

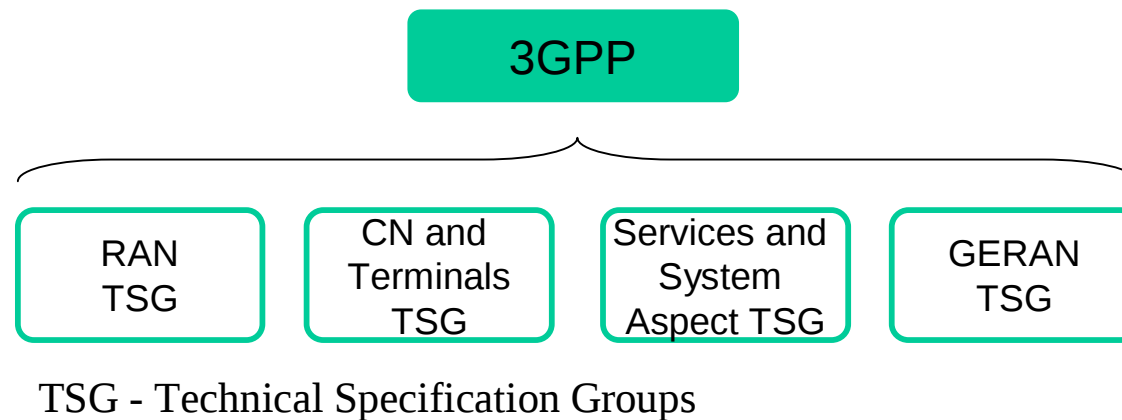
UMTS

Generations of mobile systems

Generation	Names	Features
1 (1980-1995)	NMT (Nordic Mobile Telephone); 450 MHz, 900 MHz AMPS (Advance Mobile Telephone System); USA TACS (Total Access Communication System); UK, I, SP, Radiocom 2000; FR	Analogue systems National systems Voice
2 (1992-2000)	GSM (Global System for Mobile communications) - GSM 900 - GSM 1800 (DCS, Digital Communication System) DAMPS (Digital AMPS, also know as IS136) PCS 1900 (Personal Communication System), based on DCS ...GSM variant in USA IS95 (Interim Standard) based on CDMA - IS95a,b is also referred as cdmaOne PDC (Personal Digital Communication), closed to DAMPS	Optimized for voice traffic Digital systems FDMA/TDMA/CDMA Voice + data
2,5 (1999-2010)	GPRS/ (General Packet Radio Service) EGPRS/EDGE (Enhanced GPRS/Enhanced Data rates for Global Evolution)	Voice + data
3 (2004-20?)	cdma2000 - cdma2000 1xEV-DO (cdma2000 Evolution-Data Only) - cdma2000 1xEV-DV (cdma2000 Evolution-Data/Voice) UMTS (Universal Mobile Telecommunication System)	Multimedia

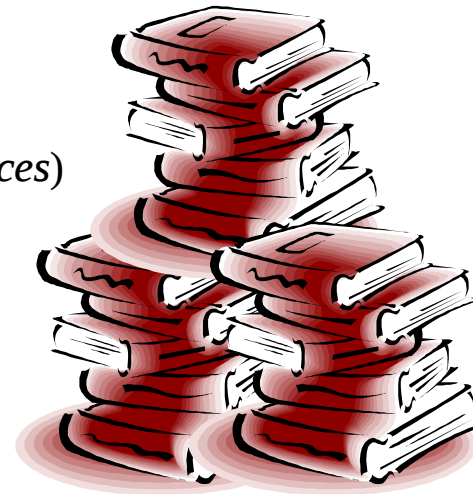
3GPP (3rd Generation Partnership Project)

- Created 1998
- Association of standardization bodies & forums
 - Ø ETSI (Europe), ARIB (Japan), ATIS (USA), CCSA (China), etc.
 - Ø UMTS forum, IPv6 forum, etc.
- Specification of UMTS (...and EDGE)
- www.3gpp.org



Releases in UMTS

- **Release 99** (1999)
 - Ø First Release
- **Release 4** (2001)
- **Release 5** (2002)
 - Ø HSDPA (*High Speed Downlink Packet Access*)
 - Ø IMS (*IP Multimedia Subsystem*)
- **Release 6** (2004)
 - Ø MBMS (*Multimedia Broadcast/Multicast Services*)
 - Ø HSUPA (*High Speed Uplink Packet Access*)
- **Release 7** (2007?)
 - Ø HSPA+
- **Release 8** (?)
 - Ø ...LTE (*Long Term Evolution*)



