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Contents

Foreword

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1 Scope

The present document specifies the Access Stratum (AS) part of the Idle Mode procedures applicable to a UE. The non-access stratum (NAS) part of Idle mode procedures and processes is specified in TS 23.122 [5].

The present document specifies the model for the functional division between the NAS and AS in a UE.

The present document applies to all UEs that support at least E-UTRA, including multi-RAT UEs as described in 3GPP specifications, in the following cases:

- When the UE is camped on an E-UTRA cell;
- When the UE is searching for a cell to camp on;

NOTE: When the UE is camped on or searching for a cell to camp on belonging to other RATs, the UE behaviour is described in the specifications of the other RAT.

The Idle Mode procedures defined in this specification are also applicable for a UE in RRC_INACTIVE state unless specified otherwise.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TR 25.990: "Vocabulary for UTRAN".

[2] 3GPP TS 36.300: "E-UTRA and E-UTRAN Overall Description; Stage 2".

[3] 3GPP TS 36.331: "E-UTRA; Radio Resource Control (RRC) - Protocol Specification".

[4] 3GPP TS 22.011: "Service accessibility".

[5] 3GPP TS 23.122: "NAS functions related to Mobile Station (MS) in idle mode".

[6] 3GPP TS 36.213: "E-UTRA; Physical layer procedures".

[7] 3GPP TS 36.214: "E-UTRA; Physical layer; Measurements".

[8] 3GPP TS 25.304: "User Equipment (UE) procedures in idle mode and procedures for cell reselection in connected mode"

[9] 3GPP TS 43.022: "Functions related to Mobile Station in idle mode and group receive mode".

[10] 3GPP TS 36.133: "Requirements for Support of Radio Resource Management".

[11] void

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[15] void

[16] 3GPP TS 24.301: "Non-Access-Stratum (NAS) protocol for Evolved Packet System (EPS); Stage 3"

[17] 3GPP2 C.S0024-C v2.0: "cdma2000 High Rate Packet Data Air Interface Specification".

[18] 3GPP2 C.S0005-F v1.0: "Upper Layer (Layer 3) Signalling Standard for cdma2000 Spread Spectrum Systems".

[19] 3GPP TS 25.304: "User Equipment (UE) procedures in idle mode and procedures for cell reselection in connected mode".

[20] 3GPP TS 24.008: "Mobile Radio Interface Layer 3 specification; Core Network Protocols; Stage 3"

[21] 3GPP TS 37.320: "Universal Terrestrial Radio Access (UTRA) and Evolved Universal Terrestrial Radio Access (E-UTRA); Radio measurement collection for Minimization of Drive Tests (MDT); Overall description; Stage 2".

[22] 3GPP TS 26.346: "Multimedia Broadcast/Multicast Service (MBMS); Protocols and codecs".

[23] 3GPP TS 23.401: "Evolved Universal Terrestrial Radio Access Network (E-UTRAN) access".

[24] 3GPP TS 23.682: "Architecture enhancements to facilitate communications with packet data networks and applications".

[25] 3GPP TS 23.402: "Architecture enhancements for non-3GPP accesses".

[26] IEEE 802.11, Part 11: "Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications, IEEE Std.".

[27] Wi-Fi Alliance Technical Committee, Hotspot 2.0 Technical Task Group: "Hotspot 2.0 (Release 2) Technical Specification".

[28] 3GPP TS 24.302: "Access to the 3GPP Evolved Packet Core (EPC) via non-3GPP access networks".

[29] 3GPP TS 23.303: "Proximity-based services (ProSe); Stage 2".

[30] 3GPP TS 36.321: "E-UTRA; Medium Access Control (MAC) protocol specification".

[31] 3GPP TS 24.105: "Application specific Congestion control for Data Communication (ACDC) Management Object (MO)".

[32] 3GPP TS 31.102: "Characteristics of the Universal Subscriber Identity Module (USIM) application".

[33] 3GPP TS 36.101: "Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) radio transmission and reception".

[34] Void

[35] 3GPP TS 23.003: "Numbering, addressing and identification".

[36] 3GPP TS 23.285: "Technical Specification Group Services and System Aspects; Architecture enhancements for V2X services".

[37] 3GPP TS 38.331: "NR; Radio Resource Control (RRC); Protocol specification".

[38] 3GPP TS 38.304: "New Generation Radio Access Network; User Equipment (UE) procedures in Idle mode and RRC Inactive state".

