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(71) Applicant: TELEFONAKTIEBOLAGET LM ERICSSON (PUBL) [SE/SE]; 164 83 Stockholm (SE).

(72) Inventors: **OLSSON, Lars-Bertil**; Fjällviolen 8 lgh 1301, 424 48 Angered (SE). **BRÄNNLUND, Tomas**; Anunds väg 17, 193 40 Sigtuna (SE). **NILSSON, Jonas**; Södra Cloettavägen 97, 590 74 Ljungsbro (SE). **NORDSTRÖM, Björn**; Förrådsgatan 12, 169 39 Solna (SE).

(74) Agent: **VEJGAARD, Christian**; ERICSSON, Patent Development, Torshamnsgatan 21-23, 164 80 STOCKHOLM (SE).

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(54) Title: MOBILITY NODE SELECTION

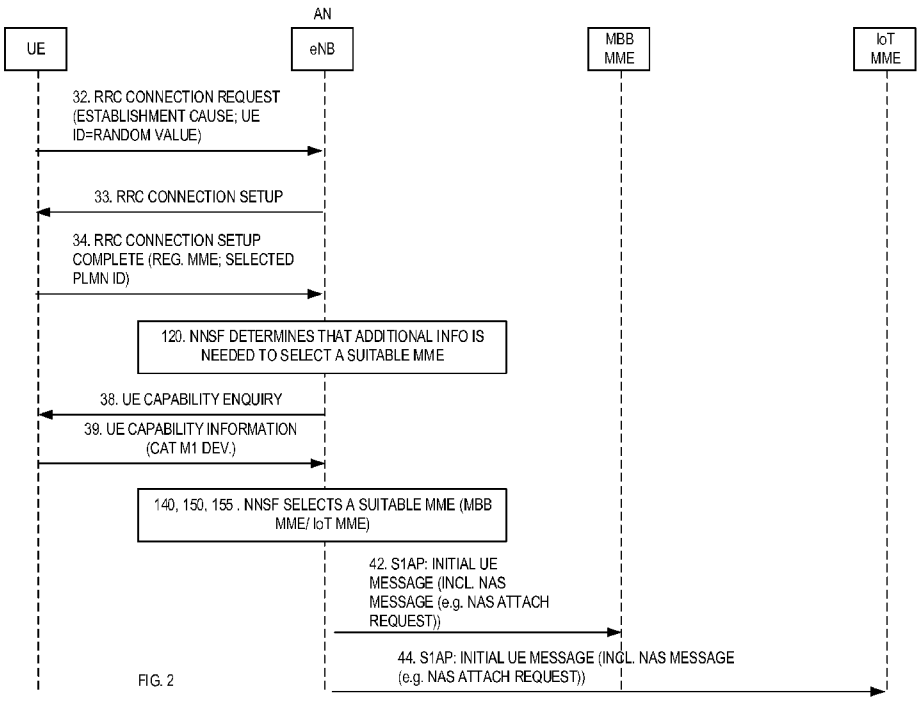

FIG. 2

(57) Abstract: A method for an access node (AN), and an apparatus such as an eNodeB, eNB, being adapted for per-forming radio access at least to a specific Internet of Things (IoT) device and a legacy mobile broad band device, the AN communicating with an IoT mobile management node (IoT MME) and a legacy mobile broadband mobility management node (MBB MME), the method comprising: - receiving (110) a Radio Resource Connection (RRC), connection setup complete message (34), - assessing (140) UE capability information (140) as to specific IoT device capability for the UE, or legacy mobile broad band device capability. Then - if specific IoT device capabilities for the UE is found, selecting (155) the IoT MME, - if legacy MBB device capabilities for the UE is found, selecting (150) the MBB MME, - transmitting (160) a Network Access Stratum message, NAS message (42, 44), to the selected MME.

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[Continued on next page]

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Published:

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Mobility node selection

This invention is directed to a selection of core net resources for among other Internet of Things, IoT, devices.

Background

In the prior art, the selection of a MME (Mobility Management Entity) for a given UE (User Equipment) depends on the PLMN (Public Land Mobile Network).

In fig.1 a prior art solution based on 3GPP TS 36.331 v 13.1.0 (2016-04) and 3GPP TS 36.413 v 13.2.0 (2016-03), both 3GPP RAN (Radio Access Network) specifications is indicated.

- The use of RRC (Radio Resource Control) signalling (as illustrated by the included flows 32 – 34 as the signalling between UE and the eNB (E-UTRAN NodeB)) is specified by 36.331,
- The use of S1AP (S1 Application Protocol) signalling (as illustrated by the included flow 42 as the signalling between eNodeB and MME) is specified by 36.413.

In 3GPP Release 13, two main device types have been defined supporting IoT. Narrow band IoT, NB-IoT is one such type and the other is UE Category M1, Cat-M1.

