UTRAN
Architecture Protocol and Procedure Overview

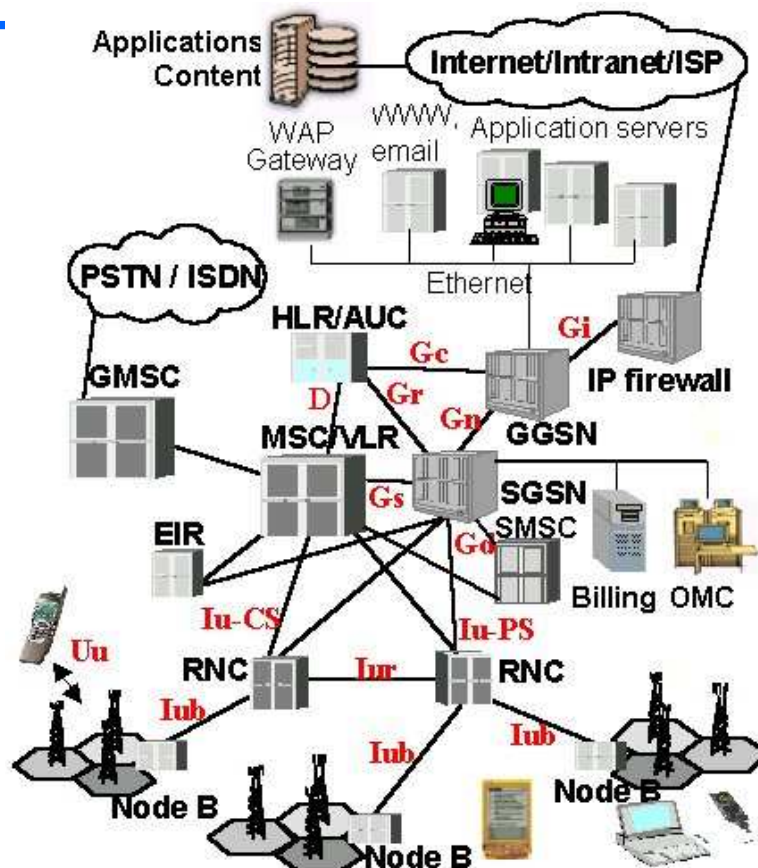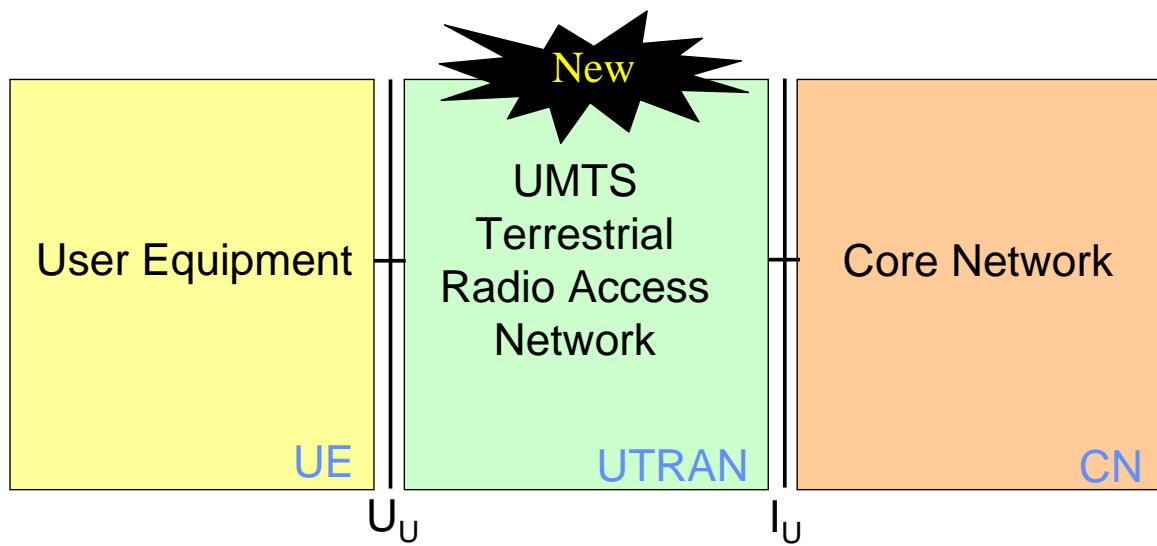*By Dr Sam Nourizadeh*

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Network Elements

The primary functions of the UTRAN include:
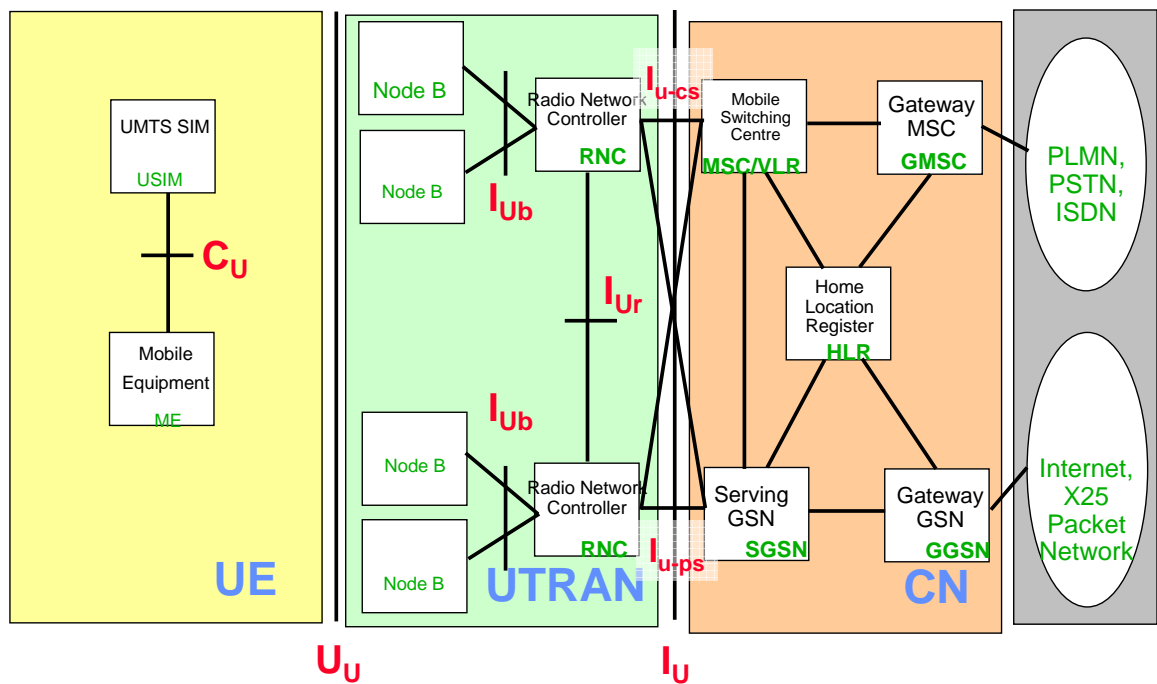
▫ Provision of Radio Coverage

▫ System Access Control

▫ Security and Privacy

▫ Handover

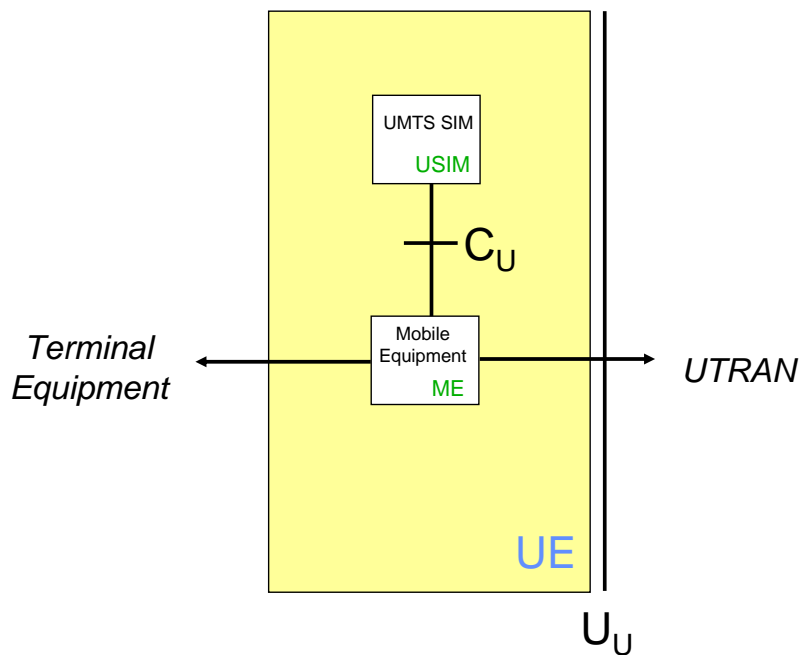▫ Radio Resource Management (RRM) and Control (RRC)

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UMTS High Level Architecture

Network Elements in UMTS

General UE Architecture

Elements of the UE

- Mobile Equipment
    - The radio terminal used for radio communication over the U_u interface

- UMTS Subscriber Identity Module
    - The smartcard that holds the subscriber identity, authentication and encryption keys etc

- Additionally one can define a Terminal Equipment item that connects to the UE
    - This carries the application specific user interface

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General Core Network Architecture

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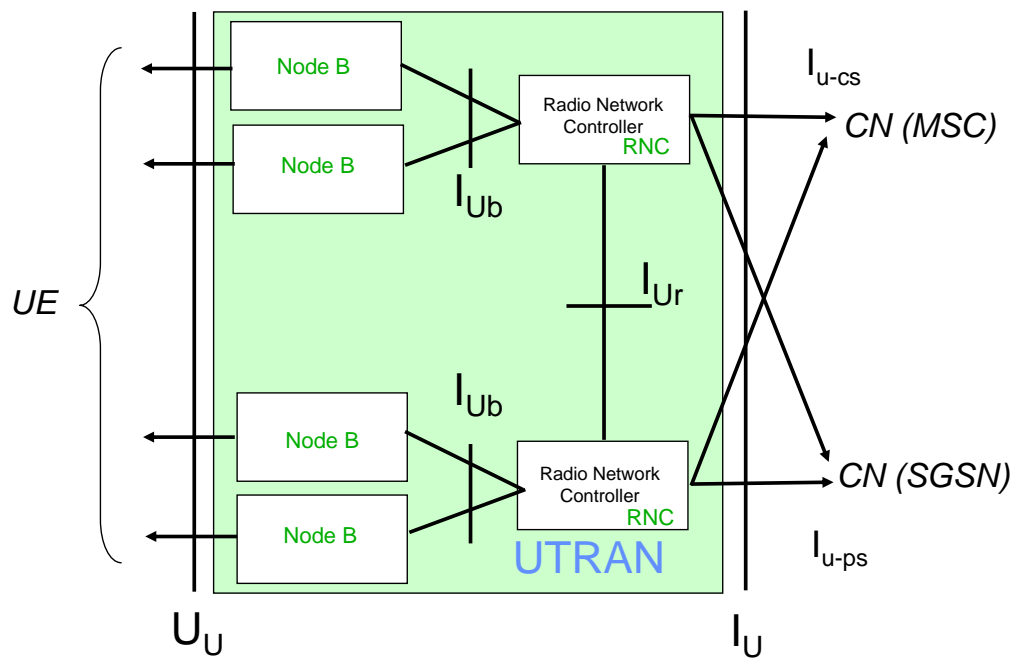INTERNATIONAL
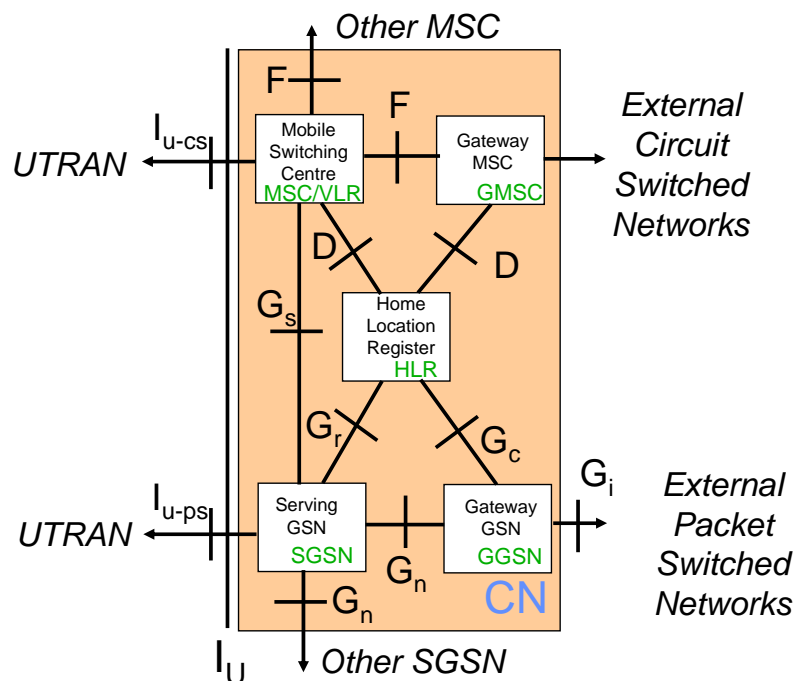
Functions of the CN

- Switching

- Service Provision

- Transmission of user traffic between UTRAN(s) and/or fixed network

- Mobility Management

- Operations, Administration and Maintenance

Why Separate CS & PS domain
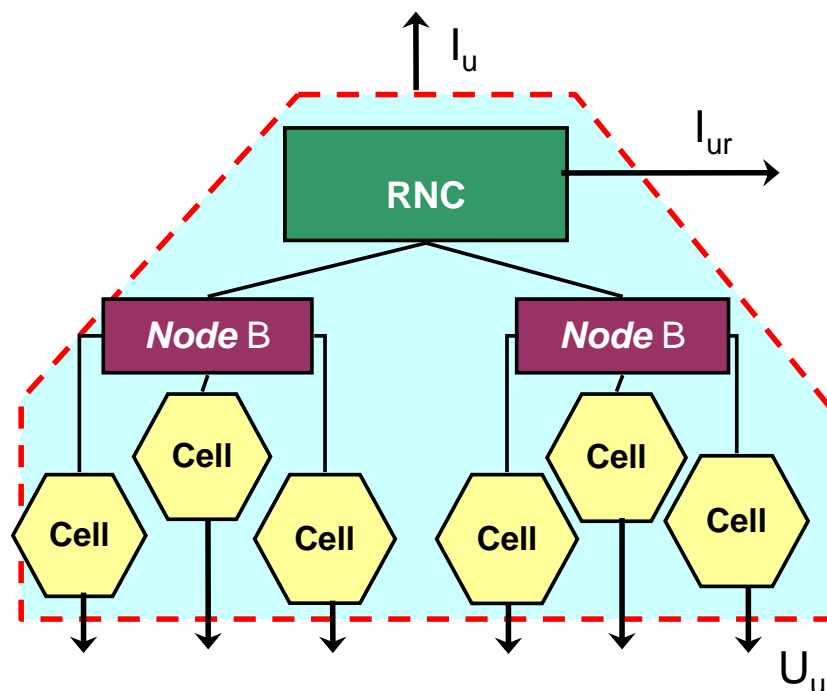
- Advantages:
  - Simple Evolution GSM/GPRS
  - Low risk
  - Early availability
  - Service continuity

- Disadvantages:
  - Built and Manage 2 networks
  - Separate Engineering and Dimensioning
  - Greater Infrastructure cost
  - Duplicated functions:
    - *Mobility management in VLR and SGSN*

Future Core Network will be All-IP !!!

General UTRAN Architecture

RNS Architecture

Radio Network Controller (RNC)

- Responsible for the use and integrity of the radio resources within the RNS

- Responsible for the handover decisions that require signalling to the UE

- Provides a combining/splitting function to support macrodiversity between different Node Bs

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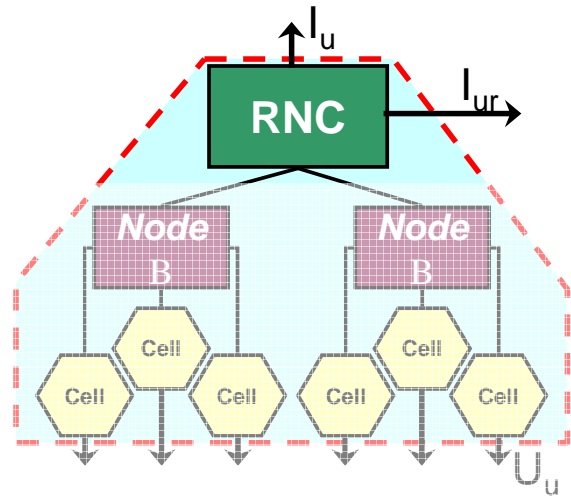
Node B

- Logical node responsible for radio transmission / reception in one or more cells to/from the UE

- Dual mode Node B can support FDD and TDD mode

- Not *necessarily* a single site according to the standards
  - Most current implementations use a single site
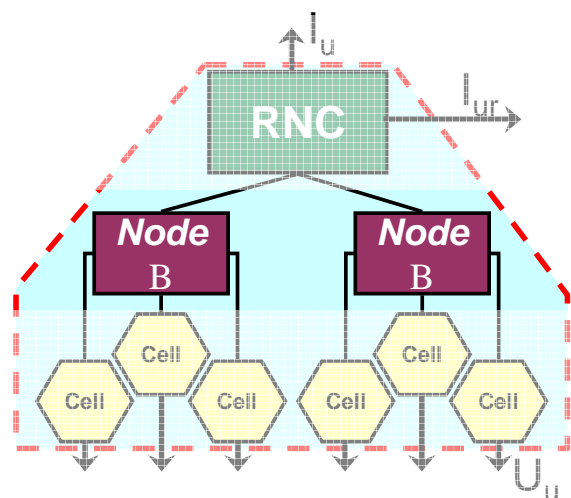
Cell

- A cell is an area of radio coverage serviced by one or more carriers
- One Primary Scrambling code per cell/sector

UTRAN Architecture (1)

- Consists of a set of **Radio Network Subsystems** (RNS) connected to the Core Network (CN) through the Iu interface.

- RNS consists of a single **Radio Network Controller** (RNC) and one or more **Node B**s.
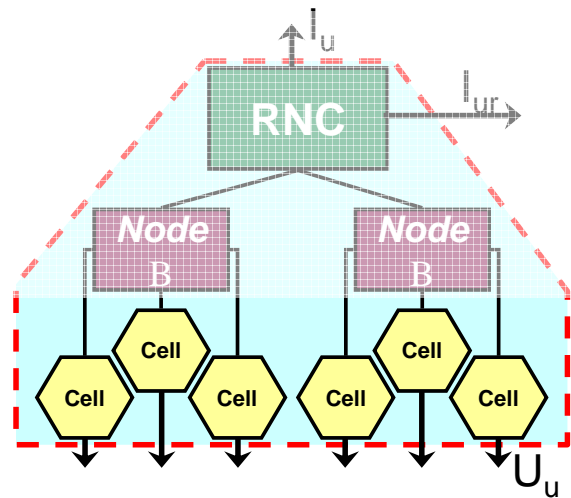
- The **RNC** is responsible for the:
  - Use and integrity of radio resources within the **RNS** (i.e. flow data between the CN & the UE).
  - Handover decisions, requiring signalling to the UE.

