WCDMA UTRAN Interface and Signaling Procedure

www.huawei.com

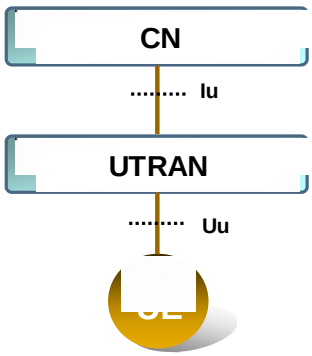
Objectives

- Upon completion of this course, you will be able to:
  - Understand UTRAN interface and structure
  - Understand the definitions about UTRAN network elements
  - Understand UTRAN signaling procedure

Contents

Contents

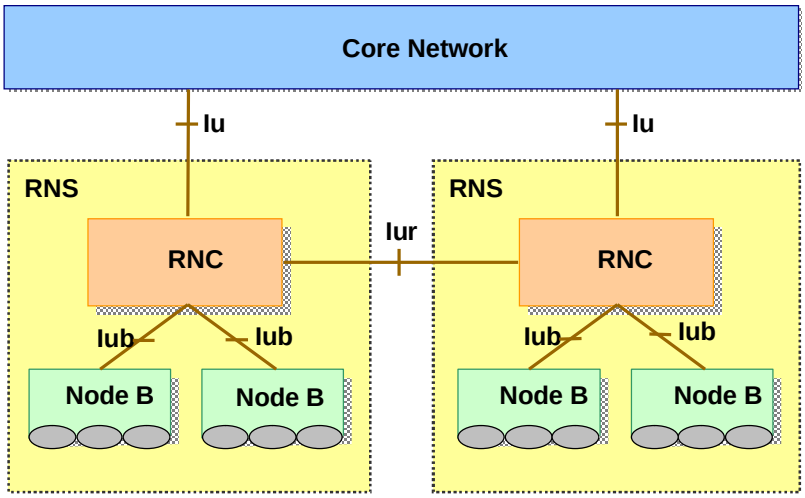
UMTS Construction



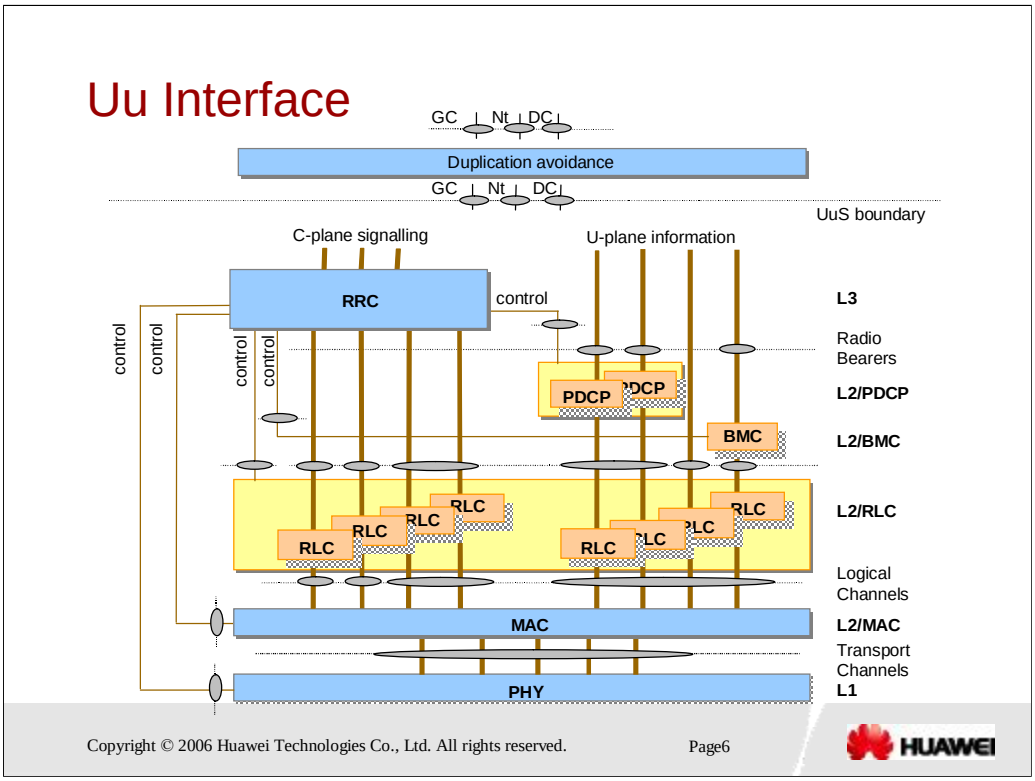
UTRAN	UMTS Terrestrial Radio Access Network
CN	Core Network
UE	User Equipment

- **UMTS network architecture** shown in slide above
- **UE (User Equipment)**
  - The User Equipment (UE) consists of two parts: the mobile equipment (ME) and the UMTS Subscriber Identity Module (USIM).
- **UTRAN (UMTS Terrestrial Radio Access network)**
  - The UTRAN consists of one or several Radio Network Subsystem **(RNS)**, each containing one RNC and one or several NodeB
- **CN (Core Network)**
  - Core network (CN) includes a lot of equipments such as MSC ,HLR, SGSN,GGSN,AUC,VLR etc.

UMTS Structure



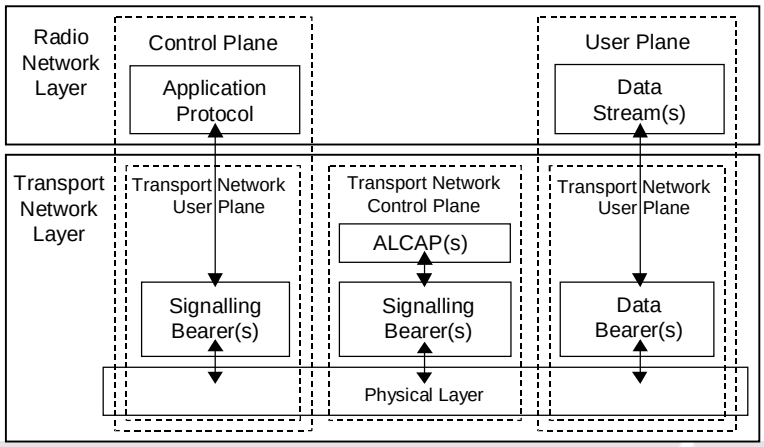
- **UTRAN (UMTS Terrestrial Radio Access network) structure**
  - The UTRAN consists of one or several Radio Network Subsystem **(RNS)**, each containing one RNC and one or several NodeB
- ***Interface***
  - **Iu interface**: the Iu interface connects the UTRAN to the CN and is split in two parts. The Iu-CS is the interface between the RNC and the circuit switched domain of the CN. The Iu-PS interface is the interface between the RNC and the packet switched domain of the CN.
  - **Uu interface**: the Uu interface is the WCDMA radio interface with in UMTS. It is the interface through which the UE accesses the fixed part of the network.
  - **Iub interface**: the Iub interface connects the NodeB and the RNC. Contrarily to GSM, this interface is fully open in UMTS and thus more competition is expected.
  - **Iur interface**: the RNC-RNC interface was initially designed in order to provide inter RNC soft handover, but more features were added during the development.



- The layer 1 supports all functions required for the transmission of bit streams on the physical medium. It is also in charge of measurements function consisting in indicating to higher layers, for example, Frame Error Rate (FER), Signal to Interference Ratio (SIR), interference power, transmit power, … It is basically composed of a “layer 1 management” entity, a “transport channel” entity, and a “physical channel” entity.
- The layer 2 protocol is responsible for providing functions such as mapping, ciphering, retransmission and segmentation. It is made of four sublayers: MAC (Medium Access Control), RLC (Radio Link Control), PDCP (Packet Data Convergence Protocol) and BMC (Broadcast/Multicast Control).
- The layer 3 is split into 2 parts: the access stratum and the non access stratum. The access stratum part is made of “RRC (Radio Resource Control)” entity and “duplication avoidance” entity. The non access stratum part is made of CC, MM parts.
- Not shown on the figure are connections between RRC and all the other protocol layers (RLC, MAC, PDCP, BMC and L1), which provide local inter-layer control services.
- The protocol layers are located in the UE and the peer entities are in the node B or the RNC.

General Protocol Mode for UTRAN Terrestrial Interface

- The structure is based on the principle that the layers and planes are logically independent of each other.

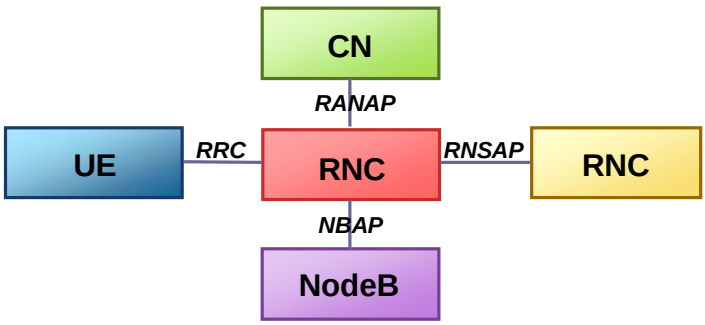


- Protocol structures in UTRAN terrestrial interfaces are designed according to the same general protocol model. This model is shown in above slide. The structure is based on the principle that the layers and planes are logically independent of each other and, if needed, parts of the protocol structure may be changed in the future while other parts remain intact.
- **Horizontal Layers**
  - The protocol structure consists of two main layers, the ***Radio Network Layer (RNL)*** and the ***Transport Network Layer (TNL).*** All UTRAN-related issues are visible only in the Radio Network Layer, and the Transport Network Layer represents standard transport technology that is selected to be used for UTRAN but without any UTRAN-specific changes.
- **Vertical Planes**
  - ***Control Plane***
  - The Control Plane is used for all UMTS-specific control signalling. It includes the Application Protocol (i.e. RANAP in Iu, RNSAP in Iur and NBAP in Iub), and the Signalling Bearer for transporting the Application Protocol messages. The Application Protocol is used, among other things, for setting up bearers to the UE (i.e. the Radio Access Bearer in Iu and subsequently the Radio Link in Iur and Iub). In the three plane structure the bearer parameters in the Application Protocol are not directly tied to the User Plane technology, but rather are general bearer parameters. The Signalling Bearer for the Application Protocol may or may not be of the same type as the Signalling Bearer for the ALCAP. It is always set up by O&M actions.

- ***User Plane***
- All information sent and received by the user, such as the coded voice in a voice call or the packets in an Internet connection, are transported via the User Plane. The User Plane includes the Data Stream(s), and the Data Bearer (s) for the Data Stream(s). Each Data Stream is characterized by one or more frame protocols specified for that interface.
- ***Transport Network Control Plane***
- The Transport Network Control Plane is used for all control signalling within the Transport Layer. It does not include any Radio Network Layer information. It includes the ALCAP protocol that is needed to set up the transport bearers (Data Bearer) for the User Plane. It also includes the Signalling Bearer needed for the ALCAP. The Transport Network Control Plane is a plane that acts between the Control Plane and the User Plane. The introduction of the Transport Network Control Plane makes it possible for the Application Protocol in the Radio Network Control Plane to be completely independent of the technology selected for the Data Bearer in the User Plane.

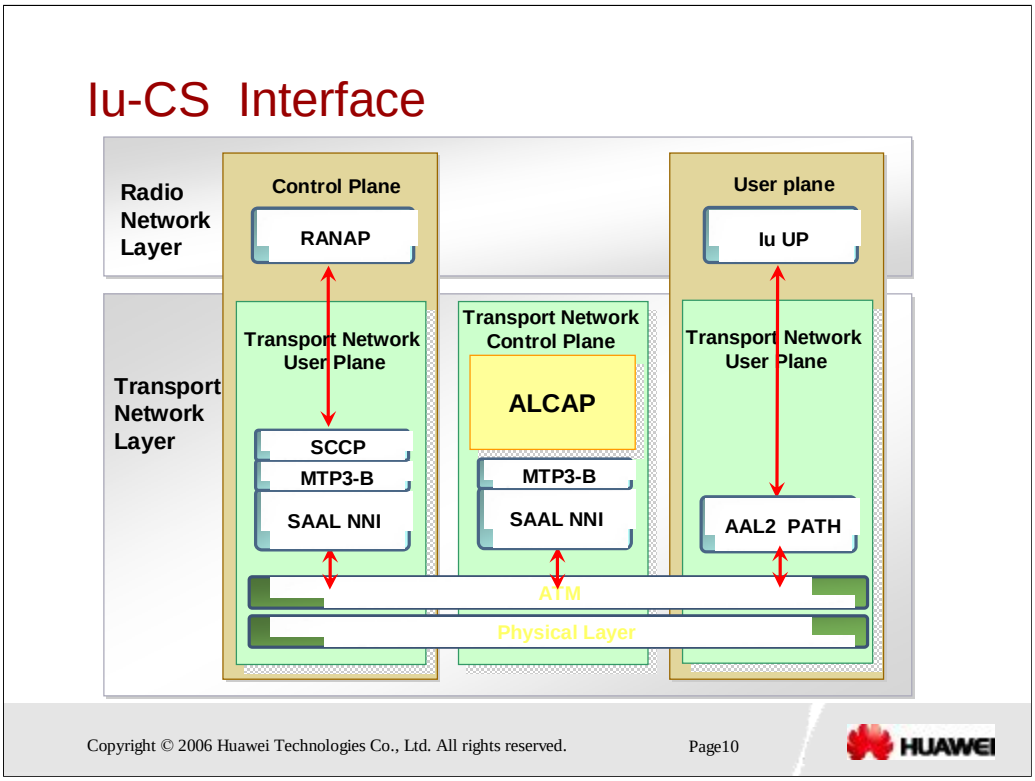
- ***About AAl2 and AAL5***
  - Above the ATM layer we usually find an ATM adaptation layer (AAL). Its function is to process the data from higher layers for ATM transmission.
  - This means segmenting the data into 48-byte chunks and reassembling the original data frames on the receiving side. There are five different AALs (0, 1, 2, 3/4, and 5). AAL0 means that no adaptation is needed. The other adaptation layers have different properties based on three parameters:
    - Real-time requirements;
    - Constant or variable bit rate;
    - Connection-oriented or connectionless data transfer.
  - The usage of ATM is promoted by the ATM Forum. The Iu interface uses two AALs: AAL2 and AAL5.
  - **AAL2 is designed for the transmission of connection oriented, real-time data streams with variable bit rates.**
  - **AAL5 is designed for the transmission of connectionless data streams with variable bit rates.**

