Network Aspects of WCDMA Base Station Systems

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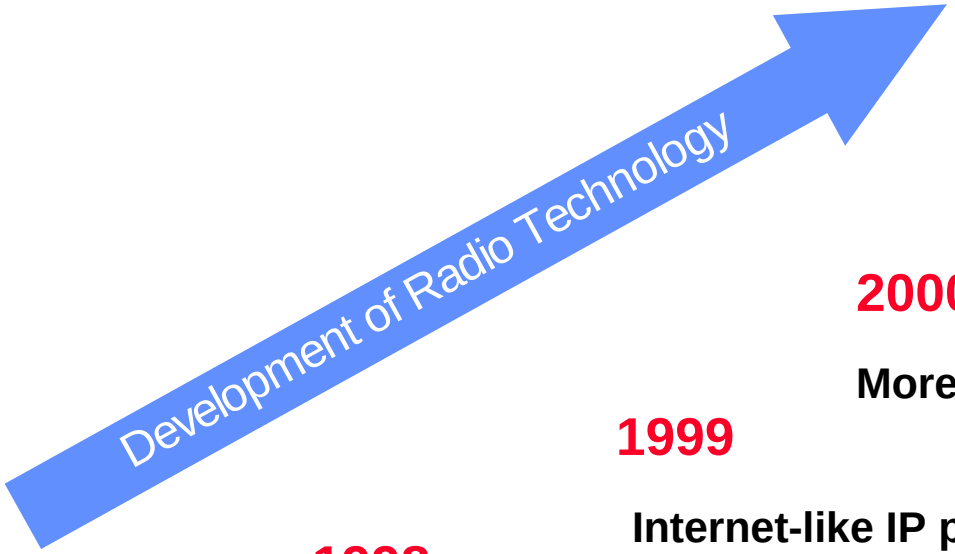
RAS/WCDMA

Outline

1. GSM Platform Evolution
2. 3rd Generation Network Architecture
   - GSM commonality
   - Iu interface
3. WCDMA Radio Access Network Architecture and functions
   - Network elements
   - RRC connection
   - Radio Access Bearers
   - Soft handovers and SRNC relocation
   - Protocol stacks
   - L2 processing
   - Radio Resource Management

The GSM Radio Steps to 3rd Generation



Introduction of 3rd generation radio

2001-2002

New multimedia services
Mass market cost of service (WCDMA)

2000

More capacity when needed (EDGE / GSM384)

1999

Internet-like IP packet services (GPRS)

1998

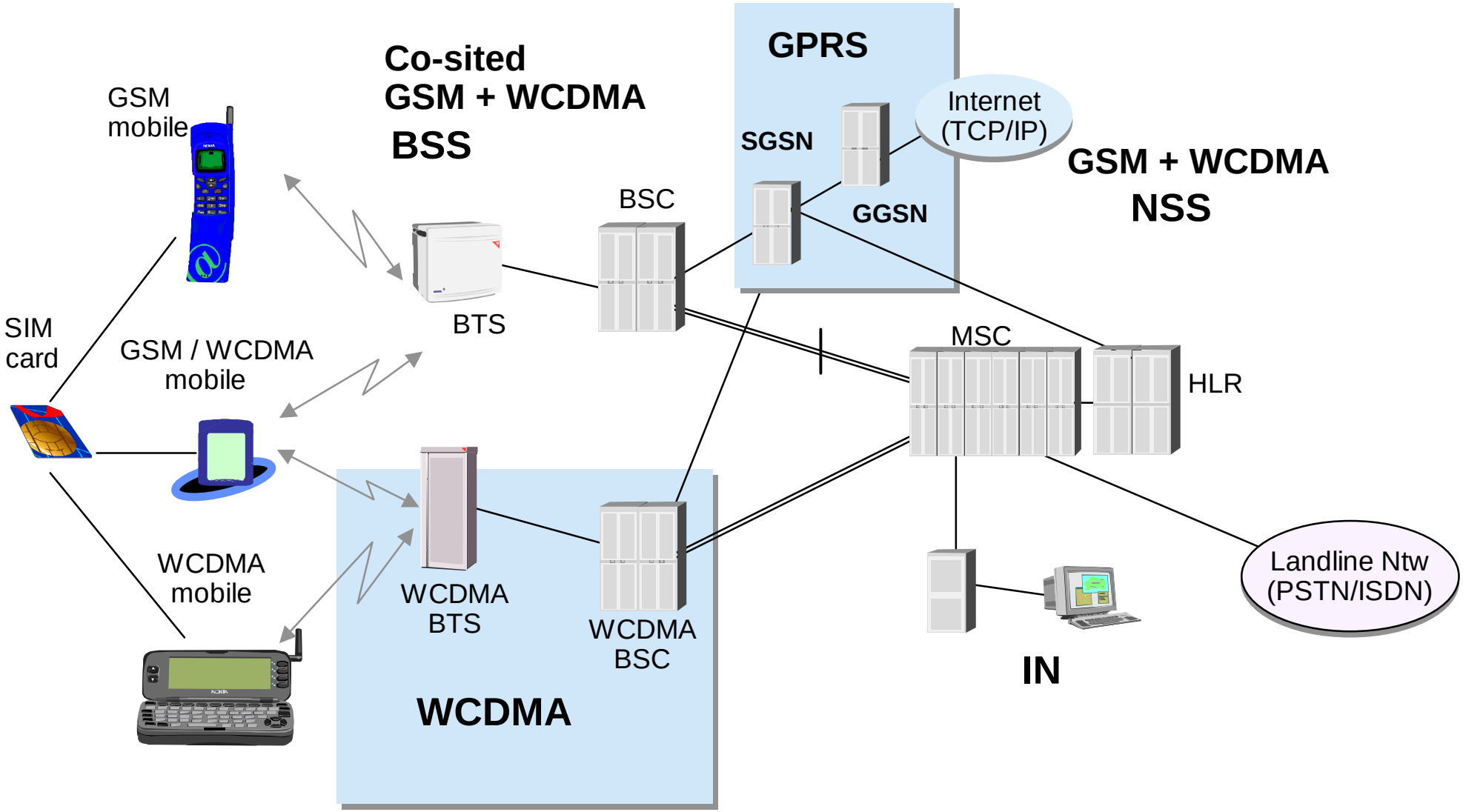
Landline-like circuit services (HSCSD)