- The **Node B** controls the radio transmitter and receiver functions of the radio interface.

- The **Node B** initiates and terminates data flow over the resources according to the instructions received by the **RNC**.

- The **Node B** provides radio access services over a **Cell** using one or more carrier frequency.

UTRAN Architecture (2)

- The **RNS** providing the interface between the **UE** and the **CN** is known as the **Serving** RNS (**SRNS**).

- The RNC providing the interface in SRNS to the UE is known as the **Controlling** RNC (**CRNC**).

- The **CRNC** controls the radio resource allocation within the **Node B**.

- If an UE handover from the SRNS to another RNS, the latter is called the Drift RNS (DRNS) and will control the resources of the UE.

- If UE handover from the **SRNC** to another RNC, the latter is called **Drift** RNC (**DRNC**) & will control the resources of the UE in DRNS.

UTRAN Interfaces (1)

There are four major interfaces:

- I_u split into I_{u-cs} and I_{u-ps}
- I_{ub}
- I_{ur}
- U_u (WCDMA, TD-CDMA…)

CN

I_u

RNC — I_{ur} — RNC

I_{ub}

Node-B

U_u

UE
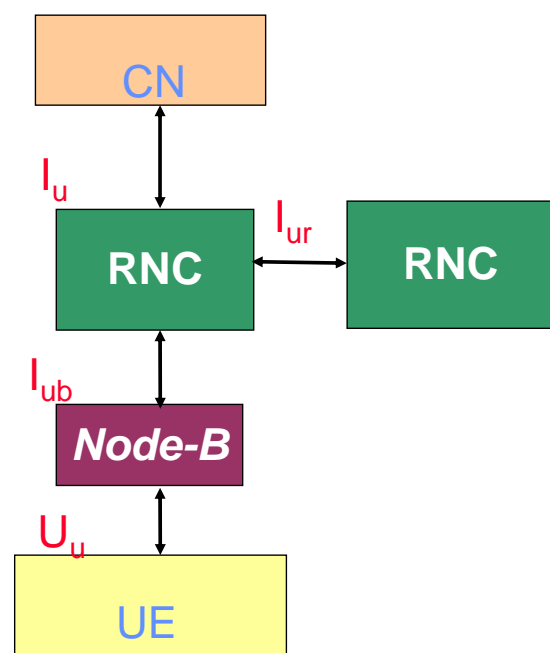
UTRAN Interfaces (2)

- The interface between **UTRAN & CN** is referred to I_u, split into:
    - I_{u-ps}, connecting the UTRAN to the **Packet Switched** Network
    - I_{u-cs}, connecting the UTRAN to the **Circuit Switched** Network

- The interface between the **RNC & Node B** is referred to I_{ub} carrying:
    - Layer 2+ signalling between the UE and the UTRAN
    - Signalling directly to the Node B
    - Control Radio Resource Allocation
    - General control of the Node B
    - O&M functionality

UTRAN Interfaces (3)

- The interface between any two RNCs is referred to I_{ur}
    - Transports the signalling between a SRNS and a DRNS
    - Support basic inter RNS mobility, Dedicated and Common Traffic CHannels and Global resource management.

Handover in UMTS

- There are three basic types of handover
  - Intra frequency handovers
    - Handovers between 2 UMTS codes at the same frequency
    - These can be soft handovers

  - Inter frequency handovers
    - Handovers between 2 UMTS carriers at different frequencies
    - These are hard handovers

  - Inter system handovers
    - Handovers between UMTS and GSM carriers
    - These are hard handovers

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Handover Sets in UMTS

- Active Set
  - Cells forming a soft handover connection to the mobile

- Candidate Set - GSM concept
  - No equivalent in UMTS

- Neighbour Set
  - Those cells which are continuously monitored but do not yet qualify for the Active Set

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Handover Decisions in UMTS
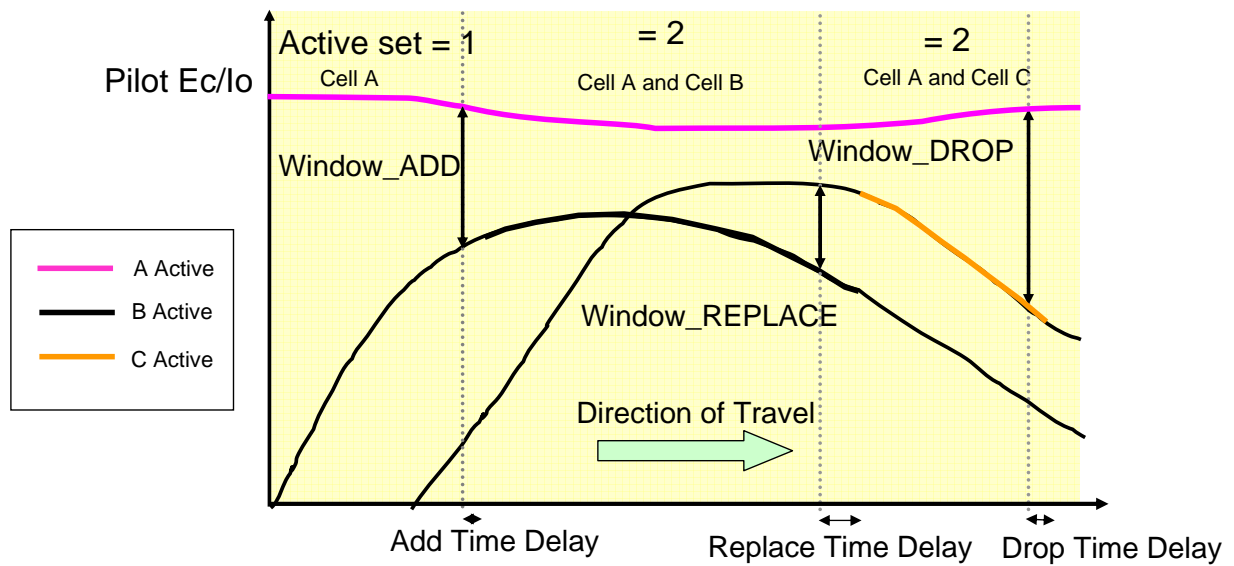
Macrodiversity between Node B's

- If an active set consists of two connections to cells parented to different Node Bs then the combining of the two channels occurs at the RNC

- This is known as a *soft handover*

- This doubles the transmission 'cost' of the call
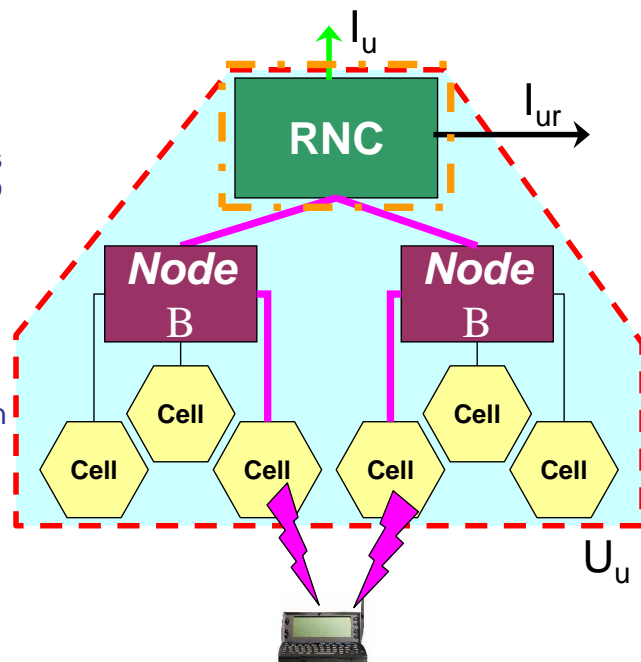
Macrodiversity between Cells on the Same Node B

- If an active set consists of two connections to cells parented to the same Node B
  - combining of the two channels occurs at the Node B
- This is known as a *softer handover*
- This has no transmission implication
- But does have capacity implications, if cells are collocated.
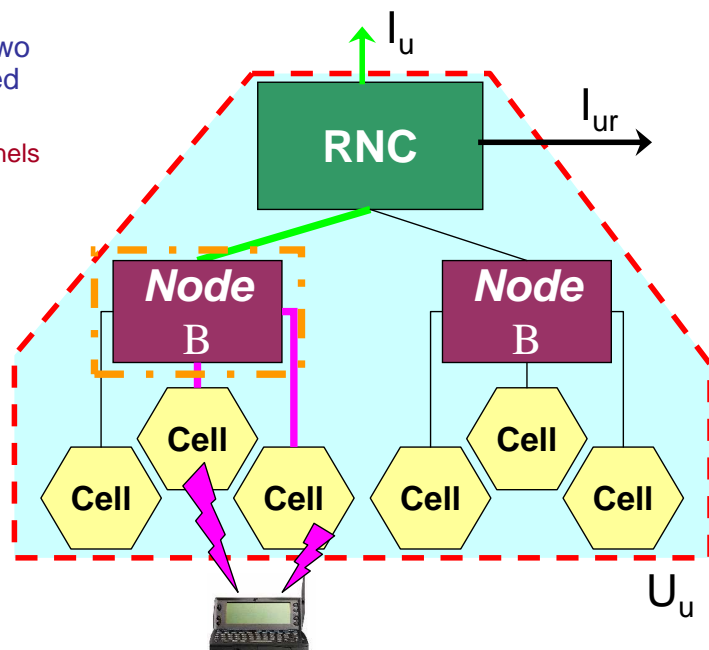
Architecture of a UMTS Bearer Service

Each bearer service on a specific layer provides services using layers below.
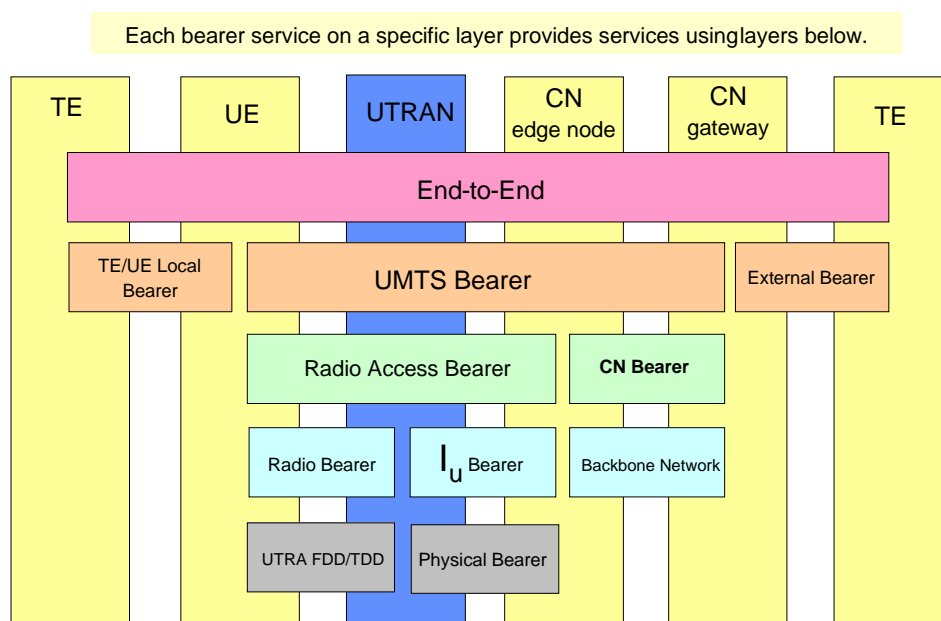
UMTS Bearer Service

- UMTS allows a user/application to negotiate bearer characteristics that are most appropriate for carrying information.

- Each bearer service on a specific layer offers its individual services using those provided by the layer and from layers below.

- The radio access bearer RAB is the principle information pipe set-up by the UTRAN to enable communication between the end-user and the core network (end-user)

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UMTS Protocol Stratums

- Access Stratum
  - Encompasses Layer 1 and 2 of the OSI 7 layers and the lower part of Layer 3

- Non Access Stratum
  - Encompasses Layer 4 to 7 of the OSI 7layers and the upper part of the layer 3

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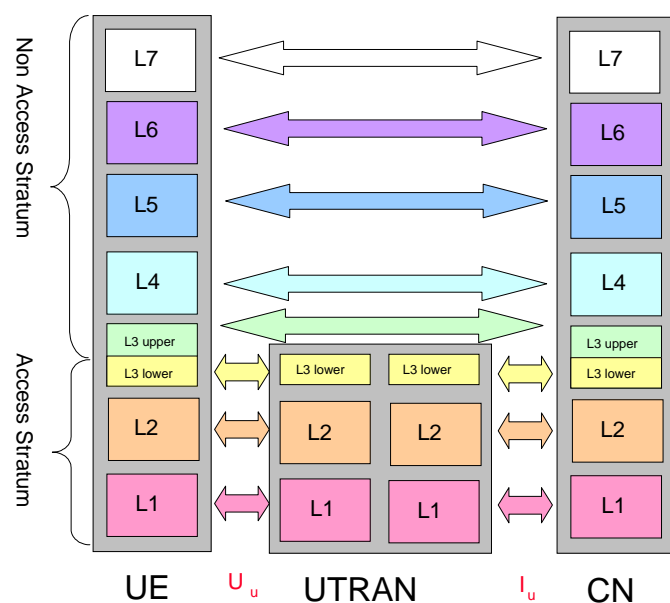
UMTS QoS Classes

1. **Conversational Class**
   - Real-time conversation. End-to-end delay less than 400ms.

2. **Streaming Class**
   - Must be able to collect the data and send it as a steady stream to the application. Very asymmetric and can withstand more delay than conversational services.

3. **Interactive**
   - Content of packets of data must be transparently transferred, with low bit error ratios.

4. **Background Class**
   - Content of packets of data does not have to bee transparently transferred. Data to be transmitted has to be received error free

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Question

1. What are the 2 principle elements of the UTRAN?
2. What are the 5 interfaces defined in UMTS?
3. Which layers of the OSI correspond with the access stratum?
4. Which QoS category in UMTS supports web browsing?
5. Is the SGSN function supported by the CS or PS network?

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UTRAN Interface Protocol

Radio Interface Protocol Architecture

The radio interface is layered into three protocols layers:

1. **Layer 1** (or the Physical Layer) processes digital data from Layer 2 and then transmits it over the radio interface using **Physical channels**.

2. **Layer 2** (or the Radio Link Layer) provides data transport services to Layer 3 using **Radio Bearers**. This is split into sub-layers:

   - Medium Access Control (**MAC**)

   - Radio Link Control (**RLC**)

   - Packet Data Convergence Protocol (**PDCP**)

   - Broadcast Multicast Control (**BMC**)

   - Layer 1 data is split into **User-Plane** data and **Control-plane** data

Radio Interface Protocol Architecture

The radio interface is layered into three protocols layers:

3. **Layer 3** and the **RLC** are divided into **Control** (C-) and **User** (U-) planes.

- The **RRC** in L3 interfaces with L2, terminates in the UTRAN and belongs to the **Access Stratum** (AS).

The higher sub-layers contain signalling functions such as

- **Mobility Management** (MM)
- **Call Control** (CC)
- Terminate in the CN and belongs to the **Non Access Stratum** (NAS)

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UTRAN Radio Interface Protocol Architecture

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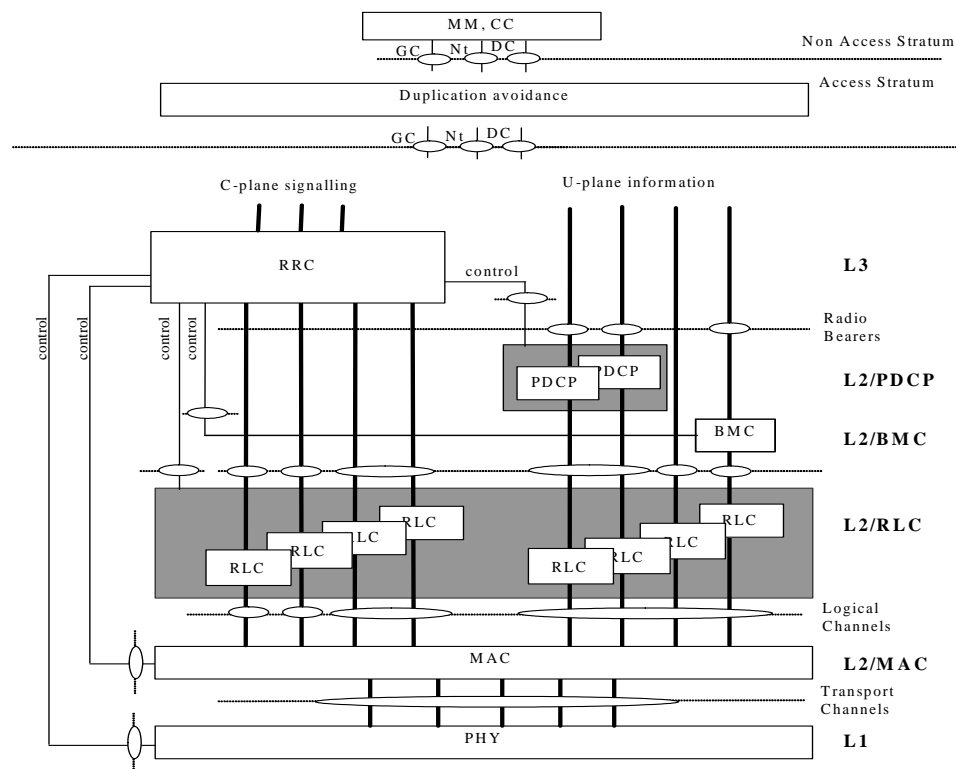
Radio Resource Control (RRC)

- The **RRC** forms the core of the Access Stratum.
- Is responsible for **coordinating** the use of **radio resources** in the UE.
- Sits between the **Dedicated Control** (DC), **Notification** (Nt) and the **General Control** (GC) SAPs.
- **Connects** with the Non Access Stratum (**NAS**) and the internal components of the Access Stratum (**RLC, MAC,PDCP & BMC**).

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Radio Resource Control (RRC)

- Its function are:
  - Cell selection and reselection
  - Reception of broadcast system information
  - Paging and Notification
  - Establishment, maintenance and release of:
    - an RRC connection between the UE & UTRAN.
    - Radio resources for the RRC connection
  - Control of requested QoS
  - UE measurements & Outer Loop Power Control

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Radio Link Control (RLC)

- RLC is a sub-layer within Layer 2.

- RLC's purpose is to provide radio link services between UE & Network.

- At the Tx, the higher layers provide data on radio bearers in **Service Data Units** (SDUs). These are mapped by the RLC layer into **Protocol Data Units** (PDUs), sent on logical channels provided by the MAC.

- RLC is **configured** by the RRC via the RLC control **SAPs**.