RNL Control Plane Application Protocol



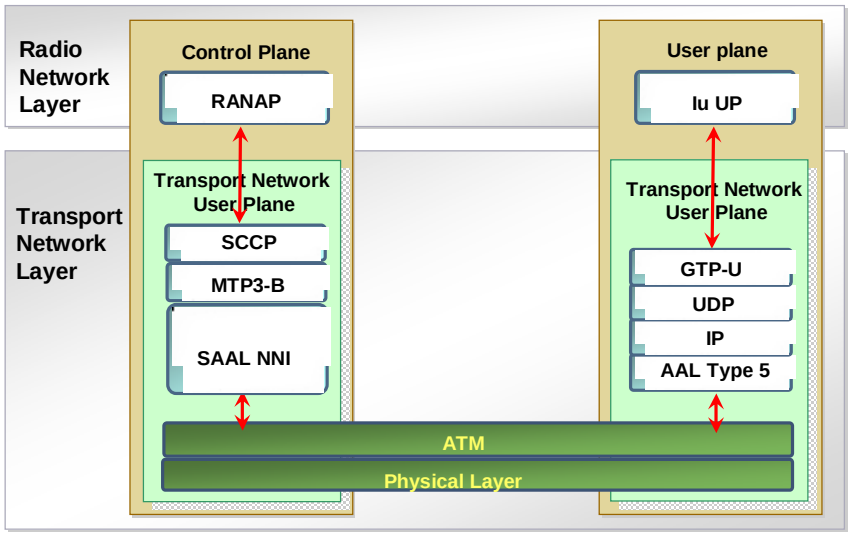
NBAP	Node B Application Part
RANAP	Radio Access Network Application Part
RNSAP	Radio Network Subsystem Application Part
RRC	Radio Resource Control

- RANAP is the signalling protocol in Iu that contains all the control information specified for the Radio Network Layer.
- RNSAP is the signalling protocol in Iur that contains all the control information specified for the Radio Network Layer.
- NBAP is the signalling protocol in Iub that contains all the control information specified for the Radio Network Layer.
- RRC is the signalling protocol in Uu that locate in the Uu interface layer 3.



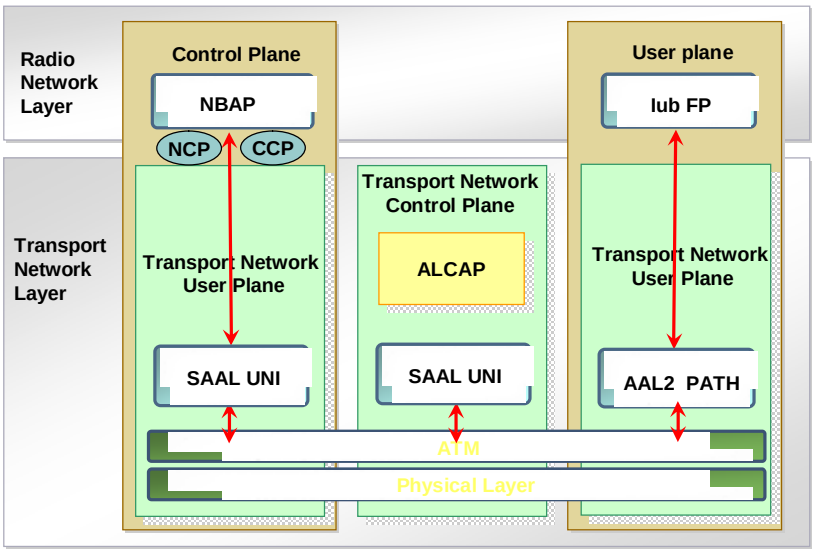
- **Protocol Structure for Iu CS**
- The Iu CS overall protocol structure is depicted in above slide. The three planes in the Iu interface share a common ATM (Asynchronous Transfer Mode) transport which is used for all planes. The physical layer is the interface to the physical medium: optical fiber, radio link or copper cable. The physical layer implementation can be selected from a variety of standard off-the-shelf transmission technologies, such as SONET, STM1, or E1.
- **Iu CS Control Plane Protocol Stack**
- The Control Plane protocol stack consists of RANAP, on top of Broadband (BB) SS7 (Signalling System #7) protocols. The applicable layers are the Signalling Connection Control Part (SCCP), the Message Transfer Part (MTP3-b) and SAAL-NNI (Signalling ATM Adaptation Layer for Network to Network Interfaces). SAAL-NNI is further divided into Service Specific Coordination Function (SSCF), Service Specific Connection Oriented Protocol (SSCOP) and ATM Adaptation Layer 5 (AAL) layers. SSCF and SSCOP layers are specifically designed for signalling transport in ATM networks, and take care of such functions as signalling connection management. AAL5 is used for segmenting the data to ATM cells.
- **Iu CS Transport Network Control Plane Protocol Stack**
- The Transport Network Control Plane protocol stack consists of the Signalling Protocol for setting up AAL2 connections (Q.2630.1 and adaptation layer Q.2150.1), on top of BB SS7 protocols. The applicable BB SS7 are those described above without the SCCP layer.
- **Iu CS User Plane Protocol Stack**
- A dedicated AAL2 connection is reserved for each individual CS service.

Iu-PS Interface



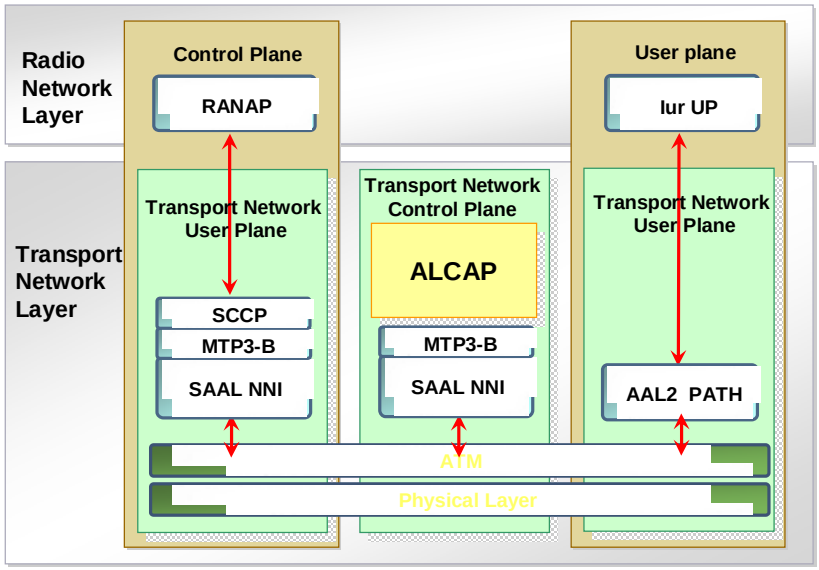
- **Protocol Structure for Iu PS**
- The Iu PS protocol structure is represented in above slide. Again, a common ATM transport is applied for both User and Control Plane. Also the physical layer is as specified for Iu CS.
- **Iu PS Control Plane Protocol Stack**
- The Control Plane protocol stack again consists of RANAP, and the same BB SS7-based signalling bearer as described in Section 5.4.1.1. Also, as an alternative, an IP-based signalling bearer is specified. The SCCP layer is also used commonly for both. The IP based signalling bearer consists of M3UA (SS7 MTP3 – User Adaptation Layer), SCTP (Simple Control Transmission Protocol), IP (Internet Protocol), and AAL5 which is common to both alternatives. The SCTP layer is specifically designed for signalling transport in the Internet. Specific adaptation layers are specified for different kinds of signalling protocol, such as M3UA for SS7-based signalling.
- **Iu PS Transport Network Control Plane Protocol Stack**
- The Transport Network Control Plane is not applied to Iu PS. The setting up of the GTP tunnel requires only an identifier for the tunnel, and the IP addresses for both directions, and these are already included in the RANAP RAB Assignment messages.
- **Iu PS User Plane Protocol Stack**
- In the Iu PS User Plane, multiple packet data flows are multiplexed on one or several AAL5 PVCs. The GTP-U (User Plane part of the GPRS Tunneling Protocol) is the multiplexing layer that provides identities for individual packet data flow. Each flow uses UDP connectionless transport and IP addressing.

Iub Interface



- The Iub interface is the terrestrial interface between NodeB and RNC. The Radio Network Layer defines procedures related to the operation of the NodeB. The Transport Network Layer defines procedures for establishing physical connections between the NodeB and the RNC.
- The Iub application protocol, NodeB application part (NBAP) initiates the establishment of a signaling connection over Iub . It is divided into two essential components, NBAP common for defining the signalling procedures across the common signalling link and NBAP dedicated for the dedicated signalling link. This split is due to the fact that the NodeB is defined as having a common part and a number of dedicated parts (each controlling a traffic connection) .
- NBAP-C is used for signaling that initiates a UE context for a dedicated UE or signals that is not related to specific UE. Example of NBAP-C procedure are cell configuration , handling of common channels and radio link setup
- NBAP-D signalling is used for signaling relating to a specific UE context. The initial request to NodeB from the RNC such as Radio link setup for a context activation uses NBAP-C ,but once the context has been set up ,NBAP-D is used from then. Example of NBAP-D functions are addition, reconfiguration and release of radio links for one UE context
- SAAL is an ATM Adaptation Layer that supports communication between signalling entities over an ATM link.
- The user plane Iub Frame Protocol (FP), defined the structure of the frames and the basic in band control procedure for every type of transport channel. There are DCH-FP, RACH-FP, FACH-FP, HS-DSCH FP and PCH FP.

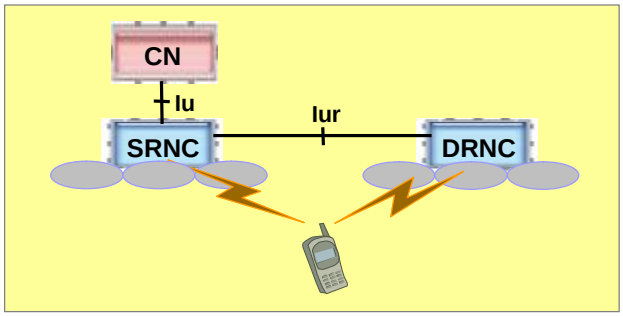
Iur Interface



- Iur interface connects two RNCs. The protocol stack for the Iur is shown in above slide.
- The RNSAP protocol is the signalling protocol defined for the Iur interface.

Contents

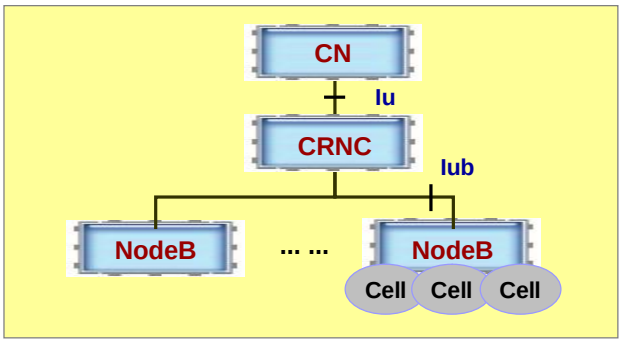
SRNC / DRNC



- SRNC and DRNC are concepts for a connected UE.
- The SRNC handles the connection to one UE, and may borrow radio resources of a certain cell from the DRNC.
- Drift RNCs support the Serving RNC by providing radio resources
- A UE in connection state has at least one and only one SRNC, but can has 0 or multiple DRNCs

- 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 direct physical connection between RNCs or virtual networks using any suitable transport network .
- For each connection between User Equipment and the UTRAN, One RNC is the Serving RNC. When required, Drift RNCs support the Serving RNC by providing radio resources. The role of an RNC (Serving or Drift) is on a per connection basis between a UE and the UTRAN.

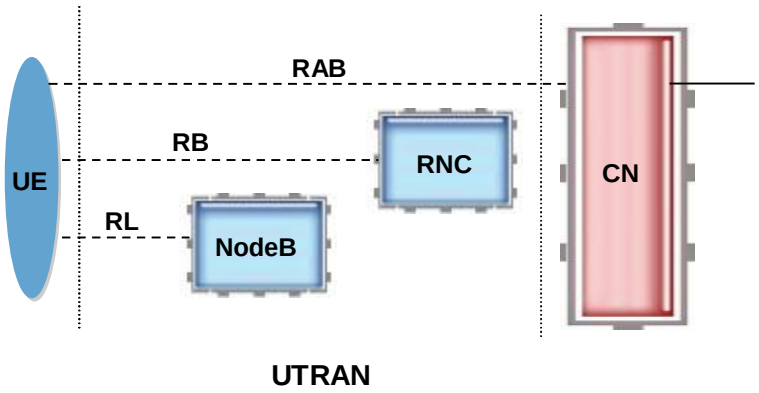
CRNC



- The CRNC owns the radio resources of a cell

- CRNC is related to a specific NodeB (or Cell)
- Dynamical control of power for dedicated channels, within limits admitted by CRNC, is done by the SRNC.
- Scheduling of data for dedicated channels is done by the SRNC, while for common channels it is done by the CRNC

RAB, RB and RL



- RAB: The service that the access stratum provides to the non-access stratum for transfer of user data between User Equipment and CN.
- RB: The service provided by the layer2 for transfer of user data between User Equipment and Serving RNC.
- RL: A "radio link" is a logical association between single User Equipment and a single UTRAN access point. Its physical realization comprises one or more radio bearer transmissions.

UE Working Modes and States

- Idle Mode
- Connected Mode
  - Cell_DCH
  - Cell_FACH
  - Cell_PCH
  - URA_PCH

- The connected mode is entered when the RRC connection is established. The UE leaves the connected mode and returns to idle mode when the RRC connection is released or at RRC connection failure.