Frequency bands (Europe)

Mode	Uplink	Downlink	Band
UMTS-FDD	1920 - 1980 MHz	2110 - 2170 MHz	60 + 60 MHz
UMTS-TDD	1900 - 1920 MHz 2010 - 2025 MHz		20 + 15 MHz
Satellite	1980 - 2010 MHz	2170 - 2200 MHz	30 + 30 MHz

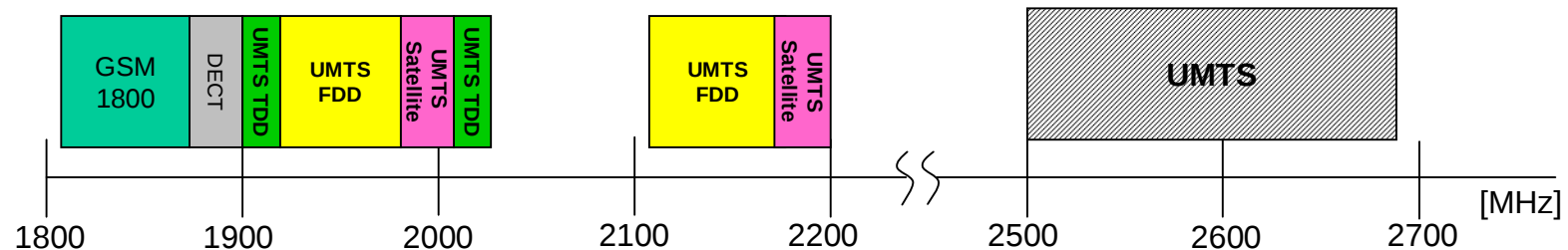
The frequency bands were specified in 1992

In 2000, additional frequency bands

Ø 806 - 960 MHz, 1710 - 1885 MHz

Ø 2500 - 2690 MHz

} GSM_{Europe}



Features

- Several simultaneous radio connections per user
- High adaptability of radio connections
 - Ø Setting of connections according to supported services
- Wide range of services with different QoS
 - Ø Voice, web, email, video/Audio streaming, etc.

...UMTS allows good support for existing and for future services

144 kbit/s	384 kbit/s	2 Mbit/s	14 Mbit/s	5,8 Mbit/s
Rural outdoor environments	Urban outdoor environments	Indoor and low range outdoor environments	HSDPA*	HSUPA**

*HSDPA (High Speed Downlink Packet Access)

**HSUPA (High Speed Uplink Packet Access)

WCDMA subscribers

- # Subscribers: 177 mil.
- # Networks Launched: 82
Ø www.ums-forum.org (11/2007)

Region	Percentage WCDMA
Asia Pacific	44%
Europe: Western	48%
USA/Canada	3%
Middle East	1%
Europe: Eastern	4%
Africa	1%

Top Ten Countries Ranked by WCDMA Penetration:

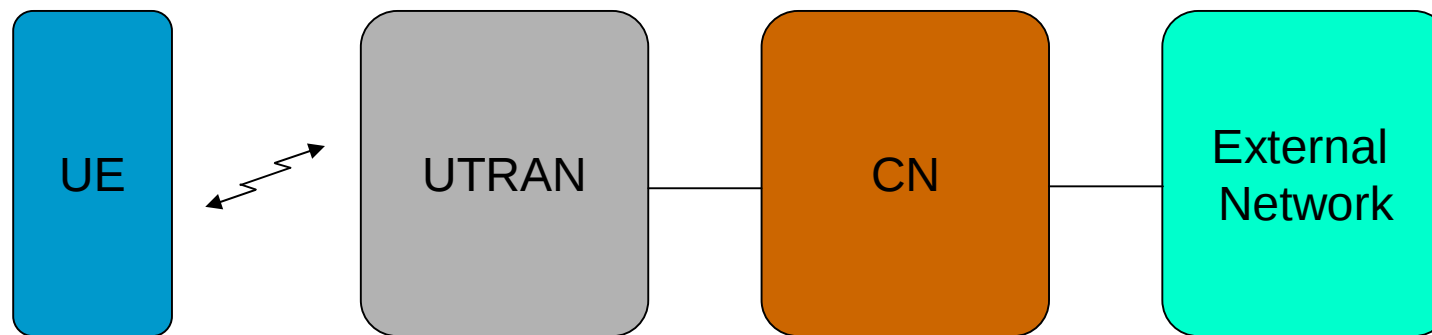
Region	Percentage WCDMA
Japan	51%
Brunei Darussalam	32%
Singapore	31%
Luxembourg	29%
Ireland	28%
Hong Kong	28%
Italy	25%
Portugal	25%
Australia	18%
Taiwan	21%