Cat-M1 allows an extended battery life of more than 10 years for a wide range of machine type communication use cases mainly through the use of power saving mode (PSM) and extended idle-mode Discontinuous Reception (eDRX), and connected mode eDRX, Cellular IoT (CIoT) control plane and user plane Evolved Packet System (EPS) optimisations for small data-transmission. Narrowband IoT (NB-IoT) is a 3GPP Release 13 feature that reuses various principles and building blocks of the LTE physical layer and higher protocol layers to enable rapid standardisation and product development. NB-IoT has been designed to offer extended coverage compared to the traditional GSM networks.

Summary

It is an object of the present invention to set forth improved apparatuses and methods for Internet of Things device handling. It is envisioned by the inventors of the present application, that an operator with a cellular network may want to have separate Core Network (CN) resources for different types of devices. By way of example, the operator may want to handle all Internet of Things (IoT) devices using CN resources separated from the CN resources used to handle legacy (Mobile Broadband, MBB) E-UTRAN (Evolved Universal Terrestrial Radio Access Network) devices.

When a UE requests to become RRC (Radio Resource Control) connected in an E-UTRAN cell where the UE is not registered by the core network, the serving MME may not be available to continue to serve the UE in the particular cell. In that case, the eNB must make an MME selection using the NAS (Network Access Stratum) Node Selection Function (NNSF).

An embodiment of the present invention is related to the NNSF logic and information used as input for deciding which MME to select for the UE when the UE is not registered by any of the available MMEs.

According to an aspect of the invention there is defined a method for an access node, AN, such as an eNodeB, eNB, being adapted for per-forming radio access at least to a specific Internet of Things, IoT, device and a legacy mobile broad band device, the AN communicating with an IoT mobile management node, IoT MME and a legacy mobile broadband mobility management node, MBB MME,
the method comprising
- receiving a Radio Resource Connection, RRC, connection setup complete message,
- assessing UE capability information as to specific IoT device capability for the UE, or legacy mobile broad band device capability.
Then - if specific IoT device capabilities for the UE is found, selecting the IoT MME,
- if legacy MBB device capabilities for the UE is found, selecting the MBB MME,
- transmitting a Network Access Stratum message, NAS message, to the selected MME.

There is also provided a method for a IoT user entity, UE, adapted for communicating with an Access Node, AN, comprising

- transmitting a Radio Resource Connection, RRC, connection setup complete message, to a AN,
upon receiving a UE capability enquiry from the AN
- UE capability information to the AN concerning specific IoT device capabilities.

There is further provided an access node, AN, such as an eNodeB, eNB, being adapted for per-forming radio access at least to a specific Internet of Things, IoT, device and a legacy mobile broad band device, the AN communicating with an IoT mobile management node, IoT MME and a legacy mobile broadband mobility management node, MBB MME,
the AN comprising a processor and a memory having stored therein instructions being configured to
- receiving a Radio Resource Connection, RRC, connection setup complete message,
- assessing UE capability information as to specific IoT device capability for the UE, or legacy mobile broad band device capability,
- if specific IoT device capabilities for the UE is found, selecting the IoT MME,
- if legacy MBB device capabilities for the UE is found, selecting the MBB MME,
- transmitting a Network Access Stratum message, NAS message, to the selected MME.

Further, there is provided an Internet of things, IoT user entity, UE, adapted for communicating with an Access Node, AN, the UE comprising a processor, and memory comprising instructions adapted for
- transmitting a Radio Resource Connection, RRC, connection setup complete message, to a AN,
Upon receiving a UE capability enquiry from the AN, the UE is
- transmitting 39 UE capability information to the AN concerning specific IoT device capabilities.

The Internet of Tings, IoT, user entity, UE, may be a Category M, Cat-M1, UE.

The specific IoT device capability may correspond to a Category M1 UE, Cat-M1 UE and the legacy mobile broad band device capability may correspond to Wide Band Evolved Universal Terrestrial Radio Access, WB-E-UTRAN, devices except Cat-M1 devices.

More specifically, this invention makes it possible for the eNB to treat Cat-M1 devices differently compared to non-Cat-M1 devices in the NNSF, hereby allowing the operator to have separate and dedicated CN resources to serve IoT traffic from Cat-M1 devices.

Brief description of the drawings

Fig. 1 shows an exemplary scenario for a known transmission procedure,

fig. 2 shows an exemplary signalling flow for a selection and transmission procedure according to an embodiment of the invention,

fig. 3 is a flow diagram relating to fig. 2, and

fig. 4 shows embodiments of an access node, e Node B, eNB, a Mobile Broadband MME, a IoT MME and a user entity, UE.