Idle Mode

- UE camps on a cell
  - It enables the UE to receive system information from the PLMN
  - UE can receive paging message from the PICH of a cell
  - It enables the UE to receive cell broadcast services.
- The idle mode tasks can be divided into three processes:
  - PLMN selection and reselection
  - Cell selection and reselection
  - Location registration

- When a UE is switched on, a public land mobile network (PLMN) is selected and the UE searches for a suitable cell of this PLMN to camp on.
- The NAS shall provide a list of equivalent PLMNs, if available, that the AS shall use for cell selection and cell reselection.
- The UE searches for a suitable cell of the chosen PLMN and chooses that cell to provide available services, and tunes to its control channel. This choosing is known as "camping on the cell". The UE will, if necessary, then register its presence, by means of a NAS registration procedure, in the registration area of the chosen cell.
- If the UE finds a more suitable cell, it reselects onto that cell and camps on it. If the new cell is in a different registration area, location registration is performed.

Connected Mode

- When UE is in connected mode, there is normally an RRC connection between UE and UTRAN.
- The UE position can be known on different levels:
  - Cell level
  - UTRAN Registration Area (URA) level

- In connected mode, the UE is assigned a Radio Network Temporary Identity (RNTI) to be used as UE identity on common transport channels. Two types of RNTI exist. The Serving RNC allocates an S-RNTI for all UEs having an RRC connection. The combination of S-RNTI and an RNC-ID is unique within a PLMN. C-RNTI is allocated by each Controlling RNC through which UE is able to communicate on DCCH. C-RNTI is always allocated by UTRAN when a new UE context is created to an RNC, but the UE needs its c-RNTI only for communicating on common transport channels.
- Within connected mode the level of UE connection to UTRAN is determined by the quality of service requirements of the active radio bearers and the characteristics of the traffic on those bearers.
- The UE-UTRAN interface is designed to support a large number of UEs using packet data services by providing flexible means to utilize statistical multiplexing. Due to limitations, such as air interface capacity, UE power consumption and network h/w availability, the dedicated resources cannot be allocated to all of the packet service users at all times.
- Variable rate transmission provides the means that for services of variable rate the data rate is adapted according to the maximum allowable output power.

- The UE state in the connected mode defines the level of activity associated to the UE. The key parameters of each state are the required activity and resources within the state and the required signalling prior to the data transmission. The state of the UE shall at least be dependent on the application requirement and the period of inactivity.
- Common Packet Channel (CPCH) uplink resources are available to UEs with an access protocol similar to the RACH. The CPCH resources support uplink packet communication for numerous UEs with a set of shared, contention-based CPCH channels allocated to the cell.
- Assuming that there exists an RRC connection, there are two basic families of RRC connection mobility procedures, URA updating and handover. Different families of RRC connection mobility procedures are used in different levels of UE connection (cell level and URA level):
  - -URA updating is a family of procedures that updates the UTRAN registration area of a UE when an RRC connection exists and the position of the UE is known on URA level in the UTRAN;
  - -Handover is a family of procedures that adds or removes one or several radio links between one UE and UTRAN when an RRC connection exists and the position of the UE is known on cell level in the UTRAN.

Connected Mode

- Cell-DCH
  - In active state
  - Communicating via its dedicated channels
  - UTRAN knows which cell UE stays in

- If there is huge data to be transmitted, it must allocate dedicated channel. Thus UE will be in Cell-DCH. UE in Cell-DCH state is communicating via DCH (downlink and uplink) with UTRAN.

Connected Mode

- Cell-FACH
  - In active state
  - Few data to be transmitted both in uplink and in downlink. There is no need to allocate dedicated channel for this UE
  - Downlink uses FACH and uplink uses RACH
  - UE need to monitor the FACH for its information
  - UTRAN knows which cell UE stays in

- If there is only few data to be transmitted, there is no need to allocate dedicated channel. Thus UE will be in Cell-FACH. UE in Cell-FACH state is communicating via FACH (downlink) and RACH (uplink) with UTRAN. UE need to monitor the FACH for its relative information because FACH is shared for all users in the cell.

Connected Mode

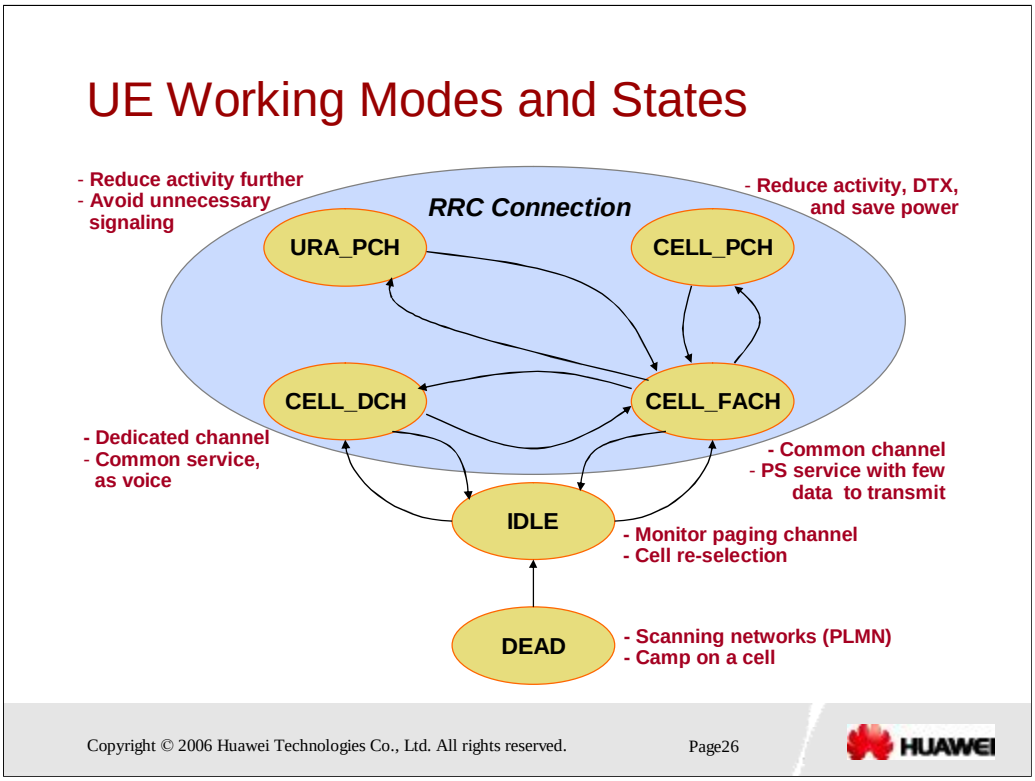
- Cell-PCH
  - No data to be transmitted or received
  - Monitor PICH, to receive its paging
  - Lower the power consumption of UE
  - UTRAN knows which cell UE stays in
  - UTRAN have to update cell information of UE when UE roams to another cell

- If UE has no data to be transmitted or received, UE will be in Cell-PCH or URA-PCH. In these two states, UE needs to monitor PICH,to receive its paging. UTRAN knows which cell or URA UE is now in. The difference between Cell-PCH and URA-PCH is that UTRAN update UE information only after UE which is in URA-PCH state has roamed to other URA.
- UTRAN have to update cell information of UE when UE roams to another cell. UE migrates to cell-FACH state to complete the cell update. If there is also no data to be transmitted or received, UE is back to CELL-PCH state after cell update. If the cell update times in a fixed time reach a preset value, UTRAN will let UE migrate to URA-PCH. URA is an area of several cells.

Connected Mode

- URA-PCH
  - No data to be transmitted or received
  - Monitor PICH, to receive its paging
  - UTRAN only knows which URA (UTRAN Registration Area, which consists of multiple cells) that UE stay
  - UTRAN updates UE information only after UE has roamed to other URA
  - A better way to reduce the resource occupancy and signaling transmission

- It is the same as the CELL-PCH state. UE should migrate to CELL-FACH state to complete the URA update.



- This is the UE states figure. These states are significant only for UTRAN and UE. They are transparent to CN. Let's focus on the switch between the states.

RNTI - Radio Network Temporary Identifier

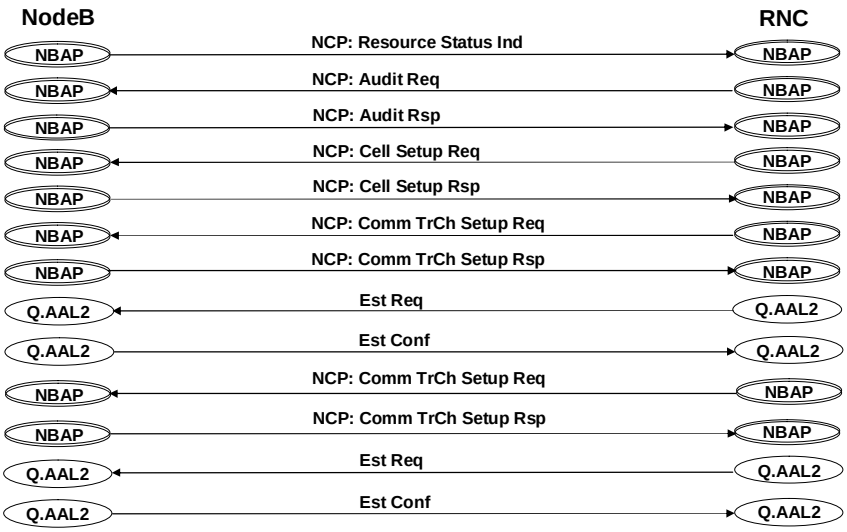
- Five types of RNTI exist
  - Serving RNC RNTI (S-RNTI)
  - Drift RNC RNTI (D-RNTI)
  - Cell RNTI (C-RNTI)
  - UTRAN RNTI (U-RNTI)
  - HS-DSCH RNTI (H-RNTI)

- **SRNTI**
  - SRNTI is used by UE to identify itself to the serving RNC;
  - SRNTI is used by SRNC to address the UE;
  - SRNTI is used by DRNC to identify the UE to serving RNC;
  - SRNTI is allocated for all UEs having a RRC connection, it is allocated by serving RNC and it unique within the SRNC. SRNTI is always reallocated when the SRNC for the RRC connection is changed.
- **DRNTI**
  - DRNTI is used to SRNC to identify the UE to the DRNC;
  - DRNTI is never used on Uu interface. DRNTI is allocated by DRNC upon drift UE contexts establishment and is unique within the DRNC.
- **CRNTI**
  - CRNTI is used to by a UE to identify itself to the CRNC;
  - CRNTI is used to by CRNC to address the UE;
  - CRNTI is allocated by CRNC when UE accessing a new cell. CRNTI is unique within the accessed cell.
- **URNTI**
  - URNTI is consisted of SRNC identity and SRNTI.
- **HRNTI**
  - HRNTI is allocated by CRNC when UE establishing a HS-DSCH channel. HRNTI shall be unique within the cell carrying the HS-DSCH.

Contents

Contents

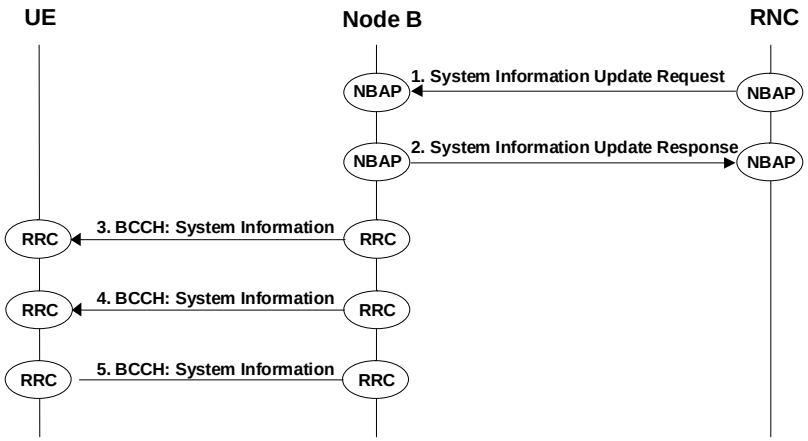
Cell Setup



- Setup NCP and CCP in SAAL link stratum, which NCP carries the NBAP public information and CCP carries the NBAP dedicated information. One NodeB only can setup one NCP, but can setup several CCP;
- To prepare the cell setting up, the resource of Node B should be audited;
- Logic cell setup: setup the common transport channel for cell, including RACH, FACH and PCH.

