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# Evolution der öffentlichen Mobilfunknetze (3G/4G)
## Chapter VI: Network architecture

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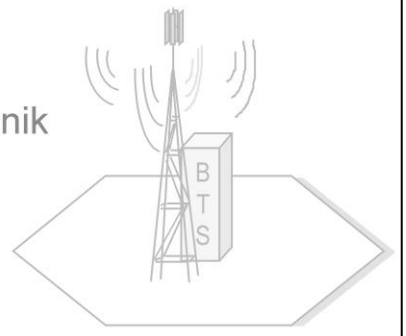


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## Evolution of public radio networks

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1. Introduction/Overview GSM/UMTS
2. Basics: Radio Transmission
3. Basics: Radio Network Planning
4. Physical Layer
5. Radio Interface Protocols
6. Architecture / Core Network
7. Security
8. UMTS Evolution / LTE
9. Supplemtary Services

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## Outline Part VI

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1. Overview
2. Network Elements
3. Location Management
4. Protocol Stack

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# Base architecture of a UMTS-Network

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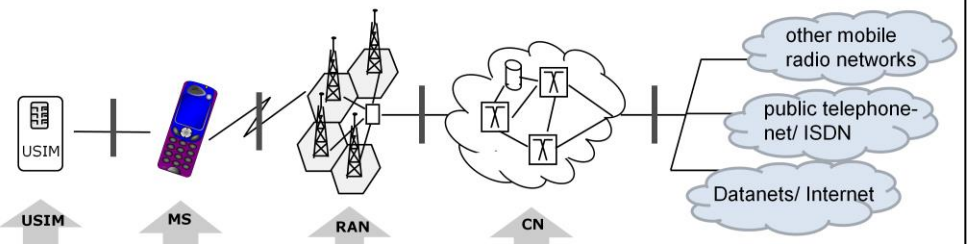


USIM MS RAN CN

**Core Network** Transport functions, mobility-management, member-databases, service-controlling, etc.

**Radio Access Network** Radio-technology dependent functions on the core network side (Radio Resource Management, etc.)

**Mobile Station** Radio-interfaces (radio transmission) Service-controlling and user interface

**UMTS Subscriber Identity Module** Contains member specific data Enables authenticated entry to the network

— Interfaces between function-blocks

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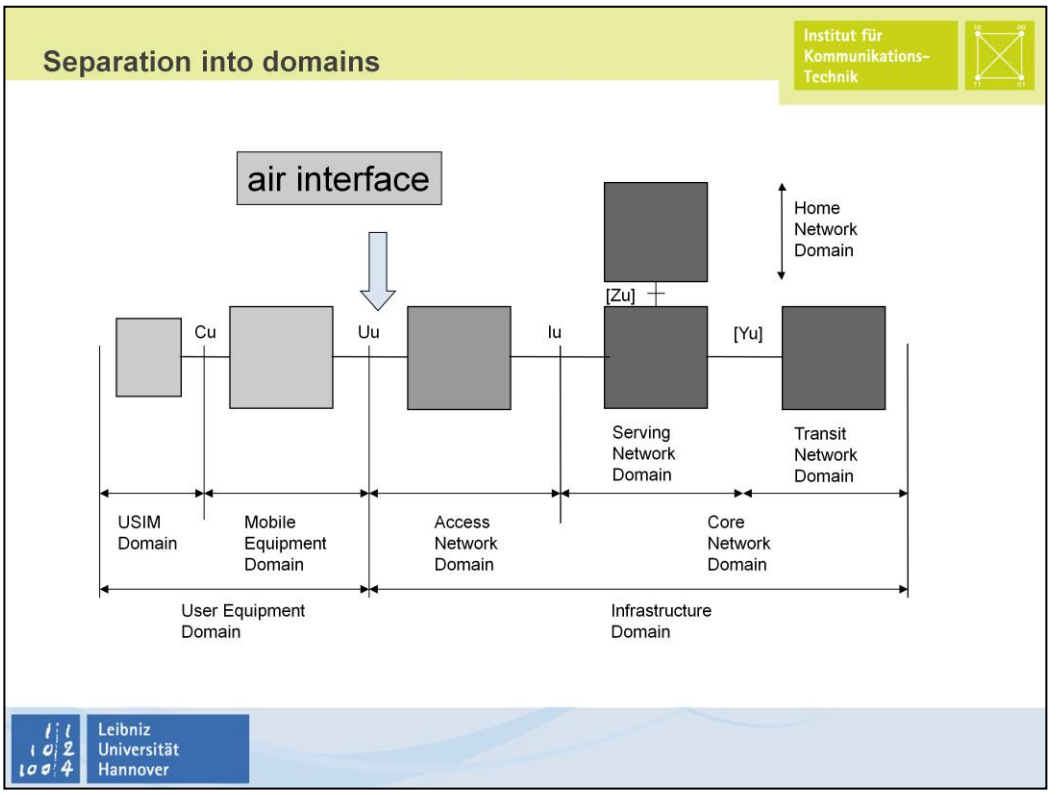



**User equipment Domain**

This domain encompasses a variety of equipment types with different levels of functionality. These equipment types are referred to as user equipment (terminals), and they may also be compatible with one or more existing access (fixed or radio) interfaces e.g. dual mode UMTS-GSM user equipment. The user equipment may include a removable smart card that may be used in different user equipment types. The user equipment is further sub-divided in to the **Mobile Equipment Domain** (ME) and the **User Services Identity Module Domain** (USIM).

**Mobile equipment Domain**

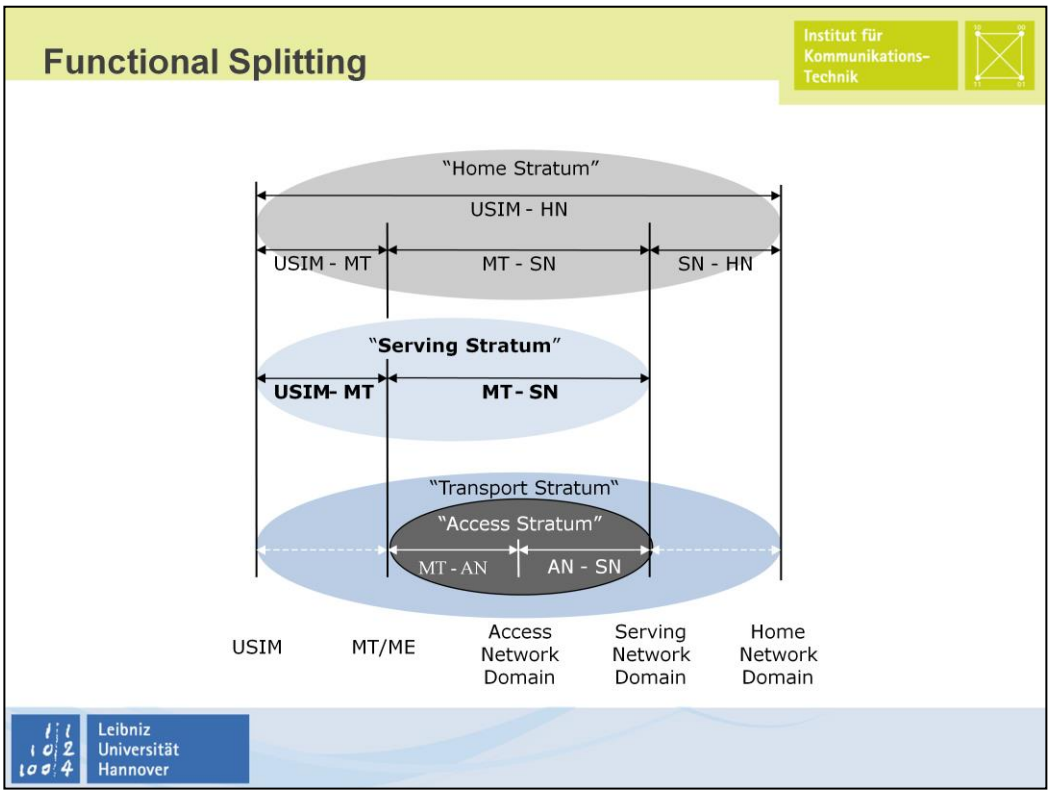
The Mobile Equipment performs radio transmission and contains applications. The mobile equipment may be further sub-divided into several entities, e.g. the one which performs the radio transmission and related functions, **Mobile Termination,** MT, and the one which contains the end-to-end application or (e.g. laptop connected to a mobile phone), **Terminal Equipment.** TE.

**USIM Domain**

The USIM contains data and procedures which unambiguously and securely identify itself. These functions are typically embedded in a stand alone smart card. This device is associated to a given user, and as such allows to identify this user regardless of the ME he uses.

**Infrastructure Domain**

The Infrastructure domain is further split into the **Access Network Domain**, which is characterised by being in direct contact with the User Equipment and the **Core Network Domain.** This split is intended to simplify/assist the process of de-coupling access related functionality from non-access related functionality and is in line with the modular principle adopted for the UMTS. The Access Network Domain comprises roughly the functions specific to the access technique, while the functions in the Core network domain may potentially be used with information flows using any access technique. This split allows for different approaches for the Core Network Domain, each approach specifying distinct types of Core Networks connectable to the Access Network Domain, as well as different access techniques, each type of Access Network connectable to the Core Network Domain.




Two basic approaches exist for the core network:

**CS Domain**

The CS domain refers to the set of all the CN entities offering "CS type of connection" for user traffic as well as all the entities supporting the related signalling. A "CS type of connection" is a connection for which dedicated network resources are allocated at the connection establishment and released at the connection release.

The entities specific to the CS domain are: MSC, GMSC, VLR.

**PS Domain**

The PS domain refers to the set of all the CN entities offering "PS type of connection" for user traffic as well as all the entities supporting the related signalling. A "PS type of connection" transports the user information using autonomous concatenation of bits called packets: each packet can be routed independently from the previous one.

The entities specific to the PS domain are the GPRS specific entities, i.e. SGSN and GGSN.

## Outline Part VI

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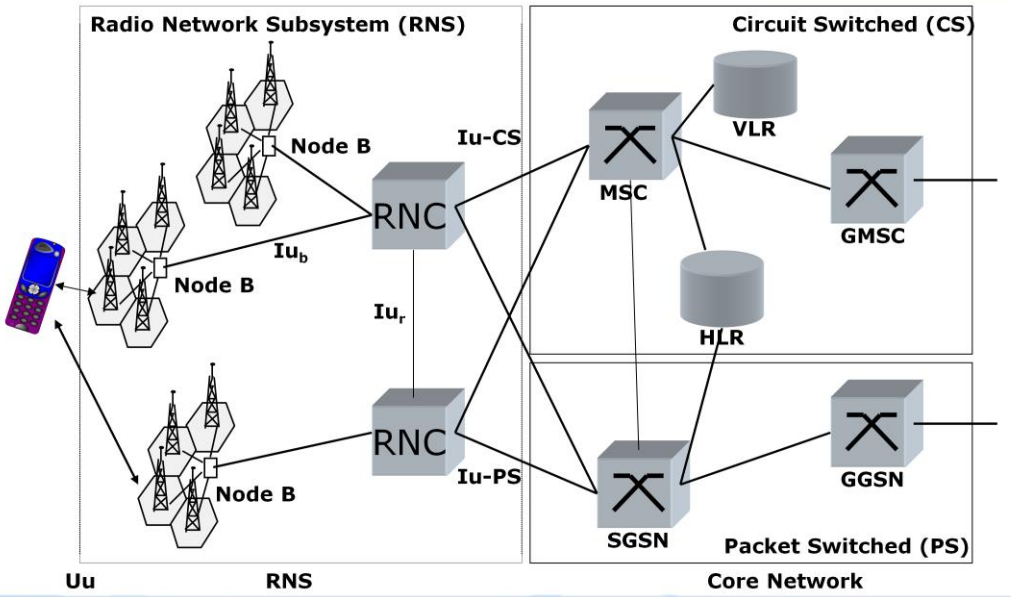
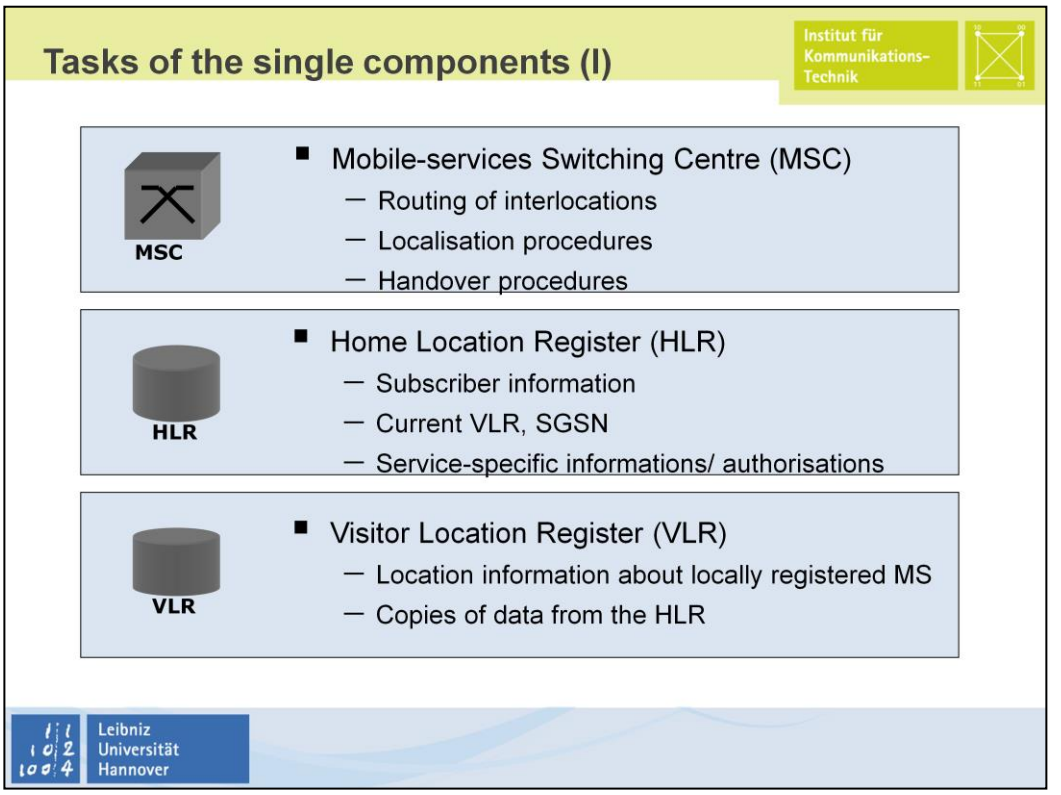
# Architecture of the Access Stratum








