UMTS TERRESTRIAL RADIO ACCESS NETWORK OVERVIEW

The UTRAN (Universal Mobile Telecommunications System**)** consists of a set of radio network subsystems (RNSs). There are two logical elements in RNS. One is node B and another is RNC.

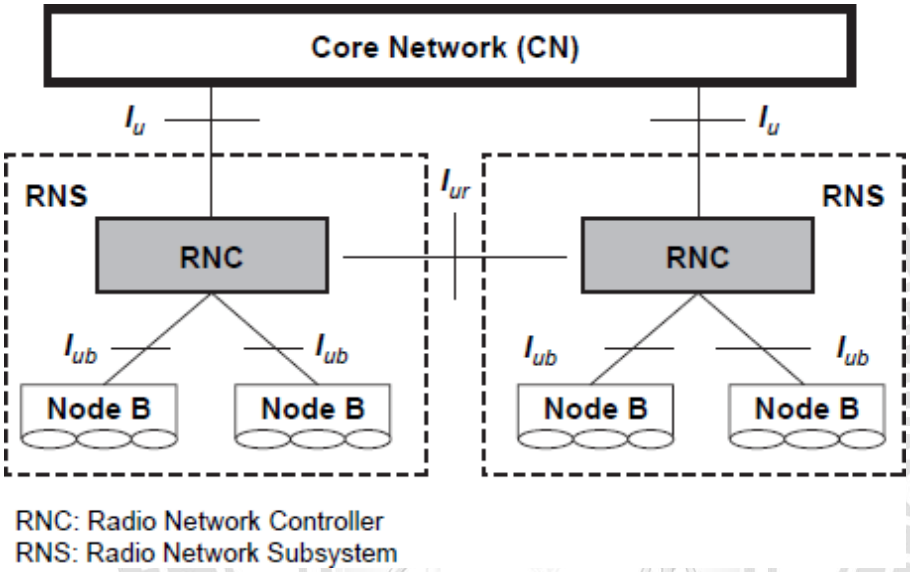

Fig.3.2 UTRAN Logical Architecture

[Source: Text book- Mobile Communications, Second Edition, Pearson Education by Jochen Schiller]

Each cell consists of one group of nodes and one RNC (Radio Network Controller). The RNC is responsible for the use and allocation of all the radio resources of the RNS.

The responsibilities of RNC

This element of the UTRAN / radio network subsystem controls the Node Bs whichis connected to it, i.e. the radio resources of the domain. The RNC is responsible for the radio resource management and some of the mobility management functions. It is responsible for data encryption / decryption.

a. Intra UTRAN handover
b. Macro diversity combining/splitting of I_{ub} data streams
c. Frame synchronization

d. Radio resource management
e. Outer loop power control
f. I_u interface user plane setup
g. Serving RNS (SRNS) relocation
h. Radio resource allocation (allocation of codes, etc.)
i. Frame selection/distribution function necessary for soft handover
j. UMTS radio link control (RLC) sub layers function execution.
k. Termination of MAC, RLC, and RRC protocols for transport channels, i.e., DCH, DSCH, RACH, FACHIub's user plane protocols termination.

The Node B architecture and responsibilities:

