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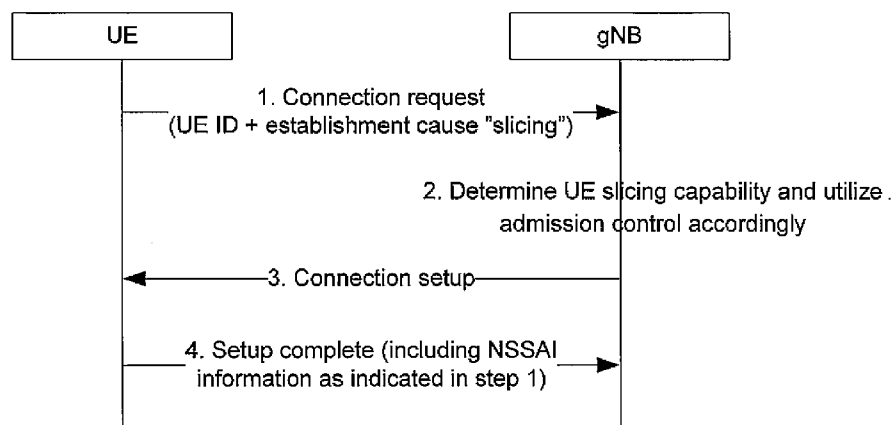


FIG. 1

(57) Abstract: A method for a user equipment includes sending an initial connection request message to a gNB in a non-slice-dedicated cell, said initial connection request message including a UE identifier and an establishment cause value determining slicing purpose; receiving a connection setup message from the gNB; and sending a setup complete message to the gNB, said setup complete message including network slice selection assistance information. A corresponding method for a gNB includes receiving an initial connection request message from a UE in a non-slice-dedicated cell, said initial connection request message including a UE identifier and an establishment cause value determining slicing purpose; determining UE slicing capability; utilizing admission control according to the UE slicing capability; sending a connection setup message to the UE; and receiving a setup complete message from the UE, said setup complete message including network slice selection assistance information.

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SLICING ESTABLISHMENT CAUSE AND REQUESTED SLICING INFORMATION

TECHNICAL FIELD

This disclosure relates to network slicing in a 3GPP NR/5G system.

5

BACKGROUND

Network slicing is introduced to 3GPP NR/5G system as an E2E service feature.

A realization network slicing is denoted as a Network Slice Instance (NSI). It is defined as “a set of network functions, and resources to run these network functions, forming a
10 ‘complete instantiated logical network’ to meet certain network characteristics required by Service Instance(s)”.

Based on 3GPP TR 23.799 vers.14.0.0, section 8.1:

- The network slice is a complete logical network (providing Telecommunication Services and Network Capabilities) including AN and CN.
- 15 • For a “Service Request”, a UE is registered or updated, and has a valid temporary ID, which is sufficient in the RAN to route the request to the serving Common CP NF. It is assumed that the slice configuration does not change within the UE’s registration areas.

In network slicing, the cells may be part of different network slices and a cell can belong to multiple network slice instances. The current assumption in 3GPP is that the cells which
20 are part of the same registration area (RA) would be part of the same set of network slices, identified by Network Slice Selection Assistance Information (NSSAI), which is a set of zero or more S-NSSAI (Single NSSAI). Once a UE does “attach” to a network, it is then provided with NSSAI, consisting of set of S-NSSAI (Allowed NSSAI or Configured NSSAI), which tells the UE which slices are supported in the current tracking area. Similarly, the NSSAI could be also received at every Tracking
25 Area Update (TAU), in case there is a change in the network support of slices. In that way, the UE always would know within its serving registration area, when entering a new cell, which of its assigned network slices would be available in the new cell.

The NSSAI information, Configured-NSSAI or Allowed-NSSAI, provided as part of the Tracking Area Update procedure and during the Initial Attach to the UE from the network,
30 contains the list of network slices applicable for the current tracking area. However, if the UE has to indicate the full set of Configured-NSSAI or Allowed NSSAI in each and every connection request or periodic TAU, the size of the messages may grow large, and, in addition, the information may not be necessary for a given gNB. The reason why the UE has been assumed always to indicate the full set is that it cannot know which information the network needs – thus, the only solution has been to

signal the full NSSAI information to the gNB to be further selected depending on AMF(s) capabilities. In terms of frequency, the signaling is redundant, that is, it requires negotiation with CN at each TAU, and, in terms of content, the signaling is redundant and unsecured, that is, the approach hides the intention of conveying full slicing information.

5 However, the network may not always require the slicing information, and may not be aware of the UE's support of slicing. This is because UE capabilities are only retrieved by radio access node from UE or AMF much later after the connection setup, so the network always has to be able to accept slicing relevant connections blindly and to cope with the slicing information sent further by UE. In addition, due to lack of control in a radio access node, the network may face
10 processing and load issues with undetermined UE slicing needs at the point of requesting connection. Further, not all UEs may even have slicing, in which case rules are needed to allow the network to distinguish whether a particular UE: 1) does not support slicing OR 2) does not have any configured Allowed NSSAI.

 Moreover, this becomes especially limiting in case the UE supports a lot of slices,
15 and the network also supports all or most of them: the UE may not be using all of them, but would still be required to signal all of them. This increases the RRC message size, which either delays RRC message delivery due to segmentation, or affects coverage in case the message is sent with higher MCS.

 This also reveals secure information and users' privacy (see [S3-170902](#)), which is
20 normally considered undesirable.

 Further, TAU can be delivered via either RRC connection setup, when moving from IDLE to CONNECTED, or via direct NAS message delivery. In either case, the UE knows nothing about the slicing handling of the gNB.

 Currently, it has been proposed that UE would always signal the full NSSAI at every
25 connection setup or NAS message delivery.

 In LTE eDECOR, a UE signals a single DCN-ID index to an eNB in Msg5 in case upper layers (=NAS) provide the ID. The network then either handles it or ignores it, but that is the only indication that the UE supports eDECOR.

 In addition, in LTE eDECOR, the UE signals a single DCN-ID index to eNB based
30 on its NAS information, which is then interpreted by the eNB. This index can represent almost whatever the network decides, as long as it has been provisioned to the UE NAS.

 It should be understood, both above and in the discussion to follow, that the term "gNB" should be understood to mean "network node". The term "gNB" is used to denote a network node in 5G. However, it should be understood that the present invention, as described below, is not

limited to 5G, but may be applicable to other generations yet to be developed. As a consequence, “gNB” should be understood more broadly as a network node.

SUMMARY

5 In a first aspect of the present invention, a method for a user equipment comprises sending an initial connection request message to a gNB in a non-slice-dedicated cell, said initial connection request message including a UE identifier and an establishment cause value determining slicing purpose; receiving a reply message from the gNB (that is, connection setup); and sending a setup complete message to the gNB, said setup complete message including network slice selection
10 assistance information.

In a second aspect of the present invention, a method for a gNB comprises receiving an initial connection request message from a UE in a non-slice-dedicated cell, said initial connection request message including a UE identifier and an establishment cause value determining slicing purpose; determining UE slicing capability; utilizing admission control according to the UE slicing
15 capability; sending a connection setup message to the UE; and receiving a setup complete message from the UE, said setup complete message including network slice selection assistance information.

