WCDMA UTRAN Interface and Signaling Procedure

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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

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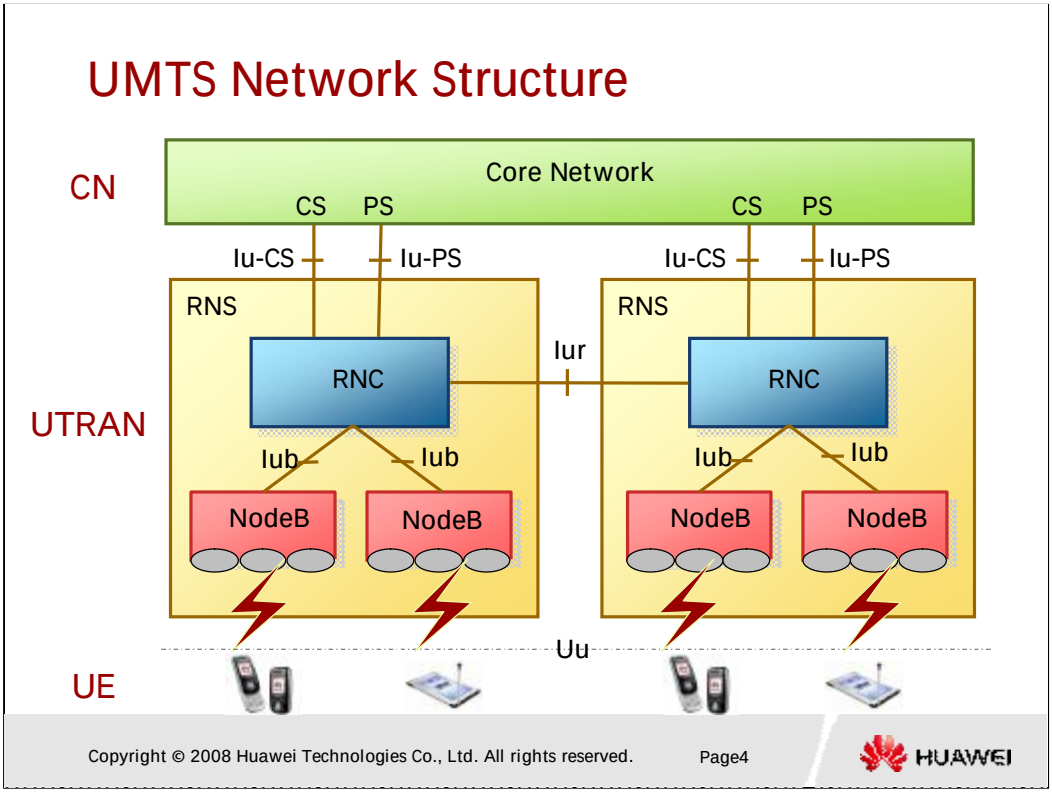
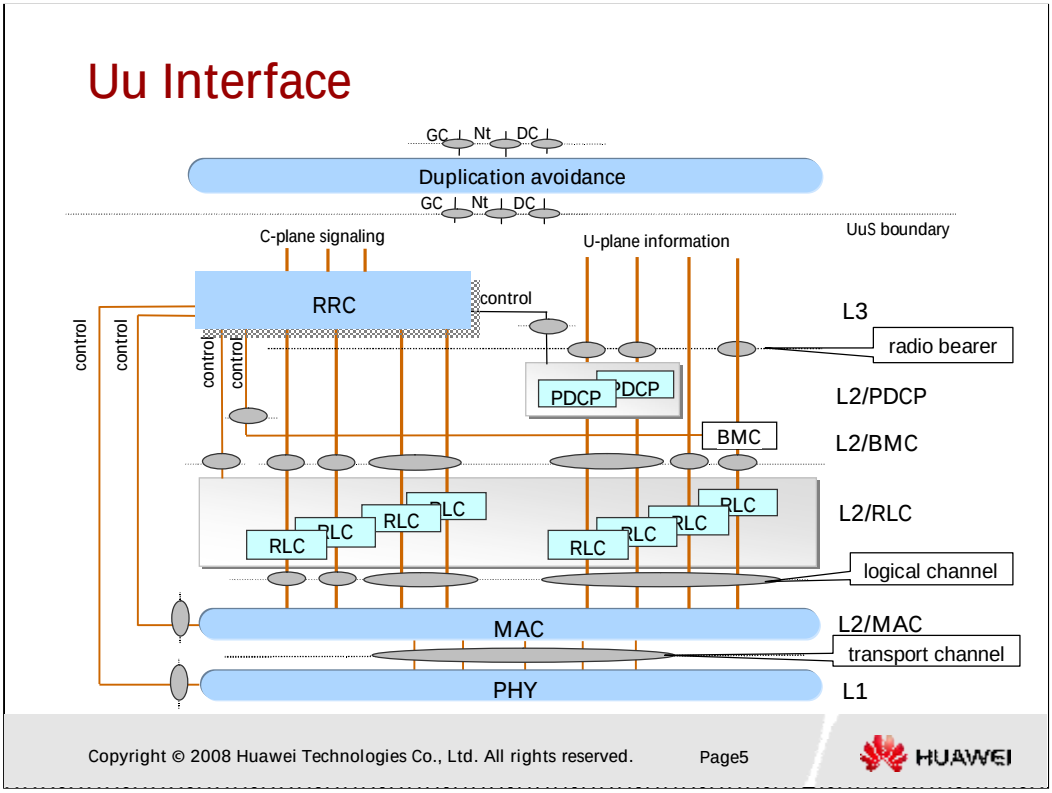


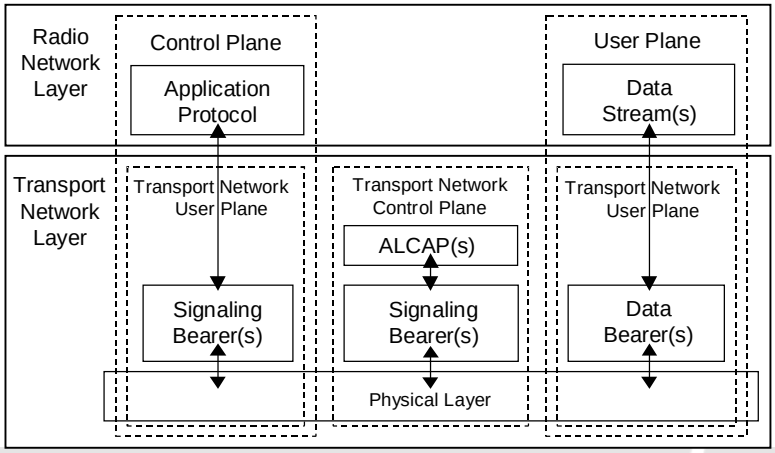
- UTRAN (UMTS Terrestrial Radio Access network) structure
  - The UTRAN consists of one or several Radio Network Subsystem (RNS), each containing one RNC and one or several NodeB
- *Interface*
  - Iu interface: the Iu interface connects the UTRAN to the CN and is split in two parts. The Iu-CS is the 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 NodeB 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.

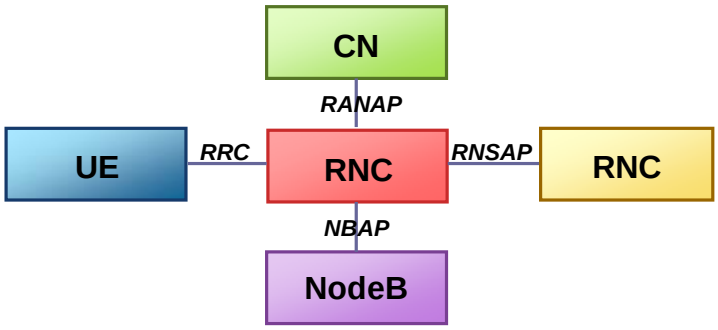


- Protocol structures in UTRAN terrestrial interfaces are designed according to the same general protocol model. This model is shown in above slide. The structure is based on the principle that the layers and planes are logically independent of each other and, if needed, parts of the protocol structure 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 signaling. It includes the Application Protocol (i.e. RANAP in Iu, RNSAP in Iur and NBAP in Iub), and the Signaling 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 Signaling Bearer for the Application Protocol may or may not be of the same type as the Signaling 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 signaling 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 Signaling 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.

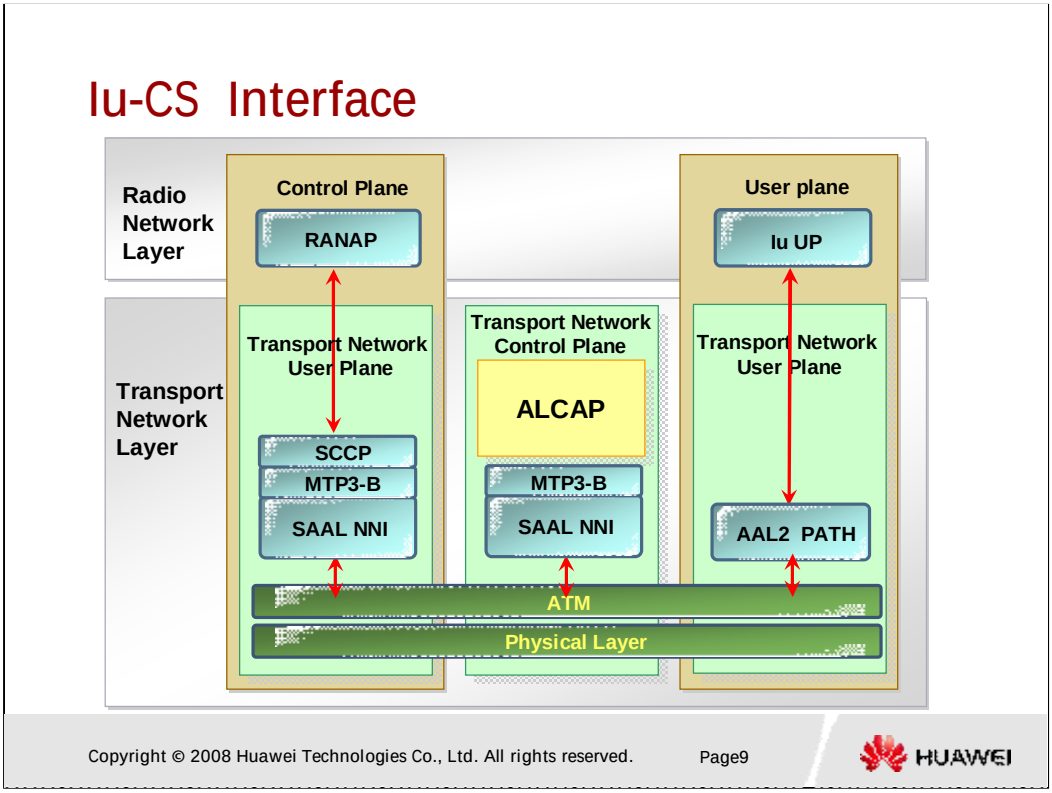
- *About AAl2 and AAL5*
  - Above the ATM layer we usually find an ATM adaptation layer (AAL). Its function is to process the data from higher layers for ATM transmission.
  - This means segmenting the data into 48-byte chunks and reassembling the original data frames on the receiving side. There are 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

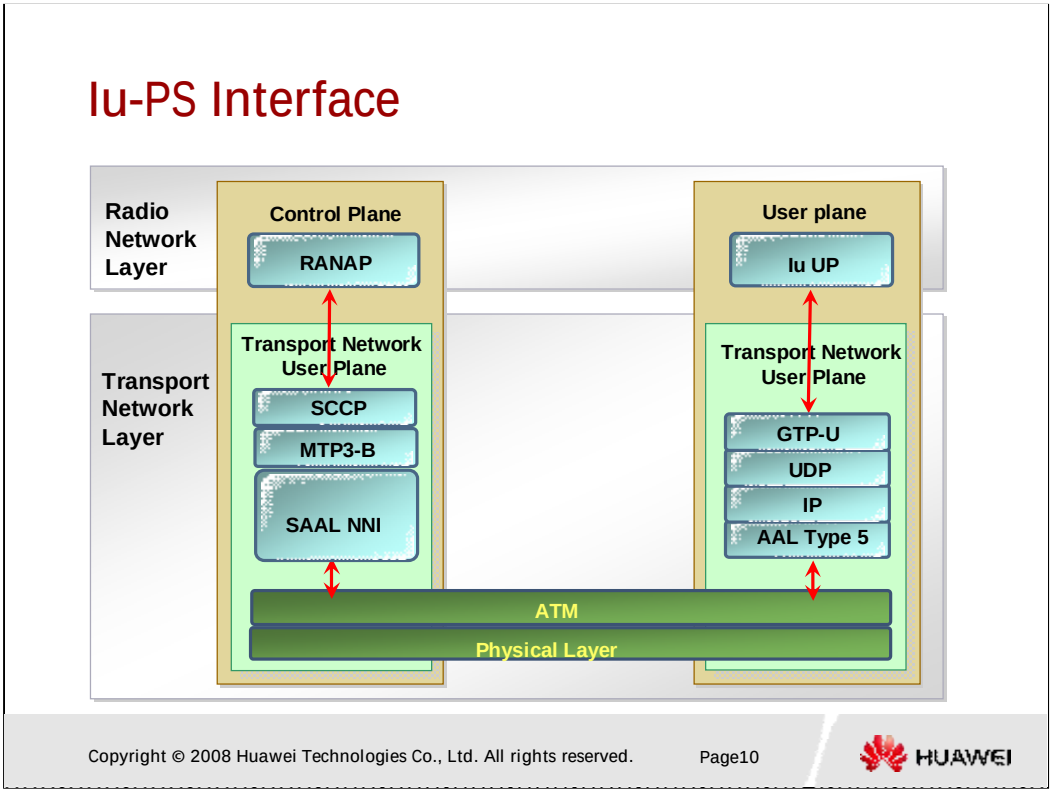


NBAP	Node B Application Part
RANAP	Radio Access Network Application Part
RNSAP	Radio Network Subsystem Application Part
RRC	Radio Resource Control