Detailed description

An NB-IoT device will access the eNB in a NB-IoT cell. The scenario will be obvious for the eNB when decoding the signals from the UE when it finds that a NB-IoT UE seeks access, because of separate NB-IoT channels are defined that will only be accessed by NB-IoT devices. This means that it will be straightforward for the NNSF to identify access attempts by NB-IoT devices and discriminate such attempts from access attempts by legacy (MBB) devices. With use of local configuration at the eNB, the eNB is aware of which particular MMEs that are suitable to serve NB-IoT devices and the eNB selects one such suitable MME as target for the S1AP Initial UE Message.

For Cat-M1 devices it is not equally straightforward. A Cat-M1 device will access the network using CE (Coverage Enhancement) PRACH (Physical Random Access Channel) resources. Such CE PRACH resources are separate from normal PRACH resources in a cell in frequency, time and/or preamble domain. However, it is a problem that also other devices than Cat-M1 can use CE PRACH resources to access the network. More specifically, UEs that are in bad coverage and have support for Coverage Enhancement (CE) may also access via CE PRACH.

To enable eNB to select a CN resource suitable to serve a Cat-M1 device there is a need to do something out of the ordinary: if the NNSF were to always forward UEs that have accessed via CE PRACH also non-Cat-M1 UEs that support Coverage Enhancement would fall into this category: i.e. the solution is unable to detect Cat-M1 devices. The information available to eNodeB from using the normal RRC connection setup signalling does not include sufficient information to enable eNB to identify Cat-M1 devices. The available information makes it possible to identify a device which is using E-UTRAN and is handled using coverage enhancement but not to identify Cat-M1 alone.

According to an embodiment of the invention, the following is provided:

The eNodeB has as part of a connection request from a UE received an RRC message RRC Connection Request with no S-TMSI (SAE-Temporary Mobile Subscriber Identity) included, and, as part of the same connection request, also received an RRC message RRC Connection Setup Complete message. The absent S-TMSI from the RRC message RRC Connection Request is a consequence from that the UE has detected that the cell is not included as part of its registered area.
The RRC message RRC Connection Setup Complete is able to convey a GUMMEI (Globally Unique Mobility Management Entity Identifier) value as the message IE (Information Element) registered MME.

For the case when the RRC Connection Setup Complete either does not include a GUMMEI parameter or when an included GUMMEI is not associated with an available MME, the eNodeB is triggered to perform MME selection.

If the network in which the eNodeB is part supports use of enhanced coverage, and the UE has accessed the network via the CE PRACH resources, the eNodeB shall
- Temporarily store the received UE-related data
- Start the UE Capability Enquiry procedure and by that request the UE to send the UE Capability Information message as response
- Use the content of a received UE Capability Information message to determine if the UE is a Cat-M1 device.
- If the UE is a Cat-M1 device, let NNSF select an MME which is suitable to serve Cat-M1.
- If the UE is not a Cat-M1 device, use NNSF to

- select an MME which is suitable to serve any E-UTRAN device,
alternatively,
- select an MME which is suitable to serve WB-E-UTRAN devices except for Cat-M1 devices.

In fig. 2 an embodiment of the invention is shown in more detail.

The UE transmits a RRC connection request with an establishment cause and a UE ID set to a random value, 32, to the eNB.

The eNB performs RRC connection setup, 33.

The UE responds with a RRC connection setup complete message including message information elements registered MME and selected PLMN, 34.

The eNB determines 120 that additional information is needed for selecting a suitable MME and queries 38, the UE of its UE capabilities.

The UE responds with a message 39 comprising the capability information, e.g. whether it is a specific IoT device such as a Cat-M1 device.

Based on this information, the eNB selects 150-155 the suitable MME and transmits message 42 or 44 depending on the selection.

Both messages 42 and 44 are the S1AP Initial UE message and comprises a NAS message such as a NAS Attach Request message.

If the UE is not a Cat-M1 device, and the MBB MME is intended to serve devices which are not of type Cat-M1, the MBB MME is selected and message 42 is transmitted to the MBB MME.

If the UE is a Cat-M1 device, and the IoT MME is intended to serve devices which are of type Cat-M1, the IoT MME is selected and message 44 is transmitted to the IoT MME.

Advantages of embodiments of the invention

The operator can easily deploy separate CN resources dedicated to serve
- Cat-M1 devices alone
- IoT devices (IoT devices in this context including NB-IoT devices and Cat-M1 devices) separately from other network use.

According to embodiments of the invention, an obstacle is overcome that the operator may only differentiate between a use of coverage enhancement and no use of coverage enhancement.

According to embodiments of the invention, the operator is enabled to select CN resources specifically designated to serve Cat-M1 devices, the combination of Cat-M1 and NB-IoT devices, and all E-UTRAN except Cat-M1 devices.

