically by respective user equipment.

[0093] It should be understood that the apparatus may include or be coupled to other units or modules etc., such as radio parts or radio heads, used in or for transmission and/or reception. This is depicted in Figure 5 as optional block 506.

[0094] Yet another example of an apparatus comprises means (504, 506) for receiving a connection request for a user device, the connection request comprising information on service, means (504, 506) for carrying out a connection configuration in response to the connection request, means (504, 506) for detecting an interruption in data transmission in relation to the configured connection, and means (504, 506) for carrying out, in response to the interruption, either a reconfiguration to an intermediate state or a connection release based on the information on service.

[0095] It should be understood that the apparatus may include or be coupled to other units or modules etc., such as radio parts or radio heads, used in or for transmission and/or reception. This is depicted in Figure 5 as optional block 506.

[0096] Figure 6 illustrates several components in an apparatus 600 that may be configured to execute the example method as described with reference to Figure 2.

[0097] The apparatus 600 may include at least one processor 604 and at least one memory 602 including a computer program code, the at least one memory and the computer program code configured to, with the at least one processor, cause the apparatus at least to: determine that the apparatus is in an idle mode; determine whether or not the user equipment is configured to automatically transmit a connection request to a network entity of said cell; and
5 in response to determining that the user equipment is both in an idle mode and configured to automatically transmit said connection request, automatically transmitting said connection request to a network entity of said cell.

[0098] It should be understood that the apparatus may include or be coupled to other units
10 or modules etc., such as radio parts or radio heads, used in or for transmission and/or reception. This is depicted in Figure 6 as optional block 606. Block 606 includes parts/units/modules needed for reception and transmission, usually called a radio front end, RF-parts, radio parts, remote radio head, etc. The parts/units/modules needed for reception and transmission may be comprised in the apparatus or they may be located outside the
15 apparatus the apparatus being operationally coupled to them. The apparatus may also include or be coupled to one or more internal or external memory units.

[0099] Yet another example of an apparatus comprises means (604, 606) for determine that a user equipment is camped on a cell; determine whether or not the user equipment is configured to automatically transmit a connection request to a network entity of said cell; and
20 in response to determining that the user equipment is both camped on a cell and configured to automatically transmit said connection request, automatically transmitting said connection request to a network entity of said cell.

[00100] It should be understood that the apparatus may include or be coupled to other units or modules etc., such as radio parts or radio heads, used in or for transmission and/or
25 reception. This is depicted in Figure 6 as optional block 606.

[00101] Although the apparatuses have been depicted as one entity in Figure 6, different modules and memory may be implemented in one or more physical or logical entities.

[00102] An apparatus may in general include at least one processor, controller or a unit or module designed for carrying out functions of embodiments operationally coupled to at least one memory unit (or service) and to typically various interfaces. Further, the memory units may include volatile and/or non-volatile memory. The memory unit may store computer program code and/or operating systems, information, data, content or the like for the processor to perform operations according to embodiments described above in relation to Figure 2. Each of the memory units may be a random access memory, hard drive, etc. The memory units may be at least partly removable and/or detachably operationally coupled to the apparatus. The memory may be of any type suitable for the current technical environment and it may be implemented using any suitable data storage technology, such as semiconductor-based technology, flash memory, magnetic and/or optical memory devices. The memory may be fixed or removable.

[00103] The apparatus may be, include or be associated with at least one software application, module, unit or entity configured as arithmetic operation, or as a program (including an added or updated software routine), executed by at least one operation processor. Programs, also called program products or computer programs, including software routines, applets and macros, may be stored in any apparatus-readable data storage medium and they include program instructions to perform particular tasks. The data storage medium may be a non-transitory medium. The computer program or computer program product may also be loaded to the apparatus. A computer program product may comprise one or more computer-executable components which, when the program is run, for example by one or more processors possibly also utilizing an internal or external memory, are configured to carry out any of the embodiments or combinations thereof described above by means of Figure 2. The one or more computer-executable components may be at least one software code or

portions thereof. Computer programs may be coded by a programming language or a low-level programming language.