Contents

System Information Broadcast Flow



Introduction of System Information

- **MIB: PLMN tag and SB (scheduling information block) or the scheduling information for SIB (system info block)**
- SB1: scheduling information for SIB
- SB2: scheduling information for SIB (extended)

Introduction of System Information

- **SIB1: system information for NAS and the timer/counter for UE**
- **SIB2: URA information**
- **SIB3: parameters for cell selection and cell re-selection**
- SIB4: parameters for cell selection and cell re-selection while UE is in connected mode
- **SIB5: parameters for the common physical channels of the cell**
- SIB6: parameters for the common physical channels of the cell while UE is in connected mode

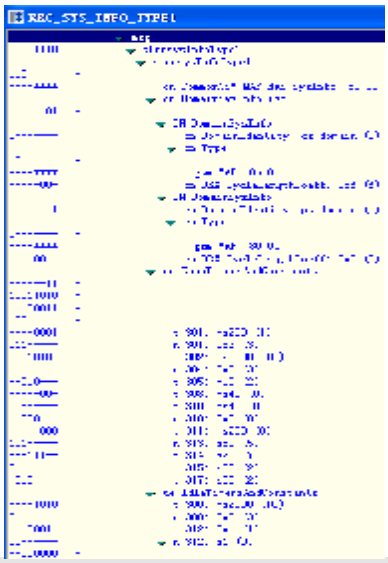
Introduction of System Information

- **SIB7: uplink interference level and the refreshing timer**
- SIB8: the CPCH static information
- SIB9: the CPCH dynamic information
- SIB10: information to be used by UEs having their DCH controlled by a DRAC procedure
- **SIB11: measurement controlling information**
- SIB12: measurement controlling information in connected mode

Introduction of System Information

- SIB13: ANSI-41 system information
- SIB14: the information in TDD mode
- SIB15: the position service information
- SIB16: the needed pre-configuration information for handover from other RAT to UTRAN
- SIB17: the configuration information for TDD
- SIB18: the PLMN identities of the neighboring cells to be used in shared networks to help with the cell reselection process

System Information Block Type 1

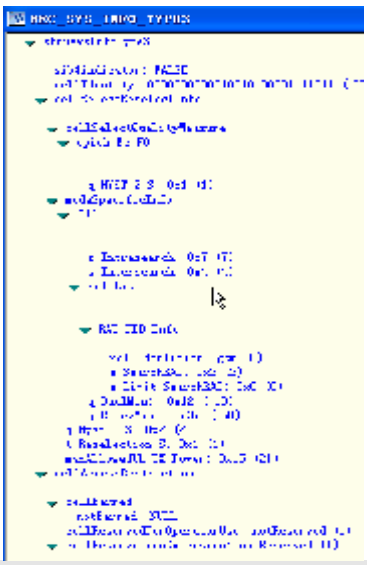


- System information type 1
  - The NAS system information
  - CS domain DRX: K = 6, then DRX period is 2^k = 2 ^ 6 = 64 TTI = 640 ms
  - PS domain DRX: K = 6, then DRX period is 2^k = 2 ^ 6 = 64 TTI = 640 ms

System Information Block Type 2

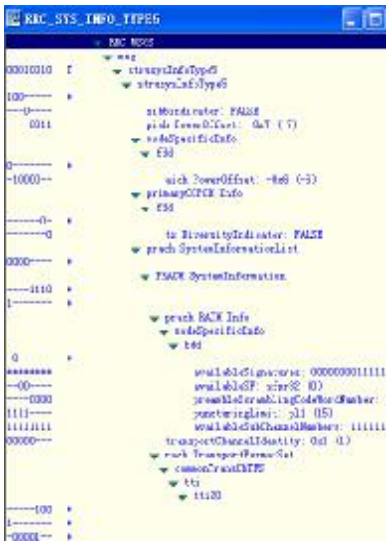
- System info type 2
  - URA information

System Information Block Type 3



- The references for cell selection and re-selection
  - Qhyst2s
  - Sintrasearch
  - Sintersearch
  - Sinterratsearch
  - Qqualmin
  - Qrxlemin
  - T reselection
  - Max Allowed UE TX power

System Information Block Type 5



- The configuration information for the following physical channels and the counterpart transport channels
  - PCCPCH
  - SCCPCH
  - PICH
  - AICH
  - PRACH

System Information Block Type 7 and 11

- System info type 7
  - Including the UL interference level which is used for open loop power control
  - Including the Expiration Time Factor which is used for refreshing the SIB7 periodically
- System info type 11
  - The neighbor cell information for cell re-selection in IDLE mode

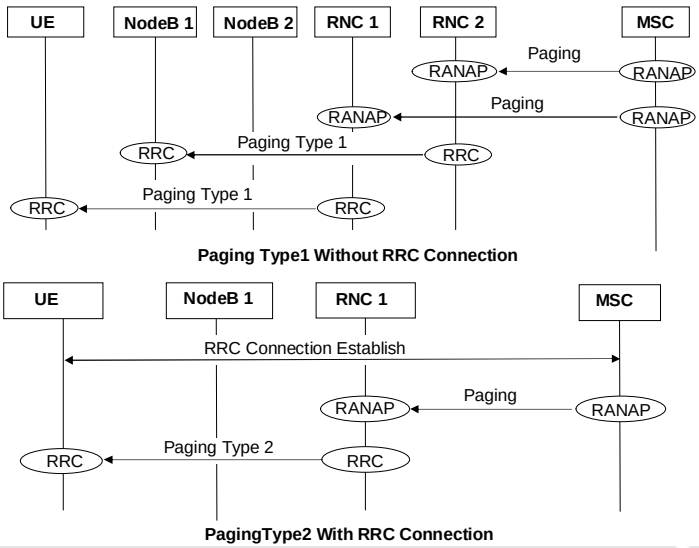
Contents

Paging Types

- The paging information type which is sent by UTRAN is decided by UE mode.
  - If UE is in the Idle mode, CELL_PCH or URA_PCH states, UTRAN sends paging type 1, and UE can use DRX method to monitor PICH.
  - If UE is in the CELL_FACH or CELL_DCH states，UTRAN sends paging type 2.

- When the RRC is idle, the UE may receive paging from the CS or PS domain. Because the UE is now in the idle state, the CN can learn the Location Area Identification (LAI) or RAI information of the UE. The paging will be sent via this location area and the LA or RA in this example crosses two RNCs.
- The above example shows the paging procedure of the UE in the RRC connected state (CELL_DCH or CELL_FACH), where the UTRAN coordinates the paging request over the DCCH in the RRC connected state.
- Paging Type 1 is sent over the PCCH when the UE is idle while Paging Type 2 is sent over the DCCH when the UE is in the RRC connected state. The typical case is that the UE uses the Paging Type 2 to send the PAGING message of the CS domain in the PS service procedure. However, the Paging Type is controlled by the RNC and the CN does not need to know it.

Paging Caused by CN

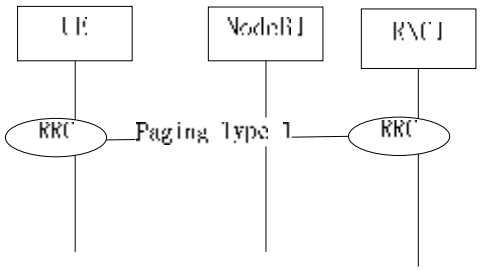


Paging Type1 Without RRC Connection

PagingType2 With RRC Connection

- The paging procedure is a procedure of paging initiated from the CN to the called party. When the CN needs to set up a connection with the called subscriber, it first needs to find the called subscriber via the paging procedure. The purpose of the paging procedure is just to enable the CN to page the called subscriber. The paging procedure is set up via connectionless signaling.

Paging Caused by UTRAN

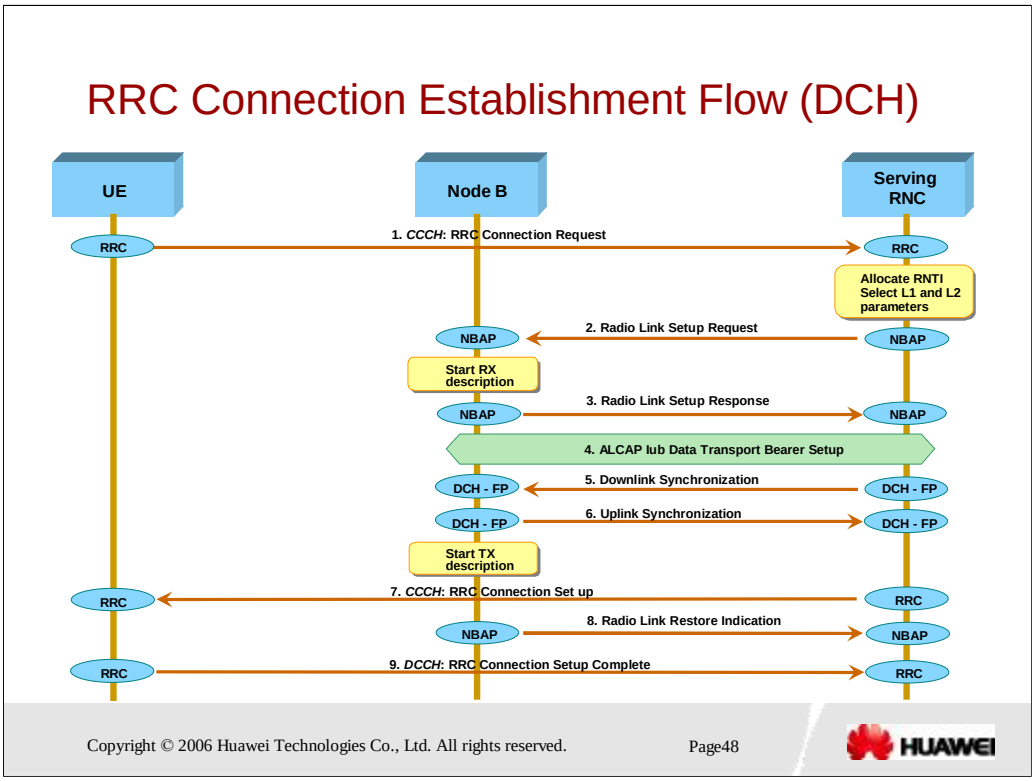


- When the system information is modified, UTRAN will send the paging information to tell UEs which are in IDLE, Cell_PCH or URA_PCH mode. Then, UE will read the modified system information from BCH.
- To change the state of UE which is in Cell_PCH or URA_PCH state, UTRAN will start a paging flow. Then, UE will start a Cell-Update or URA update flow for response.

Contents

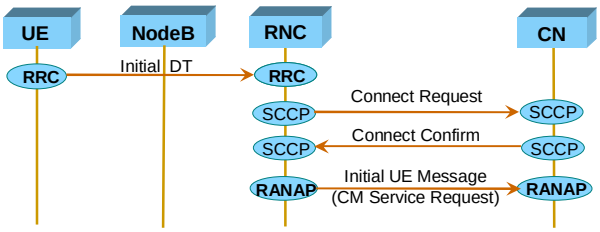
Introduction of Call Process

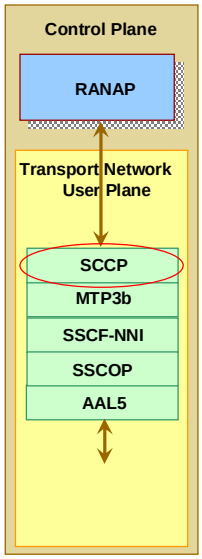
- In WCDMA system, a call process includes the following basic signaling flows:
  - RRC connection flow
  - Direct transfer message flow
  - Authentication flow (optional)
  - Security flow (optional)
  - RAB establish flow
  - Call proceeding
  - NAS signaling before correlative bearer release
  - Correlative bearer release



- In the idle mode, when the non-access layer of the UE requests to establish a signaling connection, the UE will initiate the RRC connection procedure. Each UE has up to one RRC connection only.
- Description:
  - The UE sends an **RRC Connection Request** message via the uplink CCCH to request to establish an RRC connection.
  - Based on the RRC connection request cause and the system resource state, the SRNC decides to establish the connection on the dedicated channel, and allocates the RNTI and L1 and L2 resources.
  - The SRNC sends a **Radio Link Setup Request** message to Node B, requesting the Node B to allocate specific radio link resources required by the RRC connection.
  - After successfully preparing the resources, the Node B responds to the SRNC with the **Radio Link Setup Response** message.
  - The SRNC initiates the establishment of Iub user plane transport bearer with the ALCAP protocol and completes the synchronization between the RNC and the Node B.
  - The SRNC sends an **RRC Connection Setup** message to the UE in the downlink CCCH.
  - The UE sends an **RRC Connection Setup Complete** message to the SRNC in the uplink DCCH.

Direct Transfer Message Flow





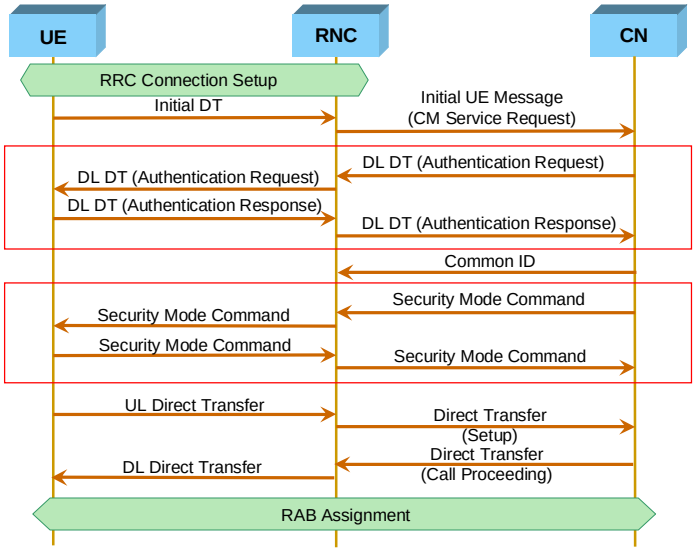
- In Iu interface, radio network layer reports the RANAP information and NAS information. NAS information is taken as directed message in RANAP information.
- And the process of Iu signaling connection is to establish the Iu interface connection of SCCP between RNC and CN.

- After the RRC connection between the UE and the UTRAN is successfully set up, the UE sets up a signaling connection with the CN via the RNC for NAS information exchange between the UE and the CN, such as authentication, service request and connection setup. This is also called the NAS signaling setup procedure.
- For the RNC, the signaling exchanged between the UE and the CN is a direct transfer message. After receiving the first direct transfer message, that is, the Initial Direct Transfer message, the RNC sets up a signaling connection with the CN on the SCCP. The procedure is shown in the above figure:
- The specific procedure is given as follows:
  - After the RRC connection is established, the UE sends the Initial Direct Transfer message to the RNC via the RRC connection. This message carries the NAS information content sent to the CN by the UE.
  - After receiving the Initial Direct Transfer message from the UE, the RNC sends the SCCP Connection Request (CR) message to the CN via the Iu interface. The message content is the Initial UE Message sent from the RNC to the CN, and carries the message content sent from the UE to the CN.
  - If the CN is ready to accept the connection request, then it returns the SCCP Connection Confirm (CC) message to the RNC. The SCCP connection is successfully set up. The RNC receives the message and confirms the signaling connection setup success.

- If the CN cannot accept the connection request, then it returns the SCCP Connection Reject (CJ) message to the RNC. The SCCP connection setup fails. The RNC receives the message and confirms the signaling connection setup failure. Then it initiates the RRC release procedure.

