9 UTRAN

Objectives:
After this chapter the student will be able to:
- understand the demands for a flexible radio access network in UMTS
- outline the interfaces to and within UTRAN
- describe the role of Node B and RNC in UTRAN

UTRAN (UMTS Radio Access Network) is the radio access network for UMTS, and it provides the connection between the core network and the user equipment. In UMTS release -99 UTRAN is considered the only access network. UTRAN will support high bit rate bearer services with the notion of negotiated QoS characteristics. It will also support asymmetric and bursty traffic for single- and multi-media IP as well as N-ISDN applications. UMTS R-99 puts interoperability requirements on both UTRAN and GSM BSS access networks, in such a way that the evolved GSM network is compatible with UTRAN regarding roaming and handover. It might however be the case that the advanced bearer capabilities of UTRAN not are fully supported by the core network.

9.1 UTRAN capabilities

The radio access bearer (RAB) capabilities for UTRAN are specified in 22.105.
UTRAN in R-99 shall have the following capabilities:

a) One UTRAN is contained in one UMTS network.
b) The set-up, re-negotiation and clearing of connections
c) Negotiation and re-negotiation of QoS
d) Supported bit rates
- At least 144 kbit/s rural outdoor
- At least 384 kbit/s urban outdoor
- At least 2048 kbit/s indoor/low range outdoor

e) Support for broadcast and multicast applications
f) Support for multiple simultaneous RABs
g) Seamless handover within UTRAN
h) Support for dual mode terminals FDD – TDD.
i) Support for handover TDD – FDD – GSM
j) Support for positioning within 50 meters
k) Support for Localised Service Area (LSA)
l) Optimisation of UTRAN radio interface is based on high bit rates, bursty, asymmetric, both real time and non-real time capabilities. Existing GSM services shall still be as leas as efficient as in GSM.
m) Standardised operation, administration and maintenance protocols co-operating with ETSI TMN.
n) USIM requirements shall be considered

9.2 UTRAN and GSM BSS

Since the evolution to UMTS will be gradually, the co-existence of UTRAN and GSM BSS in a network is essential. This requires the following for UMTS R-99:

a) Support of dual mode terminals (UMTS/GSM) that can select cells to camp on from both systems in idle mode and connected mode
b) Paging and cell selection procedures shall be designed to handle the combination of GSM and UTRAN cells
c) Support of handover between UMTS and GSM BSS in both directions. Note that some traffic flows might be re-negotiated or even released because of the different radio access bearer capabilities of the different access networks

9.3 General principles

The general principles for UTRAN:

a) Logical separation of signalling and data transport networks.
b) A full separation of UTRAN and CN functions from the transports functions.
c) Full support for macro diversity in UTRAN-FDD
d) The RRC connection and its mobility is fully controlled by the UTRAN.

9.4 UTRAN interfaces

UTRAN contain two internal interfaces (Iub, Iur) and interfaces to the UE (Uu) and the core network (Iu).

General principles for UTRAN interfaces:

a) As few options as possible for the functional division across the interfaces.
b) Interfaces should be based on a logical model of the entity controlled through this interface

Transport Network Control Plane is a functional plane in the interface protocol structure that is used for the transport bearer management. The actual signalling protocol that is in use within the Transport Network Control Plane depends on the underlying transport layer technology. The intention is not to specify a new UTRAN specific Application Part for the Transport Network Control Plane but to use signalling protocols

standardised in other groups (if needed) for the applied transport layer technology.

9.5 General architecture

UTRAN is connected to the CN over the Iu interface, and with UE over the radio interface Uu. Over these interfaces the protocols are divided in “User plane protocols” (UPP) and “Control plane protocols” (CPP). The UPP implements the actual Radio Access Bearer (RAB) service that carries the data through the Access Stratum (AS). The CPP controls the RAB, but can be used to transparently transfer Non-Access Stratum (NAS) messages (i.e. CM, MM, GMM and SM messages).