In a third aspect of the present invention, a method for a user equipment comprises sending an initial connection request message to a gNB in a slice-dedicated cell, said initial connection request message including a UE identifier and an establishment cause value determining
20 slicing purpose; receiving a connection setup message from the gNB with cell with slice specific restrictions; and sending a setup complete message to the gNB.

In a fourth aspect of the present invention, a method for a gNB comprises receiving an initial connection request message from a UE in a slice-dedicated cell, said initial connection request message including a UE identifier and an establishment cause value determining slicing
25 purpose; determining whether the UE is accessing the slice-dedicated cell according to a dedicated slice; determining UE access to the slice-dedicated cell by way of an admission control using the establishment cause value determining slicing purpose; sending a connection setup message to the UE; and receiving a setup complete message from the UE.

In a fifth aspect of the present invention, a method for a user equipment comprises,
30 after an RRC connection has been established with a gNB in a non-slice-dedicated cell, sending a new connection request message to the gNB, said new connection request message including a UE identifier and an establishment cause value determining slicing purpose; receiving a connection setup message from the gNB updating the RRC connection; and sending a setup complete message to the gNB, said setup complete message including updated network slice selection assistance information.

In a sixth aspect of the present invention, a method for a gNB comprises, after an RRC connection has been established with a UE in a non-slice-dedicated cell, receiving a new connection request message from the UE, said new connection request message including a UE identifier and an establishment cause value determining slicing purpose; determining from the UE
5 identifier that the UE is requesting additional slices or has updated its subscription; deciding whether to accept new service for the UE; sending a connection setup message to the UE; and receiving a setup complete message from the UE, said setup complete message including updated network slice selection assistance information.

In a seventh aspect of the present invention, a method for a user equipment comprises
10 sending an initial connection request message to a source gNB, said initial connection request message including a UE temporary identifier; receiving a connection setup message from the source gNB, said connection setup message indicating slice information to be added to radio resource control; and sending a setup complete message to the source gNB, said setup complete message including network slice selection assistance information in response to said connection setup
15 message.

In an eighth aspect of the present invention, a method for a gNB comprises receiving an initial connection request message from a UE, said initial connection request message including a UE temporary identifier; sending a connection setup message to the UE, said connection setup message indicating slice information to be added to radio resource control; receiving a setup complete
20 message from the UE, said setup complete message including network slice selection assistance information in response to said connection setup message; and utilizing the network slice selection assistance information for connection to an access and mobility management function.

In a ninth aspect of the present invention, a method for a user equipment comprises sending an initial connection request message to a source gNB, said initial connection request
25 message including a UE temporary identifier; receiving a connection setup message from the source gNB, said connection setup message indicating that no network slice selection assistance information is to be provided in response; sending a setup complete message to the source gNB, said setup complete message including no network slice selection assistance information in response to said connection setup message; receiving an access stratum security activation message from the source
30 gNB; and sending the network slice selection assistance information to the source gNB.

In a tenth aspect of the present invention, a method for a gNB comprises receiving an initial connection request message from a UE, said initial connection request message including a UE temporary identifier; sending a connection setup message to the UE, said connection setup message indicating that no network slice selection assistance information is to be provided in response;

receiving a setup complete message from the UE, said setup complete message including no network slice selection assistance information in response to said connection setup message; sending an access stratum security activation message to the UE; receiving the network slice selection assistance information from the UE; and utilizing the network slice selection assistance information for
5 connection to an access and mobility management function.

In an eleventh aspect of the present invention, a method for a gNB comprises, after receiving network slice selection assistance information provisioned by the upper layer, sending an RRC message with differentiated content of said connection request message; including corresponding network slice selection assistance information in said connection complete message
10 according to the differentiated content by said connection request message.

In a twelfth aspect of the present invention, a method for a user equipment comprises, after being connected to a source gNB with network slice selection assistance information requested from the source gNB, sending an RRC message with a tracking area update (TAU) including the requested network slice selection assistance information to the source gNB; and receiving updated
15 network slice selection assistance information from the source gNB.

In a thirteenth aspect of the present invention, a method for a source gNB comprises, after being connected to a UE having previously requested network slice selection assistance information, receiving an RRC message with a tracking area update (TAU) including the previously requested network slice selection assistance information from the UE; forwarding the tracking area
20 update to an access and mobility management function (AMF) based on the network slice selection assistance information; receiving updated network slice selection assistance information from the AMF; and forwarding the updated network slice selection assistance information to the UE.

In a fourteenth aspect of the present invention, a method for an access and mobility management function comprises receiving a tracking area update from a source gNB based on
25 network slice selection assistance information provided to a UE; and sending updated network slice selection assistance information to the source gNB.

In a fifteenth aspect of the present invention, a method for a user equipment comprises connecting to a source gNB with network slice selection assistance information requested from the source gNB; receiving an RRC reconfiguration message with a handover command from the
30 source gNB; and connecting to a target gNB using information in the RRC reconfiguration message.

In a sixteenth aspect of the present invention, a method for a source gNB comprises receiving a connection to a UE, said UE having previously requested network slice selection assistance information; sending a handover request to a target gNB with network slice selection assistance information from the UE; receiving a handover command including updates to network

slice selection assistance information requested in RRC messages; and sending an RRC reconfiguration message with a handover command to the UE.

In a seventeenth aspect of the present invention, a method for a target gNB comprises receiving a handover request from a source gNB with network slice selection assistance information from a UE; sending a handover command including updates to network slice selection assistance information requested in RRC messages to the source gNB; connecting to the UE; and utilizing the network slice selection assistance information for connection to an access and mobility management function.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other aspects of these teachings are made more evident in the following detailed description, when read in conjunction with the attached drawing figures.

Figure 1 illustrates sending an initial connection request with “slicing” establishment cause in a non-slice-dedicated cell.

Figure 2 illustrates sending an initial connection request with “slicing” establishment cause in a slice-dedicated cell.

Figure 3 illustrates sending a new slicing service request via RRC setup request plus slicing establishment cause.

Figure 4 illustrates sending initial connection request - gNB indicates which NSSAI information to use.

Figure 5 illustrates sending initial connection request - gNB indicates no NSSAI information should be signaled in connection establishment procedure.

Figure 6 illustrates sending TAU based on gNB configuration.

Figure 7 illustrates handover, updating what is requested from the UE as NSSAI information.

Figure 8 shows a simplified block diagram of certain apparatus according to various exemplary embodiments of the present invention.

DETAILED DESCRIPTION

In a first principal aspect of the present invention, it is proposed that a single establishment cause (that is, reason indicated in a query message for connection or service establishment from a UE to the network) be dedicated to a UE indicating that slicing information will

be provided in further messages. This may be either part of all establishment causes, or an additional indication that the current establishment cause is also related to slicing. This allows the network to differentiate the UEs that support slicing and those that do not, such as for doing different admission control algorithms for each class of UEs, in lieu of barring, which may not always be used, or for
5 setting up the connection with different parameters or applying specific treatment of connection that expose slicing information.