**Mobile-services Switching Centre (MSC)**

The Mobile-services Switching Centre (MSC) constitutes the interface between the radio system and the fixed networks. The MSC performs all necessary functions in order to handle the circuit switched services to and from the mobile stations. In order to obtain radio coverage of a given geographical area, a number of base stations are normally required; i.e. each MSC would thus have to interface several base stations. In addition several MSCs may be required to cover a country. The Mobile-services Switching Centre is an exchange which performs all the switching and signalling functions for mobile stations located in a geographical area designated as the MSC area. The main difference between a MSC and an exchange in a fixed network is that the MSC has to take into account the impact of the allocation of radio resources and the mobile nature of the subscribers and has to perform in addition, at least the following procedures:

-procedures required for the location registration (see TS 23.012);

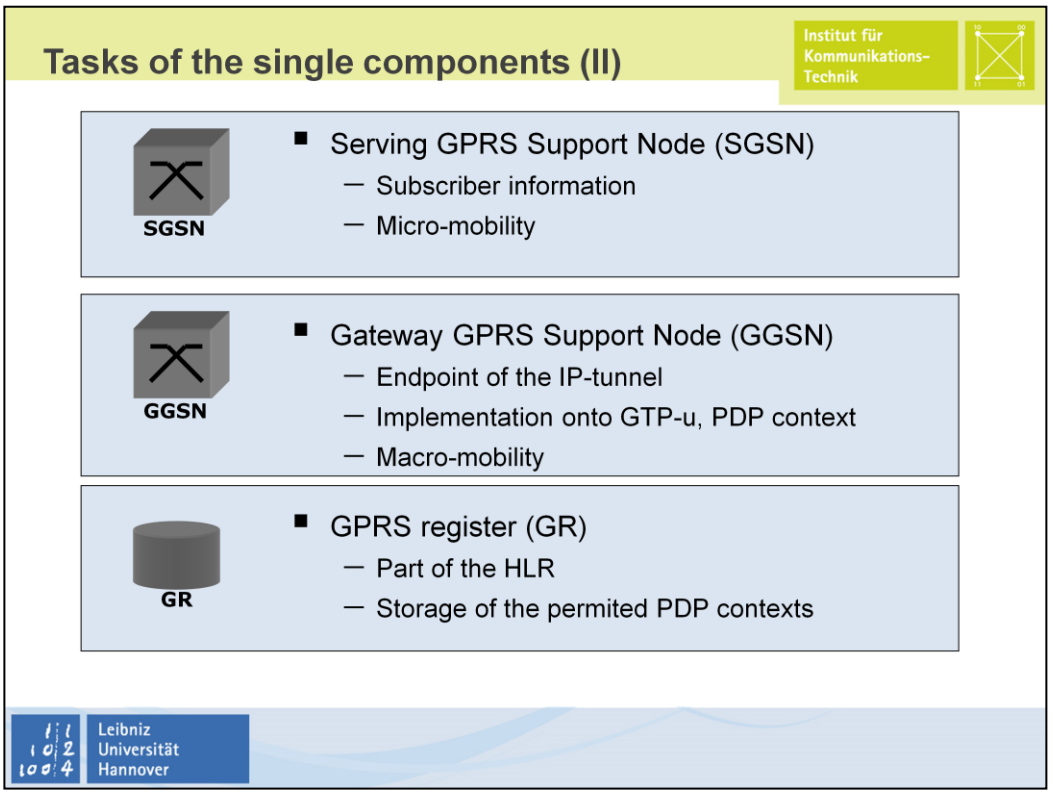
-procedures required for handover (see TS 23.009).

**The Visitor Location Register (VLR)**

A mobile station roaming in an MSC area is controlled by the Visitor Location Register in charge of this area. When a Mobile Station (MS) enters a new location area it starts a registration procedure. The MSC in charge of that area notices this registration and transfers to the Visitor Location Register the identity of the location area where the MS is situated. If this MS is no yet registered, the VLR and the HLR exchange information to allow the proper handling of calls involving the MS. A VLR may be in charge of one or several MSC areas. The VLR contains also the information needed to handle the calls set-up or received by the MSs registered in its data base (for some supplementary services the VLR may have to obtain additional information from the HLR).

**The Home Location Register (HLR)**

This functional entity is a data base in charge of the management of mobile subscribers. A PLMN may contain one or several HLRs: it depends on the number of mobile subscribers, on the capacity of the equipment and on the organisation of the network

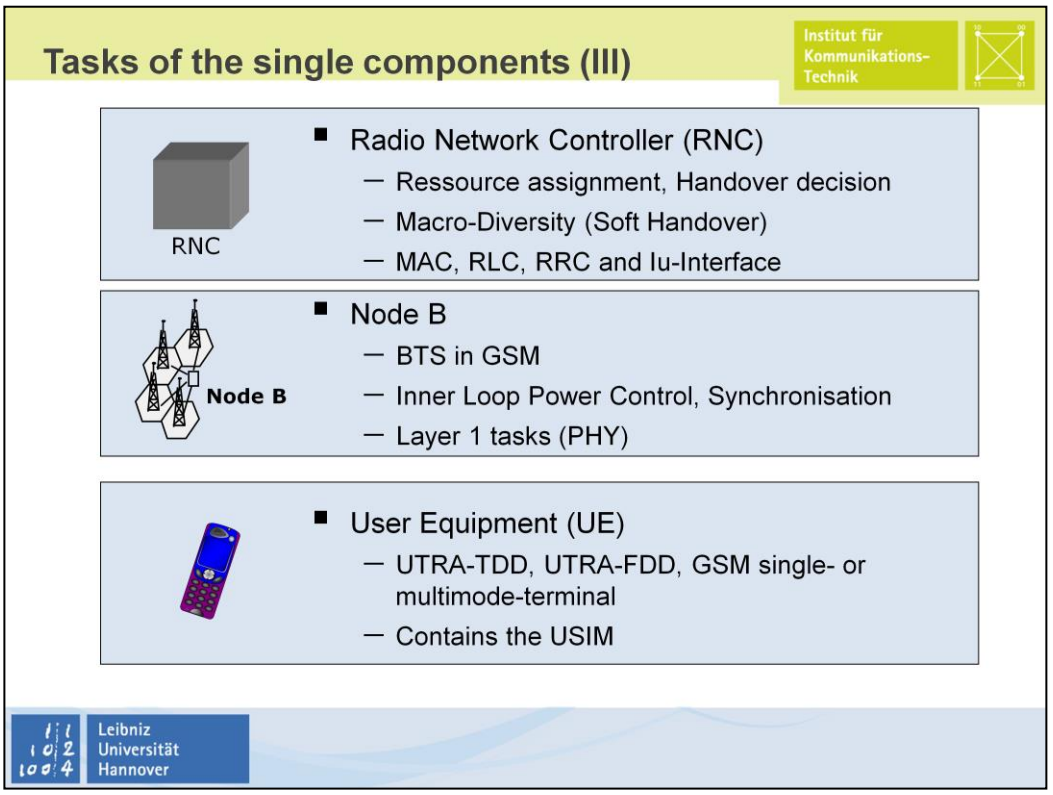



**Serving GPRS Support Node (SGSN)**

Similar to the functionality of an MSC/VLR in GSM, the SGSN is responsible for detecting MSs in its geographical area, registering them, and dealing with the micro-mobility issues keeping track of the MS as it moves in its area.The organisation of the subscriber data in the SGSN is defined in TS 23.008 and TS 23.060.

**Gateway GPRS Support Node (GGSN)**

The main functions of the GGSN involve interaction with external networks providing connections to ISPs and corporate intranets. It deals with macro-mobility in order to route packets to the serving SGSN. It also forwards data packet to the appropriate external network. The location register function in the GGSN stores subscriber data received from the HLR and the SGSN. The organisation of the subscriber data in the GGSN is defined in TS 23.008 and TS 23.060. The procedures for information transfer between the GGSN, the SGSN and the HLR are defined in TS 23.016 and TS 23.060.




The UTRAN consists of a set of Radio Network Subsystems (RNS) connected to the Core Network through the Iu. A RNS consists of a Radio Network Controller and one or more abstract entities currently called Node B. Node B are connected to the RNC through the Iub interface. The UTRAN consists of a set of Radio Network Subsystems (RNS) connected to the Core Network through the Iu.

A RNS consists of a Radio Network Controller and one or more abstract entities currently called Node B. Node B are connected to the RNC through the Iub interface.

A Node B is a physical unit for implementing UMTS radio transmission. Depending on the sectoring of the cells, one (omni) cell or multiple (sector) cells can be serviced by a Node B. Generally, up to six (60° ) cells are serviced by a Node B in UMTS. The UMTS system is however also open for the use of so-called intelligent antennae that allow particular UE to be pursued, thereby providing even greater system capacity (Space Division Multiple Access – SDMA).

A Node B can be used for FDD, TDD or dual mode operation. Collocation with GSM BTS's is recommended in order to save costs. A Node B is connected via the Uu interface with the different UE of a cell or cells, and via the Iub interface with an RNC. The UTRAN interfaces Iu, Iur and Iub are ATM-based. The Node B is therefore used as an ATM termination point. STM-1 or STM-4 lines (155.5 and 622 Mbit/s respectively) or their American or Japanese equivalents (TS 25.411/421/431) are recommended for Layer-1 implementation of the Iu, Iur and Iub interfaces.

A Node B converts user and signaling information received from the RNC via the Iub interface for transport over the radio interface, Uu, and in the opposite direction. This activity includes safeguarding of the information against loss (Forward Error Correction – FEC) in addition to the preparation for WCDMA transmission (spreading and modulation) and RF handling.

Node B's are involved in power control. Its own power is controlled in accordance with the Transmit Power Control (TPC) information received from the UL's (Inner Loop Power Control). The Node B also measures the S/N ratio of the UE, compares the value with predefined values (Outer Loop Power Control) and instructs the UE with the TPC information DL to control its transmission power. The Node B also measures the quality and strength of the links and determines the Frame Error Rate (FER). The data is transmitted in a measurement report to the Node B and is used there as a basis for handover and Macro Diversity Combining. The Node B performs Micro Diversity Combining (FDD Softer Handover) itself. Additional transport capacities to the RNC are not required. Refer to the 3G TS 25.104 / 25.105 (FDD / TDD) for details and technical parameters regarding Node B functions (Radio Transmission & Reception).