1997

Basic GSM data at 9.6 kbit/s

Evolution of GSM Platform

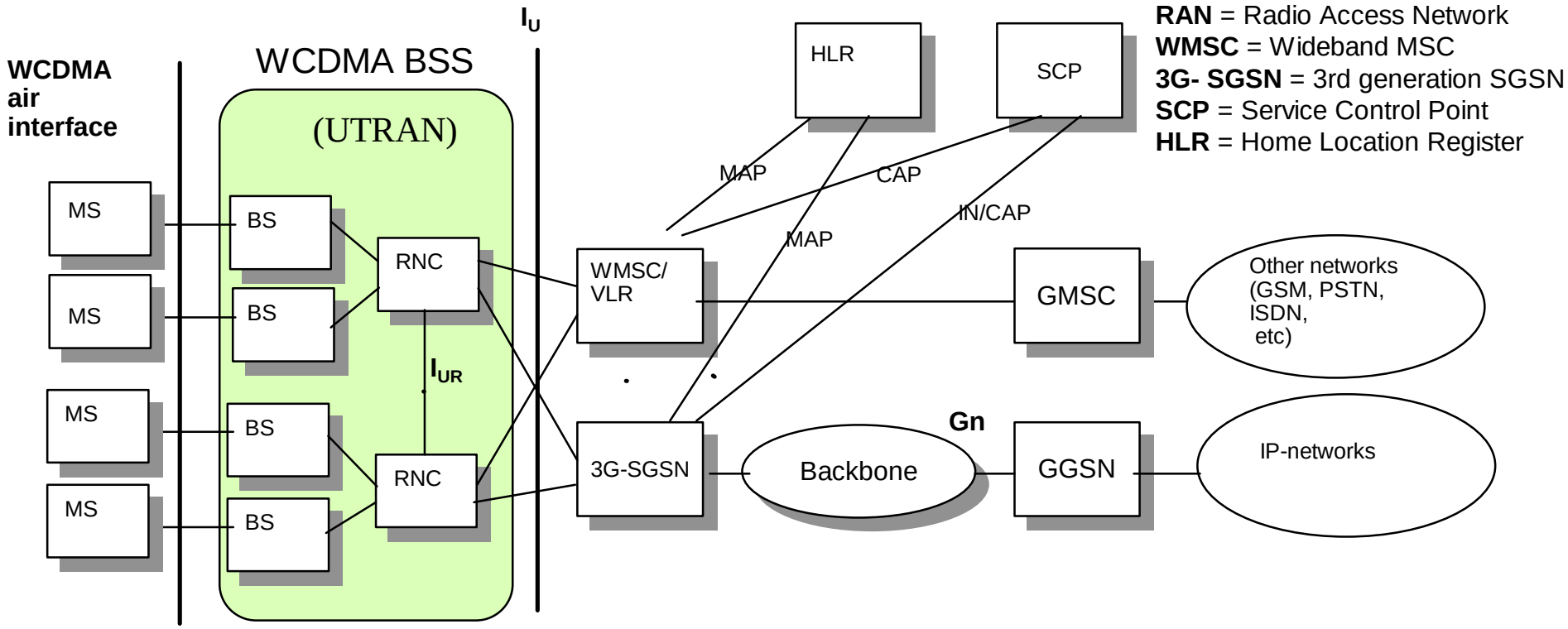
GSM platform evolution



3rd Generation System Configuration

- Core network: evolved GSM NSS (architecture, MAP protocol)
- New technologies: WCDMA UTRA (UMTS Radio Access), ATM
- New access network configuration:
  UTRAN with open I_u interface, RNC, RNC-RNC interface (I_{UR})
- Network configuration:
  Wideband MSC/VLR, 3G-SGSN

MS = Mobile Station (WCDMA)
BS = Base Station (WCDMA)
RNC = Radio Network Controller
RAN = Radio Access Network
WMSC = Wideband MSC
3G- SGSN = 3rd generation SGSN
SCP = Service Control Point
HLR = Home Location Register



GSM Evolution Aspects

Commonality

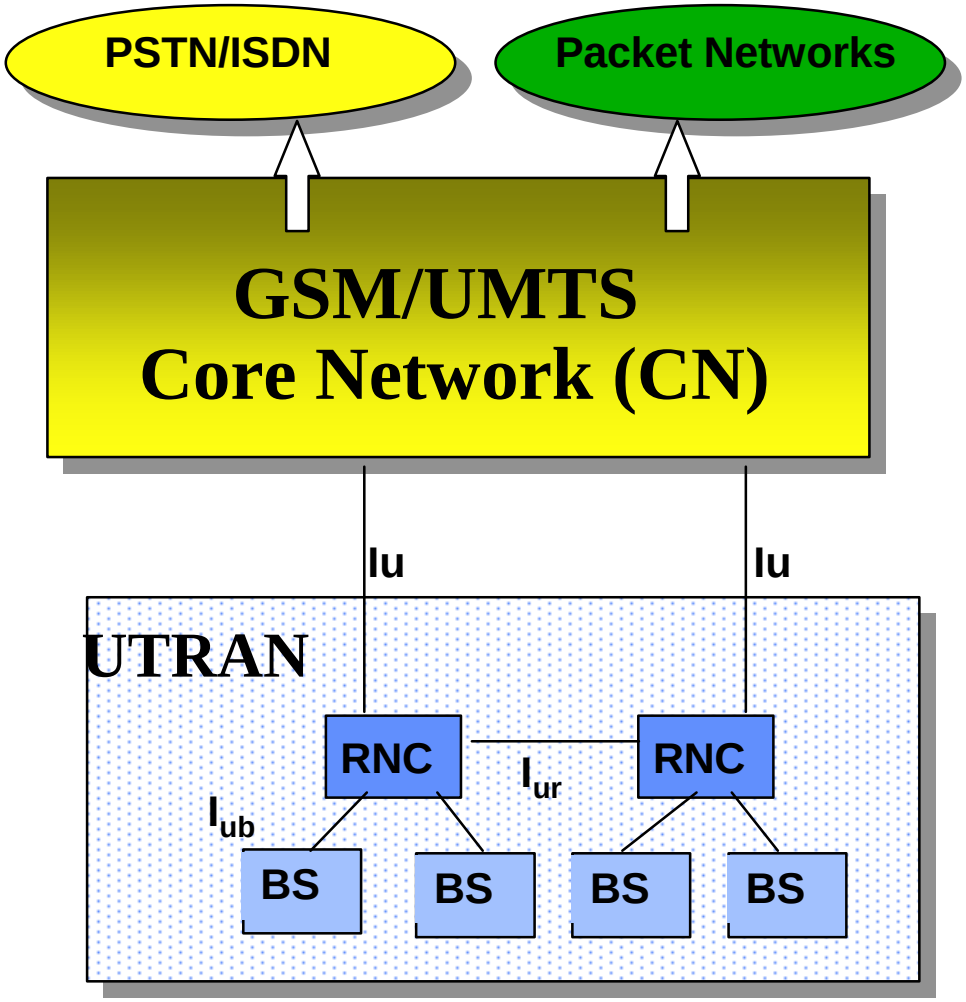
- Basic architecture
- MAP basic protocol (enhancements needed)
- HLR functions
- Gateway node for packet data (GGSN)
- GSM related air interface L3 protocols (CC, MM)
- GSM related Iu-interface L3 protocols (similar to BSSMAP)
- CAMEL; for IN services and for VHE

Difference

- Multimedia capability (speech+video+data)
- Parallel, simultaneous calls
- Wide ATM-related bearer service capability of UTRAN(circuit, packet)
- Packet data service with guaranteed quality
- Wide spread usage of ATM (RAN, transmission, MSC, packet nodes)
- New protocols (ATM, WCDMA functions)