The slicing establishment cause could also be used in case a UE also requests setup of a new slice or has updated slicing information, for example, due to updated slicing subscription that the UE just bought via the connection that was setup, that is, when doing a service request when
10 the RRC connection is already setup. This would allow the same message to be reused with same semantics, even when the RRC connection is already up and running.

In slice-dedicated cells, this indicator would also immediately tell that the UEs are expected to have the slice specific to the cell, and are not, for example, emergency calls, which may or may not be allowed in such a cell.

15 The following are provided as embodiments of this first principal aspect of the present invention from the UE and the gNB sides:

UE side:

- In one embodiment, the UE explicitly indicates an establishment cause for “slicing”, and, in a
20 subsequent message, indicates more details about the exact nature of the slicing:
 - o In a related embodiment, the UE indicates its NSSAI information in the next message to the network;
- In another embodiment, the UE establishment cause implicitly indicates use of slicing via rules applied, such as by the cell restrictions (for example, the cell is restricted only to certain
25 slices):
 - o In a related embodiment, the UE does not indicate further slicing information to implicitly indicate that it only supports the cell restrictions (for example, only the dedicated NSSAI that the cell supports);
- In another embodiment, the UE uses the establishment cause to indicate that it has updated
30 slicing information available:
 - o In a related embodiment, the updated information consists of a service request for a new S-NSSAI;
 - o In another related embodiment, the establishment cause indicates that the UE subscription has changed with different NSSAI information

gNB side:

- In one embodiment, a gNB receives a value from a UE that indicates NSSAI information exists for the UE:

5 ○ In a related embodiment, the gNB uses the information to decide whether to accept the UE request;

- In a related embodiment, the gNB uses a different admission control mechanism for UEs that support slicing compared to UEs that do not support slicing;

10 ○ In a related embodiment, the gNB takes action to request further information from the UE NSSAI in a later message (such as, message completing connection setup or later message for UL data transfer);

- In another embodiment, the gNB receives a value from the UE in a connection request to determine that the UE requests updates to its existing RRC connection;

15 ○ In a related embodiment, the gNB uses the information to request updated subscription information for the UE from the CN;

- In a related embodiment, the gNB handles the message as a request to setup new slices for the UE based on further information received from subsequent message(s) from the UE.

20

The benefits of this approach of this principal aspect of the present invention are as follows:

1. The gNB is aware of the UE support for network slicing immediately at connection request;
2. The gNB may utilize the information on UE slicing support to utilize an appropriate admission control scheme for the UE, for example, to allow a more dynamic way of access barring than SI (System Information) changes;
3. The same RRC setup-message can be reused when requesting further network services via slicing, even if the RRC connection is already ongoing. The network can use the UE identifier and the establishment cause to realize that the UE is not requesting a new connection but an update to its existing connection.

30

The signaling procedures for initial indication of slicing in RRC connection establishment in normal or slice-dedicated cell and indicating extra slicing information during RRC connection are depicted in Figures 1 to 3.

In a second principal aspect of the present invention, it is proposed that the network indicates, in a reply message to the UE query, for example, an RRC connection setup message, such as the *Msg4= RRCConnectionSetup*-message in LTE, or in a handover command, such as an *RRCConnectionReconfiguration* including *mobilityControlInfo*, what the UE should indicate about its network slices, such as, the number of S-NSSAI to indicate, full NSSAI, currently active S-NSSAI, S-NSSAI a gNB is able to serve, NSSAI for the current PLMN only, using only SSTs of S-NSSAI in signaling, and so forth, in the messages that require slicing information to be sent to the gNB. This allows the gNB to have control over the slicing information sent from UE to NG-RAN, and can be used in every single case since it is included in the first message from the network to the UE, that is, before the UE actually sends the NSSAI information to the network.

The following are provided as embodiments of this second principal aspect of the present invention from the UE and the gNB sides:

UE side:

- In one embodiment, the UE receives a request provisioning content of the slicing assistance information;
- In another embodiment, the UE receives a request always to indicate full NSSAI information when sending messages that may contain NSSAI information;
- In another embodiment, the UE receives a request to indicate a subset of its currently configured NSSAI information when sending messages that may contain NSSAI information:
 - o In a related embodiment, the subset of NSSAI that UE indicates is explicitly or implicitly indicated by the gNB;
 - o In another related embodiment, the subset of NSSAI that UE indicates consists of a single entry that is chosen by UE;
 - In a related embodiment, the choice done is done at the NAS level;
 - In another related embodiment, the choice is done at the AS level;
 - o In another related embodiment, the UE NSSAI information that the UE indicates is based on a subset of its currently configured or allowed NSSAI information in case of PDU session establishment;
 - o In another related embodiment, the subset of NSSAI that UE indicates is based only on the NSSAI applicable for the current PLMN;
 - o In another related embodiment, the UE NSSAI information that the UE indicates contains the Slice/Service Type (SST) field for each S-NSSAI in NSSAI;

- In another related embodiment, the UE NSSAI information that the UE indicates contains the Slice Differentiator (SD) field for each S-NSSAI in NSSAI;
- In another embodiment, the UE receives a request not to indicate any NSSAI information when sending messages to establish connection:
 - 5 ○ In a related embodiment, the UE receives a request only to indicate whether the UE supports network slicing instead of any NSSAI information when sending messages that may contain NSSAI information;
 - In a related embodiment, the UE indicates NSSAI information in a message after security activation (for example, a UL Information Transfer);
- 10 - In another embodiment, the UE receives a request only to indicate NSSAI information when sending a message that contains a TAU/RAU;
- In another related embodiment, the UE receives the request to indicate a subset of its currently configured or allowed NSSAI information in case of PDU session establishment;
- In another embodiment, the UE sets a subset of its currently configured NSSAI information
 - 15 when establishing RRC connection according to the content provisioned by the gNB:
 - In a related embodiment, the subset of NSSAI that UE indicates is explicitly or implicitly indicated to the gNB;
 - In another related embodiment, the subset consists of a combination of S-NSSAIs;
 - In another related embodiment, the subset consists of the UE's selected S-NSSAI(s);
 - 20 ○ In another related embodiment, the subset consists of a combination of SST fields of selected S-NSSAI(s);
 - In another related embodiment, the subset consists of a combination the SD fields of selected S-NSSAI(s).
- 25 gNB side:
 - In one embodiment, indicating to the UE which NSSAI information is indicated when it is possible to do so;
 - In a related embodiment, sending the indication to the UE in the message that sets up the UE RRC connection or does reconfiguration of the UE RRC connection:
 - 30 ▪ In a related embodiment, using the indication always to request full NSSAI information;
 - In another related embodiment, using the indication to request a subset of S-NSSAI from the UE based on information implicitly or explicitly contained within the network indication;

- In a related embodiment, using the indication to request a single S-NSSAI from the UE based on explicit rules set in the specification;
- In a related embodiment, requesting UE to decide which NSSAI to indicate:
 - In a related embodiment, indicating whether the UE decision is done at the AS or the NAS;
 - In a related embodiment, letting the UE decide whether the AS or the NAS decides on the NSSAI information to indicate;
- In a related embodiment, requesting a specific subset of NSSAIs from the UE, if it is applicable to the current request;
- In a related embodiment, requesting the UE not to indicate any NSSAI information;
 - In a related embodiment, requesting the UE only to indicate whether it supports network slicing;
- In a related embodiment, using the indication to request Slice/Service Type (SST) indication;
- In another related embodiment, using the indication to request the Slice Differentiator (SD);
- In a related embodiment, indicating whether a certain type of message, such as TAU, RRC reconfiguration response, and resumption of RRC connection, requires sending NSSAI information;
- In a related embodiment, indicating omission of sending NSSAI information by the UE.