## Tasks of the Radio Network Controller

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Autonomous RRM

- Admission Control
- Radio Resource Control RRC
- Radio Bearer Set-up/ Release
- Code Allocation
- (Outer Loop) Power Control
- Congestion Control (Packet Scheduling)
- Handover Control (incl. Combining/ Splitting)
- S-RNS Relocation (S-RNC/ D-RNC)
- Ciphering and Deciphering
- Protocol conversion (Iu ↔ Iub, Iur)
- ATM switching and multiplexing
- O&M tasks

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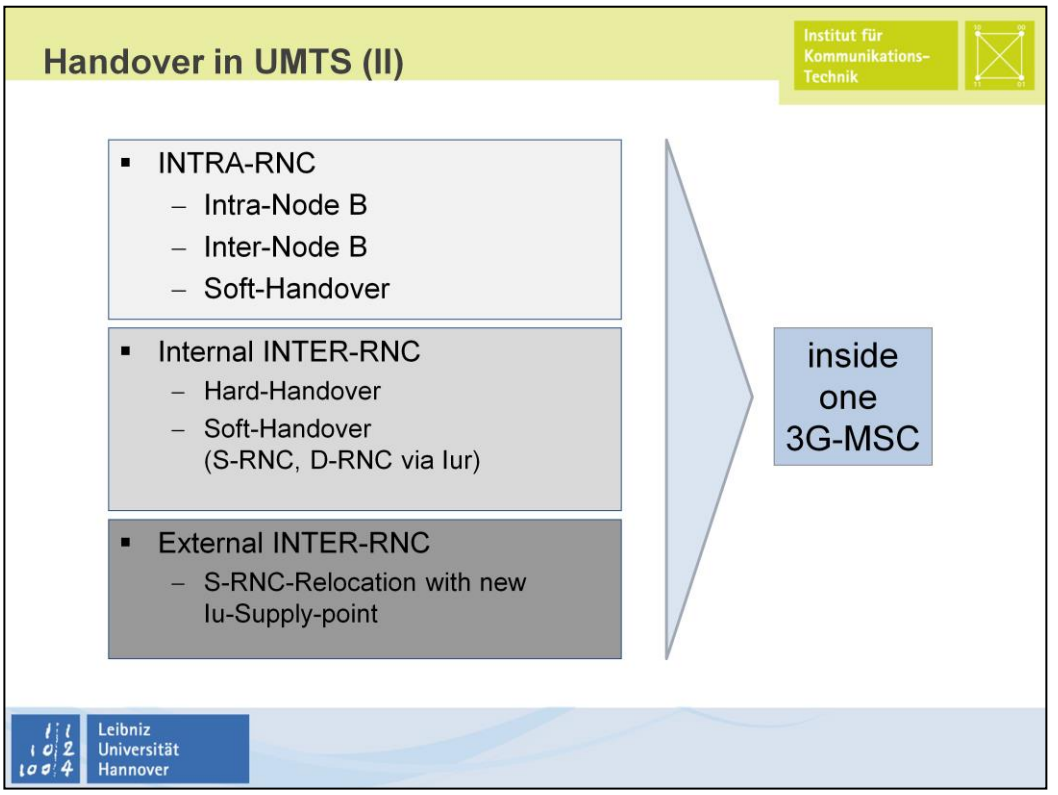
The RNC enables autonomous radio resource management (RRM) by UTRAN. It performs the same functions as the GSM BSC, providing central control for the RNS elements (RNC and Node Bs).

The RNC handles protocol exchanges between Iu, Iur, and Iub interfaces and is responsible for centralized operation and maintenance (O&M) of the entire RNS with access to the OSS. Because the interfaces are ATM–based, the RNC switches ATM cells between them. The user's circuit-switched and packet-switched data coming from Iu–CS and Iu–PS interfaces are multiplexed together for multimedia transmission via Iur, Iub, and Uu interfaces to and from the UE.

The RNC uses the Iur interface, which has no equivalent in GSM BSS, to autonomously handle 100 percent of the RRM, eliminating that burden from the CN. Serving control functions such as admission, RRC connection to the UE, congestion and handover/macro diversity are managed entirely by a single serving RNC (SRNC).

If another RNC is involved in the active connection through an inter–RNC soft handover, it is declared a drift RNC (DRNC). The DRNC is only responsible for the allocation of code resources. A reallocation of the SRNC functionality to the former DRNC is possible (serving radio network subsystem [SRNS] relocation). The term controlling RNC (CRNC) is used to define the RNC that controls the logical resources of its UTRAN access points.




UMTS TS 23.009

There are two types of handover in UMTS: soft handover and hard handover. The first one is fully performed within UTRAN, without involving the core network. The second one may be also performed within UTRAN, or the core network may be involved if the Iur interface between RNSs does not exist. This case of hard handover involving the core network is the only one that is covered in the present document, together with SRNS relocation with Iur interface.

## Handover in UMTS (III)



- INTER-MSC
  - New SRNS
- INTER-System
  - UMTS ⇔ GSM
  - UMTS ⇔ IMT-2000
- INTER-Segment
  - UMTS ⇔ SAT

between two 3G-MSC or between one 3G-MSC and one GSM-MSC

10 fundamentally different handover-types

## RNC and Handover

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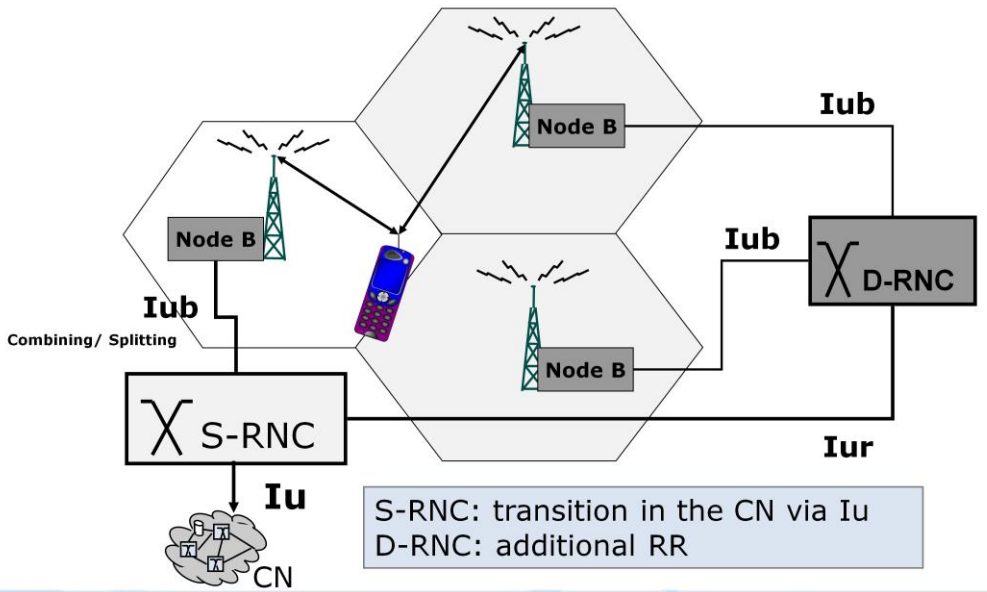


S-RNC: transition in the CN via Iu
D-RNC: additional RR

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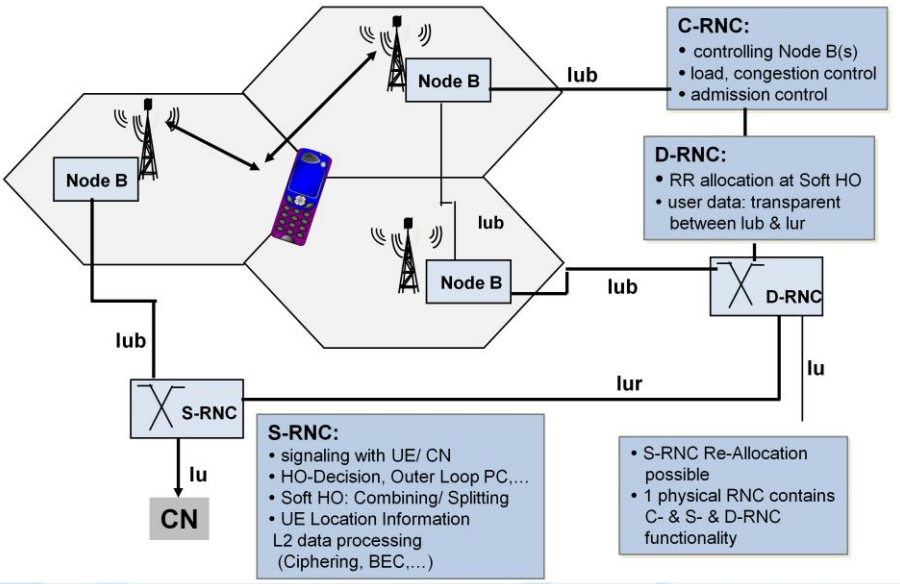
# RNC functionality








S-RNC: Serving RNC
D-RNC: Drift RNC
C-RNC: Controlling RNC

## Example

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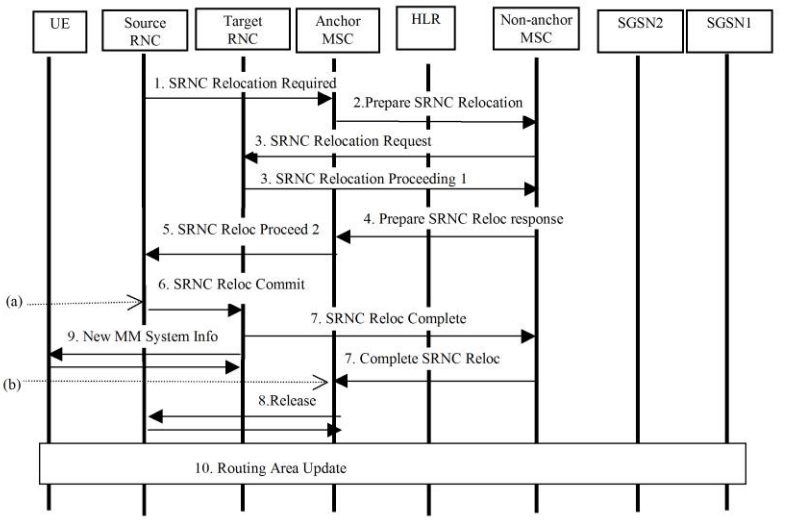


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TS23.121

UTRAN makes the decision to perform the Serving RNC relocation procedure. This includes decision on into which RNC (Target RNC) the Serving RNC functionality is to be relocated. The source SRNC sends SRNC Relocation required messages to the MSC. This message includes parameters such as target RNC identifier and an information field that shall be passed transparently to the target RNC.

Upon reception of SRNC Relocation required message the Anchor MSC (MSC1) prepares itself for the switch and determines from the received information that the SRNC relocation will (in this case) involve another MSC. The Anchor MSC will then send a Prepare SRNC Relocation Request to the applicable non-anchor MSC (MSC2) including the information received from the Source RNC.

The non-anchor MSC will send a SRNC Relocation Request message to the target RNC. This message includes information for building up the SRNC context, transparently sent from Source RNC (UE id., no of connected CN nodes, UE capability information), and directives for setting up Iu user plane transport bearers. When Iu user plane transport bearers have been established, and target RNC has completed its preparation phase, SRNC Relocation Proceeding 1 message is sent to the non-anchor MSC.

The Prepare SRNC Relocation Response that is sent from non-anchor MSC to Anchor MSC will contain the SRNC Relocation Proceeding 1 received from target RNC.

When the SRNC Relocation Proceeding 1 has been received in the Anchor MSC, the user plane transport bearers has been allocated the whole path between target RNC and Anchor MSC and the Anchor MSC is ready for the SRNC move, then the Anchor MSC indicates the completion of preparation phase at the CN side for the SRNC relocation by sending the SRNC relocation proceeding 2 message to the Source RNC.

When the source RNC has received the SRNC Relocation Proceeding 2 message, the source RNC sends a SRNC Relocation Commit message to the target RNC. The target RNC executes switch for all bearers at the earliest suitable time instance.

Immediately after a successful switch at RNC, target RNC (=SRNC) sends SRNC Relocation Complete message to the non-anchor MSC. This message is included by the non-anchor MSC in the Complete SRNC relocation message that is sent to the anchor MSC. Upon reception of this message, the Anchor-MSC switches from the old Iu transport bearers to the new ones.

After a successful switch at the Anchor MSC, a release indication is sent towards the Source RNC. This will imply release of all UTRAN resources that were related to this UE.

When the target RNC is acting as SRNC, it will send New MM System Information to the UE indicating e.g. relevant Routing Area and Location Area. Additional RRC information may then also be sent to the UE, e.g. new RNTI identity.

When receiving new MM system information indicating a new Routing Area, the UE will in this case initiate a Routing Area update procedure towards the SGSN.

