



(51) International Patent Classification:
H04W 36/00 (2009.01)

(21) International Application Number:
PCT/EP2017/060064

(22) International Filing Date:
27 April 2017 (27.04.2017)

(25) Filing Language: English

(26) Publication Language: English

(71) Applicant: NOKIA SOLUTIONS AND NETWORKS OY [FI/FI]; Karaportti 3, 02610 ESPOO (FI).

(72) Inventors: KOLLAR, Martin; Hlinkova 12, 04001 Kosice (PL). ZIEBA, Arkadiusz; Czeslawa Milosza 53/14, 80-126 Gdansk (PL).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM,

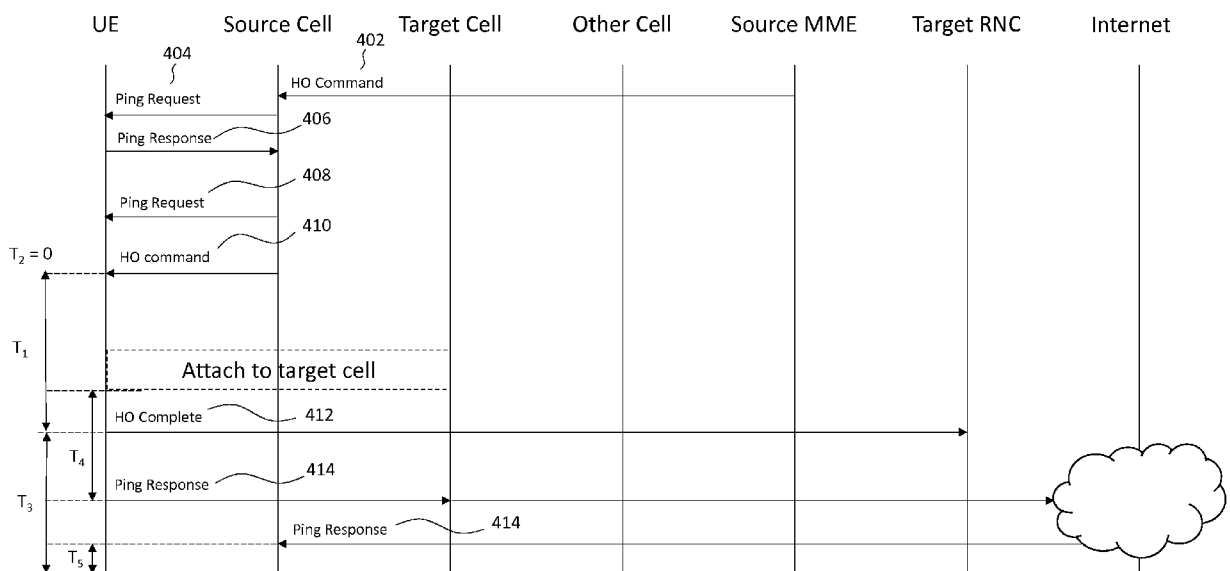
PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:
— with international search report (Art. 21(3))

(54) Title: METHOD FOR REDUCTION OF UNWANTED RETRANSMISSIONS

Figure 4



(57) Abstract: There is provided a method comprising transmitting from a first base station to a communications device at least one reachability request message and a command to handover the communications device to a second base station; receiving, a reachability response message in response to the at least one reachability request message and using said reachability response message to stop retransmission of said command to handover the communications device

WO 2018/196978 A1

Title

METHOD FOR REDUCTION OF UNWANTED RETRANSMISSIONS

5

Field

The present application relates to a method, apparatus, system and computer program and in particular but not exclusively to a method and apparatus relating to reachability requests.

10

Background

A communication system may be a facility that enables communication between two or more nodes or devices, such as fixed or mobile communication devices. Signals can be carried on wired or wireless carriers.

15

An example of a cellular communication system is an architecture that is being standardized by the 3rd Generation Partnership Project (3GPP). One development in this field is often referred to as the long-term evolution (LTE) of the Universal Mobile Telecommunications System (UMTS) radio-access technology. E-UTRA (evolved UMTS Terrestrial Radio Access) is the air interface of 3GPP's Long Term Evolution (LTE) upgrade path for mobile networks. In LTE, base stations or access points (APs), which are referred to as enhanced Node AP (eNBs), provide wireless access within a coverage area or cell. In LTE, mobile devices, user devices or mobile stations are referred to as user equipment (UEs). Currently 3GPP is also developing the new 5G standards, sometimes known as New Radio NR. Such development is taking place, for example, in the Radio Access Network (RAN) working group.

20

25

Mobile technologies aim to support high throughput rates and high quality of experience at the same time. A factor that may impact achievable throughput is the interference in relation to the signal power. Especially at the cell's boundary the signal to interference conditions may be unfavourable to achieve a high throughput. Interference mitigation wherever possible is therefore desirable for each mobile operator.

30

35

In a cellular communication system, it may be necessary to perform handover in which the

UE moves from one cell to another cell. A base station of the cell from which the UE originates (the source cell) transmits a message to the UE so as to initiate the handover. In many cases, the base station of the source cell may continue to re-transmit handover commands to the UE, even after a handover message has already been successfully received by the UE. Unwanted retransmission may negatively increase interference and thus decrease the signal to interference ratio at the border of the cells when the handover procedure is being performed.

Summary of the Invention

10

According to a first aspect, there is provided a method comprising transmitting from a first base station to a communications device at least one reachability request message and a command to handover the communications device to a second base station; receiving, a reachability response message in response to the at least one reachability request message; and using said reachability response message to stop retransmission of said command to handover the communications device.

15

The method may further comprise receiving the reachability response message from a further base station.

20

Said further base station may be the second base station.

25

Said further base station may be different to the second base station if the command to handover the communications device is not successfully received by the communications device.

30

Said at least one of the at least one reachability request message may be sent prior to the command to handover the communications device.

Said at least one of the at least one reachability request message may be sent after the command to handover the communications device.

35

Said at least one reachability request message may be one of a plurality of reachability request messages sent after the command to handover the communications device.

Said at least one reachability request message may comprise the last of a plurality of reachability request messages sent to the communications device prior to the command to handover the communications device.

- 5 The method may further comprise sending at least one of the at least one reachability request messages to the communications device via the further base station.

The method may further comprise transmitting at least one reachability request message prior to sending the command to handover the communications device and at least one reachability request message after sending the command to handover the communications device.

10 The method may further comprise transmitting at least one set of one or more reachability request messages, in response to receiving at least one reachability response message to at least one reachability request message of a respective set of one or more reachability request messages, stopping the transmission of further reachability request messages of the respective set.

15 The method may further comprise transmitting a command to handover the communications device to a second base station in response to receipt of a handover instruction from a network entity.

20 The method may further comprise transmitting a command to handover the communications device to a second base station in response to receipt of a handover instruction from the communications device.

25 Said at least one of the reachability request messages may be sent after the command to handover the communications device only if a failed transmission of at least one reachability request message occurred after receipt of the handover instruction and prior to sending the command to handover the communications device.

30 Said at least one reachability request message may be sent in at least one internet protocol packet.

Said at least one internet protocol packet may comprise user data.

35

Said first base station may be configured to communicate with the communications device according to a first protocol, and said second base station may be configured to communicate with the communications device according to a second protocol different to the first protocol.

5 According to a second aspect, there is provided a method comprising receiving at a communications device from a first base station at least one reachability request message; attaching to a further base station; and subsequent to attaching to the further base station, transmitting to the further base station, a reachability response message in response to the at least one reachability request message, the reachability response message configured to be
10 forwarded to the first base station.

The method may further comprise attaching to the further base station in response to receipt from the first base station of a command to handover to the further base station.

15 The method may further comprise attaching to the further base station in response to a failed transmission from the first base station of a command to handover to a second base station.

According to a third aspect, there is provided a method comprising connecting with a communications device during handover of the communications device from a first base
20 station; receiving from the communications device, a reachability response message in response to at least one reachability request message received at the communications device; and sending the reachability response message to the first base station.

The method may further comprise receiving the at least one reachability request message
25 from a first base station; and upon completion of the handover, transmitting the at least one reachability request message to the communications device.

According to a fourth aspect, there is provided an apparatus comprising at least one processor and at least one memory including computer code for one or more programs, the at least one
30 memory and the computer code configured, with the at least one processor, to cause the apparatus at least to: transmit from a first base station to a communications device at least one reachability request message and a command to handover the communications device to a second base station; receive a reachability response message in response to the at least one reachability request message; and use said reachability response message to stop
35 retransmission of said command to handover the communications device.

The apparatus may further be caused to receive the reachability response message from a further base station.

Said further base station may be the second base station.

5

Said further base station may be different to the second base station if the command to handover the communications device is not successfully received by the communications device.

10 Said at least one of the at least one reachability request message may be sent prior to the command to handover the communications device.

Said at least one of the at least one reachability request message may be sent after the command to handover the communications device.

15

Said at least one reachability request message may be one of a plurality of reachability request messages sent after the command to handover the communications device.

20 Said at least one reachability request message may comprise the last of a plurality of reachability request messages sent to the communications device prior to the command to handover the communications device.

The apparatus may further be caused to send at least one of the at least one reachability request messages to the communications device via the further base station.

25

The apparatus may further be caused to transmit at least one reachability request message prior to sending the command to handover the communications device and at least one reachability request message after sending the command to handover the communications device.

30

The apparatus may further be caused to transmit at least one set of one or more reachability request messages and caused to stop the transmission of further reachability request messages of the respective set, in response to receiving at least one reachability response message to at least one reachability request message of a respective set of one or more reachability request messages.

35

The apparatus may further be caused to transmit a command to handover the communications device to a second base station in response to receipt of a handover instruction from a network entity.

- 5 The apparatus may further be caused to transmit a command to handover the communications device to a second base station in response to receipt of a handover instruction from the communications device.

10 Said at least one of the reachability request messages may be sent after the command to handover the communications device only if a failed transmission of at least one reachability request message occurred after receipt of the handover instruction and prior to sending the command to handover the communications device.

15 Said at least one reachability request message may be sent in at least one internet protocol packet.

Said at least one internet protocol packet may comprise user data.

20 Said first base station may be configured to communicate with the communications device according to a first protocol, and said second base station may be configured to communicate with the communications device according to a second protocol different to the first protocol.

25 According to a fifth aspect, there is provided an apparatus comprising at least one processor and at least one memory including computer code for one or more programs, the at least one memory and the computer code configured, with the at least one processor, to cause the apparatus at least to: receive at the communications device from a first base station at least one reachability request message; attach to a further base station; and subsequent to attaching to the further base station, transmit to the further base station, a reachability response message in response to the at least one reachability request message, the reachability response message configured to be forwarded to the first base station.

The apparatus may further be caused to attach to the further base station in response to receipt from the first base station of a command to handover to the further base station.

- 35 The apparatus may further be caused to attach to the further base station in response to a failed transmission from the first base station of a command to handover to a second base station.

According to a sixth aspect, there is provided an apparatus comprising at least one processor and at least one memory including computer code for one or more programs, the at least one memory and the computer code configured, with the at least one processor, to cause the apparatus at least to: connect with a communications device during handover of the communications device from a first base station; receive from the communications device, a reachability response message in response to at least one reachability request message received at the communications device; and send the reachability response message to the first base station.

10

The apparatus may further be caused to receive the at least one reachability request message from a first base station; and be caused to transmit, upon completion of the handover, the at least one reachability request message to the communications device.

15 According to a seventh aspect, there is provided an apparatus comprising means for transmitting from a first base station to a communications device at least one reachability request message and a command to handover the communications device to a second base station; means for receiving, a reachability response message in response to the at least one reachability request message; and means for using said reachability response message to stop retransmission of said command to handover the communications device.

20

The apparatus may further comprise means for receiving the reachability response message from a further base station.

25 Said further base station may be the second base station.

Said further base station may be different to the second base station if the command to handover the communications device is not successfully received by the communications device.

30

Said at least one of the at least one reachability request message may be sent prior to the command to handover the communications device.

Said at least one of the at least one reachability request message may be sent after the command to handover the communications device.

35

Said at least one reachability request message may be one of a plurality of reachability request messages sent after the command to handover the communications device.

5 Said at least one reachability request message may comprise the last of a plurality of reachability request messages sent to the communications device prior to the command to handover the communications device.

10 The apparatus may further comprise means for sending at least one of the at least one reachability request messages to the communications device via the further base station.

The apparatus may further comprise means for transmitting at least one reachability request message prior to sending the command to handover the communications device and at least one reachability request message after sending the command to handover the communications device.

15

The apparatus may further comprise means for transmitting at least one set of one or more reachability request messages and means for stopping the transmission of further reachability request messages of the respective set, in response to receiving at least one reachability response message to at least one reachability request message of a respective set of one or more reachability request messages.

20

The apparatus may further comprise means for transmitting a command to handover the communications device to a second base station in response to receipt of a handover instruction from a network entity.

25

The apparatus may further comprise means for transmitting a command to handover the communications device to a second base station in response to receipt of a handover instruction from the communications device.

30 Said at least one of the reachability request messages may be sent after the command to handover the communications device only if a failed transmission of at least one reachability request message occurred after receipt of the handover instruction and prior to sending the command to handover the communications device.

35 Said at least one reachability request message may be sent in at least one internet protocol packet.

Said at least one internet protocol packet may comprise user data.

Said first base station may be configured to communicate with the communications device according to a first protocol, and said second base station may be configured to communicate with the communications device according to a second protocol different to the first protocol.

According to an eighth aspect, there is provided an apparatus comprising means for receiving at a communications device from a first base station at least one reachability request message; means for attaching to a further base station; and means for transmitting to the further base station, subsequent to attaching to the further base station, a reachability response message in response to the at least one reachability request message, the reachability response message configured to be forwarded to the first base station.

The apparatus may further comprise means for attaching to the further base station in response to receipt from the first base station of a command to handover to the further base station.

The apparatus may further comprise means for attaching to the further base station in response to a failed transmission from the first base station of a command to handover to a second base station.

According to a ninth aspect, there is provided an apparatus comprising means for connecting with a communications device during handover of the communications device from a first base station; means for receiving from the communications device, a reachability response message in response to at least one reachability request message received at the communications device; and means for sending the reachability response message to the first base station.

The apparatus may further comprise means for receiving the at least one reachability request message from a first base station; and means for transmitting, upon completion of the handover, the at least one reachability request message to the communications device.

According to a tenth aspect there is provided a computer program comprising computer code means adapted to perform at least part of the herein described methods.

In accordance with further embodiments apparatus and/or computer program product that can be embodied on a non transitory computer readable medium for providing at least one of the above methods is provided.

- 5 It should be appreciated that any feature of any aspect may be combined with any other feature of any other aspect.

Various other aspects and further embodiments are also described in the following detailed description of examples embodying the invention and in the attached claims.

10

Brief Description of Drawings

Embodiments will now be described, by way of example only, with reference to the
15 accompanying Figures in which:

Figure 1 shows a schematic diagram of an example communication system comprising a plurality of base stations and a plurality of communication devices;

20 Figure 2 shows a schematic diagram of an example mobile communication device;

Figure 3 illustrates an example communication system comprising three base stations and a communication device;

25 Figure 4 shows a message sequence chart in which ping requests are transmitted in downlink packets;

Figure 5 shows a message sequence chart in which ping requests are transmitted in downlink packets and a handover command transmission fails;

30

Figure 6 shows a message sequence chart in which the failed transmission of ping requests in downlink packets occurs;

Figure 7 shows a message sequence chart in which the failed transmission of ping requests
35 and handover commands occurs;

Figure 8 shows a message sequence chart in which ping requests are transmitted via a network;

Figure 9 shows a message sequence chart in which ping requests are transmitted via a
5 network and a handover command transmission fails;

Figure 10 shows a message sequence chart in which the failed transmission of ping requests via a network occurs;

10 Figure 11 shows a message sequence chart in which the failed transmission of ping requests and handover commands occurs.