[00104] Modifications and configurations required for implementing functionality of an embodiment may be performed as routines, which may be implemented as added or updated software routines, application circuits (ASIC) and/or programmable circuits. Further, software routines may be downloaded into an apparatus. The apparatus, such as a node device, or a corresponding component, may be configured as a computer or a microprocessor, such as single-chip computer element, or as a chipset, including at least a memory for providing storage capacity used for arithmetic operation and an operation processor for executing the arithmetic operation.

[00105] Embodiments provide computer programs embodied on a distribution medium, comprising program instructions which, when loaded into electronic apparatuses, constitute the apparatuses as explained above. The distribution medium may be a non-transitory medium.

[00106] The computer program may be in source code form, object code form, or in some intermediate form, and it may be stored in some sort of carrier, distribution medium, or computer readable medium, which may be any entity or device capable of carrying the program. Such carriers include a record medium, computer memory, read-only memory, photoelectrical and/or electrical carrier signal, telecommunications signal, and software distribution package, for example. Depending on the processing power needed, the computer program may be executed in a single electronic digital computer or it may be distributed amongst a number of computers. The computer readable medium or computer readable storage medium may be a non-transitory medium.

[00107] Various techniques described herein may also be applied to a cyber-physical system (CPS) (a system of collaborating computational elements controlling physical entities). CPS may enable the implementation and exploitation of massive amounts of interconnected ICT

devices (sensors, actuators, processors microcontrollers, etc.) embedded in physical objects at different locations. Mobile cyber physical systems, in which the physical system in question has inherent mobility, are a subcategory of cyber-physical systems. Examples of mobile physical systems include mobile robotics and electronics transported by humans or animals.

5 [00108] The techniques described herein may be implemented by various means. For example, these techniques may be implemented in hardware (one or more devices), firmware (one or more devices), software (one or more modules), or combinations thereof. For a hardware implementation, the apparatus may be implemented within one or more application specific integrated circuits (ASICs), digital signal processors (DSPs), digital signal processing
10 devices (DSPDs), programmable logic devices (PLDs), field programmable gate arrays (FPGAs), processors, controllers, micro-controllers, microprocessors, digitally enhanced circuits, other electronic units designed to perform the functions described herein, or a combination thereof. For firmware or software, the implementation may be carried out through modules of at least one chip set (e.g., procedures, functions, and so on) that perform the
15 functions described herein. The software codes may be stored in a memory unit and executed by processors. The memory unit may be implemented within the processor or externally to the processor. In the latter case it may be communicatively coupled to the processor via various means, as is known in the art. Additionally, the components of systems described herein may be rearranged and/or complimented by additional components in order to facilitate achieving
20 the various aspects, etc., described with regard thereto, and they are not limited to the precise configurations set forth in the given figures, as will be appreciated by one skilled in the art.

[00109] It will be obvious to a person skilled in the art that, as technology advances, the inventive concept may be implemented in various ways. The invention and its embodiments are not limited to the examples described above but may vary within the scope of the claims.

CLAIMS

1. A method comprising:
 - determining that a user equipment is in an idle mode;
 - determining whether or not the user equipment is configured to automatically transmit a connection request to a network entity; and
 - in response to determining that the user equipment is both in an idle mode and configured to automatically transmit said connection request, automatically transmitting said connection request to the network entity.
2. The method as claimed in claim 1, further comprising:
 - starting a timer when the request for connection is automatically transmitted;
 - and
 - in response to the expiry of the timer without a connection being established with the network entity, automatically transmitting another request for connection.
3. The method as claimed in any preceding claim, wherein, the method comprises remaining in the idle mode in response to determining that the user equipment is both in an idle mode and is not configured to automatically transmit said connection request.
4. The method as claimed in any preceding claim, wherein the determining whether or not the user equipment is configured to automatically transmit a connection request to a network entity comprises:
 - determining the type of user equipment; and
 - determining that the user equipment is configured to automatically transmit a connection request to a network entity if the type is one of a predetermined type of user equipment.