Network architecture

UMTS architecture (1/3)

- Air interface
 - Ø WCDMA (Wideband Code Division Multiple Access)
 - Ø Radio channel 5 MHz
- New or enhanced protocols on the radio interface
- Core network based on the GSM/GPRS core network

UMTS architecture (2/3)

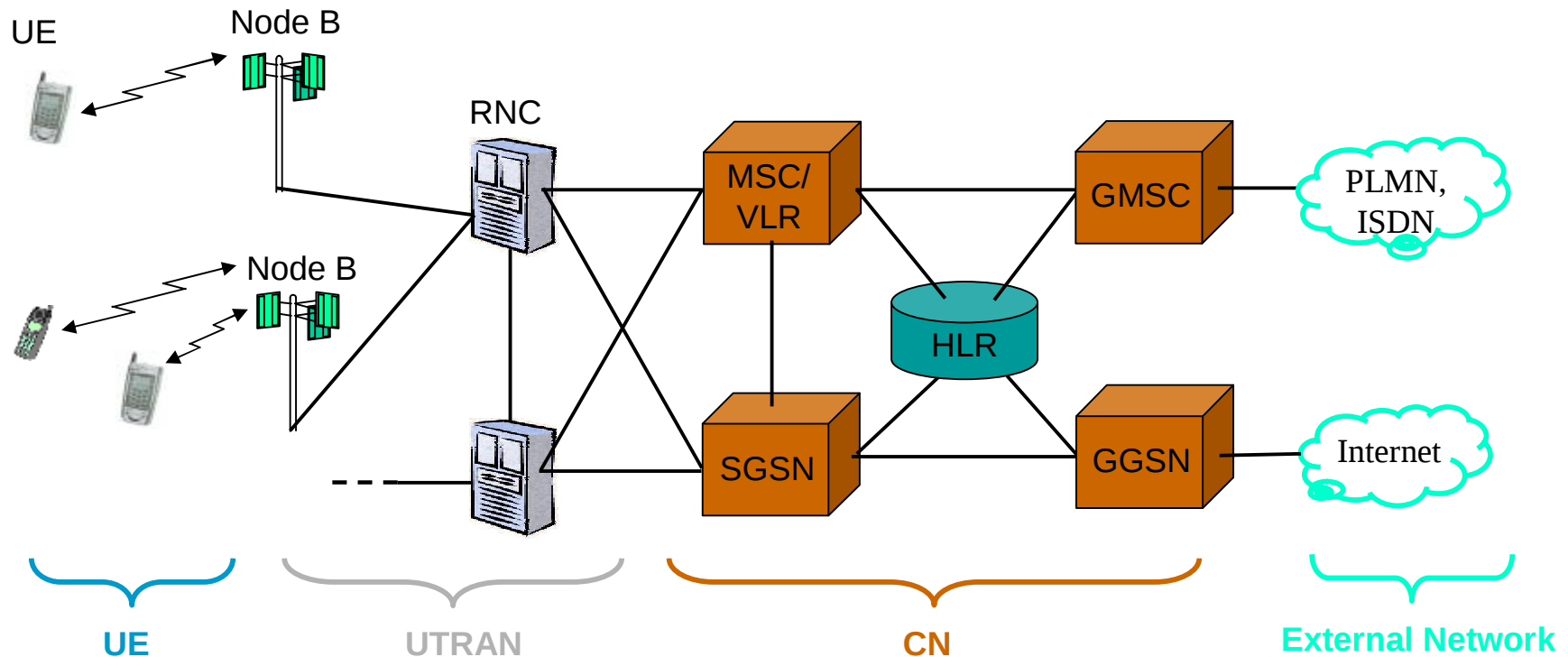


UE: **User Equipment**

UTRAN: **UMTS Terrestrial Radio Access Network, (or RAN)**

CN: **Core Network**

UMTS architecture (3/3)