9.6 UTRAN architecture

The UTRAN consists of a set of Radio Network Subsystems connected to the Core Network through the Iu. A RNS consists of a Radio Network Controller and one or more Node Bs. A Node B is connected to the RNC through the Iub interface. A Node B can support FDD mode, TDD mode or dual-mode operation. The RNC is responsible for the Handover decisions that require signalling to the UE. The RNC comprises a combining/splitting function to support macro diversity between different Node B. A RNC supporting the FDD mode may include a combining/splitting function to support macro diversity between different Node B. Inside the UTRAN, the RNCs of the Radio Network Subsystems can be interconnected together through the Iur. Iu(s) and Iur are logical interfaces. Iur can be conveyed over physical direct connection between RNCs or via any suitable transport network.

9.7 Identifiers

The following identifiers are used within UTRAN

UTRAN identifiers

PLMN identifier
PLMN-Id = MCC + MNC

CN Domain Identifier
CN CS Domain-Id = PLMN-Id + LAC
CN PS Domain-Id = PLMN-Id + LAC + RAC

RNC Identifier
Global RNC-Id = PLMN-Id + RNC-Id

Service Area Identifier
SAI = PLMN-Id + LAC + SAC

Cell Identifier
UC-Id = RNC-Id + C-Id

UE Identifiers

When the UE is known to UTRAN is given an identity, called the Radio Network Temporary Identity. There are four different RNTIs.

RNTI
s-RNTI: Serving RNC RNTI
d-RNTI: Drift RNC RNTI
c-RNTI: Cell RNTI
u-RNTI: UTRAN RNTI

9.8 UTRAN functions

The functions of UTRAN is divided in functions for overall system control, mobility and radio resource handling.

Overall system access control:
a) Admission Control
b) Congestion Control
c) System information broadcasting
d) Radio channel ciphering and deciphering

Mobility
a) Handover
b) SRNS Relocation

Radio resource management and control
a) Radio resource configuration and operation
b) Radio environment survey
c) [FDD - Macro-diversity control]
d) Radio bearer connection set-up and release (Radio Bearer Control)
e) Allocation and de-allocation of Radio Bearers
f) [TDD - Dynamic Channel Allocation (DCA)]
g) Radio protocols function

h) RF power control
i) RF power setting
j) [TDD - Timing Advance]
k) Radio channel coding
l) Radio channel decoding
m) Channel coding control
n) Initial (random) access detection and handling
o) CN Distribution function for Non Access Stratum messages

9.9 Quality of service (QoS)

The general QoS approach for UMTS is that only the QoS perceived by end-user matter, that is from one terminal equipment to another terminal equipment. To realise a certain network QoS a Bearer Service with clearly defined characteristics and functionality is to be set up from the source to the destination of a service. A bearer service includes all aspects to enable the provision of a contracted QoS. These aspects are among others the control signalling, user plane transport and QoS management functionality. The UMTS QoS concept is described in the specification 23.107

The QoS negotiation is a trade off between bit error rate (BER) delay and bit rate. There are four QoS classes defined for UMTS (the same as for GPRS) responding to different requirements for delay.

23.107 - Table 1: UMTS QoS classes

Traffic class	**Conversational class** conversational RT	**Streaming class** streaming RT	**Interactive class** Interactive best effort	**Background** Background best effort
Fundamental characteristics	- Preserve time relation (variation) between information entities of the stream Conversational pattern (stringent and low delay)	- Preserve time relation (variation) between information entities of the stream	Request response pattern Preserve payload content	Destination is not expecting the data within a certain time Preserve payload content
Example of the application	- voice	- streaming video	- Web browsing	- background download of emails

When negotiating QoS a number of service attributes are agreed (Traffic class, maximum and guaranteed bit rate, deelay and BER, etc.)