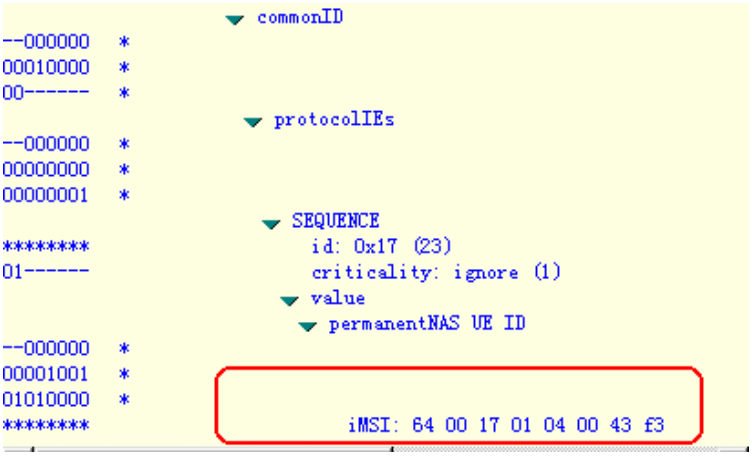
- After the signaling connection is successfully set up, the message sent by the UE to the CN is forwarded to the RNC via the Uplink Direct Transfer message, and the RNC converts it into the Direct Transfer message to send to the CN. The message sent by the CN to the UE is forwarded to the RNC via the Direct Transfer message, and the RNC converts it into the Downlink Direct Transfer to send to the UE.

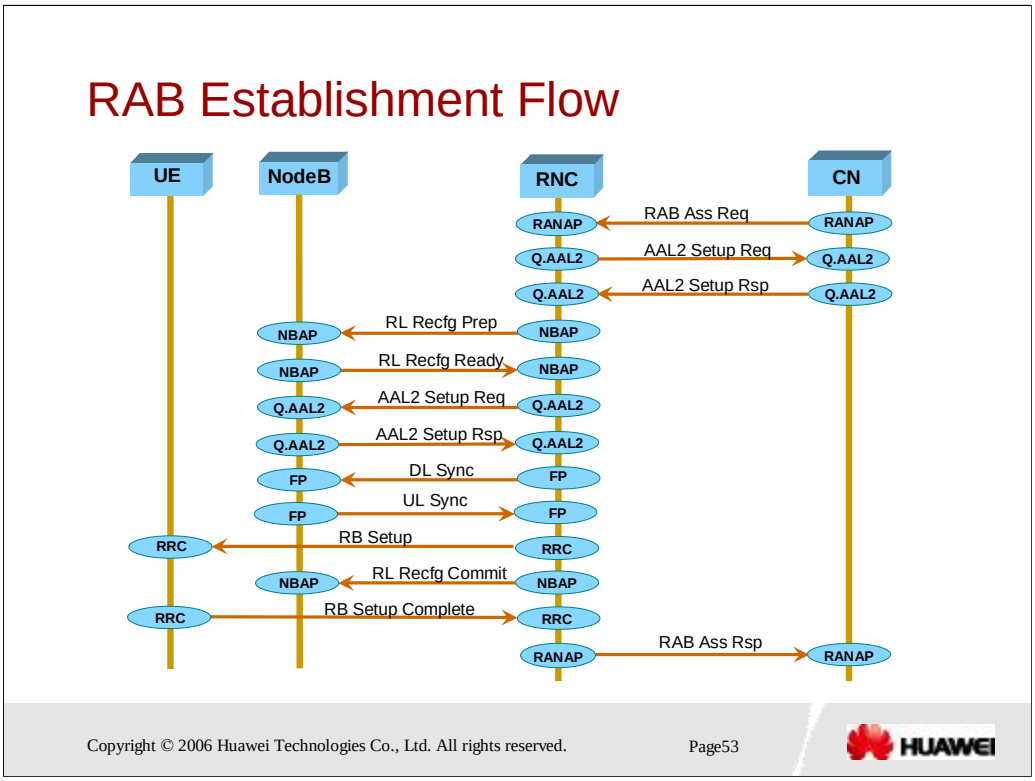
Authentication and Security Flow



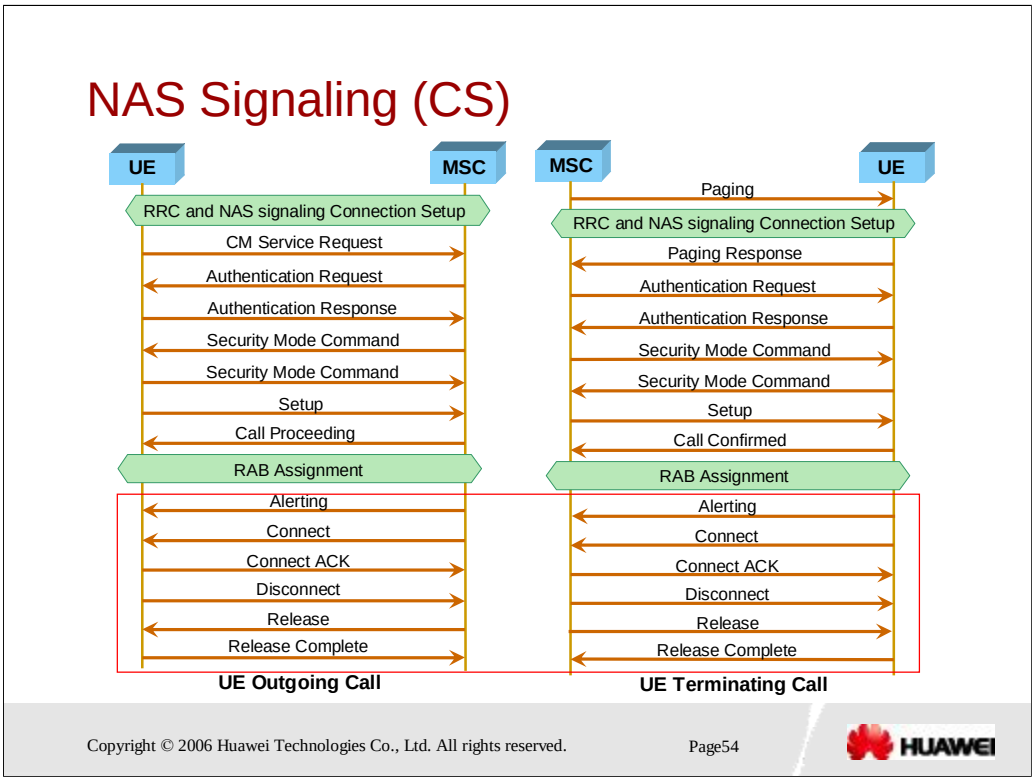
- Authentication is used for the validity of CN and UE.
- Security flow includes the encrypt process and integrity protection.

Common ID



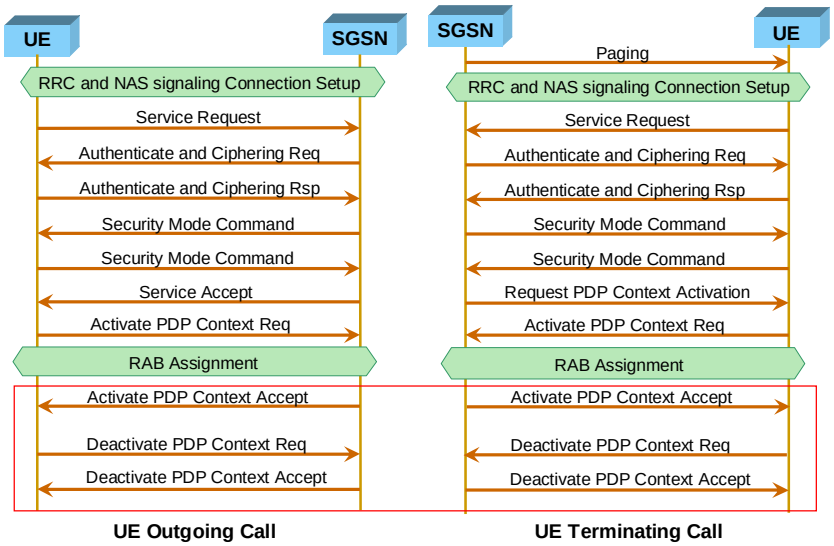


- RAB is the carrier which is provided by AS for NAS.
- RAB is the carrier in user plane, which is for transferring the voice service, data service or multiple media service between UE and CN.
- RAB establishment flow mainly includes the AAL2 PATH establishment of Iu and Iub interface, also includes the reconfiguration process of radio resource.
- The RAB refers to the user plane bearer that is used to transfer voice, data and multimedia services between the UE and the CN. The UE needs to complete the RRC connection establishment before setting up the RAB.
- The RAB setup is initiated by the CN and executed by the UTRAN. The basic procedure is as follows:
  1. First the CN sends the RAB assignment request message to the UTRAN, requesting the UTRAN to establish the RAB.
  2. The SRNC in the UTRAN initiates the establishment of the data transport bearer between the Iu interface and the Iub interface (Iur interface).
  3. The SRNC sends the RB setup request to the UE.
  4. After completing the RB establishment, the UE responds to the SRNC with the RB setup complete message.
  5. The SRNC responds to the CN with the RAB assignment response message and the RAB setup procedure ends.
- When the RAB is successfully established, a basic call is set up and the UE enters the conversation process.

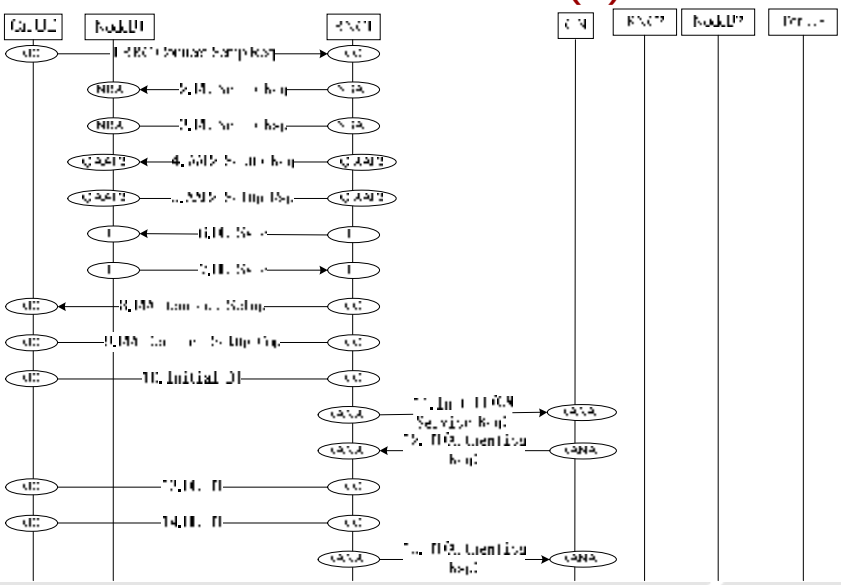


- Authentication and security flow are optional.
- CN does not need to the CM Service Response if the security mode is used.

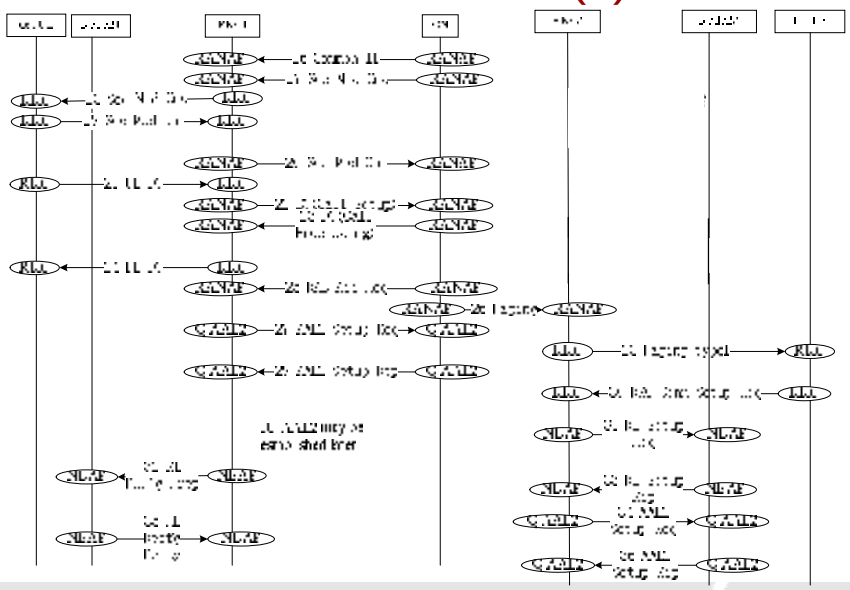
NAS Signaling (PS)



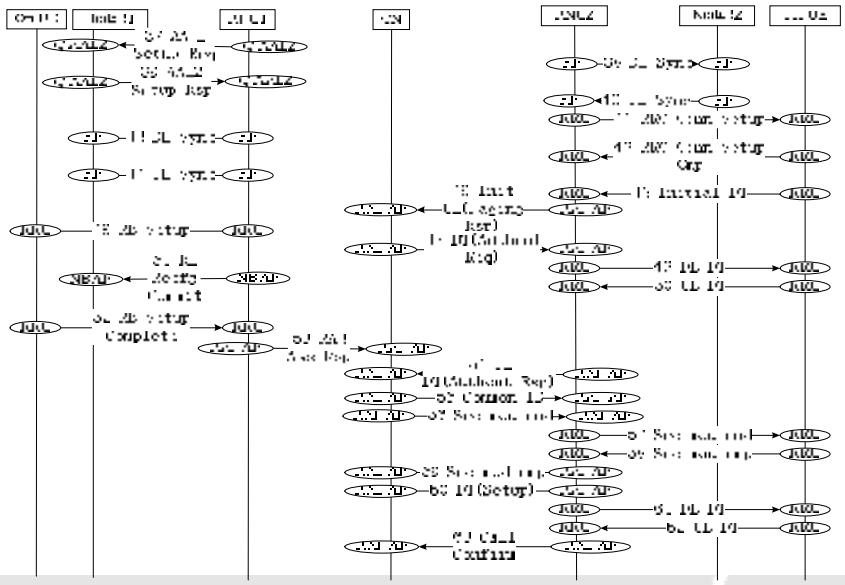
UE to UE CS Call Process (1)