Radio Link Control (RLC)

- The RLC layer provides three types of SAPs, one for each RLC operation mode:

  1. **Transparent Mode** (TM), used for simple data transfer. Transparent Data are passed through the RLC in PDUs which are unchanged.

  2. In **Unacknowledged Mode** (UM), RLC signalling added to the data to permit variable relationship.

  3. In **Acknowledge Mode** (AM), additional PDUs, to the RLC signalling, are defined to permit bidirectional signalling between peer RLC entities.

Packet Data Convergence Protocol

- Defined for **Packet Switched domain** only and sits above the RLC.

- Each of the Packet Switch domain RAB is associated with one RB.

- PDCP converts all the packet data network into RLC SDUs, vice-versa (in TM mode).

Packet Data Convergence Protocol

- The basic functionality of the PDCP includes:

  - **Transfer** of packet user data;

  - To perform **header compression** and **decompression** of IP data streams for the transmit and the receive entity, respectively;

  - Maintain the sequence number for RBs which are configured to support lossless SRNS relocation.

  - Add a header on the packet during SRNS relocation.

PDCP Architecture
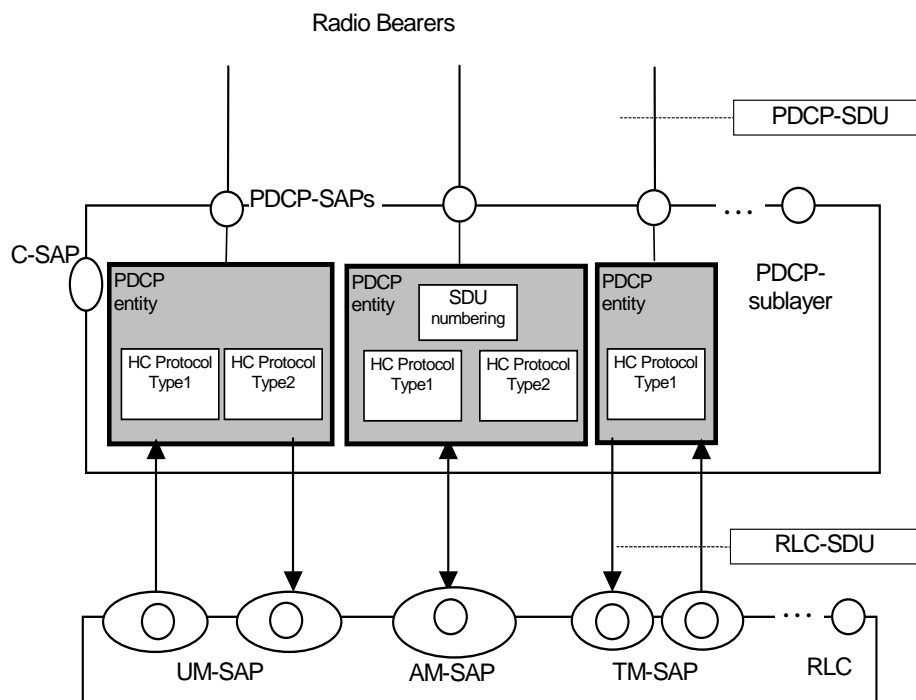
Broadcast Multicast Control

- The BMC is above the RLC in Layer 2 of the AS and active in the U-Plane.

- BMC is responsible for receiving CBS traffic on the CTCH.

- The CBS traffic consists of:
  - **CBS messages**, that contains user data for broadcast to the NAS.
  - **Schedule Messages**, containing information regarding which CBS messages are broadcasted in radio frame.

Medium Access Control (MAC)

- The MAC sits between **L1** and the **RLC** in Layer 2 of the Access Stratum.

- The responsibilities of the MAC include:

  - Data exchange between **RLC** and the **Physical Layer**, done via **logical channels** (defined as a mapping between the **RLC** entity and a **TrCH**);

  - Selection of the Transport Format Combination (**TFC**) for transmission;

  - Random Access channel (**RACH**) transmission control. The MAC is responsible for controlling the timing of transmissions on the RACH;

  - Multiplexing multiple Logical channel into a single Transport channel

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Medium Access Control (MAC)

- The responsibilities of the MAC include:

  - Identification of UE on **Common Transport Channels**;

  - **Traffic Volume measurements**. The MAC is responsible for measuring the amount of data being transmitted on the logical channels and reporting the measurements to the RRC;

  - **Ciphering**. The MAC is responsible for enciphering and deciphering data on **DCCH** and **DTCH** logical channels that are mapped to **TM** (**Transparent Mode**) RLC entities.

  - Security / Encryption.

Medium Access Control (MAC)

- The responsibilities of the MAC include:

  - Priority handling between data flows of one UE;
  - Priority handling between UEs by means of dynamic scheduling;
  - Identification of UEs on common transport channels;

  - Multiplexing/demultiplexing of upper layer PDUs into/from **transport blocks** delivered to/from the physical layer on **common** transport channels.
  - Multiplexing/demultiplexing of upper layer PDUs into/from **transport block sets** delivered to/from the physical layer on **dedicated** transport channels**.**
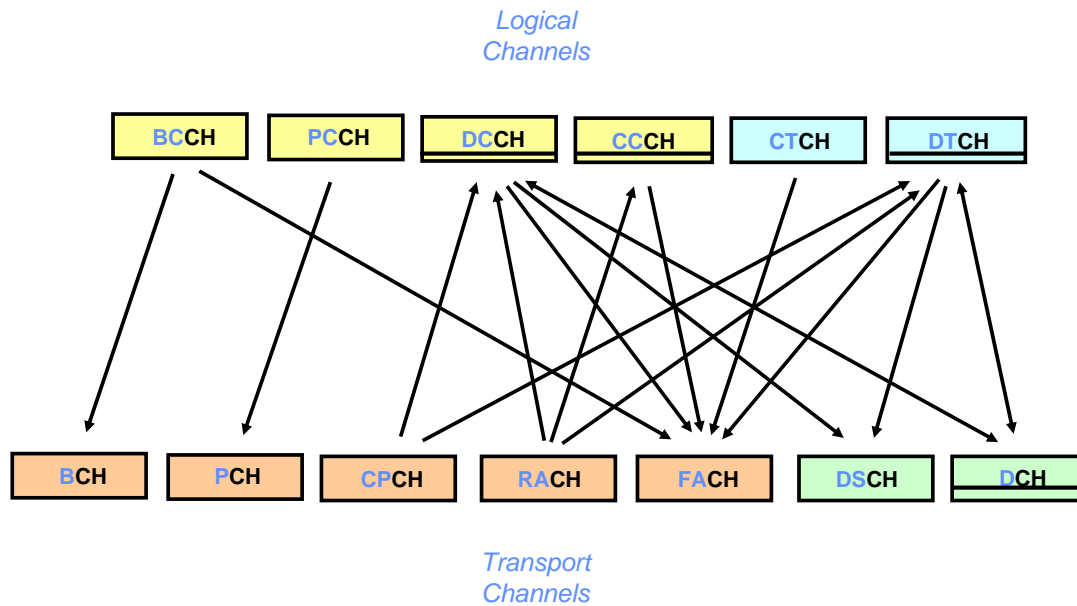
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Medium Access Control (MAC)

- The responsibilities of the MAC include:

  - Identification of MBMS services on common transport channels

 - Control of HS-DSCH transmission and reception including support of HARQ.

  - HS-DSCH Provided Bit Rate measurement;

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UTRAN MAC Architecture

MAC Control

MAC Control

BCCH
PCCH   CC

Logical Channels

Control Channel ——————— Broadcast Control Channel (BCCH)

——— Paging Control Channel (PCCH)

——— Dedicated Control Channel (DCCH)

——— Common Control Channel (CCCH)

——— Shared Channel Control Channel (SHCCH)

——— MBMS point-to-multipoint Control Channel (MCCH)

——— MBMS point-to-multipoint Scheduling Channel (MSCH)

Traffic Channel ——————— Dedicated Traffic Channel (DTCH)

——— Common Traffic Channel (CTCH)

——— MBMS point-to-multipoint Traffic Channel (MTCH)

FACH FA

Mapping of Logical Channels to Transport Channels

Mapping Logical to Transport Channel

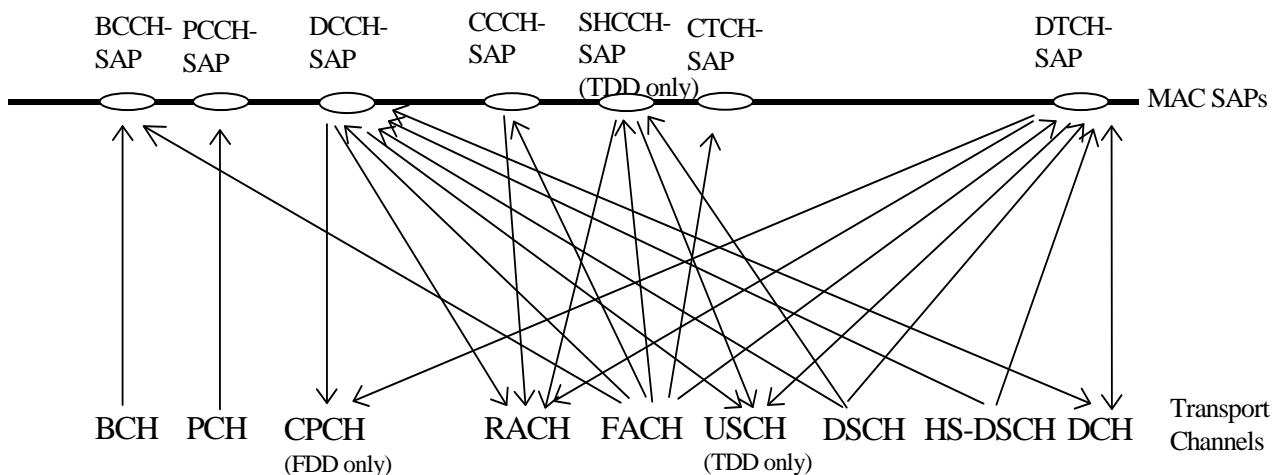**Logical Channel mapped onto Transport Channels, seen from the "UTRAN" side:**
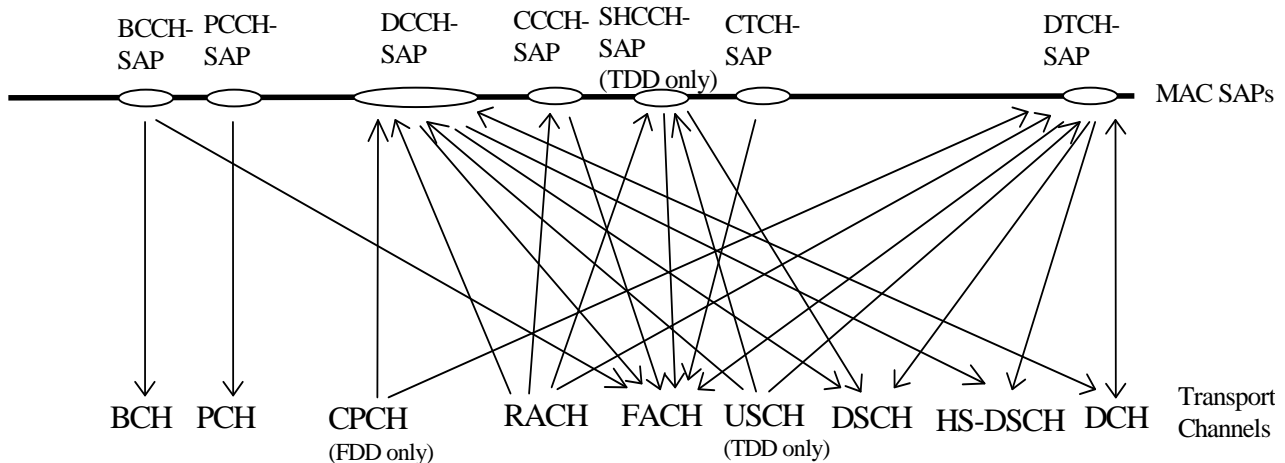
UE MAC Architecture
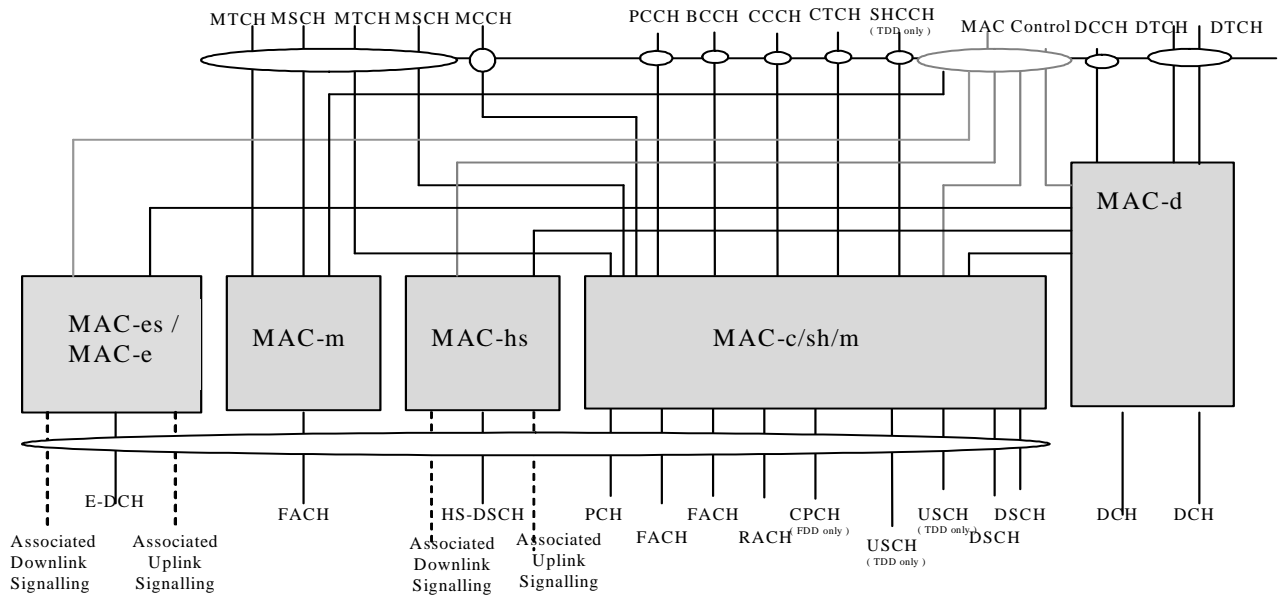
Mapping Logical to Transport Channel

**Logical Channel mapped onto Transport Channels, seen from the "UE" side:**

Major Physical Channels for UMTS

- Common Control Channels
  - P-CCPCH   Primary Common Control Physical Channels (DL)
  - S-CCPCH   Secondary Common Control Physical Channels (DL)
  - P-SCH   Primary Synchronisation Channel (DL)
  - S-SCH   Secondary Synchronisation Channel (DL)
  - CPICH   Common Pilot Channel (DL)
  - AICH   Acquisition Indicator Channel (DL)
  - PICH   Paging Indicator Channel (DL)
  - PDSCH   Physical Downlink Shared Channel (DL)
  - PRACH   Physical Random Access Channel (UL)
  - PCPCH   Physical Common Packet Channel (UL)
  - AP-AICH   Access Preamble Acquisition Indicator Channel (DL)
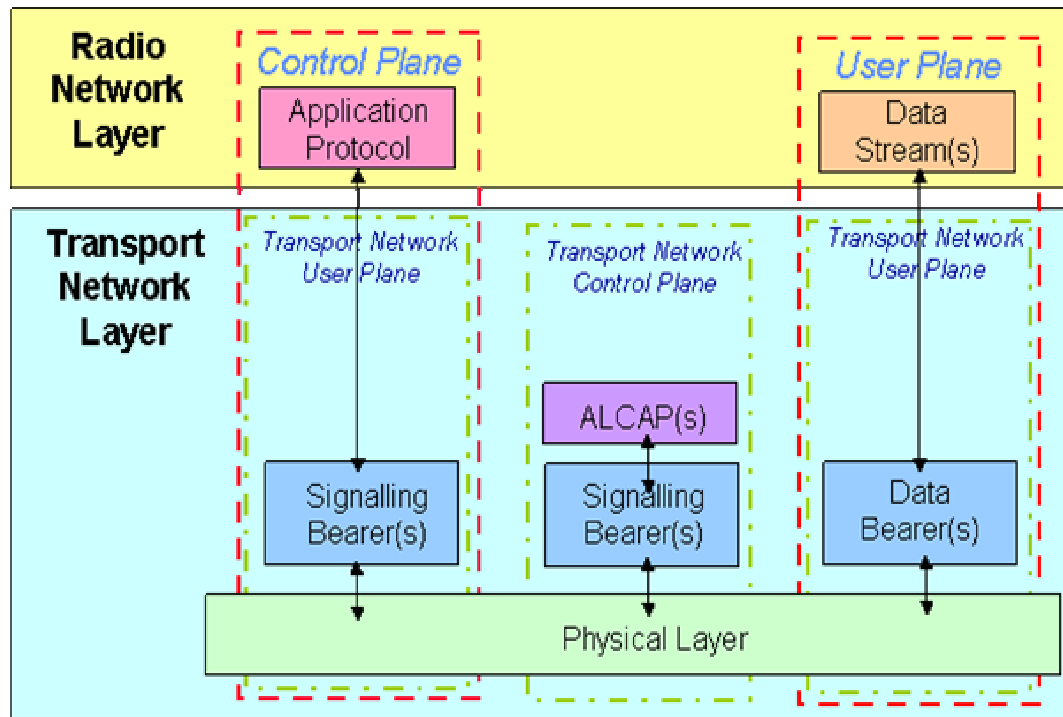 - CD/CA-ICH   Collision Detection/Channel Assignment Indicator Channel (DL)

- Dedicated Channels
  - DPDCH   Dedicated Physical Data Channel (DL & UL)
  - DPCCH   Dedicated Physical Control Channel (DL & UL)

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Mapping of Transport Channels to Physical Channels
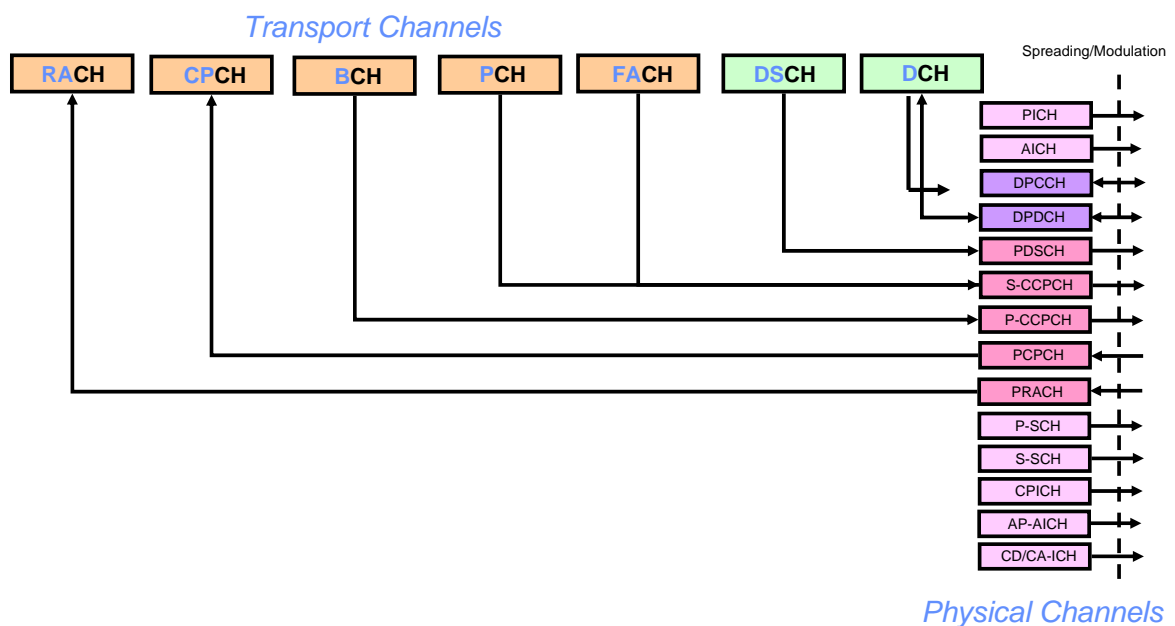
General Protocol Model for UTRAN

User Plane & Control Plane

- From the structure, the **layers** and **planes** are logically independent.