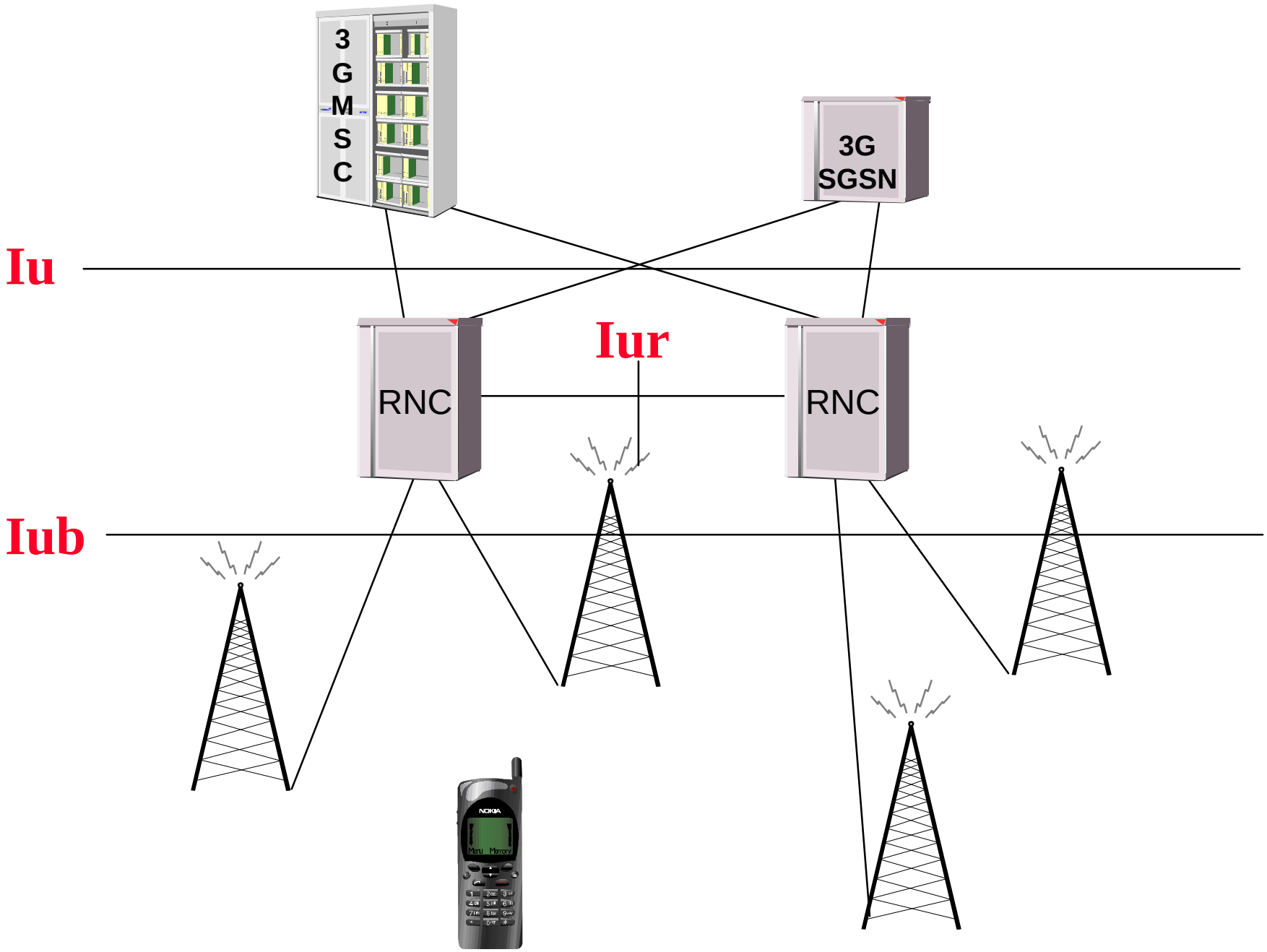
I_u Interface, the Concept

- Interface between UTRAN and GSM/UMTS Core Network
- Provides means for radio system management, bearer allocation and transportation of mobile signalling via the RANAP protcol
- Provides means to carry user plane data via user plane frame protocols
- Allows connection of RNC to 2G MSC via IWU (Iu is similar to A interface)
- Same RANAP protocol towars the Circuit Switch (MSC) and Packet Switch (SGSN) domain
- Different user plane protocol for CS (ALL2/ATM based) and PS domain (GTP/IP/ALL5 based)



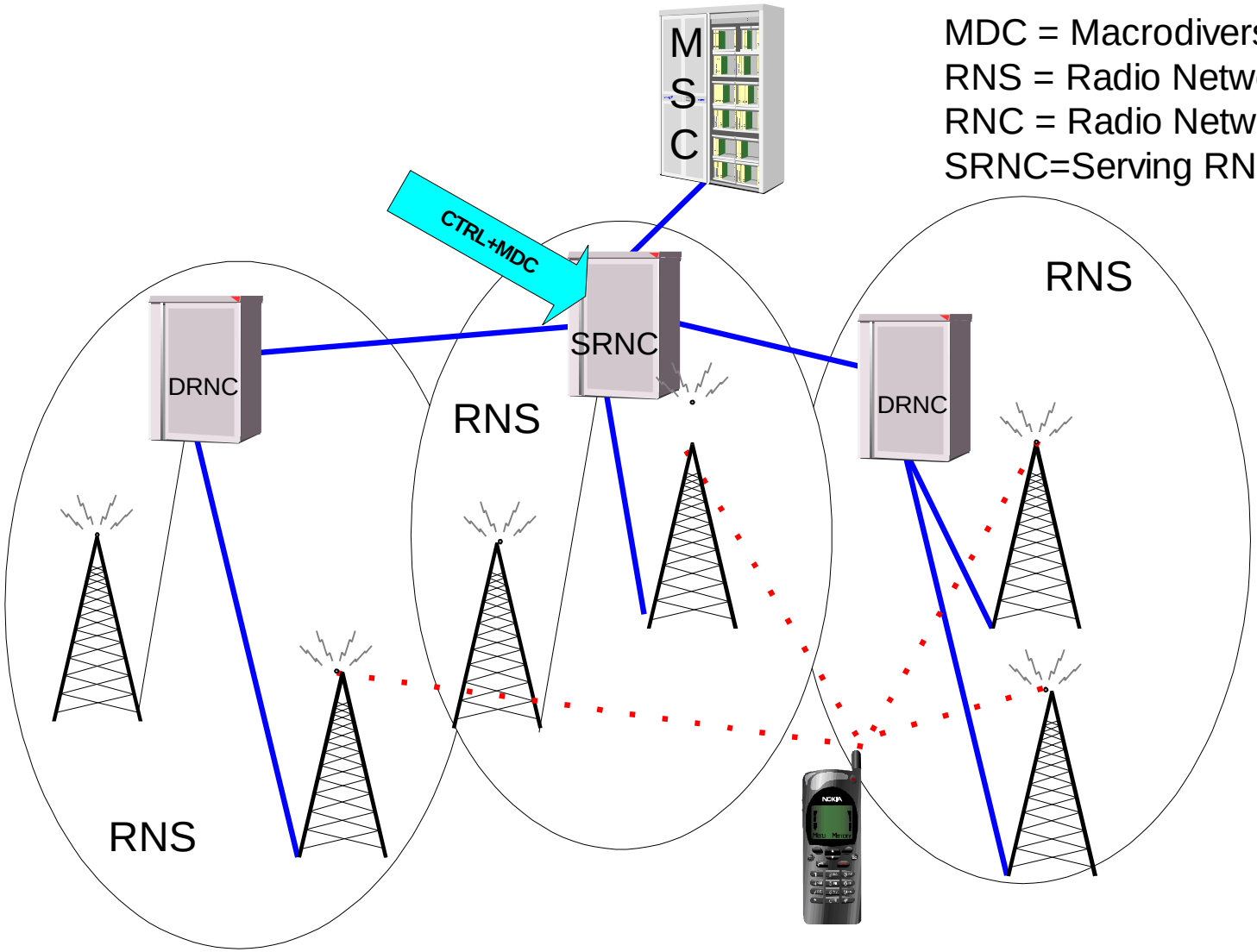
WCDMA RAN Principles

- Based on the **WCDMA** air interface concept, which was selected to be used for the UMTS FDD band
- **Macrodiversity** is a major new feature introduced by the WCDMA air interface
  - handovers allowed to be "soft" (no discontinuity in transmission on air interface during handover)
  - Iur interface between RNCs needed to support macrodiversity between RNCs
  - macrodiversity combiner (MDC) in RNC-> all traffic controlled by RNC
- Effective utilisation of air interface resources supported by various **RRM algorithms**
- Radio resource (RR) control is highly centralised in RAN
  - RAN decides the use of radio resources and physical channels on air interface, not visible for the core network
  - Harmonised management of services (e.g. packet and circuit switched), multiplexing to same physical channel (code) on air interface supported
  - RAN keeps track the terminal location during active service state
- **ATM** used in RAN as transportation and switching technology
- One **common protocol stack** for all supported services (internal functionality may vary depending on the service)