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

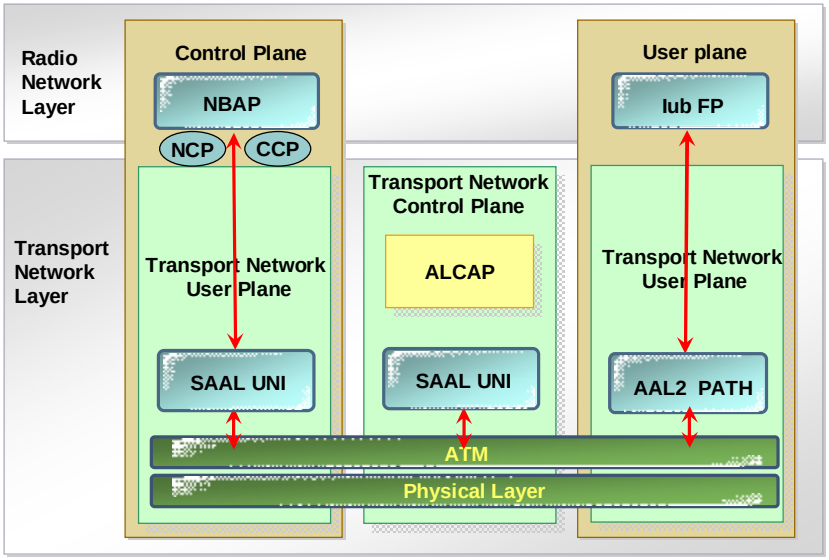


- Protocol Structure for Iu CS
  - The Iu CS overall protocol structure is depicted in above slide. The three planes in the Iu interface share a common ATM (Asynchronous Transfer Mode) transport which is used for all planes. The physical layer is the interface to the physical medium: optical fiber, radio 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 (Signaling System #7) protocols. The applicable layers are the Signaling Connection Control Part (SCCP), the Message Transfer Part (MTP3-b) and SAAL-NNI (Signaling ATM Adaptation Layer for Network to Network Interfaces).
- Iu CS Transport Network Control Plane Protocol Stack
  - The Transport Network Control Plane protocol stack consists of the Signaling 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.

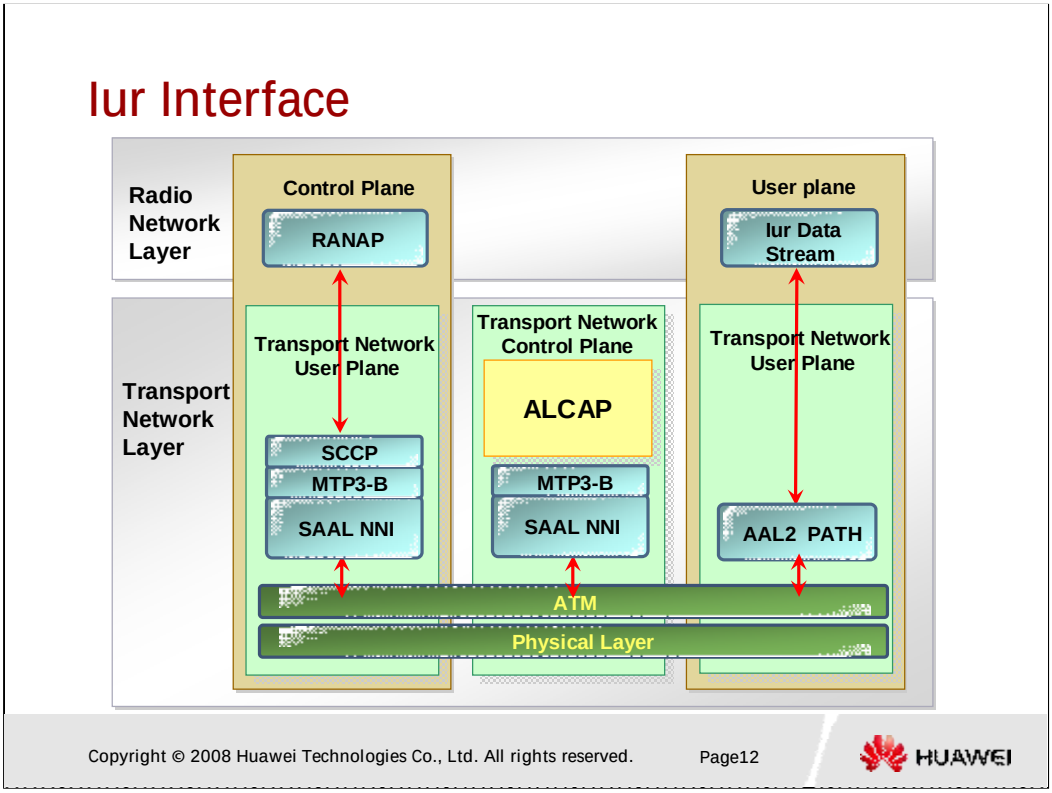


- Protocol Structure for Iu PS
  - The Iu PS protocol structure is represented in above slide. Again, a common ATM transport is applied for both User and Control Plane. Also the physical layer is as specified for Iu CS.
- Iu PS Control Plane Protocol Stack
  - The Control Plane protocol stack consists of RANAP, on top of Broadband (BB) SS7 (Signaling System #7) protocols. The applicable layers are the Signaling Connection Control Part (SCCP), the Message Transfer Part (MTP3-b) and SAAL-NNI (Signaling ATM Adaptation Layer for Network to Network Interfaces).
- 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, CCP and NCP.
- NCP 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
- CCP is used for signaling relating to a specific UE context.
- SAAL is an ATM Adaptation Layer that supports communication between signaling 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 connects two RNCs. The protocol stack for the Iur is shown in above slide.
- The RNSAP protocol is the signaling protocol defined for the Iur interface.

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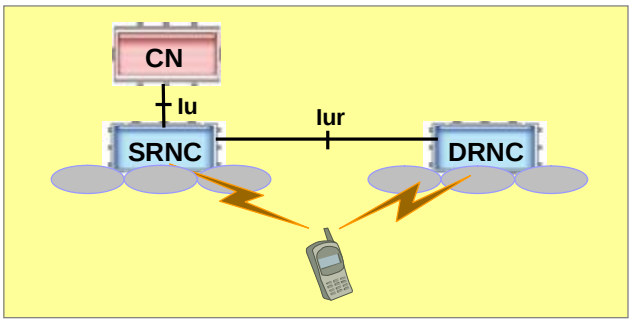
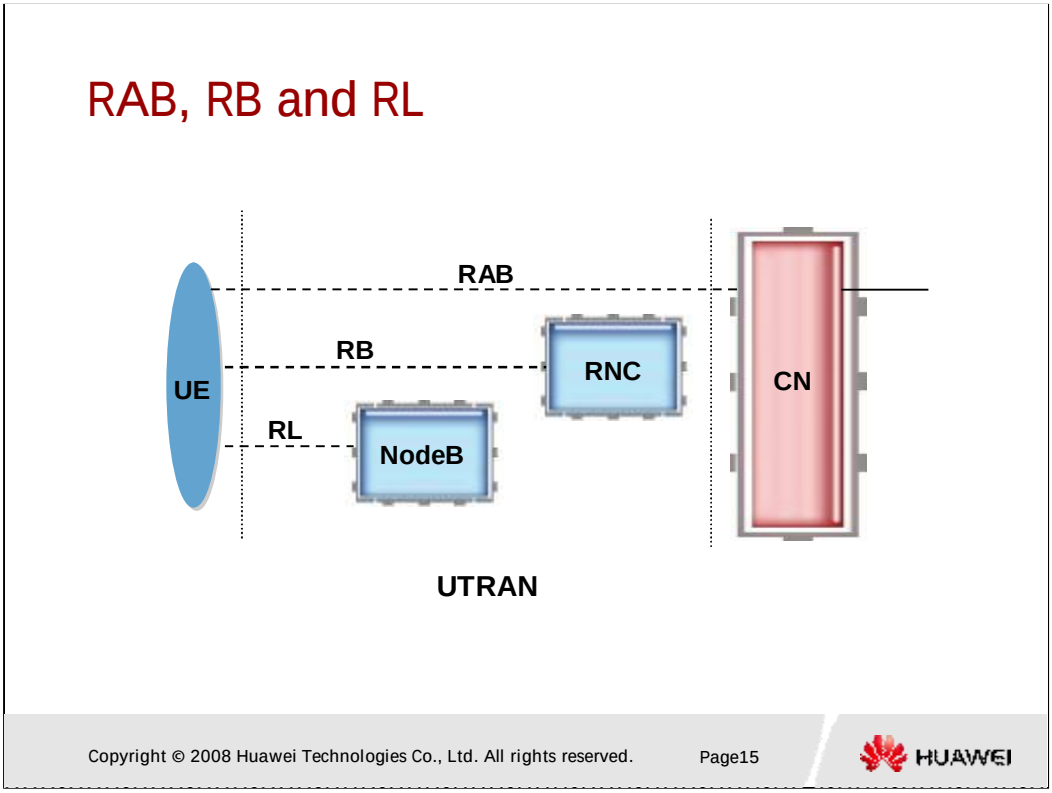
SRNC / DRNC



- 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.



- 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

- If RRC connection does not exit between UE and RNC, then the UE is in idle mode.
- If RRC connection exits between UE and RNC, then the UE is in connected mode.
- Based on UE mobility and activity UE in connected mode may be allocated to four different states: CELL_DCH, CELL_FACH, CELL_PCH and URA_PCH.
- The UE leaves the connected mode and returns to idle mode when the RRC connection is released or at RRC connection failure.

Idle Mode

- The UE has no relation to UTRAN, only to CN. For data transfer, a signaling connection has to be established.
- UE camps on a cell
  - It enables the UE to receive system information from the PLMN
  - UE can monitor PICH of a cell for paging
- 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 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
  - The UE position can be known on different levels:
    - Cell level (CELL_DCH/CELL_FACH/CELL_PCH)
    - UTRAN Registration Area (URA) level (URA_PCH)
  - The UE can use different types of channels in connected mode
    - Dedicated transport channels (CELL_DCH)
    - Common transport channels (CELL_FACH)

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- 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.
- Which type of transport channel is used by UE in connected mode is decided by RNC according to the UE activity.

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 needs to monitor the FACH for its information
  - UTRAN knows which cell the 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

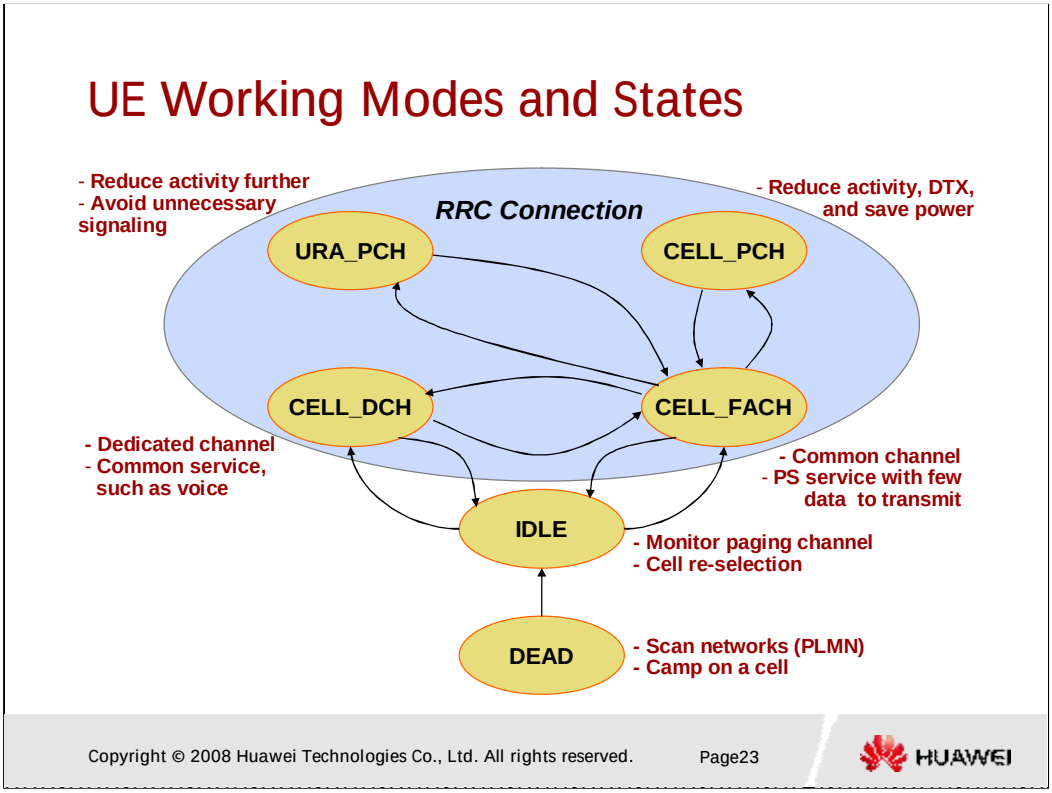
- Cell-PCH
  - No data to be transmitted or received
  - Monitor PICH, to receive its paging
  - UTRAN knows which cell the UE stays in
  - UTRAN has to update cell information of UE when UE roams to another cell
  - Lower the power consumption of UE

- 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 (which consists of multiple cells) that UE stays
  - 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.