- The protocol structure of the UTRAN is described in two layers:

  1. **Radio Network Layer** (RNL), handles all UTRAN related issues.
  2. **Transport Network Layer** (TNL), represents standard transport technology to carry the RNL protocol information between nodes.

- **TNL & RNL** are split into **Control** (signalling data) & **User** (traffic) Planes.

- User Plane protocols functions implement the bearer service to carry user data.

- Control Plane protocol functions control the radio access bearer & the connection between the UE and the network.

Vertical Planes in the General Protocol Model

- The **Control Plane** is for all UMTS specific control signalling including:
  - Application Protocols
  - Signaling Bearers

- The **User Plane** is for all data sent and received by the user including:
  - Data Streams
  - Data Bearers

- **Transport Network Control Plane** contains all signalling within the Transport Layer

- **Transport Network User Plane** contains the Signalling and Data Bearers for the Radio Network Layer Protocols
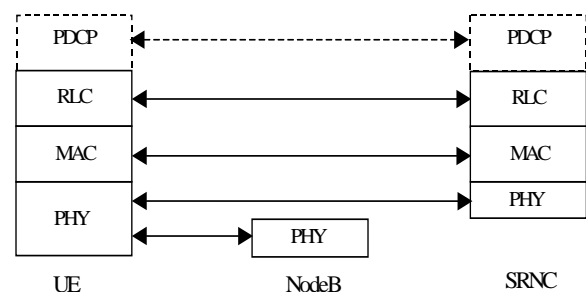

Protocol Terminations for DCH
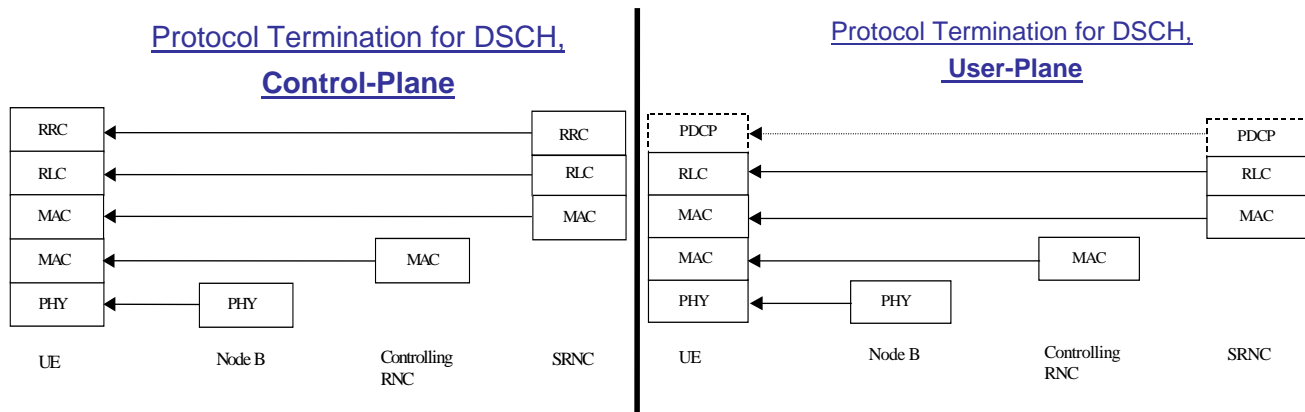
Protocol Termination for DCH, C-Plane
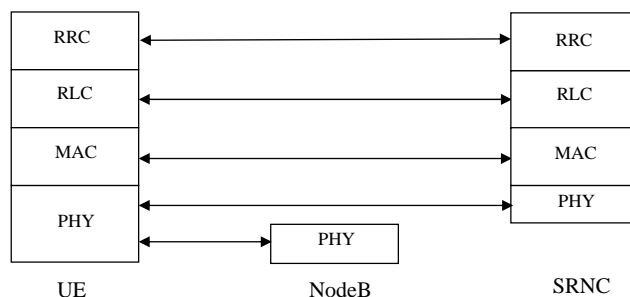
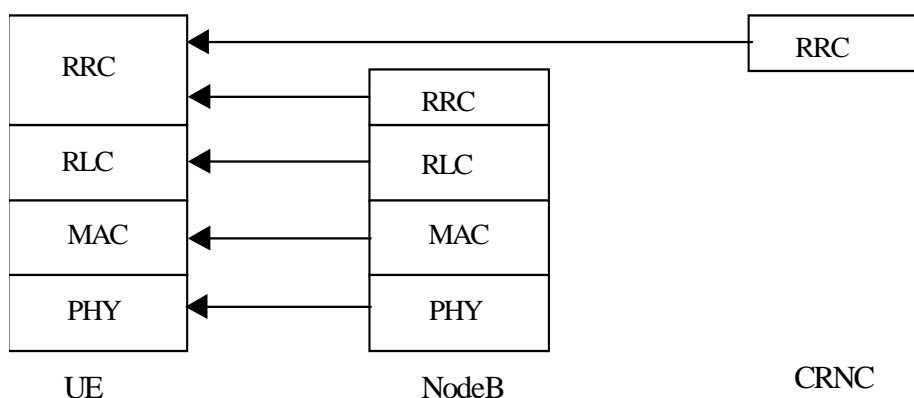## Protocol Termination for DCH, U-plane

Protocol Terminations for DSCH

- The **DSCH** exists only in **Downlink** .
- The DSCH has only impact on the Physical and Transport Channel Levels.
- The DSCH is a transport channel shared dynamically between several UEs.
- **No** definition of Shared channel in the **Logical channels** provided by MAC

Protocol Termination for DSCH, **Control-Plane**

Protocol Termination for DSCH, **User-Plane**

Protocol Terminations for BCH

- BCH can contain information (i.e. Uplink interference) available only to Node B
- Node B updates information very frequently (every 20-100ms)
- Information sent from CRNC is **transparent** to Node B which in return handles the **repetition**.
- Protocol is distributed between Node B & CRNC……less signalling on Iub !!
- The RLC is transparent for BCH channel.

Protocol Terminations for PCH

- The MAC scheduling function is in CRNC to enable co-ordination scheduling between PCH and FACH/DSCH.

- RLC and RRC are therefore located in the CRNC

- The RLC is transparent for PCH channel.

UE   Node B   Controlling RNC
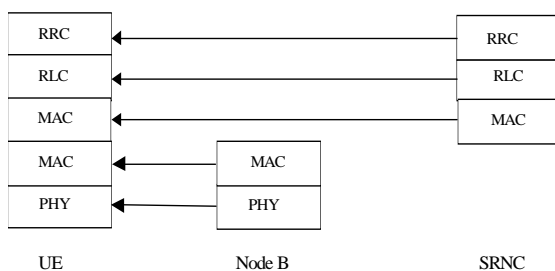
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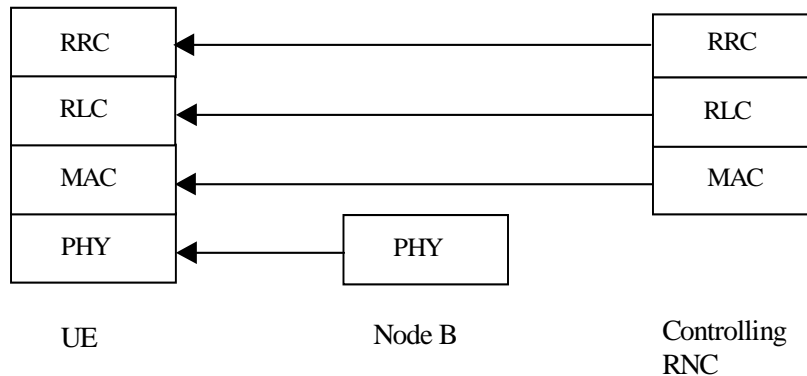
Protocol Terminations for HS-DSCH

- The HS-DSCH is a **transport channel shared dynamically** between several UEs.
- HS-DSCH is mapped onto one or several physical channels.
- No macrodiversity is applied, HS-DSCH is **transmitted in a single** cell only.
- The HS-DSCH is a resource that exists in **downlink only**.
- The DSCH has only impact on the Physical and Transport Channel Levels.
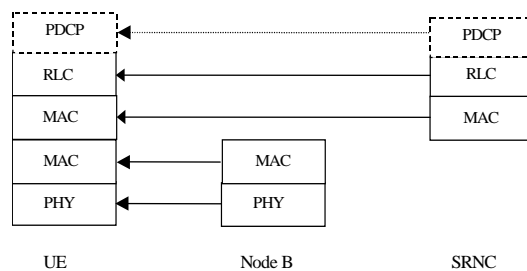- No definition of Shared channel in the Logical channels provided by MAC

Protocol Termination for HS-DSCH, **Control-Plane**

Protocol Termination for HS-DSCH, **User-Plane**

UE   Node B   SRNC   UE   Node B   SRNC

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UTRAN
Signalling & Control
Protocols

UTRAN Signalling & Control Protocols

UTRAN Signalling Protocols

- There are four UTRAN signalling protocols:
  - Radio Access Network Application Part (**RANAP**):
    - Between the RNC and the CN.
    - Used to organise and manage the connectivity in Iu-A.S.
  - Radio Network Subsystem Application Part (**RNSAP**):
    - Inter-RNC signalling and protocol
    - Support of Soft-Handover
  - Node B Application Part (**NBAP**):
    - Used to coordinate the transmission between the UE & NodeB
    - Node B gets all relevant information to manage the radio access
  - Radio Resource Control Protocol (**RRC**):
    - Control protocol used between the UE and the S-RNC
    - Used to manage the UE radio interface connection

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RANAP

- RANAP protocol is an UTRAN specific protocol and used for:

  1. **S-RNC relocation**: happened when the UE is served by NodeBs which are under control of one RNC not being S-RNC. The functionalities are allocated from the old S-RNC to the new S-RNC.

  2. **RAB management**: establishment, maintenance and release of RABs.

  3. **Iu signalling connection management**: release of Iu signalling resources, Iu resetting and includes load control.

  4. **NAS transport**: information are exchanged between the UE and the CN in transparent transport of NAS signalling messages.

  5. **Location reporting**: The CN have no location information about the UE than the LA, RA and the Iu connection to a S-RNC.

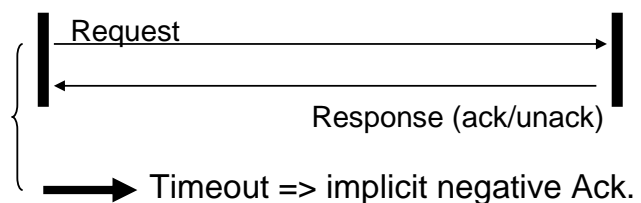 6. **Paging:** used by the CN to notify RNCs who then notify the specified UE that a call is terminated.

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RANAP Services

- S-RNC Relocation
- RAB Management
- Iu Signalling
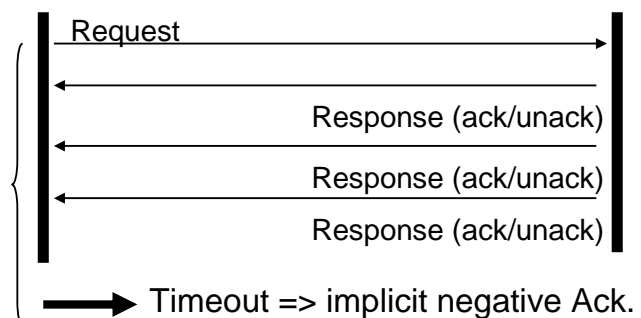- NAS PDU Transport
- Location Reporting
- Paging

RNS

RNC

Iu-CS: RANAP

Iu-PS: RANAP

CN

MSC/VLR

SGSN

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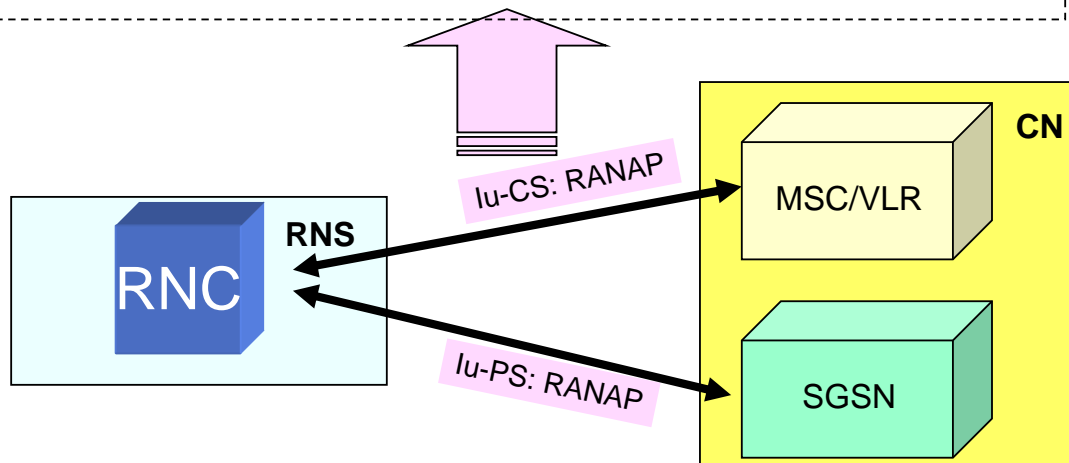
RANAP Elementary Procedures

Class 1: EP with response
e.g. Paging

Request

Response (ack/unack)

Timeout => implicit negative Ack.

Class 2: EP with no response

Request

Class 3: EP with multiple responses

Request

Response (ack/unack)

Response (ack/unack)

Response (ack/unack)

Timeout => implicit negative Ack.
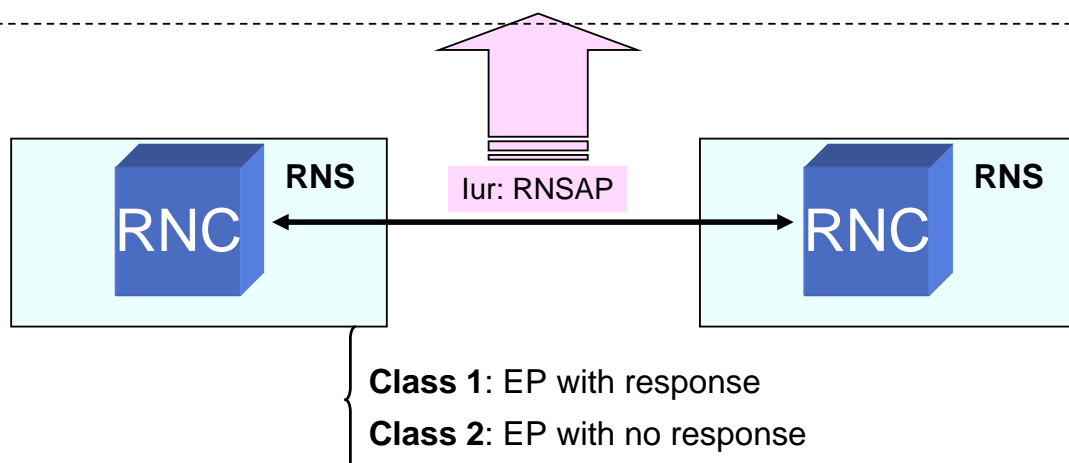
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RNSAP

- The Radio Network Sub-system Application Part is in use between neighbouring RNCs and offers the following services:

  - **S-RNC Relocation Execution**: once the relocation confirmed by the other interfaces, it is then triggered on RNSAP.
  - **Paging**: a S-RNC can page a UE via a D-RNC.
  - **Radio Link Management**: S-RNC can manage dedicate resources for radio link in a D-RNC.
  - **Radio Link Supervision**: if link failure between RNCs, the D-RNC reports it to the S-RNC and attempt to restore it.
  - **Common Control Signalling Transfer and Transport Channel Management**: information is transferred between UE & S-RNC via a D-RNC.
  - **Measurement of Dedicated Resources**: The S-RNC triggers measurements on dedicated resources of the D-RNC.

- RNSAP uses the EP class 1 and 2.

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RNSAP Service

- Relocation Execution
- Paging
- Radio Link Management
- CCCH Signalling transfer
- Measurement on dedicated resources
- CTCH resource management
- PhyCH reconfiguration

RNC **RNS**

Iur: RNSAP

RNC **RNS**

Class 1: EP with response

**Class 2**: EP with no response

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NBAP

- The NodeB element interfaces Iub and the Uu interfaces.

- It is responsible to transform PDUs to allow a transport via the interfaces.

- The NodeB stands under command of its C-RNC.