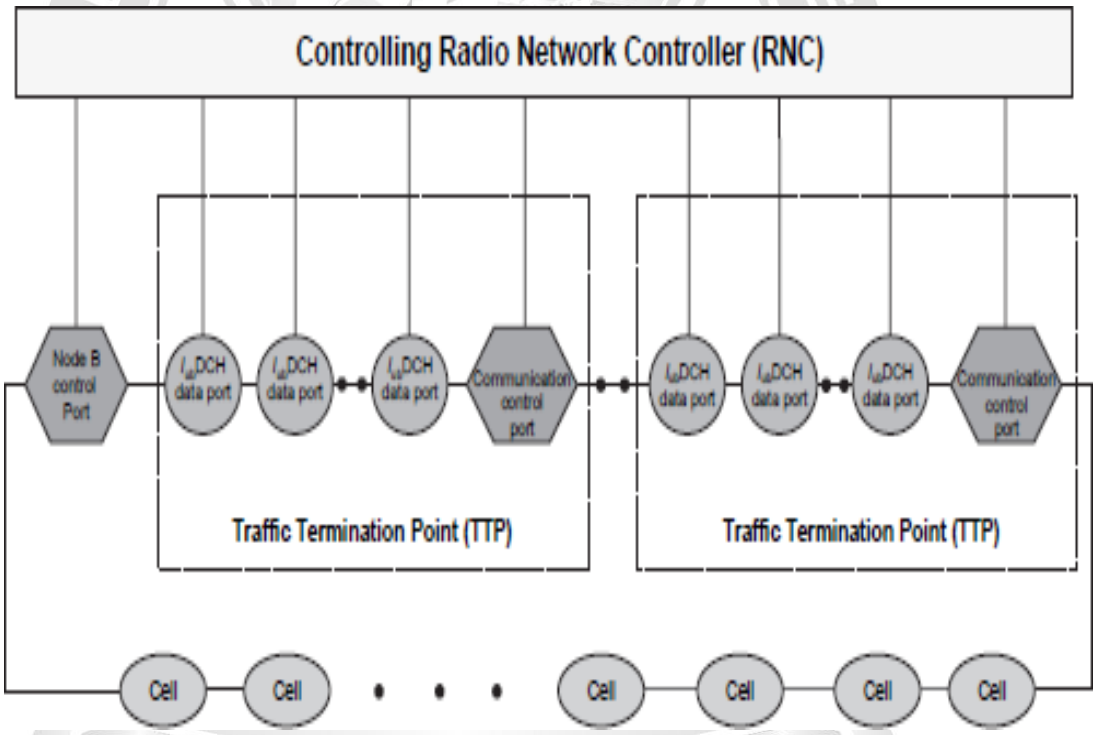

Fig.3.3 Node B logical Architecture

[Source: Text book- Mobile Communications, Second Edition, Pearson Education by Jochen Schiller]

A Node B is responsible for radio transmission and reception in one or more cells to/from the user equipment (UE).

Node B denotes the base station transceiver within UMTS. It contains the transmitter and receiver to communicate with the UEs within the cell. It participates

with the RNC in the resource management. Node B is the 3GPP term for base station, and often the terms are used interchangeably.

The following are the responsibilities of the Node B:

PCH Termination of I_{ub} interface from RNC

Termination of MAC protocol for transport channels RACH, FACH Termination of MAC, RLC, and RRC protocols for transport channels: BCH,

Radio environment survey (BER estimate, receiving signal strength, etc.)

Inner loop power control

Open loop power control

Radio channel coding/decoding

Macro diversity combining/splitting of data streams from its cells (sectors)

Termination of U_u interface from UE

Error detection on transport channels and indication to higher layers

FEC encoding/decoding and interleaving/deinter leaving of transport channels

Multiplexing of transport channels and de- multiplexing of coded composite transport channels

Power weighting and combining of physical channels

Modulation and spreading/demodulation and dispreading of physical channels

Frequency and time (chip, bit, slot, frame) synchronization RF processing.

UTRAN Logical Interfaces

The UTRAN protocol structure contains two main layers

The radio network layer(RNL) The

transport network layer (TNL)

Control Plane: It is used for all UMTS- specific signaling. It includes the application protocol (i.e., radio access network application part (RANAP) in I_u, radio network subsystem application part (RNSAP) in I_ur and node B applicationpart (NBAP) in I_{ub}).