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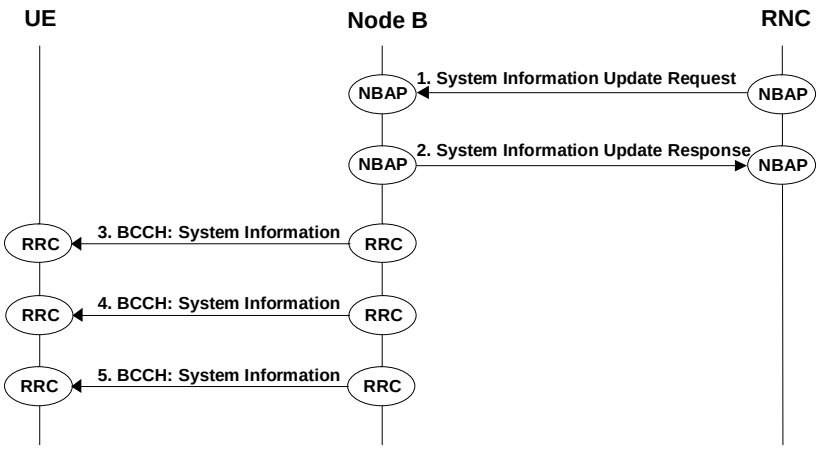
System Information Broadcast Flow



Introduction of System Information

- MIB:
  - PLMN tag
  - Scheduling information for SB (Scheduling Block)
  - Scheduling information for SIB (System Information 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*

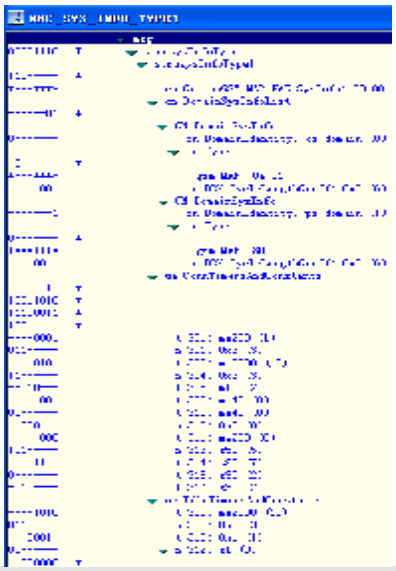
Introduction of System Information

- 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

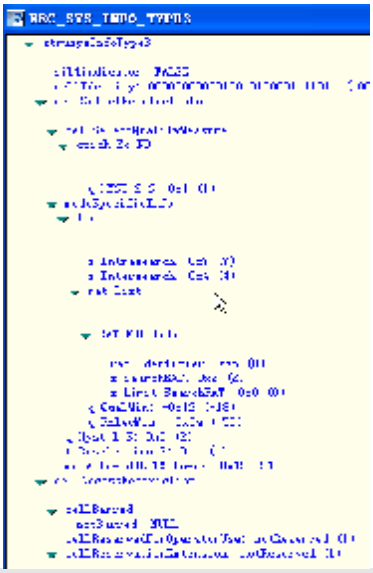


- System information type 1
  - The NAS system information
  - CS domain DRX: K=6, then DRX period is 2^k= 2^6= 64TTI=640 ms
  - PS domain DRX: K=6, then DRX period is 2^k=2^6=64TTI =640 ms

System Information Block Type 2

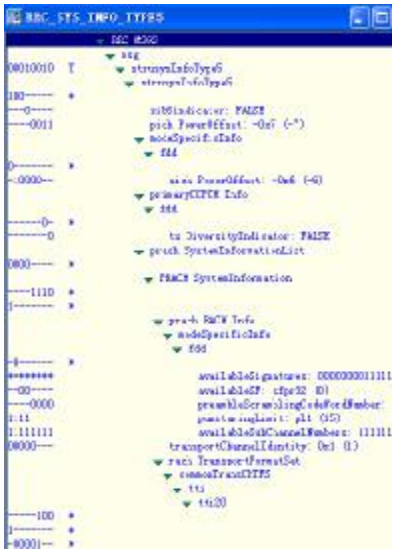
- System info type 2
  - URA information

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

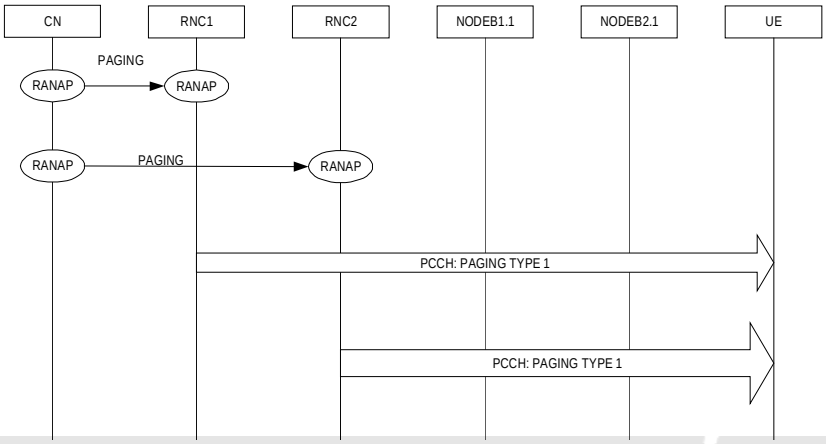
Paging Initiation

- CN initiated paging
  - Establish a signaling connection
- UTRAN initiated paging
  - Trigger the cell update procedure
  - Trigger reading of updated system information

- For CN originated paging:
  - In order to request UTRAN connect to UE, CN initiates the paging procedure, transmits paging message to the UTRAN through Iu interface, and UTRAN transmits the paging message from CN to UE through the paging procedure on Uu interface, which will make the UE initiate a signaling connection setup process with the CN.
- For UTRAN originated paging:
  - UE state transition: In order to trigger UE in the CELL_PCH or URA_PCH state to carry out state transition (for example, transition to the CELL_FACH state), the UTRAN will perform a paging process. Meanwhile, the UE will initiate a cell update or URA update process, as a reply to the paging.
  - When the cell system message is updated: When system messages change, the UTRAN will trigger paging process in order to inform UE in the idle, CELL_PCH or URA_PCH state to carry out the system message update, so that the UE can read the updated system message.

Paging Type 1

- If UE is in CELL_PCH,URA_PCH or IDLE state， the paging message will be transmitted on PCCH with paging type 1



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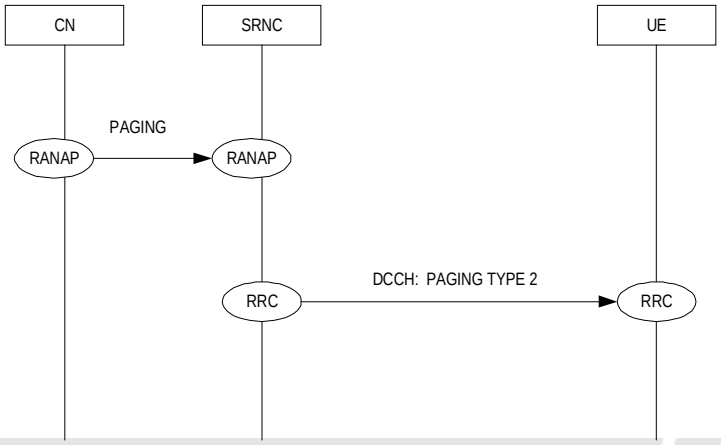
- Paging type 1:
  - The message is transmitted in one LA or RA according to LAI or RAI.
  - After calculating the paging time, the paging message will be transmitted at that time
  - If UE is in CELL_PCH or URA_PCH state, the UTRAN transmits the paging information in PAGING TYPE 1 message to UE. After received paging message, UE performs a cell update procedure to transit state to CELL_FACH.
- As shown in the above figure, the CN initiates paging in a location area (LA), which is covered by two RNCs. After receiving a paging message, the RNC searches all the cells corresponding to the LAI, and then calculates the paging time, at which it will send the PAGING TYPE 1 message to these cells through the PCCH.

Paging Type 2

- If UE is in CELL_DCH or CELL_FACH state，the paging message will be transmitted on DCCH with paging type 2



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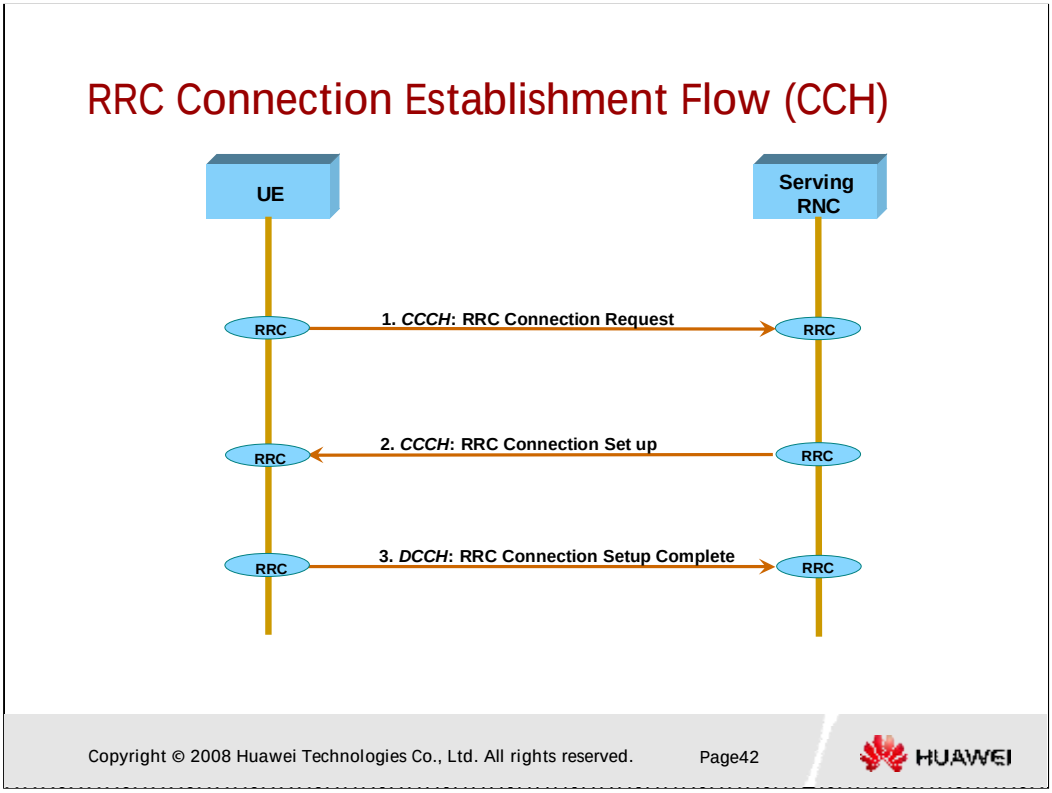
- Paging type 2:
  - If UE is in CELL_DCH or CELL_FACH state，the paging message will be transmitted on DCCH with paging type 2
  - The message will be only transmitted in a cell
- As shown in the above figure, if the UE is in the CELL_-DCH or CELL_FACH state, the UTRAN will immediately transmit PAGING TYPE 2 message to the paged UE on DCCH channel.