[39] 3GPP TS 23.501: "System Architecture for the 5G System; Stage 2".

[40] 3GPP TS 23.287: "Architecture enhancements for 5G System (5GS) to support Vehicle-to-Everything (V2X) services".

[41] 3GPP TS 22.261: "Service requirements for the 5G system".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

Acceptable Cell: A cell that satisfies certain conditions as specified in 4.3. A UE can always attempt emergency calls on an acceptable cell, but restriction as in 5.3.3 apply.

Accepted IMSI Offset value: An offset value allocated by core network used for calculating the Alternative IMSI value as specified in TS 23.401 [23].

Alternative cell reselection priority: Cell reselection priority broadcast in the system information via *altCellReselectionPriority* and *altCellReselectionSubPriority*.

Alternative IMSI value: A temporary substitute IMSI value used for deriving the paging occasion for Multi-USIM UE to avoid paging occasion collision as specified in TS 23.401 [23].

Available PLMN(s): One or more PLMN(s) for which the UE has found at least one cell and read its PLMN identity(ies).

Barred Cell: A cell a UE is not allowed to camp on.

Camped on a cell: UE has completed the cell selection/reselection process and has chosen a cell. The UE monitors system information and (in most cases) paging information.

Camped on any cell: UE is in idle mode and has completed the cell selection/reselection process and has chosen a cell irrespective of PLMN identity.

Closed Subscriber Group (CSG): A Closed Subscriber Group identifies subscribers of an operator who are permitted to access one or more cells of the PLMN but which have restricted access (CSG cells).

CN type: The type of core network connectivity supported by an E-UTRA cell, either EPC or 5GC.

Commercial Mobile Alert System: Public Warning System that delivers *Warning Notifications* provided by *Warning Notification Providers* to CMAS capable UEs.

CSG cell: A cell broadcasting a CSG indication that is set to TRUE and a specific CSG identity.

CSG identity: An identifier broadcast by a CSG or hybrid cell/cells and used by the UE to facilitate access for authorised members of the associated Closed Subscriber Group.

CSG member cell: a cell broadcasting the identity of the selected PLMN, registered PLMN or equivalent PLMN and for which the Permitted CSG list of the UE includes an entry comprising cell's CSG ID and the respective PLMN identity.

DRX cycle: Individual time interval between monitoring Paging Occasion for a specific UE.

eDRX cycle: Time interval between the first Paging Occasions occurring after successive extended DRX periods.

eCall Only Mode: A UE configuration option that allows the UE to attach at EPS and register in IMS to perform only eCall Over IMS, and a non-emergency IMS call for test and/or terminal reconfiguration services.

EHPLMN: Any of the PLMN entries contained in the Equivalent HPLMN list TS 23.122 [5].

Equivalent PLMN list: List of PLMNs considered as equivalent by the UE for cell selection, cell reselection, and handover according to the information provided by the NAS.

EU-Alert: Public Warning System that delivers Warning Notifications provided by Warning Notification Providers using the same AS mechanisms as defined for CMAS.

Home PLMN: A PLMN where the Mobile Country Code (MCC) and Mobile Network Code (MNC) of the PLMN identity are the same as the MCC and MNC of the IMSI.

HNB Name: The Home eNodeB Name is a broadcast string in free text format that provides a human readable name for the Home eNodeB CSG identity and any broadcasted PLMN identity.

HSDN cell: A cell that has higher priority than other cells for cell reselection for HSDN capable UE in a High-mobility state.

Hybrid cell: A cell broadcasting a CSG Indicator that is set to FALSE and a specific CSG identity.

Hyper SFN: Index broadcast in System Information that increments at every SFN wrap around (i.e every 10.24s).

Korean Public Alert System (KPAS): Public Warning System that delivers Warning Notifications provided by Warning Notification Providers using the same AS mechanisms as defined for CMAS.

Location Registration (LR): UE registers its presence in a registration area, for instance regularly or when entering a new tracking area.

MBMS-dedicated cell: cell dedicated to MBMS transmission.

MBMS/Unicast-mixed cell: cell supporting both unicast and MBMS transmissions.

FeMBMS/Unicast-mixed cell: cell supporting MBMS transmission and unicast transmission as SCell.

NB-IoT: NB-IoT allows access to network services via E-UTRA with a channel bandwidth limited to 200 kHz.

Non-Terrestrial Network: An E-UTRAN consisting of eNBs, which provide non-terrestrial LTE access to UEs by means of an NTN payload embarked on a space-borne NTN vehicle and an NTN Gateway.