Before point (a), in figure 4.24, the connection is established between UE and Anchor MSC via Source RNC.

After point (b), in figure 4.24, the connection is established between UE and Anchor MSC via Target RNC and Non-anchor MSC.

## Tasks of Node B

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**Node B:**

- equivalent to BTS in GSM
- physical unit
  - ⇨ implements 1 / more cells
  - ⇨ FDD / TDD or Dual-Mode operation
- ATM termination (Iub)
- interfaced to: UE via Uu / RNC via Iub
- data conversion → Uu transmission
- Inner Loop PC
- measures connection quality and strength
- generates Measurement Report for RNC
- FDD: Micro-Diversity (softer handover)
- Synchronization
- Error Handling

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Name was planned as temporary solution but remained and is now final ☺

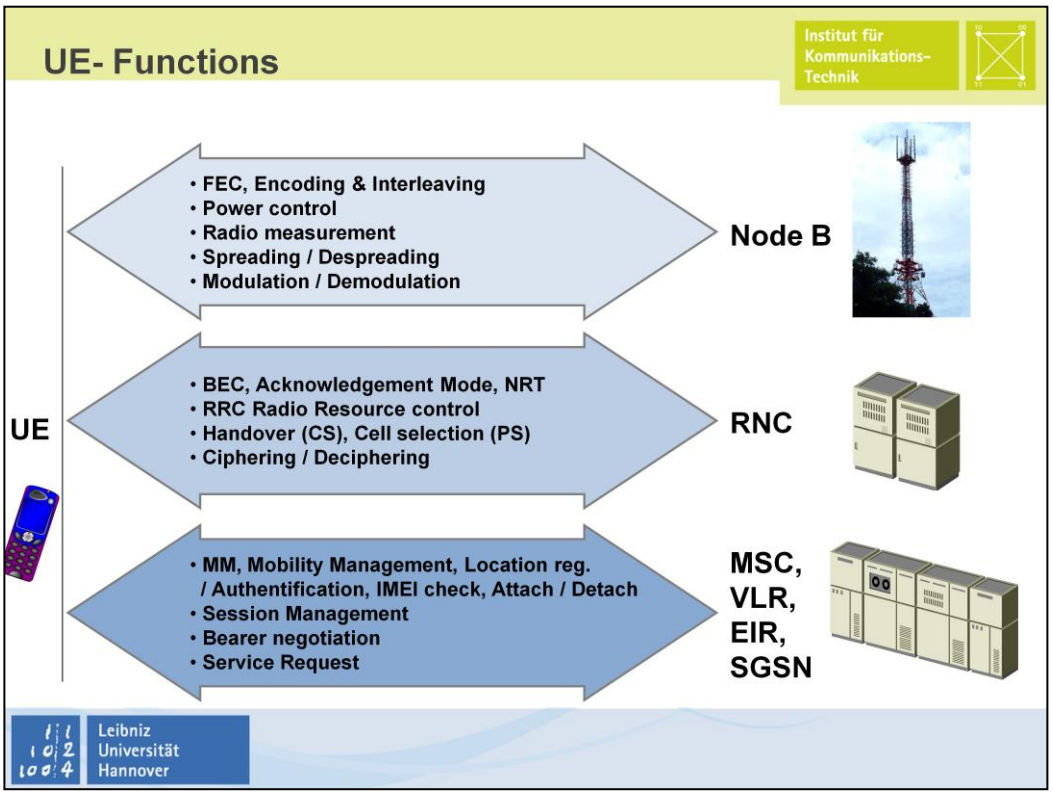
The functions of Node-B are:

- •Air interface Transmission / Reception
- •Modulation / Demodulation
- •CDMA Physical Channel coding
- •Micro Diversity
- •Error Handling
- •Closed loop power control

Node B is the physical unit for radio transmission/reception with cells. Depending on sectoring (omni/sector cells), one or more cells may be served by a Node B. A single Node B can support both FDD and TDD modes, and it can be co-located with a GSM BTS to reduce implementation costs. Node B connects with the UE via the W–CDMA Uu radio interface and with the RNC via the Iub asynchronous transfer mode (ATM)–based interface. Node B is the ATM termination point.

The main task of Node B is the conversion of data to and from the Uu radio interface, including forward error correction (FEC), rate adaptation, W–CDMA spreading/despreading, and quadrature phase shift keying (QPSK) modulation on the air interface. It measures quality and strength of the connection and determines the frame error rate (FER), transmitting these data to the RNC as a measurement report for handover and macro diversity combining. The Node B is also responsible for the FDD softer handover. This micro diversity combining is carried out independently, eliminating the need for additional transmission capacity in the Iub.

The Node B also participates in power control, as it enables the UE to adjust its power using downlink (DL) transmission power control (TPC) commands via the inner-loop power control on the basis of uplink (UL) TPC information. The predefined values for inner-loop power control are derived from the RNC via outer-loop power control.




The UMTS UE is based on the same principles as the GSM MS—the separation between mobile equipment (ME) and the UMTS subscriber identity module (SIM) card (USIM). The figure above shows the user equipment functions. The UE is the counterpart to the various network elements in many functions and procedures

## Outline Part VI



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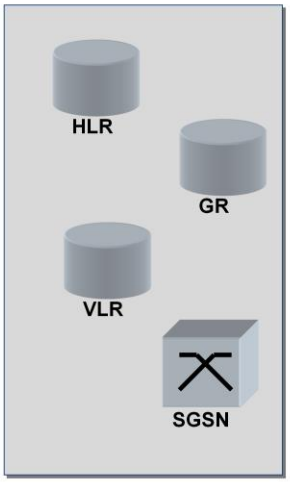
## Location Management (I)






UMTS must know the location of the UE

Storage of the position in database in the CN

Mobile station updates the data if required

Different requirements by CS and PS-Services

## Location Management (II)



The more often a mobile station will be called, so much smaller must be the ”Paging Area“ .

seldom for CS Services

often for PS Services

Different zone quantities for CS and PS Services

## Location Management (III)

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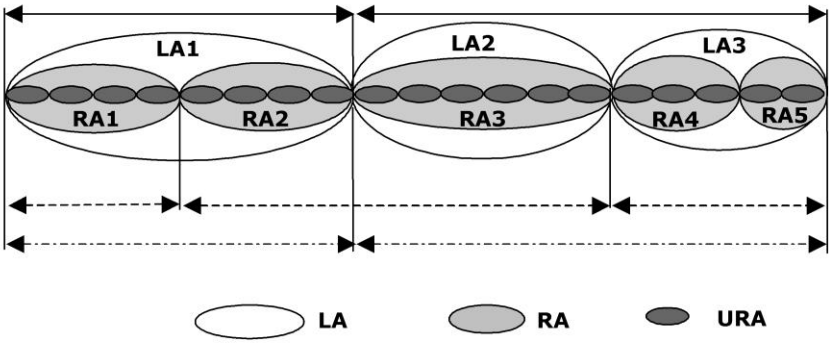
### Area Concepts

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LA: Location area (CS)
RA: Routing area (PS)
URA: UTRAN Registration area

3G TS 23.121

LA: Location Area f. CS-Services

RA: Routing Area f. PS- Services

URA: UTRAN Registration Area (internal information, similar to cell ID in GSM, but more flexible)

... Handled by one Core Network Node

Area concepts

For the mobility functionality four different area concepts are used. Location Area and Routing Area in the CN as well as UTRAN Registration Area and Cell areas in the UTRAN.

Location areas

For CS services, the CN uses Location Areas (LA). Location Area is used e.g. at CN initiated paging related to CS services. A CS service related temporary identity, CS –TMSI, may be allocated to the UE. This temporary identity is then unique within a LA.

Routing areas

For PS services, the CN uses Routing Areas (RA). Routing Area is used e.g. at CN initiated paging related to PS services. A PS service related temporary identity, PS-TMSI, may be allocated to the UE. This temporary identity is then unique within a RA.

UTRAN internal areas

UTRAN internal areas are used when the terminal is in RRC-Connected mode (see chapter 3.3). The areas are used at e.g. UTRAN initiated paging. UTRAN internal area updating is a radio network procedure and the UTRAN internal area structure should not be visible outside UTRAN. In RRC connected mode, the UE position is known on cell level or on UTRAN Registration Area (URA) level. RNTI is used as a temporary UE identifier used within UTRAN and allocated at RRC connection establishment.

Relationship between the different areas

The following area relations exist:

there may not be any relation between URA and LA respectively between URA and RA. The URA concept is defined in TS 25.331;

one RA consists of a number of cells belonging to RNCs that are connected to the same CN node;

one LA consists of a number of cells belonging to RNCs that are connected to the same CN node;

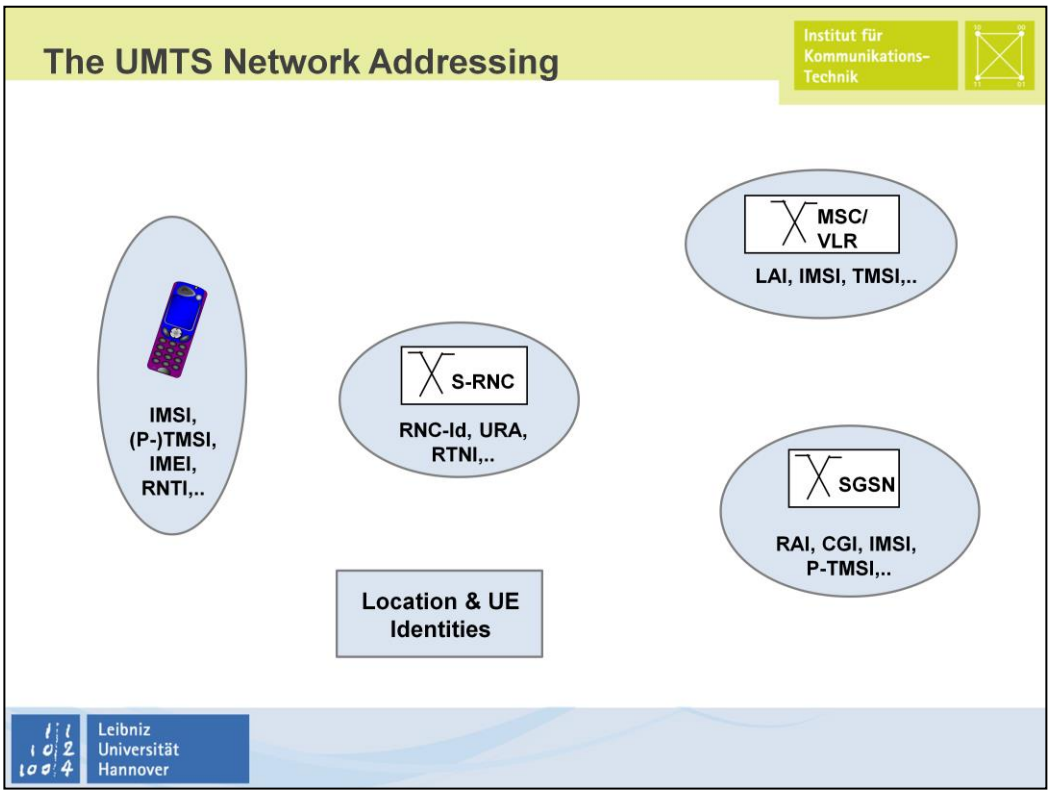
one RA is handled by only one CN serving node, i.e. one UMSC or one 3G_SGSN;

one LA is handled by only one CN serving node, i.e. one UMSC or one 3G_MSC/VLR.

The GSM defined relations between LA and RA applies i.e. the following relations between LA and RA are possible:

- RA and LA is equal;
- one RA is a subset of one, and only one, LA, meaning that a RA do not span more than one LA.

The mapping between one LA and RNCs is handled within the MSC/VLR owning this LA. The mapping between one RA and RNCs is handled within the SGSN owning this RA. The mapping between LA and cells respective between RA and cells is handled within RNC.




PLMN Identifier

A Public Land Mobile Network is uniquely identified by its PLMN identifier. PLMN-Id is made of Mobile Country Code (MCC) and Mobile Network Code (MNC).

-**PLMN-Id = MCC + MNC**

The MCC and MNC are predefined within a UTRAN, and set in the RNC via O&M.

CN Domain Identifier

A CN Domain Edge Node is identified within UTRAN by its CN Domain Identifier. The CN Domain identifier is used over UTRAN interfaces to identify a particular CN Domain Edge Node for relocation purposes. The CN Domain identifier is made of the PLMN-Id and of the LAC or RAC of the first accessed cell in the target RNS.