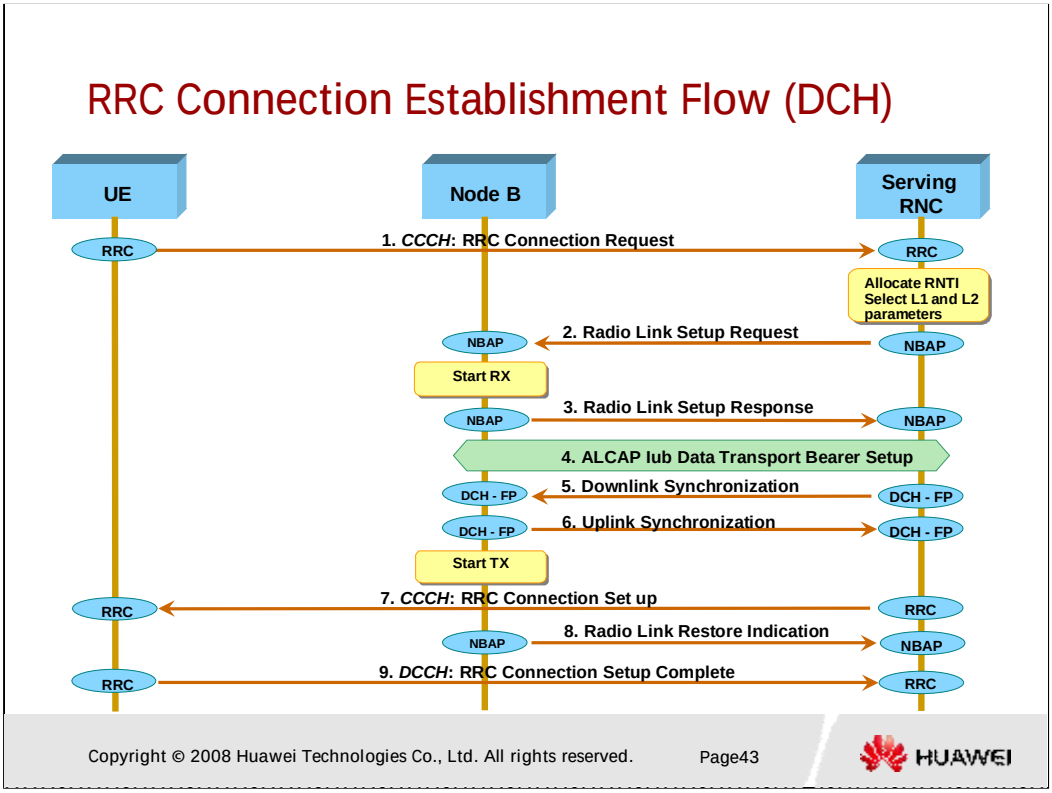
Contents

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



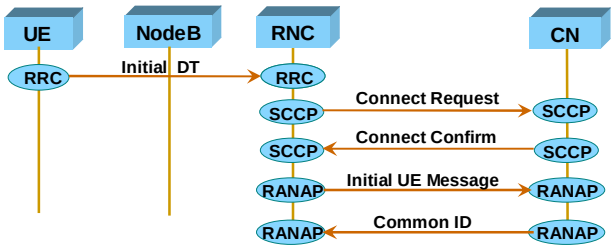
- In the idle mode, when the non-access layer of the UE requests to establish a signaling connection, the UE will initiate the RRC connection procedure. Each UE has up to one RRC connection only.
- When the SRNC receives an RRC CONNECTION REQUEST message from the UE, the Radio Resource Management (RRM) module of the RNC determines whether to accept or reject the RRC connection request according to a specific algorithm. If accepting the request, the RRM module determines whether to set up the RRC connection on a Dedicated Channel (DCH) or on a Common Channel (CCH) according to a specific RRM algorithm.
- Description:
  - The UE sends an RRC CONNECTION REQUEST message to the SRNC through the uplink CCCH, requesting the establishment of an RRC connection.
  - Based on the RRC connection request cause and the system resource state, the SRNC decides to establish the connection on the common channel.
  - The SRNC sends an RRC CONNECTION SETUP message to the UE through the downlink CCCH. The message contains the information about the CCH.
  - The UE sends an RRC CONNECTION SETUP COMPLETE message to the SRNC through the uplink CCCH.



- Typically, an RRC connection is set up on the DCH.
- 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.

ID	Name	Recommended value
ORIGCONVCALLEST	Originating Conversational Call	DCH_13.6K_SIGNALLING
ORIGSTREAMCALLEST	Originating Streaming Call	DCH_13.6K_SIGNALLING
ORIGINTERCALLEST	Originating Interactive Call	DCH_13.6K_SIGNALLING
ORIGBKGCALLEST	Originating Background Call	DCH_13.6K_SIGNALLING
ORIGSUBSTRAFFCALLEST	Originating Subscribed traffic Call	DCH_13.6K_SIGNALLING
TERMCONVCALLEST	Terminating Conversational Call	DCH_13.6K_SIGNALLING
TERMSTREAMCALLEST	Terminating Streaming Call	DCH_13.6K_SIGNALLING
TERMINTERCALLEST	Terminating Interactive Call	DCH_13.6K_SIGNALLING
TERMBKGCALLEST	Terminating Background Call	DCH_13.6K_SIGNALLING
EMERGCALLEST	Emergency Call RRC establish type	DCH_13.6K_SIGNALLING
INTERRATCELLRESELEST	Inter-RAT cell re-selection	DCH_3.4K_SIGNALLING
INTERRATCELLCHGORDEREST	Inter-RAT cell change order	DCH_3.4K_SIGNALLING
REGISTEST	Registration	DCH_13.6K_SIGNALLING
DETACHEST	Detach	FACH
ORIGHIGHPRIORSIGEST	Originating High Priority Signaling	DCH_13.6K_SIGNALLING
ORIGLOWPRIORSIGEST	Originating Low Priority Signaling	FACH
CALLREEST	Call re-establishment	DCH_3.4K_SIGNALLING
TERMHIGHPRIORSIGEST	Terminating High Priority Signaling	DCH_13.6K_SIGNALLING
TERMLOWPRIORSIGEST	Terminating Low Priority Signaling	FACH
TERMCAUSEUNKNOWN	Terminating cause unknown	FACH
DEFAULTEST	Spare RRC establish	DCH_3.4K_SIGNALLING

Direct Transfer Message Flow



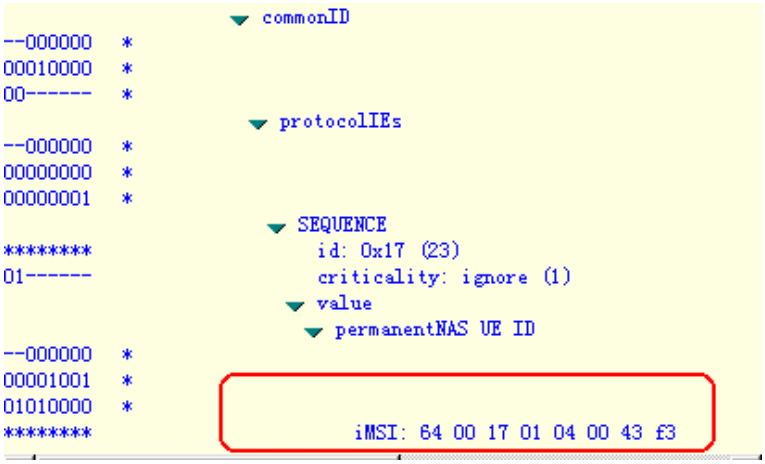
- In Iu interface, radio network layer reports the RANAP information and NAS information. NAS information is taken as directed message in RANAP information.

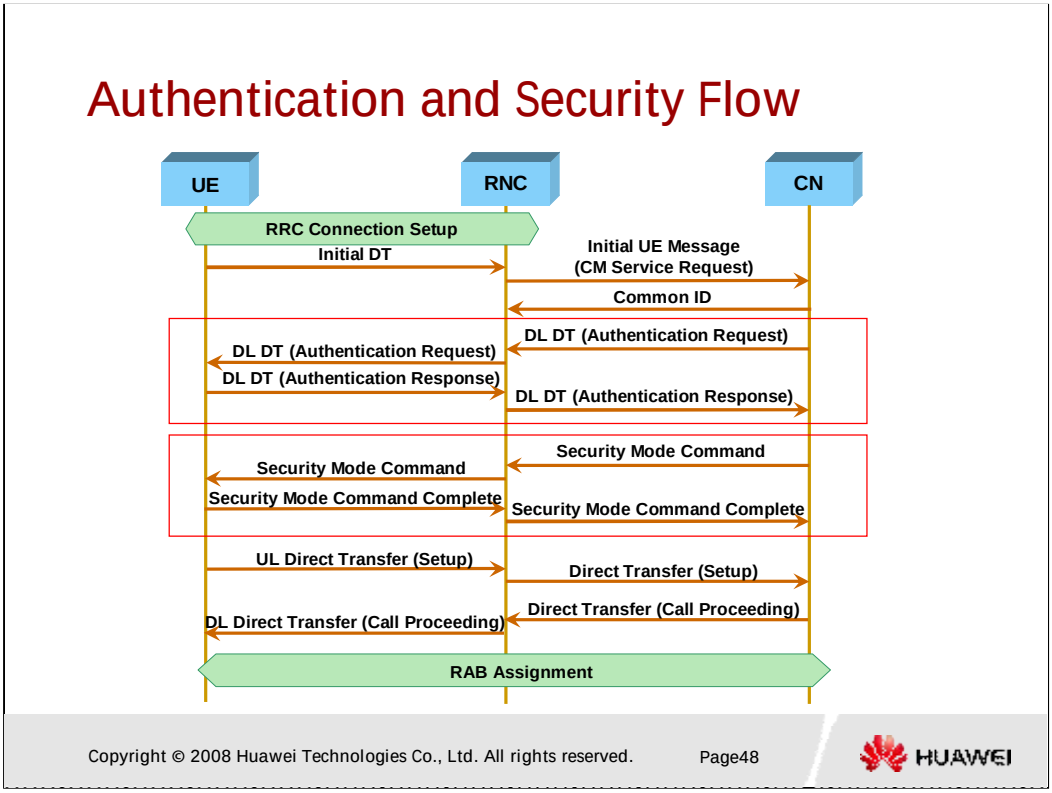
- After the RRC connection between the UE and the UTRAN is successfully set up, the UE sets up a signaling connection with the CN via the RNC for NAS information exchange between the UE and the CN, such as authentication, service request and connection setup. This is also called the NAS signaling setup 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.

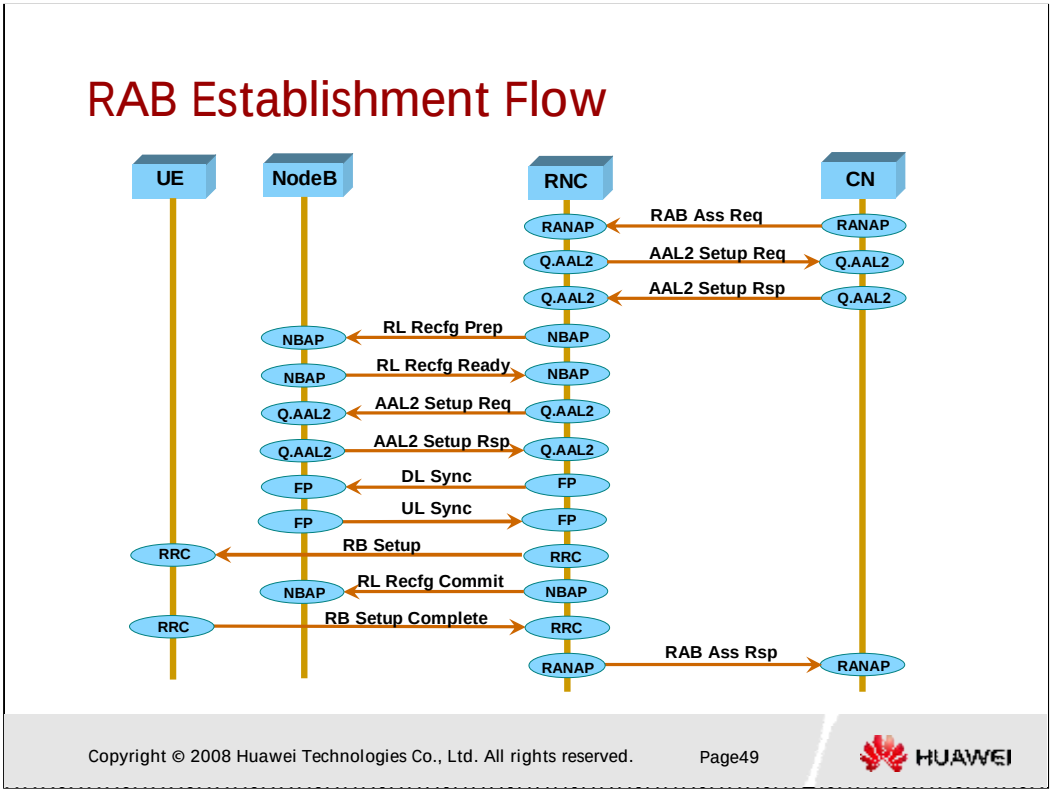
- After the signaling connection is successfully set up, the message sent by the UE to the CN is forwarded to the RNC via the Uplink Direct Transfer message, and the RNC converts it into the Direct Transfer message to send to the CN. The message sent by the CN to the UE is forwarded to the RNC via the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

Common ID

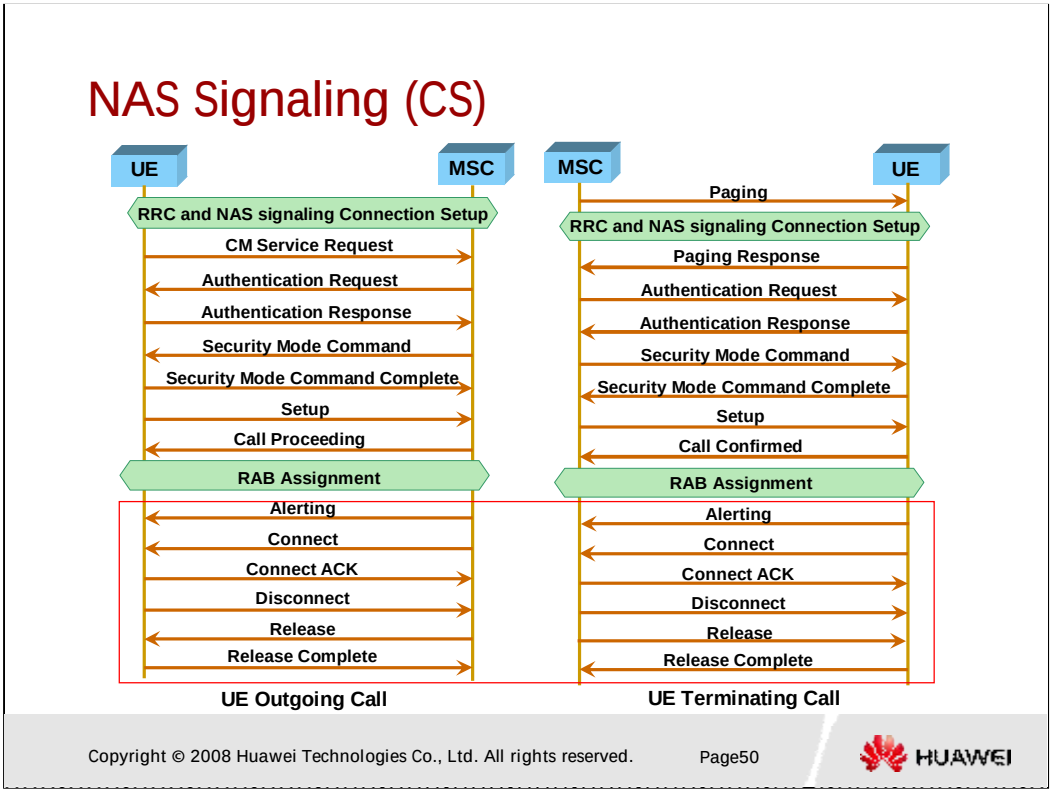




- Authentication is used for the validity of CN and UE.
- Security flow includes the encrypt process and integrity protection.