5. The method as claimed in claim 4, wherein the predetermined type of user equipment is a machine-type-communication device and/or a customer premises equipment.

6. The method as claimed in any preceding claim, wherein the determining whether or not the user equipment is configured to automatically transmit a connection request to a network entity comprises:

determining whether or not the network supports a user equipment that automatically transmits said connection request.

7. The method as claimed in any preceding claim, wherein the determining whether or not the user equipment is configured to automatically transmit a connection request to a network entity comprises:

determining whether the type of public land mobile network, PLMN, of the network entity is a home PLMN, an equivalent home PLMN or a visitor PLMN; and

determining the user equipment is configured to automatically transmit a connection request to a network entity only if the PLMN is an equivalent home PLMN or a home PLMN.

8. The method as claimed in any preceding claim, further comprising:

transmitting to the network entity an indication that the user equipment is able to automatically transmit said connection request.

9. The method as claimed in any preceding claim, further comprising:

receiving from the network entity an indication that the network entity does not allow the automatic transmission of said connection request.

10. The method as claimed in any preceding claim, wherein determining that a user equipment is in an idle mode comprises determining that the user equipment is in one of: a camped normally state; and a camped on any cell state.

11. An apparatus comprising:

at least one processor and at least one memory including computer program code, the at least one memory and the computer program code being configured to, with the at least one processor, cause the apparatus to:

determine that a user equipment is in an idle mode;

determine whether or not the user equipment is configured to automatically transmit a connection request to a network entity; and

in response to determining that the user equipment is both in an idle mode and configured to automatically transmit said connection request, automatically transmitting said connection request to the network entity.

12. The apparatus as claimed in claim 11, wherein the at least one memory and the computer program code is configured to, with the at least one processor, cause the apparatus to:

start a timer when the request for connection is automatically transmitted; and

in response to the expiry of the timer without a connection being established with the network entity, automatically transmit another request for connection.

13. The apparatus as claimed in any of claims 11 to 12, wherein the at least one memory and the computer program code is configured to, with the at least one processor, cause the apparatus to remain in the idle mode in response to determining that the user equipment is both in an idle mode and is not configured to automatically transmit said connection request.

14. The apparatus as claimed in any of claims 11 to 13, wherein the at least one memory and the computer program code is configured to, with the at least one processor, cause the apparatus to determine whether or not the user equipment is configured to automatically transmit a connection request to a network entity by:

determining the type of user equipment; and

determining that the user equipment is configured to automatically transmit a connection request to a network entity if the type is one of a predetermined type of user equipment.

15. The apparatus as claimed in claim 14, wherein the predetermined type of user equipment is a machine-type-communication device and/or a customer premises equipment.

16. The apparatus as claimed in any of claims 11 to 15, wherein the at least one memory and the computer program code is configured to, with the at least one processor, cause the apparatus to determine whether or not the user equipment is configured to automatically transmit a connection request to a network entity comprises:

determining whether or not the network entity supports a user equipment that automatically transmits said connection request.

17. The apparatus as claimed in any of claims 11 to 16, wherein the at least one memory and the computer program code is configured to, with the at least one processor, cause the apparatus to determine whether or not the user equipment is configured to automatically transmit a connection request to a network entity by:

determining whether the type of public land mobile network, PLMN, of the network entity is a home PLMN, an equivalent home PLMN or a visitor PLMN; and

determining the user equipment is configured to automatically transmit a connection request to a network entity only if the PLMN is an equivalent home PLMN or a home PLMN.

18. The apparatus as claimed in any of claims 11 to 17, wherein the at least one memory and the computer program code is configured to, with the at least one processor, further cause the apparatus to:

transmitting to the network entity an indication that the user equipment is able to automatically transmit said connection request.

19. The apparatus as claimed in any of claims 11 to 18, wherein the at least one memory and the computer program code is configured to, with the at least one processor, cause the apparatus to:

receive from the network entity an indication that the network entity does not allow the automatic transmission of said connection request.