The two following CN Domains Identifiers are defined:

**-CN CS Domain-Id = PLMN-Id + LAC**

-**CN PS Domain-Id = PLMN-Id + LAC+ RAC**

The LAC and RAC are defined by the operator, and set in the RNC via O&M.

RNC Identifier

An RNC node is uniquely identified within UTRAN by its RNC Identifier (RNC-Id). RNC-Id together with the PLMN identifier is used to globally identify the RNC. RNC-Id or the RNC-Id together with the PLMN-Id is used as RNC identifier in UTRAN Iub, Iur and Iu interfaces. SRNC-Id is the RNC-Id of the SRNC. C-RNC-Id is the RNC-Id of the controlling RNC. D-RNC-Id is the RNC Id of the drift RNC.

-**Global RNC-Id = PLMN-Id + RNC-Id**

The RNC-Id is defined by the operator, and set in the RNC via O&M.

Service Area Identifier

The Service Area Identifier (SAI) is used to uniquely identify an area consisting of one or more cells belonging to the same Location Area. Such an area is called a Service Area and can be used for indicating the location of a UE to the CN.

The Service Area Code (SAC) together with the PLMN-Id and the LAC will constitute the Service Area Identifier.

-**SAI = PLMN-Id + LAC + SAC**

The SAC is defined by the operator, and set in the RNC via O&M.

For Release 99 the BC-domain requires that Service Area consists of one cell. This does not limit the usage of Service Area for other domains.

Cell Identifier

The Cell identifer (C-Id) is used to uniquely identify a cell within an RNS. The Cell-Id together with the identifier of the controlling RNC (CRNC-Id) constitutes the UTRAN Cell Identity (UC-Id) and is used to identify the cell uniquely within UTRAN. UC-Id or C-Id is used to identify a cell in UTRAN Iub and Iur interfaces.

-**UC-Id = RNC-Id + C-Id**

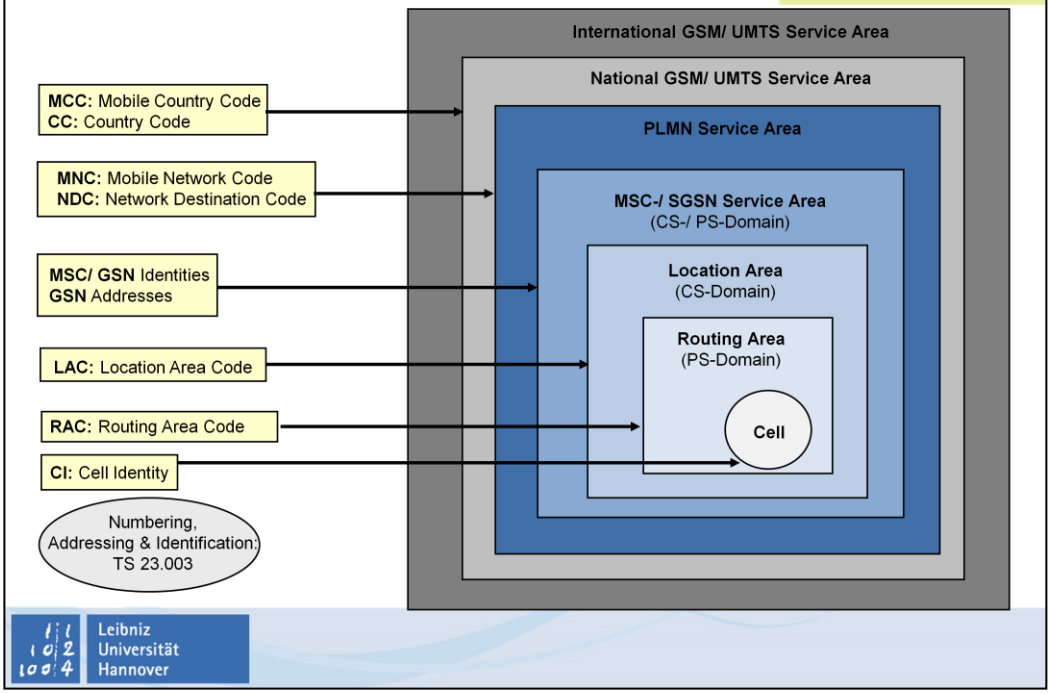
The C-Id is defined by the operator, and set in the RNC via O&M. The C-Id is set in a Node B by its C-RNC.

Local Cell Identifier

The Local Cell identifier is used to uniquely identify the set of resources within a Node B required to support a cell (as identified by a C-Id). As a minimum it shall be unique within the Node B, but it is also capable of supporting uniqueness within the UTRAN for management system purposes.

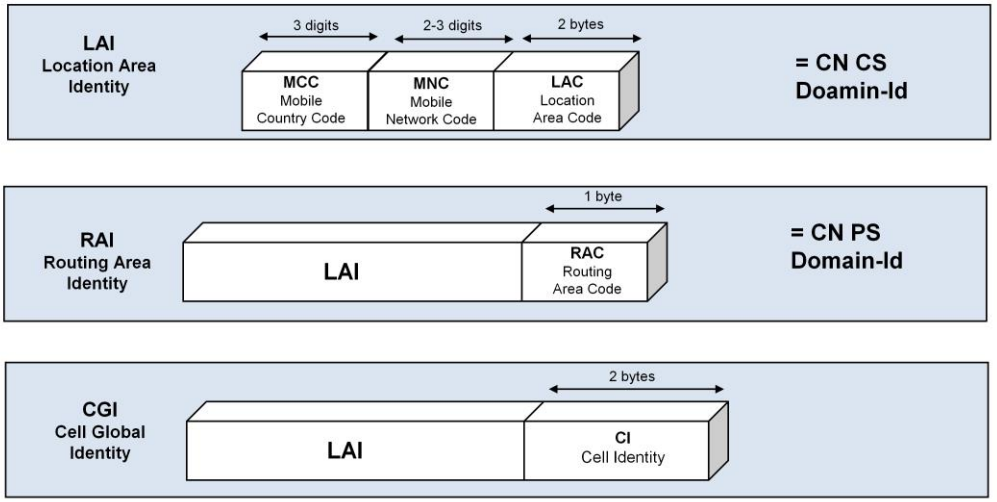
The Local Cell Identifier is used for the initial configuration of a Node B when no C-Id is defined. The Local Cell identifier is defined by the operator, and set in both the Node B and its C-RNC via O&M. The relationship between the Local Cell Identifier and C-Id is set in the C-RNC via O&M.

## Service Areas



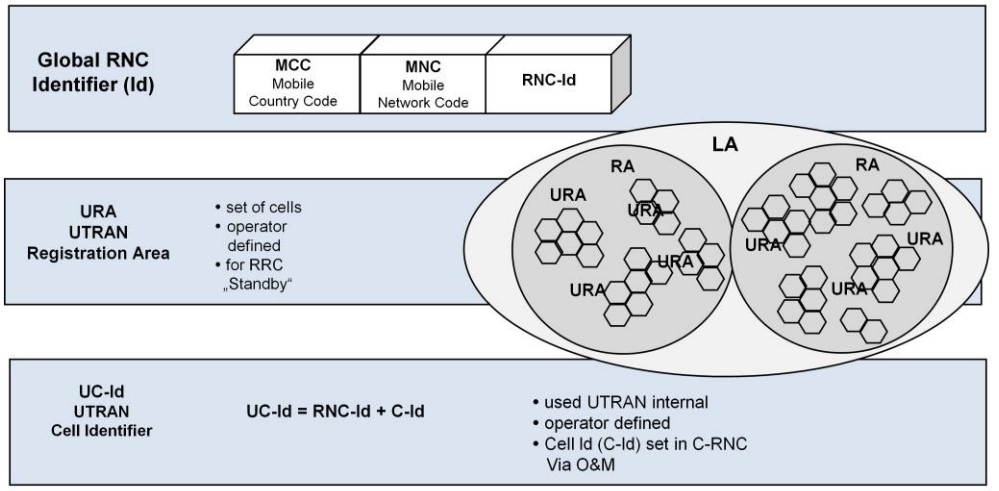
# Identification of Location Areas





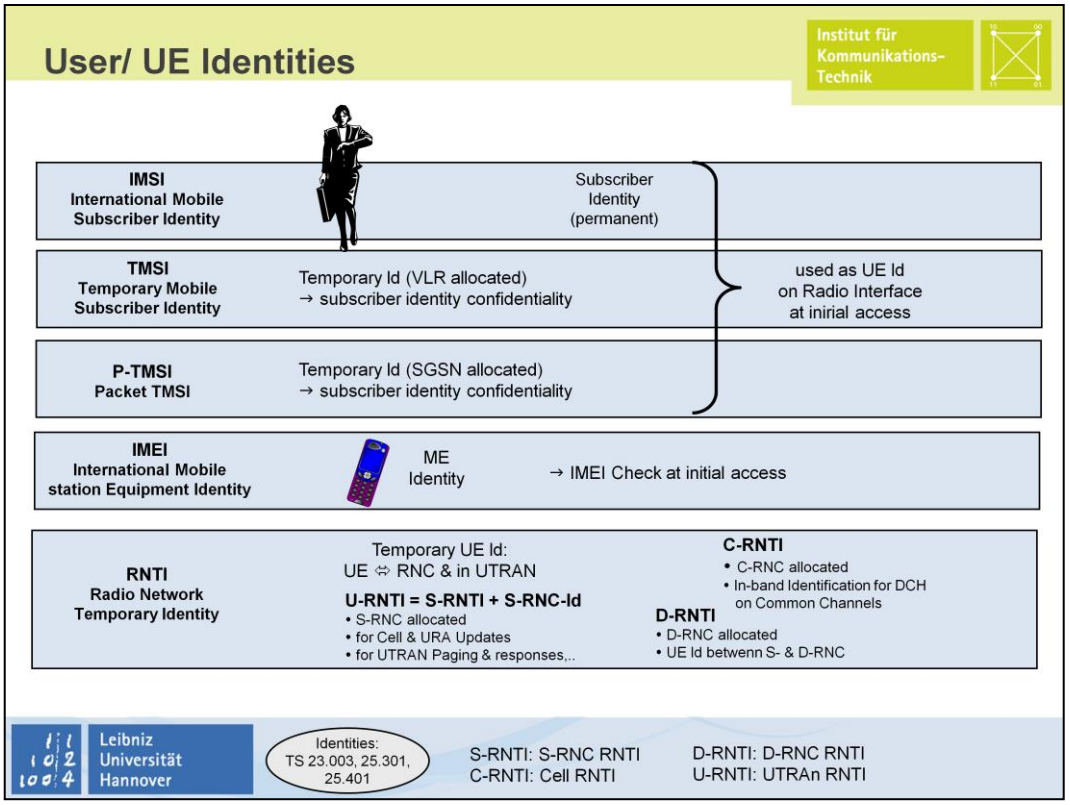
# UTRAN Identifiers & Areas








TS 23.121, 25.401




UE Identifiers

NOTE: This RNTI definition and usage needs to be confirmed by 3GPP TSG RAN WG2.

Radio Network Temporary Identities (RNTI) are used as UE identifiers within UTRAN and in signalling messages between UE and UTRAN.

Four types of RNTI exist:

1) Serving RNC RNTI (s-RNTI);
2) Drift RNC RNTI (d-RNTI);
3) Cell RNTI (c-RNTI);
4) UTRAN RNTI (u-RNTI);

**s-RNTI is used:**

- by UE to identify itself to the Serving RNC;
- by SRNC to address the UE;
- by DRNC to identify the UE to Serving RNC.

s-RNTI is allocated for all UEs having a RRC connection, it is allocated by the Serving RNC and it is unique within the Serving RNC. s-RNTI is reallocated always when the Serving RNC for the RRC connection is changed.

**d-RNTI is used:**

- by serving RNC to identify the UE to Drift RNC.

NOTE: The d-RNTI is never used on Uu.

d-RNTI is allocated by drift RNC upon drift UE contexts establishment and it shall be unique within the drift RNC. Serving RNC shall know the mapping between s-RNTI and the d-RNTIs allocated in Drift RNCs for the same UE. Drift RNC shall know the s-RNTI and SRNC-ID related to existing d-RNTI within the drift RNC.

**c-RNTI is used:**

- by UE to identify itself to the controlling RNC;
- by controlling RNC to address the UE.

c-RNTI is allocated by controlling RNC upon UE accessing a new cell. C-RNTI shall be unique within the accessed cell. Controlling RNC shall know the d-RNTI associated to the c-RNTI within the same logical RNC (if any).

**u-RNTI**

The u-RNTI is allocated to an UE having a RRC connection and identifies the UE within UTRAN.

u-RNTI is composed of:

- SRNC identity;
- s-RNTI.