NR sidelink communication: AS functionality enabling at least V2X Communication as defined in TS 23.287 [40], between two or more nearby UEs, using NR technology but not traversing any network node.

Paging Time Window: The period configured for a UE in extended DRX, during which the UE monitors Paging Occasions following DRX cycle.

Permitted CSG list: A list provided by NAS containing all the CSG identities and their associated PLMN IDs of the CSGs to which the subscriber belongs.

NOTE: This list is known as Allowed CSG List in Rel-8 Access Stratum specifications.

Power saving mode: Mode allowing the UE to reduce its power consumption, as defined in TS 24.301 [16], TS 23.401 [23], TS 23.682 [24].

Process: A local action in the UE invoked by a RRC procedure or an Idle Mode or RRC_INACTIVE state procedure.

Radio Access Technology: Type of technology used for radio access, for instance E-UTRA, UTRA, GSM, CDMA2000 1xEV-DO (HRPD) or CDMA2000 1x (1xRTT).

Registered PLMN: This is the PLMN on which certain Location Registration outcomes have occurred TS 23.122 [5].

Registration Area: (NAS) registration area is an area in which the UE may roam without a need to perform location registration, which is a NAS procedure.

Reserved Cell: A cell on which camping is not allowed, except for particular UEs, if so indicated in the system information.

Restricted Cell: A cell on which camping is allowed, but access attempts are disallowed for UEs whose access classes are indicated as barred.

Selected PLMN: This is the PLMN that has been selected by the NAS, either manually or automatically.

Serving cell: The cell on which the UE is camped.

Sidelink: UE to UE interface for sidelink communication, V2X sidelink communication and sidelink discovery. The Sidelink corresponds to the PC5 interface as defined in TS 23.303 [29].

Sidelink communication: AS functionality enabling ProSe Direct Communication as defined in TS 23.303 [29], between two or more nearby UEs, using E-UTRA technology but not traversing any network node. The terminology "sidelink communication" without "V2X" prefix only concerns PS unless specifically stated otherwise.

Sidelink discovery: AS functionality enabling ProSe Direct Discovery as defined in TS 23.303 [29], using E-UTRA technology but not traversing any network node.

Strongest cell: The cell on a particular carrier that is considered strongest according to the layer 1 cell search procedure TS 36.213 [6], TS 36.214 [7].

Suitable Cell: This is a cell on which an UE may camp. For a E-UTRA cell, the criteria are defined in clause 4.3, for a UTRA cell in TS 25.304 [8], for a GSM cell in TS 43.022 [9], and for a NR cell in TS 38.304 [38].

V2X sidelink communication: AS functionality enabling V2X Communication as defined in TS 23.285 [36], between nearby UEs, using E-UTRA technology but not traversing any network node.

3.2 Symbols

For the purposes of the present document, the following symbols apply:

<symbol> <Explanation>

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

1xRTT	CDMA2000 1x Radio Transmission Technology
AS	Access Stratum
AC	Access Class (of the USIM)
ACDC	Application specific Congestion control for Data Communication
BCCH	Broadcast Control Channel
BL	Bandwidth reduced Low complexity
BR-BCCH	Bandwidth Reduced Broadcast Control Channel
BSS	Basic Service Set
CMAS	Commercial Mobile Altert System
CSG	Closed Subscriber Group
DRX	Discontinuous Reception
DL-SCH	Downlink Shared Channel
EHPLMN	Equivalent Home PLMN
EPC	Evolved Packet Core
EPS	Evolved Packet System
ETWS	Earthquake and Tsunami Warning System
E-UTRA	Evolved UMTS Terrestrial Radio Access
E-UTRAN	Evolved UMTS Terrestrial Radio Access Network
FDD	Frequency Division Duplex
GERAN	GSM/EDGE Radio Access Network
GWUS	Group Wake Up Signal
HPLMN	Home PLMN
HSDN	High Speed Dedicated Network
H-SFN	Hyper System Frame Number
HRPD	High Rate Packet Data
IAB	Integrated Access and Backhaul
IMSI	International Mobile Subscriber Identity
MBMS	Multimedia Broadcast-Multicast Service
MBSFN	Multimedia Broadcast multicast service Single Frequency Network
MCC	Mobile Country Code
MCCH	Multicast Control Channel
MDT	Minimization of Drive Tests
MM	Mobility Management
MNC	Mobile Network Code
MPDCCH	MTC Physical Downlink Control Channel
MTCH	Multicast Traffic Channel
NAS	Non-Access Stratum
NB-IoT	NarrowBand Internet of Things
NR	NR Radio Access
NRS	Narrowband Reference Signal