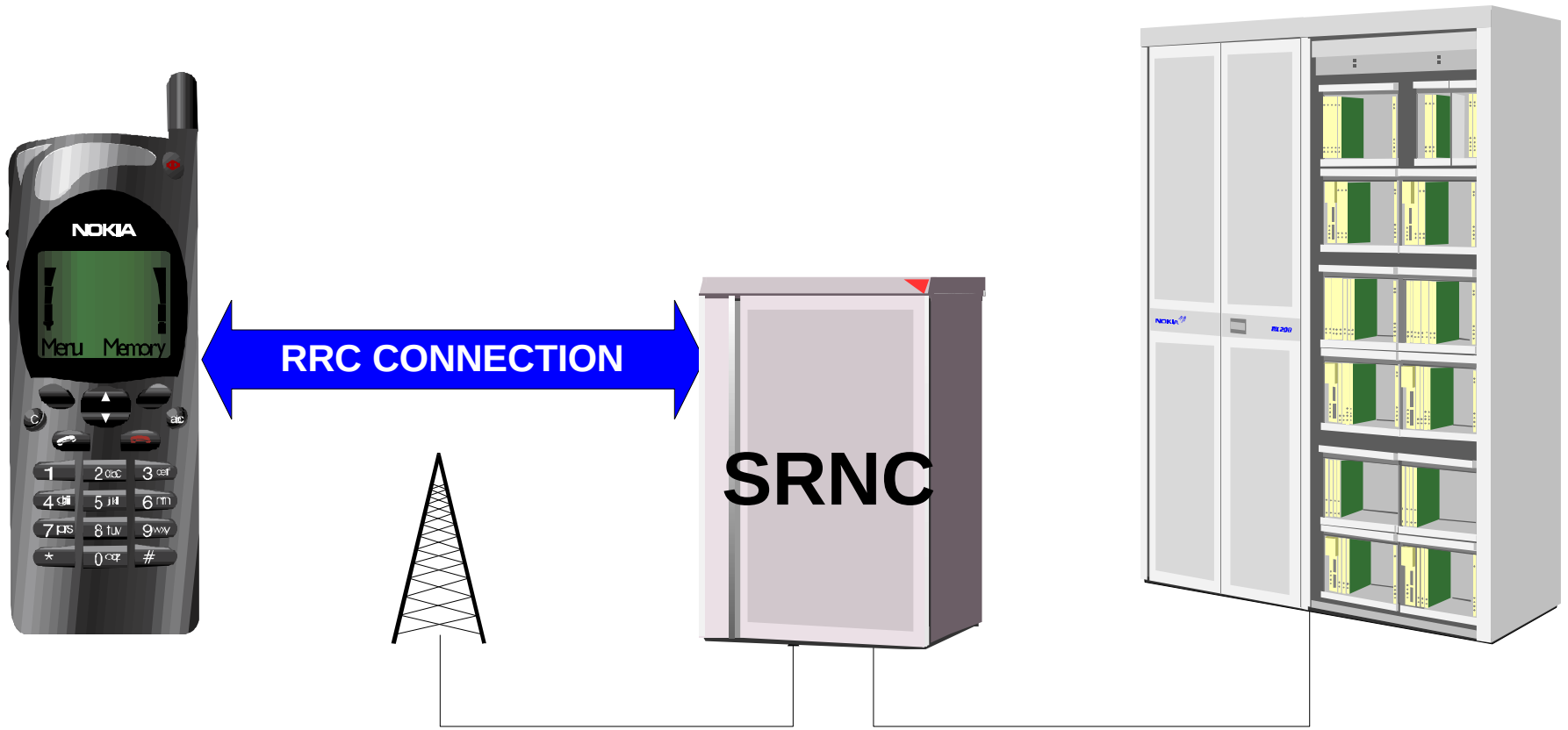

3
G
M
S
C
3G
SGSN
Iu
RNC
Iur
RNC
Iub

RAN FUNCTIONALITY FROM RAN-MS CONNECTION POINT OF VIEW

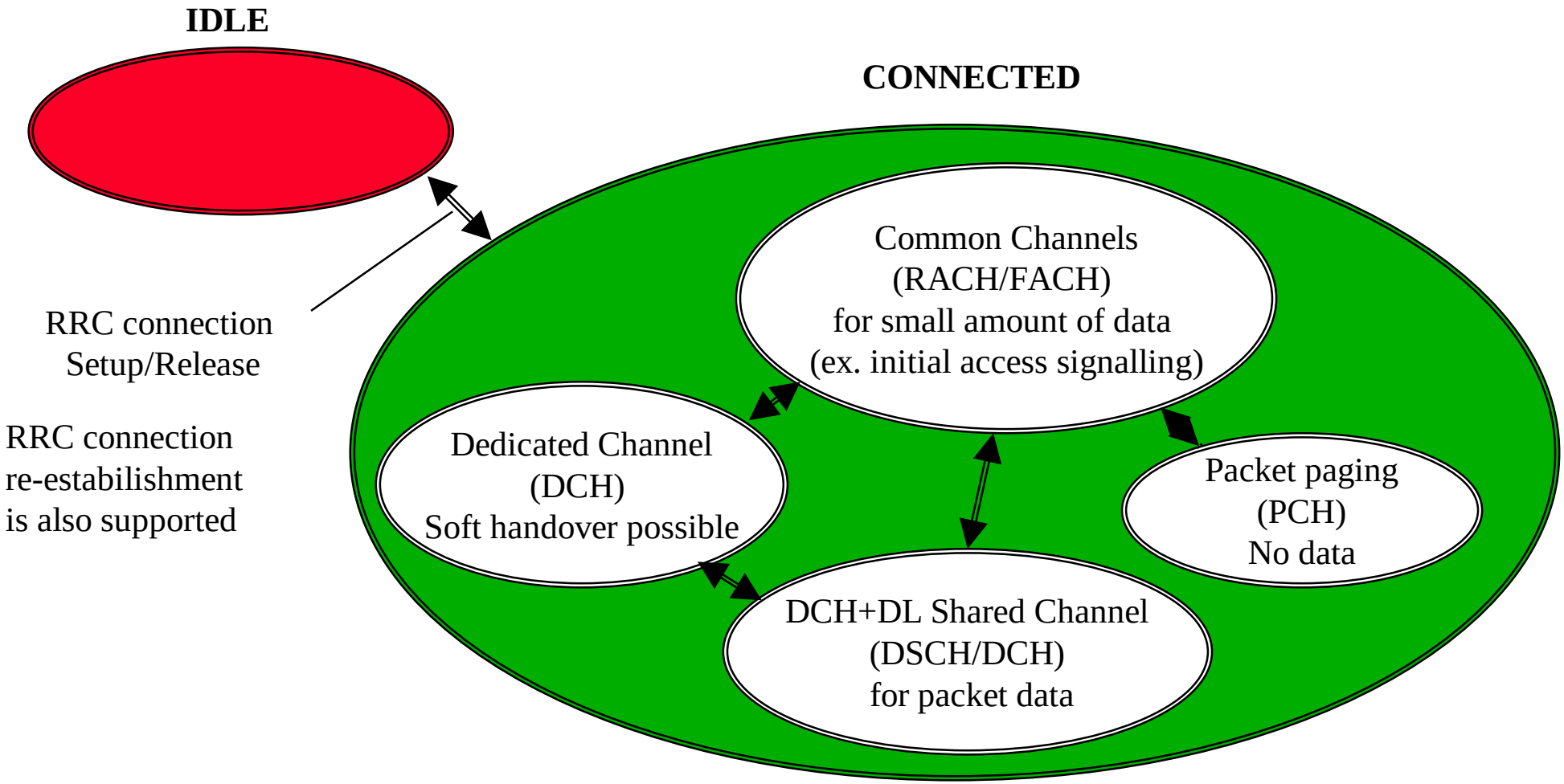
MDC = Macrodiversity Combiner
RNS = Radio Network Sub-system
RNC = Radio Network Controller
SRNC=Serving RNC DRNC=Drift RNC
AS= Active Set