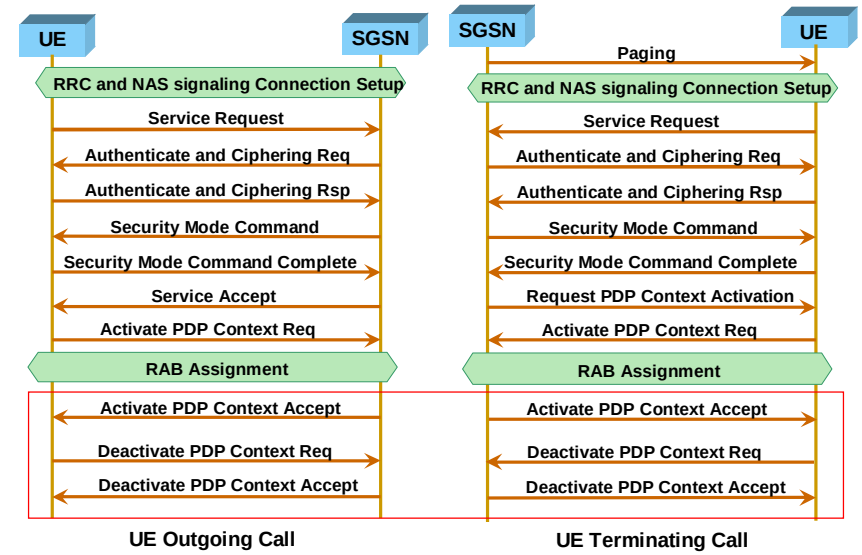


- RAB is the carrier which is provided by AS for NAS.
- RAB is the carrier in user plane, which is for transferring the voice service, data service or multiple media service between UE and CN.
- RAB establishment flow mainly includes the AAL2 PATH establishment of Iu and Iub interface, also includes 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.

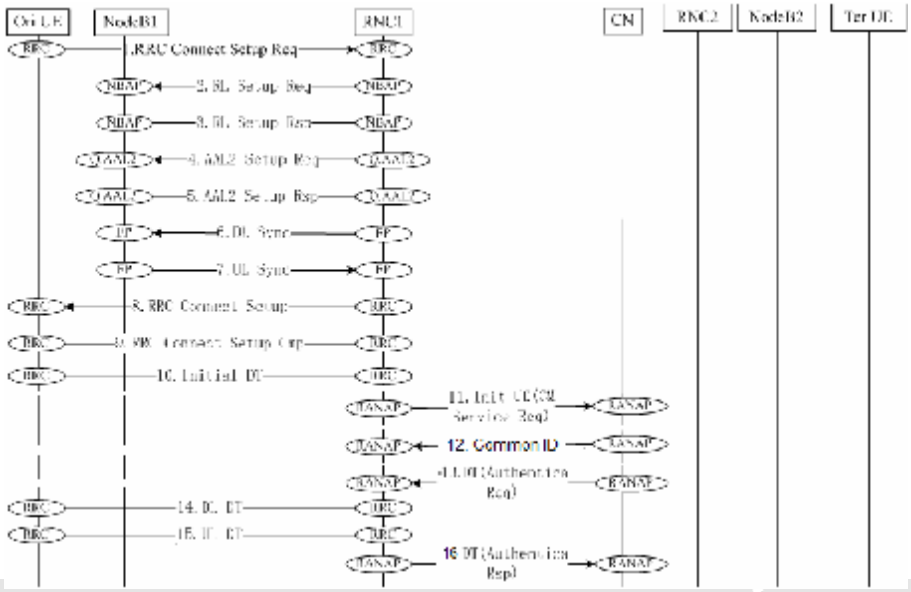


- Authentication and security flow are optional.
- CN does not need to the CM Service Response if the security mode is used.

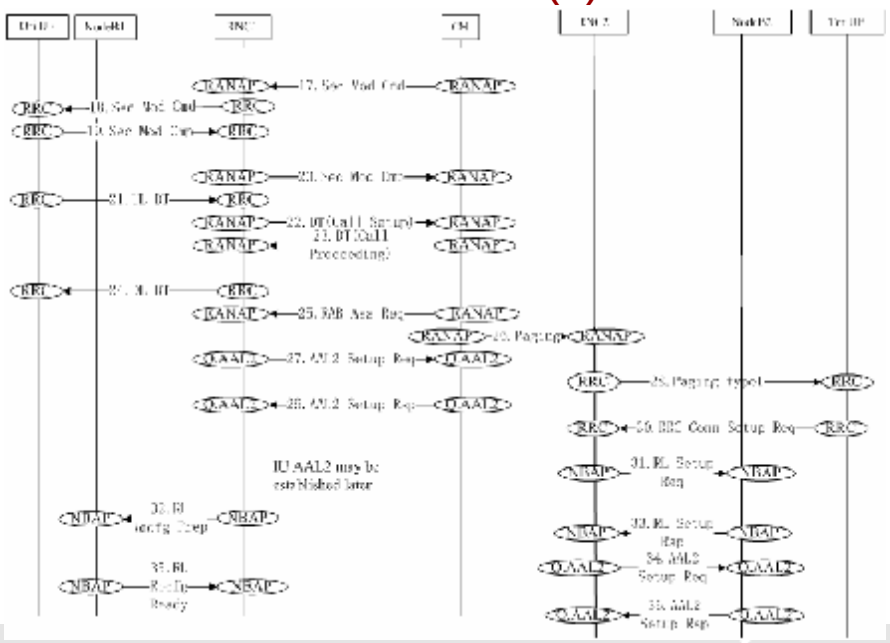
NAS Signaling (PS)



UE to UE CS Call Process (1)

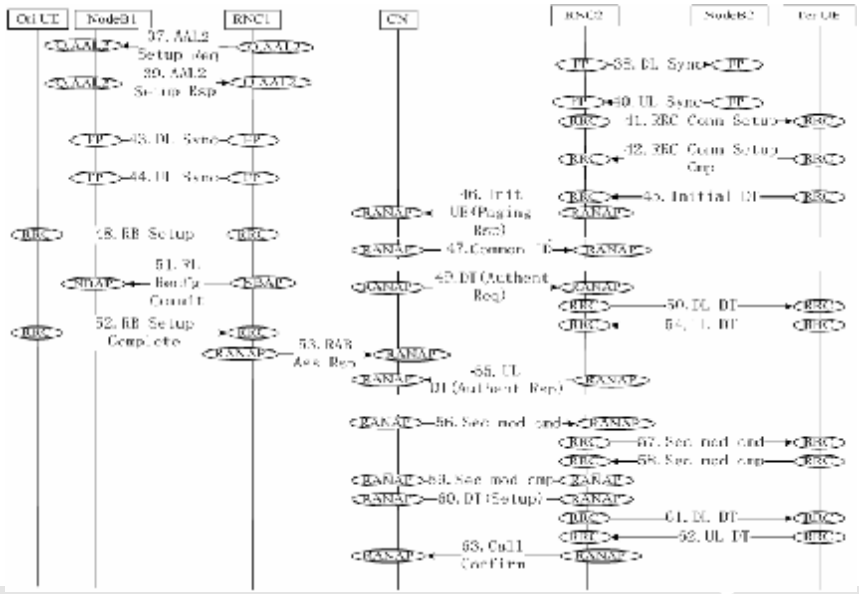


UE to UE CS Call Process (2)

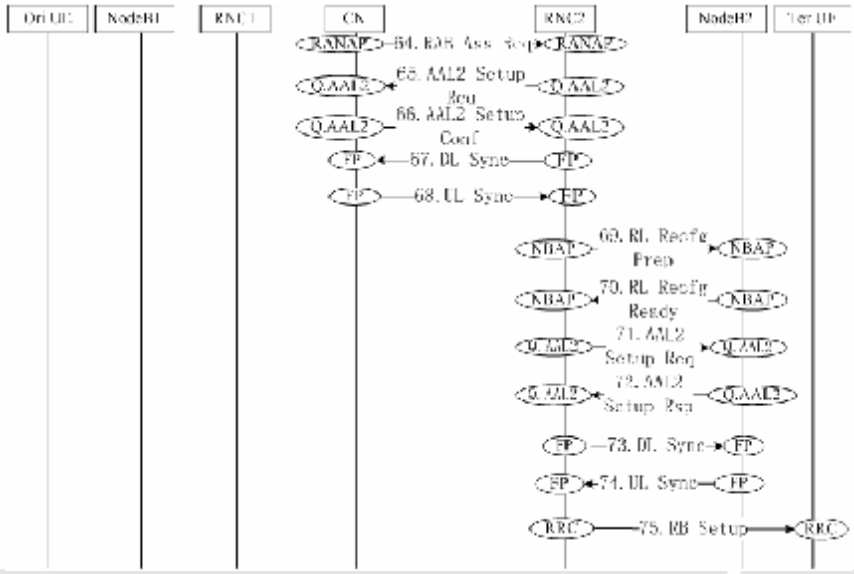


HUAWEI

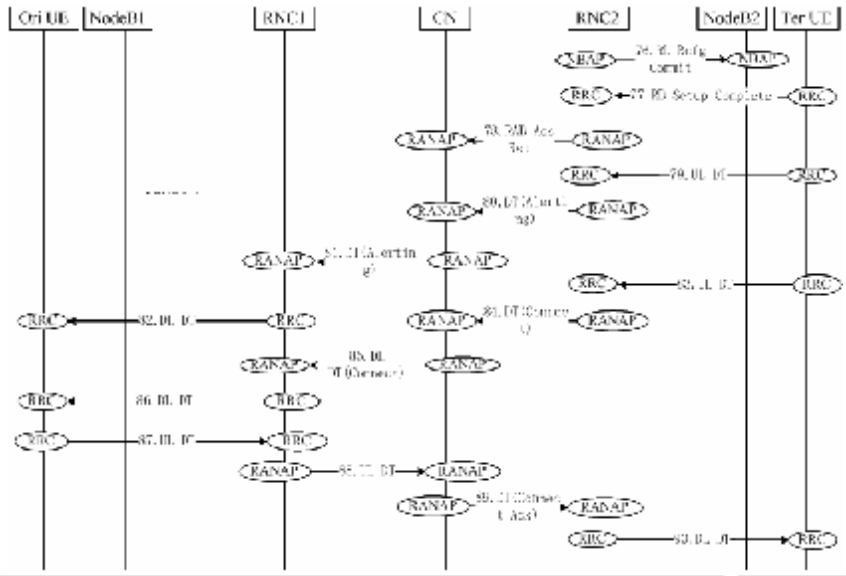
UE to UE CS Call Process (3)



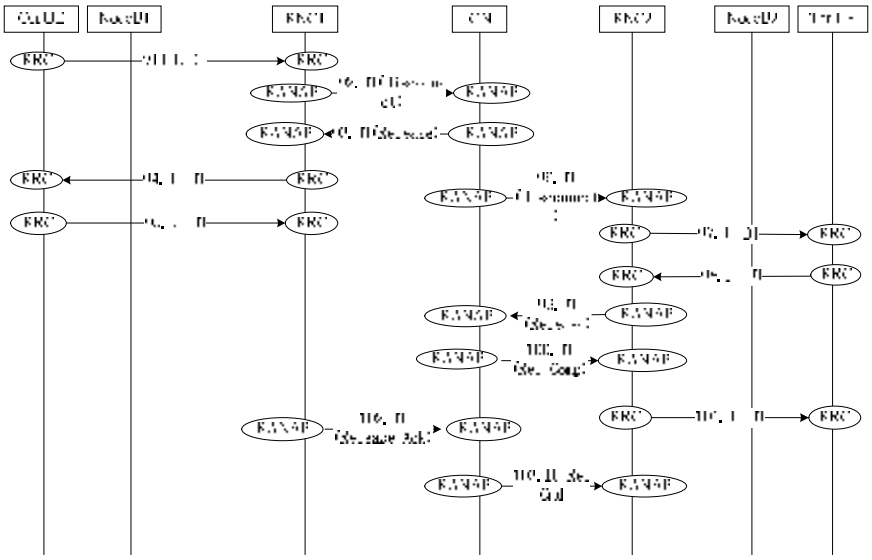
UE to UE CS Call Process (4)