NTN	Non-Terrestrial Network
PLMN	Public Land Mobile Network
ProSe	Proximity-based Services
PSM	Power Saving Mode
PTW	Paging Time Window
PWS	Public Warning System
RAT	Radio Access Technology
RNA	RAN-based Notification Area
RNAU	RAN-based Notification Area Update
RRC	Radio Resource Control
SAP	Service Access Point
SIBX	SystemInformationBlockTypeX
TDD	Time Division Duplex
UAC	Unified Access Control
UE	User Equipment
UMTS	Universal Mobile Telecommunications System
USIM	Universal Subscriber Identity Module
UTRA	UMTS Terrestrial Radio Access
UTRAN	UMTS Terrestrial Radio Access Network
V2X	Vehicle-to-Everything
WUS	Wake Up Signal

4 General description of Idle mode

4.1 Overview

The idle mode tasks can be subdivided into four processes:

- PLMN selection;
- Cell selection and reselection;
- Location registration;
- Support for manual CSG selection.

The relationship between these processes is illustrated in Figure 4.1-1.

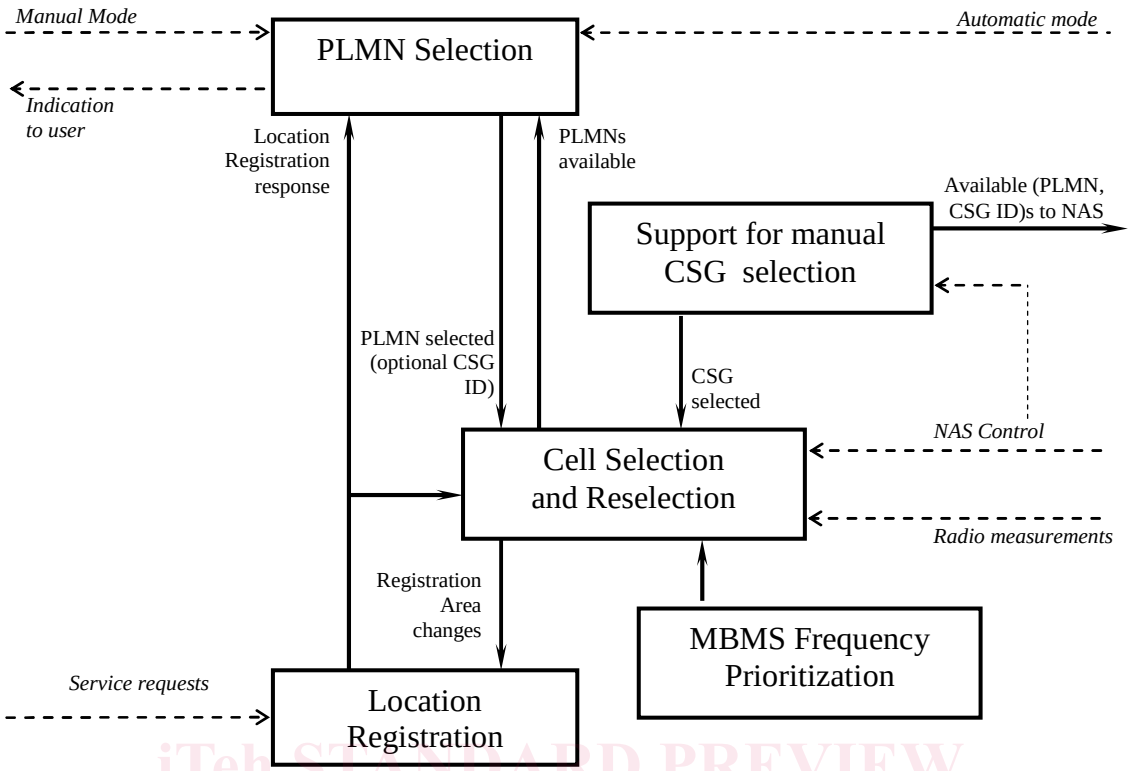

Figure 4.1-1: Overall Idle Mode process

When a UE is switched on, a public land mobile network (PLMN) is selected by NAS. For the selected PLMN, associated RAT(s) may be set TS 23.122 [5]. The NAS shall provide a list of equivalent PLMNs, if available, that the AS shall use for cell selection and cell reselection.