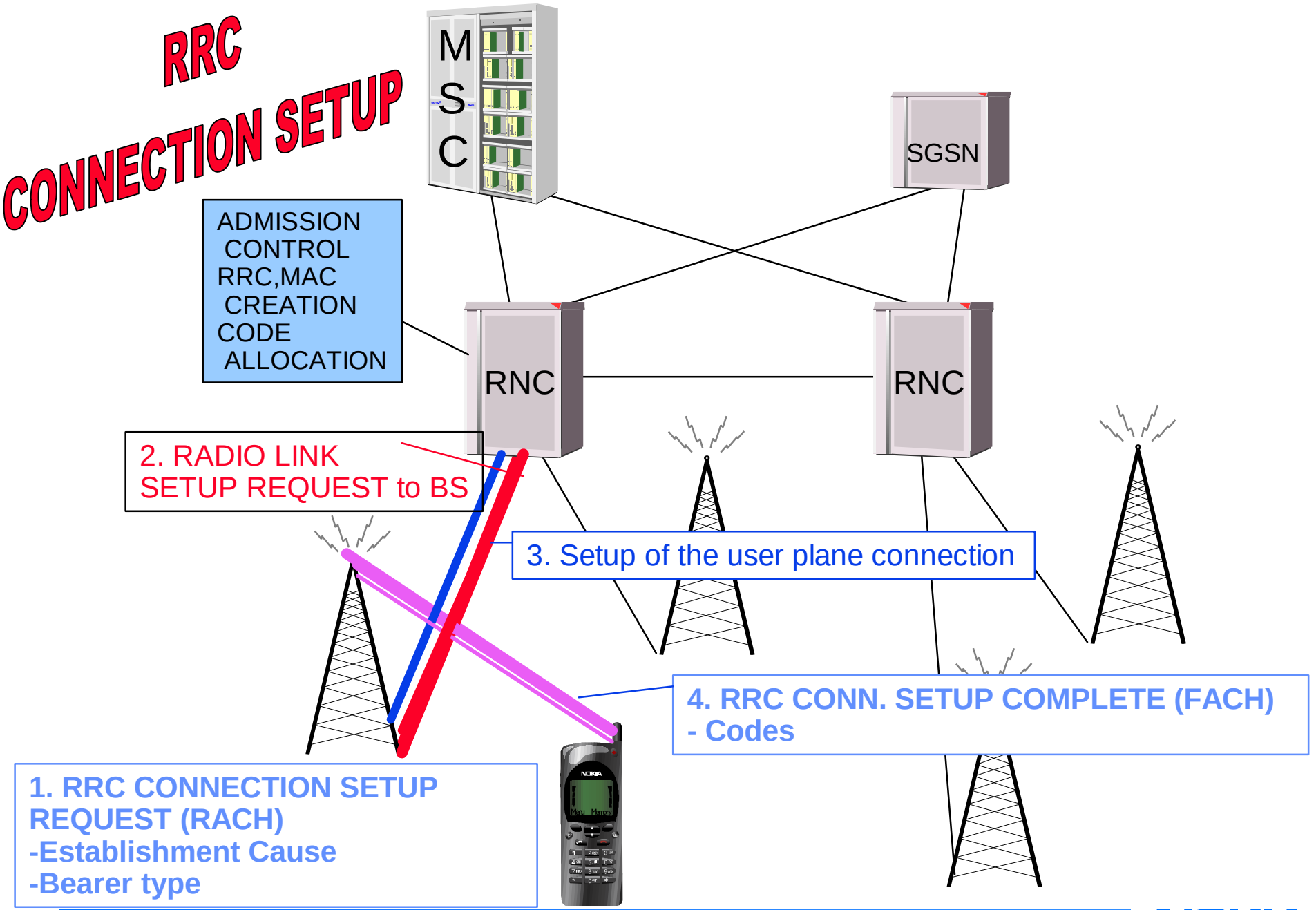
RRC CONNECTION



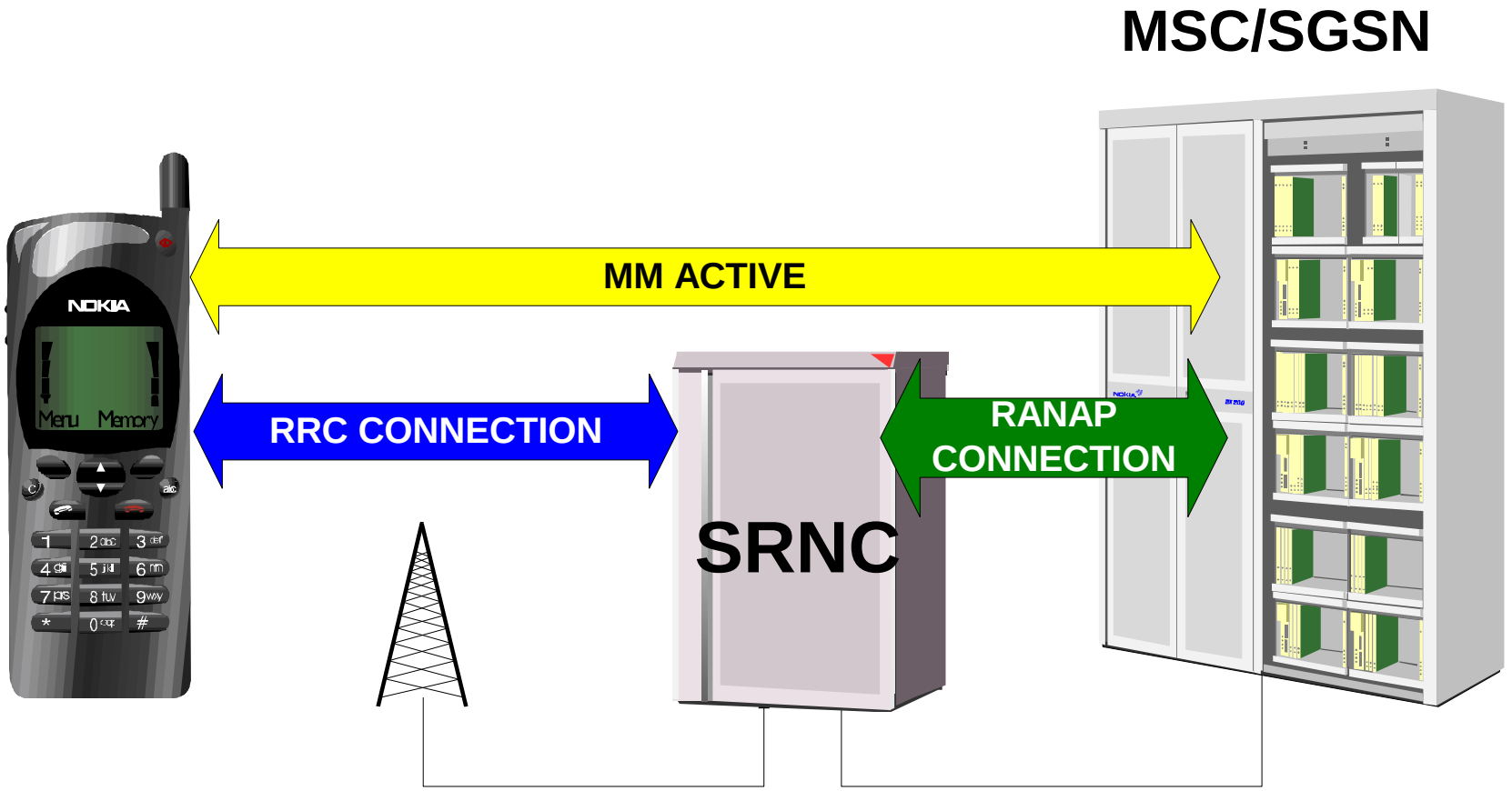
States of the RRC connection



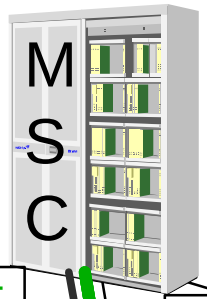
RRC CONNECTION SETUP



MM and RRC in active state



BEARER SETUP



SGSN

1) BEARER REQUEST
-Bearer parameters
-Binding ID

5. RAB setup Acknowledgement

6. SETUP OF THE USER PLANE

2. ADMISSION CONTROL
CODES AND TF SET ALLOCATION

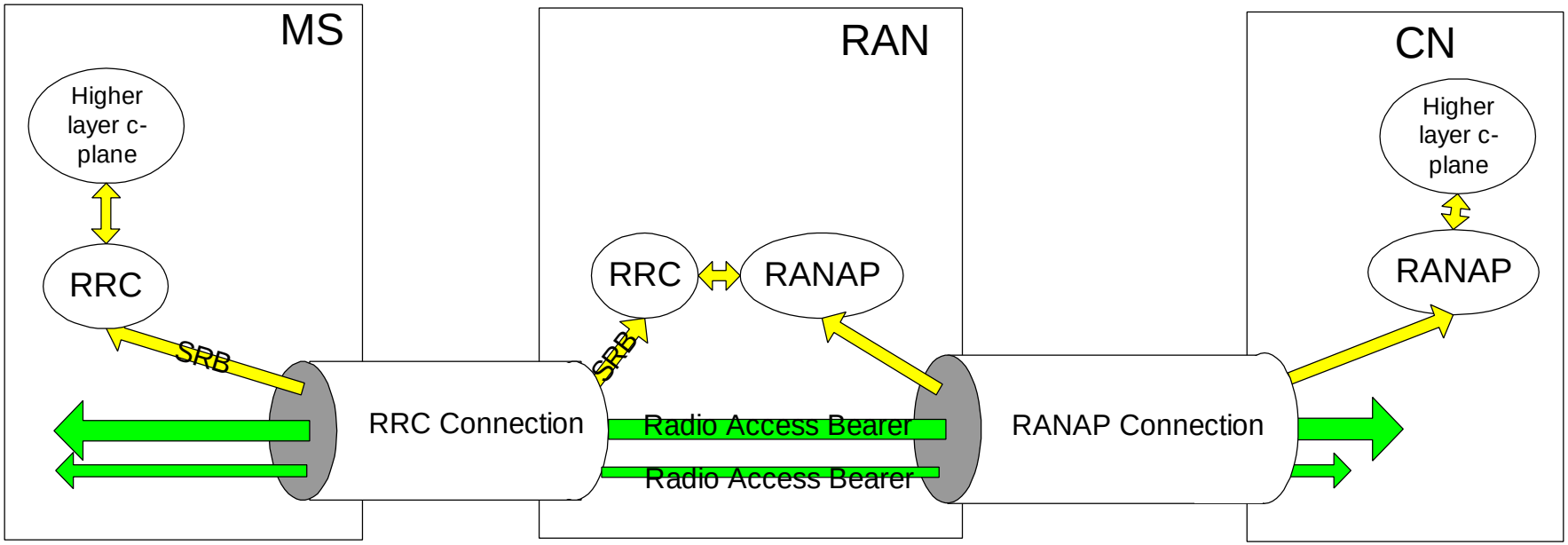
RNC

RNC

3. RADIO LINK MODIFICATION
- New Spreading codes
-TF set

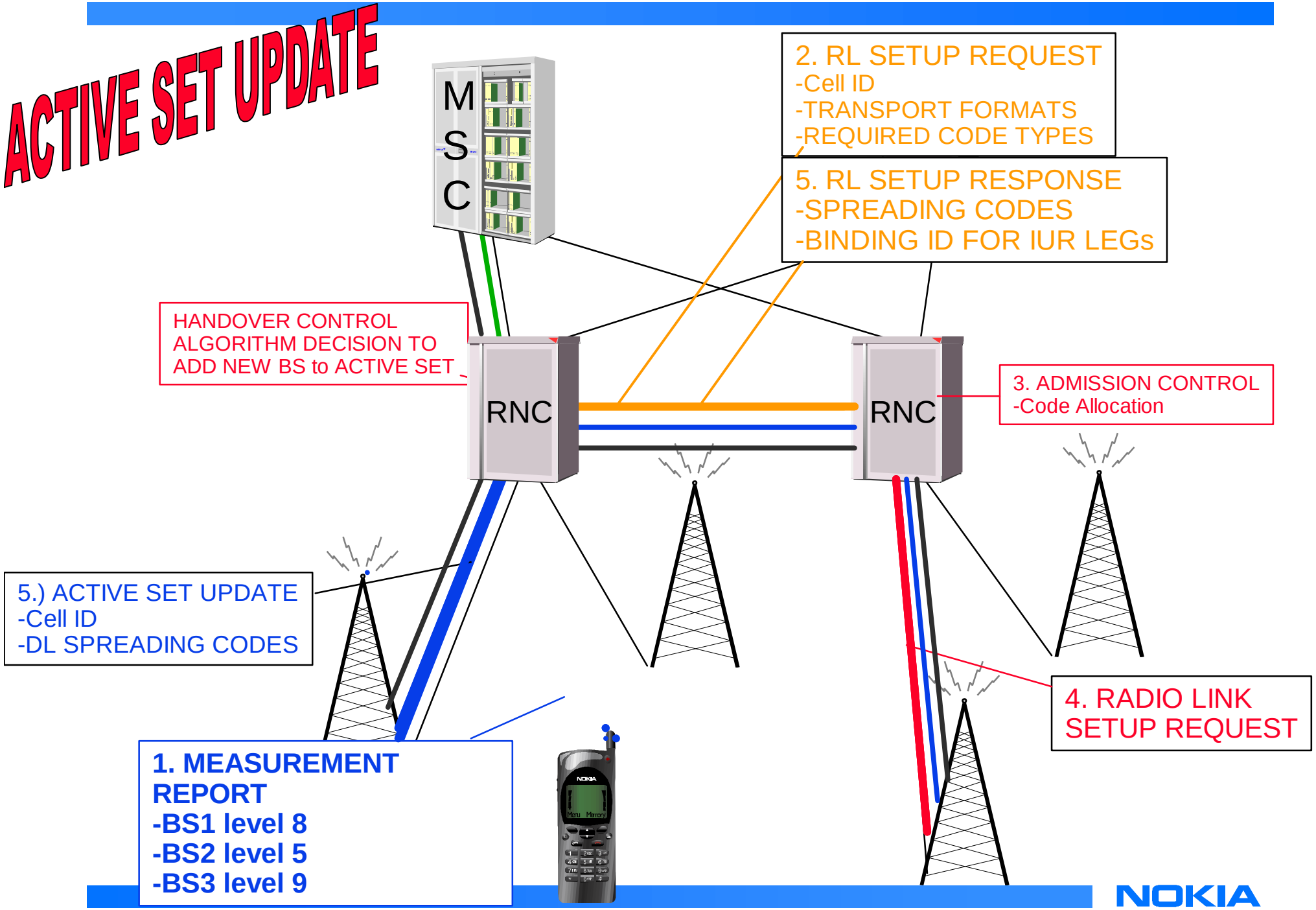