Figure 12 illustrates an example method that may be performed in a base station to stop retransmissions of handover commands using ping messages sent in downlink packets;
15

Figure 13 illustrates an example method that may be performed in a base station to stop retransmissions of handover commands using ping messages sent via a network;

Figure 14 illustrates an example method that may be performed by a communication device
20 to stop retransmissions of handover commands;

Figure 15 shows a schematic diagram of an example control apparatus; and

Figure 16 shows a message sequence chart of an example handover process.
25

Detailed Description

Before explaining in detail the examples, certain general principles of a wireless communication system and mobile communication devices are briefly explained with
30 reference to Figures 1 to 2 to assist in understanding the technology underlying the described examples.

In a wireless communication system 100, such as that shown in Figure 1, mobile communication devices or user equipment (UE) 102, 104, 105 are provided wireless access
35 via at least one base station or similar wireless transmitting and/or receiving node or point. A base station is referred to as an eNodeB (eNB) in LTE. Base stations are typically controlled

by at least one appropriate controller apparatus, so as to enable operation thereof and management of mobile communication devices in communication with the base stations. The controller apparatus may be located in a radio access network (e.g. wireless communication system 100) or in a core network (CN) (not shown) and may be implemented as one central apparatus or its functionality may be distributed over several apparatus. The controller apparatus may be part of the base station and/or provided by a separate entity such as a Radio Network Controller. In Figure 1 control apparatus 108 and 109 are shown to control the respective macro level base stations 106 and 107. In some systems, the control apparatus may additionally or alternatively be provided in a radio network controller.

10

LTE systems may however be considered to have a so-called “flat” architecture, without the provision of RNCs; rather the eNB is in communication with a system architecture evolution gateway (SAE-GW) and a mobility management entity (MME), which entities may also be pooled meaning that a plurality of these nodes may serve a plurality (set) of eNBs. Each UE is served by only one MME and/or S-GW at a time and the (e) NB keeps track of current association. SAE-GW is a “high-level” user plane core network element in LTE, which may consist of the S-GW and the P-GW (serving gateway and packet data network gateway, respectively). The functionalities of the S-GW and P-GW are separated and they are not required to be co-located.

20

In Figure 1 base stations 106 and 107 are shown as connected to a wider communications network 113 via gateway 112. A further gateway function may be provided to connect to another network.

25

The smaller base stations 116, 118 and 120 may also be connected to the network 113, for example by a separate gateway function and/or via the controllers of the macro level stations. The base stations 116, 118 and 120 may be pico or femto level base stations or the like. In the example, stations 116 and 118 are connected via a gateway 111 whilst station 120 connects via the controller apparatus 108. In some embodiments, the smaller stations may not be provided.

30

The devices 102, 104, 105, described above may also be configured to send and receive communications in accordance with wideband code division multiple access (WCDMA) in addition or alternatively to sending and receiving LTE communications.

35

In one embodiment, a first base station 106 may be configured to communicate with devices

102, 104, and 105 according to a first protocol (e.g. LTE) and a second base station 107
may be configured to communicate with devices 102, 104, and 105 according to a second
protocol (e.g. WCDMA). In some embodiments, the first base station 106 and the second
base station 107 may be configured to communicate with the devices 102, 104, and 105
5 according to the same protocol.

The first base station 106 and second base station 107 each serve a cell. There may be an
amount of overlap in the area covered by the cells. A handover operation may be performed,
wherein a device terminates communications with one of the base stations 106, 107, and
10 resumes communications with the other of the base stations 106, 107.

A user device (user terminal, user equipment (UE) or mobile station) may refer 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
15 types of devices: a mobile station (MS), a mobile phone, a cell phone, a smartphone, a
personal digital assistant (PDA), a handset, a device using a wireless modem (alarm or
measurement device, etc.), a laptop and/or touch screen computer, a tablet, a phablet, a
game console, a notebook, and a multimedia device, as examples. It should be appreciated
that a user device may also be a nearly exclusive uplink only device, of which an example is
20 a camera or video camera loading images or video clips to a network.

A possible UE will now be described in more detail with reference to Figure 2 showing a
schematic, partially sectioned view of a UE 200. An appropriate UE may be provided by any
device capable of sending and receiving radio signals. Non-limiting examples comprise a
25 mobile station (MS) or mobile device such as a mobile phone or what is known as a 'smart
phone', a computer provided with a wireless interface card or other wireless interface facility
(e.g., USB dongle), personal data assistant (PDA) or a tablet provided with wireless
communication capabilities, or any combinations of these or the like. A UE may provide, for
example, communication of data for carrying communications such as voice, electronic mail
30 (email), text message, multimedia, and so on. Users may thus be offered and provided
numerous services via their communication devices. Non-limiting examples of these services
comprise two-way or multi-way calls, data communication or multimedia services or simply an
access to a data communications network system, such as the Internet. Users may also be
provided broadcast or multicast data. Non-limiting examples of the content comprise
35 downloads, television and radio programs, videos, advertisements, various alerts and other
information.

The UE 200 may receive signals over an air or radio interface 207 via appropriate apparatus for receiving and may transmit signals via appropriate apparatus for transmitting radio signals. In Figure 2, transceiver apparatus is designated schematically by block 206. The transceiver apparatus 206 may be provided for example by means of a radio part and associated antenna arrangement. The antenna arrangement may be arranged internally or externally to the mobile device.

A UE is typically provided with at least one data processing entity 201, at least one memory 202 and other possible components 203 for use in software and hardware aided execution of tasks it is designed to perform, including control of access to and communications with access systems and other communication devices. The data processing, storage and other relevant control apparatus can be provided on an appropriate circuit board and/or in chipsets. This feature is denoted by reference 204. The user may control the operation of the mobile device by means of a suitable user interface such as key pad 205, voice commands, touch sensitive screen or pad, combinations thereof or the like. A display 208, a speaker and a microphone can be also provided. Furthermore, a UE may comprise appropriate connectors (either wired or wireless) to other devices and/or for connecting external accessories, for example hands-free equipment, thereto.

It would be understood by the person skilled in the art that a UE may not include all of the features discussed above with respect to figure 2, but may be simpler than the example presented. A UE need not include, for example, a display 208 or a speaker. It should be appreciated that in some embodiments, a device with communications ability may be used.

As mentioned previously, a first base station servicing a first cell (source cell) may transmit a handover message to a device to transfer the device from the first cell to a second cell (target cell). The device is configured to, upon receiving this message, attach itself to the target cell so as to communicate with the base station servicing that target cell.

The communication device typically performs the handover as soon as possible following the reception of the message triggering the handover, which could be before confirming successful reception of the message by for example Automatic Repeat Request (ARQ) or Hybrid Automatic Repeat Request (HARQ). In some cases, the communication device may not always support the sending of Acknowledgment messages. Some communication devices may support sending acknowledgments on one layer of the protocol stack (e.g. the sending of HARQ ACKs on the Medium Access Control layer of the LTE protocol stack), but may not support the sending of acknowledgments on another layer of the protocol stack (e.g.

the sending of ARQ ACKs on the Radio Link Control layer of the LTE protocol stack). Other devices may not support the sending of acknowledgments on both of these layers of the protocol stack. This may lead to the situation where the base station of the source cell will keep on re-transmitting the handover command to the device, because there are no
5 acknowledgments being received from one or more of the protocol layers, despite the handover command being successfully received by the device.

A large number of unwanted retransmissions may negatively increase interference and thus decrease signal to interference ratio at the border of the cells when the handover procedure
10 is performed. Furthermore, the unwanted transmissions are often counted in the total number of MAC/RLC retransmission related PM or KPIs, which may lead to unrealistic conditions being detected in the network being monitored. For these reasons, it is desirable to reduce the number of unnecessary retransmissions of the handover command.

One possibility to reduce the number of unwanted retransmissions could be to provide a low limit on the number of retransmissions that will be performed by the first base station. In this case, the first base station would stop retransmissions even if the device hasn't successfully received at handover command. However, the 3GPP instruction, wherein the number of retransmissions is kept high may be useful in bad conditions, when transmission success
20 rate is low, and having a high limit on the number of retransmissions may be helpful in ensuring that the handover command is received by a communication device.

In some base stations (e.g. eNB) currently only acknowledgment is performed for transmission on the MAC layer, but no acknowledgment is performed for transmission on the RLC layer.
25 This may result in an increased number of RLC retransmission especially during inter radio access technology (inter RAT) handover for signalling radio bearer (SRB) scheduling when almost each time the maximum number of RLC transmissions is reached.

In some base stations stopping of data radio bearer (DRB) scheduling is done after the
30 handover command is sent to the device (SRB scheduling is still ongoing and can be measured via RLC retransmission ratio). Embodiments, may reduce the number of unwanted RLC retransmission seen through network indicators, while keeping the amount of time required to perform the handover low.

According to some embodiments, the source cell base station is configured to transmit one or more ping request messages to the device prior to transmitting the handover command to the device. Alternatively or additionally, the source cell base station may transmit one or

more ping request messages to the device after transmitting the handover command to the device. After the handover is complete, the device is configured to answer the ping request by transmitting a ping response to the source cell base station, via the target cell base station. Upon receiving the ping response, the source cell base station is configured to
5 cease performing retransmission of the handover command to the device. Hence, ping requests may be used by the communication system to reduce the number of retransmissions of handover commands.

10 In response to receiving the ping response message, the first base station may translate the ping response message to a command to lower protocol layers (e.g. MAC and RLC) to stop retransmissions on these layers.

A ping request message is a message typically sent to test the reachability of a computer on a network. An originating host may transmit a ping request message to a destination
15 computer, which then returns a ping response message. This allows the originating host to determine the reachability of the destination computer and may allow it to determine the round trip time. In some cases, ping operates using the Internet control message protocol, and the ping request message and the ping response packets are ICMP echo request packets and the ping response packets are ICMP echo reply packets. However, it should be appreciated that the ping
20 request and response packets are not so limited but may use other protocols.

Although in describing the embodiments, a ping request message and a ping response message are referred to, it would be understood by the skilled person that not all
25 embodiments are so limited. Instead of a ping request message and a ping response message any other suitable reachability request message and reachability response message could be used. It would be understood by the skilled person, therefore, that where the description refers to a ping request message a reachability request message more generally may be intended, and where the description refers to a ping response message a reachability response message more generally may be intended.

30

In some embodiments one or more reachability messages may be provided by a RRC (radio resource control message and/or via any other suitable mechanism.

35 Since in some case, a plurality of ping request messages is sent to the communication device from the first base station, the first base station may receive a plurality of ping response messages. The first base station is configured to stop the retransmissions of the handover command in response to the first value ping response received from the

communication device after the transmission of the handover command.

Reference is made to figure 3, which shows an example communication system scenario to illustrate some embodiments.

5

Figure 3 shows a first base station 302, configured to service a first cell 308, a second base station 304 configured to service a second cell 310, and a third base station 306 configured to service a third cell 312. Also shown is a communication device 314, which may be a UE. In this example, the device 314 is shown as being in the coverage area of the first cell 308, second cell 310, and third cell 312. The three base stations may be configured to communicate using the same protocol or different protocols. The first base station 302 may be configured to communicate with the device 314 using a first protocol, e.g. LTE, whilst the second base station 304 may be configured to communicate with the device 314 using a second protocol, e.g. WCDMA. In some embodiment, the first base station 302 and the second base station 304 may be configured to communicate with the device 314 using the same protocol.

10

15

20

The first cell 308 may act as a source cell, which is initially the cell to which the device 314 is attached. The second cell 310 may act as a target cell, which is the cell to which the device 310 is to handover to. The third cell 312 may act as a default cell, to which the device 314 is configured to attach to, if the handover to the target cell 310 fails.

25

To trigger the handover operation, first base station 302 may be configured to receive a handover command from a network entity, e.g. a mobility management entity. In some case, the first base station 302 may be configured to receive a handover command from the communications device 314. In response, to this command, the first base station transmits ping request messages to the device 314. The first base station may await receipt of a ping response from the device 314, before transmitting a further ping request message to the device 314.

30

35

In one embodiment, the ping request message may be included in packets that are transmitted on the downlink to the device 314. These packet may be IP packets. Additionally or alternatively, the packets may be radio resource control messages. The ping request message may be sent according to the Internet control message protocol. The ping request message may be emulated or injected into IP packets, which are sent to the device 314 in the downlink direction. The Internet Control Message Protocol content (which may constitute a Ping message) may become embedded into the downlink (DL) message by adding to the

DL message an IP container containing the ICMP content. The container may be maintained in the device so that the transport layer in the device side answers.

The device responds to the ping request message by sending a ping response message.

5 The ping response message may be sent in the uplink direction by including in an uplink message an IP container comprising the ping response message.

In another embodiment, the ping request messages are sent to the device via the standard IP link. The ping request messages may be forwarded through the internet to the device 314.

10

The first base station may be configured to transmit a predefined number of ping request messages before transmitting the handover command to handover to the second base station. The first base station may be configured to transmit ping request messages for a predefined time period from the receipt of a handover command, and then on expiry of the

15 time period, transmit a handover command to the device 314.

In the case that the source cell 308 is an LTE cell, and the target cell 310 is a WCDMA cell, the handover command may be a "RRC mobility from E-UTRAN Command message". Of course, in different standards or modifications to the mentioned standards, different

20

handover command messages may be provided.

The first base station may also be configured to repeatedly transmit ping request messages to the device for a predefined period of time after sending the handover command. After the predefined time period expires (which may be after the first base station has stopped any

25 scheduling for the communication device on data radio bearers), the first base station may be configured to monitor for reception of a ping response message from the device. The first base station may monitor for this ping response on the IP layer.

After transmitting the handover command, the first base station 302 may be configured to

30 transmit one or more ping request messages. The first base station 302 may also be configured to repeatedly retransmit the handover command, until a ping response message corresponding to a ping request message sent to the device 314 is received. The first base station 302 may also cease retransmission of the handover command message after a predefined number (e.g. 16 or any suitable number) of retransmissions have been

35 performed, even if a ping response is not received.

The device 314, upon receiving the handover command is configured to attach to the second

cell 304. Upon completion of the handover to the second cell 310, the device 314 may be configured to transmit a handover completion message to the second base station 304, which may be forwarded to the radio network controller (not shown) of the second cell 310. After the handover is complete, the device 314 is then configured to communicate with the second base station. The device 314 is configured to respond to any pending ping requests, by transmitting a ping response to the second base station 304, which then forwards the ping response to the first base station 302. Upon receiving the ping response message, the first base station is configured to cease transmitting handover commands to the device 314.

In one embodiment, the ping response message may be included in packets that are transmitted on the uplink from the device 314. These packet may be IP packets. The ping response message may be sent according to the Internet control message protocol. The ping request message may be emulated or injected into IP packets, which are sent by the device to the second base station 304 in the uplink direction. The second base station 304 may be configured to forward the IP packets to the first base station 302 via an IP link. The Internet Control Message Protocol content (which may constitute a Ping response message) may become embedded into the uplink (UL) message by adding to the UL message an IP container containing the ICMP content. By transmitting the ping response message via the IP layer in this way, no dedicated ping response messages are required.

The device is able to answer the ping request in the target cell after radio resource control has successfully completed and the device has uplink connectivity with the second base station. When the ping response is received the first base station, it may cause the first base station to stop the retransmissions on the different protocol layers (e.g. MAC and RLC).

In some embodiments, if the handover command is not successfully received by the device 314, the device may attach to the third cell 312 so as to communicate with the third base station. The device may be configured to perform radio resource control reestablishment so as to connect to the third base station 306 and disconnect from the first base station 302. In this case, the first base station 302 is still performing unwanted retransmissions of the handover command. Therefore, the device 314 is configured to transmit a ping response message to the ping request received from the first base station 302 to the third base station. The third base station receives the ping response and forwards it to the first base station 302. Upon reception of the first ping response, the first base station ceases retransmission of the handover commands to the device 314.