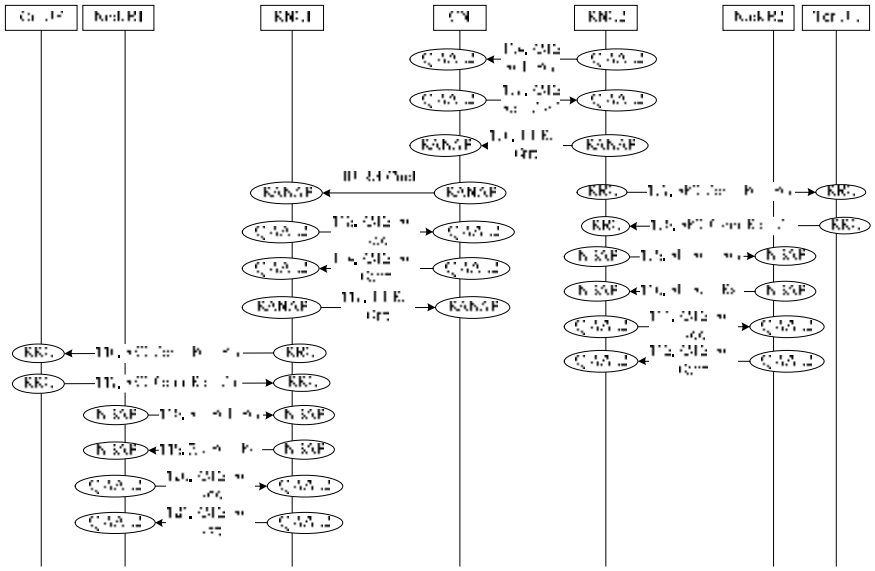
UE to UE CS Call Process (5)



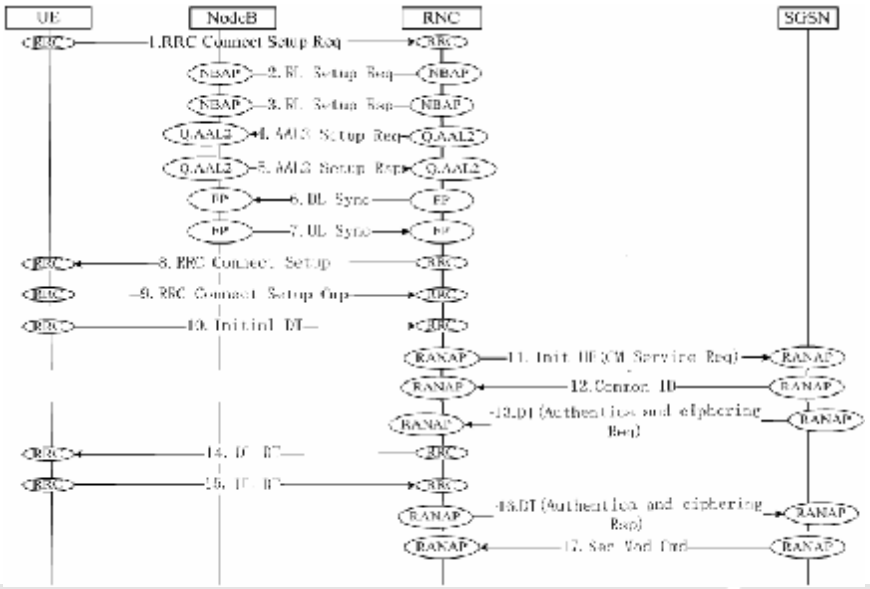
UE to UE CS Call Process (6)



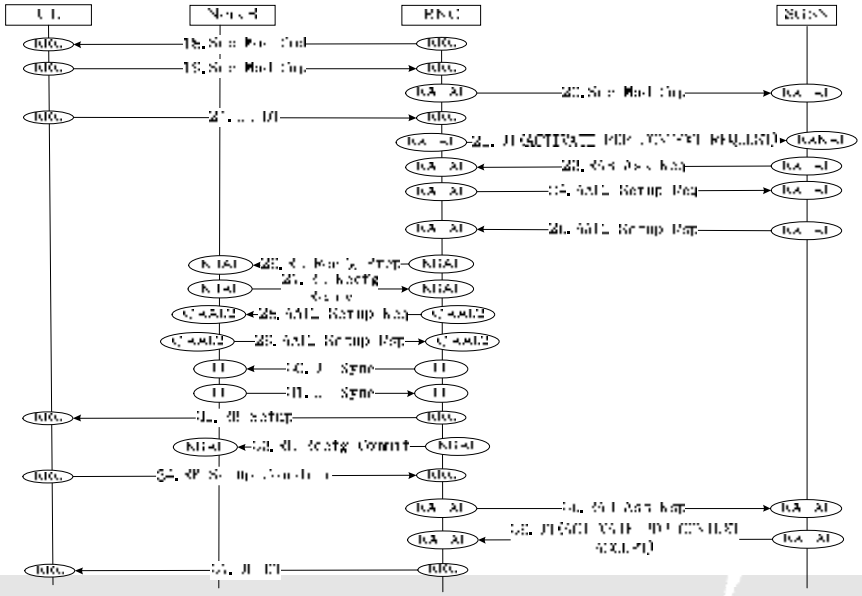
UE to UE CS Call Process (7)



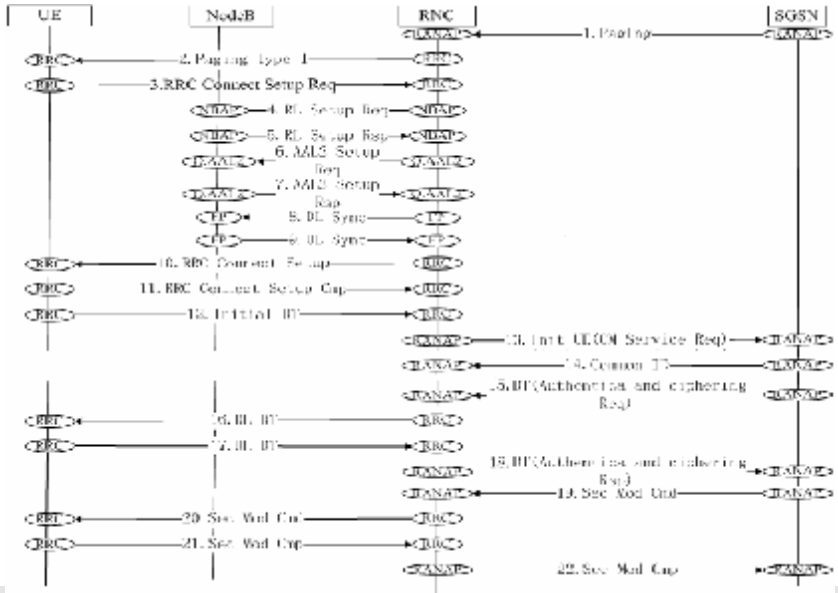
Activate PDP Context from UE (1)



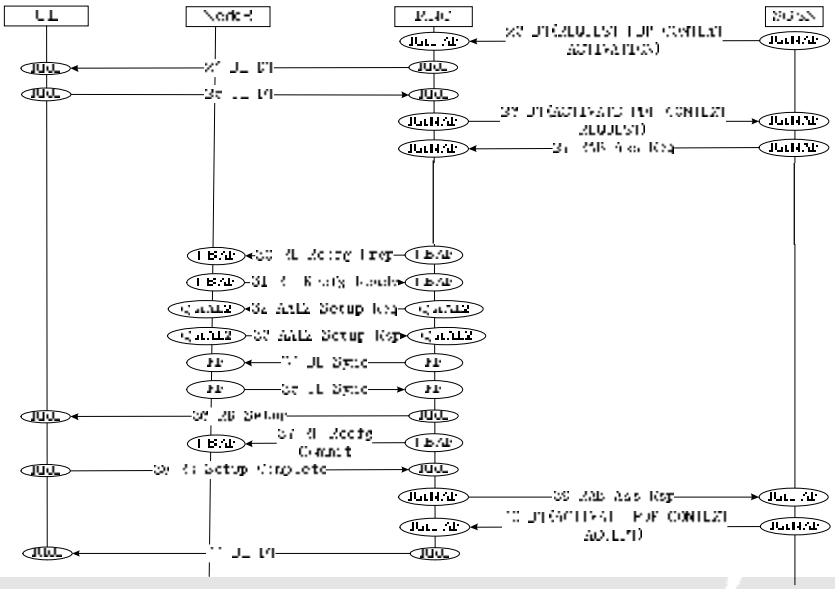
Activate PDP Context from UE (2)



Activate PDP Context from Network (1)



Activate PDP Context from Network (2)