20. The apparatus as claimed in any of claims 11 to 19, wherein the at least one memory and the computer program code is configured to, with the at least one processor, cause the apparatus to determine that the user equipment is in an idle mode when the user equipment is in one of: a camped normally state; and a camped on any cell state.

21. A computer program comprising computer executable instructions, which when executed by a computer, cause the computer to perform each of the method steps of any of claims 1 to 10.

22. A method comprising:

receiving, by a network entity, a connection request from a user equipment;

determining, by the network entity, that the connection request was transmitted automatically by the user equipment when the user equipment was in an idle mode; and

in response to the determination, prioritising by the network element said connection request after connection requests that were determined to not have been transmitted automatically by respective user equipment.

23. An apparatus comprising:

means for determining that a user equipment is in an idle mode;

means for determining whether or not the user equipment is configured to automatically transmit a connection request to a network entity; and

means for, in response to determining that the user equipment is both in an idle mode and configured to automatically transmit said connection request, automatically transmitting said connection request to a network entity.

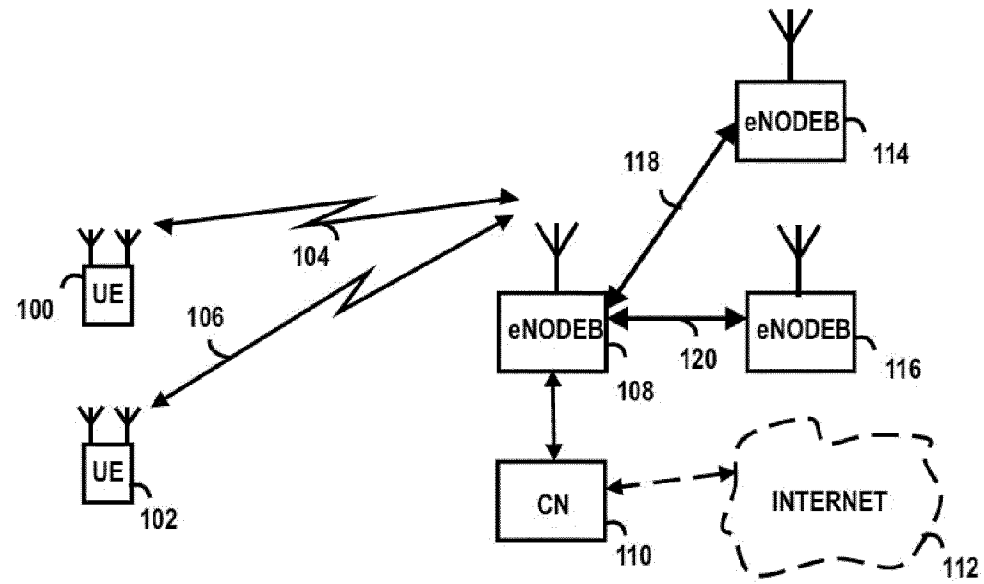


FIG. 1

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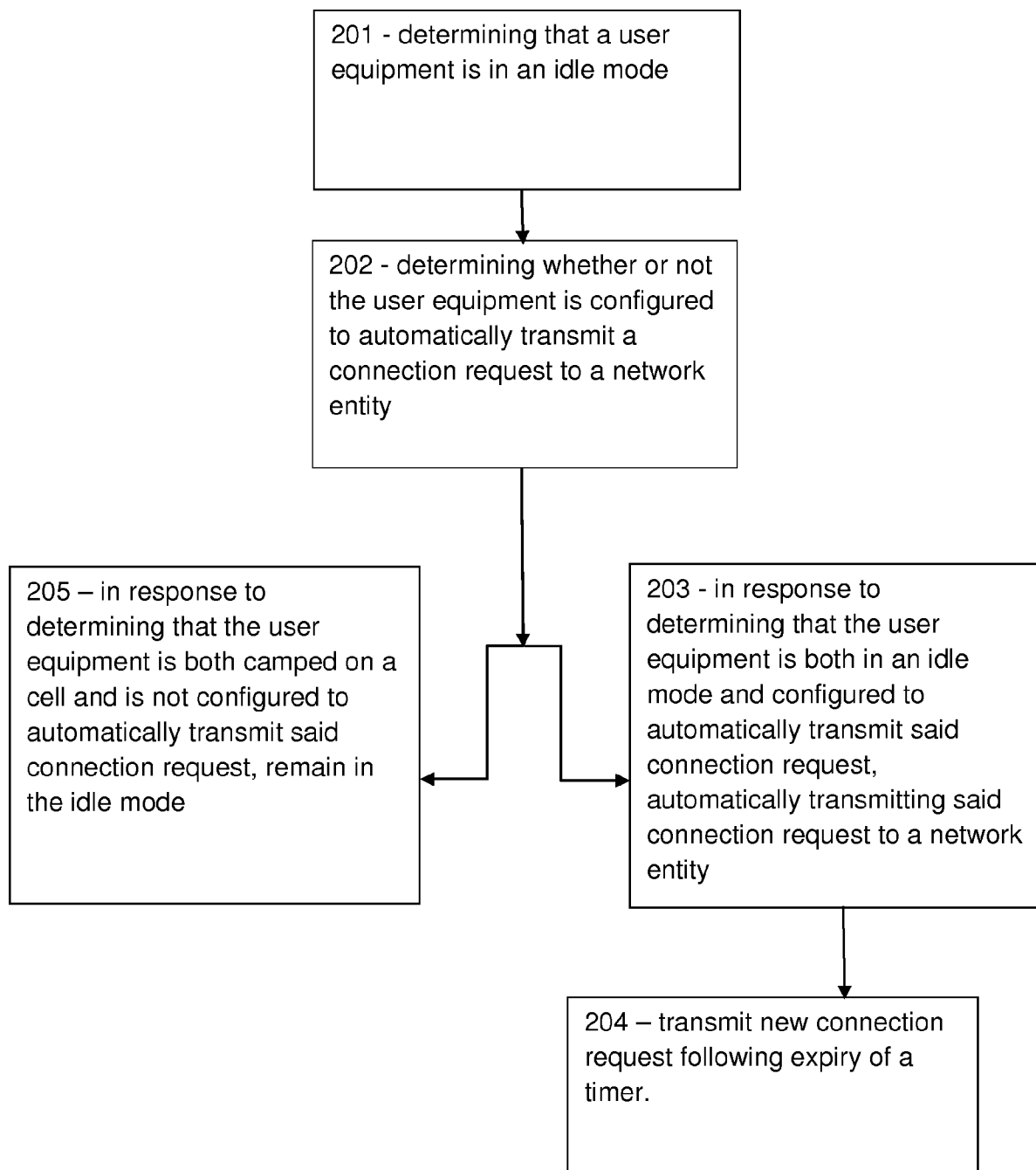