In one embodiment, the ping response message may be included in packets that are

transmitted on the uplink from the device 314. These packet may be IP packets. The ping response message may be sent according to the Internet control message protocol. The ping request message may be emulated or injected into IP packets, which are sent by the device to the third base station 306 in the uplink direction. The second base station 306 may be configured to forward the IP packets to the first base station 302 via an IP link. The Internet Control Message Protocol content (which may constitute a Ping response message) may become embedded into the uplink (UL) message by adding to the UL message an IP container containing the ICMP content. By transmitting the ping response message via the IP layer in this way, no dedicated ping response messages are required.

10

In some cases, both the ping request messages and the handover commands may fail to be successfully transmitted to their intended destinations. Therefore, differences may exist in the response of the communication system. Different scenarios that may occur, and the corresponding response of the communication system will now be explained with reference to the message sequence charts shown in figures 4 to 11. Figures 4 to 7 relate to cases where the ping request messages are transmitted in packets on the downlink between the first base station and the device. Figures 8 to 11 relate to cases where the ping request messages are transmitted via the internet. It would be appreciated by the skilled person that features from these embodiments may be combined to create new embodiments.

15
20

Although in the following examples, it is shown that a plurality of ping requests are transmitted prior to the transmission of the handover command to the device, it should be appreciated that this need not be the case. In some embodiments, only one ping request message will be transmitted prior to the handover command. In other cases, one or more ping request messages may only be transmitted after transmission of the handover command to the device.

25

The figures include a set of time intervals (T_1 , T_2 , T_3 , T_4 , and T_5). The total time from the transmission of the handover command to the communications device until successful processing by the first base station of the ping response message so as to stop the retransmissions is given by $T = T_1 + T_2 + T_3$.

30

T_1 is the time interval from the reception of the handover command at the device until the transmission of the completion of the handover (which may be marked by the transmission of a handover complete message).

35

T_2 is the time interval from the completion of the handover (which may be marked by the

transmission of a handover complete message) until the reception by the device of the ping request message. In some cases, $T_2 = 0$, since the ping request message is received at the device prior to the completion of the handover.

- 5 T_3 is the time interval between the latest of the completion of the handover (which may be marked by the transmission of a handover complete message) and the reception of the latest ping request message by the device until the successful processing of the ping response message by the first base station to stop retransmissions.
- 10 T_4 is the time interval from completion of the process of the communication device attaching to the base station to which it is being handed over until the transmission by the communications device of the ping response that is to cause a stop to transmission by the communications device.
- 15 T_5 is the time interval between the reception, by the first base station, of the ping response and the successful processing by the first base station of this ping response so as to stop the retransmissions of the handover command.

20 These time intervals may be used to predict the number of unwanted retransmissions of the handover command that may occur in different scenarios. By the term “number of unwanted retransmissions” may be understood, the number of re-transmissions of the handover command by the first base station. These re-transmissions may continue to be sent even if a previous handover command has been successfully received by the device.

- 25 Reference is made to figure 4, which shows an embodiment in which the ping request messages are transmitted in downlink packets to the device from the first base station, and in which both the ping request messages and the handover command are successfully received by the device.
- 30 A network entity, e.g. a mobility management entity that is dedicated to the source cell, transmits a handover message 402 to the first base station 302. In response, the first base station begins transmitting ping request messages to the device. The ping request messages are preferably contained in IP packets. In this example, the first base station transmits a ping request 404 to the device 314. In response, the device transmits a ping
- 35 response 406 to the first base station. After receiving the ping response 406, the first base station then transmits a further ping request 408. Before, the device transmits a ping response back to the first base station, the first base station transmits a handover command

message 410 to the device, instructing handover to the second base stations/target cell.

In the case that the source cell 308 is an LTE cell, and the target cell 310 is a WCDMA cell, the handover command may be a "RRC mobility from E-UTRAN Command message".

5

After the handover message 410 has been transmitted, the device performs the necessary processes to attach to the target cell. The first base station continues to transmit handover command messages to the device.

10

Once, the handover is complete and the device is attached to the target cell, the device transmits a handover complete message 412. This message may be received by the second base station 304 of the target cell 310, and then forwarded to the radio network controller of the target cell.

15

The device transmits a ping response 414 message to the second base station. In this example, the ping response 414 is in response to the ping request message 408, which was received by the device before the handover command 410. In other embodiments, the ping response message 414 may be transmitted in response to a ping request received after the handover command 410. The ping response message is received at the second base

20

station. The second base station may send the ping response message 414 via the IP link or any suitable link to the first base station. The IP link is a communication link configured for the sending of packets to and from a network according to the internet protocol. The network may be the internet. In response to the receipt of the ping response 414, the first base station is configured to cease the retransmissions of the handover commands.

25

In this example, $T_2 = 0$, since the ping request message is received at the device prior to the completion of the handover. Also, since the completion of the handover occurs after the receipt of the latest ping request 408, T_3 begins from the completion of the handover.

30

Reference is made to figure 5, which shows an embodiment in which the ping request messages are transmitted in downlink packets to the device from the first base station. In this example, the ping request messages are successfully received by the device, but the handover command is not successfully received and decoded by the device.

35

A network entity, e.g. a mobility management entity that is dedicated to the source cell, transmits a handover message 502 to the first base station 302. In response, the first base station begins transmitting ping request messages to the device. The ping request

messages are preferably contained in IP packets. In this example, the first base station transmits a ping request 504 to the device 314. In response, the device transmits a ping response 506 to the first base station. After receiving the ping response 506, the first base station then transmits a further ping request 508. The first base station then attempts to transmit a handover command message 510 to the device, instructing handover to the second base stations/target cell.

After the first base station has attempted to transmit a handover command message 510, the first base station may continue to attempt to transmit further handover command messages to the device.

In some cases, the first base station may transmit the handover command message 510, however, the message 510 may not be successfully received at the device, for example, due to interference. In other cases, the handover command message 510 may not be successfully transmitted by the first base station. In either case, a handover command is not successfully received and decoded by the device 314.

Since the device 314 did not successfully receive a handover command, the device is configured to attach to the other cell/third base station. The device 314 performs any necessary procedures to attach to this cell, for example, RRC reestablishment, so that it is able to send data in the uplink to the third base station.

Since the device 314 is then able to send data in the uplink to the third base station 306, the ping response 512 to the ping request 508 that was received earlier, is sent to the third base station. The third base station may be configured to forward this ping response via the internet to the first base station. Upon receiving the ping response, the first base station is configured to not send any further transmissions of the handover command to the device.

As with the example described with respect to figure 4, T_2 is equal to zero. T_1 in figure 5 may be larger than in figure 4 due to additional time required to connect to the third base station rather than the second base station, which was selected for handover.

Reference is made to figure 6, which shows an embodiment in which the ping request messages are transmitted in downlink packets to the device from the first base station. In this example, a handover command is successfully received and decoded by the device. However, the transmission of the ping request message and return of the ping response message is not successful. In some cases, the failure may be due to a failure in the

successful transmission of the ping request message. In another case, a ping request message may be successfully received by the device 314. However, the corresponding ping response message may not be successfully received by the first base station 302.

- 5 A network entity, e.g. a mobility management entity that is dedicated to the source cell, transmits a handover message 602 to the first base station 302. In response, the first base station 302 begins attempting to transmit ping request messages to the device. The ping request messages are preferably contained in an IP container.
- 10 In this example, the first base station attempts to transmit a ping request 604 to the device 314. However, the ping request message is not successfully received at the device 314. Therefore, the ping response message 606 is not successfully transmitted back to the first base station. The first base station then attempts to transmit a further ping request 608. The transmission of this ping request message 608 also fails. It should be appreciated that
- 15 not all of the ping request message transmissions may fail, but only some of them. It may be that only the transmission of the ping request message 608 (or the transmission of its corresponding ping response message) prior to the handover command being transmitted fails.
- 20 After the failed ping request/response 608, the first base station transmits a handover command message 610 to the device, instructing handover to the second base station/target cell.

In the case that the source cell 308 is an LTE cell, and the target cell 310 is a WCDMA cell,

25 the handover command may be a "RRC mobility from E-UTRAN Command message". Of course, different suitable handover commands may be used in other embodiments.

After the handover message 610 has been transmitted, the device performs the necessary processes to attach to the target cell. The device is then capable of sending uplink data to

30 the second base station. The first base station continues to transmit handover command messages to the device.

After the transmission of the handover command 610 to the device, the first base station transmits a ping request message 612 to the second base station to be forwarded to the

35 device after handover is complete. In one embodiment, the ping request message 612 may be sent to the second base station via the internet/IP link or any suitable link. Additionally, or alternatively, the ping request message 612 may be sent to the second base station via a

packet data network gateway, via the internet or via any other suitable connection.

The device performs the necessary processes to attach to the target cell. The first base station continues to transmit handover command messages to the device.

5

The ping request message 612 may be received by the second base station and stored in a buffer of the target cell. The second base station is configured to transmit the ping request message 612 to the device upon completion of the handover.

10 The device is configured to transmit a handover complete message 614 to the radio network controller of the target cell. In response, the radio network controller is configured to cause the second base station to forward the ping request message 612 to the device. In response to receiving the ping request message 612, the device is configured to transmit a corresponding ping response message 616 to the second base station to be forwarded to
15 the first base station. The second base station receives the ping response message 616 and sends it via the IP link or any suitable link to the first base station. In response to receiving the ping response message, the first base station ceases the retransmissions of the handover command.

20 In this example, T_2 is not equal to zero and may take some not negligible time interval. T_1 may have the same value as in the example described with respect to figure 4.

Reference is made to figure 7, which shows an embodiment in which the ping request messages are transmitted in downlink packets to the device from the first base station. In
25 this example, both the ping request/response procedure and the transmission of the handover command fail. The failures of transmission may occur for the same reasons as in the examples described with respect to figures 5 and 6.

A network entity, e.g. a mobility management entity that is dedicated to the source cell,
30 transmits a handover message 702 to the first base station 302. In response, the first base station 302 begins attempting to transmit ping request messages to the device. The ping request messages may be contained in IP packets.

In this example, the first base station attempts to transmit a ping request 704 to the device
35 314. However, the ping request message is not successfully received at the device 314. Therefore, the ping response message 706 is not successfully transmitted back to the first base station. The first base station then attempts to transmit a further ping request 708.

The transmission of this ping request message 708 also fails. It should be appreciated that not all of the ping request message transmissions may fail, but only some of them. It may be that only the transmission of the ping request message 708 (or the transmission of its corresponding ping response message) immediately prior to the handover command being transmitted fails.

The first base station then attempts to transmit a handover command message 710 to the device, instructing handover to the second base stations/target cell. After the first base station has attempted to transmit a handover command message 710, the first base station may continue to attempt to transmit further handover command messages to the device.

In some cases, the first base station may transmit the handover command message 710, however, the message 710 may not be successfully received at the device, for example, due to interference. In other cases, the handover command message 710 may not be successfully transmitted by the first base station. In either case, a handover command is not successfully received and decoded by the device 314.

After the attempted transmission of the handover command 710 to the device, the first base station transmits a ping request message 712 to the second base station to be forwarded to the device after handover is complete. The ping request message 712 may be sent to the second base station via the internet/IP link or any suitable communication link.

Since, the device did not successfully receive a handover command, the device is configured to attach to the other cell. The device performs any necessary procedures to attach to this cell, for example, RRC reestablishment, so that it is able to send data in the uplink to the third base station.

Since the device 314 is then configured to send and receive data with the third base station, the ping request message 712 that was received earlier by the third base station, is sent by the third base station to the device. In response to receiving the ping request 712 from the third base station, the device is configured to send a ping response 714 to the third base station. The third base station may be configured to forward this ping response 714 via the internet to the first base station. Upon receiving the ping response 714, the first base station is configured to not send any further transmissions of the handover command to the device.

In this example, T_2 is not equal to zero and may take a higher value than in the example described with respect to figure 7. T_1 may have the same value as in the example described

with respect to figure 5.

Reference is made to figure 8, which shows an embodiment in which the ping request messages are transmitted via an internet protocol communication link, and in which both the ping request messages and the handover command are successfully received by the device.

A network entity, e.g. a mobility management entity that is dedicated to the source cell, transmits a handover message 802 to the first base station 302. In response, the first base station begins transmitting ping request messages to the device. The ping request messages are sent via the internet protocol communication link. In this example, the first base station transmits a ping request 804 to the device 314. In response, the device transmits a ping response 806 to the first base station. After receiving the ping response 806, the first base station then transmits a further ping request 808. Before the device transmits a ping response back to the first base station, the first base station transmits a handover command message 810 to the device, instructing handover to the second base stations/target cell.

After the handover message 810 has been transmitted, the device performs the necessary processes to attach to the target cell. The first base station continues to transmit handover command messages to the device.

Once, the handover is complete and the device is attached to the target cell, the device transmits a handover complete message 812. This message may be received by the second base station 304 of the target cell 310, and then forwarded to the radio network controller of the target cell.

The device transmits a ping response 814 message to the second base station. In this example, the ping response 814 is in response to the ping request message 808. In other embodiments, the ping response message transmitted after handover may be transmitted in response to a ping request received after the handover command 810. The ping response message 814 is received at the second base station. The second base station may send the ping response message 814 via the IP link, or any suitable communication link, to the first base station. In response to the receipt of the ping response 814, the first base station may be configured to cease the retransmissions of the handover commands.

35

In this example, $T_2 = 0$, since the ping request message is received at the device prior to the completion of the handover. Also, since the completion of the handover occurs

after the receipt of the latest ping request 808, T_3 begins from the completion of the handover.

Reference is made to figure 9, which shows an embodiment in which the ping request
5 messages are transmitted via an internet protocol communication link. In this example, the ping request messages are successfully received by the device, but the handover command is not successfully received and decoded by the device.

A network entity, e.g. a mobility management entity that is dedicated to the source cell,
10 transmits a handover message 902 to the first base station. In response, the first base station begins transmitting ping request messages to the device. The ping request messages are sent via the internet protocol communication link. In this example, the first base station transmits a ping request 904 to the device 314. In response, the device transmits a ping response 906 to the first base station. After receiving the ping response
15 906, the first base station then transmits a further ping request 908. The first base station then attempts to transmit a handover command message 910 to the device, instructing handover to the second base stations/target cell.

After the first base station has attempted to transmit a handover command message 910,
20 the first base station may continue to attempt to transmit further handover command messages to the device.

In some cases, the first base station may transmit the handover command message 910, however, the message 910 may not be successfully received at the device, for example, due
25 to interference. In other cases, the handover command message 910 may not be successfully transmitted by the first base station. In either case, a handover command is not successfully received and decoded by the device 314.

Since, the device 314 did not successfully receive a handover command, the device is
30 configured to attach to the other cell. The device 314 performs any necessary procedures to attach to this cell, for example, RRC reestablishment, so that it is able to send data in the uplink to the third base station.

Since the device 314 is then able to send data in the uplink to the third base station 306, the
35 ping response 912 to the ping request 908 that was received earlier, is sent to the third base station. The third base station may forward this ping response via the internet to the first base station. Additionally or alternatively, the third base station may be configured to forward

this ping response via the packet data network gateway to the first base station. As explained, the ping response may be sent in an IP packet. Therefore, the third base station may forward the ping response to its destination using the IP address in the IP destination field of the IP packet in which the ping response is contained. Upon receiving the ping
5 response, the first base station is configured to not send any further transmissions of the handover command to the device.

As with the example described with respect to figure 8, T_2 is equal to zero. T_1 in figure 9 may be larger than in figure 8 due to the additional time required to connect to the third base
10 station rather than the second base station, which was selected for handover.

Reference is made to figure 10, which shows an embodiment in which the ping request messages are transmitted via an internet protocol communication link. In this example, handover command is successfully received and decoded by the device. However, the
15 transmission of the ping request message and return of the ping response message is not successful. In some cases, the failure may be due to a failure in the successful transmission of the ping request message. In another case, a ping request message may be successfully received by the device 314. However, the corresponding ping response message may not be successfully received by the first base station 302.

20

A network entity, e.g. a mobility management entity that is dedicated to the source cell, transmits a handover message 1002 to the first base station 302. In response, the first base station 302 begins attempting to transmit ping request messages to the device. The ping request messages may be contained in IP packets.