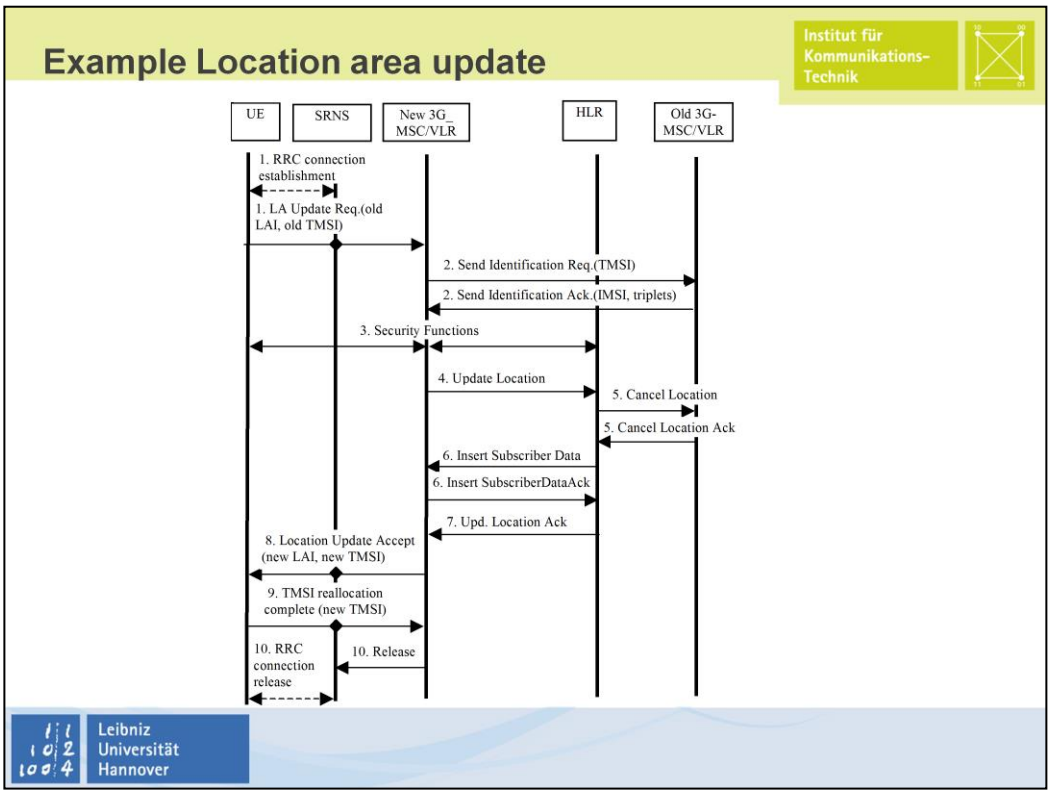
Each RNC has a unique identifier within the UTRAN part of the PLMN, denoted by RNC identifier (RNC-ID). This identifier is used to route UTRAN interface messages to correct RNC. RNC-ID of the serving RNC together with the s-RNTI is a unique identifier of the UE in the UTRAN part of the PLMN.

Usage of RNTI

u-RNTI is used as a UE identifier for the first cell access (at cell change) when a RRC connection exists for this UE and for UTRAN originated paging including associated response messages. RNC-ID is used by Controlling RNC to route the received uplink messages towards the Serving RNC.

NOTE: For the initial access two different methods of identification, a random number and a unique core network UE identifier are under consideration.

c-RNTI is used as a UE identifier in all other DCCH/DTCH common channel messages on air interface.




This example shows location registration when changing Location Area including change of 3G-MSC/VLR and when the UE is in MM idle state towards the 3G_MSC/VLR.

The illustrated transfer of MM signalling to/from the UE uses an established RRC connection. This RRC connection can have been established beforehand due to ongoing interwork between UE and 3G-SGSN or be established only for this location registration procedure towards the 3G_MSC/VLR.

For each indicated MM message sent in this case to/from UE, the CN discriminator indicates 3G_MSC/VLR.**:**

The RRC connection is established, if not already done. The UE sends the initial message Location Area Update Request (old TMSI, old LAI, etc.) to the new 3G_MSC/VLR. The old TMSI and the old LAI are assigned data in UMTS. The SRNS transfers the message to the 3G_MSC/VLR. The sending of this message to 3G_MSC/VLR will also imply establishment of a signalling connection between SRNS and 3G_MSC/VLR for the concerned UE. The UTRAN shall add the RAC and the LAC of the cell where the message was received before passing the message to the MSC.

The new 3G_MSC/VLR sends an Send Identification Request (old TMSI) to the old 3G_MSC/VLR to get the IMSI for the UE. (The old LAI received from UE is used to derive the old 3G_MSC/VLR identity/address.) The old 3G_MSC/VLR responds with Send Identification Ack. (IMSI and Authentication triplets).

Security functions may be executed.

The new 3G_MSC/VLR inform the HLR of the change of 3G_MSC/VLR by sending Update Location (IMSI, MSC address, VLR number) to the HLR.

The HLR cancels the context in the old 3G_MSC/VLR by sending Cancel Location (IMSI). The old 3G_MSC/VLR removes the context and acknowledges with Cancel Location Ack.

The HLR sends Insert Subscriber Data (IMSI, subscription data) to the new 3G_MSC/VLR. The new 3G_MSC/VLR acknowledges with Insert Subscriber Data Ack.

The HLR acknowledges the Update Location by sending Update Location Ack. to the new 3G_MSC/VLR.

The new 3G_MSC/VLR validates the UE presence in the new LA. If due to regional, national or international restrictions the UE is not allowed to attach in the LA or subscription checking fails, then the new 3G_MSC/VLR rejects the location area update with an appropriate cause. If all checks are successful, then the new 3G_MSC/VLR responds to the UE with Location Area Update Accept (new TMSI, new LAI).

The UE acknowledges the new TMSI with a TMSI reallocation Complete. (TMSI can optionally be reallocated with the TMSI reallocation procedure).

When the location registration procedure is finished, the 3G_MSC/VLR may release the signalling connection towards the SRNS for the concerned UE. The SRNS will then release the RRC connection if

there is no signalling connection between 3G_SGSN and SRNS for the UE.

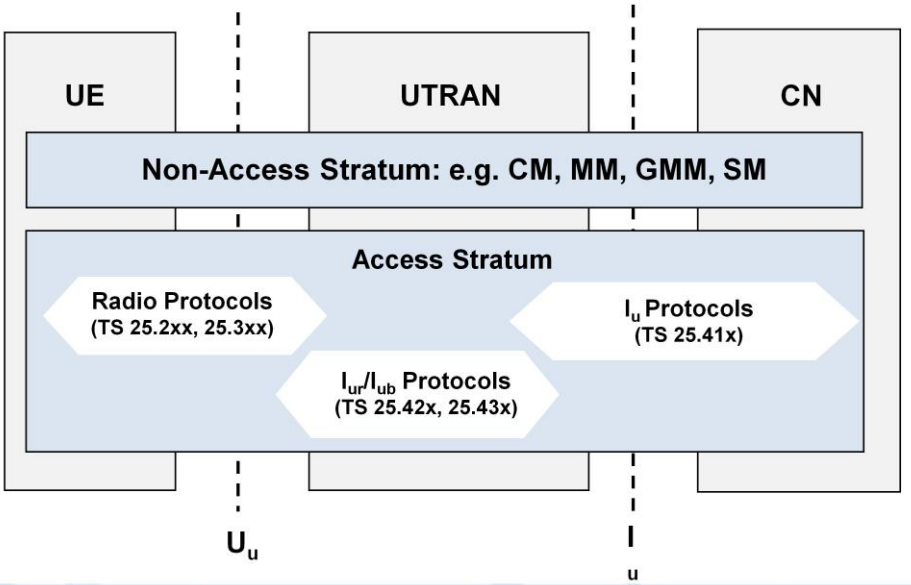
## Outline Part VI

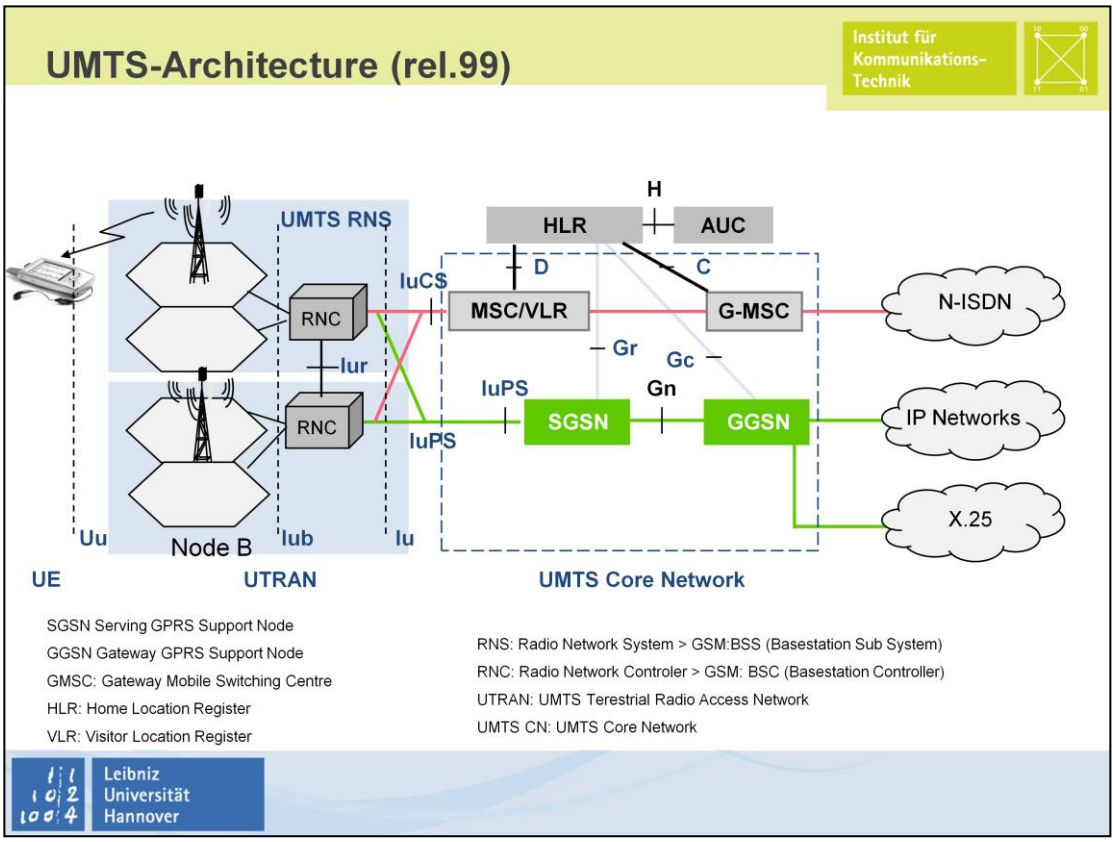


1. Overview
2. Network Elements
3. Location Management
4. Protocol Stack

# General Protocol Architecture



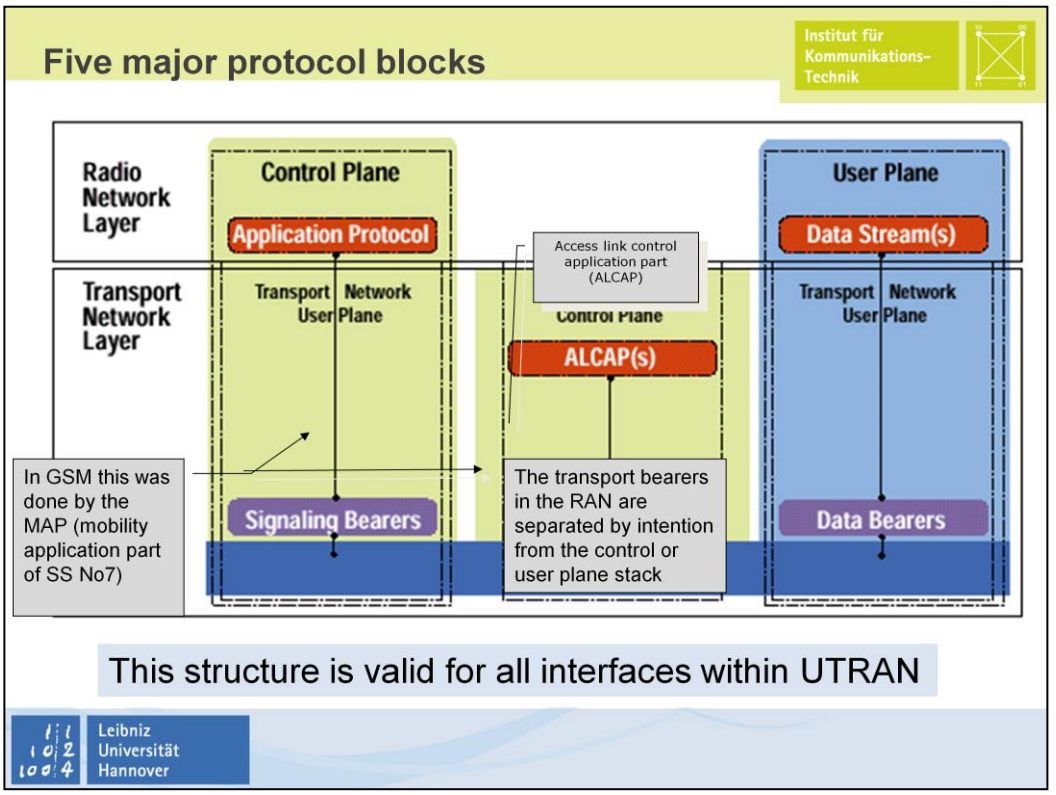





Interfaces:

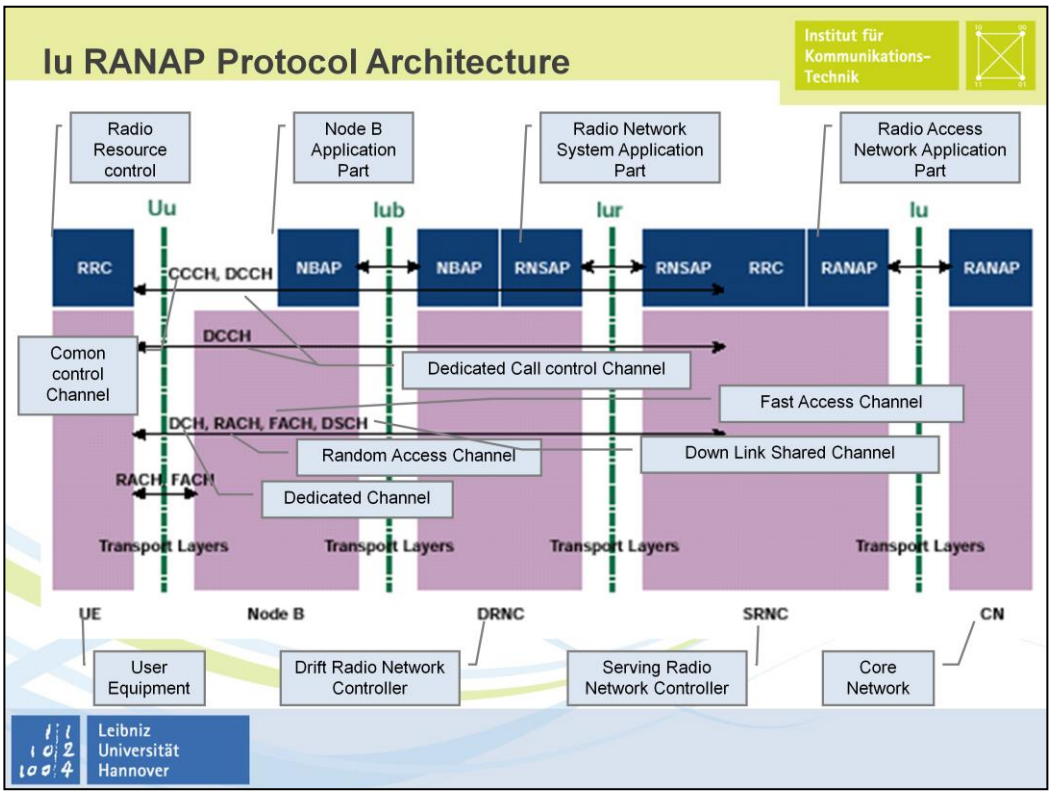
Iu interface: enables interconnection of Radio Network Controllers (RNCs) with Core Network nodes.

The Iu (IuPS and IuCS) interface is available in two separate packages IuPS and IuCS for Packet Switched and Circuit Switched domains respectively. The IuCS interface interconnects the MSC/ VLR and the RNC network nodes while the IuPS interface provides interconnection between the SGSN and the RNC network nodes in UMTS/3G networks




UTRAN interface consists of a set of horizontal and vertical layers. The UTRAN requirements are addressed in the horizontal radio network layer across different types of control and user planes. Control planes are used to control a link or a connection; user planes are used to transparently transmit user data from the higher layers. Standard transmission issues, which are independent of UTRAN requirements, are applied in the horizontal transport network layer.

- Signaling bearers are used to transmit higher layers' signaling and control information. They are set up by O&M activities.
- Data bearers are the frame protocols used to transport user data (data streams). The transport network–control plane (TN–CP) sets them up.
- Application protocols are used to provide UMTS–specific signaling and control within UTRAN, such as to set up bearers in the radio network layer.
- Data streams contain the user data that is transparently transmitted between the network elements. User data is comprised of the subscriber's personal data and mobility management information that are exchanged between the peer entities MSC and UE.
- Access link control application part (ALCAP) protocol layers are provided in the TN–CP. They react to the radio network layer's demands to set up, maintain, and release data bearers. The primary objective of introducing the TN–CP was to totally separate the selection of the data bearer technology from the control plane (where the UTRAN–specific application protocols are located). The TN–CP is present in the Iu–CS, Iur, and Iub interfaces. In the remaining interfaces where there is no ALCAP signaling, preconfigured data bearers are activated.




**Application Protocols**

Application protocols are Layer-3 protocols that are defined to perform UTRAN–specific signaling and control. A complete UTRAN and UE control plane protocol architecture is illustrated. UTRAN–specific control protocols exist in each of the four interfaces.

**Iu: Radio Access Network Application Part (RANAP) [3G TS 25.413]**

This protocol layer provides UTRAN–specific signaling and control over the Iu (see Figure 11). The following is a subset of the RANAP functions:

• Overall radio access bearer (RAB) management, which includes the RAB's setup, maintenance, and release

• Management of Iu connections

• Transport of nonaccess stratum (NAS) information between the UE and the CN; for example, NAS contains the mobility management signaling and broadcast information.

• Exchanging UE location information between the RNC and CN

• Paging requests from the CN to the UE

• Overload and general error situation handling

**Iur: Radio Network Sublayer Application Part (RNSAP) [3G TS 25.423]**

UTRAN–specific signaling and control over this interface contains the following:

•Management of radio links, physical links, and common transport channel resources

•Paging

•SRNC relocation

•Measurements of dedicated resources

**Iub: Node B Application Part (NBAP) [3G TS 25.433]**

UTRAN specific signaling and control in the Iub includes the following (see Figure 13):

•Management of common channels, common resources, and radio links

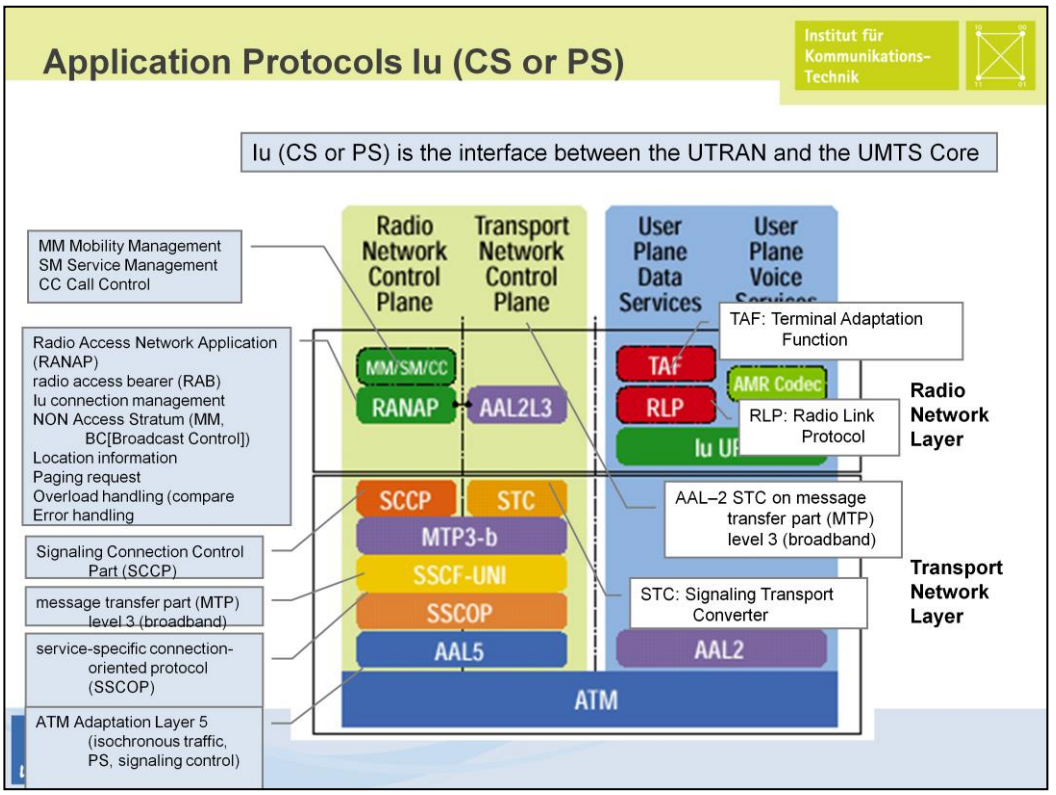
•Configuration management, such as cell configuration management

•Measurement handling and control

•Synchronization (TDD)

•Reporting of error situations

***Downlink Shared Channel (DSCH)*** dynamically reallocates channel resources to speed data transmission and effectively increase network capacity.




**Iu: Radio Access Network Application Part (RANAP) [3G TS 25.413]**

This protocol layer provides UTRAN–specific signaling and control over the Iu. The following is a subset of the RANAP functions:

- Overall radio access bearer (RAB)
- management, which includes the RAB's setup, maintenance, and release
- Management of Iu connections
- Transport of nonaccess stratum (NAS) information between the UE and the CN; for example, NAS contains the mobility management signaling and broadcast information.
- Exchanging UE location information between the RNC and CN
- Paging requests from the CN to the UE
- Overload and general error situation handling

**Transport Network Layer: Specific Layer-3 Signaling and Control Protocols**

**Two types of layer-3 signaling protocols are found in the transport network layer:**

1. Iu, Iur: Signaling Connection Control Part (SCCP) [ITU-T Q.711–Q. 716] This provides connectionless and connection-oriented services. On a connection-oriented link, it separates each mobile unit and is responsible for the establishment of a connection-oriented link for each and every one of them.
2. Iu–CS, Iur, Iub: ALCAP [ITU–T Q.2630.1, Q.2150.1, and Q.2150.2]. Layer-3 signaling is needed to set up the bearers to transmit data via the user plane. This function is the responsibility of the ALCAP, which is applied to dynamically establish, maintain, release, and control ATM adaptation layer (AAL)–2 connections. ALCAP also has the ability to link the connection control to another higher layer control protocol. This and additional capabilities were specified in ITU–T Q.2630.1. Because of the protocol layer specified in Q.2630.1, a converter is needed to correspond with underlying sublayers of the protocol stack. These converters are called (generically) signaling transport converter (STC). Two converters are defined and applied in UTRAN:

- Iu–CS, Iur: AAL–2 STC on message transfer part (MTP) level 3 (broadband) for Q.2140 (MTP3b) [Q.2150.1]
- Iub: AAL–2 STC on service-specific connection-oriented protocol (SSCOP) [Q.2150.2]
- With AAL–5, isochronous connections with variable bit rate in a connection-oriented mode are supported. This layer is used for Internet protocol (IP) local-area network (LAN) emulation, and signaling. In UTRAN, AAL–5 is used to carry the packet-switched user traffic in the Iu–PS-interface and the signaling and control data throughout.