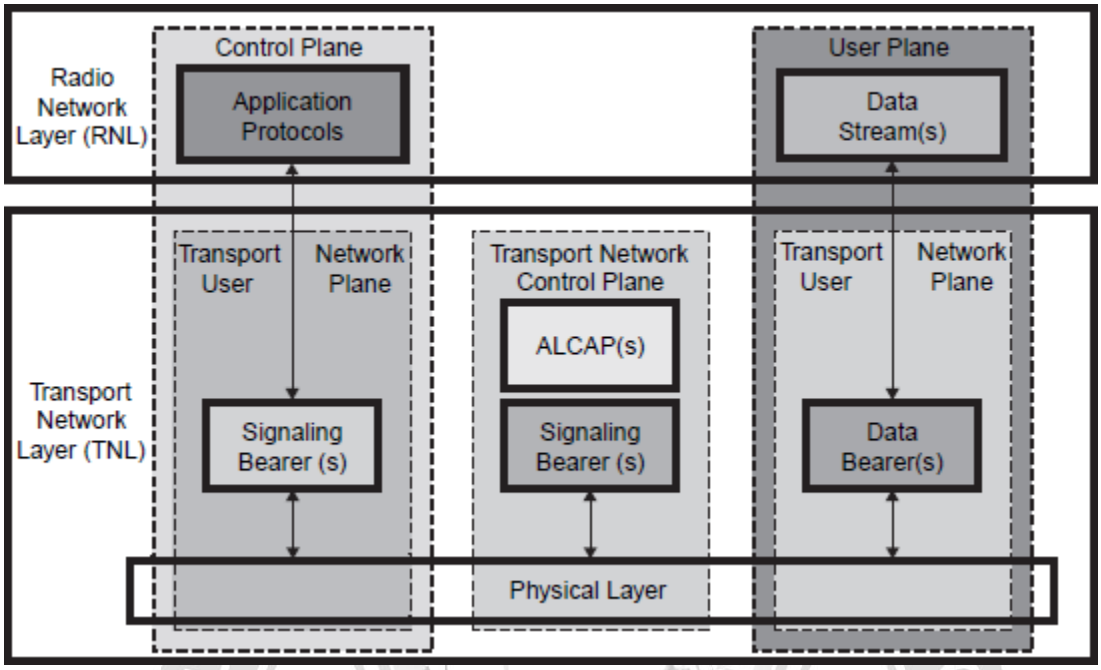

Fig.3.4 General protocol model for UTRAN interfaces

[Source: Text book- Mobile Communications, Second Edition, Pearson Education by Jochen Schiller]

User Plane:

The user plane carries the user information. It includes data streams and data bearers for data streams.

Transport network control plane:

It carries all control signaling. It contains access link control application part (ALCAP) required to set up the transport bearers (data bearers) for the user plane.It also includes the signaling bearer needed for the ALCAP. The transport plane lies between the control plane and the user plane. The addition of the transport plane in UTRAN allows the application protocol in the radio network control plane to be totally independent of the technology selected for the data bearer in the user plane.lu Interface

The UMTS Iu interface connects the UTRAN to the UMTS core network (UCN). It consists of three planes.

1. Radio network control plane:

It carries information for the general control of UTRAN radio network operations.

It carries information for control of UTRAN in the context of each specific call.

It carries user call control (CC) and mobility management (MM) signaling messages.

2. The transport network control plane (TNCP):

It carries information for the control of transport network used within UCN.

3. User plane (UP):

It carries user voice and packet data information.

AAL2 is used for the following services: narrowband speech (e.g., EFR, AMR); unrestricted digital information service (up to 64 kbps, i.e., ISDN B channel); any low to average bit rate CS service (e.g., modem service to/from PSTN/ISDN). AAL5 is used for the following services: non-real-time PS data service (i.e., best effort packet access) and real-time PS data.

I_{ur} Interface

The I_{ur} interface allows communication between different RNCs within the UTRAN. The open I_{ur} interface enables capabilities like soft handover to occur as well as helping to stimulate competition between equipment manufacturers.**Two different protocol planes are defined for it:**Radio network control plane (RNCP) Transport network control plane (TNCP)

User plane (UP)

The I_{ur} interface is used to carry:

Information to control the radio resources in the context of specific service request of one mobile on RNCP

Information to control the transport network used within UTRAN on TNCPUser voice and packet data information on UP

The protocols used on this interface are:

Radio access network application part (RANAP)

RANAP signaling protocol resides in the control plane of Radio network layer of Iu interface in the UMTS (Universal Mobile Telecommunication System) protocol stack. Iu interface is the interface between RNC (Radio Network Controller) and CN (Core Network).

DCH frame protocol (DCHFP)

The data transfer takes place using a frame protocol. The procedures belonging to this set include establishment, modification and release of dedicated channel in the DRNC due to hard and soft handover, set-up/release of dedicated transport connections over Iur interface and data transfer for dedicated channels.

RACH frame protocol (RACHFP)

A random-access channel (RACH) is a shared channel used by wireless terminals to access the mobile network (TDMA/FDMA, and CDMA based network) for call set-up and burst data transmission. Whenever mobile wants to make a MO call it schedules the RACH. RACH is transport-layer channel.

FACH frame protocol (FACHFP)

Forward Access Channel

Access link control application part (ALCAP)

Control plane protocol for the transport layer. It is used for multiplexing of different users onto one AAL2 transmission path using channel IDs (CIDs).