25

In this example, the first base station attempts to transmit a ping request 1004 to the device 314. However, the ping request message is not successfully received at the device 314. Therefore, the ping response message 1006 is not successfully transmitted back to the first base station. The first base station then attempts to transmit a further ping request 1008.

30

The transmission of this ping request message 1008 also fails. It should be appreciated that not all of the ping request message transmissions may fail, but only some of them. It may be that only the transmission of the ping request message 1008 (or the transmission of its corresponding ping response message) prior to the handover command being transmitted fails.

35

After the failed ping request/response 1008, the first base station transmits a handover command message 1010 to the device, instructing handover to the second base

station/target cell.

After the handover message 1010 has been transmitted, the device performs the necessary processes to attach to the target cell. The device is then capable of sending uplink data to the second base station. The first base station continues to transmit handover command messages to the device.

After the transmission of the handover command 1010 to the device, the first base station transmits a ping request message 1012 to the second base station to be forwarded to the device after handover is complete. In one embodiment, the ping request message 1012 may be sent to the second base station via the internet/IP link or any suitable communication link. Additionally or alternatively, the ping request message 1012 may be sent to the second base station via a packet data network gateway.

The device performs the necessary processes to attach to the target cell. The first base station continues to transmit handover command messages to the device.

The device is configured to transmit a handover complete message 1014 to the radio network controller of the target cell. In response, the radio network controller is configured to cause the second base station to forward the ping request message 1012 to the device. In response to receiving the ping request message 1012, the device is configured to transmit a corresponding ping response message 1016 to the second base station to be forwarded to the first base station. The second base station receives the ping response message 1016 and sends it via the IP link or any suitable communication link to the first base station. In response to receiving the ping response message, the first base station ceases the retransmissions of the handover command.

In this example, T_2 is not equal to zero and may take some not negligible time interval. T_1 may have the same value as in the example described with respect to figure 8.

30

Reference is made to figure 11, which shows an embodiment in which the ping request messages are transmitted via an internet protocol communication link. In this example, the ping request/response procedure fails and the handover command 1110 is not successfully received and decoded by the device. The failures of transmission may occur for the same reasons as in the examples described with respect to figures 9 and 10.

35

A network entity, e.g. a mobility management entity that is dedicated to the source cell,

transmits a handover message 1102 to the first base station 302. In response, the first base station 302 begins attempting to transmit ping request messages to the device. The ping request messages may be contained in IP packets.

5 In this example, the first base station attempts to transmit a ping request 1104 to the device 314. However, the ping request message is not successfully received at the device 314. Therefore, the ping response message 1106 is not successfully transmitted back to the first base station. The first base station then attempts to transmit a further ping request 1108. The transmission of this ping request message 1108 also fails. It should be appreciated that
10 not all of the ping request message transmissions may fail, but only some of them. It may be that only the transmission of the ping request message 1108 (or the transmission of its corresponding ping response message) prior to the handover command being transmitted fails.

15 The first base station then attempts to transmit a handover command message 1110 to the device, instructing handover to the second base stations/target cell. After the first base station has attempted to transmit a handover command message 1110, the first base station may continue to attempt to transmit further handover command messages to the device.

20 In some cases, the first base station may transmit the handover command message 1110, however, the message 1110 may not be successfully received at the device, for example, due to interference. In other cases, the handover command message 1110 may not be successfully transmitted by the first base station. In either case, a handover command 1110 is not successfully received and decoded by the device 314.

25 After the attempted transmission of the handover command 1110 to the device, the first base station transmits a ping request message 1112 to the second base station to be forwarded to the device after handover is complete. The ping request message 1112 may be sent to the second base station via the internet/IP link or any suitable communication link.

30 Since the device did not successfully receive a handover command, the device is configured to attach to the other cell. The device performs any necessary procedures to attach to this cell, for example, RRC reestablishment, so that it is able to send data in the uplink to the third base station.

35 Since the device 314 is then configured to send and receive data with the third base station, the ping request message 1112 that was received earlier by the third base station, is sent by

the third base station to the device. In response to receiving the ping request 1112 from the third base station, the device is configured to send a ping response 1114 to the first base station via the third base station. The third base station may be configured to forward this ping response 1114 via the internet to the first base station. Upon receiving the ping
5 response 1114, the first base station is configured to not send any further transmissions of the handover command to the device.

In this example, T_2 is not equal to zero and may take a higher value than in the example described with respect to figure 10. T_1 may have the same value as in the example
10 described with respect to figure 9.

All of the examples given with respect to figures 4 and 11 provide an effective way of reducing the number of wanted re-transmissions.

15 The examples shown in figures 4 to 7, in which the ping messages are sent in downlink data packets may reduce the amount of time required for ping request messages to reach the communication device, and hence reducing the need for careful timing.

The examples shown in figures 8 to 11, in which the ping messages are sent via an IP link/
20 the internet may provide a reduced cost method of sending ping messages.

Reference is made to figure 12, which shows an example method 1200 that may be performed at base station that is configured to transmit a handover command message to handover a device to another base station. The base station performing this method may be
25 the first base station of 302 of figure 3, and the device may be the device 314 of figure 3. The steps of the method 1200 in figure 12 are shown in the context of a handover from LTE to WCDMA. In this case, the base station is an eNB, and the transmissions of handover command occur on the MAC/RLC layers. However, it would be understood by the person skilled in the art that this is by way of example only.

30

At S1205, the base station determines whether or not a handover command is to be sent to the device. A positive determination may be reached if a message indicating that the device is to be handed over is received from another entity in the network or communication system, for example, from a mobility management entity or from the communications device
35 itself. If the base station determines that a handover command is to be sent, the method proceeds to step S1210.

At S1210, the base station sends a ping request message in a packet to the device. The ping messages are emulated into packets that are sent to the device in the downlink communication link.

5 At S1215, the base station determines whether or not the instruction to perform the handover to another cell has been sent to the device. If not, the method returns to S1205. If a handover command is still to be sent, the base station repeats step S1210 and sends a further one or more ping request messages. If the handover command has been sent to the device, the method proceeds to S1220 or S1225.

10

At S1220, the base station sends a ping request to device via the internet. This may be done by sending the ping request via the IP link to the further base station to which the handover command is instructing handover. The further base station may then forward the ping request to the device upon completion.

15

At S1225, the base station sends a ping request message in a packet to be sent to the device via the further base station to which the handover command is instructing handover. The ping requests messages may be sent to the radio network controller of the further base station, and then sent by the further base station to the device once the device has attached
20 to the further base station. The ping messages are emulated into packets, that may contain other information (e.g. RRC messaging), that are sent to the device in the downlink communication link.

At S1230, the base station determines whether or not a ping response has been received by
25 the base station from the device in response to the ping request that was transmitted in S1220 or S1225. If the ping response has not yet been received, the base station may continue to await the receipt of the response. If the ping response has been received, the method proceeds to step S1235.

30 At S1235, the base station is configured to stop the retransmissions of the handover command to the device.

Reference is made to figure 13, which shows an example method 1300 that may be performed at base station that is configured to transmit a handover command message to
35 handover a device to another base station. The base station performing this method may be the first base station of 302 of figure 3, and the device may be the device 314 of figure 3. The steps of the method 1300 in figure 13 are shown in the context of a handover from LTE

to WCDMA. In this case, the base station is an eNB, and the transmissions of handover command occur on the MAC/RLC layers. However, it would be understood by the person skilled in the art that this is by way of example only.

5 At S1305, the base station determines whether or not a handover command is to be sent to the device. A positive determination may be reached if a message indicating that the device is to be handed over is received from another entity in the network or communication system, for example, a mobility management entity or from the communications device itself. If the base station determines that a handover command is to be sent, the method proceeds
10 to step S1310.

At S1310, the base station sends a ping request to device via the internet.

At S1315, the base station determines whether or not the instruction to perform the
15 handover to another cell has been sent to the device. If not, the method returns to S1305. If a handover command is still to be sent, the base station repeats step S1310 and sends a further one or more ping request messages. If the handover command has been sent to the device, the method proceeds to S1320.

20 At S1320, the base station sends a ping request to device via the internet.

At S1325, the base station determines whether or not a ping response has been received by the base station from the device in response to the ping request that was transmitted in S1320. If the ping response has not yet been received, the base station may continue to
25 await the receipt of the response. If the ping response has been received, the method proceeds to step S1330.

At S1330, the base station is configured to stop the retransmissions of the handover command to the device.

30

Reference is made to figure 14, which shows an example method 1400 that may be performed in a device that is configured to receive a handover command from a first base station and is configured to attach to a second base station. In some embodiments, the first and second base station may correspond to the first and second base station of figure 3,
35 respectively.

At S1405, the device is configured to determine whether or not the handover command has

been received from the first base station. If so, the method proceeds to S1425. If not, the method may proceed to S1410.

At S1410, the device is configured to receive a ping request message from a first base station. This ping request message may be emulated in a DL packet or may be sent via the IP link.

At S1415, the device is configured to determine whether or not the handover command has been received from the first base station.

10

At S1420, device transmits a ping response message to the first base station.

At S1425, after the device has received the handover command from the first base station, the device is configured to attach to the second base station. Once, it has completed this process the device transmits a handover complete message to the second base station.

15

In some embodiments, the second base station may be a base station to which the device is configured to attach if no handover command message is successfully received. The device may be configured to attach to the second base station if no handover message is successfully received by the second base station.

20

At S1430, the device determines whether or not a ping request has been received from the first base station that must be answered. This ping request may have been received at S1410 or S1420. If a ping request is pending, the method proceeds to S1435 at which a ping response is sent to the first base station via the second base station. The device may send the ping response to the second base station which may forward the ping response via the IP link or any suitable communication link to the first base station.

25

At S1440, if there is no ping request pending, the device receives a ping request message from the first base station that has been forwarded via the second base station. At S1445, the device then sends the ping response message to the second base station from which it is sent to the first base station.

30

By using the ping request/response mechanism to stop retransmission of the handover command, some embodiments may reduce the number of retransmissions. For example, the maximum number of retransmissions of the handover command may be set to 16 or any suitable number, and the time between retransmission may be set to 100ms or any suitable

35

time period. However, halting the retransmission of the handover command when the ping response is received, may cause the number of retransmissions to be only 3 or 4.

Specifically, in the examples illustrated with respect to figures 4, 6, 8, and 10 (in which the communication device attaches to the cell to which the handover was instructed by the first

5 base station), the number of unwanted retransmissions that are performed may be estimated to be 3. In the examples illustrated with respect to figures 5, 7, 9, and 11 (in which the communication device attaches to a cell to which handover was not instructed by the first base station) may be estimated to be 4. In some cases, there may be variation from these values (which are based on best case scenario). For example, when radio link failures

10 causes the communication device to establish a new RRC connection, the time interval to attach to a new cell may be longer and the number of unwanted retransmission may consequently be larger than 3 or 4.

An explanation will now be given of how the estimates of the number of unwanted

15 retransmissions may be arrived at. As explained in some cases, the limit on the number of retransmissions may be set of 16, and the time between transmissions may be set to 100ms. Therefore, the maximum amount of time that be used for sending retransmissions may be 1.6s.

20 The percentage reduction in the number of retransmissions in each scenario may be given by:

$$100 * (\text{Limit on the number of retransmissions} - \text{number of unwanted retransmissions performed in the scenario}) / \text{Limit on the number of transmissions}$$

25

In the examples, described with respect to figures 4, 6, 8, and 10, the expected time interval between the handover command and the time until the communication device can receive a ping request in the downlink from the third base station may be 160ms. Additional time will also be required to send the ping response to the first base station, and for the first base

30 station to use this response to stop the retransmissions. This time may be estimated at approximately 120ms, which results in a total time from the handover command being sent to the stopping of the retransmissions of 280 ms (160ms + 120ms). Since, the time period between retransmission is 100ms, this may result in a reduction in the number of unwanted retransmissions from 16 to 3 and thus achieve a percentage reduction in the number of

35 retransmissions of 81%.

In the examples describes with respect to figures 5, 7, 9, and 11, the time interval between

the handover command being sent and the time at which the communication device can send the ping response in the uplink to the second base station may be 260ms. Additional time will also be required to receive the ping request from the first base station, send the ping response to the first base station, and for the first base station to use this response to stop the retransmissions. This time may be estimated at approximately 140ms, which results in a total time from the handover command being sent to the stopping of the retransmissions of 400 ms (260ms + 140ms). Since, the time period between retransmission is 100ms, this may result in a reduction in the number of unwanted retransmissions from 16 to 4 and thus achieve a percentage reduction in the number of retransmissions of 75%.

10

Hence, there is a reduction in the number of retransmissions of the handover command.

Table 1 below provides examples in the context of LTE-3G of the origin of the handover interruption time.

15

	Category	Cause	Assumed time [ms]	
			2G/3G->LTE	LTE->2G/3G
(a)	Radio Low Layer process	-Radio switch over -Synchronizing at target RAT -L1/L2 process for L3 signaling	60	
(b)	UL RRC signaling	-RRC Transmission time and delay -RRC processing time	5	100
(c)	DL RRC signaling	-RRC Transmission time and delay -RRC processing time	5	100
(d)	Path switch process	-Message transmission time and delay -Path switch processing time -Packet transmission time and delay	14	

TABLE 1

Figure 16 provides an example message sequence diagram according to some embodiments of the handover process. This figure illustrates some of the processes carried out, and some of the messages sent, during the user plane transient period.

20

It is noted that whilst embodiments have been described in relation to examples of LTE or WCDMA networks, similar principles maybe applied in relation to other examples of standalone 3G, LTE or 5G networks. It should be noted that other embodiments may be based on other cellular technology other than LTE or WCDMA or on variants of LTE or WCDMA. Therefore, although certain embodiments were described above by way of example with reference to certain example architectures for wireless networks, technologies and standards, embodiments may be applied to any other suitable forms of communication systems than those illustrated and described herein.

25

30

It is also noted herein that while the above describes example embodiments, there are several variations and modifications which may be made to the disclosed solution without departing from the scope of the present invention.

5

The method may additionally be implemented in a control apparatus as shown in Figure 15. The method may be implemented in a single processor 201 or control apparatus or across more than one processor or control apparatus. Figure 15 shows an example of a control apparatus 1500 for a communication system, for example to be coupled to and/or for
10 controlling a station of an access system, such as a RAN node, e.g. a base station, (e) node B. In some embodiments, base stations comprise a separate control apparatus unit or module. In some embodiments, each base station may have such a control apparatus as well as a control apparatus being provided in a radio network controller. The control apparatus 1500 can be arranged to provide control on communications in the service area of
15 the system. The control apparatus 1500 comprises at least one memory 1510, at least one data processing unit 1520, 1530 and an input/output interface 1540. Via the interface the control apparatus can be coupled to a receiver and a transmitter of the base station. The receiver and/or the transmitter may be implemented as a radio front end or a remote radio head. For example, the control apparatus 1500 or processor 201 can be configured to
20 execute an appropriate software code to provide the control functions.

Control functions may comprise transmitting from a first base station to a communications device at least one reachability request message and a command to handover the communications device to a second base station; receiving, a reachability response message
25 in response to the at least one reachability request message; and using said reachability response message to stop retransmission of said command to handover the communications device.

Alternatively, or in addition, control functions may comprise receiving at a communications
30 device from a first base station at least one reachability request message; attaching to a further base station; and subsequent to attaching to the further base station, transmitting to the further base station, a reachability response message in response to the at least one reachability request message, the reachability response message configured to be forwarded to the first base station.

35

Alternatively, or in addition, control functions may comprise connecting with a communications device during handover of the communications device from a first base station; receiving from

the communications device, a reachability response message in response to at least one reachability request message received at the communications device; and sending the reachability response message to the first base station.

- 5 Although the apparatuses have been described as one entity, different modules and memory may be implemented in one or more physical or logical entities.

In general, the various embodiments may be implemented in hardware or special purpose circuits, software, logic or any combination thereof. Some aspects of the invention may be implemented in hardware, while other aspects may be implemented in firmware or software which may be executed by a controller, microprocessor or other computing device, although the invention is not limited thereto. While various aspects of the invention may be illustrated and described as block diagrams, flow charts, or using some other pictorial representation, it is well understood that these blocks, apparatus, systems, techniques or methods described herein may be implemented in, as non-limiting examples, hardware, software, firmware, special purpose circuits or logic, general purpose hardware or controller or other computing devices, or some combination thereof.