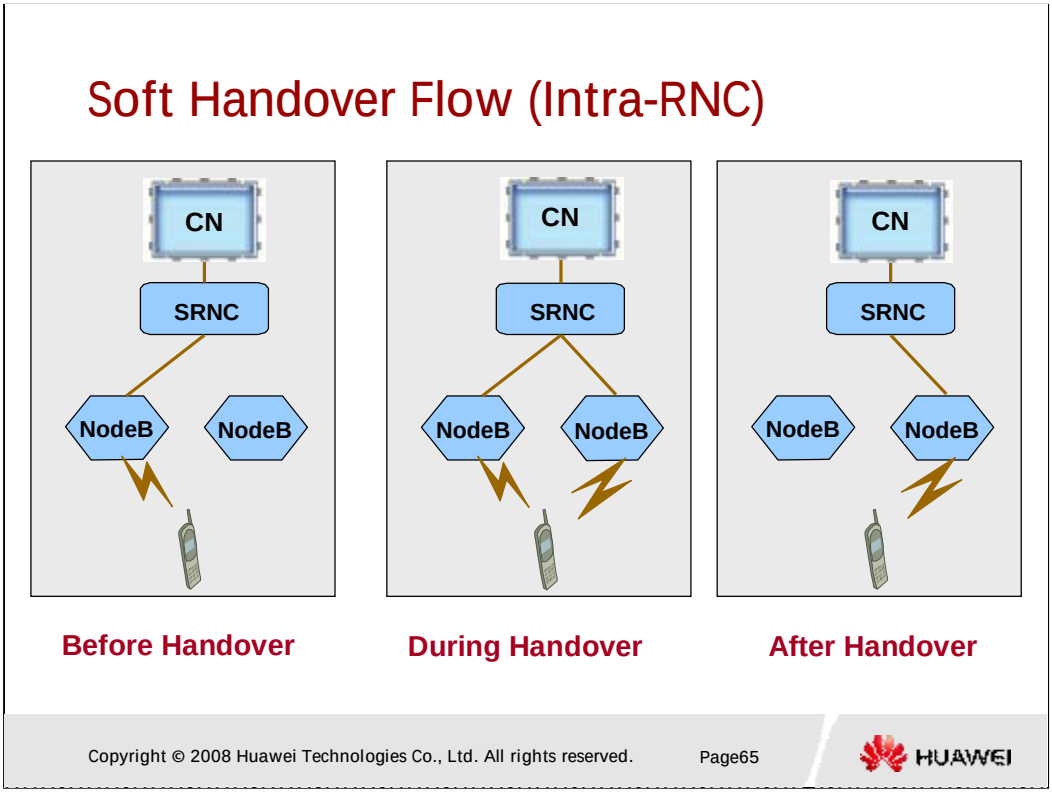


Contents

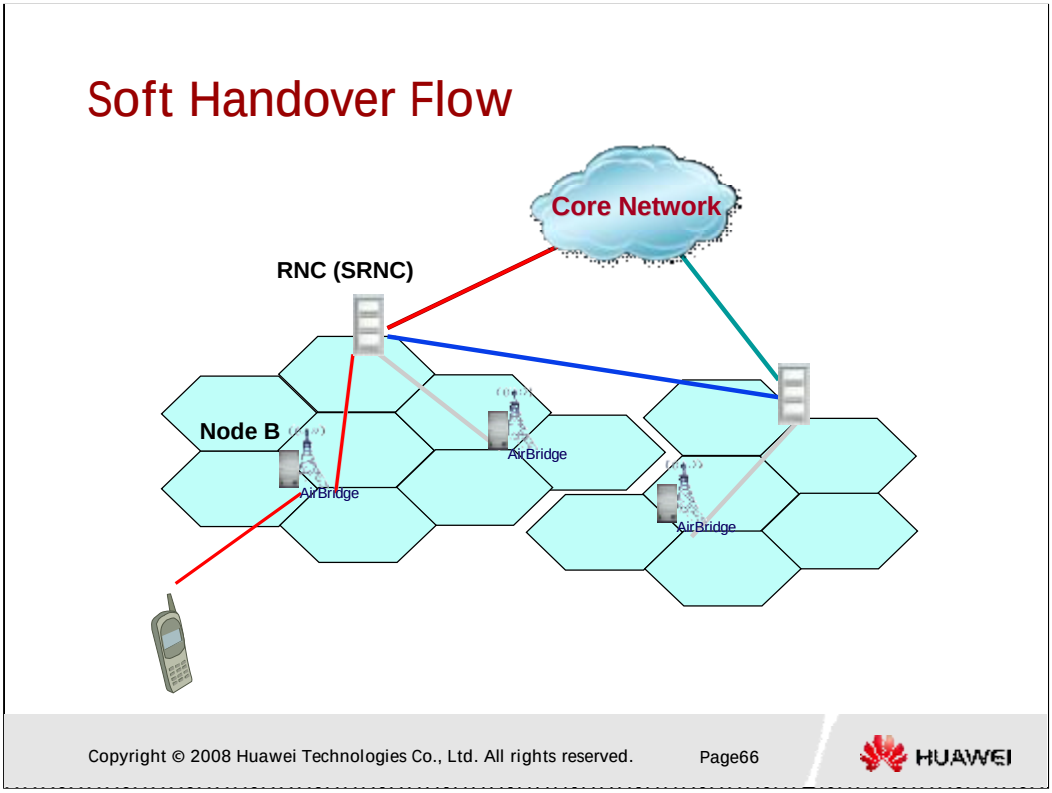
Concepts about Soft Handover

- 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

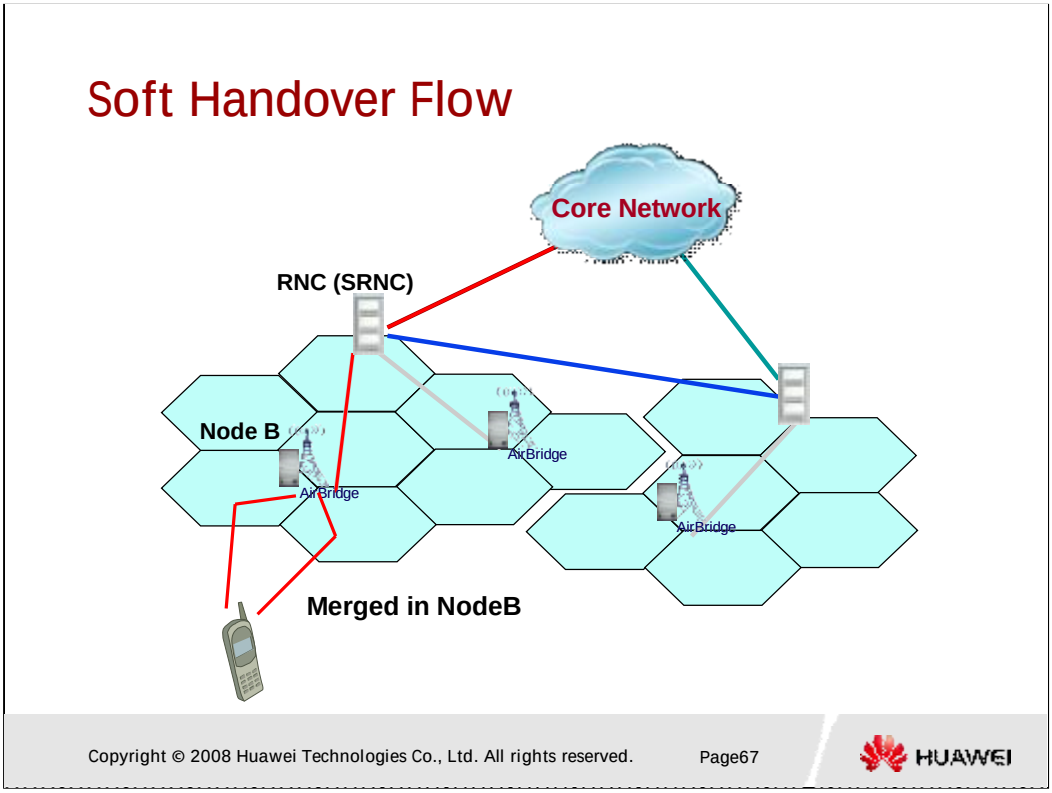
- In the WCDMA system, since the intra-frequency exists among neighboring cells, the UE can communicate with the network via multiple radio links, and can select one with good signal quality by comparison when these radio links are merged, thus optimizing the communication quality. The soft handover 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.
- Soft handover:
  - Selection combination in uplink
  - Maximum combination in downlink
- Softer handover
  - Maximum combination in uplink and downlink



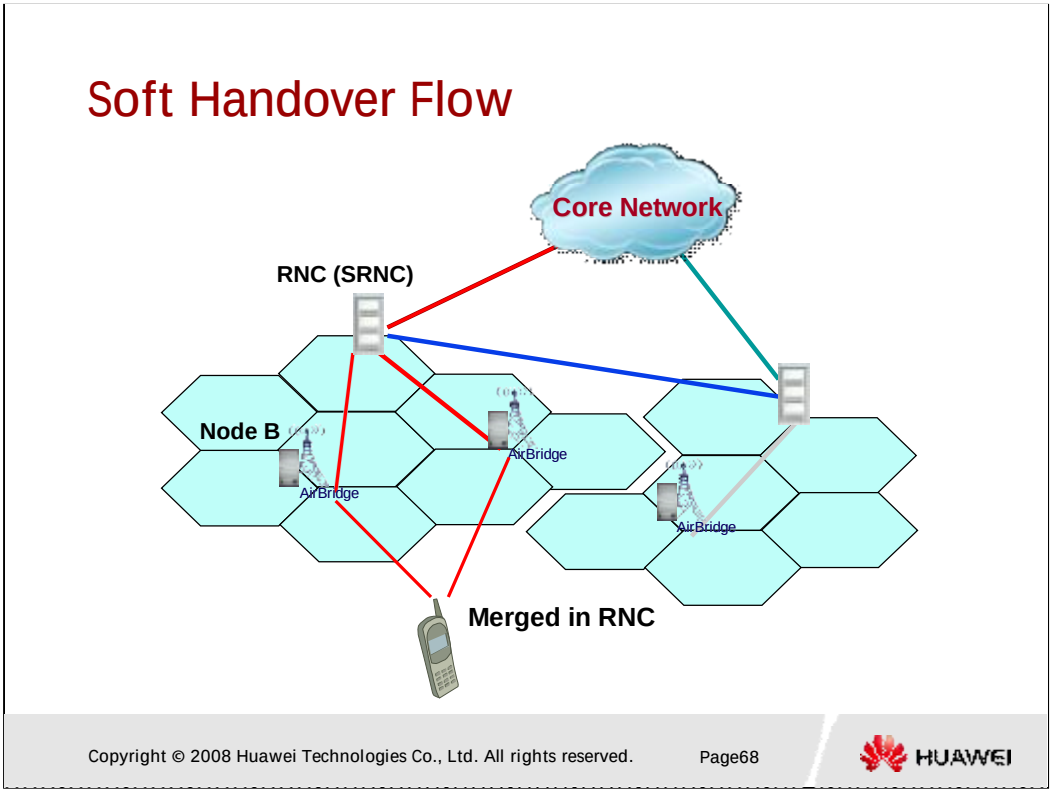
- During the soft handover, two or more radio links are connected with UE, and data in each RL are same.
- The following are some key concepts about the neighboring cell in the soft handover:
  - *Active set*: The set of cells currently used by the UE. The execution result of the soft handover indicates the increase or decrease of the cells in the active set.
  - *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.
  - *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.



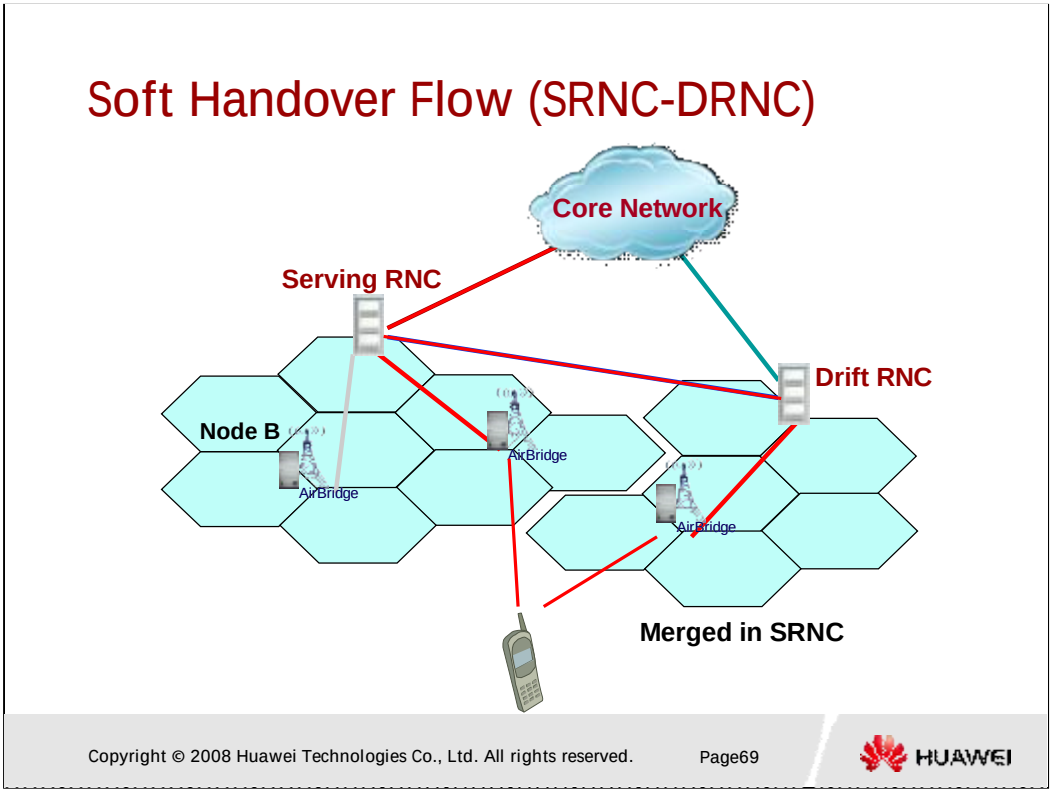
- It is no handover in this slide, only one radio links is connected with UE.



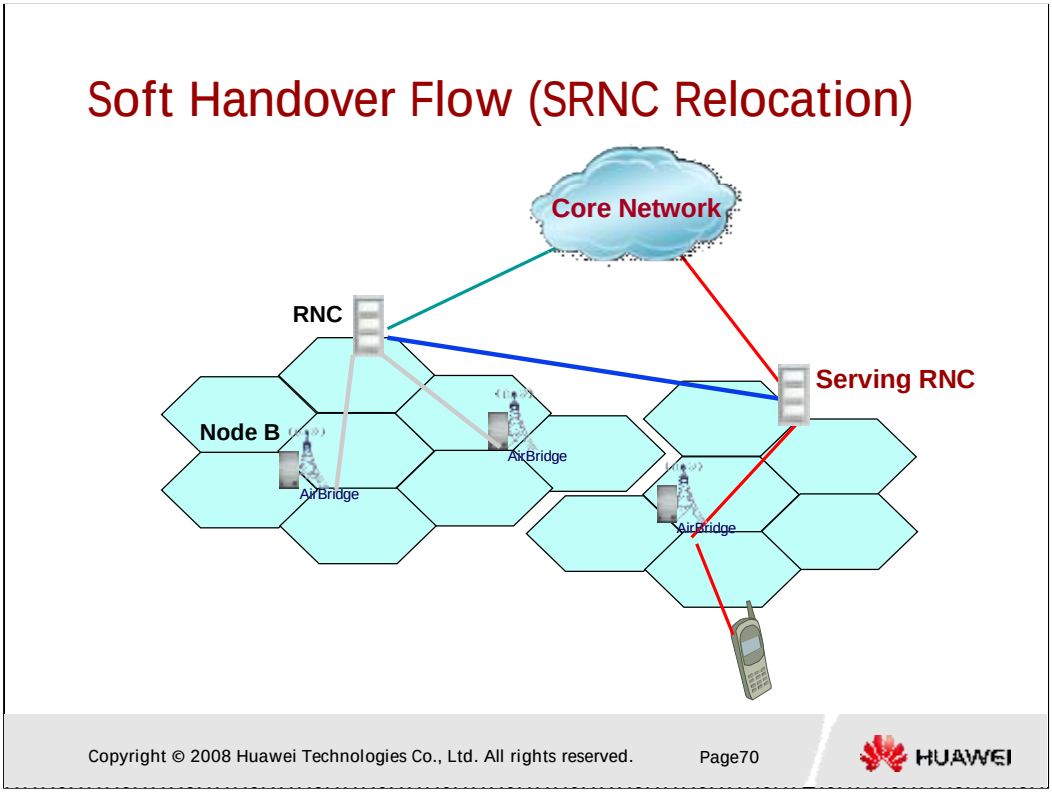
- It is softer handover. During the handover, the cells in active set belong to one NodeB. The NodeB uses the RAKE receiver to combine the data, and the UE also combines the data in RAKE receiver.



- It is soft handover. During the handover, the cells in active set 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.



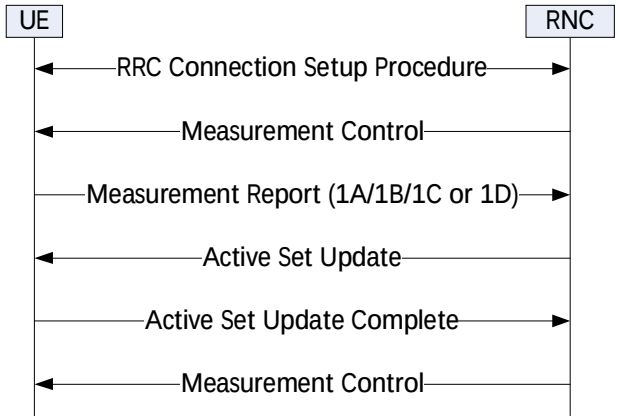
- It is soft handover. During the handover, the cells in active set belong to different RNCs. So the UE can combine the data in RAKE receiver. But in uplink, the data are combined with selection combination in SRNC.