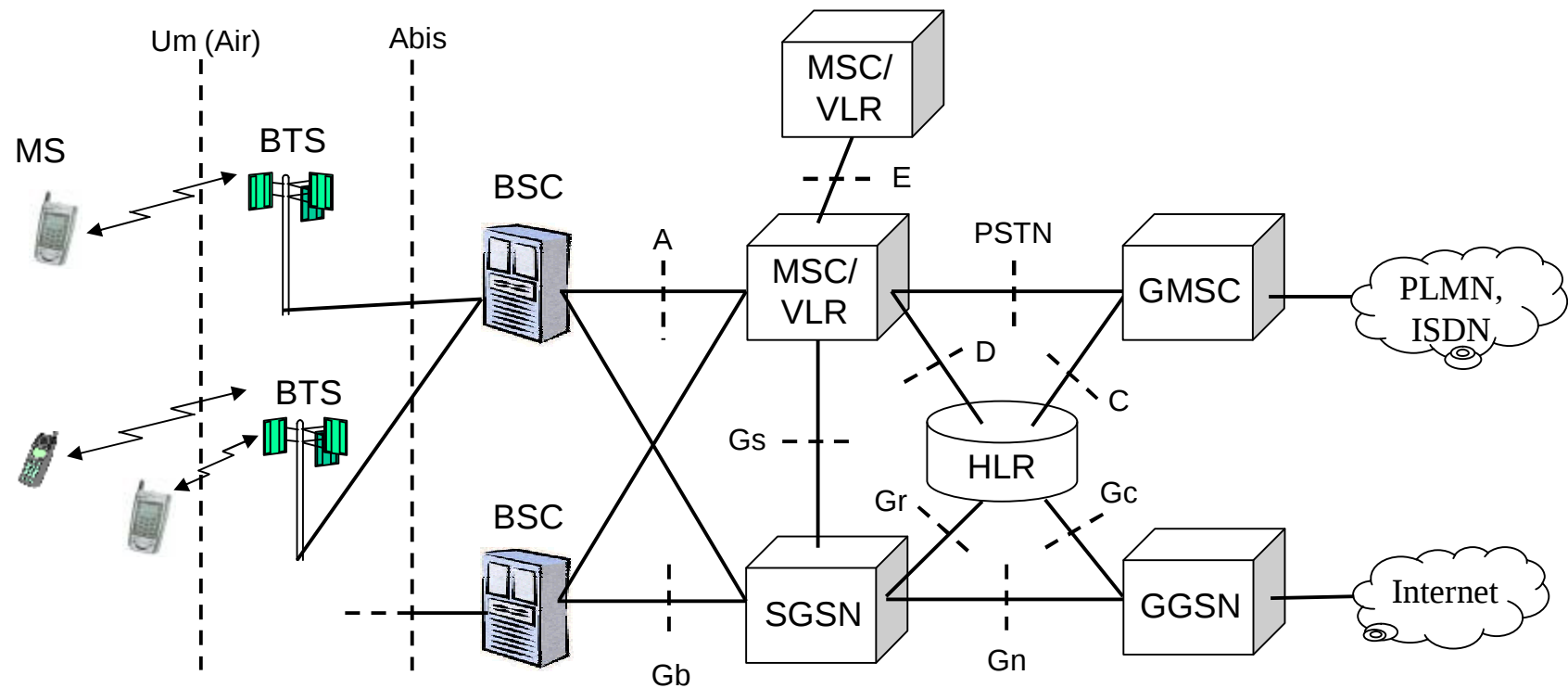


UE: User Equipment
RNC: Radio Network Controller

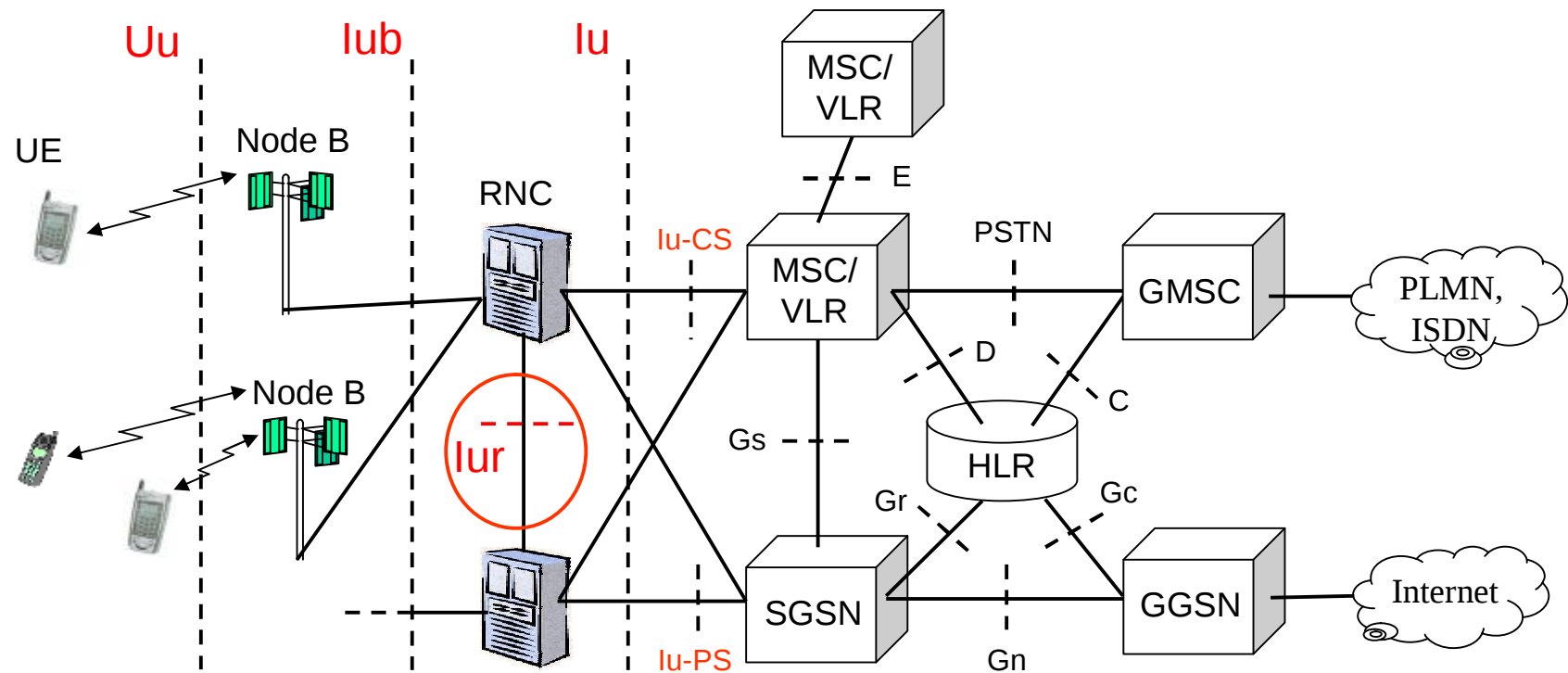
MSC: Mobile Switching Centre
VLR: Visitor Location Register