The embodiments of this invention may be implemented by computer software executable by a data processor of the mobile device, such as in the processor entity, or by hardware, or by a combination of software and hardware. Computer software or program, also called program product, including software routines, applets and/or macros, may be stored in any apparatus-readable data storage medium and they comprise program instructions to perform particular tasks. A computer program product may comprise one or more computer-executable components which, when the program is run, are configured to carry out embodiments. The one or more computer-executable components may be at least one software code or portions of it.

Further in this regard it should be noted that any blocks of the logic flow as in the Figures may represent program steps, or interconnected logic circuits, blocks and functions, or a combination of program steps and logic circuits, blocks and functions. The software may be stored on such physical media as memory chips, or memory blocks implemented within the processor, magnetic media such as hard disk or floppy disks, and optical media such as for example DVD and the data variants thereof, CD. The physical media is a non-transitory media.

35

The memory may be of any type suitable to the local technical environment and may be implemented using any suitable data storage technology, such as semiconductor based

memory devices, magnetic memory devices and systems, optical memory devices and systems, fixed memory and removable memory. The data processors may be of any type suitable to the local technical environment, and may comprise one or more of general purpose computers, special purpose computers, microprocessors, digital signal processors (DSPs),
5 application specific integrated circuits (ASIC), FPGA, gate level circuits and processors based on multi core processor architecture, as non-limiting examples.

Embodiments of the inventions may be practiced in various components such as integrated circuit modules. The design of integrated circuits is by and large a highly automated process.
10 Complex and powerful software tools are available for converting a logic level design into a semiconductor circuit design ready to be etched and formed on a semiconductor substrate.

The foregoing description has provided by way of non-limiting examples a full and informative description of the exemplary embodiment of this invention. However, various modifications and adaptations may become apparent to those skilled in the relevant arts in view of the
15 foregoing description, when read in conjunction with the accompanying drawings and the appended claims. However, all such and similar modifications of the teachings of this invention will still fall within the scope of this invention as defined in the appended claims. Indeed there is a further embodiment comprising a combination of one or more embodiments
20 with any of the other embodiments previously discussed.

Claims

1. A method comprising:
transmitting from a first base station to a communications device at least one
5 reachability request message and a command to handover the communications device to a
second base station;
receiving, a reachability response message in response to the at least one reachability
request message; and
using said reachability response message to stop retransmission of said command to
10 handover the communications device.
2. A method as claimed in claim 1, further comprising receiving the reachability response
message from a further base station.
- 15 3. A method as claimed in claim 1 or 2, wherein the further base station is the second
base station.
4. A method as claimed in claim 1 or 2, wherein the further base station is different to the
second base station if the command to handover the communications device is not
20 successfully received by the communications device.
5. A method as claimed in any preceding claim, wherein the least one of the at least one
reachability request message is sent prior to the command to handover the communications
device.
25
6. A method as claimed in any preceding claims, wherein at least one of the at least one
reachability request message is sent after the command to handover the communications
device.
- 30 7. A method as claimed in any preceding claims, wherein the at least one reachability
request message is one of a plurality of reachability request messages sent after the command
to handover the communications device.
8. A method as claimed in any of claims 1 to 5, wherein the at least one reachability
35 request message comprises the last of a plurality of reachability request messages sent to the
communications device prior to the command to handover the communications device.

9. A method as claimed in any preceding claim, comprising sending at least one of the at least one reachability request messages to the communications device via the further base station.

5

10. A method as claimed in any preceding claim, further comprising transmitting at least one reachability request message prior to sending the command to handover the communications device and at least one reachability request message after sending the command to handover the communications device.

10

11. A method as claimed in any preceding claim, further comprising:
transmitting at least one set of one or more reachability request messages,
in response to receiving at least one reachability response message to at least one reachability request message of a respective set of one or more reachability request
15 messages, stopping the transmission of further reachability request messages of the respective set.

15

12. A method as claimed in any preceding claim, further comprising transmitting a command to handover the communications device to a second base station in response to receipt of a
20 handover instruction from a network entity.

20

13. A method as claimed in any of claims 1 to 11, further comprising transmitting a command to handover the communications device to a second base station in response to receipt of a handover instruction from the communications device.

25

14. A method as claimed in claims 12 or 13 when dependent upon claim 6, wherein at least one of the reachability request messages is sent after the command to handover the communications device only if a failed transmission of at least one reachability request message occurred after receipt of the handover instruction and prior to sending the command
30 to handover the communications device.

30

15. A method as claimed in any preceding claim, wherein the at least one reachability request message is sent in at least one internet protocol packet.

35

16. A method as claimed in claim 15, wherein the at least one internet protocol packet comprises user data.

17. A method as claimed in any preceding claim, wherein the first base station is configured to communicate with the communications device according to a first protocol, and the second base station is configured to communicate with the communications device according to a second protocol different to the first protocol.
18. A method comprising:
receiving at a communications device from a first base station at least one reachability request message;
attaching to a further base station; and
subsequent to attaching to the further base station, transmitting to the further base station, a reachability response message in response to the at least one reachability request message, the reachability response message configured to be forwarded to the first base station.
19. A method as claimed in claim 18, further comprising attaching to the further base station in response to receipt from the first base station of a command to handover to the further base station.
20. A method as claimed in claim 18, further comprising attaching to the further base station in response to a failed transmission from the first base station of a command to handover to a second base station.
21. A method comprising:
connecting with a communications device during handover of the communications device from a first base station;
receiving from the communications device, a reachability response message in response to at least one reachability request message received at the communications device; and
sending the reachability response message to the first base station.
22. A method of claim 21, further comprising:
receiving the at least one reachability request message from a first base station; and
upon completion of the handover, transmitting the at least one reachability request message to the communications device.

23. An apparatus comprising at least one processor and at least one memory including computer code for one or more programs, the at least one memory and the computer code configured, with the at least one processor, to cause the apparatus at least to:

5 transmit from a first base station to a communications device at least one reachability request message and a command to handover the communications device to a second base station;

receive, a reachability response message in response to the at least one reachability request message; and

10 use said reachability response message to stop retransmission of said command to handover the communications device.

24. An apparatus comprising at least one processor and at least one memory including computer code for one or more programs, the at least one memory and the computer code configured, with the at least one processor, to cause the apparatus at least to:

15 receive at the communications device from a first base station at least one reachability request message;

attach to a further base station; and

20 subsequent to attaching to the further base station, transmit to the further base station, a reachability response message in response to the at least one reachability request message, the reachability response message configured to be forwarded to the first base station.

25. An apparatus comprising at least one processor and at least one memory including computer code for one or more programs, the at least one memory and the computer code configured, with the at least one processor, to cause the apparatus at least to:

25 connect with a communications device during handover of the communications device from a first base station;

receive from the communications device, a reachability response message in response to at least one reachability request message received at the communications device; and

30 send the reachability response message to the first base station.

26. A computer program comprising computer code that, when executed on at least one processor, causes the method of any of claims 1 to 22 to be performed.

35 27. A computer readable medium having stored thereon instructions that cause a processor to execute a method of any of claims 1 to 22.