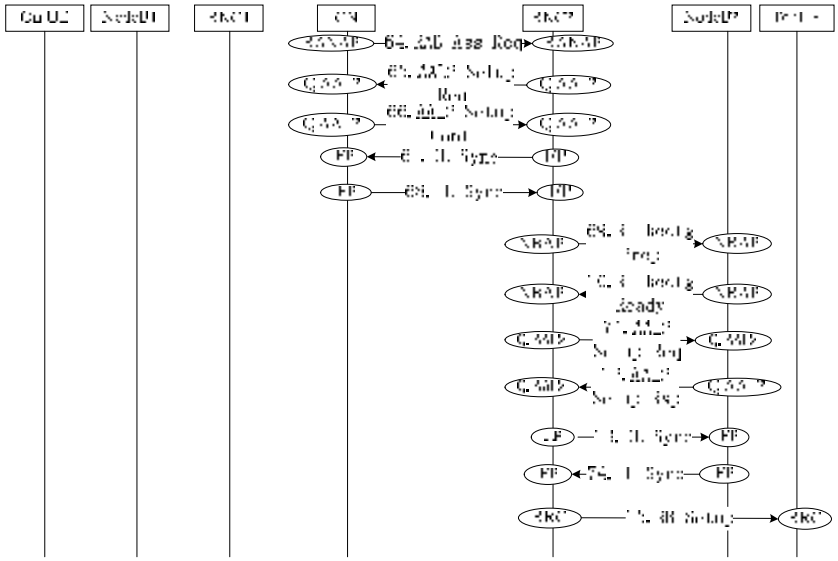
UE to UE CS Call Process (2)



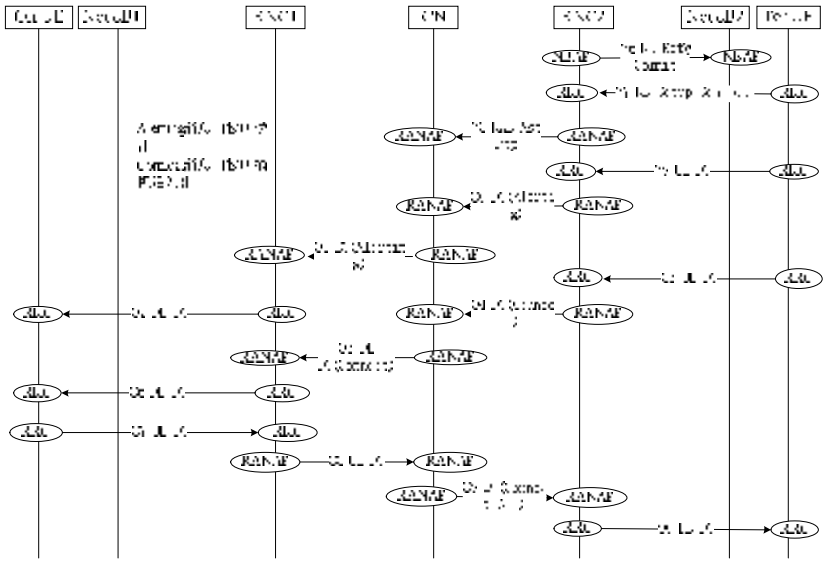
UE to UE CS Call Process (3)



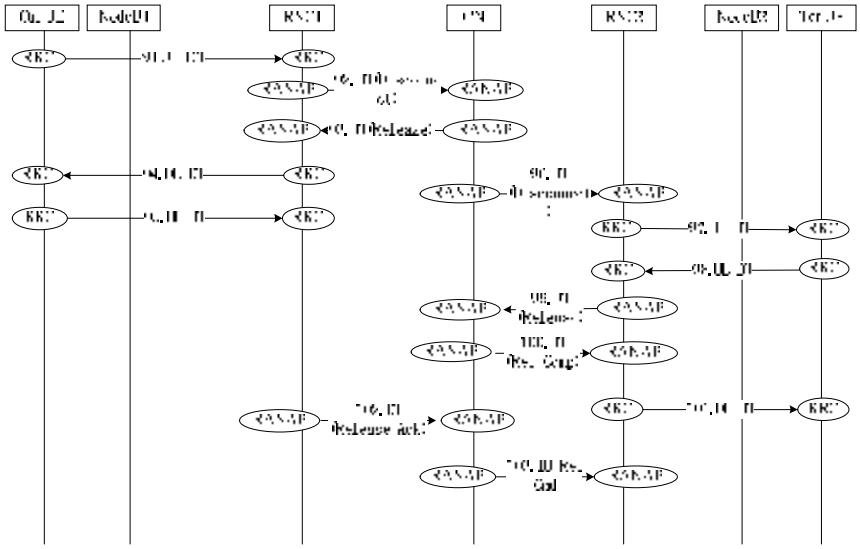
UE to UE CS Call Process (4)



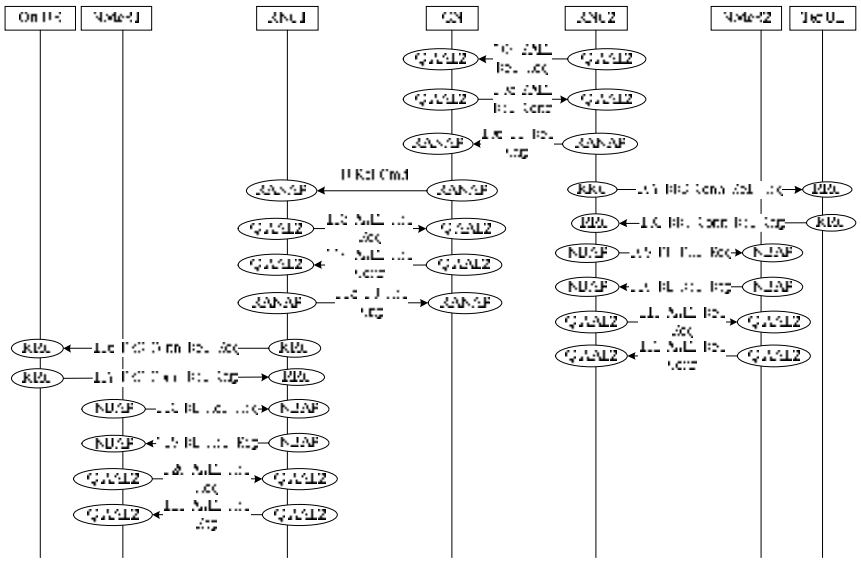
UE to UE CS Call Process (5)



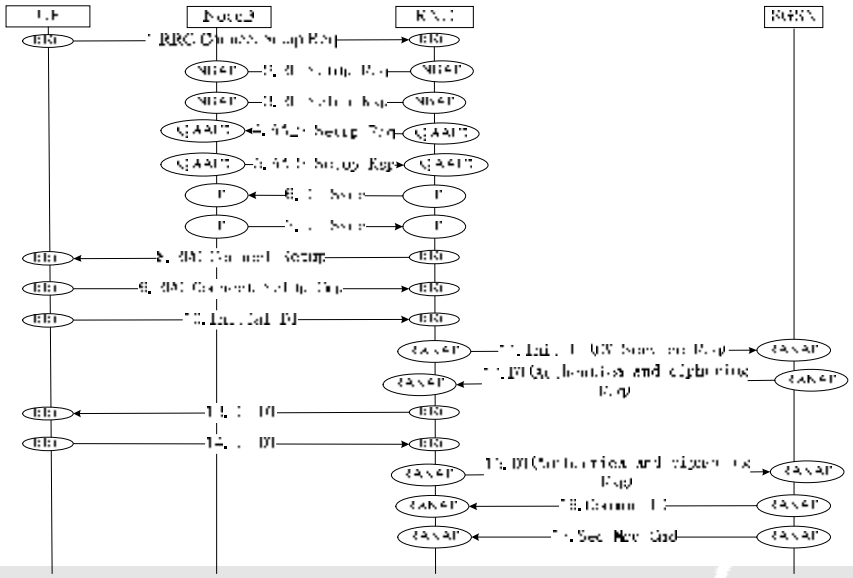
UE to UE CS Call Process (6)



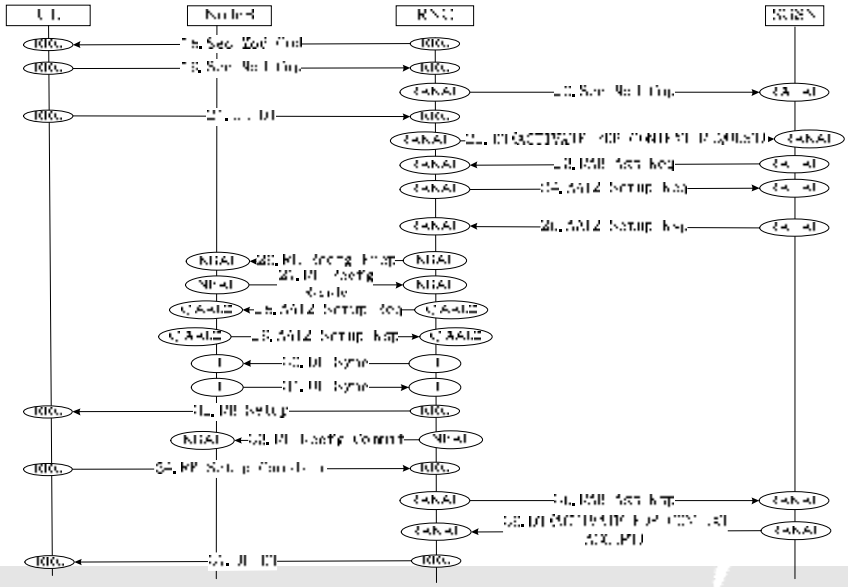
UE to UE CS Call Process (7)



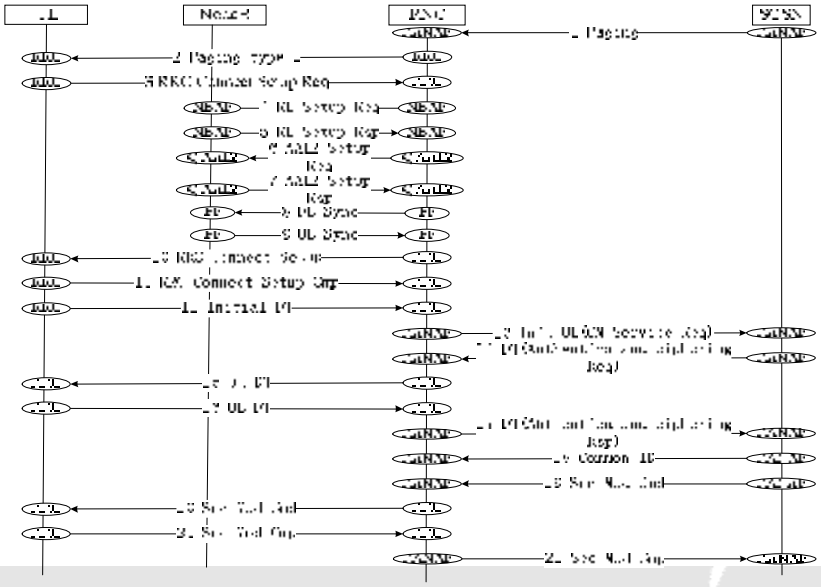
Activate PDP Context from UE (1)



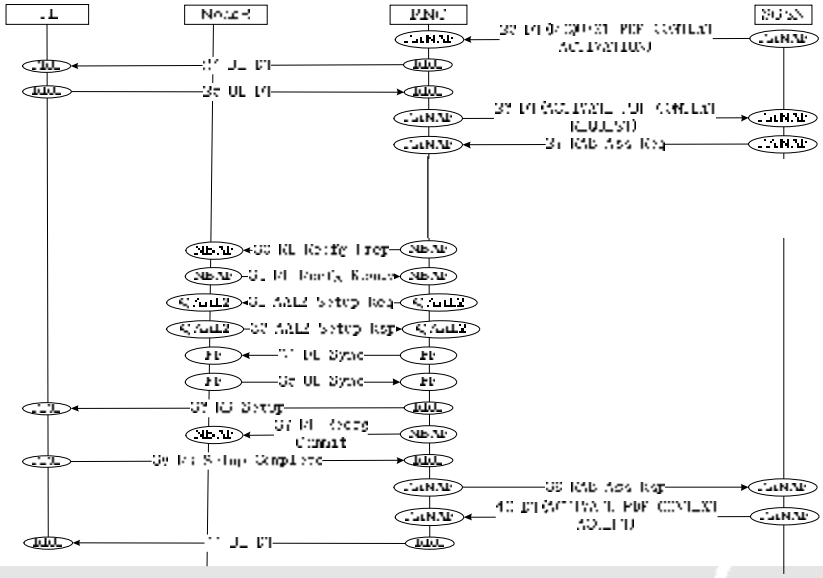
Activate PDP Context from UE (2)



Activate PDP Context from Network (1)



Activate PDP Context from Network (2)



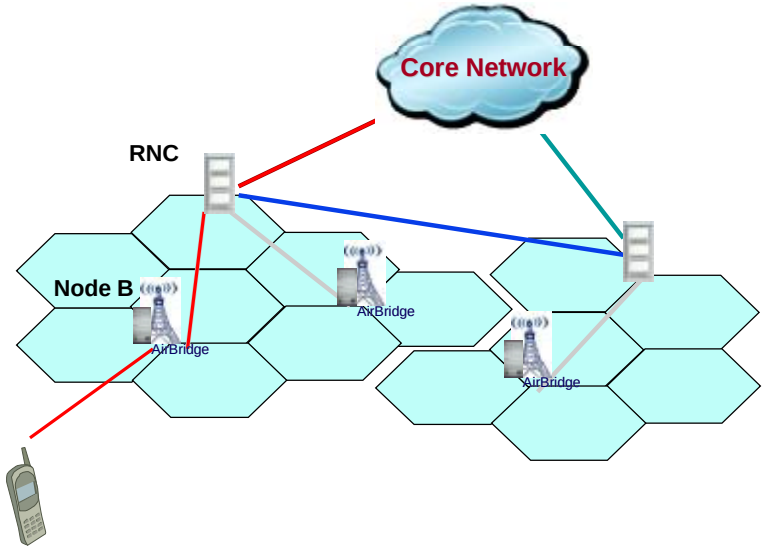
Contents

Concepts about Soft Handover

- Soft handover: the signals from different NodeBs are merged in RNC
- Softer handover: the signals from different cells, but from the same NodeB are merged in NodeB