In fig. 3, a flow diagram pertaining to an Access Node, AN, such as an eNB is shown.

In step 110, An RRC Connection Request Complete message 34 is received, by AN.

In 120, it is assessed whether additional information is needed for MME selection.

In step 130, the AN requests 38 and potentially receives 39 UE capability information.

In 140, the UE capability information is assessed and if the UE is not of type Cat-M1 step 150 select MBB MME is carried out and if the UE is of type Cat-M1 step 155 select IoT MME is carried out.

Consequently, in step 160, a S1AP message such as a NAS Attach Request is transmitted by the AN to the selected MME.

In fig. 4, embodiments of an access node, AN, e.g. an E-UTRAN Node B, eNB, a Mobile Broadband MME, MBB MME, an IoT MME and a user equipment, UE, are shown.

The eNB comprises a processor PCU_N and a memory MEM_N having stored therein instructions being configured to, when carried out on the processor PCU_N, carrying out the steps shown in the figures above. The eNB is moreover comprising and interface IF_N, through which the eNB communicates with other nodes.

The MBB MME comprises a processor PCU_M and a memory MEM_M having stored therein instructions being configured to, when carried out on the processor PCU_M, carrying out the steps shown in the figures above. The MBB MME moreover comprises and interface IF_M, through which the MBB MME communicates with other nodes.

The IoT MME comprises a processor PCU_I and a memory MEM_I having stored therein instructions being configured to, when carried out on the processor PCU_I, carrying out the steps shown in the figures above. The IoT MME moreover comprises and interface IF_I, through which the IoT MME communicates with other nodes.

There is also shown a user equipment, UE, comprising a processor, UE_PCU, memory, UE_MEM and an interface, IF_UE. The processor is adapted to carry out instructions as described above, which instructions are moreover adapted to be stored in the memory of the UE, UE_MEM. The UE communicates with the eNB through the interface IF_UE.

There are also provided computer programs and computer program products according to the above description.

In other words there is provided:

A method for an access node, AN, such as an eNodeB, eNB, being adapted for performing radio access at least to a specific Internet of Things, IoT, device and a legacy mobile broad band device, the AN communicating with an IoT mobile management node, IoT MME and a legacy mobile broadband mobility management node, MBB MME, the method comprising

- receiving 110 a Radio Resource Connection, RRC, connection setup complete message 34,
- assessing 140 UE capability information 140 as to specific IoT device capability for the UE, or legacy mobile broad band device capability.

Then - if specific IoT device capabilities for the UE is found, selecting 155 the IoT MME,

- if legacy MBB device capabilities for the UE is found, selecting 150 the MBB MME,
- transmitting 160 a Network Access Stratum message, NAS message 42, 44, to the selected MME.

The specific IoT device capability may correspond to a Category M1 UE, Cat-M1 UE and wherein the legacy mobile broad band device capability corresponds to Wide Band

Evolved Universal Terrestrial Radio Access, WB-E-UTRAN, devices except Cat-M1 devices.

There is also provided a method for a IoT user entity, UE, adapted for communicating with an Access Node, AN, comprising
- transmitting a Radio Resource Connection, RRC, connection setup complete message 34, to a AN,
upon receiving a UE capability enquiry from the AN
- UE capability information to the AN concerning specific IoT device capabilities.

The UE may be a Category M, Cat-M1, UE and the UE capability information is then Cat-M1 UE capability.

There is further provided an access node, AN, such as an eNodeB, eNB, being adapted for per-forming radio access at least to a specific Internet of Things, IoT, device and a legacy mobile broad band device, the AN communicating with an IoT mobile management node, IoT MME and a legacy mobile broadband mobility management node, MBB MME,
the AN comprising a processor PCU_N and a memory MEM_N having stored therein instructions being configured to
- receiving 110 a Radio Resource Connection, RRC, connection setup complete message 34,
- assessing 140 UE capability information 140 as to specific IoT device capability for the UE, or legacy mobile broad band device capability,
- if specific IoT device capabilities for the UE is found, selecting 155 the IoT MME,
- if legacy MBB device capabilities for the UE is found, selecting 150 the MBB MME,
- transmitting 160 a Network Access Stratum message, NAS message 42, 44, to the selected MME.

The specific IoT device capability may correspond to a Category M1 UE, Cat-M1 UE and the legacy mobile broad band device capability may correspond to Wide Band Evolved Universal Terrestrial Radio Access, WB-E-UTRAN, devices except Cat-M1 devices.

Further, there is provided an Internet of things, IoT user entity, UE, adapted for communicating with an Access Node, AN, the UE comprising a processor UE_PCU, and memory UE_MEM comprising instructions adapted for

- transmitting a Radio Resource Connection, RRC, connection setup complete message 34, to a AN,

Upon receiving a UE capability enquiry from the AN, the UE is

- transmitting 39 UE capability information to the AN concerning specific IoT device capabilities.