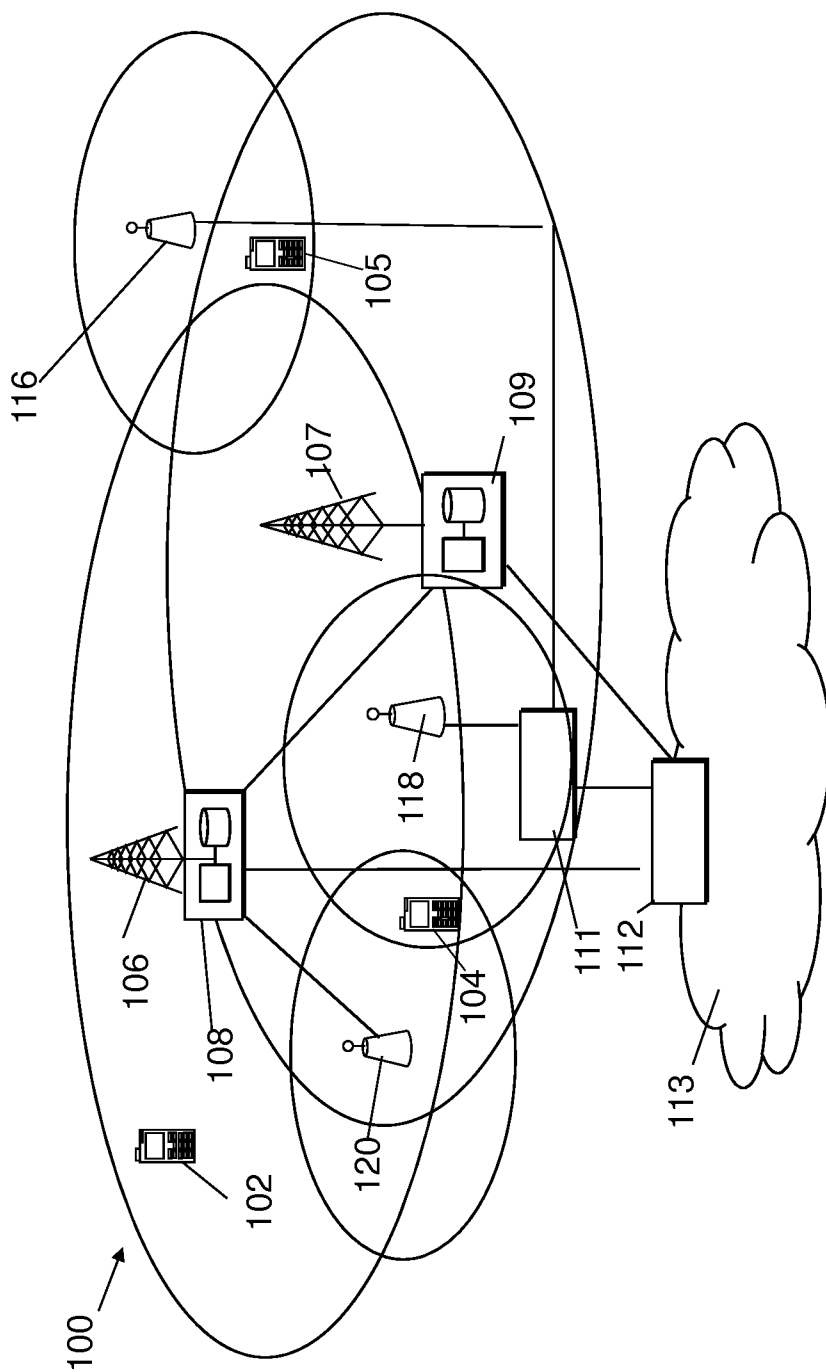


Figure 1

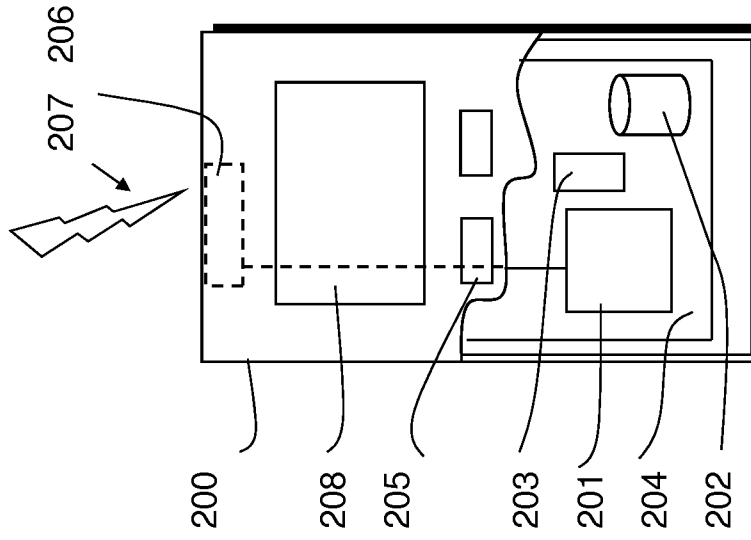


Figure 2

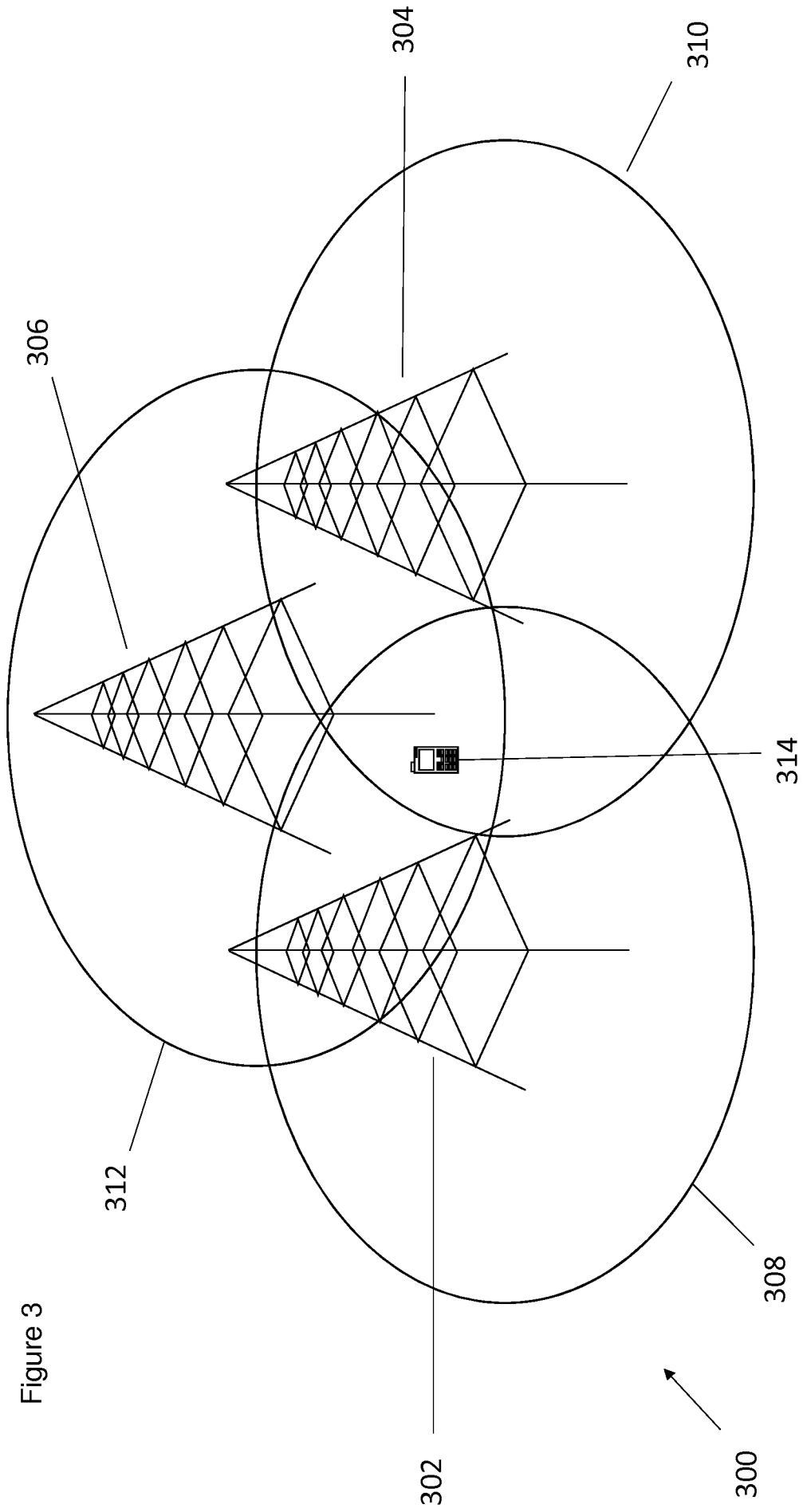


Figure 3

Figure 4

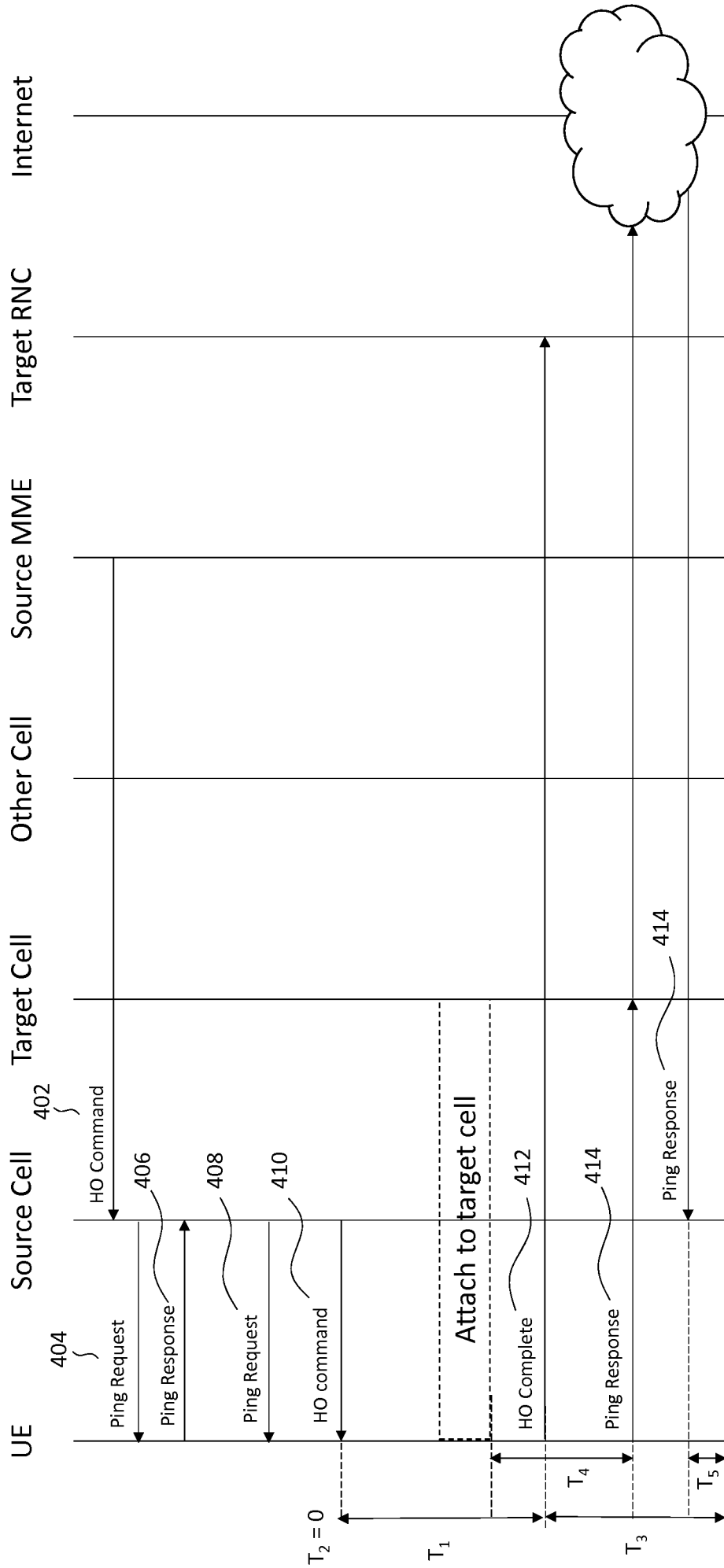


Figure 5

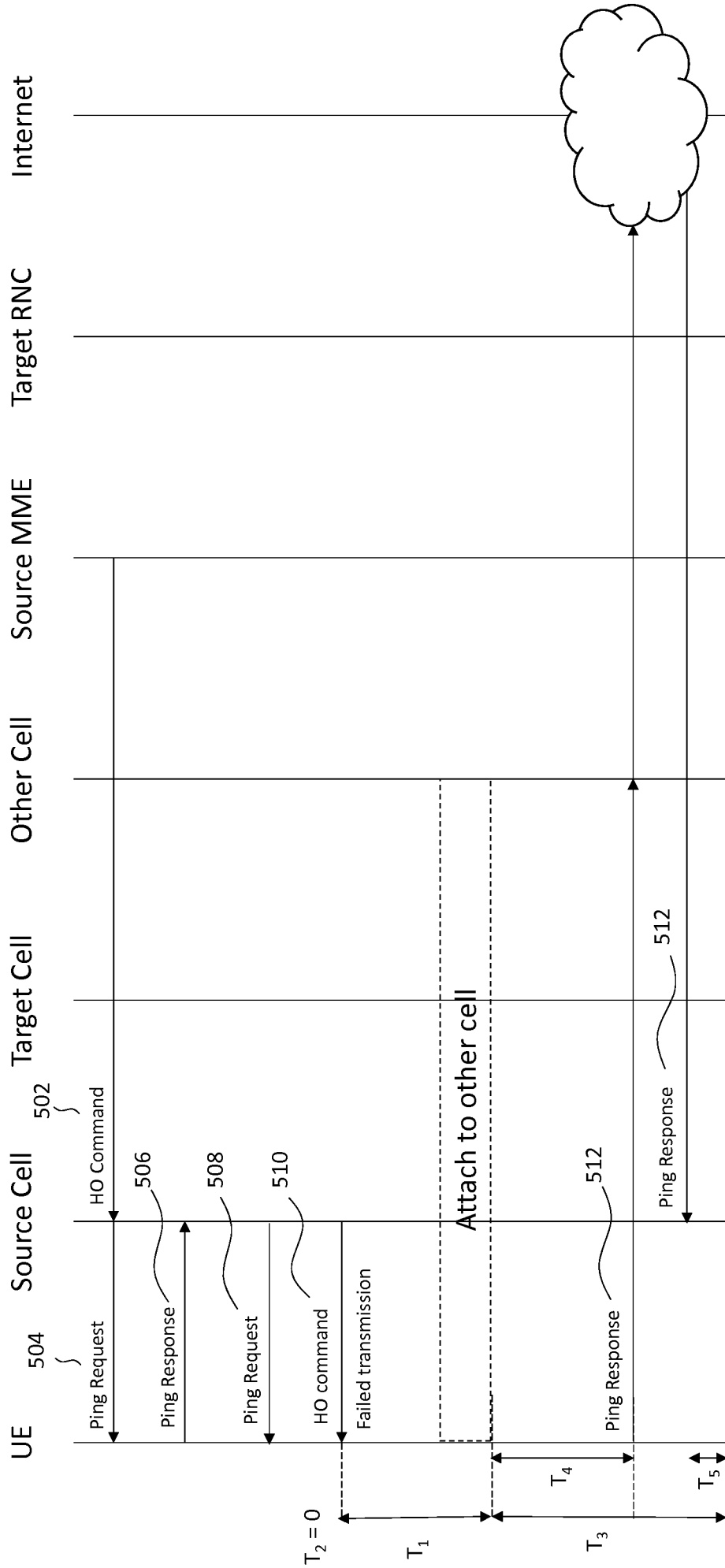


Figure 6