HLR: Home Location Register

SGSN: Serving GPRS Support Node
GMSC: Gateway MSC
GGSN: Gateway GPRS Support Node

GPRS vs. UMTS (1/2)

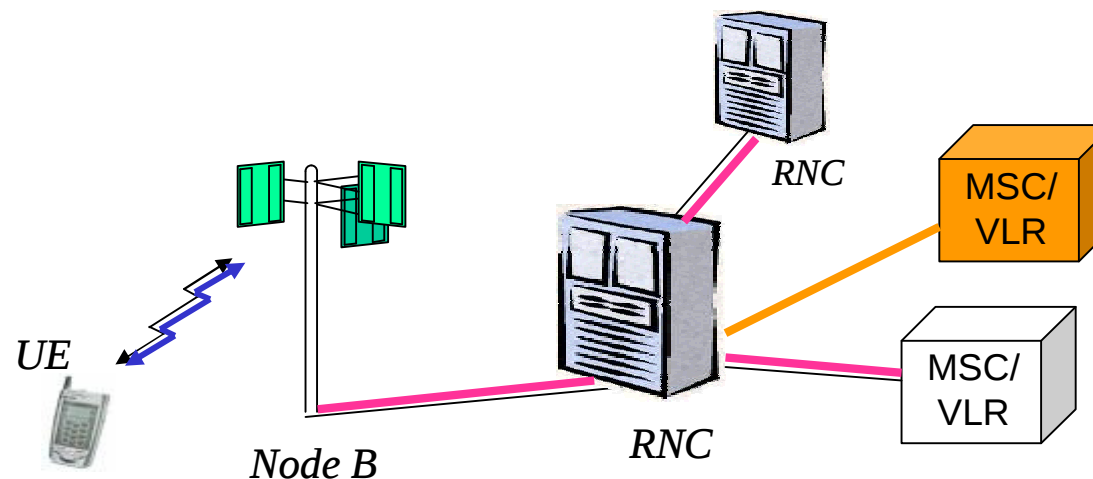


GPRS vs. UMTS (2/2)