FIG. 2

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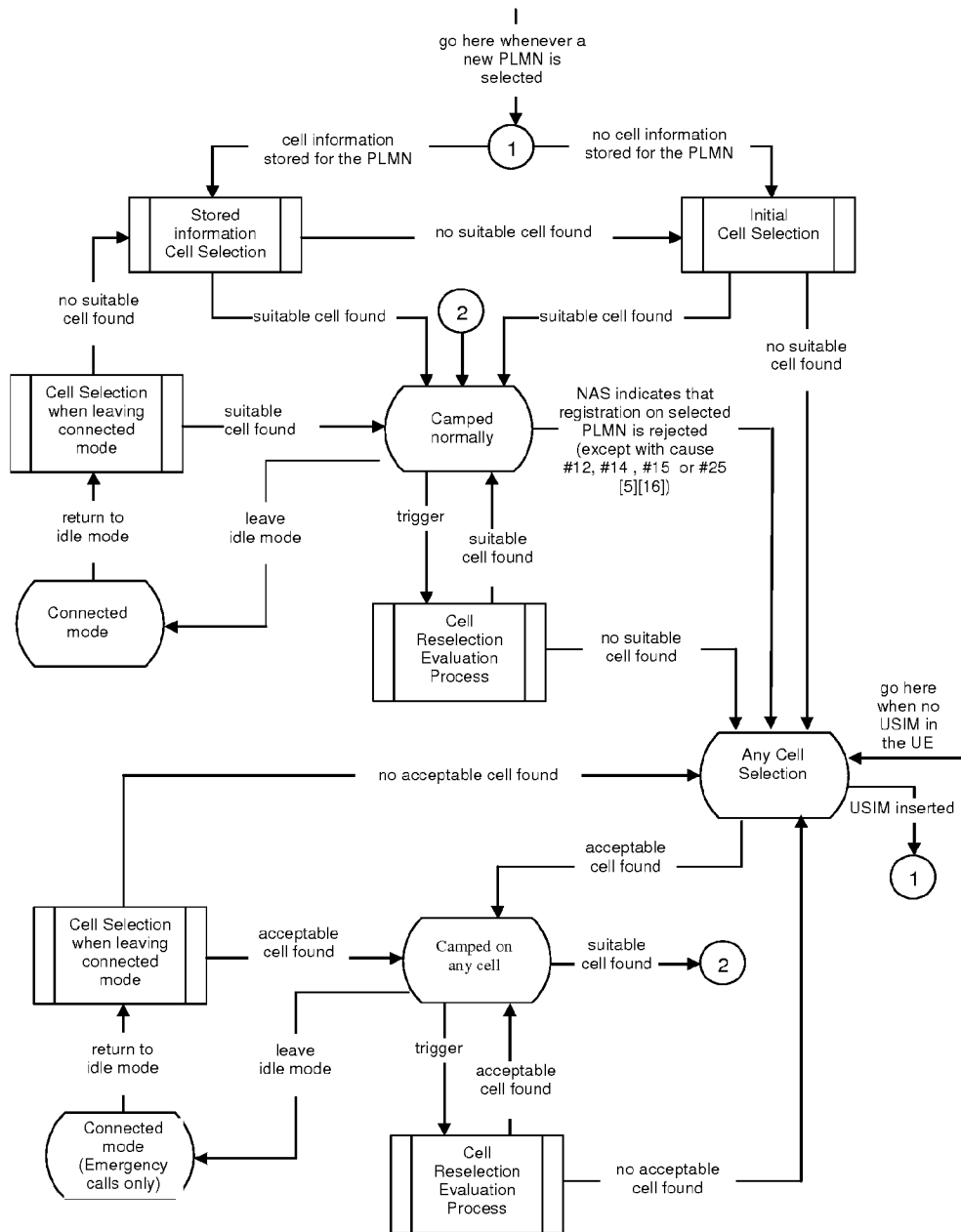