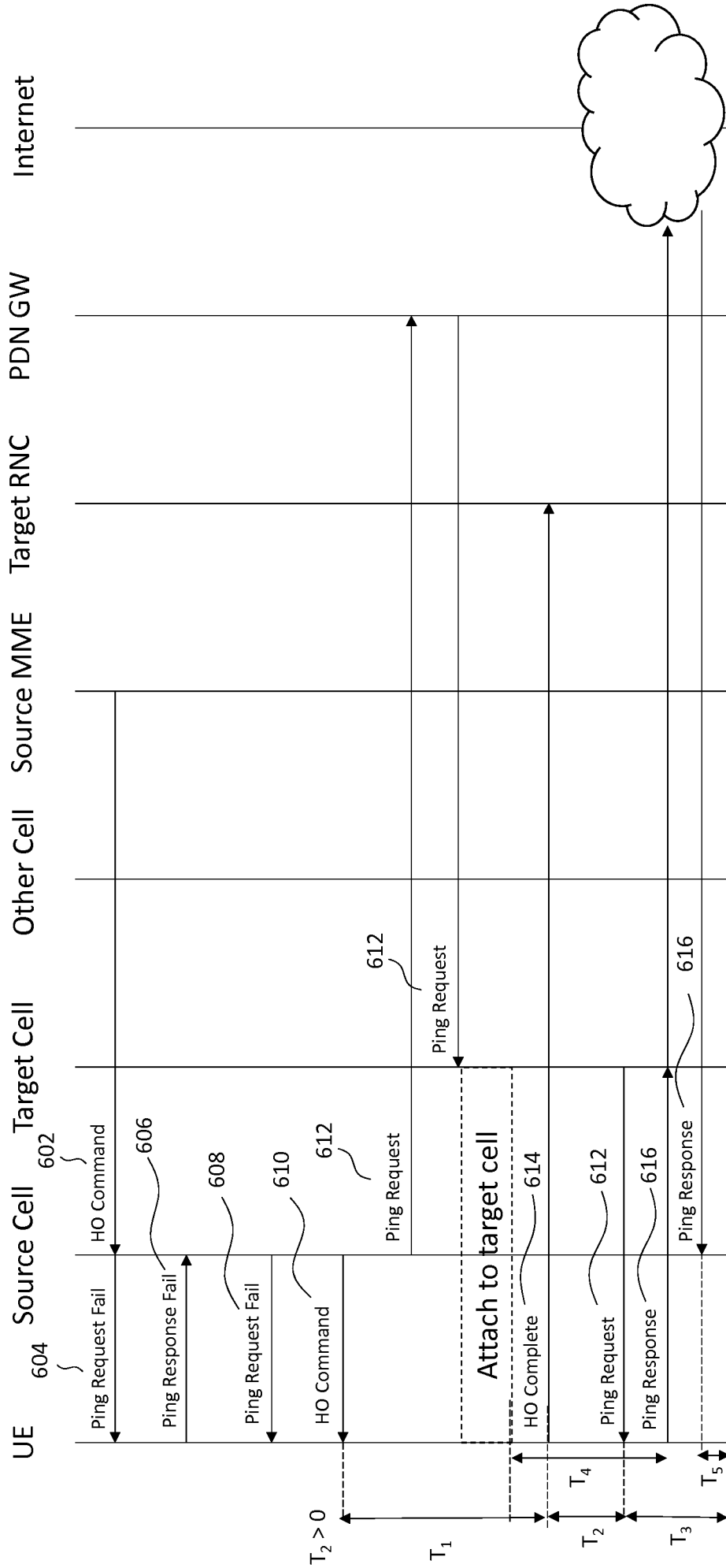


Figure 7

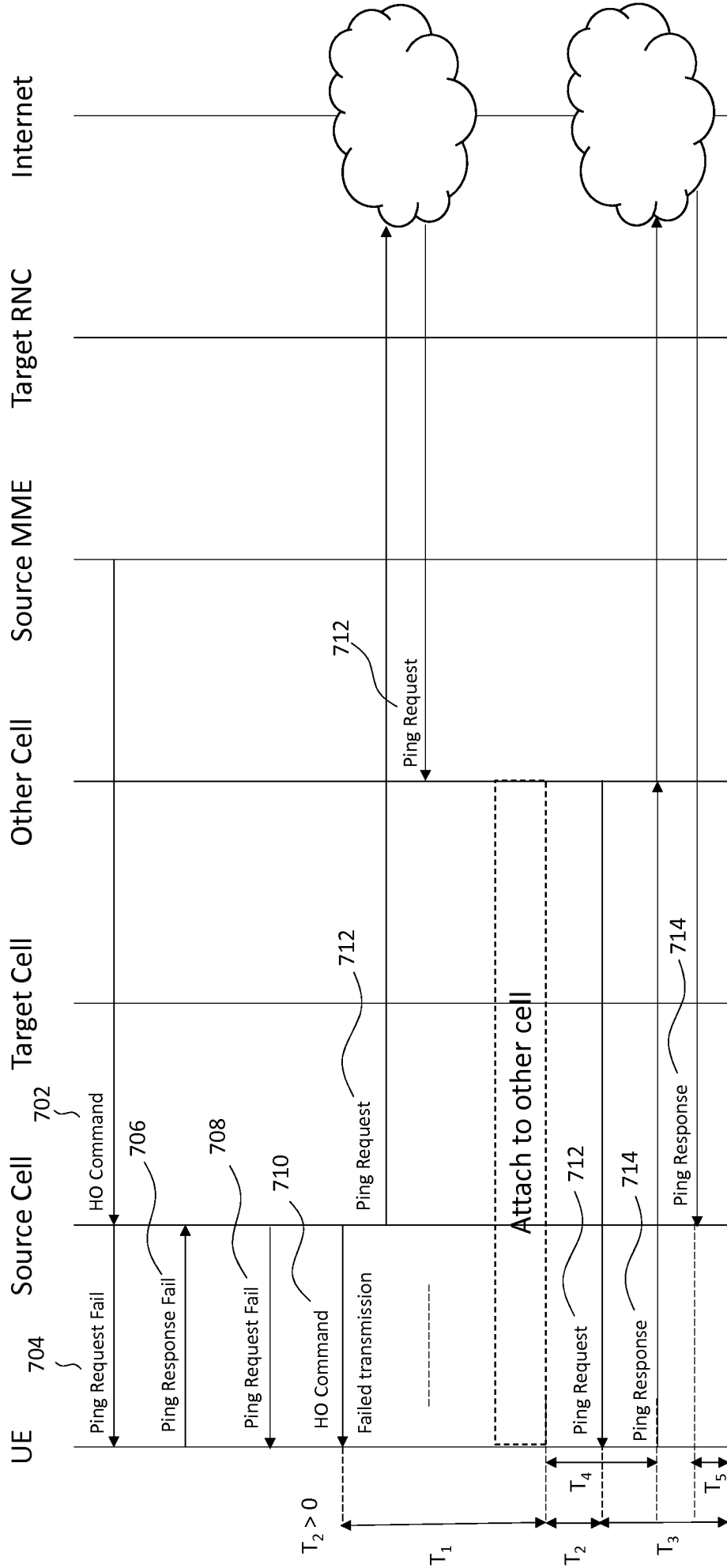


Figure 8

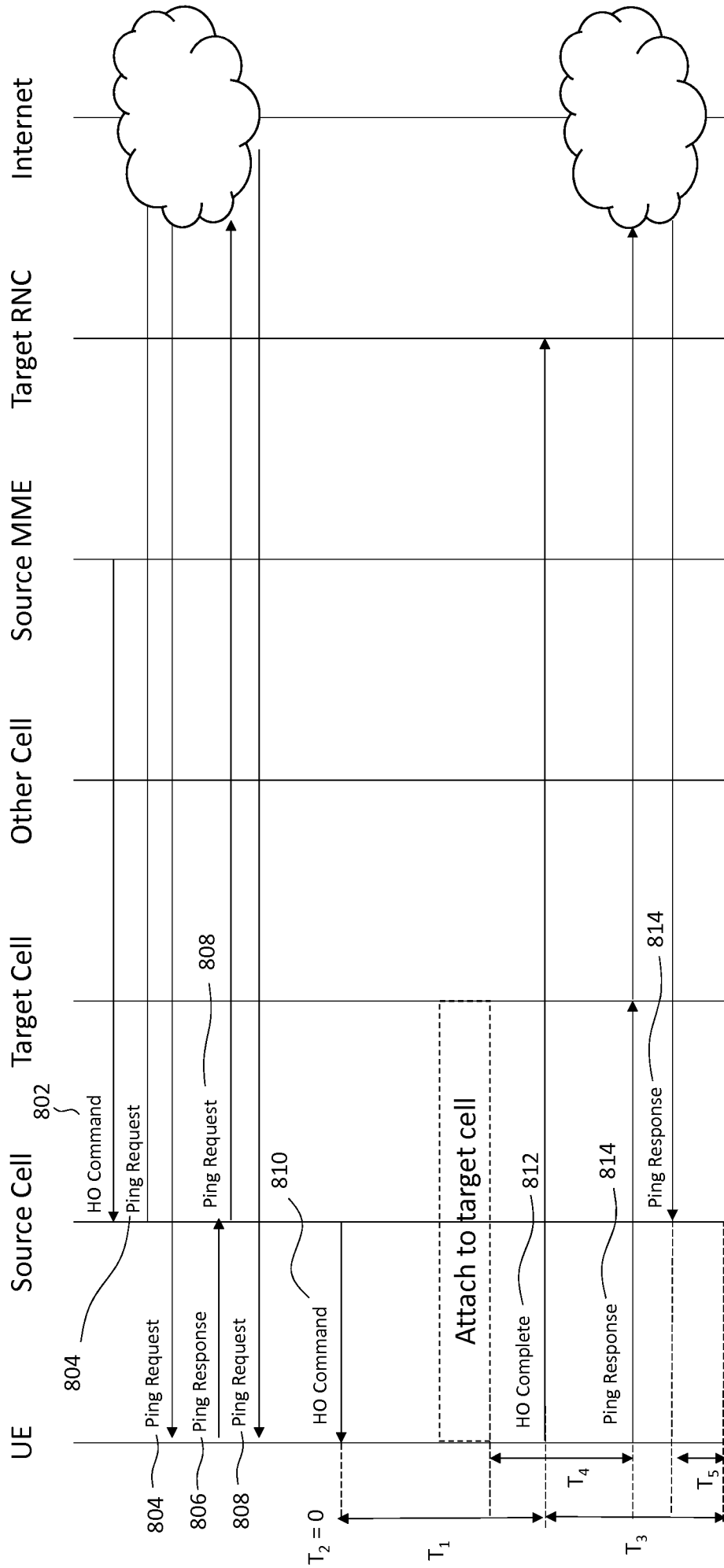


Figure 9

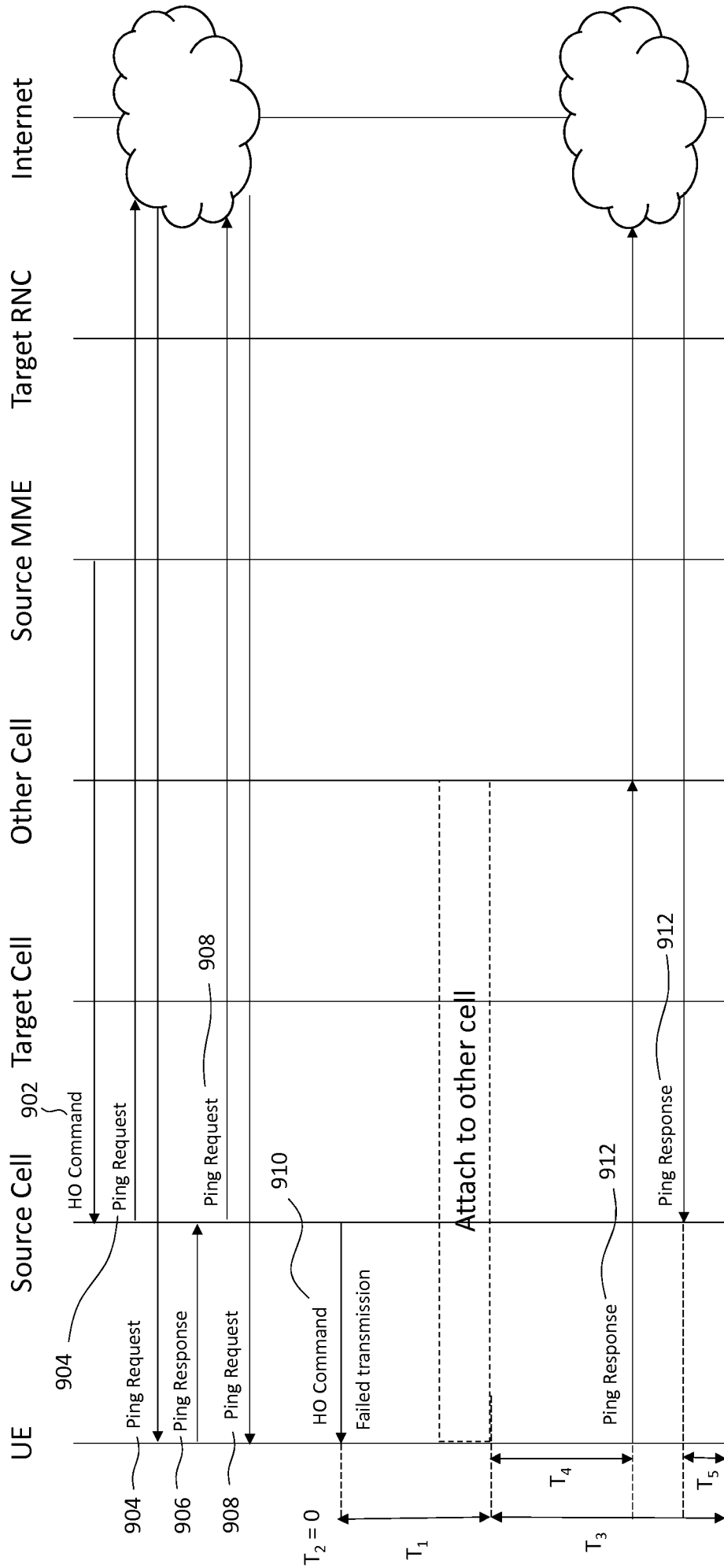


Figure 10

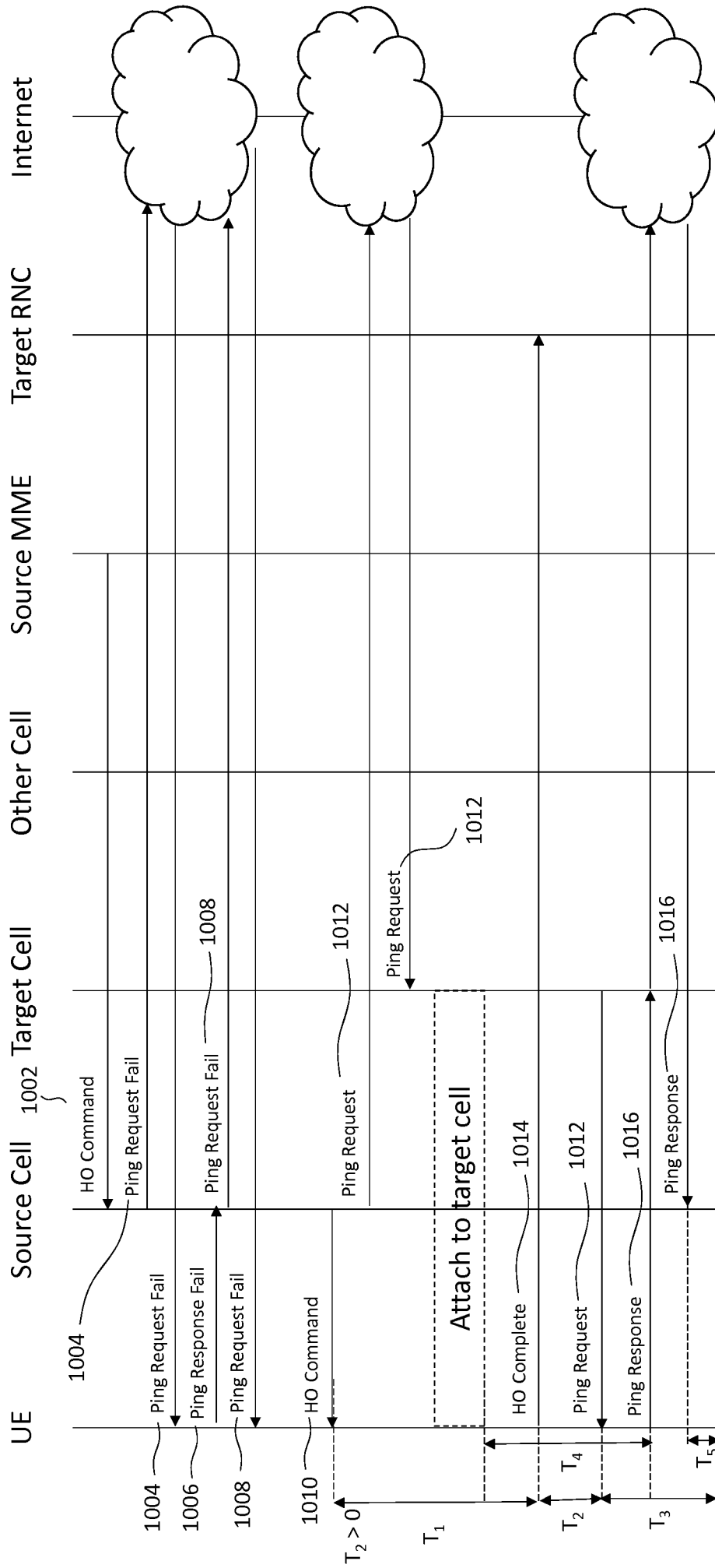
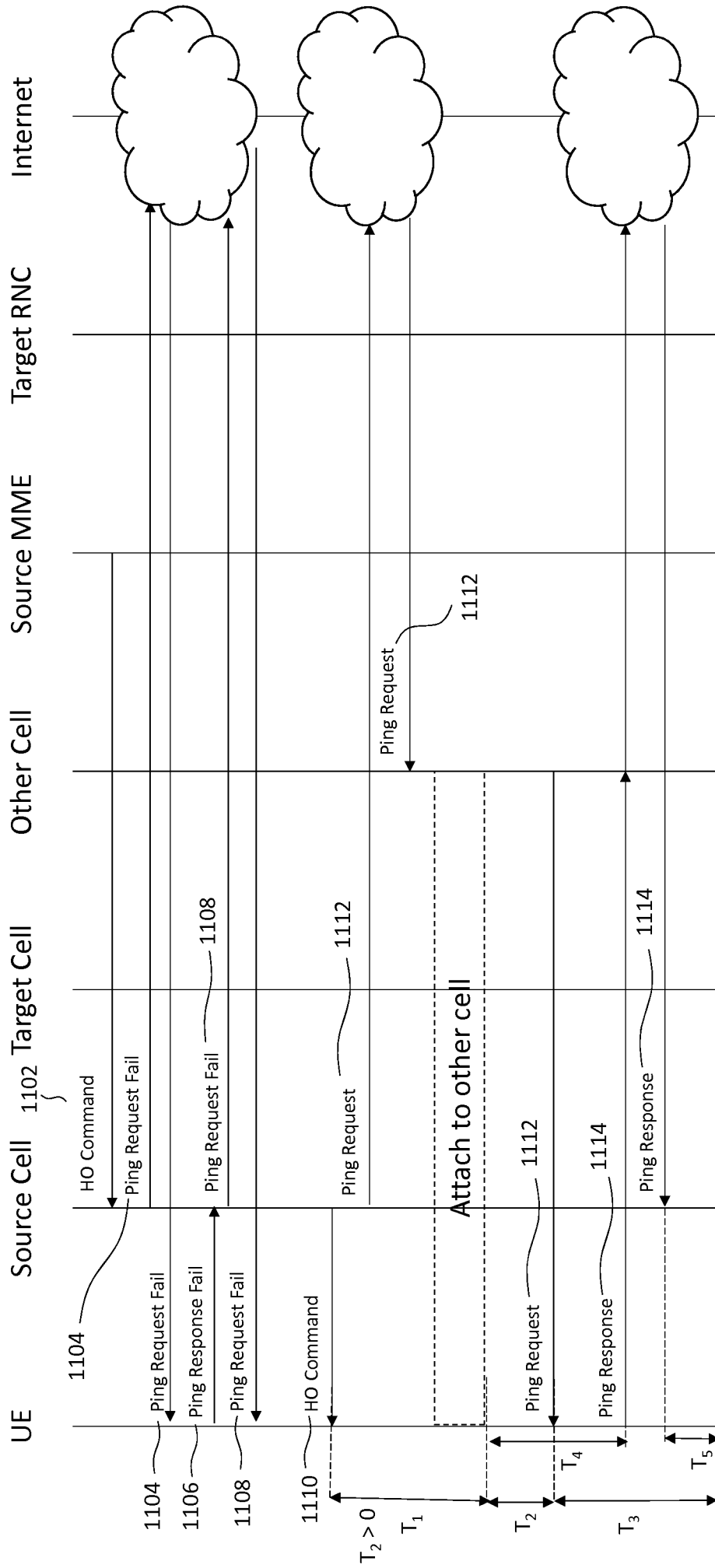