The Internet of Tings, IoT, user entity, UE, may be a Category M, Cat-M1, UE and the UE capability information then concerns a Cat-M1 UE capability.

Claims

1. Method for an access node, AN, such as an eNodeB, eNB, being adapted for performing radio access at least to a specific Internet of Things, IoT, device and a legacy mobile broad band device, the AN communicating with an IoT mobile management node, IoT MME and a legacy mobile broadband mobility management node, MBB MME,
the method comprising

- receiving (110 a Radio Resource Connection, RRC, connection setup complete message (34),

- assessing (140) UE capability information (140) as to specific IoT device capability for the UE, or legacy mobile broad band device capability,

- if specific IoT device capabilities for the UE is found, selecting (155) the IoT MME,

- if legacy MBB device capabilities for the UE is found, selecting (150) the MBB MME,

- transmitting (160) a Network Access Stratum message, NAS message (42, 44), to the selected MME.

2. Method according to 1 wherein the specific IoT device capability corresponds to a Category M1 UE, Cat-M1 UE and wherein the legacy mobile broad band device capability corresponds to Wide Band Evolved Universal Terrestrial Radio Access, WB-E-UTRAN, devices except Cat-M1 devices.

3. Computer program or computer program product according to claims 1 or 2.

4. Method for a IoT user entity, UE, adapted for communicating with an Access Node, AN, comprising
- transmitting a Radio Resource Connection, RRC, connection setup complete message (34), to a AN,

upon receiving a UE capability enquiry from the AN

- UE capability information to the AN concerning specific IoT device capabilities.

5. Method according to claim 4, wherein the UE is a Category M, Cat-M1, UE and the UE capability information is Cat-M1 UE capability.

6. Computer program or computer program product according to claims 4 or 5.

7. Access node, AN, such as an eNodeB, eNB, being adapted for performing radio access at least to a specific Internet of Things, IoT, device and a legacy mobile broad band device, the AN communicating with an IoT mobile management node, IoT MME and a legacy mobile broadband mobility management node, MBB MME, the AN comprising a processor (PCU_N) and a memory (MEM_N) having stored therein instructions being configured to

- receiving (110) a Radio Resource Connection, RRC, connection setup complete message (34),

- assessing (140) UE capability information (140) as to specific IoT device capability for the UE, or legacy mobile broad band device capability,

- if specific IoT device capabilities for the UE is found, selecting (155) the IoT MME,

- if legacy MBB device capabilities for the UE is found, selecting (150) the MBB MME, and

- transmitting (160) a Network Access Stratum message, NAS message (42, 44), to the selected MME.

8. Access node, AN, according to claim 7 wherein the specific IoT device capability corresponds to a Category M1 UE, Cat-M1 UE and wherein the legacy mobile broad band device capability corresponds to Wide Band Evolved Universal Terrestrial Radio Access, WB-E-UTRAN, devices except Cat-M1 devices.

9. Internet of things, IoT user entity, UE, adapted for communicating with an Access Node, AN, the UE comprising a processor (UE_PCU), and memory (UE_MEM) comprising instructions adapted for

- transmitting a Radio Resource Connection, RRC, connection setup complete message (34), to a AN, and

upon receiving (38) a UE capability enquiry from the AN

- transmitting (39) UE capability information to the AN concerning specific IoT device capabilities.

10. Internet of Tings, IoT, user entity, UE, according to claim 9, wherein the UE is a Category M, Cat-M1, UE and the UE capability information is Cat-M1 UE device capability.

