UE Modes

- Idle mode
- Connected mode
- Camping on a cell
- Idle mode tasks
  - PLMN selection
  - Cell selection and reselection

References:
- 3GPP TS 25.301-4.1.0: overview on UE modes
- 3GPP TS 25.304 and 25.122: details on idle mode
- 3GPP TS 25.303: details on connected mode
Overview on Modes and States (PS mode)

- **UE**: User Equipment
- **SGSN**: Serving GPRS Support Node
- **GGSN**: Gateway GPRS Support Node
- **SM**: Session Management
- **SM PDP context**: (active, inactive)
- **PMM state**: (detached, idle, connected)
- **RNC**: Radio Network Controller
- **Signaling connection**
- **RRC connection**

**UE mode**

**PMM**: Packet Mode Mobility Management
(soon GMM – GPRS Mobility Management)
**SM**: Session Management

UMTS Networks  
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Overview on Modes and States (CS mode)

CM: call state (active, null)

MM state (detached, idle, connected)

Signaling connection

RRC connection

UE mode

MM: Mobility Management
CM: Connection Management
Relations between CM/SM, MM/PMM and RRC States

Core Network
- CM/SM state(s) (UE-SGSN-GGSN)
- MM/PMM state (UE, SGSN, HLR)

UTRAN
- Signaling connection (UE-SGSN)
- RRC state (UE-RNC)

Subscription
- PDCP address
  - inactive
  - active

MM/PMM state
- detached
- idle
- connected

Signaling connection
- none
- yes

RRC state
- idle
- connected

Paging using TMSI/P-TMSI
Addressing using RNTI
UE Modes

**Idle mode** (paging area is known; paging needed)
- UE is identified by non-access stratum identities such as IMSI, TMSI and P-TMSI
- UTRAN has no own information about the individual UEs in idle mode (no RRC connection)
- UTRAN can only address e.g. all UEs in a cell or all UEs monitoring a specific paging occasion

**Connected mode** (cell or URA is known; RRC connection)
- connected mode is entered when the UTRAN establishes and maintains information about the individual UE (RRC connection)
- RRC connection is established between UE and Serving RNC
- UE is assigned a radio network temporary identity (U-RNTI and possibly a C-RNTI) to be used as UE identity on common transport channels (RACH, FACH, PCH)
- connected mode does not require assignment of physical channel resources
UE Idle Mode – Camping on a cell

Purpose of camping on a cell in idle mode:

- UE receives system information from the PLMN (BCH)
- UE is able to establish an RRC connection (access of the network on the control channel of the cell on which it is camped - RACH/FACH)
- PLMN knows (in most cases) the registration area of UE
  => paging on control channels within the registration area (PCH)
- UE may receive cell broadcast services (BCH)

„Limited service“ state:

If
- UE is unable to find a suitable cell to camp on, or
- USIM is not inserted, or
- location registration failed,
UE attempts to camp on a cell irrespective of the PLMN identity, and enters a "limited service" state in which only emergency calls are possible

Source: 3GPP 25.304
UE Idle Mode – Camping on a cell

UE is switched on
- a PLMN is selected and
- UE searches for a suitable cell of this PLMN to camp on

Functions executed when camped on a cell
(i.e. UE is in idle mode and has chosen a cell)
- UE monitors system information
- UE monitors paging information (PLMN is not aware of the cell chosen by the UE; PLMN is not aware of the UE in „limited service state“)
- UE executes a cell reselection if it finds a more suitable cell to camp on
- UE executes a location registration to register its presence in the registration area by means of a NAS registration procedure if the new cell is in a different registration area (LA or RA)

Source: 3GPP 25.304
**UE Idle Mode – Tasks**

### Manual Mode

- **PLMN Selection and Reselection**
  - Location Registration response
  - PLMN selected
  - CM requests

### Automatic Mode

- **Registration with UMTS network**
  - PLMNs available
  - NAS Control
  - Radio measurements
  - Location registration with UMTS network

**Source:** 3GPP 25.304
UE Idle Mode – States and Transitions

Initial Cell Selection

- Stored information Cell Selection
  - Cell Selection when leaving connected mode
    - return to idle mode
    - Connected mode

- Initial Cell Selection
  - go here whenever a new PLMN is selected
  - no cell information stored for the PLMN

Connected mode

- Camped normally
  - NAS indicates that registration on selected PLMN is rejected (except with cause #14 or #15 [5][16])
  - no suitable cell found

- Cell Reselection Evaluation Process
  - no suitable cell found

Any Cell Selection

- go here when no USIM in the UE
  - USIM inserted

Limited service state

- Limited service state
  - return to idle mode

Connected mode

- Camped on any cell
  - trigger
    - acceptable cell found
    - leave idle mode
    - Connected mode (Emergency calls only)
    - return to idle mode

- Cell Reselection Evaluation Process
  - no acceptable cell found
UE Idle Mode – PLMN reselection

The NAS provides a list of equivalent PLMNs that the AS uses for PLMN selection, cell selection, cell reselection and handover.

PLMN reselection: if necessary, the UE will look for more suitable cells on other PLMNs at regular time intervals.

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 (manual selection)

Registration is not performed by UEs only capable of services that need no registration (emergency call).

Source: 3GPP 25.304
UE Idle Mode – Cell Selection and Reselection

When camped on a cell, the UE shall regularly search for a better cell according to the cell reselection criteria.

If a better cell is found, that cell is selected.

The change of cell may imply a change of radio access technology (RAT), e.g. from UMTS to GSM.

The NAS is informed if the cell selection and reselection results in changes in the received system information.

For normal service, the UE has to camp on a suitable cell, tune to that cell's control channel(s) so that the UE can:

- receive system information from the PLMN
- receive registration area information from the PLMN, e.g. LA or RA
- receive other AS and NAS information

If registered:

- receive paging and notification messages from the PLMN and
- initiate call setup for outgoing calls or other actions from the UE.