3. RADIO ACCESS BEARER SETUP COMMAND

RRC Connection vs. Radio Bearer

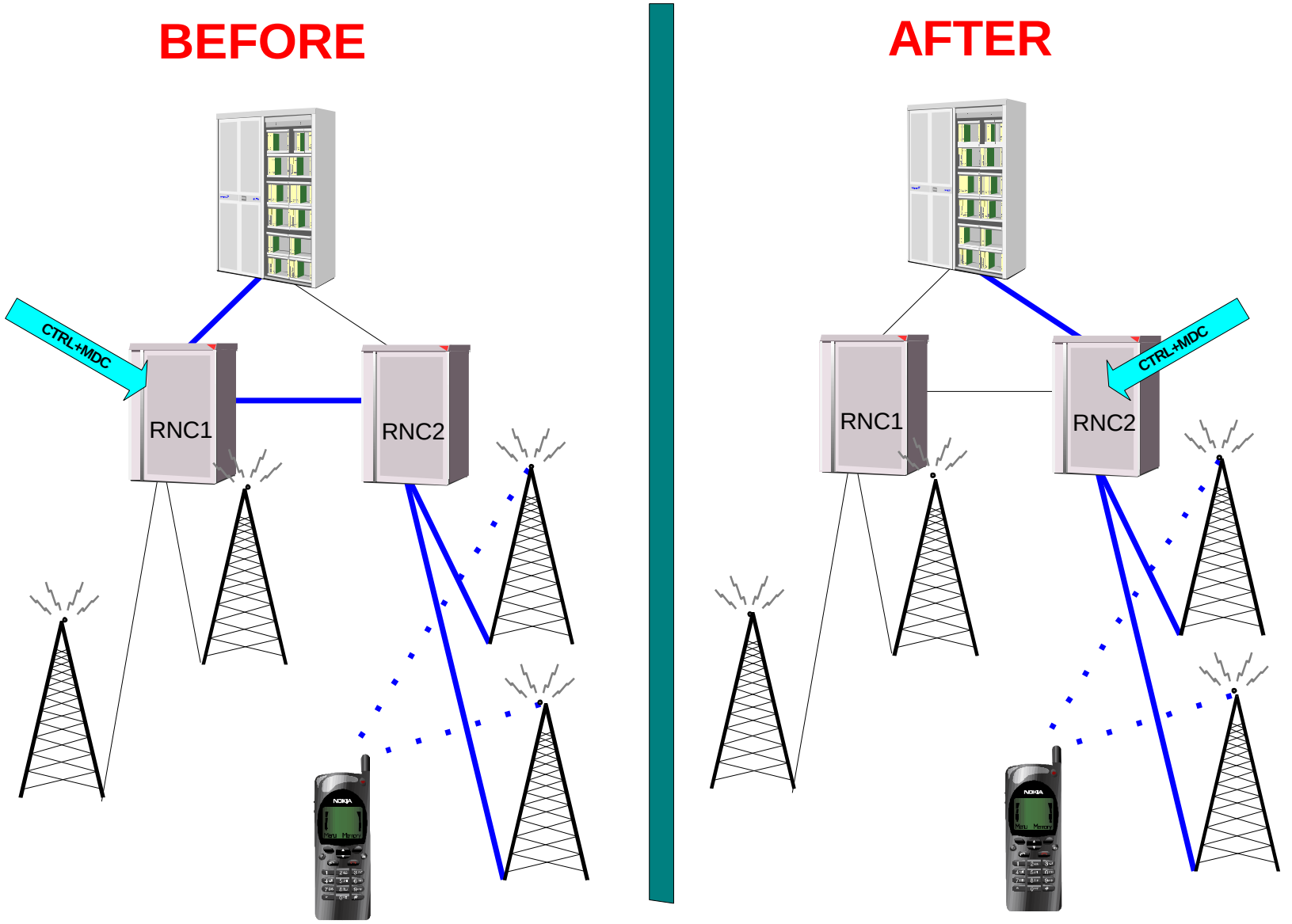


- RRC connection is the ‘envelope’ between MS and RAN containing information from where (and how) the MS can be reached and also information of the established radio access bearers
- SRB = Signalling Radio Bearer (signalling link used for RRC signalling and for transportation of higher layer signalling between MS and CN)
- Multiplexing of multiple Radio Access Bearers to same physical channel on air interface supported