- The RNC determines how to set the radio link and Iub frame resources.
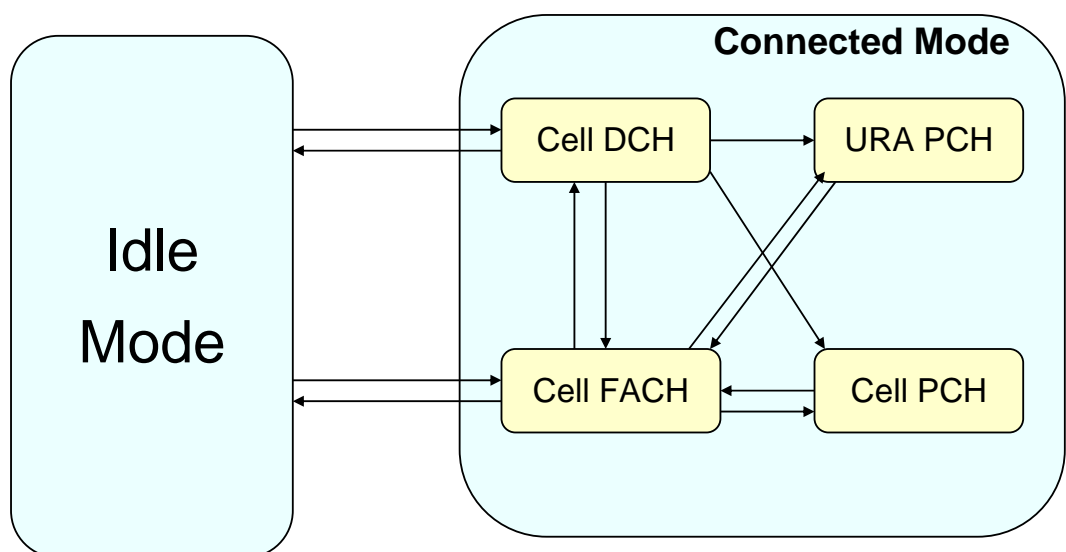

NBAP Services

- Radio Link Mgt
- Cell Configuration Mgt
- System Information Mgt
- CTCH Resource Mgt

- Measurement on common & dedicated resources
- Resource Event Status
- General Error Reporting
- DL power drift correction

RNS

Iub: NBAP

RNC

Node B

Class 1: EP with response

Class 2: EP with no response
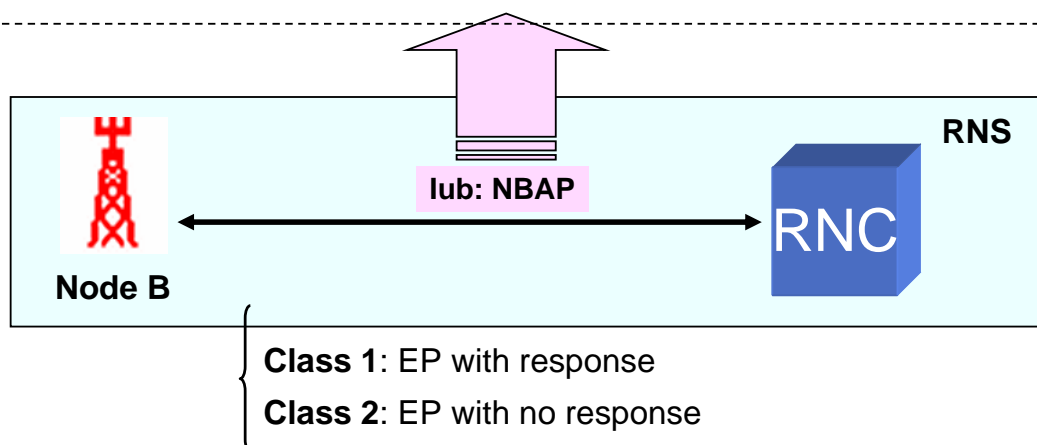
RRC Modes

RRC Modes/Service States

Connected Mode

Idle Mode

Cell DCH

URA PCH

Cell FACH

Cell PCH

RRC Idle Mode

- Once the UE switched on, it enters the **RRC idle mode**:
  - The UE chooses either automatically or manually its PLMN.
  - UE camps in one of the chosen PLMN's cell.
  - No Connection on the access stratum level between UE & UTRAN.
  - UTRAN has no info about UEs in RRC idle mode.
  - To address the UE, UTRAN must use the NAS identifiers
  - The UE monitors the BCCH and once registered to the CN, it also listen to paging on its PICH.

- The UE stays in Idle mode until it transmits a request to establish an RRC connection…

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RRC Connected Mode Stated

- In the **Cell_DCH** state a dedicated physical channel is allocated to the UE.
  - The UE is known by its serving RNC on a cell active set level.
  - DCCH and DTCH information can be transmitted.
  - The UE performs measurements and sends measurement reports according to measurement control information received from RNC.
  - The DSCH can also be used in this state

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RRC Connected Mode Stated

- In **Cell_FACH** state no dedicated physical channel is allocated:

  - Instead FACH and RACH are used for transmitting signalling messages and small amounts of user plane data.
  - The UE is capable of listening to the BCH to acquire system information. The CPCH is an alternative if UE is instructed by UTRAN.
  - UE performs cell reselections and after reselection always sends a Cell Update message to the RNC which in turns the UE's location.
  - For identification, C-RNTI in the MAC PDU header separates UEs from each other in a cell.
  - When he UE performs cell reselection it uses the U-RNTI which is part of the RRC message (and not in the MAC header).

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RRC Connected Mode Stated

- **Cell_PCH** and **URA_PCH** were introduced to cope with inactive data users:
  - e.g. internet users once finished downloading a page…
  - No DCCH nor DTCH is allocated to the UE
  - No exchange of data is possible between UE and UTRAN
- In **Cell_PCH** state the UE is still known on a cell level in SRNC, but it can be reached only via the paging channel (PICH).
  - The battery consumption is less than in Cell_FACH state.
  - To exchange information the UE has to change state to Cell_FACH
- In **URA_PCH** state, similar to Cell_PCH except the UE reads UTRAN Registration Area (URA) identities from the BCH.
  - URAs are a combination of one or several cells under one C-RNC.
  - The UE is responsible for URA updates when required by UTRAN.

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Transition btw RRC Connected Mode State

- From the URA_PCH state:
  - No resource granted to the UE for UL data transmission
  - The UE can only move to the Cell_FACH state.

- From the Cell_PCH state:
  - No resource granted to the UE for UL data transmission
  - The UE can only move to the Cell_FACH state (can then use RACH).

- From Cell_DCH:
  - Transfer to other state is done via explicit signalling
  - Achieved with RRC messages Physical Channel Reconfiguration and Radio Bearer Configuration.

- From Cell_FACH:
  - To Cell_DCH occurs once a dedicated physical channel is established.
  - To Cell_PCH/URA_PCH done via signalling e.g. Cell Update Confirm

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UTRAN Signalling

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UTRAN Signalling Procedures

- The signalling procedures shown in the following sections do not represent the complete set of possibilities.

- The standard specifies a set of EPs for each interface, which may be combined in different ways in an implementation.

- Therefore these sequences are at present merely examples of a typical implementation.

System Procedures / Information

- The **System Information** is organised as a tree; also known as **"Information Blocks"**.

- System Information is broadcast in **System Information Blocks (SIB)**.

- A **Master Information Block** (**MIB**) gives references and scheduling information to a number of **SIB** in a cell.

- The **MIB** may contain ref. and scheduling to one or two **Scheduling Block (SB)**.

- **SB** provides additional references and scheduling information to **SIB**.

- Scheduling Information for a **SIB** are either included in **MIB** or in **SB**.

System Procedures / Information

- There are 3 kind of **"Information Blocks"**:
    1. MIB → only one MIB and contains PLMN ID and SIB reference list.
    2. SB → only 2 SB and contains Reference List.
    3. SIB → there 18 SIB.
        - → Cell selection/re-selection parameters
        - → Open Loop Power Control parameters (interference level is sent on the SIB by the Node B); specific to TDD !!!
        - → PLMN IDs of neighbour cells.
        - → Contains information on Common Channel (RACH/FACH/PCH and Shared UL & DL channel).

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System Information Broadcasting
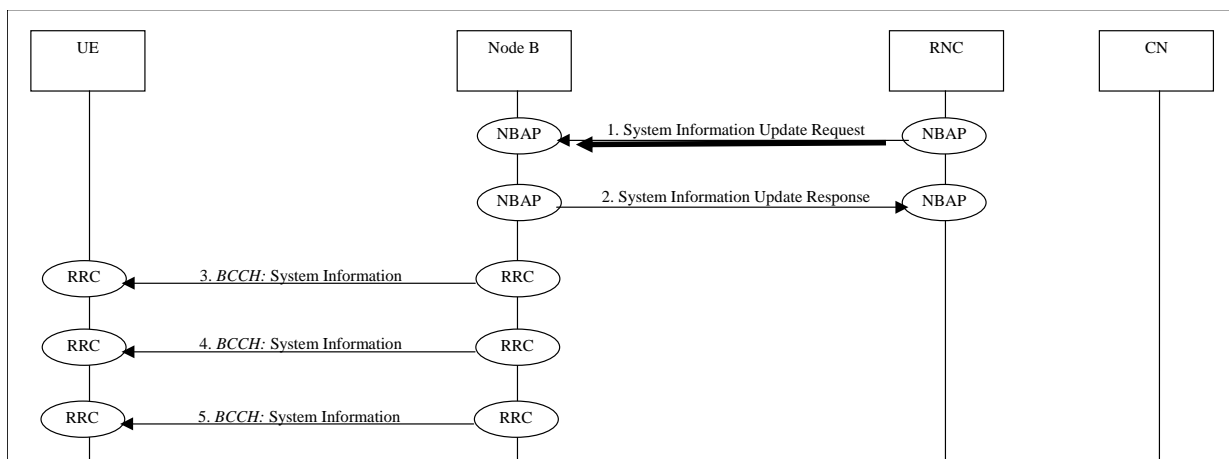
1. The RNC forwards a request to node B via a Node B application part NBAP message '**System Information Update Request'**.
Parameters: Master/Segment Information Block(s) (System information to be broadcasted), BCCH modification time.

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System Information Broadcasting
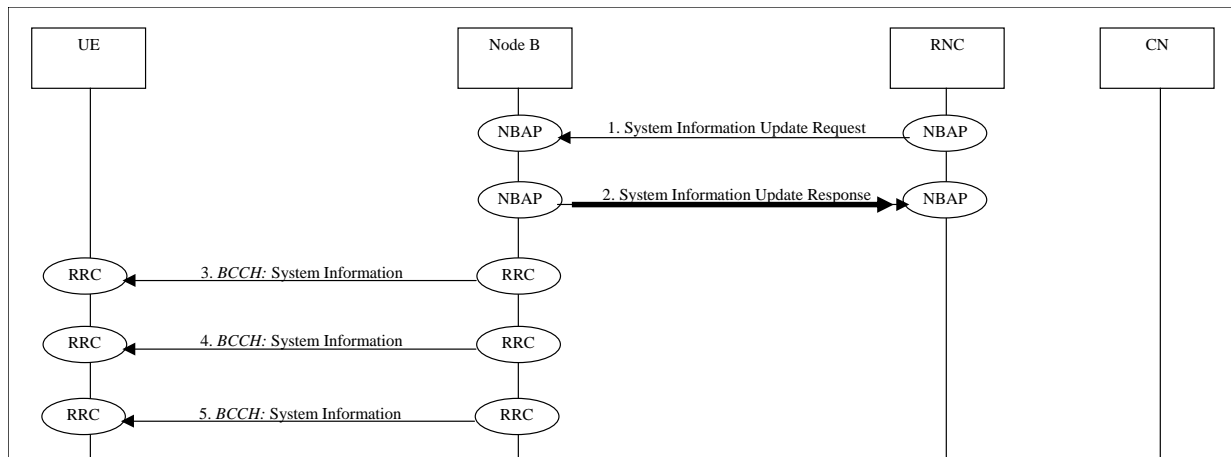
2. The Node B confirms the ability to broadcast the information sending
System Information Update Response message to the RNC via NBAP.
(If the Node B cannot Broadcast the information as requested, System
Information Update Failure is returned to the RNC).

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System Information Broadcasting
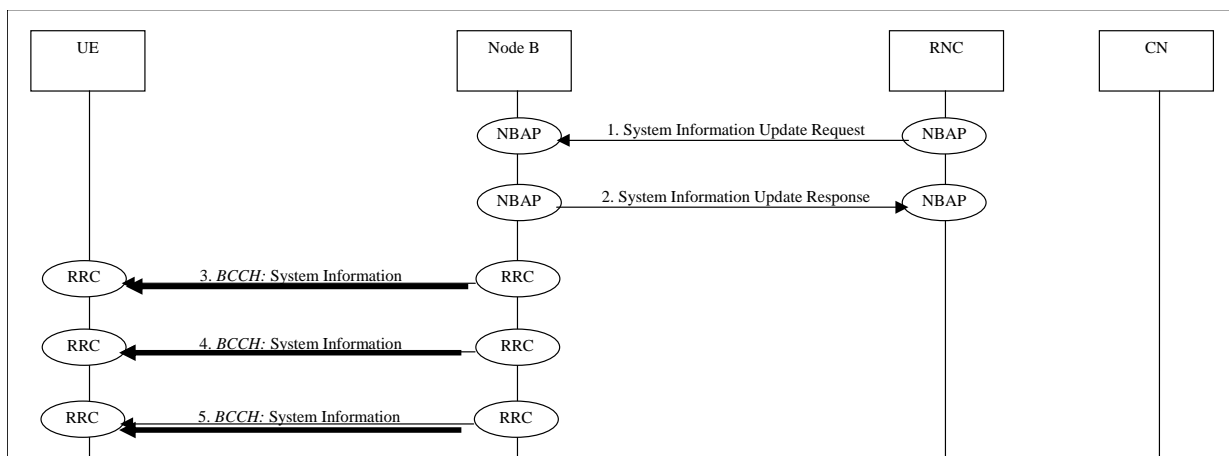
3./4./5.   The information is broadcast via BCCH, on the air interface by
RRC message **System Information**.
Parameters: Master/Segment Information Block(s) (System information).

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System Information Blocks SIB's

- 18 SIB's defined by ETSI TS 25.331 Release 4
  - Type 1
    - NAS system information as well as UE Timers and counters
  - Type 2
    - URA identity
  - Type 3
    - Parameters for cell selection and re-selection
  - Type 4
    - Same as Type 3 but in connected mode
  - Type 5
    - Parameters for configuration of common physical channels
  - Type 6
    - Same as Type 5 but in connected mode

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System Information Blocks SIB's

- 18 SIB's defined by ETSI TS 25.331 Release 4
  - Type 7
    - Fast changing parameters for UL interference
  - Type 8
    - Only for FDD – static CPCH information to be used in the cell
  - Type 9
    - Only for FDD -- CPCH information to be used in the cell
  - Type 10
    - Only FDD – Used by UE's having their DCH controlled by a DRAC.
    - DRAC
  - Type 11
    - Contains measurement control information to be used in the cell
  - Type 12
    - Same as Type 11 but in connected mode

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System Information Blocks SIB's

- 18 SIB's defined by ETSI TS 25.331 Release 4
  - Type 13
    - Used for ANSI-41
  - Type 14
    - Only TDD
  - Type 15
    - UE positioning method for example GPS
  - Type 16
    - Radio bearer, transport channel and physical channel parameters to be stored by UE for use during Handover HO
  - Type 17
    - Only TDD
  - Type 18
    - Contains PLMN identities of neighbouring cells

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Paging for a UE in RRC Idle Mode

- This example shows how paging is performed for an UE in radio resource control RRC Idle Mode.

- The UE may be paged for both CS and PS services.

- Since the UE is in RRC Idle Mode, the location is only known at CN level and therefore paging is distributed over a defined geographical area (Location Area).

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Paging for a UE in RRC Idle Mode
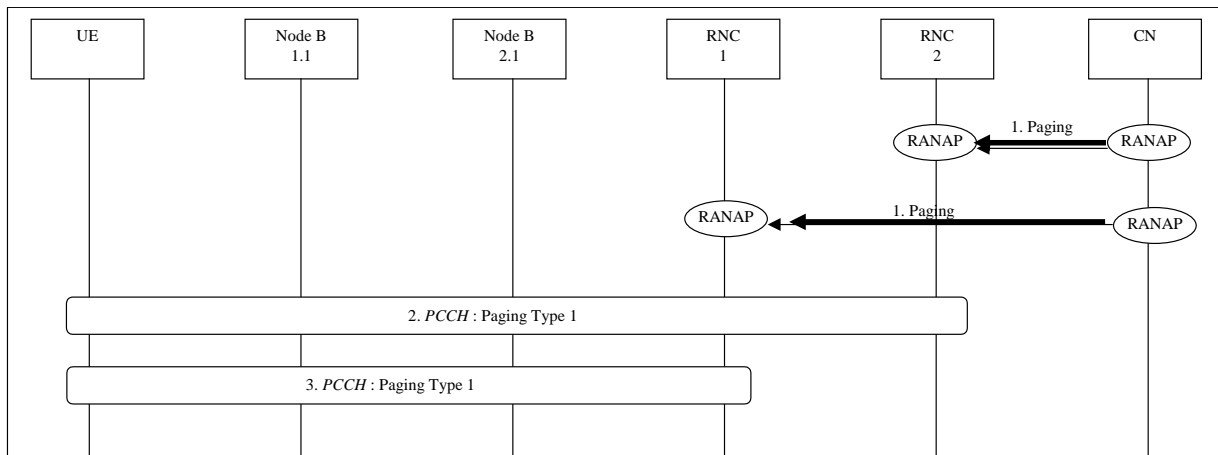
1. CN initiates the paging of a UE over a LA spanning two RNCs (i.e. RNC1 and RNC2) via RANAP message **Paging**.
Parameters: CN Domain Indicator, Permanent NAS UE Identity, Temporary UE Identity, Paging Cause.

Paging for a UE in RRC Idle Mode
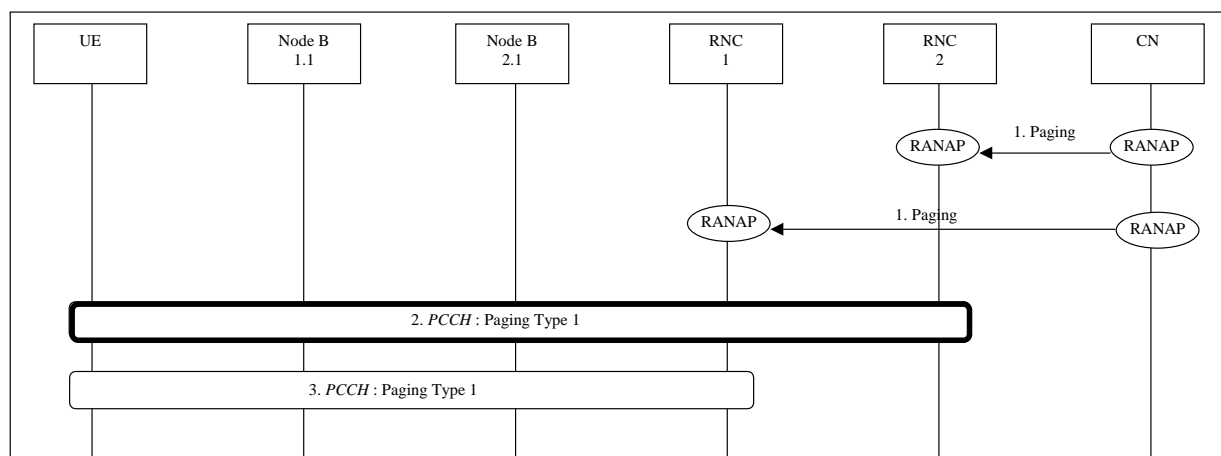
2. Paging of UE performed by cell1 using Paging Channel PCCH **Paging Type 1** message.