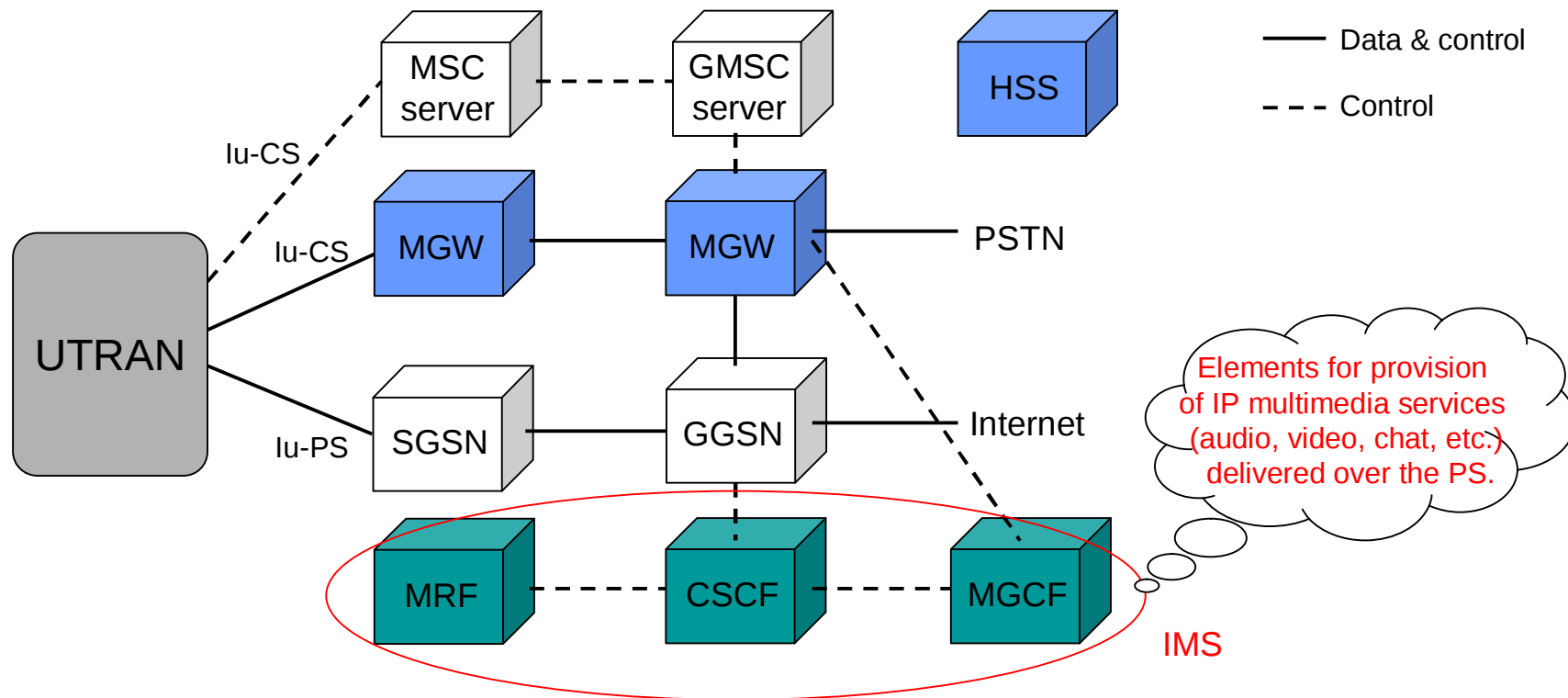


UTRAN evolutions

- IP transport in UTRAN (...instead of ATM)
 - Ø Iur/Iub, Iu-CS
- Iu flex (flexible)
 - Ø RNC have more than one Iu-CS/Iu-PS interfaces with CN
- HSPA
 - Ø HSDPA, HSUPA