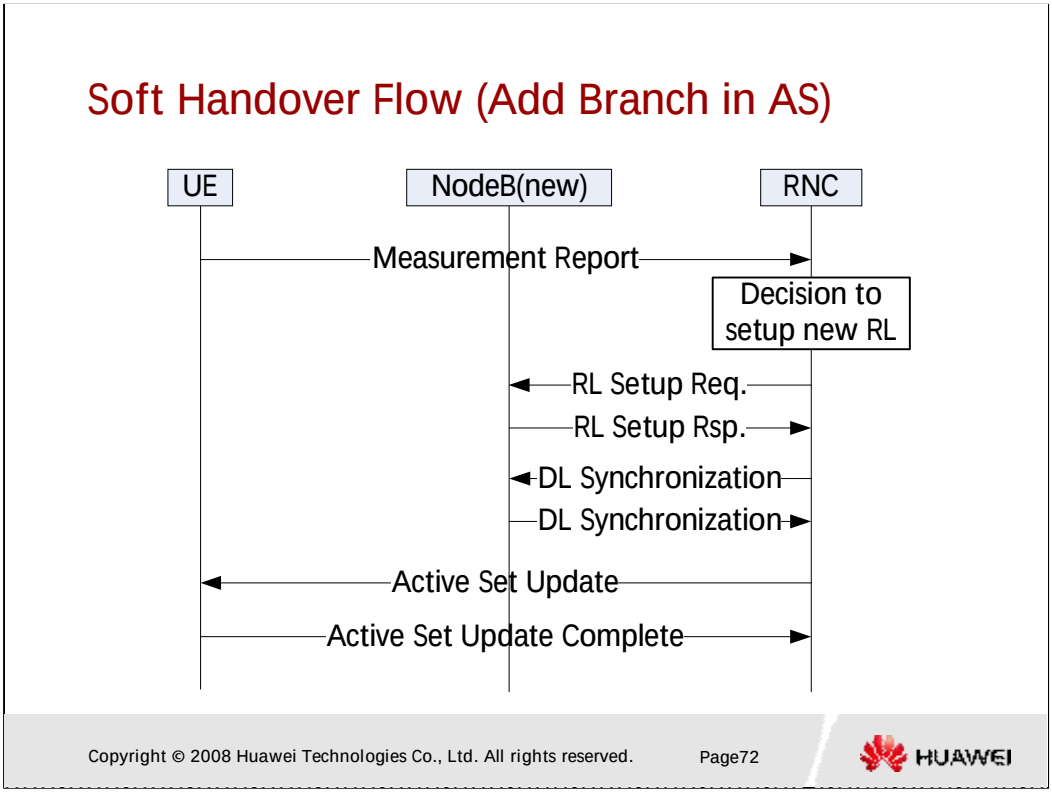
- There is no handover, but the SRNC has been changed.

Typical Soft Handover Flow (L3 Signaling)

- Soft handover is triggered by 1A/1B/1C or 1D event

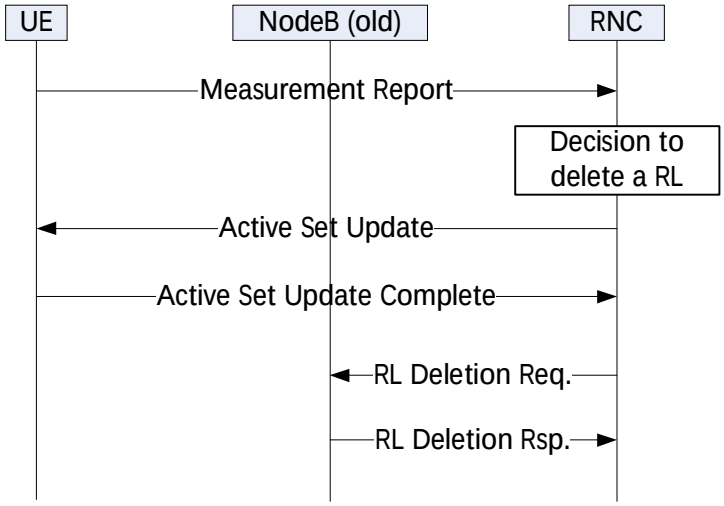


- The soft handover procedure comprises the following steps:
  - Based on the *Measurement Control* information from the RNC, the UE measures the intra-frequency neighboring cells, and reports the measurement result to the RNC via *Measurement Report*.
  - The RNC compares the reported measurement result with the set threshold to decide the cells to be added and deleted.
  - (If some cells are to be added, the RNC notifies the Node B to get ready.)
  - The RNC notifies the UE to add and/or delete cells via the *Active Set Update* message.
  - After the UE successfully update the active set, UE will send *Active Set Update Complete* to inform RNC.
  - (if the cells are deleted, the Node B will be notified to release the corresponding resources.)
  - After the soft handover, perhaps the measurement control information changes, if it is, RNC will send new *Measurement Control* to UE.
- The original communication is not affected during the soft handover procedure so that smooth handover from a cell to another can be successfully completed.



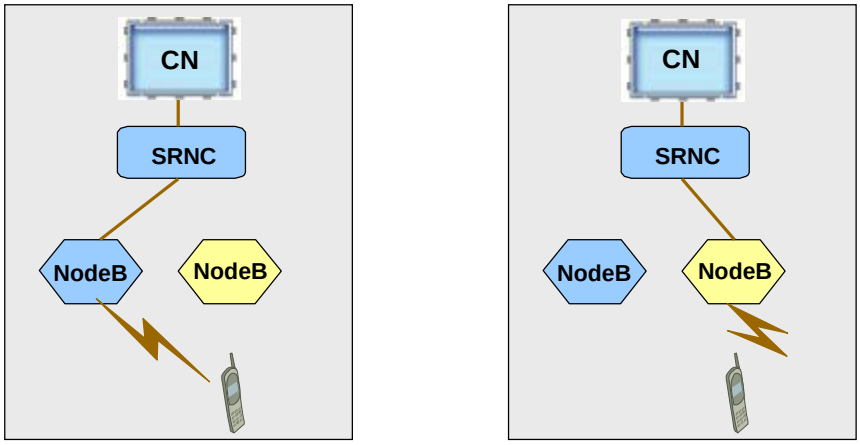
- For adding a cell into Active Set, RNC will notify NodeB to prepare the new RL before sending *Active Set Update*.

Soft Handover Flow (Del Branch from AS)



- For deleting a cell from Active Set, RNC sends *Active Set Update* to UE first. After UE deleting the RL successfully, RNC will inform NodeB to delete the RL.

Hard Handover



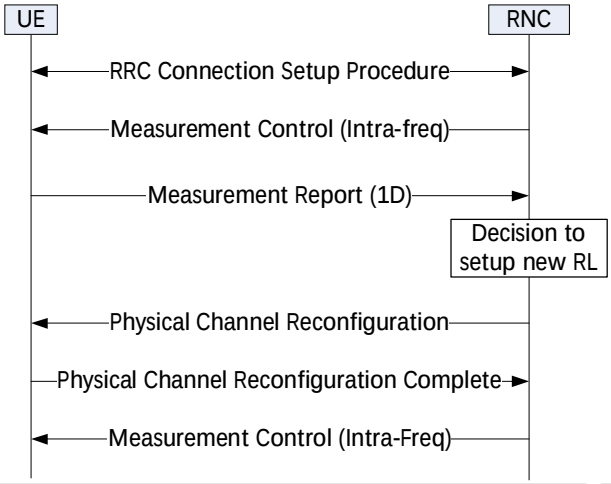
Before Handover **After Handover**

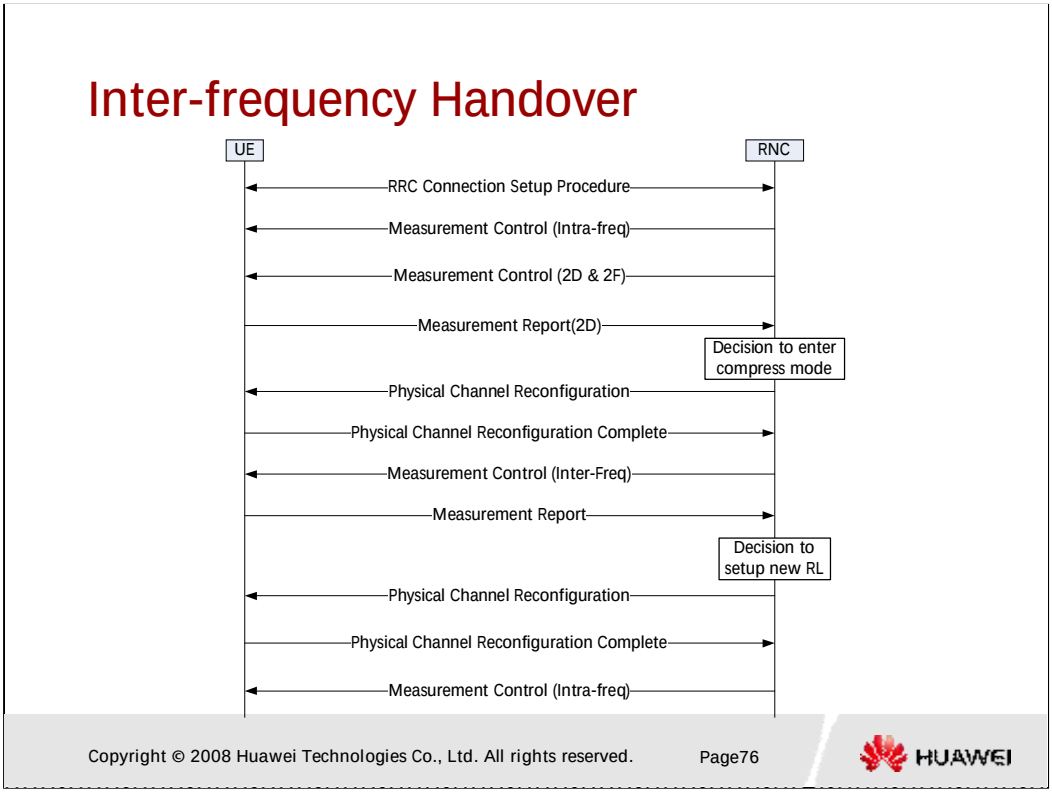
Radio Link can not exist simultaneously

- 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.

Intra-Frequency Hard Handover

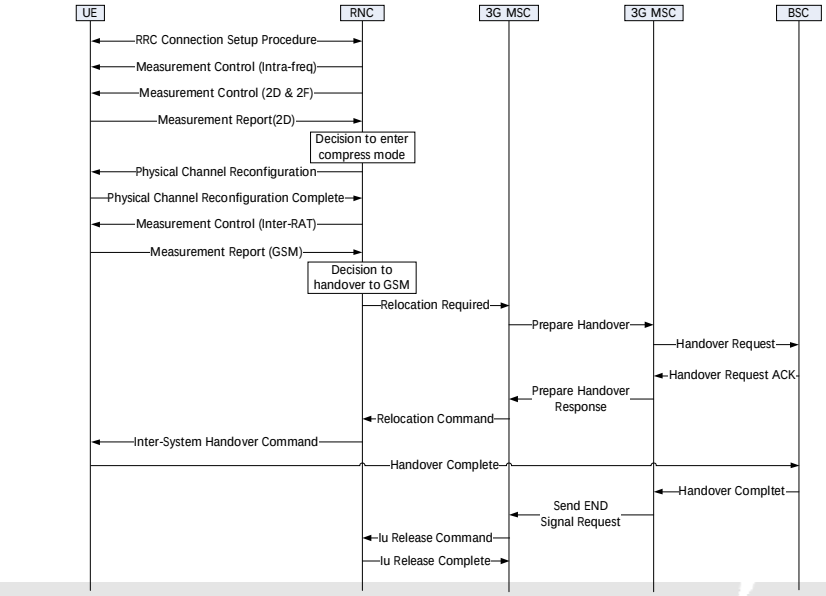
- Intra-Frequency hard handover is triggered by 1D event



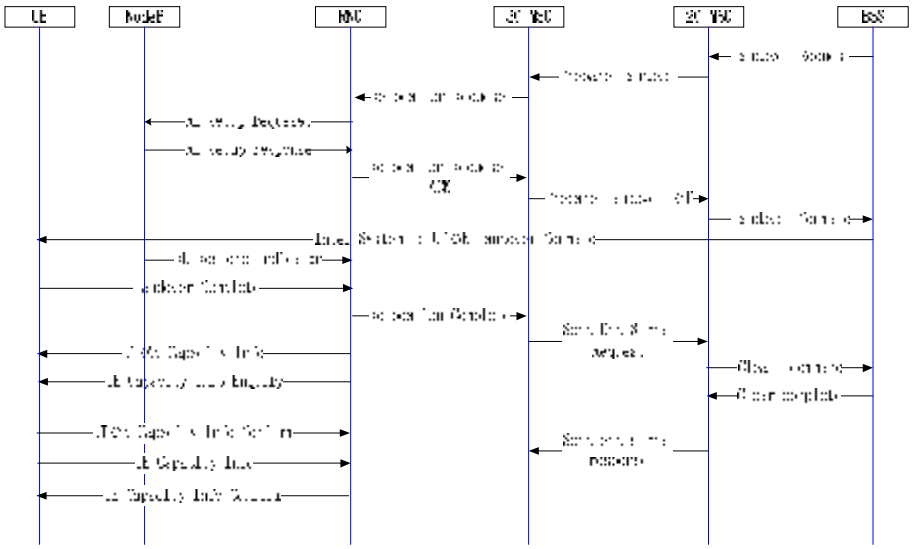


- Description:
  - Step 1 to step 5 is similar with soft handover, the differences are:
  - The SRNC sends the Physical Channel Reconfiguration message carrying the target cell information to the UE via the downlink DCCH.
  - After the UE hands over from the source cell to the target cell, the Node B 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.

Inter-RAT Handover Flow (UMTS->GSM)



Inter-RAT Handover Flow (GSM->UMTS)



Thank you

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