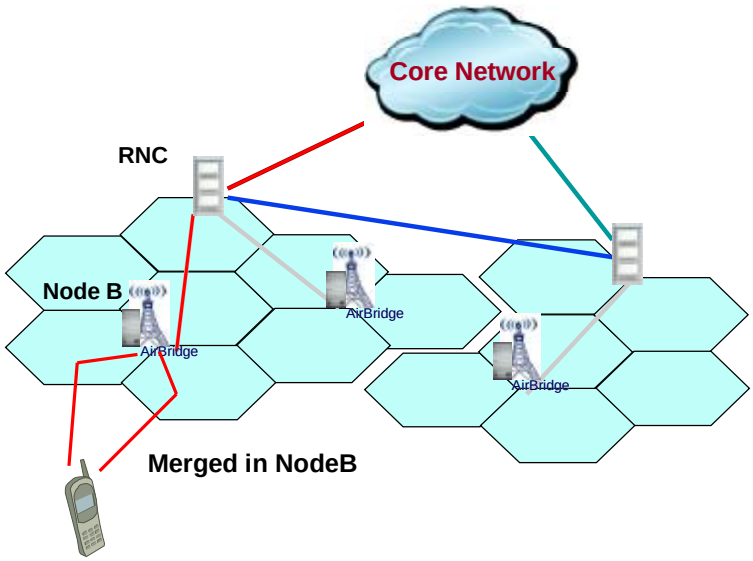
- Soft handover:
  - Selection combination in uplink
  - Maximum combination in downlink
- Softer handover
  - Maximum combination in uplink and downlink

Soft Handover Flow



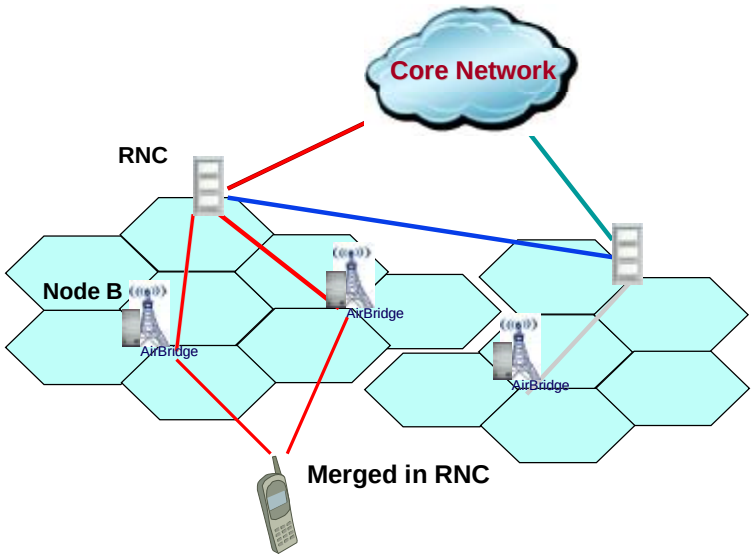
- It is no handover in this slide, only one radio links is connected with UE.

Soft Handover Flow



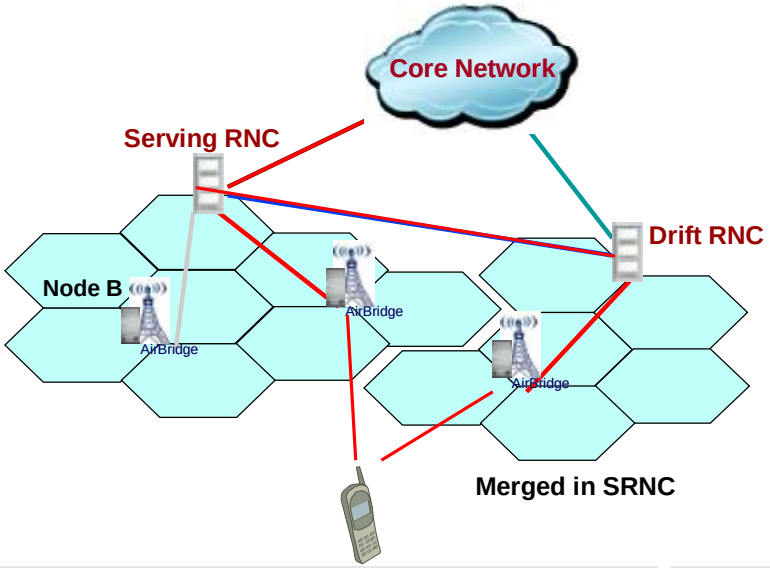
- It is softer handover. During the handover, the cells in active set are belong to one NodeB. The NodeB uses the RAKE receiver to combine the data, and the UE also combines the data in RAKE receiver.

Soft Handover Flow



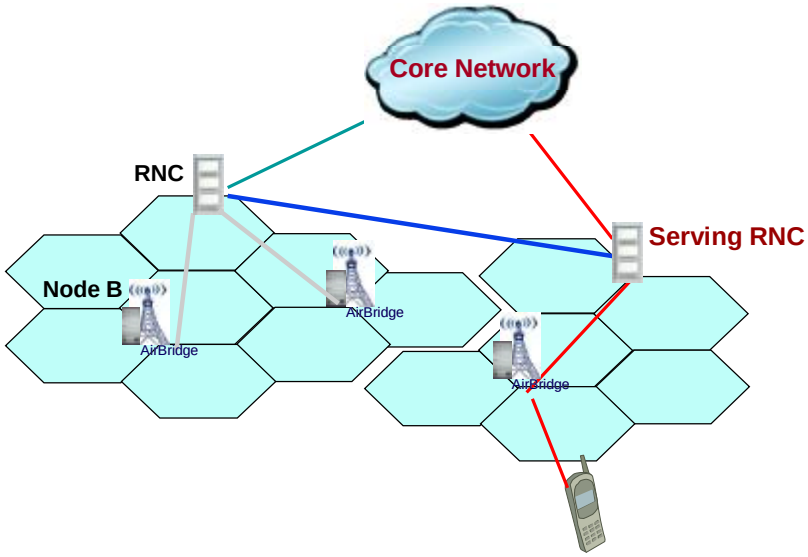
- It is soft handover. During the handover, the cells in active set are belong to one RNC, but different NodeBs. So the UE can combine the data in RAKE receiver. But in uplink, the data are combined with selection combination in RNC.

Soft Handover Flow (SRNC-DRNC)



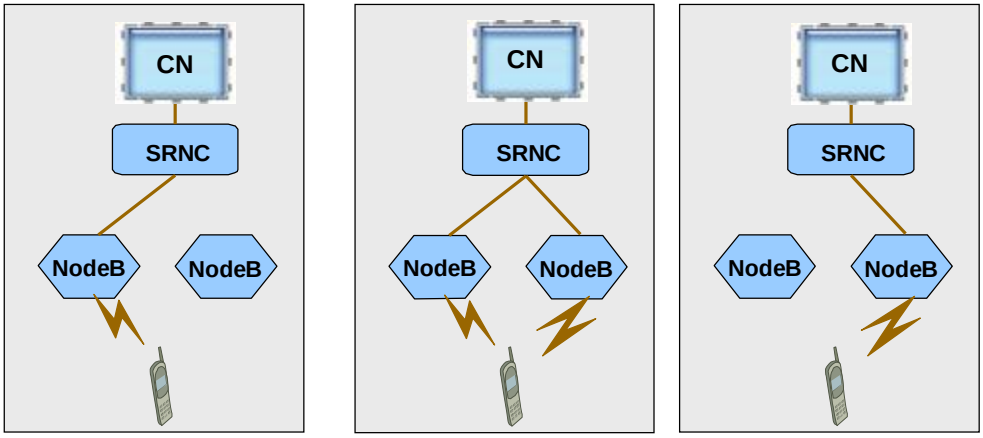
- It is soft handover. During the handover, the cells in active set are belong to different RNCs. So the UE can combine the data in RAKE receiver. But in uplink, the data are combined with selection combination in SRNC.

Soft Handover Flow (SRNC Relocation)



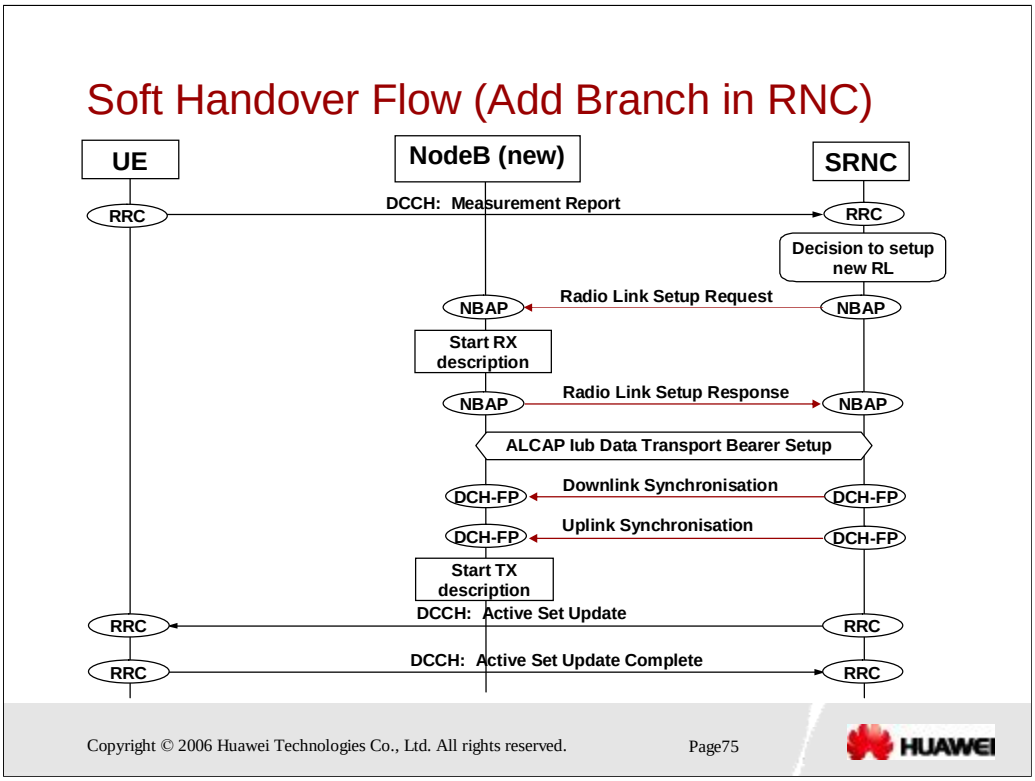
- There is no handover, but the SRNC has been changed.

Soft Handover Flow (Intra-RNC)



Before Handover During Handover After Handover

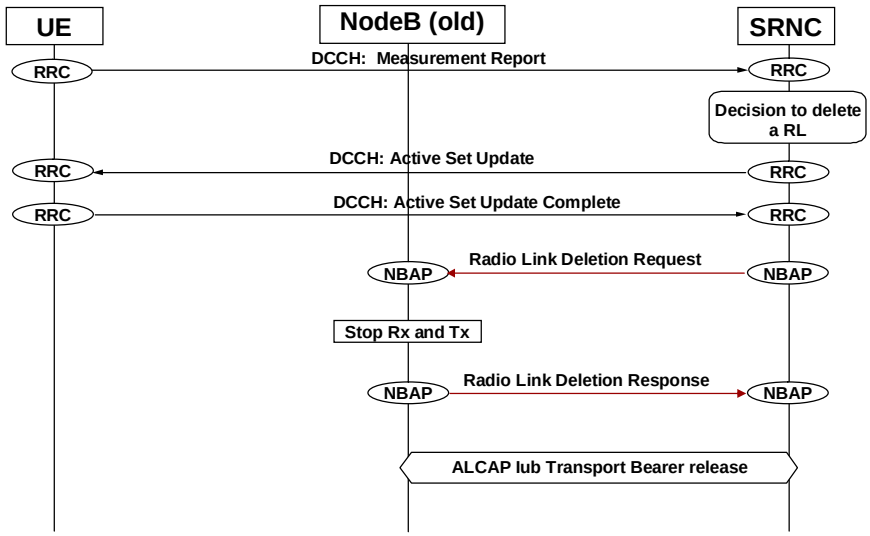
- During the soft handover, two radio links are connected with UE, and data in each RL are same.



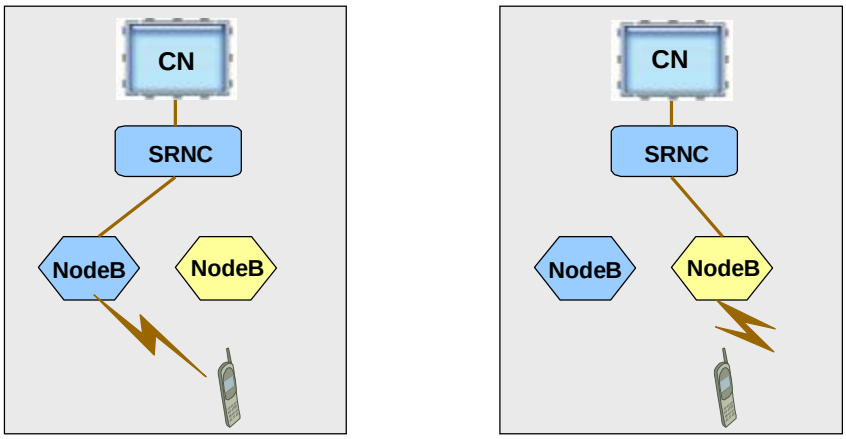
- In the WCDMA system, since the intra-frequency exists among neighboring cells, the UE can communicate with the network via multiple radio links, and can select one with good signal quality by comparison when these radio links are merged, thus optimizing the communication quality. The soft handover can be conducted only in the FDD mode. The soft handover falls into the following cases according to the locations of the cells. The first case is the soft handover among difference cells of the Node B. In this case, the radio links can be merged within the Node B or the SRNC. If they are merged within the Node B, it is called softer handover. The second case is the soft handover among different Node Bs within the same RNC and among different RNCs.
- An important issue during the soft handover is the merge of multiple radio links. In the WCDMA system, the MACRO DIVERSITY technology is adopted for the merge of the radio links, that is, the system compares the data from different radio links based on certain standards (such as BER), and selects the data with better quality to send to the upper layer.