CN evolutions (1/2)



MGM: Media Gateway

HSS: Home Subscriber Server

IMS: IP Multimedia Subsystem

MRF: Media Resource Function

CSCF: Call Session Control Function

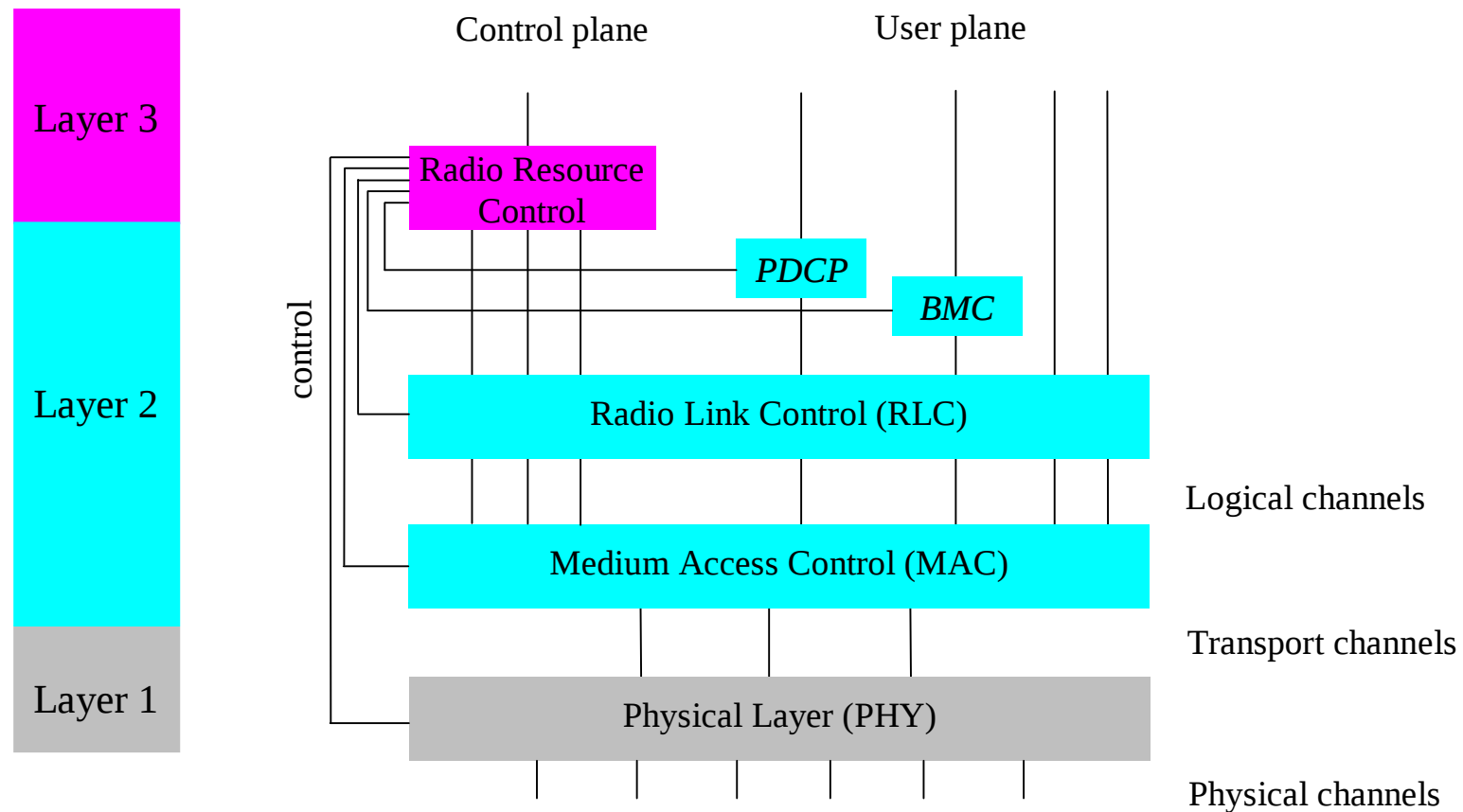
MGCF: Media Gateway Control Function

CN evolutions (2/2)