Paging for a UE in RRC Idle Mode
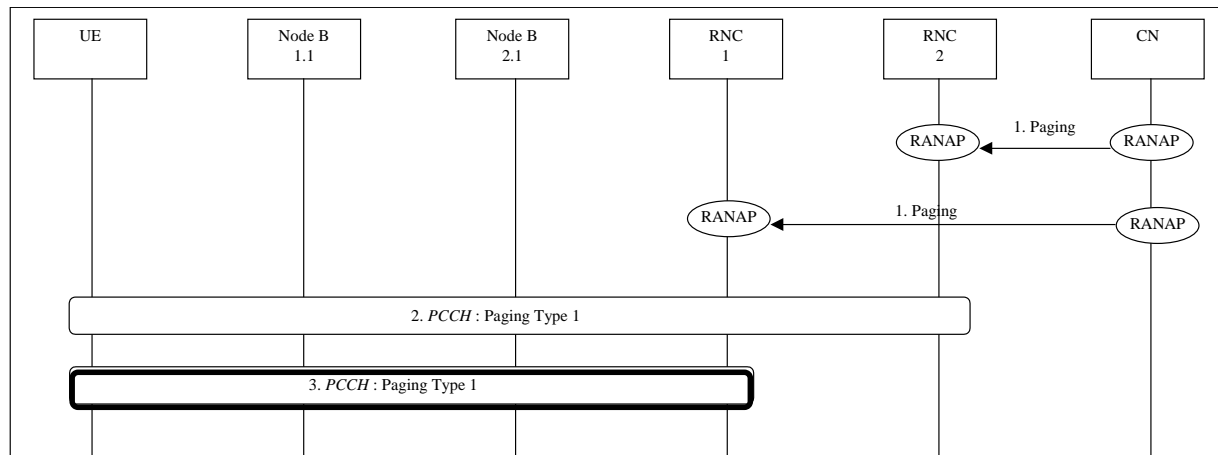
3. Paging of UE performed by cell2 using **Paging Type 1** message.

The UE detects page message from RNC1 (as example) and the procedure for non-access stratum NAS signalling connection establishment follows. NAS message transfer can now be performed.

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NAS Signalling Connection Establishment

- This example shows establishment of a non-access stratum NAS Signalling Connection.

- This establishment could be requested by the terminal by itself (for example to initiate a service) or could be caused by a paging from the CN.

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NAS Signalling Connection Establishment
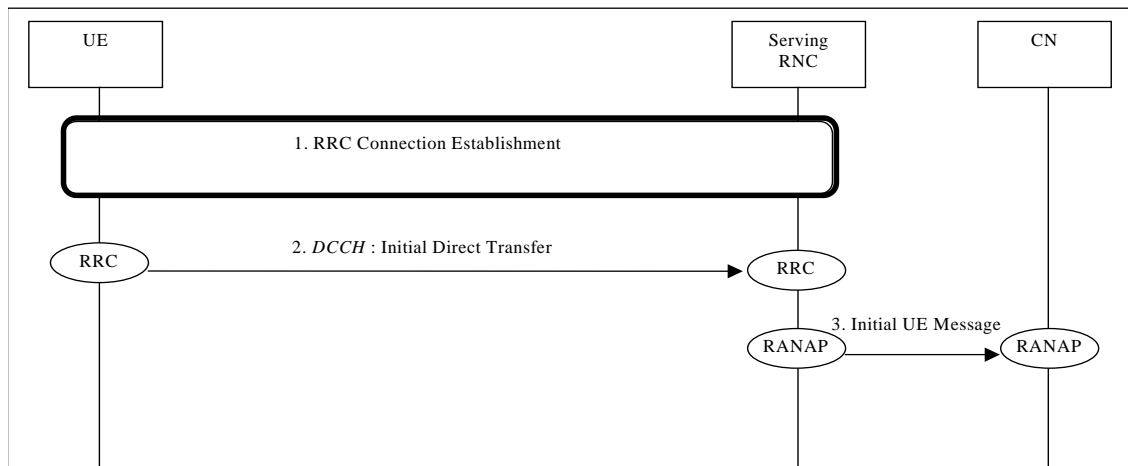
1. Radio resource control RRC Connection is established.

NAS Signalling Connection Establishment
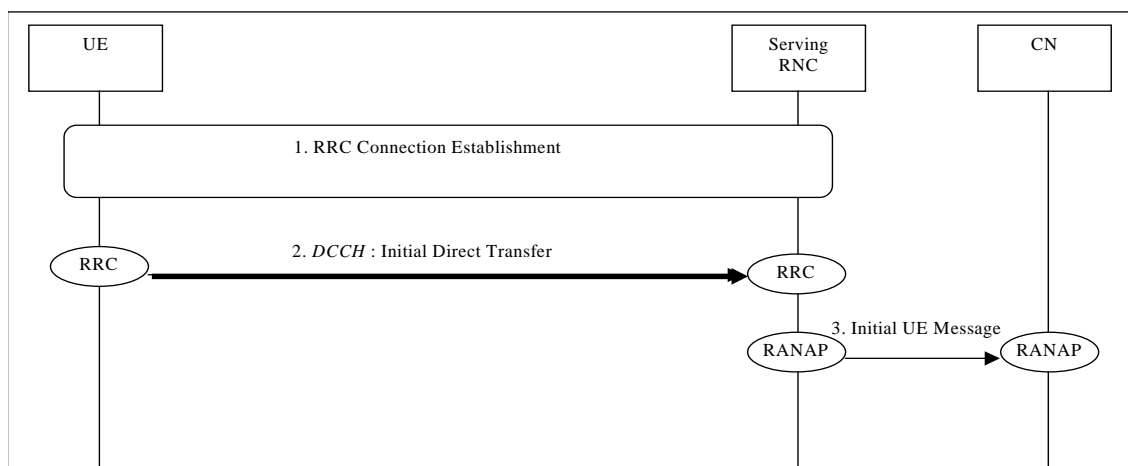
2. UE sends RRC **Initial Direct Transfer** to SRNC.
Parameters: Initial NAS Message CN node indicator (it indicates the correct CN node into which the NAS message shall be forwarded).

NAS Signalling Connection Establishment
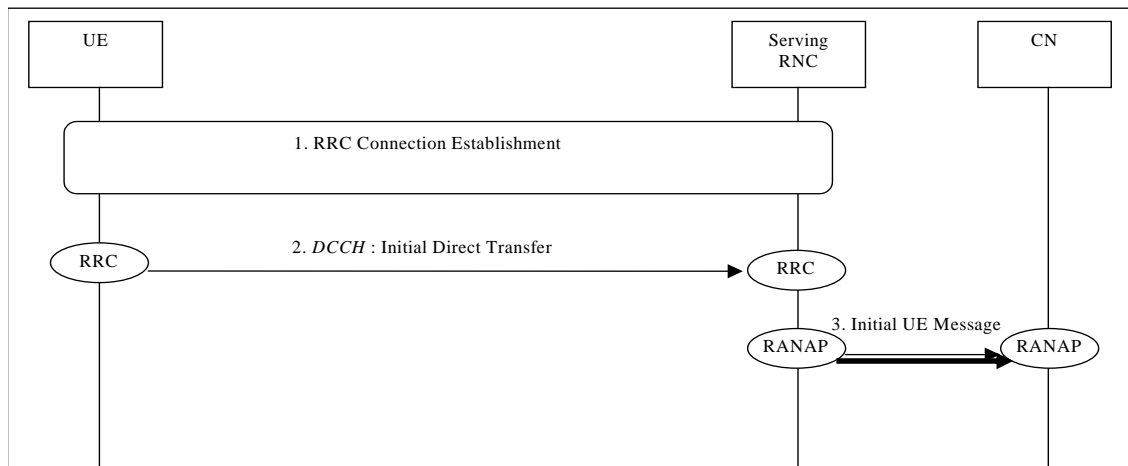
3.   SRNC initiates signalling connection to CN, and sends the RANAP message **Initial UE Message**.
Parameters: NAS PDU

The NAS signalling connection between UE and CN can now be used for NAS message transfer.

![AIRCOM INTERNATIONAL]

RRC Connection Establishment

- The following example shows establishment of a RRC connection in a dedicated transport channel (DCH) state

![AIRCOM INTERNATIONAL]

Dedicated transport Channel DCH Establishment
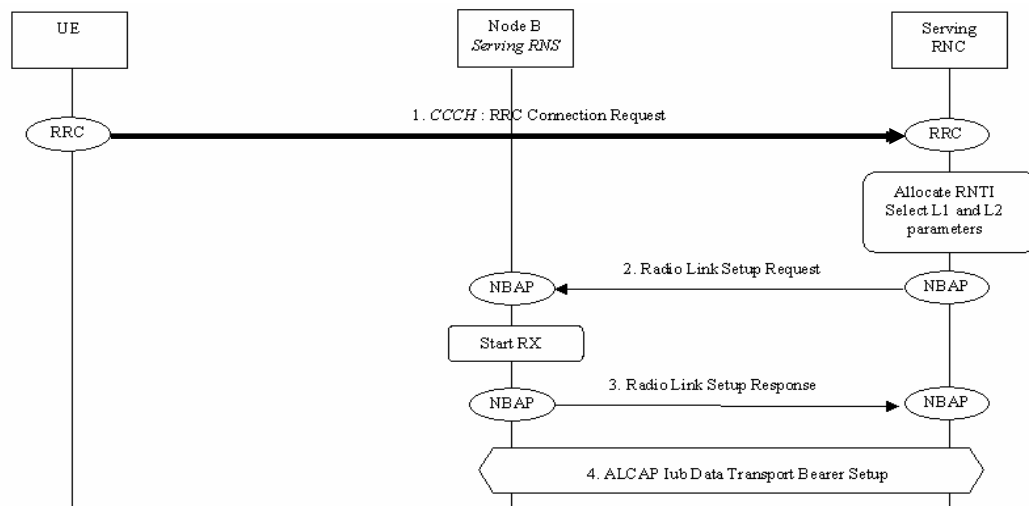
1. The UE initiates set-up of an RRC connection by sending RRC message
Connection Request on common control channel CCCH.
Parameters: Initial UE Identity, Establishment cause, Initial UE Capability.

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Dedicated transport Channel DCH Establishment
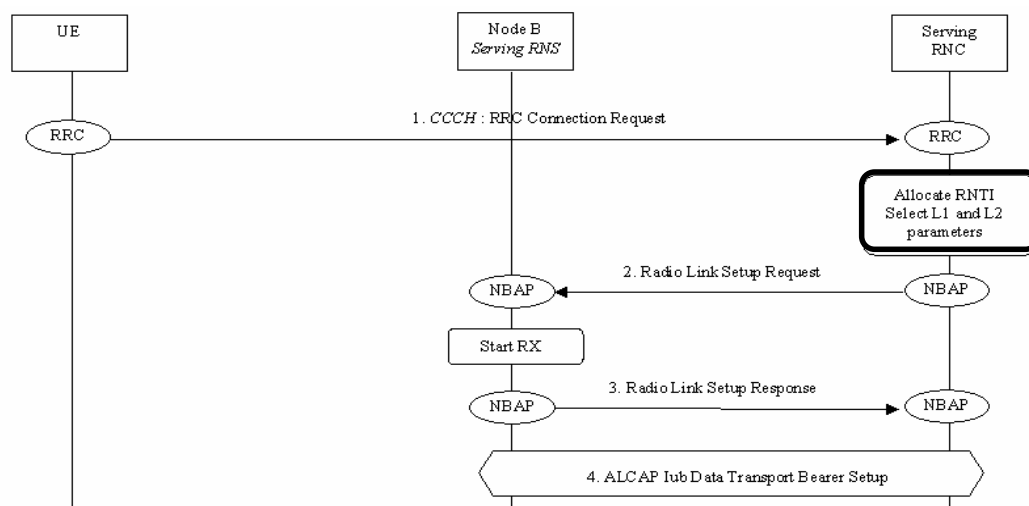
The SRNC decides to use a DCH for this RRC connection, allocates a
radio network temporary identity RNTI and radio resources for the RRC
connection.

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Dedicated transport Channel DCH Establishment
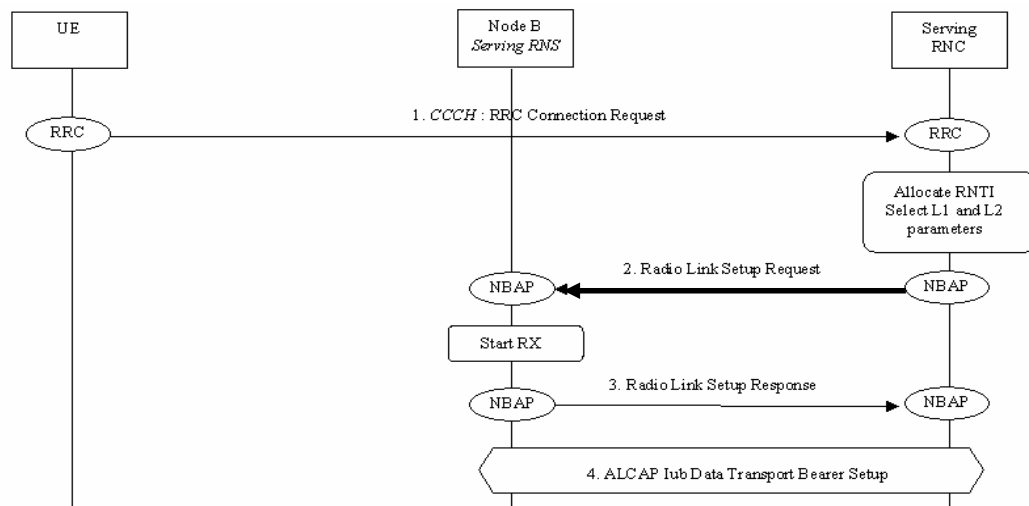
2. When a DCH is set-up, a NBAP message **Radio Link Setup Request** is sent to Node B.

Dedicated transport Channel DCH Establishment
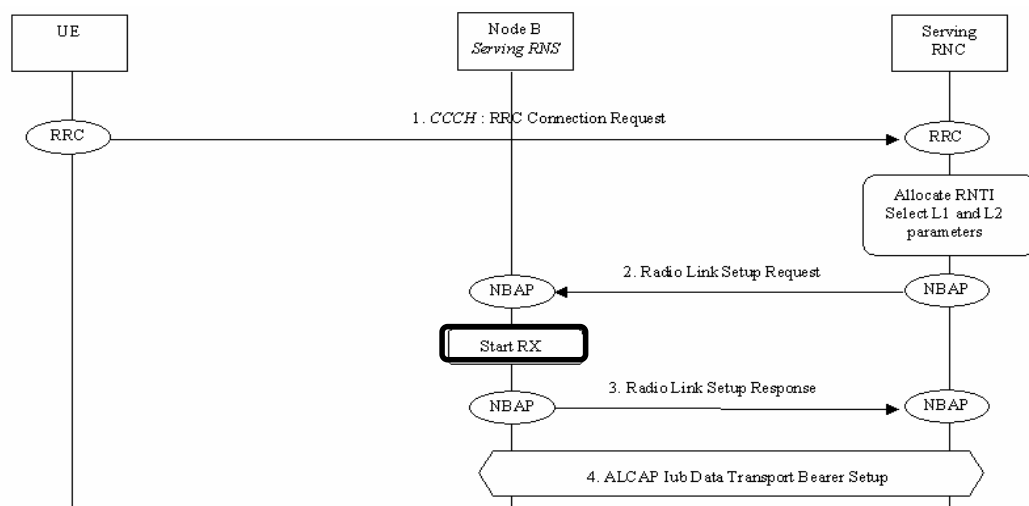
Node B allocates resources, starts physical layer PHY reception

Dedicated transport Channel DCH Establishment
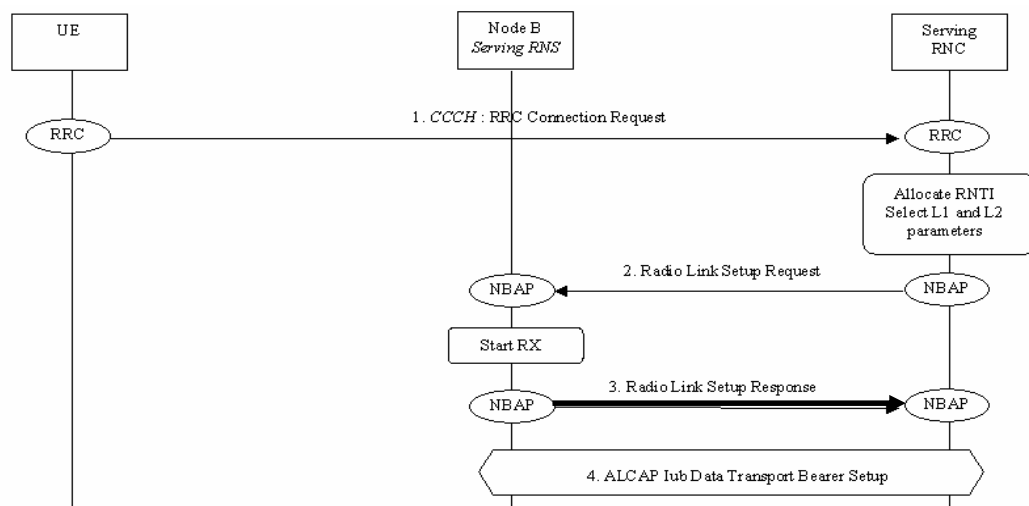
3. Node B responses with NBAP message **Radio Link Setup Response**.

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Dedicated transport Channel DCH Establishment

Parameters: Signalling link termination, Transport layer addressing information (AAL2 address, AAL2 Binding Identity) for the Iub Data Transport Bearer.
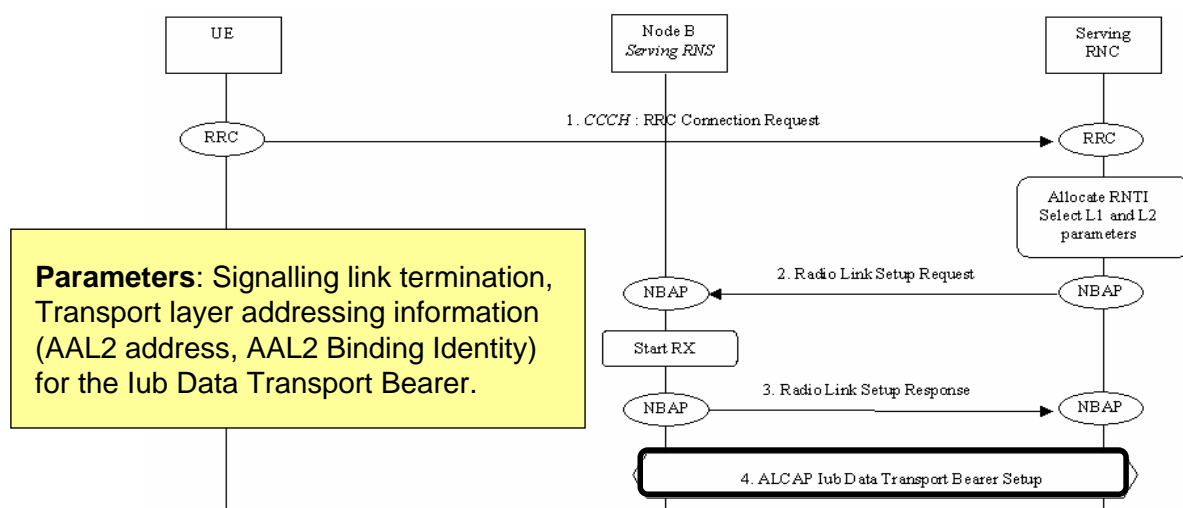
4.SRNC initiates set-up of Iub Data Transport bearer using ALCAP protocol. This request contains the AAL2 Binding Identity to bind the Iub Data Transport Bearer to the DCH. The request for set-up of Iub Data Transport bearer is acknowledged by Node B.