- The following are some key concepts about the neighboring cell in the soft handover:
  1. ***Active set***: The set of cells currently used by the UE. The execution result of the soft handover indicates the increase or decrease of the cells in the active set.
  2. ***monitor set***: The set of cells that are not in the active set but are being observed by the UE based on the neighboring cell information from the UTRAN. The UE measures the cells in the observation set. When the measurement results satisfy certain conditions, the cells may be added to the active set. Therefore, the observation set sometimes is also called the candidate set.
  3. ***Detected set:*** The set of cells that have been detected by the UE but do not belong to the active set or the observation set. The UTRAN can request the UE to report the measurement result of the detected set. Since the cells in the detected set are not listed in the neighboring cell list, this set is also called the unlisted set.
- The soft handover procedure comprises the following steps:
  1. Based on the measurement control information from the RNC, the UE measures the intra-frequency neighboring cells, and reports the measurement result to the RNC after processing.
  2. The RNC compares the reported measurement result with the set threshold to decide the cells to be added and deleted.
  3. If some cells are to be added, the RNC notifies the Node B to get ready.
  4. The RNC notifies the UE to add and/or delete cells via the active set update message.
  5. After the UE successfully update the active set, if the cells are deleted, the Node B will be notified to release the corresponding resources.
- The original communication is not affected during the soft handover procedure so that smooth handover from a cell to another can be successfully completed.

Soft Handover Flow (Del Branch in RNC)



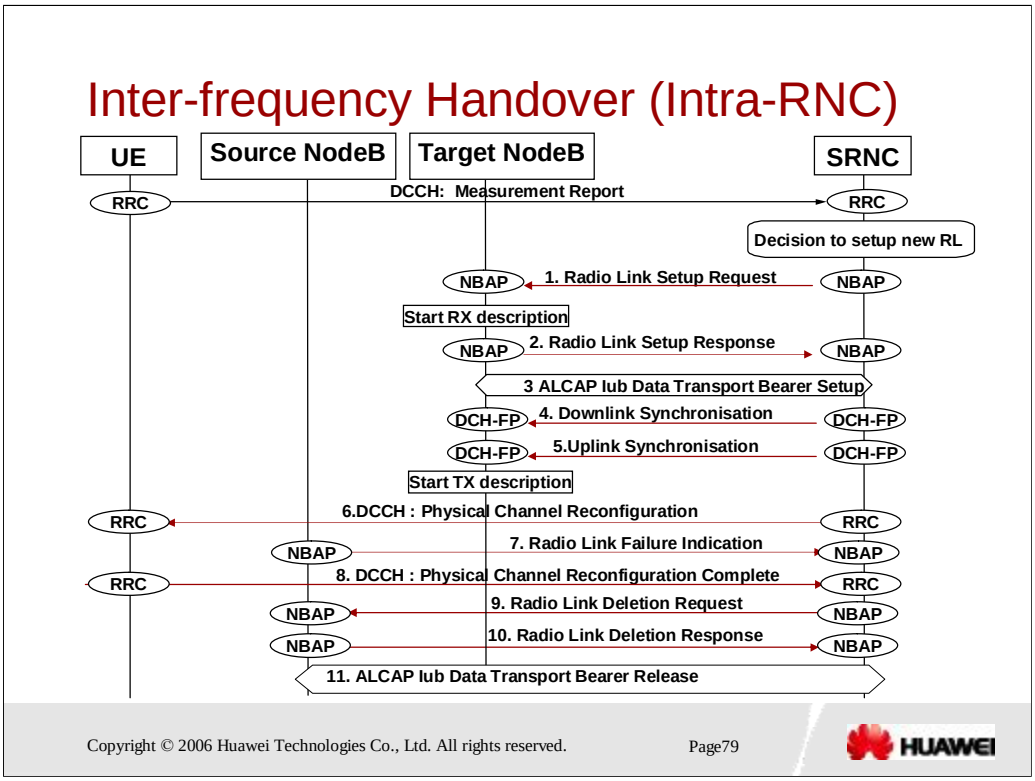
Inter-frequency Handover (Intra-RNC)



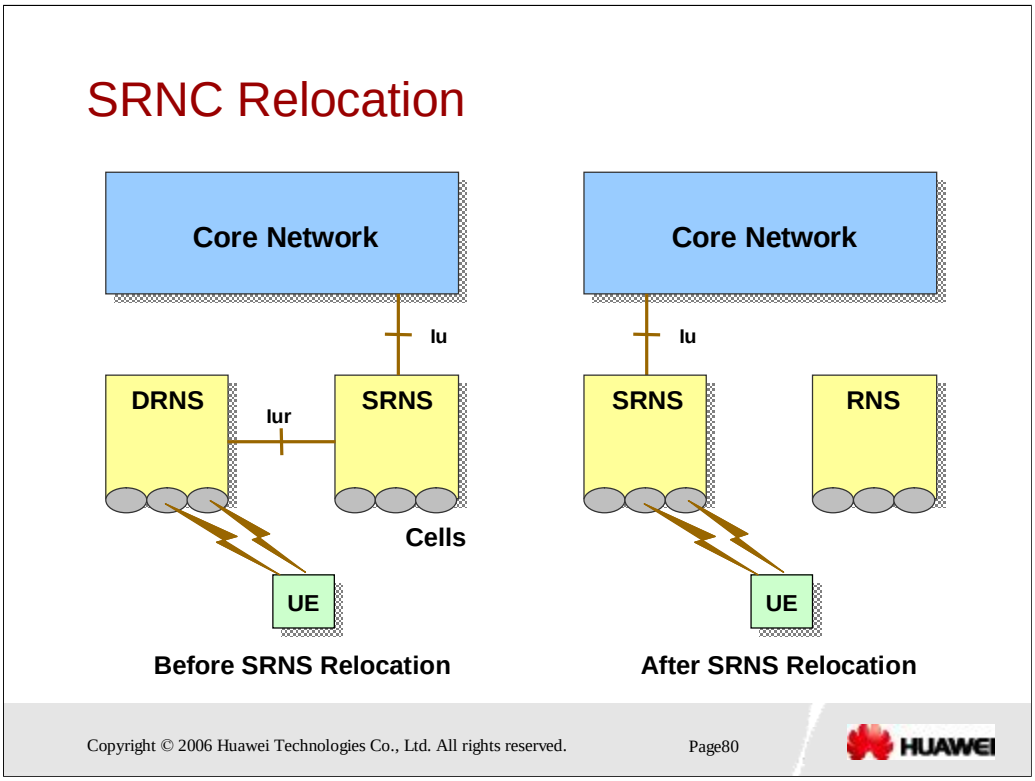
Before Handover **After Handover**

Radio Link can not exist simultaneously

- It is hard handover. The UE disconnects the original radio link, then connects to the target cell. It happens in intra-frequency, inter-frequency and inter-RAT.

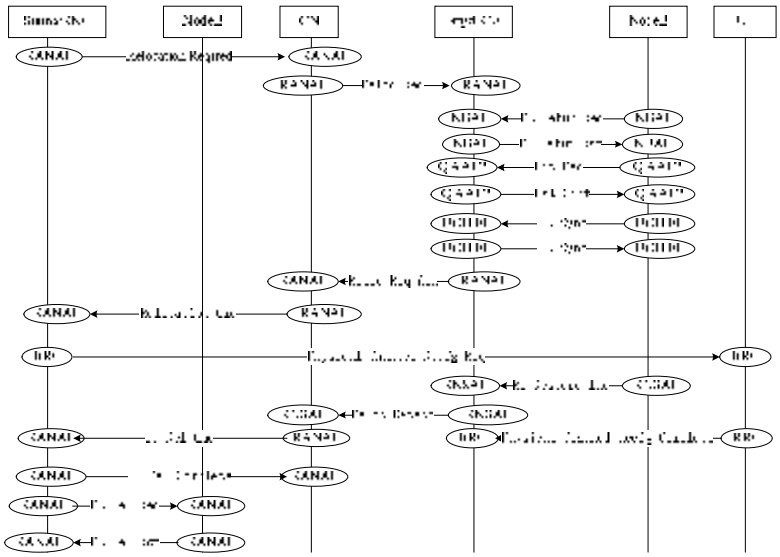


- Description:
  - Step 1 to step 5 is similar with soft handover, the differences are:
  - The SRNC sends the Physical Channel Reconfiguration message carrying the target cell information to the UE via the downlink DCCH.
  - After the UE hands over from the source cell to the target cell, the Node B of the source cell detects the radio link communication failure and then sends the Radio Link Failure Indication message to the SRNC, indicating the radio link failure.
  - After successfully handing over to the target cell, the UE sends the Physical Channel Reconfiguration Complete message to the SRNC via the DCCH, notifying the SRNC that the physical cannel reconfiguration is complete.
  - The Node B where the source cell is deletes the radio link resources, and then responds to the SRNC with the Radio Link Deletion Response message.
  - The SRNC adopts the ALCAP protocol to release the Iub interface transport bearer of the SRNC and the Node B where the source cell is.



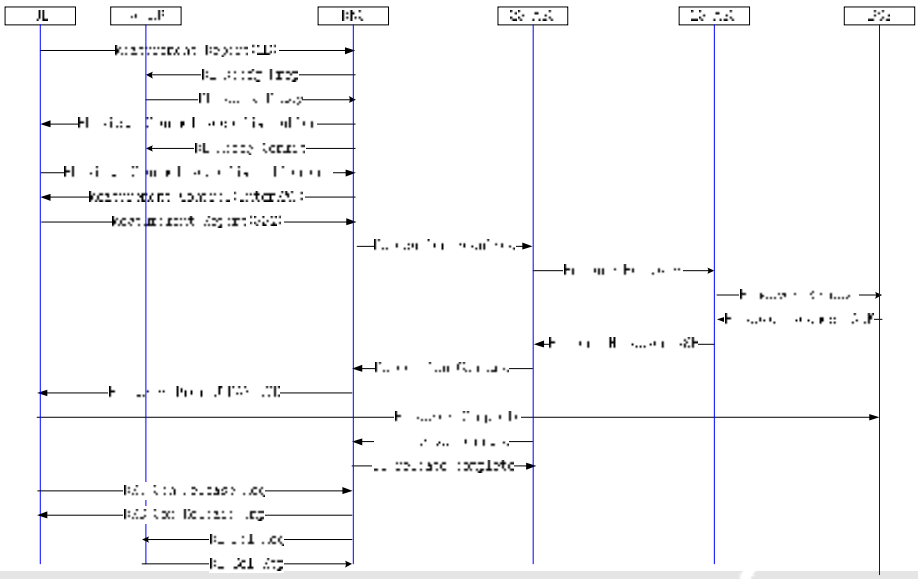
- The RNC relocation refers to that the SRNC of the UE changes from one RNC to another RNC. It is divided into two cases based on the UE location at the time of relocation: Static relocation and associated relocation, or in other words, UE Not Involved and UE Involved.
- The precondition for the static relocation is that the UE accesses the network from one and only one DRNC. Since the relocation procedure does not require the UE's participation, it is also called the UE Not Involved relocation. The following is an example of two radio links. After the relocation, the original DRNC becomes the SRNC, the Iur interface connection is released, and the Iu interface migrates
- Associated relocation refers to that the UE accesses the target RNC from the SRNC via hard handover, and the Iu interface changes at the same time. Since the relocation procedure requires the UE's participation, it is also called the UE Involved relocation.

Handover with SRNC Relocation

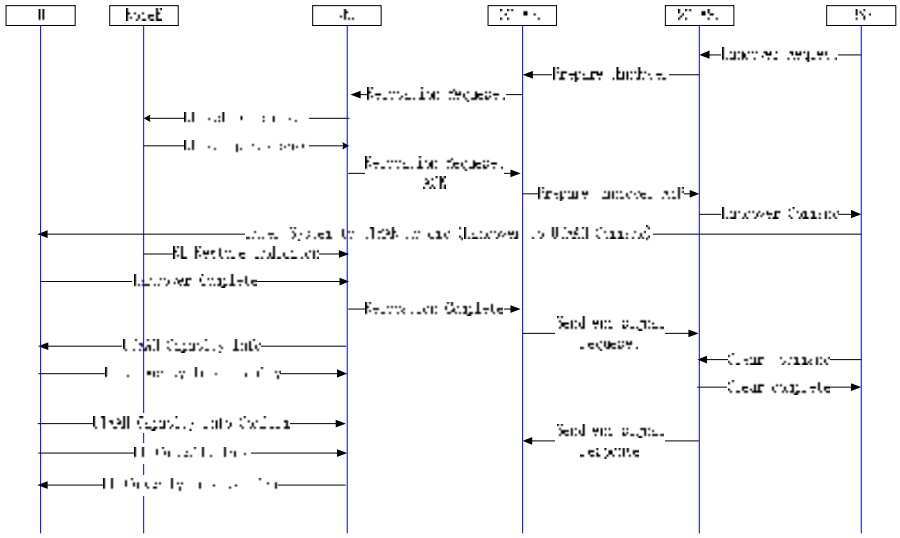


- Associated relocation refers to that the UE accesses the target RNC from the SRNC via hard handover, and the Iu interface changes at the same time. Since the relocation procedure requires the UE's participation, it is also called the UE Involved relocation.

Inter-System Handover Flow (UMTS->GSM)



Inter-System Handover Flow (GSM->UMTS)



Thank you

www.huawei.com