The benefits of this approach of this second principal aspect of the present invention are as follows:

1. Full gNB control over which information the UE indicates;
2. Reduced message size when the information is not required;
3. The UE always knows what to indicate since it is received before the message that UE uses to indicate the slicing information;
4. Even if the network requests the UE not to indicate NSSAI information, it can request to know whether the UE supports network slicing;
5. Reduced signaling with Core Network and mitigated UE's re-routing need.

The signaling procedures for initial connection establishment, TAU update and handover are depicted in Figures 4 to 7.

Reference is now made to Figure 8 for illustrating a simplified block diagram of various electronic devices and apparatus that are suitable for use in practicing the exemplary
5 embodiments of the present invention. In Figure 8, a wireless network 1 is adapted for communication over a wireless link 11 with an apparatus, such as a mobile communication device, which is referred to as a UE 10, via a wireless network access node, such as a base station or relay station or remote radio head, and more specifically shown as a gNodeB 12. The network 1 may include a network control element (NCE) 14, which serves as an access and mobility management
10 function or entity (AMF or MME) and/or a serving gateway (S-GW) to a broader network, such as a public switched telephone/data network and/or the Internet.

The UE 10 includes a controller, such as a computer or a data processor (DP) 10A, a computer-readable memory medium embodied as a memory (MEM) 10B, which stores a program of computer instructions (PROG) 10C, and a suitable radio frequency (RF) transmitter and receiver 10D
15 for bi-directional wireless communications with the gNodeB (gNB) 12 via one or more antennas. The gNodeB 12 also includes a controller, such as a computer or a data processor (DP) 12A, a computer-readable memory medium embodied as a memory (MEM) 12B that stores a program of computer instructions (PROG) 12C, and a suitable RF transmitter and receiver 12D for communication with the UE 10 via one or more antennas. The eNodeB 12 is coupled via a
20 data/control path 13 to the NCE 14. The path 13 may be implemented as an S1 interface when the network 1 is an LTE network. The gNodeB 12 may also be coupled to another gNodeB via data/control path 15, which may be implemented as an X2 interface when the network 1 is an LTE network.

At least one of the PROGs 10C and 12C is assumed to include program instructions
25 that, when executed by the associated DP, enable the device to operate in accordance with the exemplary embodiments of this invention as was detailed above with respect to Figures 1 to 7. That is, the exemplary embodiments of this invention may be implemented at least in part by computer software executable by the DP 10A of the UE 10 and/or by the DP 12A of the eNodeB 12, or by hardware, or by a combination of software and hardware (and firmware).

30 In general, the various embodiments of the UE 10 can include, but are not limited to, cellular telephones; personal digital assistants (PDAs) having wireless communication capabilities; portable computers having wireless communication capabilities; image capture devices, such as digital cameras, having wireless communication capabilities; gaming devices having wireless communication capabilities; music storage and playback appliances having wireless communication

capabilities; and Internet appliances permitting wireless Internet access and browsing, as well as portable units or terminals that incorporate combinations of such functions.

The computer-readable MEMs 10B and 12B 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, flash memory, magnetic-memory devices and systems, optical-memory devices and systems, fixed memory and removable memory. The DPs 10A and 12A may be of any type suitable to the local technical environment, and may include one or more of general purpose computers, special purpose computers, microprocessors, digital signal processors (DSPs) and processors based on a multicore processor architecture, as non-limiting examples.

It should be noted that the various DPs 10A, 12A may be implemented as one or more processors/chips, either or both of the UE 10 and the gNodeB 12 may include more than one transmitter and/or receiver 10D, 12D, and particularly the gNodeB 12 may have its antennas mounted remotely from the other components of the gNodeB 12, such as for example tower-mounted antennas.

In general, the various exemplary embodiments may be implemented in hardware or special purpose circuits, software, logic or any combination thereof. For example, some aspects 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 exemplary embodiments of this 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.

It should thus be appreciated that at least some aspects of the exemplary embodiments of the inventions may be practiced in various components, such as integrated circuit chips and modules, and that the exemplary embodiments of this invention may be realized in an apparatus that is embodied as an integrated circuit. The integrated circuit, or circuits, may comprise circuitry, as well as possibly firmware, for embodying at least one or more of a data processor or data processors, a digital signal processor or processors, baseband circuitry and radio frequency circuitry that are configurable so as to operate in accordance with the exemplary embodiments of this invention.

Various modifications and adaptations to the foregoing exemplary embodiments of this invention may become apparent to those skilled in the relevant arts in view of the foregoing description, when read in conjunction with the accompanying drawings. For example, while the

exemplary embodiments have been described above in the context of advancements to the 5G NR system, it should be appreciated that the exemplary embodiments of this invention are not limited for use with only this one particular type of wireless communication system. The exemplary embodiments of the invention presented herein are explanatory and not exhaustive or otherwise limiting of the scope of the invention.

The following abbreviations have been used in the preceding discussion:

	AMF	Access and Mobility Management function
	AN	Access Network
	AS	Access Stratum
10	CN	Core Network
	CP	Control Plane
	DECOR	Dedicated Core network
	eDECOR	enhanced DECOR
	gNB	5G node-B
15	ID	Identifier
	MME	Mobility Management Entity
	NAS	Non-Access Stratum
	NF	Network Function
	NSI	Network Slice Instance
20	NSSAI	Network Slice Selection Assistance Information
	PLMN	Public Land Mobile Network
	RA	Registration Area
	RRC	Radio Resource Control
	S-NSSAI	Accepted NSSAI
25	SD	Slice Differentiator
	SST	Slice/Service Type
	TA	Tracking Area
	TAI	Tracking Area Indicator
	TAU	Tracking Area Update
30	UE	User Equipment

The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of the invention. As used herein, the singular forms “a”, “an”, and “the” are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms “comprises” and/or “comprising”, when used

in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof.

5 The description of the present invention has been presented for purposes of illustration and description, but is not intended to be exhaustive or limited to the invention in the form disclosed. Many modifications and variations will be apparent to those of ordinary skill in the art without departing from the scope and spirit of the invention. The embodiment was chosen and described in order to best explain the principles of the invention and the practical application, and to enable others of ordinary skill in the art to understand the invention for various embodiments with
10 various modifications as are suited to the particular use contemplated.

Various modifications and adaptations may become apparent to those skilled in the relevant arts in view of the foregoing description, when read in conjunction with the accompanying drawings. However, any and all modifications of the teachings of this disclosure will still fall within the scope of the non-limiting embodiments of this invention.

15 Although described in the context of particular embodiments, it will be apparent to those skilled in the art that a number of modifications and various changes to these teachings may occur. Thus, while the invention has been particularly shown and described with respect to one or more embodiments thereof, it will be understood by those skilled in the art that certain modifications or changes may be made therein without departing from the scope of the invention as set forth above,
20 or from the scope of the claims to follow.