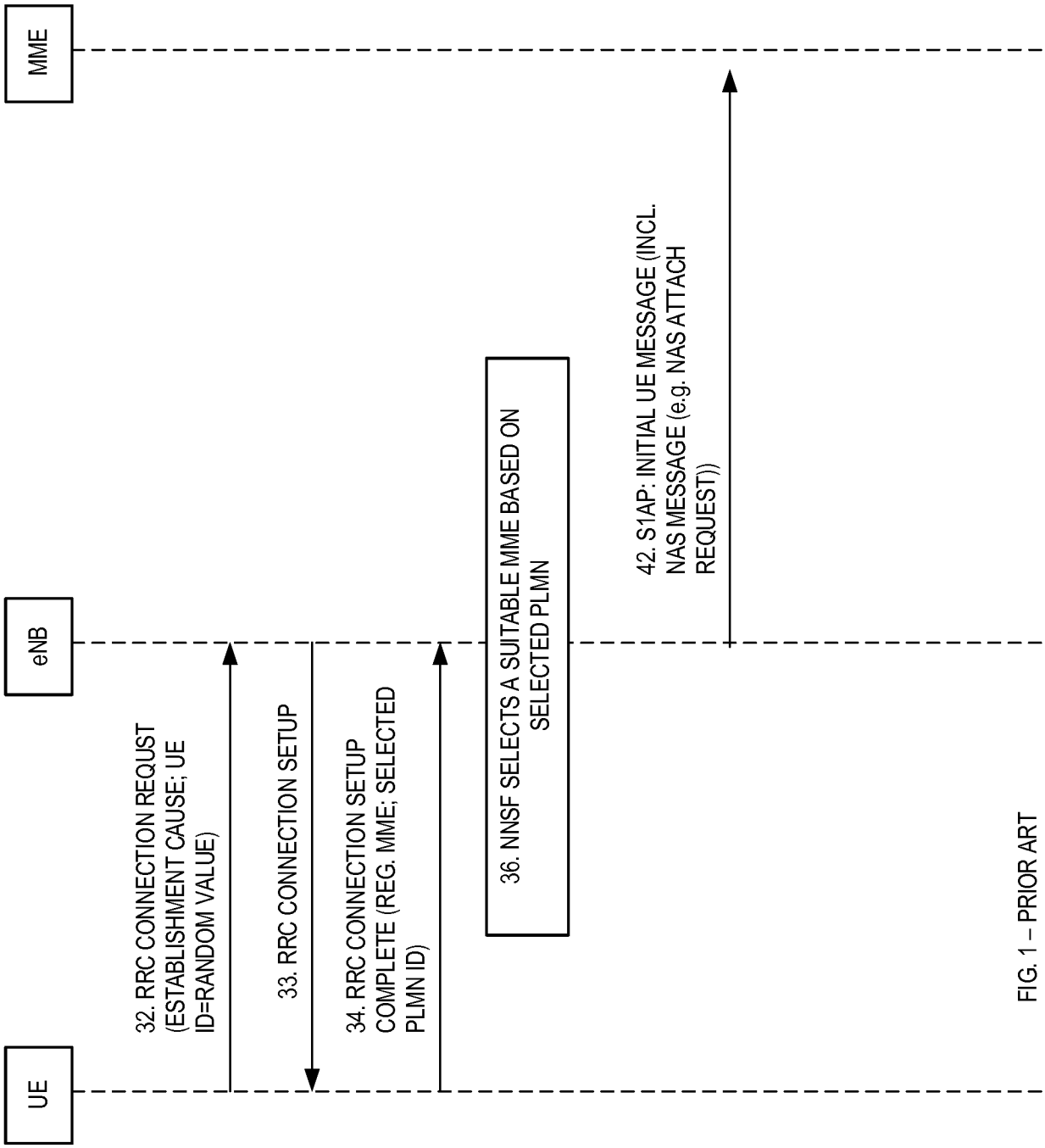


FIG. 1 – PRIOR ART

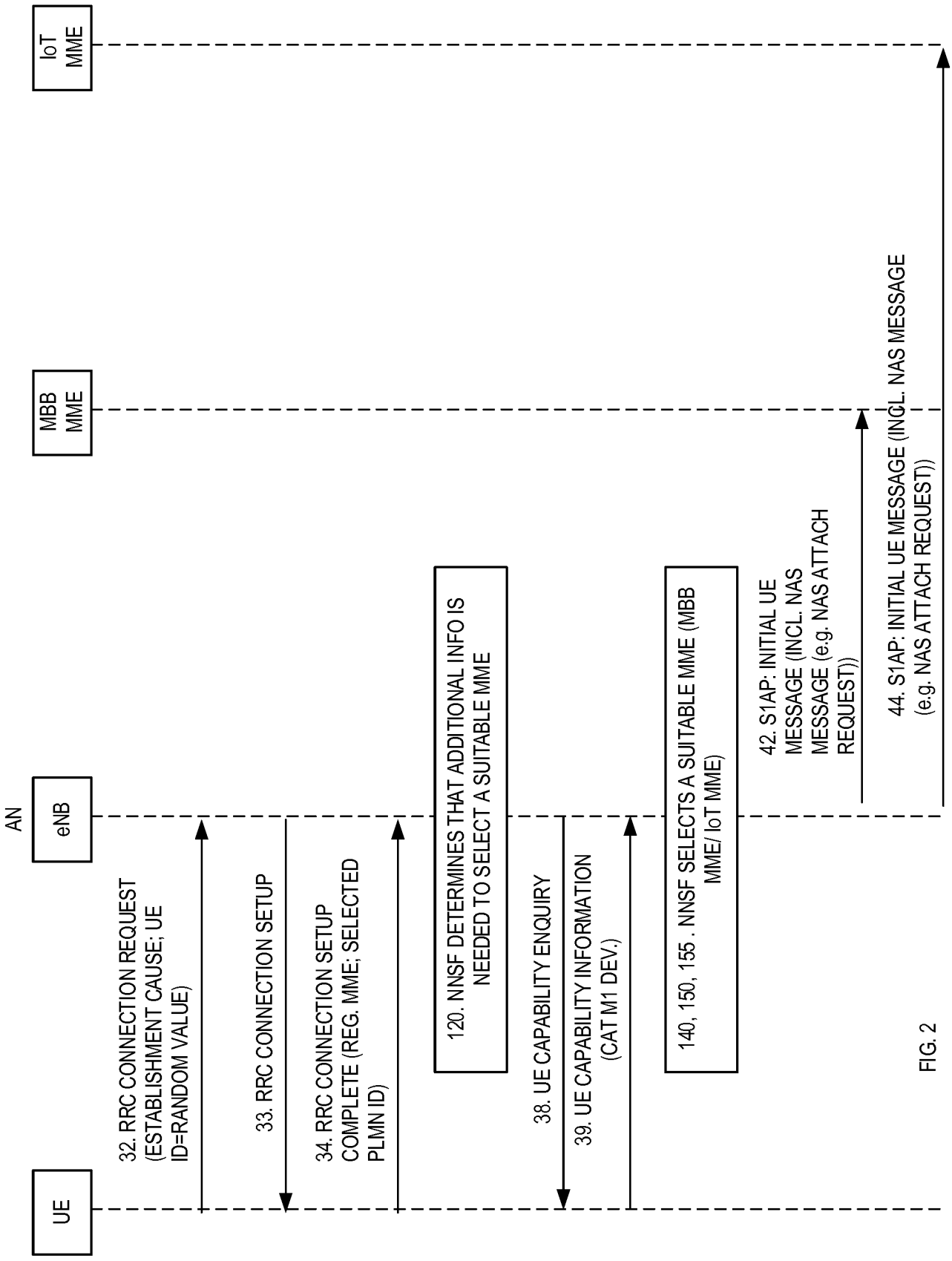

UE
AN
eNB
MBB MME
IoT MME
32. RRC CONNECTION REQUEST (ESTABLISHMENT CAUSE; UE ID=RANDOM VALUE)
33. RRC CONNECTION SETUP
34. RRC CONNECTION SETUP COMPLETE (REG. MME; SELECTED PLMN ID)
120. NNSF DETERMINES THAT ADDITIONAL INFO IS NEEDED TO SELECT A SUITABLE MME
38. UE CAPABILITY ENQUIRY
39. UE CAPABILITY INFORMATION (CAT M1 DEV.)
140, 150, 155 . NNSF SELECTS A SUITABLE MME (MBB MME/ IoT MME)
42. S1AP: INITIAL UE MESSAGE (INCL. NAS MESSAGE (e.g. NAS ATTACH REQUEST))
44. S1AP: INITIAL UE MESSAGE (INCL. NAS MESSAGE (e.g. NAS ATTACH REQUEST))