With the cell selection, the UE searches for a suitable cell of the selected PLMN and chooses that cell to provide available services, further the UE shall tune to its control channel. This choosing is known as "camping on the cell".

For E-UTRA a cell may be associated with more than one CN type (EPC and/or 5GC) and hence the selected cell can be suitable for more than one CN type. The CN type(s) for which the selected cell is suitable are reported to NAS which selects a CN type to be used for camping and for the NAS registration procedure (see below). Note that CN type selection is only applicabe for UE supporting E-UTRA connected to 5GC.

For E-UTRA a cell may be associated with more than one tracking area. The UE reports all the broadcasted tracking area codes in the selected cell to NAS for registration procedure.

The UE shall, if necessary, then register its presence, by means of a NAS registration procedure, in the tracking area of the chosen cell and as outcome of a successful Location Registration the selected PLMN becomes the registered PLMN TS 23.122 [5].

If the UE finds a more suitable cell, according to the cell reselection criteria, it reselects onto that cell and camps on it. Similar to cell selection procedure, if the reselected cell is an E-UTRA cell and the UE supports E-UTRA connected to 5GC, the CN type(s) for which the cell is suitable are reported to NAS which selects one of them. If the new cell does not belong to at least one tracking area to which the UE is registered, location registration is performed. In RRC_INACTIVE state, if the new cell does not belong to the configured RNA, a RNA update procedure is performed.

If necessary, the UE shall search for higher priority PLMNs at regular time intervals as described in TS 22.011 [4] and search for a suitable cell if another PLMN has been selected by NAS.

Search of available CSGs may be triggered by NAS to support manual CSG selection.

If the UE loses coverage of the registered PLMN, either a new PLMN is selected automatically (automatic mode), or an indication of which PLMNs are available is given to the user, so that a manual selection can be made (manual mode).

Registration is not performed by UEs only capable of services that need no registration.

The UE may perform sidelink communication or V2X sidelink communication or sidelink discovery or NR sidelink communication while in-coverage or out-of-coverage for sidelink, as specified in clause 11.

The purpose of camping on a cell in idle mode is fivefold:

a) It enables the UE to receive system information from the PLMN.

b) When registered and if the UE wishes to establish an RRC connection, it can do this by initially accessing the network on the control channel of the cell on which it is camped.

c) If the PLMN receives a call for the registered UE, it knows (in most cases) the set of tracking areas (in RRC_IDLE state) or RNAs (in RRC_INACTIVE state) in which the UE is camped. It can then send a "paging" message for the UE on the control channels of all the cells in this set of tracking areas. The UE will then receive the paging message because it is tuned to the control channel of a cell in one of the registered tracking areas and the UE can respond on that control channel.

d) It enables the UE to receive ETWS and CMAS notifications.

e) It enables the UE to receive MBMS services.

If the UE is unable to find a suitable cell to camp on or if the location registration failed (except for LR rejected with cause #12, cause #14, cause #15 or cause #25, see TS 23.122 [5] and TS 24.301 [16]), it attempts to camp on a cell irrespective of the PLMN identity, and enters a "limited service" state.

When NAS indicates that PSM starts, the AS configuration (e.g. priorities provided by dedicated signalling and logged measurements) is kept, all running timers continue to run but the UE need not perform any idle mode tasks. If a timer expires while the UE is in PSM it is up to UE implementation whether it performs the corresponding action immediately or the latest when PSM ends. When NAS indicates that PSM ends, the UE shall perform all idle mode tasks.

If *SystemInformationBlockType32* has been received and if the UE has determined that it is out of coverage using available satellite assistance information (e.g. ephemeris parameters and coverage parameters in current or previously received *SystemInformationBlockType32*, *SystemInformationBlockType31*, *t-Service* in *SystemInformationBlockType3* or other parameters), the AS configuration (e.g. priorities provided by dedicated signalling and logged measurements) is kept, but the UE need not perform any idle mode tasks. It is up to UE implementation to handle running timers. The detection of out of coverage using satellite assistance information is up to UE implementation and once in coverage the UE shall perform all idle mode tasks.

4.2 Functional division between AS and NAS in Idle mode

Table 1 presents the functional division between UE non-access stratum (NAS) and UE access stratum (AS) in idle mode. The NAS part is specified in TS 23.122 [5] and the AS part in the present document.