WHAT IS CLAIMED IS:

1. A method comprising:

5 sending an initial connection request message to a gNB in a non-slice-dedicated cell, said initial connection request message including a UE identifier and an establishment cause value determining slicing purpose;
receiving a connection setup message from the gNB; and
sending a setup complete message to the gNB, said setup complete message including network slice selection assistance information.

10

2. A method comprising:

receiving an initial connection request message from a UE in a non-slice-dedicated cell, said initial connection request message including a UE identifier and an establishment cause value determining slicing purpose;
15 determining UE slicing capability;
utilizing admission control according to the UE slicing capability;
sending a connection setup message to the UE; and
receiving a setup complete message from the UE, said setup complete message including network slice selection assistance information.

20

3. A method comprising:

25 sending an initial connection request message to a gNB in a slice-dedicated cell, said initial connection request message including a UE identifier and an establishment cause value determining slicing purpose;
receiving a connection setup message from the gNB with cell with slice specific restrictions;
and
sending a setup complete message to the gNB.

4. A method comprising:

30 receiving an initial connection request message from a UE in a slice-dedicated cell, said initial connection request message including a UE identifier and an establishment cause value determining slicing purpose;
determining whether the UE is accessing the slice-dedicated cell according to a dedicated slice;

determining UE access to the slice-dedicated cell by way of an admission control using the establishment cause value determining slicing purpose slicing;

sending a connection setup message to the UE; and

receiving a setup complete message from the UE.

5

5. A method comprising:

after an RRC connection has been established with a gNB in a non-slice-dedicated cell, sending a new connection request message to the gNB, said new connection request message including a UE identifier and an establishment cause value determining slicing purpose;

10 receiving a connection setup message from the gNB updating the RRC connection; and sending a setup complete message to the gNB, said setup complete message including updated network slice selection assistance information.

6. A method comprising:

15 after an RRC connection has been established with a UE in a non-slice-dedicated cell, receiving a new connection request message from the UE, said new connection request message including a UE identifier and an establishment cause value determining slicing purpose;

determining from the UE identifier that the UE is requesting additional slices or has updated its subscription;

20 deciding whether to accept new service for the UE;

sending a connection setup message to the UE; and

receiving a setup complete message from the UE, said setup complete message including updated network slice selection assistance information.

25 7. A method comprising:

sending an initial connection request message to a source gNB, said initial connection request message including a UE temporary identifier;

receiving a connection setup message from the source gNB, said connection setup message indicating slice information to be added to radio resource control; and

30 sending a setup complete message to the source gNB, said setup complete message including network slice selection assistance information in response to said connection setup message.

8. A method comprising:

receiving an initial connection request message from a UE, said initial connection request message including a UE temporary identifier;

sending a connection setup message to the UE, said connection setup message indicating slice information to be added to radio resource control;

- 5 receiving a setup complete message from the UE, said setup complete message including network slice selection assistance information in response to said connection setup message; and
utilizing the network slice selection assistance information for connection to an access and mobility management function.

- 10 9. A method comprising:

sending an initial connection request message to a source gNB, said initial connection request message including a UE temporary identifier;

receiving a connection setup message from the source gNB, said connection setup message indicating that no network slice selection assistance information is to be provided in response;

- 15 sending a setup complete message to the source gNB, said setup complete message including no network slice selection assistance information in response to said connection setup message;
receiving an access stratum security activation message from the source gNB; and
sending the network slice selection assistance information to the source gNB.

- 20 10. A method comprising:

receiving an initial connection request message from a UE, said initial connection request message including a UE temporary identifier;

sending a connection setup message to the UE, said connection setup message indicating that no network slice selection assistance information is to be provided in response;

- 25 receiving a setup complete message from the UE, said setup complete message including no network slice selection assistance information in response to said connection setup message;
sending an access stratum security activation message to the UE;
receiving the network slice selection assistance information from the UE; and
utilizing the network slice selection assistance information for connection to an access and
30 mobility management function.

11. A method comprising:

after receiving network slice selection assistance information provisioned by the upper layer, sending an RRC message with differentiated content of said connection request message;

including corresponding network slice selection assistance information in said connection complete message according to the differentiated content by said connection request message.

12. A method comprising:

5 after being connected to a source gNB with network slice selection assistance information requested from the source gNB, sending an RRC message with a tracking area update (TAU) including the requested network slice selection assistance information to the source gNB; and receiving updated network slice selection assistance information from the source gNB.

10 13. A method comprising:

after being connected to a UE having previously requested network slice selection assistance information, receiving an RRC message with a tracking area update (TAU) including the previously requested network slice selection assistance information from the UE;

forwarding the tracking area update to an access and mobility management function (AMF)

15 based on the network slice selection assistance information;

receiving updated network slice selection assistance information from the AMF; and

forwarding the updated network slice selection assistance information to the UE.

14. A method comprising:

20 receiving a tracking area update from a source gNB based on network slice selection assistance information provided to a UE; and

sending updated network slice selection assistance information to the source gNB.

15. A method comprising:

25 connecting to a source gNB with network slice selection assistance information requested from the source gNB;

receiving an RRC reconfiguration message with a handover command from the source gNB;

and

connecting to a target gNB using information in the RRC reconfiguration message.

30

16. A method comprising:

receiving a connection to a UE, said UE having previously requested network slice selection assistance information;

sending a handover request to a target gNB with network slice selection assistance information from the UE;

receiving a handover command including updates to network slice selection assistance information requested in RRC messages; and

5 sending an RRC reconfiguration message with a handover command to the UE.

17. A method comprising:

receiving a handover request from a source gNB with network slice selection assistance information from a UE;

10 sending a handover command including updates to network slice selection assistance information requested in RRC messages to the source gNB;

connecting to the UE; and

utilizing the network slice selection assistance information for connection to an access and mobility management function.