## Radio Access Network Application Part (RANAP)



Applications, based on SS7 and which support the special requirements of a mobile-radio network

- SRNS Relocation, Handover
- RAB Management
- Iu Release
- Unsuccessfull transmission reporting
- Paging
- Tracing
- Direct Signalling between UE and CN
- Cipher Control
- Load Management and Overload Protection
- Protocol Reset
- Location Management

# Radio Network Subsystem Application Part (RNSAP)



Applications, based on SS7 and which supports the special requirements of the RSS

→ 4 Iur Functions

- Iur1: Support of the Basic Inter-RNC mobility
- Basic Module, required for Iur-Function
- SRNC relocation (high complexity)
- Inter-RNC cell/ registration area update
- Inter-RNC packet paging

- Iur2: Support of Dedicated Channel Traffic
- Soft-Handover for CS connections
- Dynamic design of AAL2-Connections

## Radio Network Subsystem Application Part (RNSAP)

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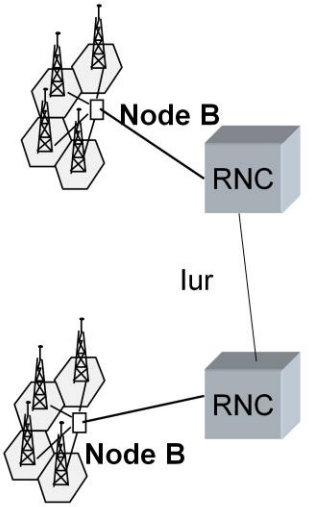
- Iur3: Support of Common Channel Traffic
- Splitting of PS-data in the MAC-layer
- Not required, but helps to avoid SRNS relocation

- Iur4: Support of Global Resource Management
- Exchange of cell measurement data between different RNCs
- Exchange of Node-B timing information between two RNCs

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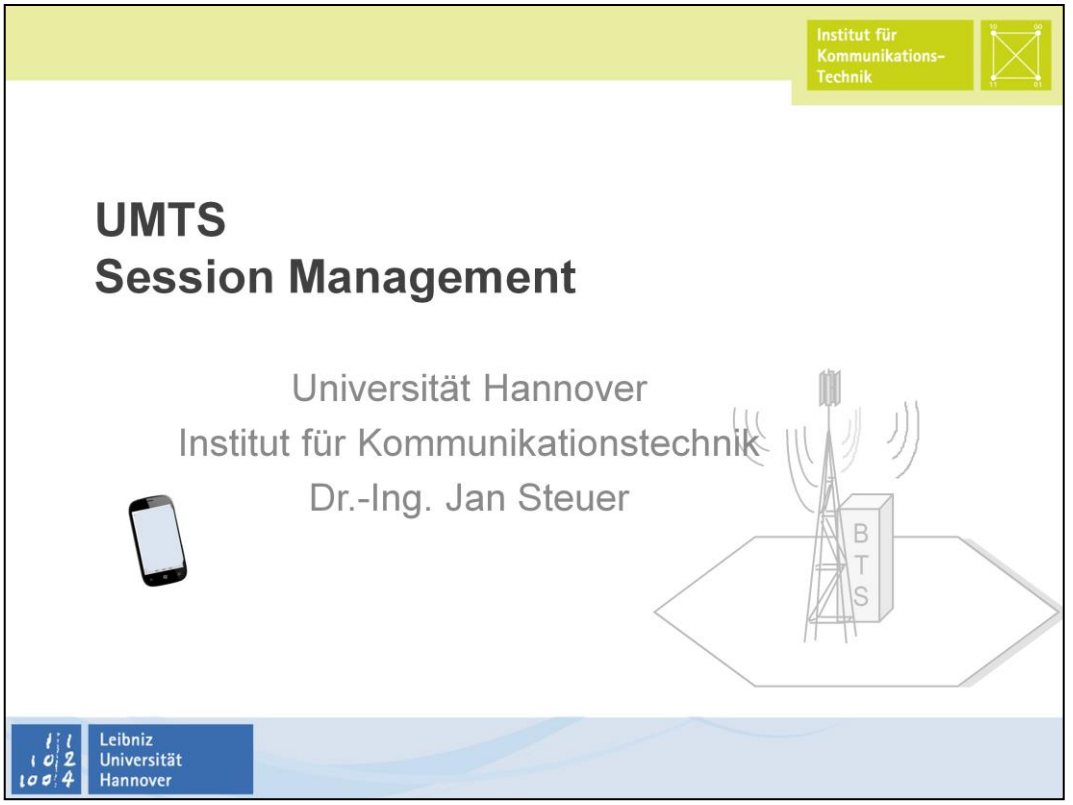


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## Introduction



Session Management (SM):

- establishes, modifies
- and releases packet data sessions with well defined QoS between UE and GGSN
- Packet session attributes are called **PDP contexts**
- A UE may have more than one PDP context
- simultaneously, each with a SM protocol entity

**Entities involved**

## PDP Context Centents



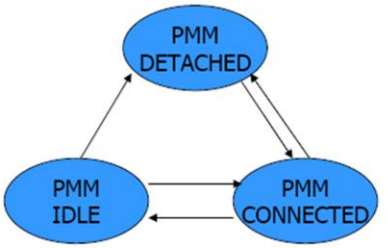
- PDP = Packet Data Protocol (generic name)
- protocols to be used: IP

| UE keeps | SGSN keeps | GGSN keeps |
|---|---|---|
| Mobility Management info | Mobility Management info | IMSI, MSISDN plus |
| plus: | plus: | |
| PDP type (PPP, IP) | PDP type | PDP type |
| PDP address (IP address) | PDP address | PDP address |
| PDP state | PDP state | |
| | PDP context identifier | |
| dynamic address allowed | | dynamic address used |
| APN requested | | APN in use |
| NSAPI & TI | NSAPI & TI | NSAPI |
| QoS requested, negotiated | QoS subscribed, requested, negotiated | QoS negotiated |
| | Charging information | Charging information |
| | TEID (Tunnel Endpoint ID) | TEID (Tunnel Endpoint ID) |

## Session Management Procedures



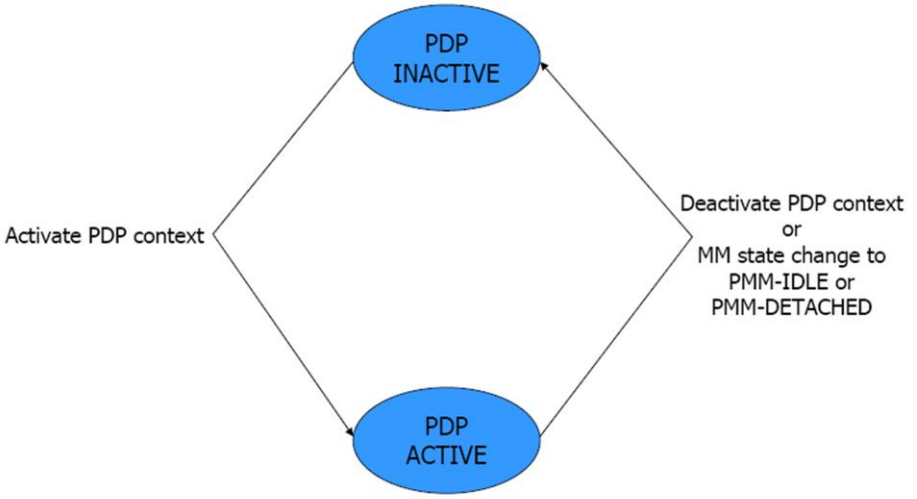
- SM procedures require existing GMM context
- SM procedures are:
  - **PDP context activation**
    - PDP address, QoS etc. are set
    - UE must be in PMM-CONNECTED
  - **PDP context modification**
    - QoS etc. is modified
    - UE must be in PMM-CONNECTED state
  - **PDP context deactivation**
    - packet data session is released
    - PDP context also deactivated when UE moves to PMM-IDLE or PMM-DETACHED state




Reminder: PMM state model

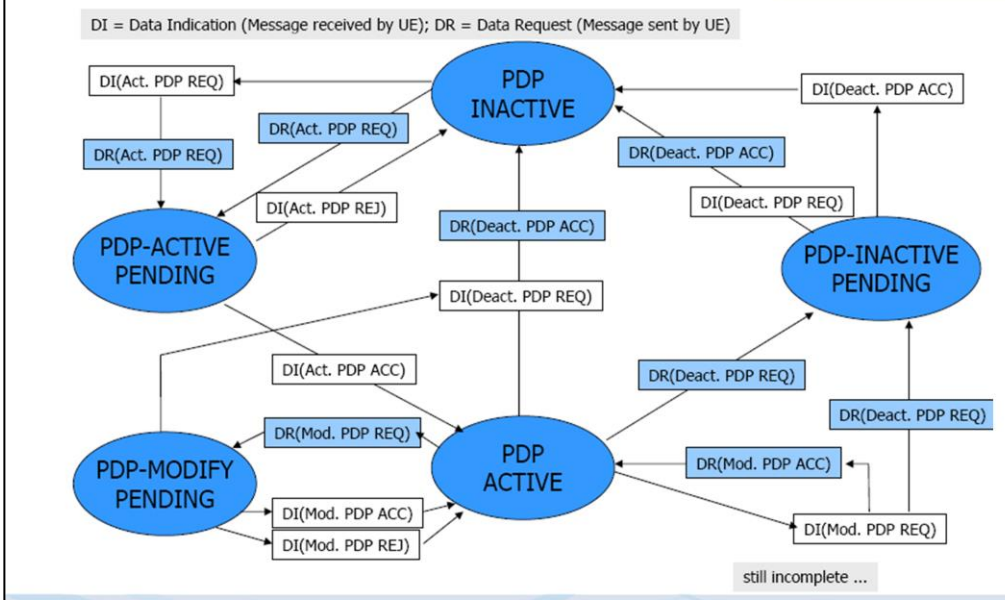
## Session Management State Model (1)





# Session Management State Model (2)





## PDP Context Activation by UE

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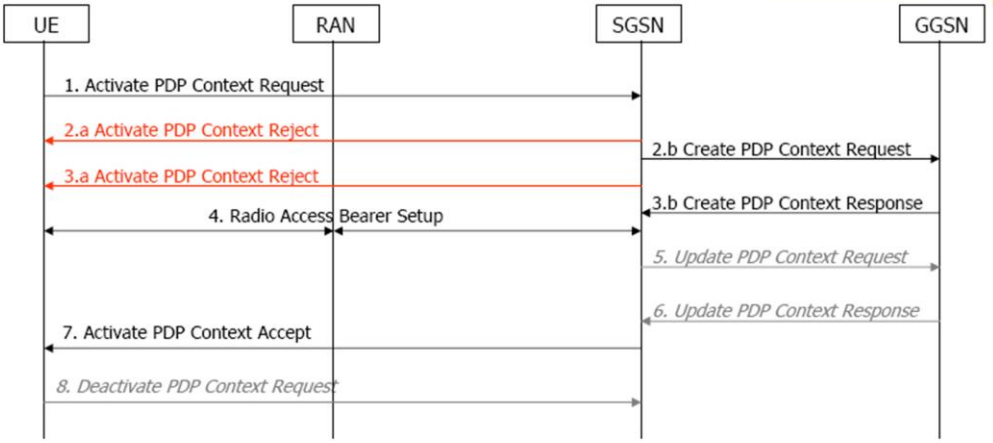


- Request (1) contains NSAPI, PDP type, QoS, PDP address (static, dyn.)
- Reject may occur due to insufficient resources, unknown PDP address
- or PDP type, unsupported or not subscribed options wished
- Request (8) may occur if network does not offer requested QoS

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## PDP Context Activation by network

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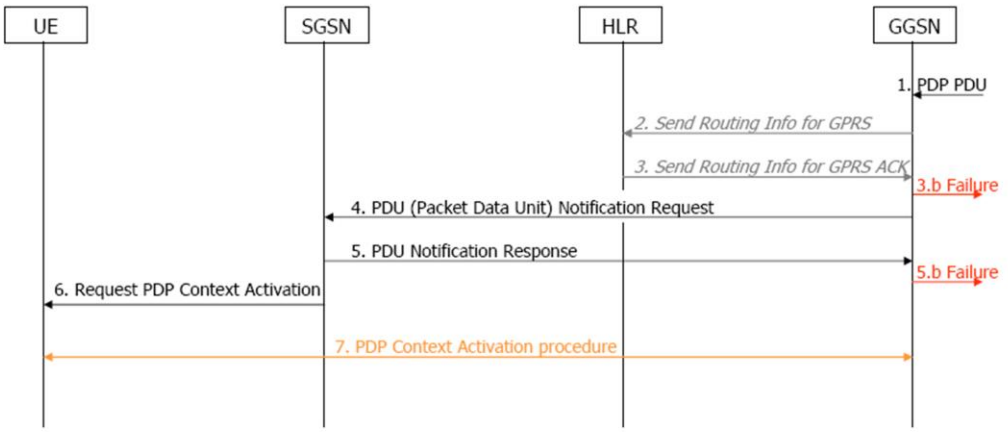


- If HLR can not determine a SGSN or the SGSN cannot find the UE with specified IMSI, the PDP Context Activation Procedure fails (3.b, 5.b)
- After the SGSN's request the UE performs the PDP Context Activation

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