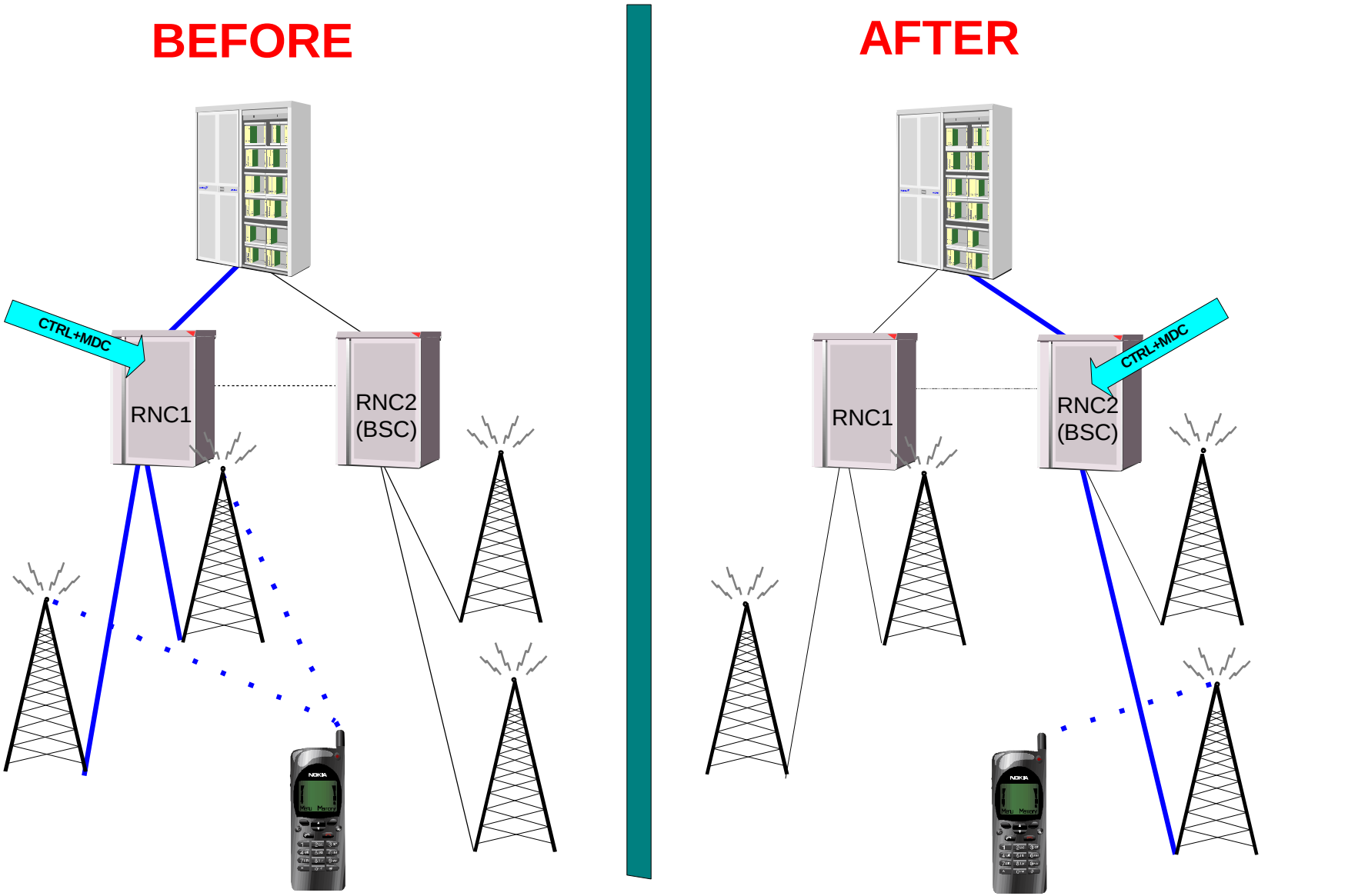
ACTIVE SET UPDATE



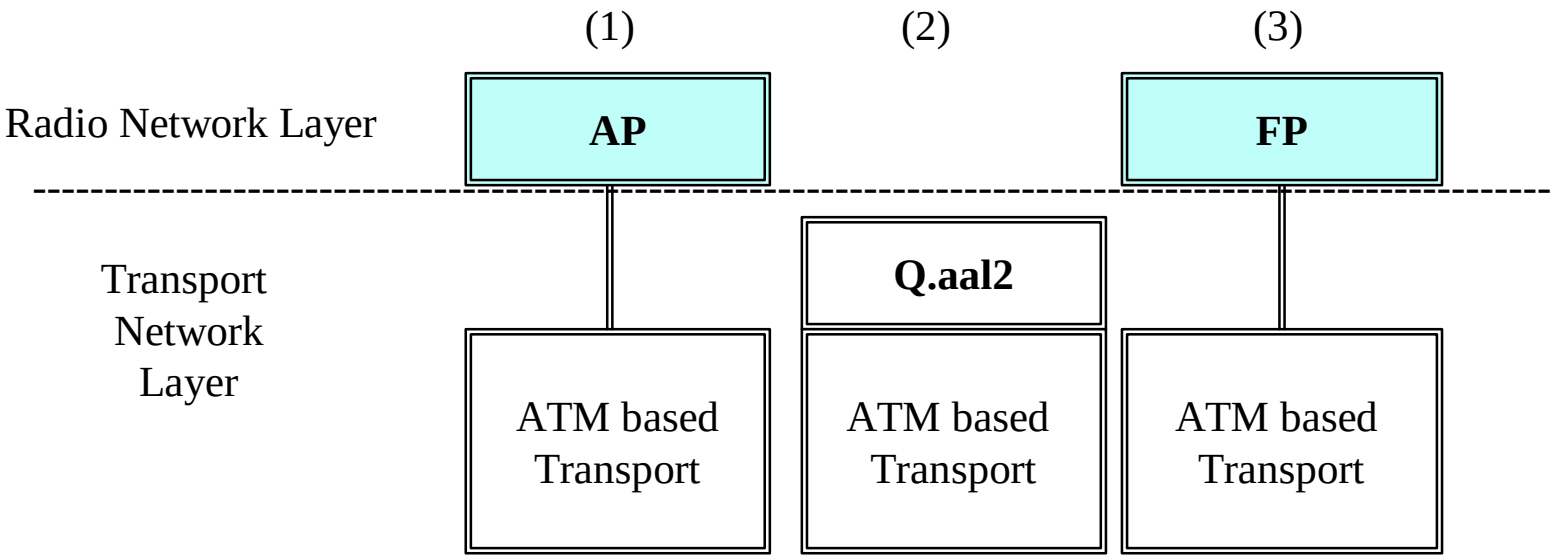
Serving RNC Relocation



Inter RNC (or inter system) Hard Handover



UTRAN Interfaces Protocol Stacks

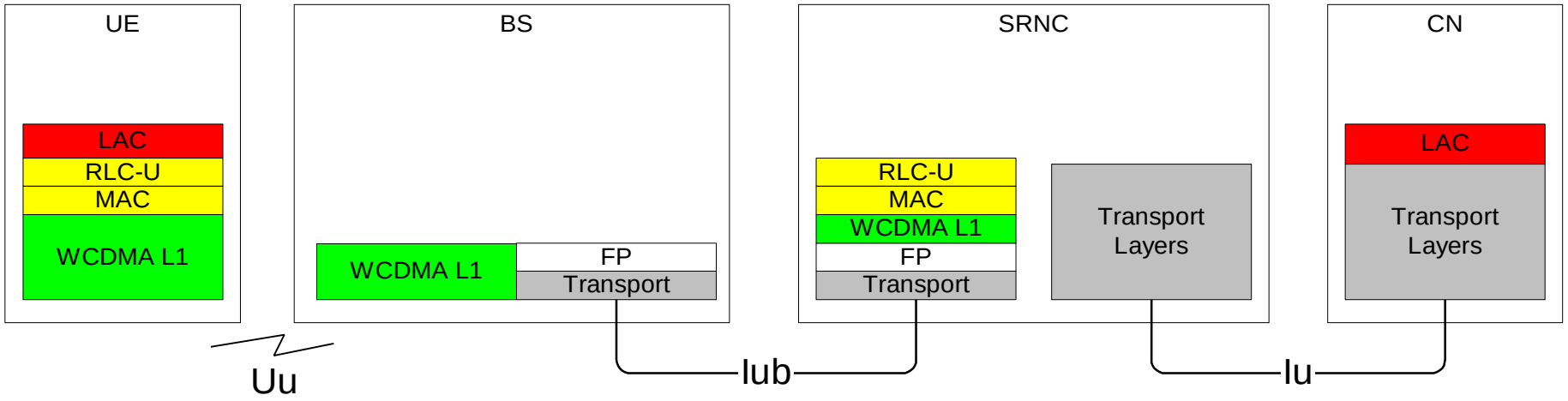


(1) Control Plane: Defines the interface application part (the Aps are RANAP for Iu, RNSAP for Iur, NBAP for Iub) and the bearers (ex: SS7, CTP/IP)