23.107 - Table 4: Value ranges for UMTS Bearer Service Attributes

Traffic class	Conversational class	Streaming class	Interactive class	Background class
Maximum bitrate (kbps)	<2000 (1) (2)	<2000 (1) (2)	< 2000 - overhead (2) (3)	<2000 - overhead (2) (3)
Delivery order	Yes/No	Yes/No	Yes/No	Yes/No
Maximum SDU size (octets)	<1500 (4)	<1500 (4)	<1500 (4)	<1500 (4)
SDU format information	(5)	(5)		
Delivery of erroneous SDUs	Yes/No/- (6)	Yes/No/- (6)	Yes/No/- (6)	Yes/No/- (6)
Residual BER	$5*10^{-2}$, 10^{-2}, 10^{-3}, 10^{-4} (7)	$5*10^{-2}$, 10^{-2}, 10^{-3}, 10^{-4}, 10^{-5}, 10^{-6} (7)	$4*10^{-3}$, 10^{-5}, $6*10^{-8}$ (8) (7)	$4*10^{-3}$, 10^{-5}, $6*10^{-8}$ (8) (7)
SDU error ratio	10^{-2}, 10^{-3}, 10^{-4}, 10^{-5} (7)	10^{-2}, 10^{-3}, 10^{-4}, 10^{-5} (7)	10^{-3}, 10^{-4}, 10^{-6} (7)	10^{-3}, 10^{-4}, 10^{-6} (7)
Transfer delay (ms)	100 – maximum value(7)	500 – maximum value (7)		
Guaranteed bit rate (kbps)	<2000 (1) (2)	<2000 (1) (2)		
Traffic handling priority			1,2,3 (9)	
Allocation/Retention priority	1,2,3 (9)	1,2,3 (9)	1,2,3 (9)	1,2,3 (9)

9.10 Radio access bearers

RAB is described by:
Information quality of service
- Bit rate
- Bit error ratio
- Maximum transfer delay
- Delay variation

Traffic characteristics
- Point-point, uni-directional or bi-directional (symmetric or asymmetric)
- Point-to-multipoint, uni-directional (multicast and broadcast)

9.11 UTRAN nodes

Node B

Node B transmits and receives in one or more cells. There are three modes for a Node B: TDD, FDD or a combination of TDD and FDD. The Node B interfaces the UE over the Uu interface, and the RNC over the Iub interface. One Node B consists of the following blocks:

Control
The control function is responsible for the signalling towards the RNC and the O&M functions. It also monitors the radio quality in the cells, and insert data in the system information.

Signal Processing

The processing of the signal has different requirements in UL and DL.
uplink:

- SC/CC generation
- Despreading
- Rake receiver
- deinterleaving
- channel decoding
- combining (in softer handover)

downlink
- Splitting (in softer handover)
- Channel coding
- Interleaving
- CC/SC generation
- Spreading

Transmitter / Receiver

The transmission/reception part handles the carrier generation and is reponsible for the output power. Here is the modulation / demodulation performed. The modulation is QPSK.

The Radio Network Controller

The RNC is in control of one or several Node B:s. It interfaces the MSC or SGSN in the core network over the Iu interface, and the Node B over the Iub interface. An interface between RNC:s is specified, and knpwn as the Iur interface. The RNC consists of the following:

Radio Network Management

Signalling both to CN and UE is handled by radio network management functions. This function is also responsible for the (re-)negotiation with an UE in a cell and the CN for the QoS for a call/session. This function is also responsible for the control of system information from CN and UTRAN.

Radio Access Bearer Management

The radio access bearer management functions is responsible for the establishment, supervision and release of radio bearers.

- **establishment**: assigns and activates channels in Node B, and assigns channels to the UE
- **supervision**: monitors QoS, handover decisions
- **release**: deactivates channels

Signal Processing

The signal processing functions handles flow control and retransmissions, as well as the SOHO procedures combining (UL) and splitting (DL). It also handles the ciphering / deciphering.