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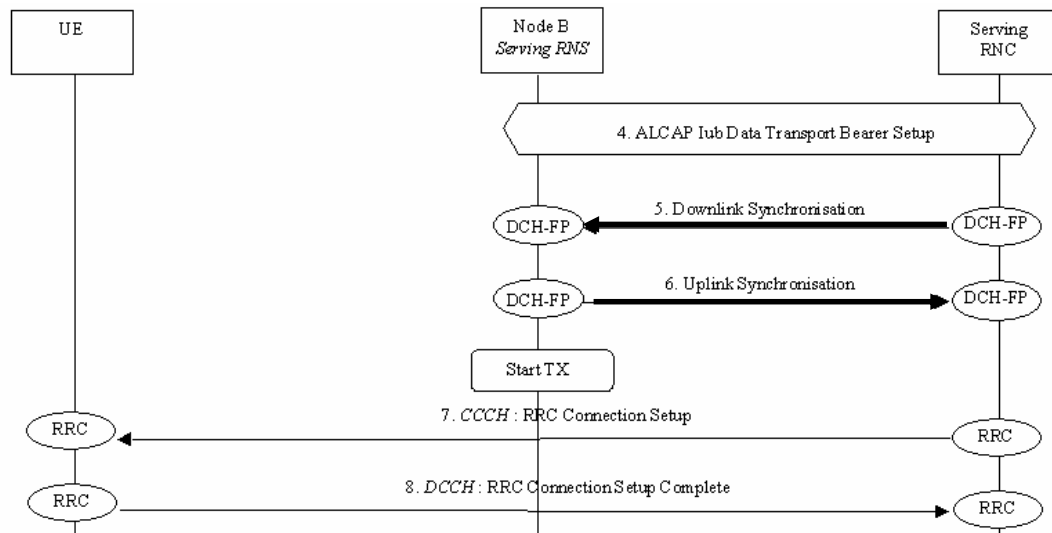
DCH Establishment

5./6.The Node B and SRNC establish synchronism for the Iub and Iur Data Transport Bearer by means of exchange of the appropriate DCH Frame Protocol frames **Downlink Synchronisation** and **Uplink Synchronisation**.

![AIRCOM INTERNATIONAL]
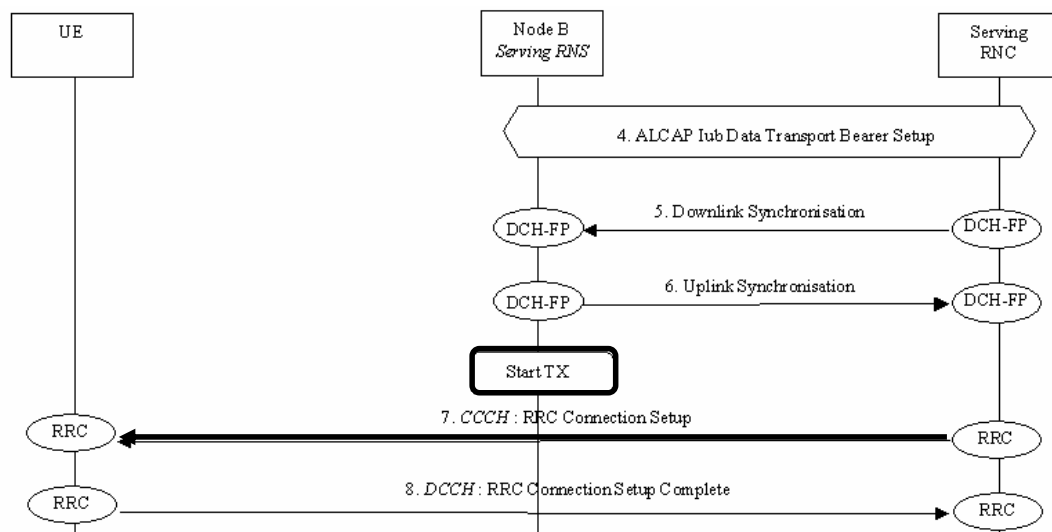
DCH Establishment

Then Node B starts downlink DL transmission.

7.   Message **RRC Connection Setup** is sent on CCCH from SRNC to UE.

![AIRCOM INTERNATIONAL]

DCH Establishment

Parameters: Initial UE Identity, RNTI, Capability update Requirement, Transport Format Set, Transport Format Combination Set, frequency, DL scrambling code (FDD only), Time Slots (TDD only), User Codes (TDD only), Power control information.
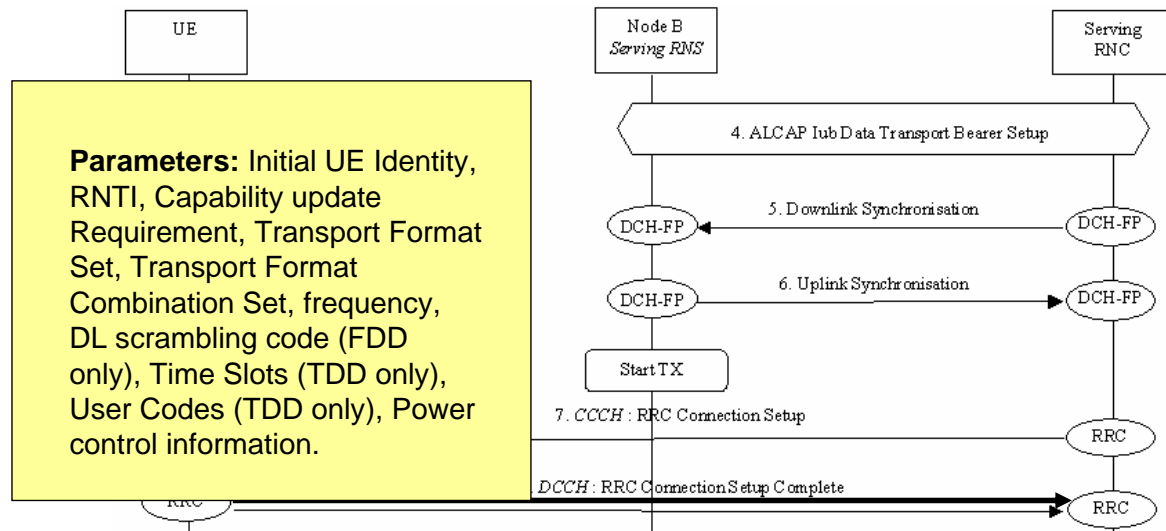
8.   Message **RRC Connection Setup Complete** is sent on DCCH from UE to SRNC.
Parameters: Integrity information, ciphering information.

Soft Handover (FDD)

- Radio Link Addition (Branch Addition)
  - This example shows establishment of a radio link via a Node B controlled by a RNC other than the serving RNC.

  - This is the first radio link to be established via this RNS, thus macro-diversity combining/splitting with already existing radio links within DRNS is not possible.

Radio Link Addition (Branch Addition)
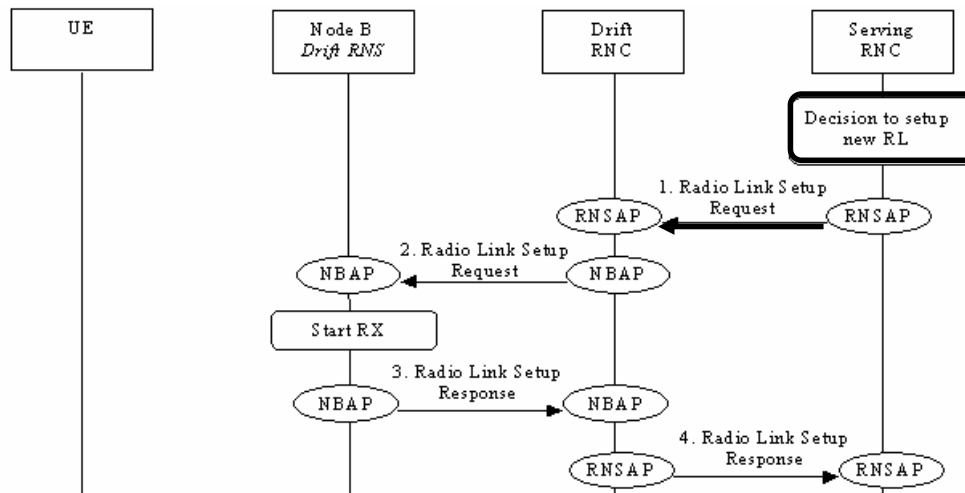
SRNC decides to setup a radio link RL via a new cell controlled by another RNC.

1. SRNC requests DRNC for radio resources by sending RNSAP message **Radio Link Setup Request**.

Parameters: Cell id, Transport Format Set per DCH, Transport Format Combination Set, frequency, UL scrambling code

---

Radio Link Addition (Branch Addition)

If this is the first radio link via the DRNC for this UE, a new Iur signalling connection is established.

This Iur signalling connection will be used for all RNSAP signalling related to this UE.
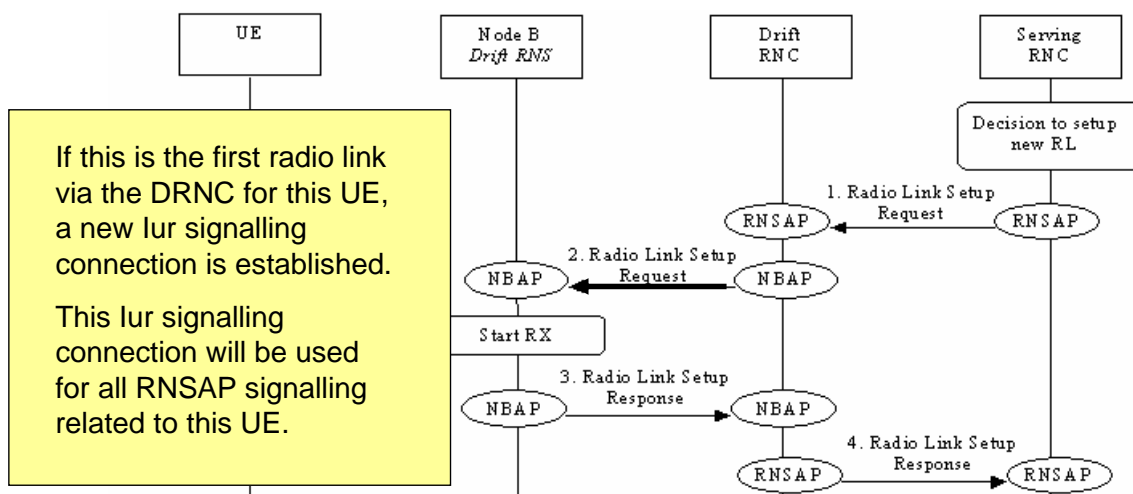
2. If requested resources are available, DRNC sends NBAP message **Radio Link Setup Request** to Node B.
Parameters: Cell id, Transport Format Set per DCH, Transport Format Combination Set, frequency, UL scrambling code.

Radio Link Addition (Branch Addition)
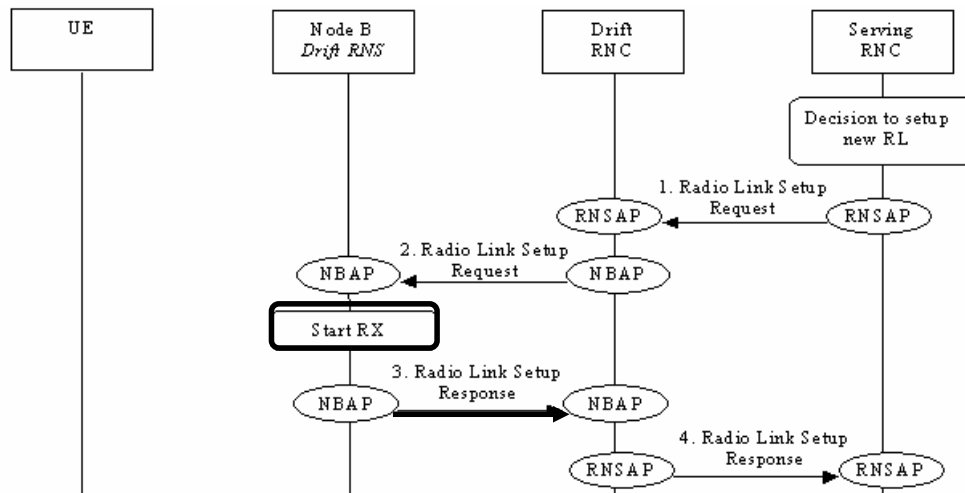
• Then Node B start the uplink UL reception.

3.   Node B allocates requested resources. Successful outcome is reported in NBAP message **Radio Link Setup Response**.
Parameters: Signalling link termination, Transport layer addressing information (AAL2 address, AAL2 Binding Identitie(s)) for Data Transport Bearer(s).
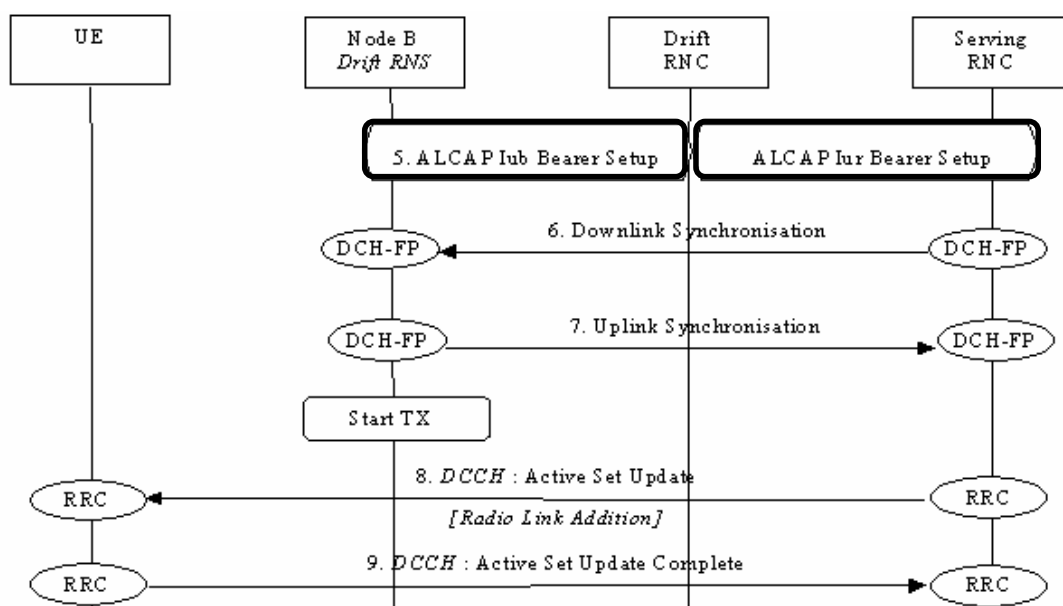
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Radio Link Addition (Branch Addition)
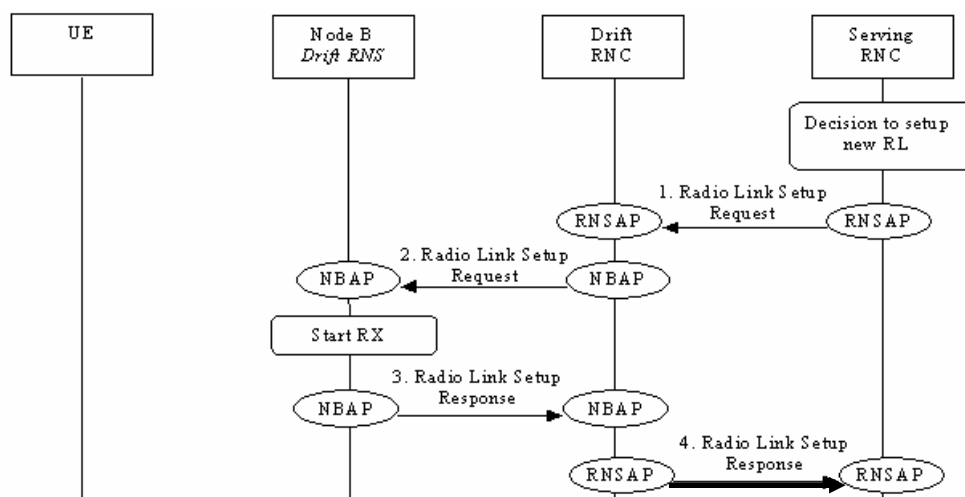
4.   DRNC sends RNSAP message **Radio Link Setup Response** to SRNC.
Parameters: Transport layer addressing information (AAL2 address, AAL2 Binding Identity) for Data Transport Bearer(s), Neighbouring cell information.

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Radio Link Addition (Branch Addition)

5.   SRNC initiates setup of Iur/Iub Data Transport Bearer using access link control application part ALCAP protocol.

This request contains the AAL2 Binding Identity to bind the Iub Data Transport Bearer to DCH.