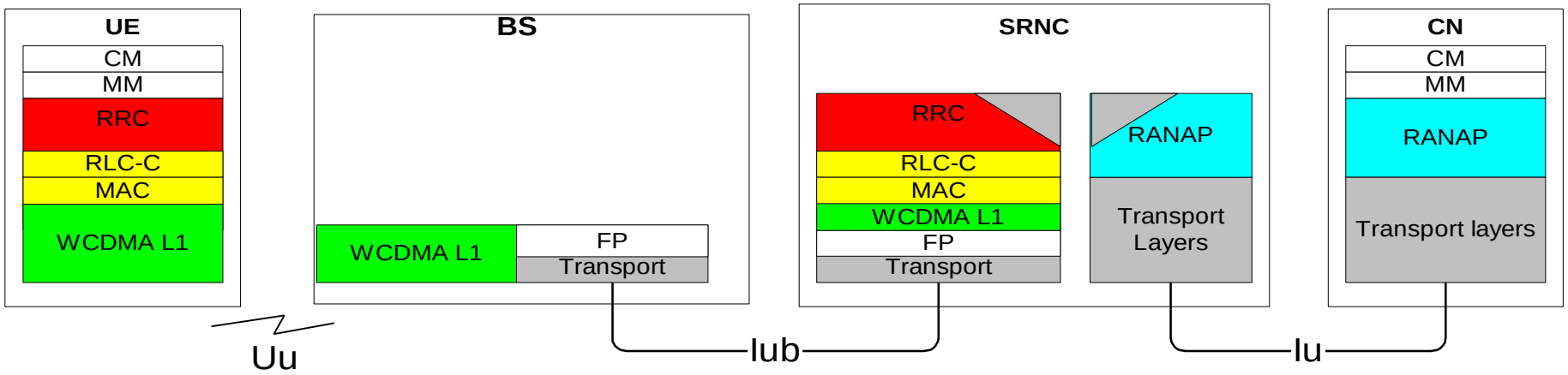
(2) Transport Network Control Plane: Defines the signalling protocol used for the control of the ALL2/ATM channels in the user plane (Q.AAL2)

(3) User Plane: Defines the Frame protocols (FP) to transfer user data through the interrace and the AAL2/ATM based transport

RAN protocol stacks

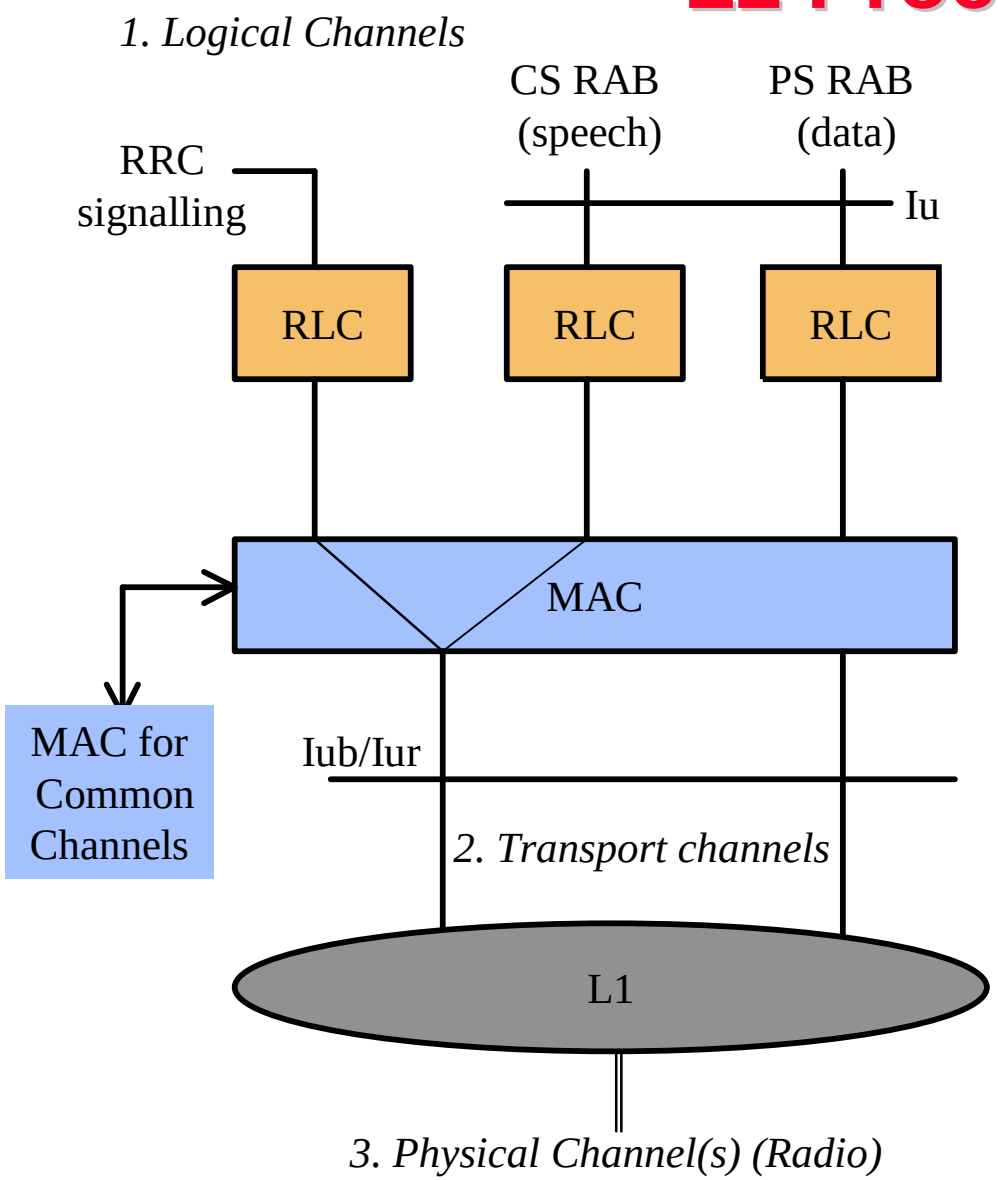


Air interface user plane for dedicated channel



Air interface control plane for dedicated channel

L2 Processing



- Segmentation
- Retransmission across the air
- Ciphering of NRT data
- Buffering

- Selection of the data to be inserted in the Radio Frame
- Selection of common or dedicated channels
- Multiplexing of logical channels into same transport channels
- Ciphering for RT

RLC: Radio Link control
MAC: Medium Access Control

Radio Resource Management

RRM functions provide an efficient use of the WCDMA capacity.

Main components are:

- **Admission Control:** To allow/deny the admission of a new Radio Bearer estimating the increase of interference level that it will cause. To define the Transport Format Set from the QoS parameters.
- **Load Control:** To maintain the load of the cell under a critical threshold, performing limiting actions when necessary.
- **Packet Scheduler:** To schedule the NRT data transmission accordingly to the available capacity in the cell
- **Handover Control:** To manage the Active Set of the UE. Possible softer, soft, hard (interfrequency and intersystems) handovers. MEHO and NEHO supported.
- **Power Control:** To control the BS/UE transmission power
  - Inner loop PC: Receiver maintains a target Signal to Interference Ratio (SIR) commanding power up/down every .625 msec to the Transmitter
  - Outer loop PC: SIR target is adjusted accordingly to BER/FER after the MDC combining
  - Open loop PC: Set initial power, CCH power