Figure 11



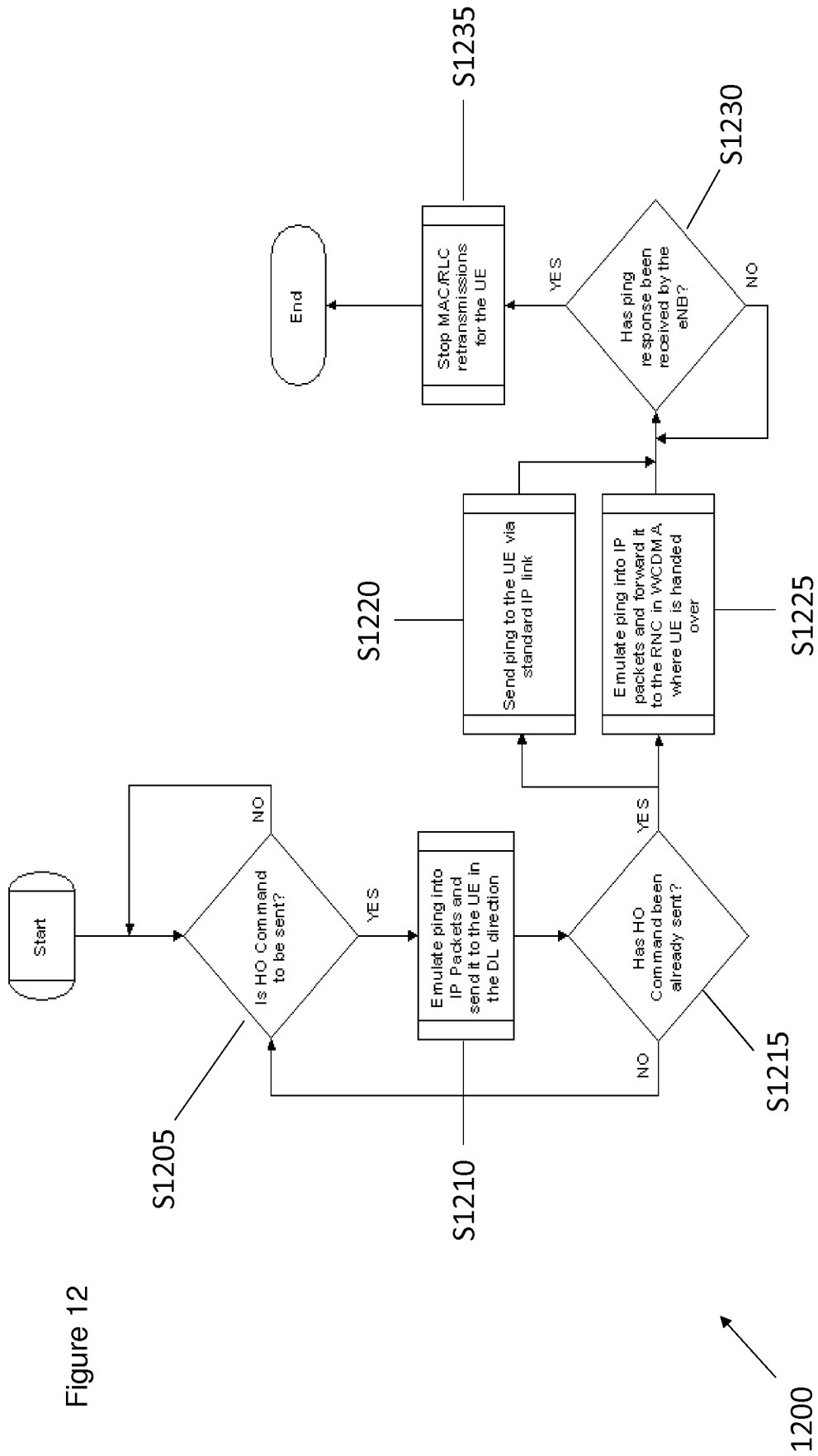


Figure 12

1200

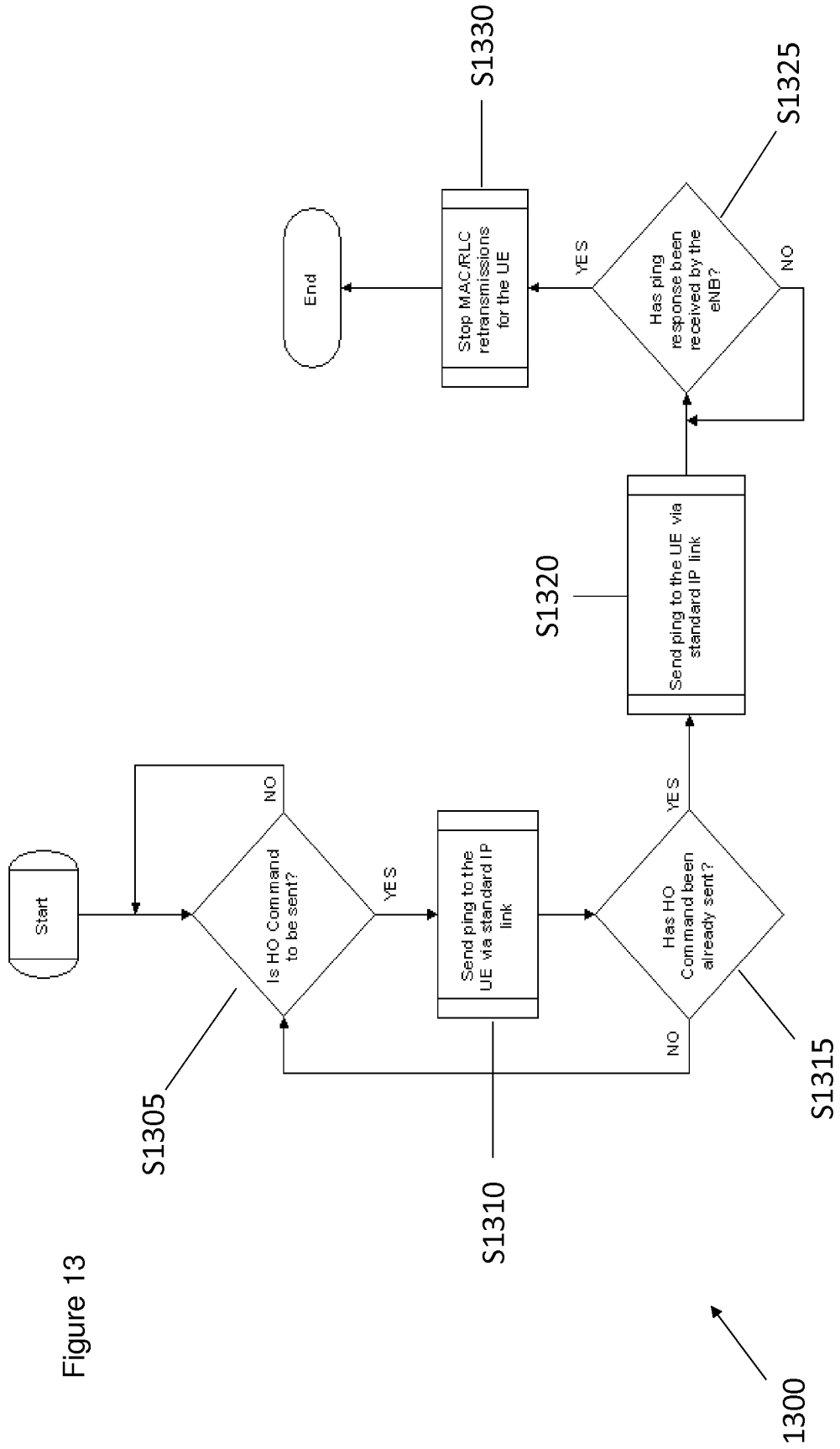


Figure 13

1300

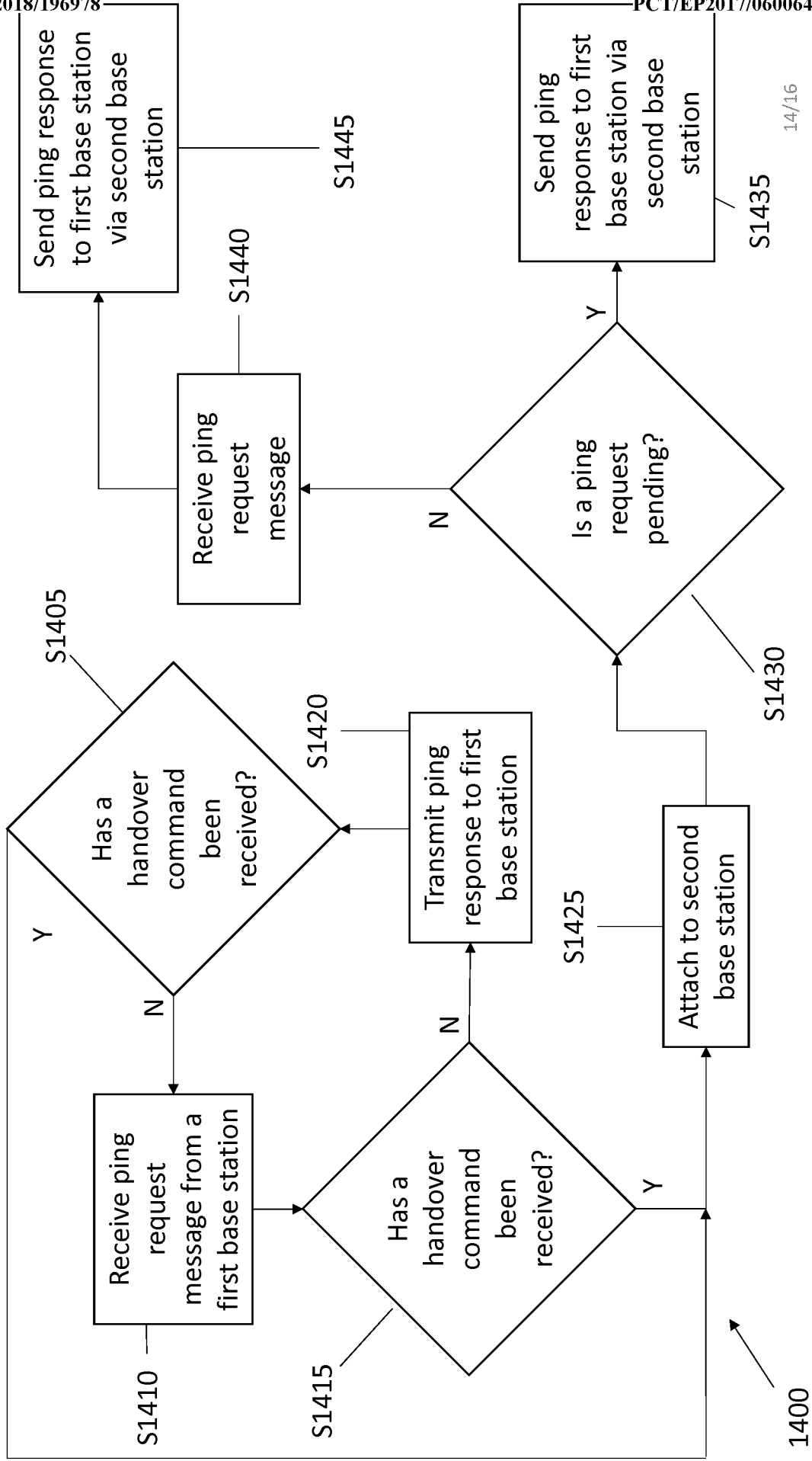


Figure 14

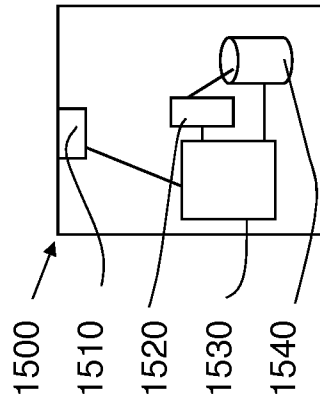


Figure 15

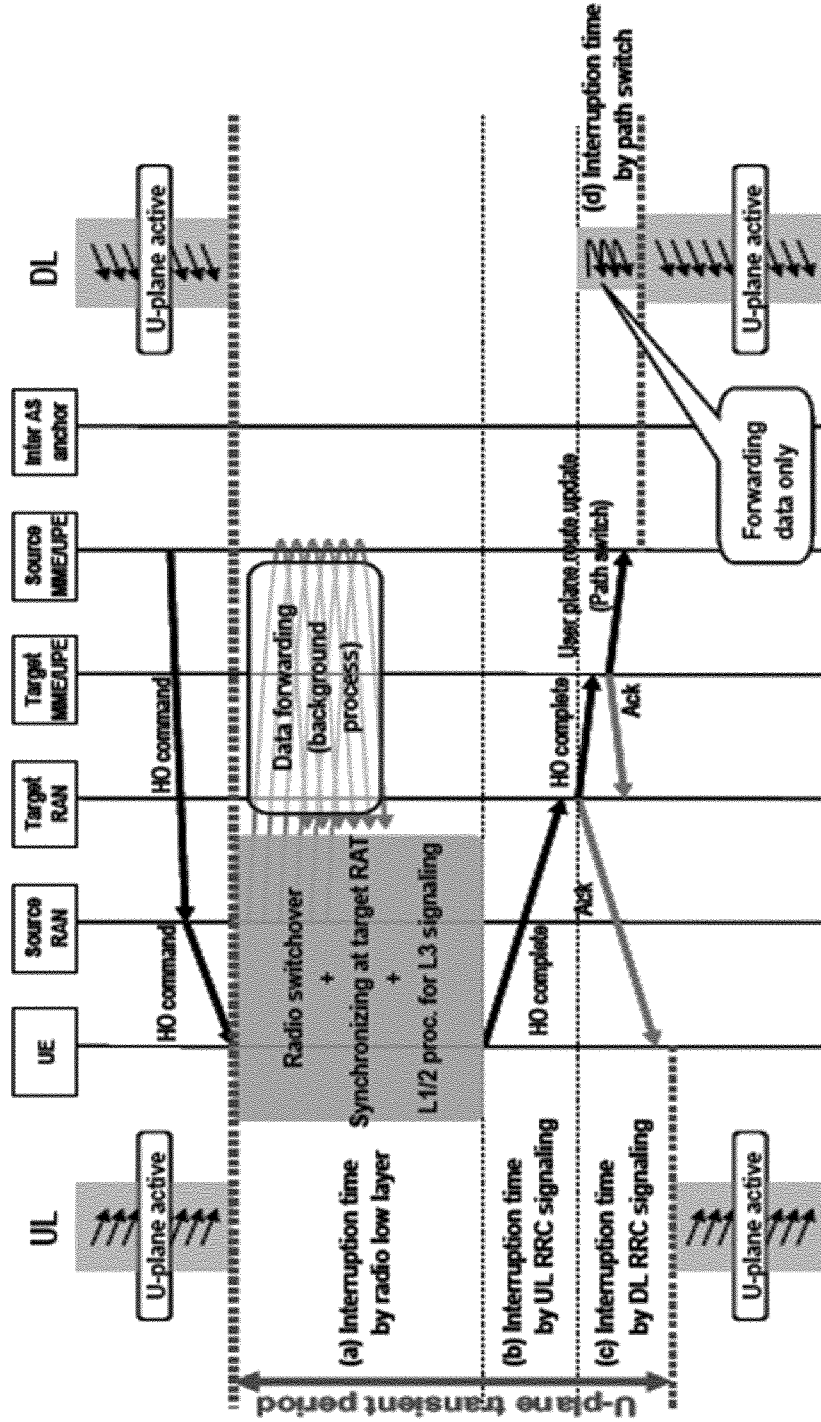


Figure 16

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2017/060064

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04W36/00
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)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2014/341189 A1 (YANG DONGLI [CN]) 20 November 2014 (2014-11-20)	1,5-8, 10,11, 23,26,27
Y	paragraph [0004] paragraphs [0035], [0036], [0037], [0038], [0039] paragraphs [0040], [0041] paragraph [0054] paragraphs [0071], [0074] - [0079] paragraph [0080] -----	2-4,9, 12-17
Y	US 2008/019320 A1 (PHAN VINH VAN [FI] ET AL) 24 January 2008 (2008-01-24) paragraph [0095] paragraph [0101] ----- -/--	2,3,9, 12,13

Further documents are listed in the continuation of Box C.

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
- "E" earlier application or patent but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "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 7 November 2017	Date of mailing of the international search report 15/11/2017
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer Mele, Marco

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2017/060064

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2014/016617 A1 (FROEBERG OLSSON JONAS [SE] ET AL) 16 January 2014 (2014-01-16) paragraph [0059] -----	4,14
Y	US 2016/286449 A1 (CHOI HYEYOUNG [KR] ET AL) 29 September 2016 (2016-09-29) paragraphs [0080], [0087] -----	15-17
Y	US 2014/057566 A1 (WATFA MAHMOUD [CA] ET AL) 27 February 2014 (2014-02-27) paragraph [0086] paragraphs [0095] - [0099] paragraph [0100] paragraphs [0142], [0145] paragraph [0170] -----	18-22, 24,25
Y	NOKIA ALCATEL-LUCENT SHANGHAI BELL: "TS 23.502: UE reachability for SMS", 3GPP DRAFT; S2-172339 WAS 2110 SMS 23.502 AMF ALERT-REV, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE , vol. SA WG2, no. Busan, S. Korea; 20170327 - 20170331 3 April 2017 (2017-04-03), XP051257906, Retrieved from the Internet: URL: http://www.3gpp.org/ftp/tsg_sa/WG2_Arch/TSGS2_120_Busan/Docs/ [retrieved on 2017-04-03] Fig. 4.2.5.2-1 -----	18-22, 24,25

INTERNATIONAL SEARCH REPORT

International application No.
PCT/EP2017/060064

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-17, 23(completely); 26, 27(partially)

Claims 1-7, 23, (part of) 26, 27 relate to the problem of how to stop retransmission of handover command to a communications device.

2. claims: 18-22, 24, 25(completely); 26, 27(partially)

Claims 18-22, 24, 25, (part of) 26, 27 relate to the problem of providing a first base station with a reachability response message from a communications device in response to a reachability request message from the first base station subsequent to attaching the communications device to a second base station.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2017/060064

Patent document cited in search report	Publication date	Patent family member(s)	Publication date	
US 2014341189	A1	20-11-2014	CN 102742207 A	17-10-2012
			EP 2802172 A2	12-11-2014
			US 2014341189 A1	20-11-2014
			WO 2012092898 A2	12-07-2012

US 2008019320	A1	24-01-2008	US 2008019320 A1	24-01-2008
			WO 2008010063 A2	24-01-2008

US 2014016617	A1	16-01-2014	CN 103460752 A	18-12-2013
			EP 2695426 A1	12-02-2014
			US 2014016617 A1	16-01-2014
			WO 2012138268 A1	11-10-2012

US 2016286449	A1	29-09-2016	CN 105210416 A	30-12-2015
			EP 2978261 A1	27-01-2016
			JP 2016524826 A	18-08-2016
			KR 20150143428 A	23-12-2015
			US 2016286449 A1	29-09-2016
			WO 2014148874 A1	25-09-2014

US 2014057566	A1	27-02-2014	TW 201433194 A	16-08-2014
			US 2014057566 A1	27-02-2014
			WO 2014031713 A1	27-02-2014