FIG. 3

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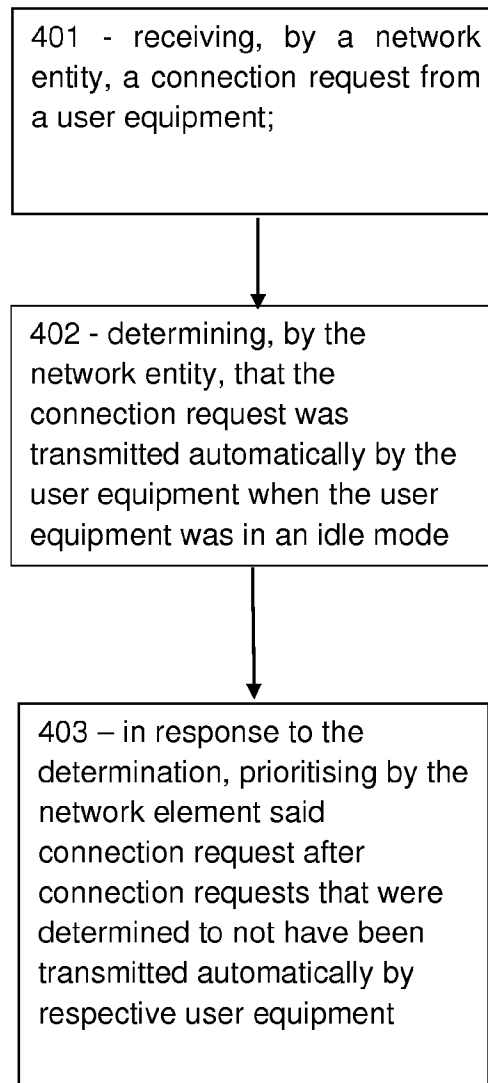
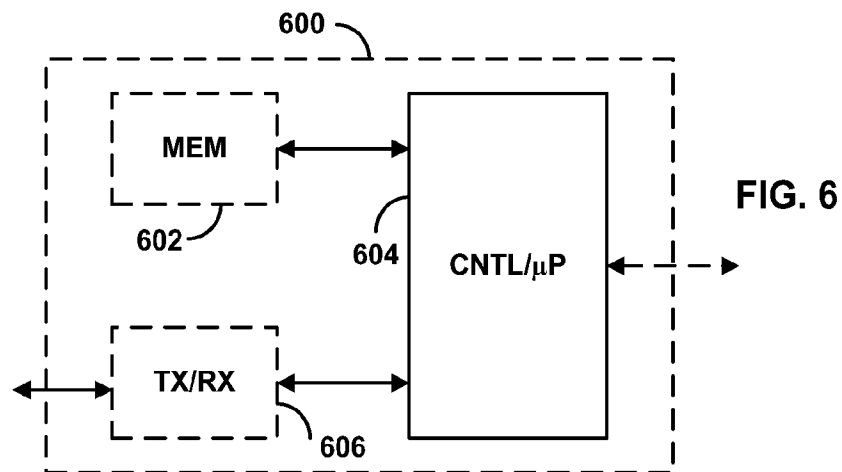
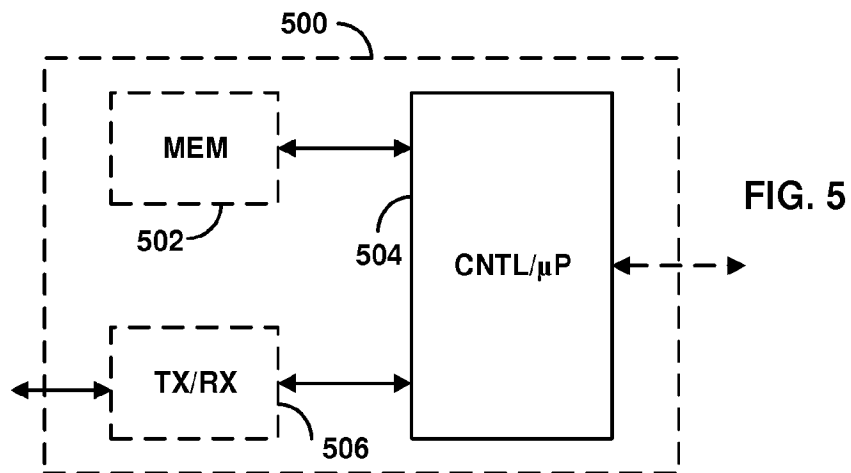


FIG. 4



INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/057257

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04W48/20 H04W48/14 H04W48/00
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)

EP0-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 2008/310370 A1 (KITANI MITSUHIRO [JP]) 18 December 2008 (2008-12-18) abstract figures 2, 12 paragraph [0009] - paragraph [0016] paragraph [0058] paragraph [0063] - paragraph [0064] paragraph [0070] -----	1-23
X	EP 1 845 749 A2 (SAMSUNG ELECTRONICS CO LTD [KR]) 17 October 2007 (2007-10-17) figures 4, 5, 9, 10 -----	1-23
A	EP 2 869 648 A1 (ALCATEL LUCENT [FR]) 6 May 2015 (2015-05-06) the whole document -----	1-23

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Further documents are listed in the continuation of Box C.

☒

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"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

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"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

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Date of the actual completion of the international search

14 June 2016

Date of mailing of the international search report

22/06/2016

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2016/057257

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