Signaling connection control part (SCCP)

A network layer protocol that provides extended routing, flow control, segmentation, connection-orientation, and error correction facilities in Signaling System & telecommunications networks.

Message transfer part 3-B (MTP3-B)

Signaling ATM adaptation layer for network-to-network interface (SAALNNI) (SAAL-NNI is further divided into service specific coordination function for network to network interface (SSCF-NNI), service specific connection oriented protocol (SSCOP), and ATM adaptation layer 5 (AAL5))

Basic inter-RNC mobility support

Support of SRNC relocation

Support of inter-RNC cell and UTRAN registration area updateSupport of inter-RNC packet paging

Reporting of protocol errors

Dedicated channel traffic support

Establishment, modification, and release of a dedicated channel in theDRNC due to hard and soft handoff in the dedicated channel state

Setup and release of dedicated transport connections across the Iur interfaceTransfer of DCH transport blocks between SRNC and DRNC Management of radio links in the DRNS via dedicated measurement reportprocedures and power setting procedures

Common channel traffic support

Setup and release of the transport connection across the Iur for common channel data streams

Splitting of the MAC layer between the SRNC (MAC-d) and DRNC (MAC-c and MAC-sh); the scheduling for downlink data transmission is performed in the DRNC

Flow control between the MAC-d and MAC-c/MAC-sh

Global resource management support

Transfer of cell measurements between two RNCsTransfer of Node B timing between two RNCs

I_{ub} Interface

The I_{ub} connects the Node B and the RNC within the UTRAN. Although when it was launched, a standardization of the interface between the controller and base station in the UTRAN was revolutionary, the aim was to stimulate competition between suppliers, allowing opportunities like some manufacturers who might concentrate just on base stations rather than the controller and other network entities.

Three different protocol planes are defined for it.

Radio network control plane (RNCP)

Transport network control plane (TNCP)

User plane (UP)

The I_{ub} interface is used to carry the information for the general control of Node B for radio network operation on RNCP Information for the control of radio resources in the context of specific service request of one mobile on RNCP Information for the control of a transport network used within UTRAN onTCNP User CC and MM signaling message on RNCP.

UTRA uplink & downlink

At the radio air interface and its associated properties, it is necessary to define the directions in which the transmissions are occurring. Being a full duplex system, i.e. transmitting simultaneously in both directions, it is necessary to be able to define which direction is which.

- Uplink; This may also sometimes be known as the reverse link, and it is the link from the User Equipment (UE) to the Node B or base station.
- Downlink; This may also sometimes be known as the forward link, and it is the link from the Node B or base station to the User Equipment (UE).

UTRA FDD & TDD

In view of the fact that transmissions have to be made in both directions, i.e. in both uplink and downlink. It is necessary to organize the way these transmissions are made. Two techniques are used to ensure concurrent or near concurrent transmissions in both directions: frequency division duplex and time division duplex.

UTRA-FDD: The frequency division duplex version of UTRA uses a scheme whereby transmissions in the uplink and downlink occur on different frequencies. Although this requires double the bandwidth to accommodate the two transmissions,

and filters to prevent the transmitted signal from interfering with thereceiver. Even though there is a defined split between uplink and downlink, effective filters are required.

UTRA-TDD: The time division version of the UTRA uses uplink and downlink transmissions that use the same frequency but are timed to occur at different intervals.

Distribution of UTRAN Functions

Located in the RNC

Radio resource control (L3 Function)

Radio link control (RLC)

Macro diversity combining

Active cell set modification

Assign transport format combination set (centralized data base function)

Multiplexing/de-multiplexing of higher layer PDUs into/from transport block delivered to/from the physical layer on shared dedicated transport channels (used for soft handover)

L1 function: macro diversity distribution/combining (centralized multipoint termination)

Selection of the appropriate transport format for each transport channel depending upon the instantaneous source rate — collocate with RRCPriority handling between data flows of one user.

Located in Node B

Scheduling of broadcast, paging, and notification messages; location in Node B — to reduce data repetition over I_{ub} and reduce RNC CPU load and memory space Collision resolution on RACH (in Node B — to reducenonconstructive Traffic over I_{ub} interface and reduce round trip delay) Multiplexing/de-multiplexing of higher layer PDUs to/from transportblocks delivered to/from the physical layer on common transport channels