15

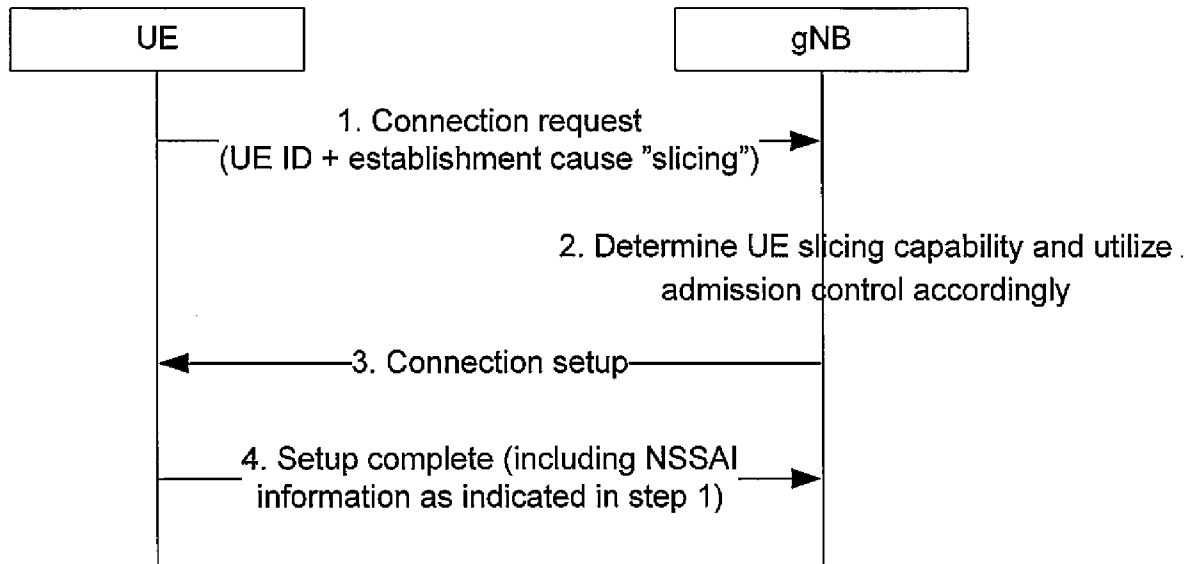


FIG. 1

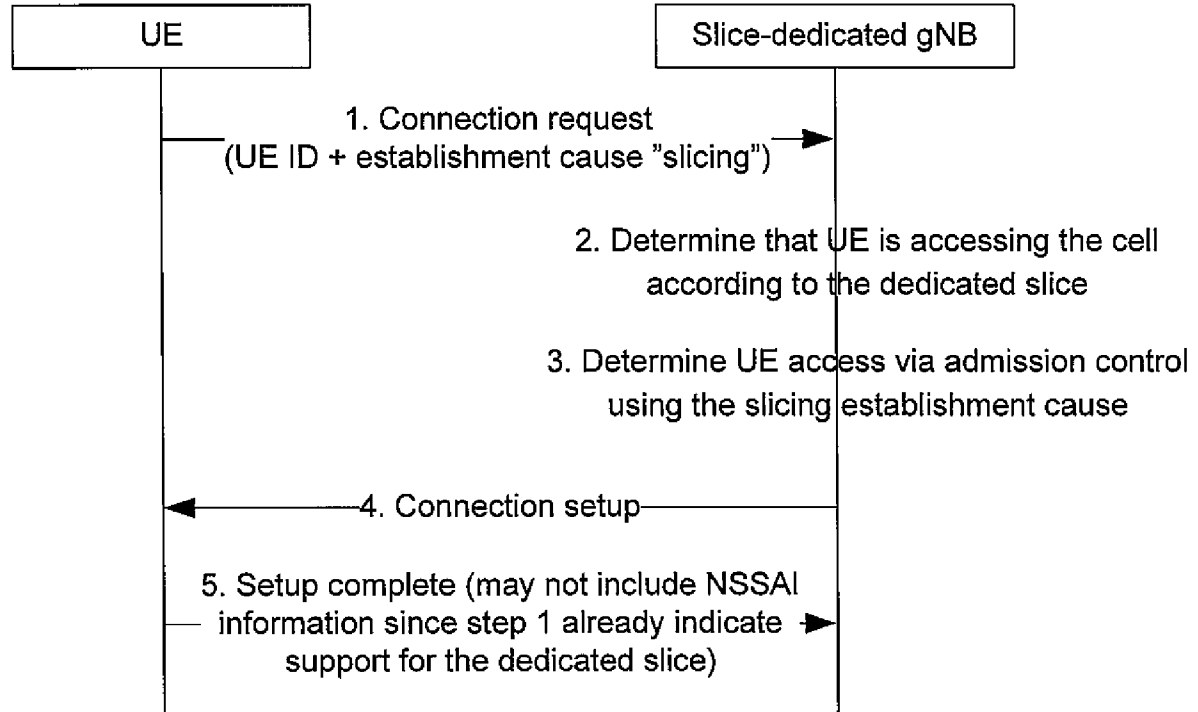


FIG. 2

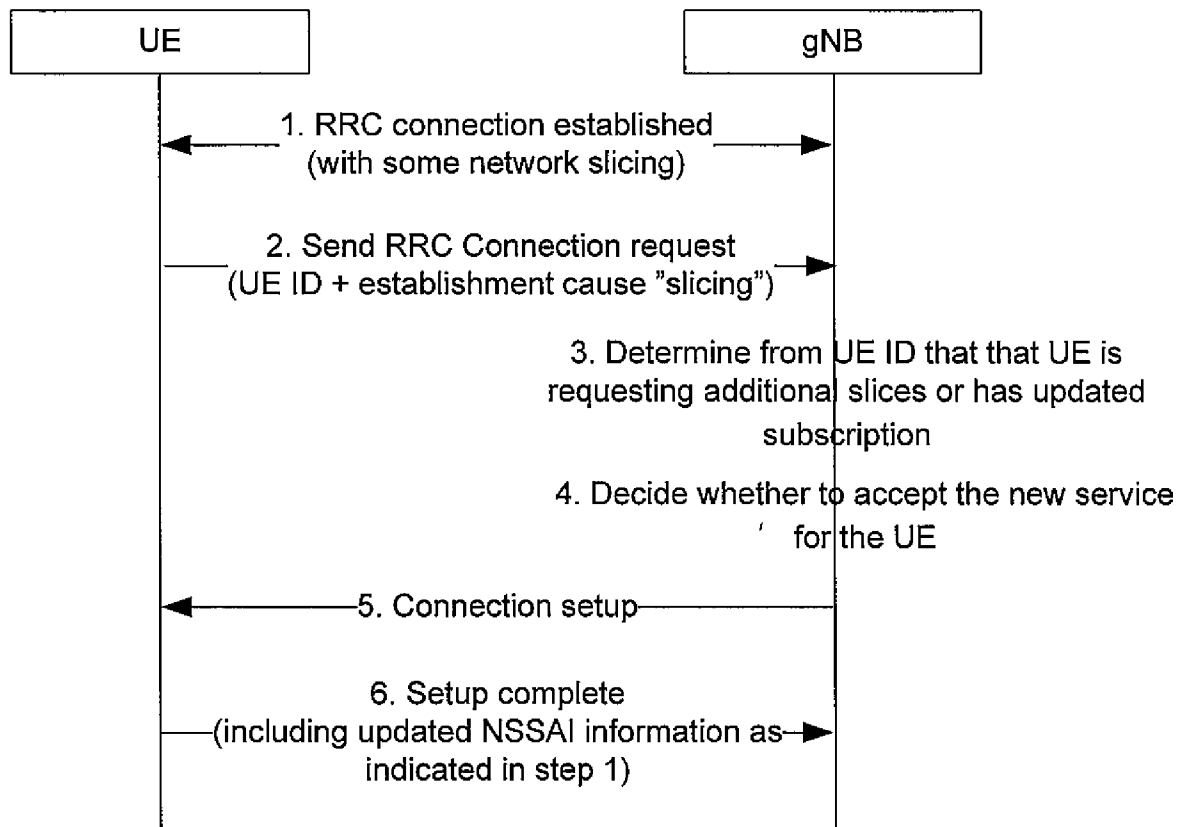


FIG. 3

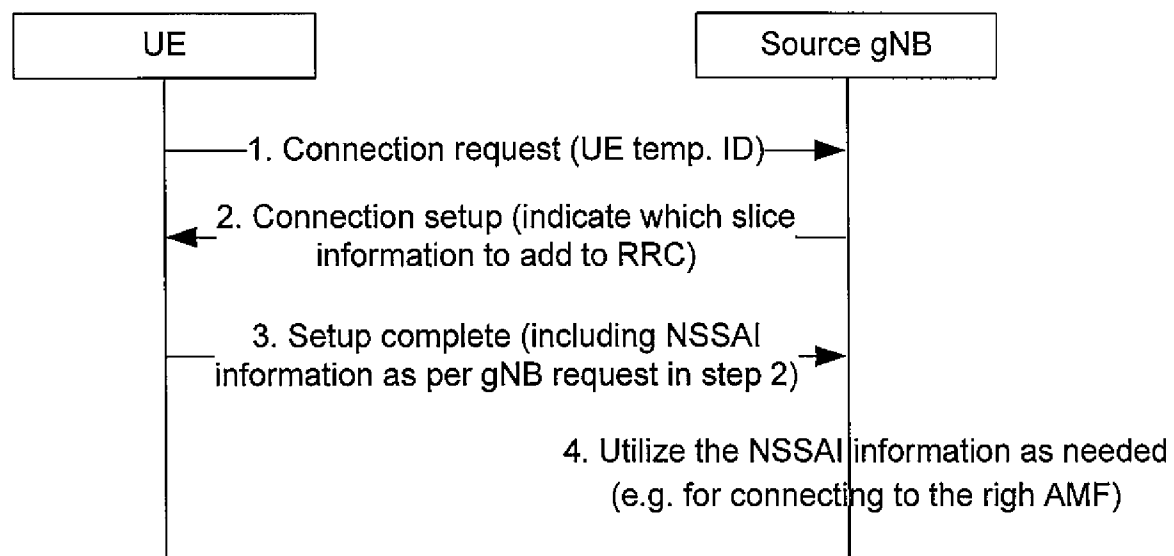


FIG. 4

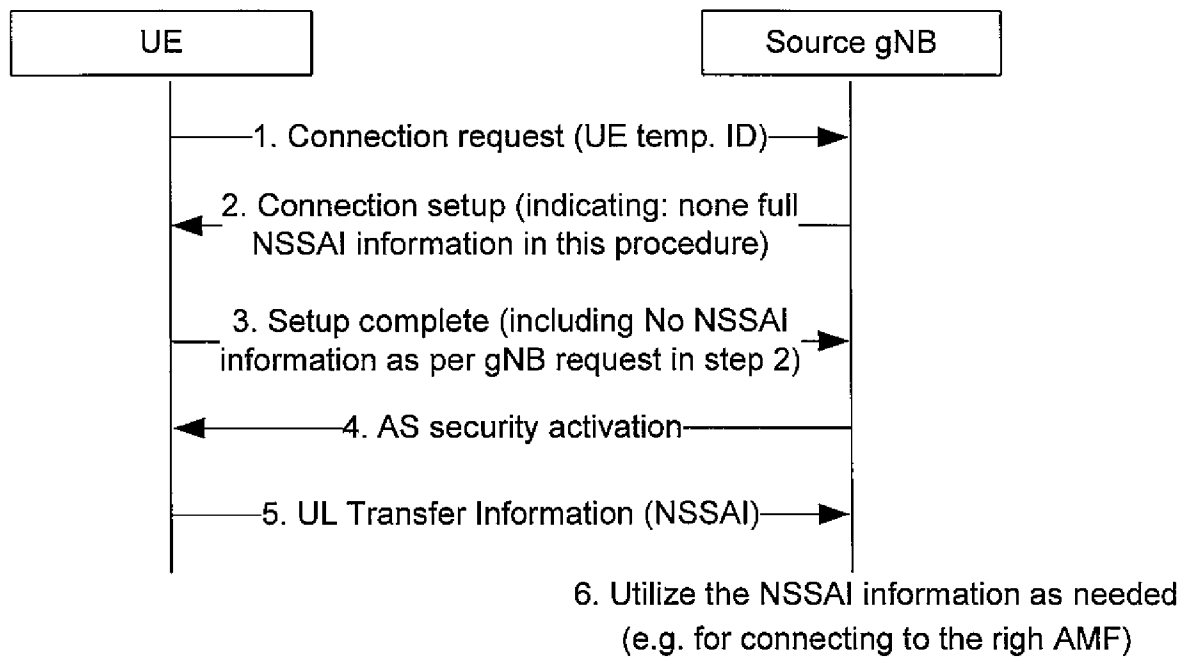


FIG. 5

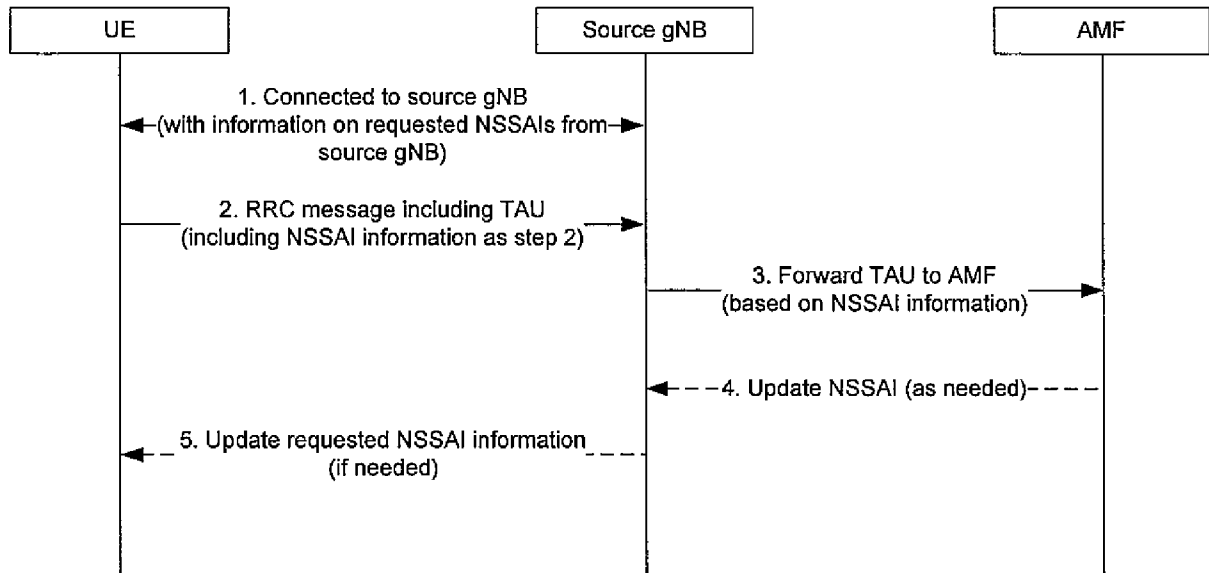


FIG. 6

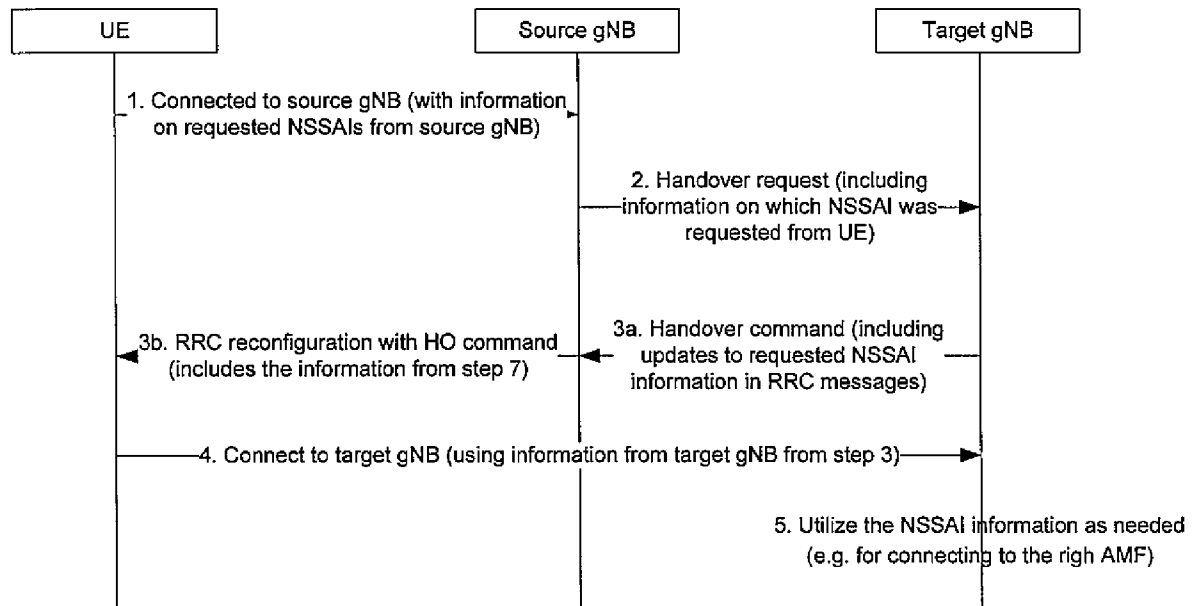


FIG. 7

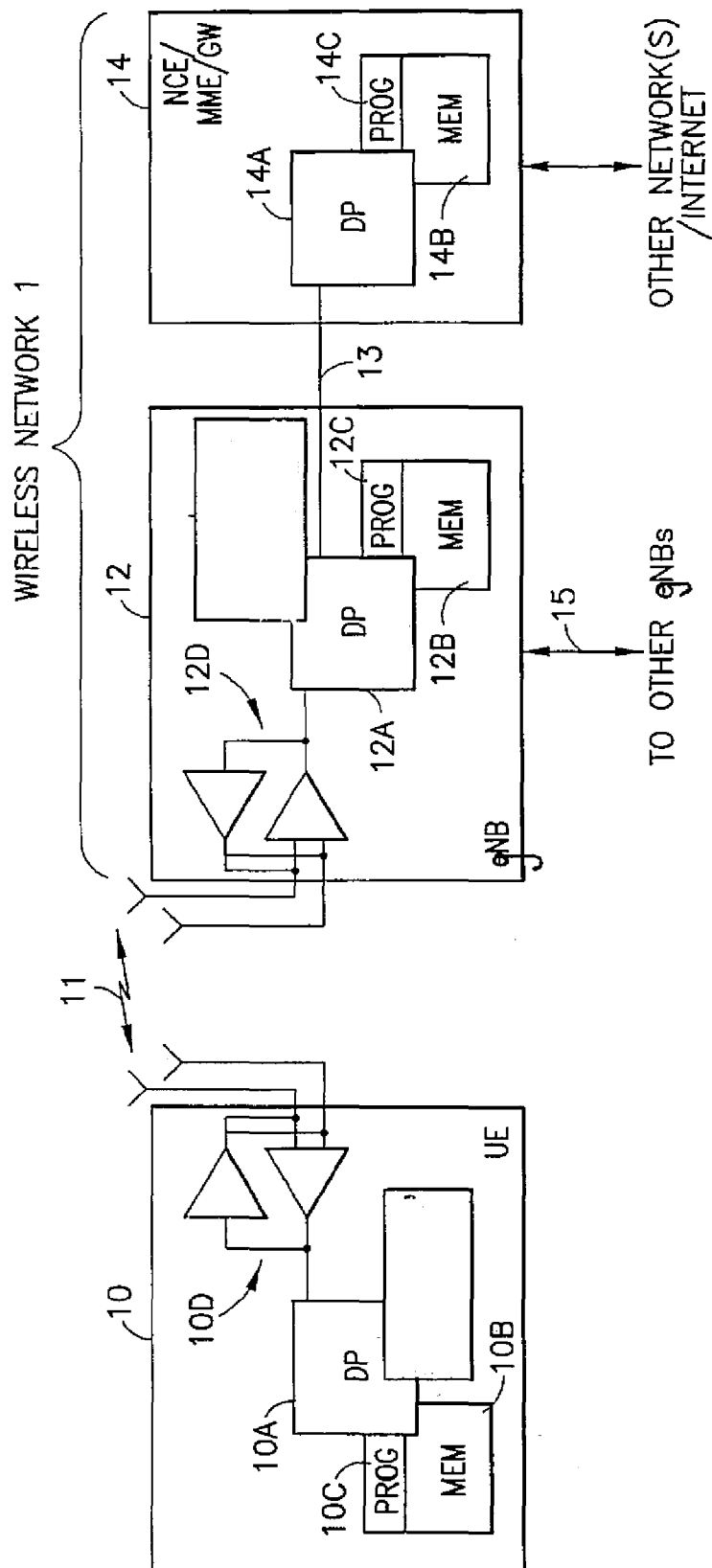


FIG. 8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB2018/053049

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

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)

IPC: H04W

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

SE, DK, FI, NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, PAJ, WPI data, COMPENDEX, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	3GPP TSG-RAN WG2#97bis; R2-1702551; Spokane, USA, 3-7 Apr, 2017; Ericsson; Signalling aspects of network slicing; Published 2014-04-03; whole document	1-2, 5-6, 15-17
A	--	3-4, 7-14
X	3GPP TR23.799 v14.0.0 (2016-12-16); 3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Study on Architecture for Next Generation System (Release 14); whole document; Chapter 6.1.2.2.3.3.2 and 8.1	12-14
A	--	1-11, 15-17



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:	"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
"A" document defining the general state of the art which is not considered to be of particular relevance	"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
"E" earlier application or patent but published on or after the international filing date	"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
"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)	"&" document member of the same patent family
"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	

Date of the actual completion of the international search

28-09-2018

Date of mailing of the international search report

28-09-2018

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB2018/053049

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	3GPP TSG-RAN WG2#97bis; R2-1702590; Spokane, USA, 3-7 Apr, 2017; Huawei, HiSilicon; Network Slice Selection Assistance Information over RRC; Published 2014-04-03; whole document -- -----	1-17

Continuation of: second sheet

International Patent Classification (IPC)

H04W 76/11 (2018.01)

H04W 48/18 (2009.01)