This may be repeated for each Iur/Iub Data Transport Bearer to be setup.
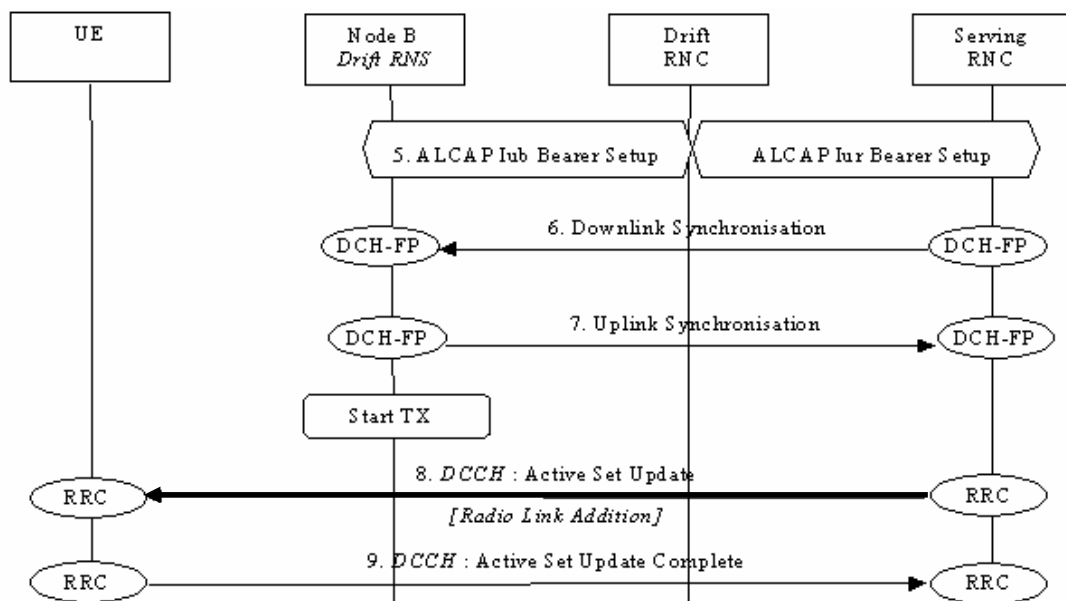

Radio Link Addition (Branch Addition)
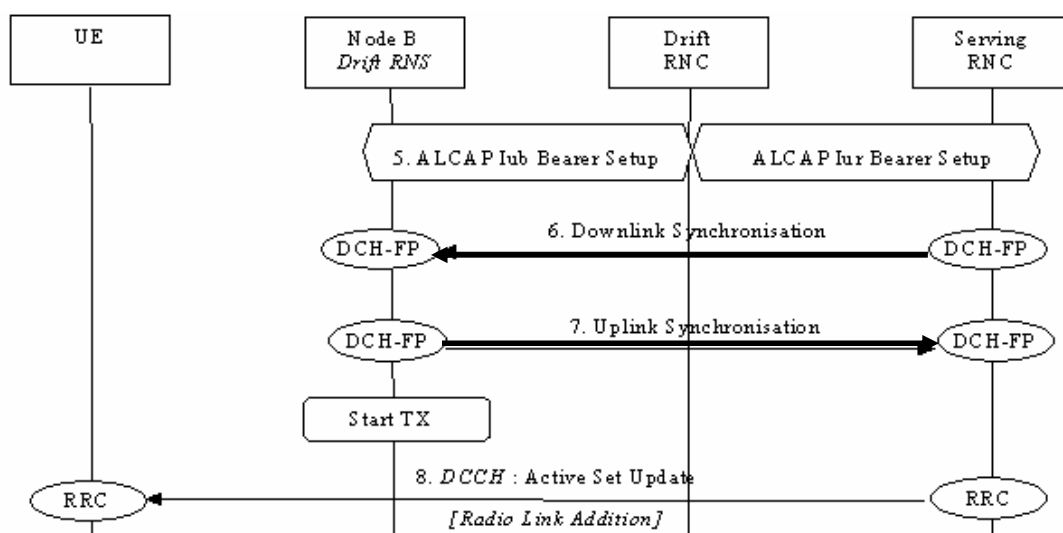
6./7. Node B and SRNC establish synchronism for the Data Transport Bearer(s) by means of exchange of the appropriate DCH Frame Protocol frames **Downlink Synchronisation** and **Uplink Synchronisation**, relative to already existing radio link(s).

Radio Link Addition (Branch Addition)
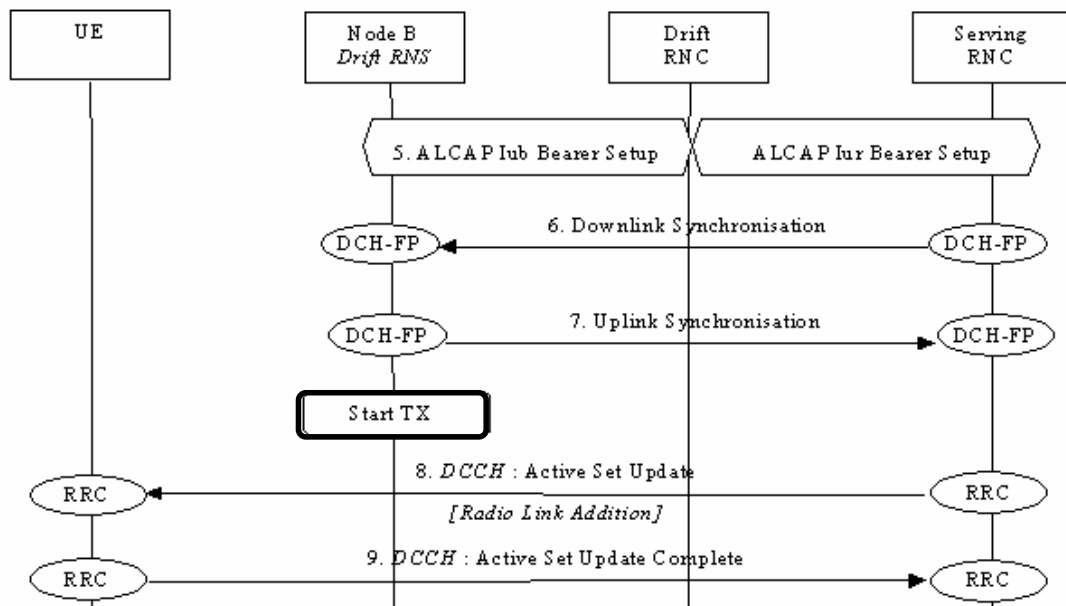
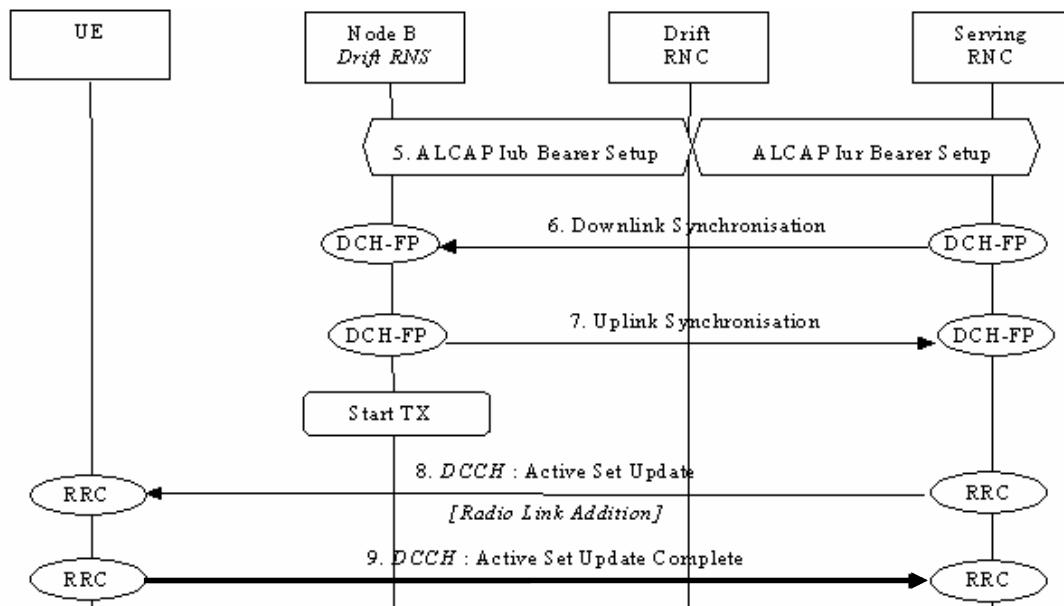Then Node B starts DL transmission.

Radio Link Addition (Branch Addition)

8.   SRNC sends RRC message **Active Set Update** (Radio Link Addition)
to UE on dedicated control channel DCCH.
Parameters: Update type, Cell id, DL scrambling code, Power control information,
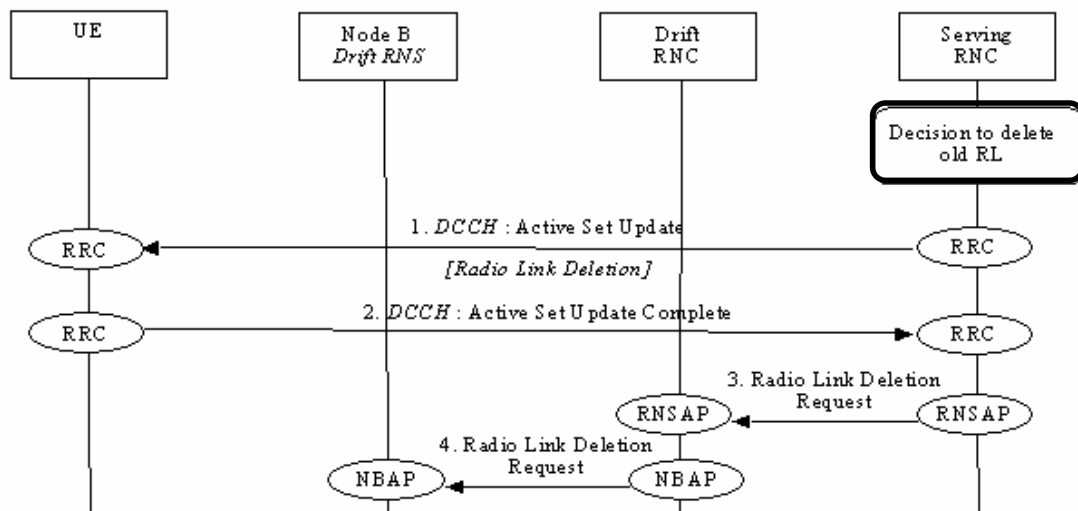Ncell information.

Radio Link Addition (Branch Addition)

9. UE acknowledges with RRC message **Active Set Update Complete**.
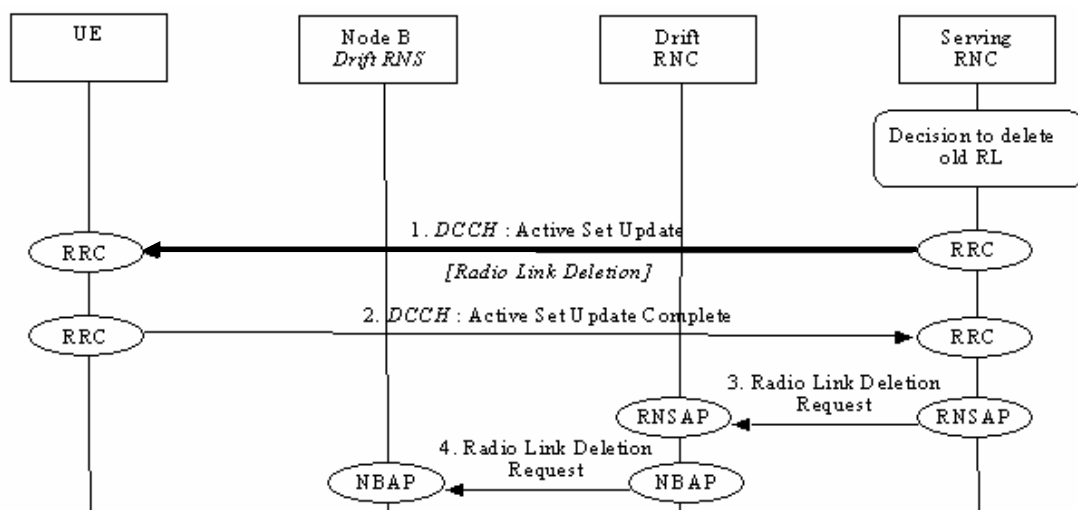

Soft Handover 'continued'

- **Radio link Deletion (Branch Deletion)**
  - This example shows deletion of a radio link belonging to a Node B controlled by a RNC other than the serving RNC.

Radio link Deletion (Branch Deletion)

SRNC decides to remove a radio link via an old cell controlled by another RNC.
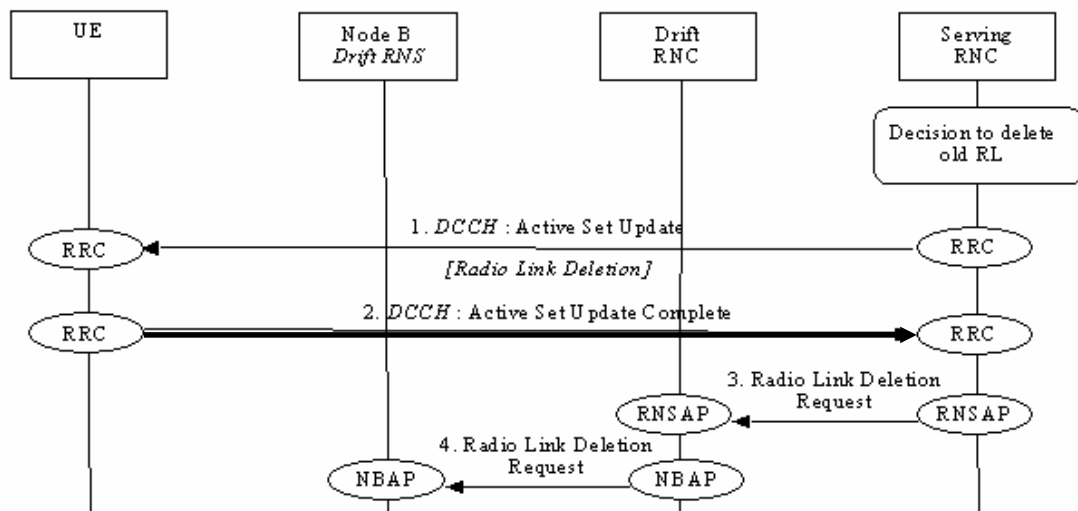

Radio link Deletion (Branch Deletion)

1. SRNC sends RRC message **Active Set Update** (Radio Link Deletion) to UE on DCCH.
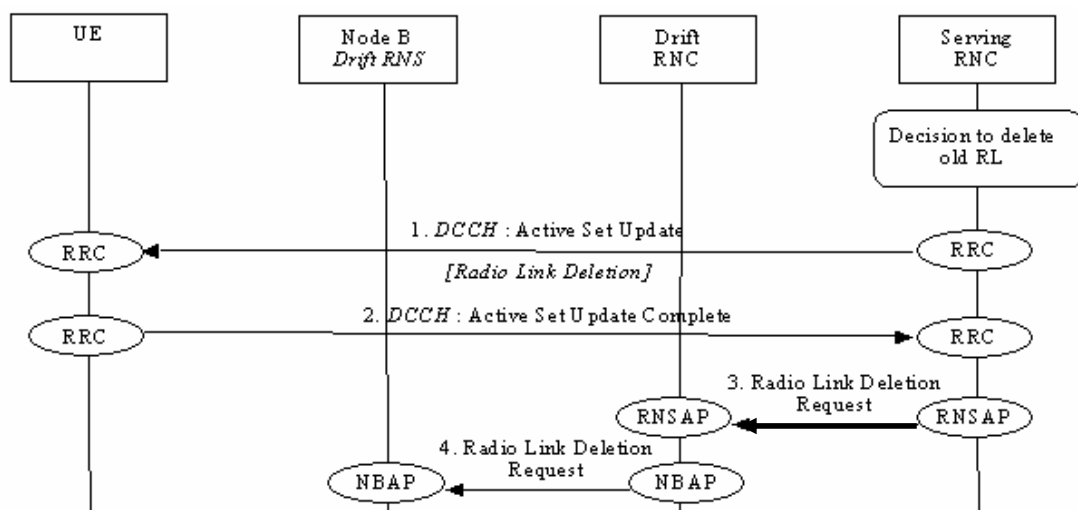 Parameters: Update type, Cell id.
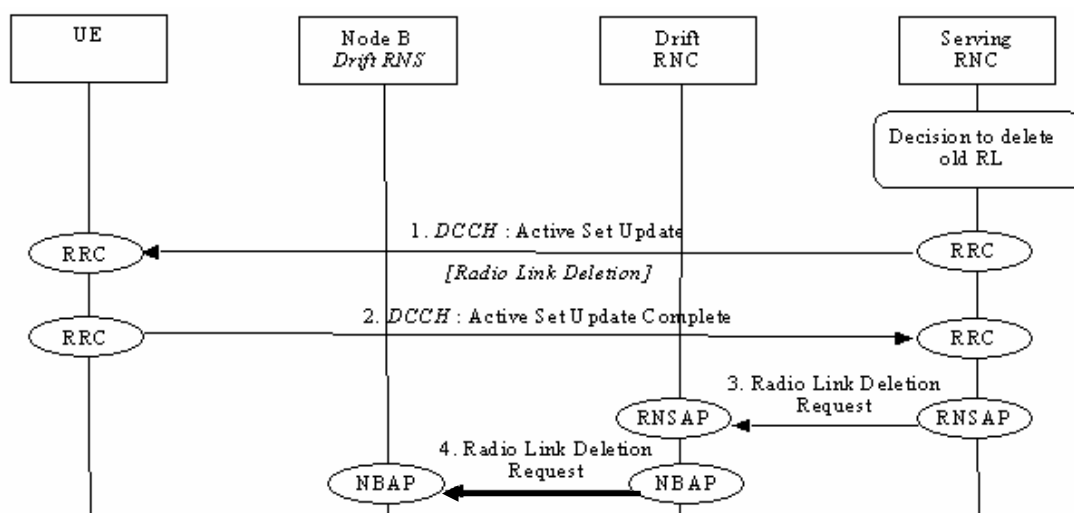
Radio link Deletion (Branch Deletion)

2.   UE deactivates DL reception via old branch, and acknowledges with RRC message **Active Set Update Complete**.

Radio link Deletion (Branch Deletion)

3.   SRNC requests DRNC to deallocate radio resources by sending RNSAP message **Radio Link Deletion Request**.
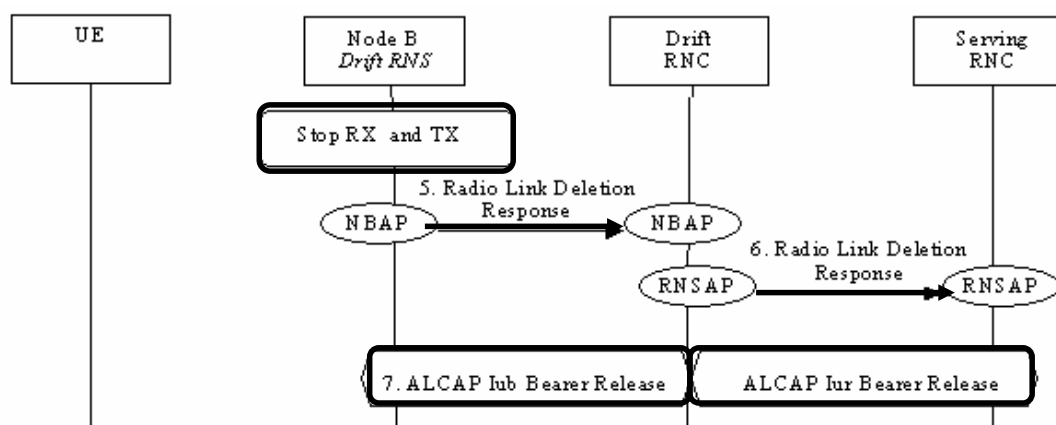Parameters: Cell id, Transport layer addressing information.

Radio link Deletion (Branch Deletion)

4.   DRNC sends NBAP message **Radio Link Deletion Request** to Node B.
Parameters: Cell id, Transport layer addressing information.

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Radio link Deletion (Branch Deletion)

Node B deallocates radio resources.

5. Successful outcome is reported in NBAP message **Radio Link Deletion Response**.

6.   DRNC sends RNSAP message **Radio Link Deletion Response** to SRNC.
7. SRNC initiates release of Iur/Iub Data Transport Bearer using ALCAP protocol.

![AIRCOM INTERNATIONAL]