FIG. 2

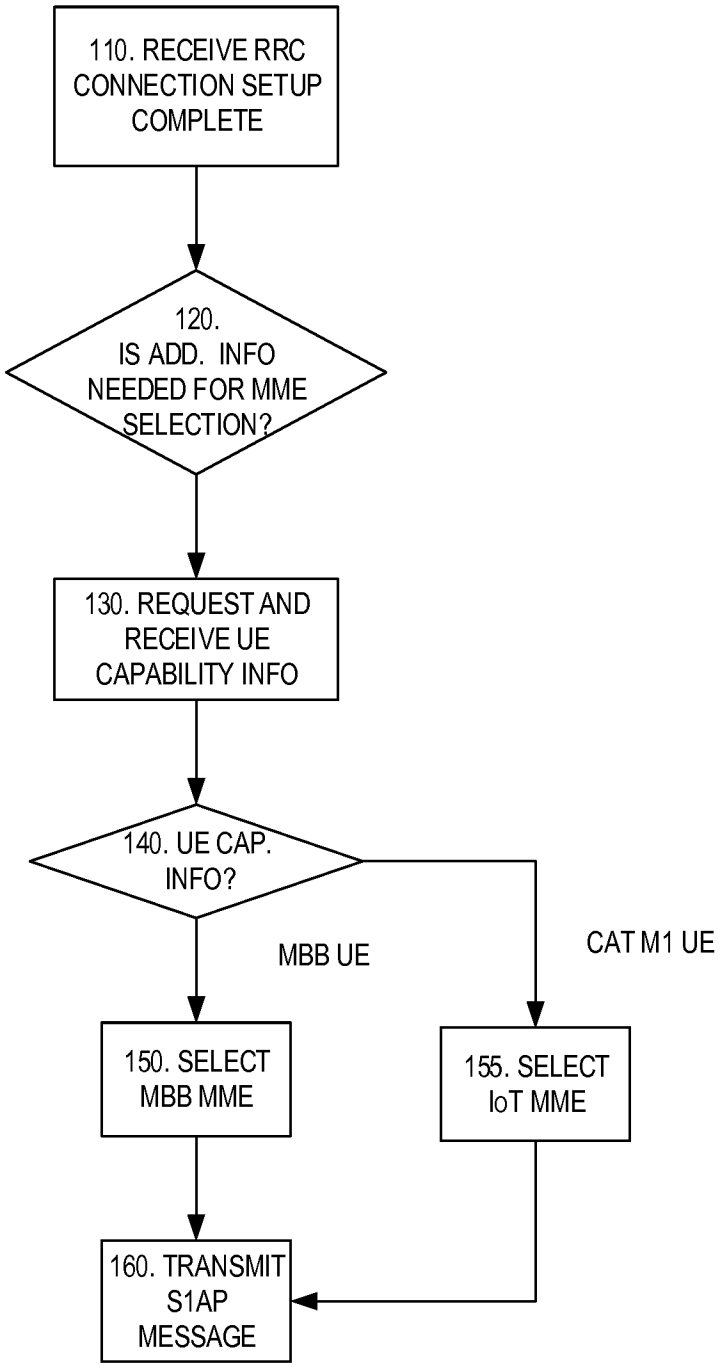
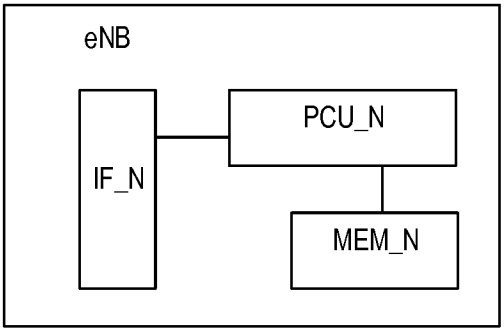
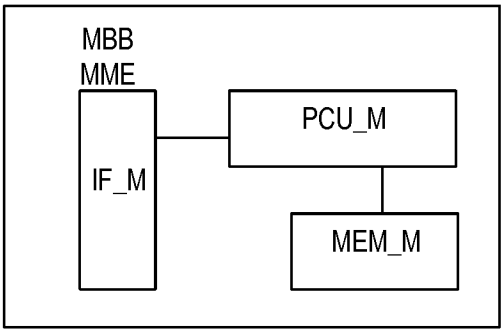

110. RECEIVE RRC CONNECTION SETUP COMPLETE
120. IS ADD. INFO NEEDED FOR MME SELECTION?
130. REQUEST AND RECEIVE UE CAPABILITY INFO
140. UE CAP. INFO?
MBB UE
CAT M1 UE
150. SELECT MBB MME
155. SELECT IoT MME
160. TRANSMIT S1AP MESSAGE

FIG. 3


eNB
IF_N
PCU_N
MEM_N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MME
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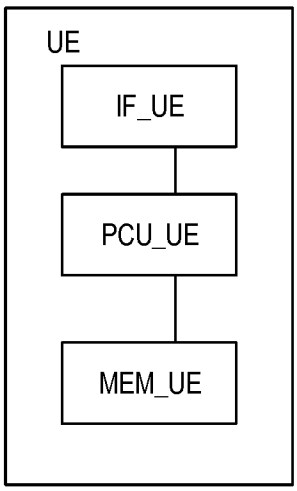
PCU_M
MEM_M


UE
IF_UE
PCU_UE
MEM_UE

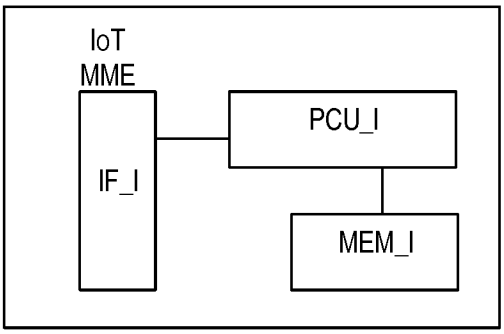

IoT
MME
IF_I
PCU_I
MEM_I

FIG. 4

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2017/067209

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04W8/06 H04W48/18 H04W8/22 H04W8/24 H04W76/02
ADD.

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

B. FIELDS SEARCHED

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

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2012/302230 A1 (LIM CHAE GWON [KR] ET AL) 29 November 2012 (2012-11-29) abstract paragraphs [0005] - [0012], [0031] - [0050], [0055] - [0057], [0121] - [0125], [0136] - [0143] figures 1, 2, 4, 5, 8, 10, 12, 14, 15, 17	1-3,7,8

-/--

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

[X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
26 September 2017	02/10/2017

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

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2017/067209

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