- MSC, GMSC servers
 - Ø Provide control functionalities (...data through MGW)
 - Ø One MSC, GMSC server can control several MGWs
 - ... When data rates increase, only the number of MGWs need to be increased
- HSS
 - Ø ...Instead of HLR (mobility management, security, identification, etc.)
- MRF
 - Ø Setting up multimedia connections
- CSCF
 - Ø Switching of multimedia connections and their management
- MGCF
 - Ø Handling of protocol conversion between ISUP and IMS call control protocols
 - Ø Exchange of signalling related to IP services between UMTS and CS networks
- 3GPP 23.002

Protocol architecture of UTRAN

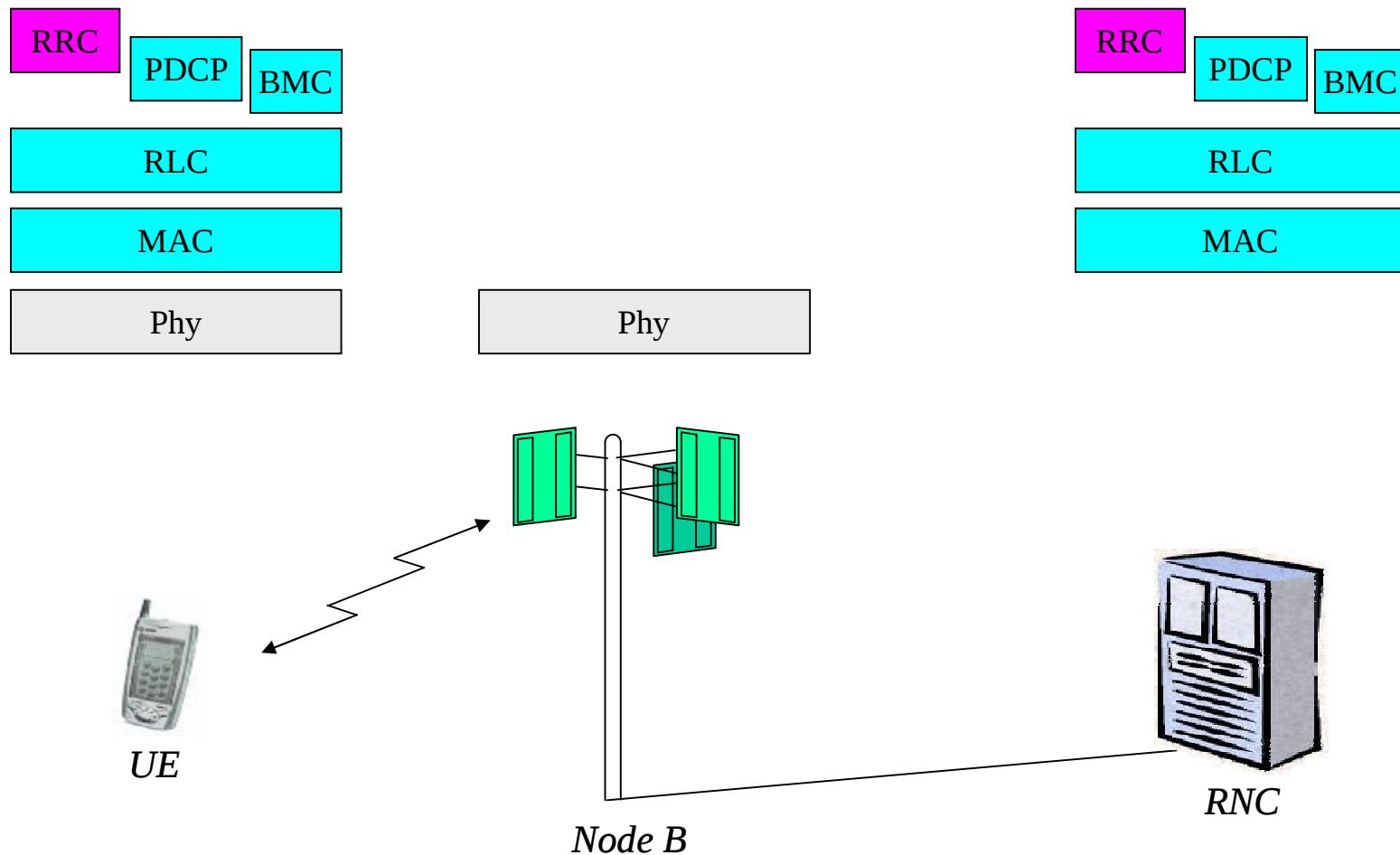
Protocol architecture (1/2)



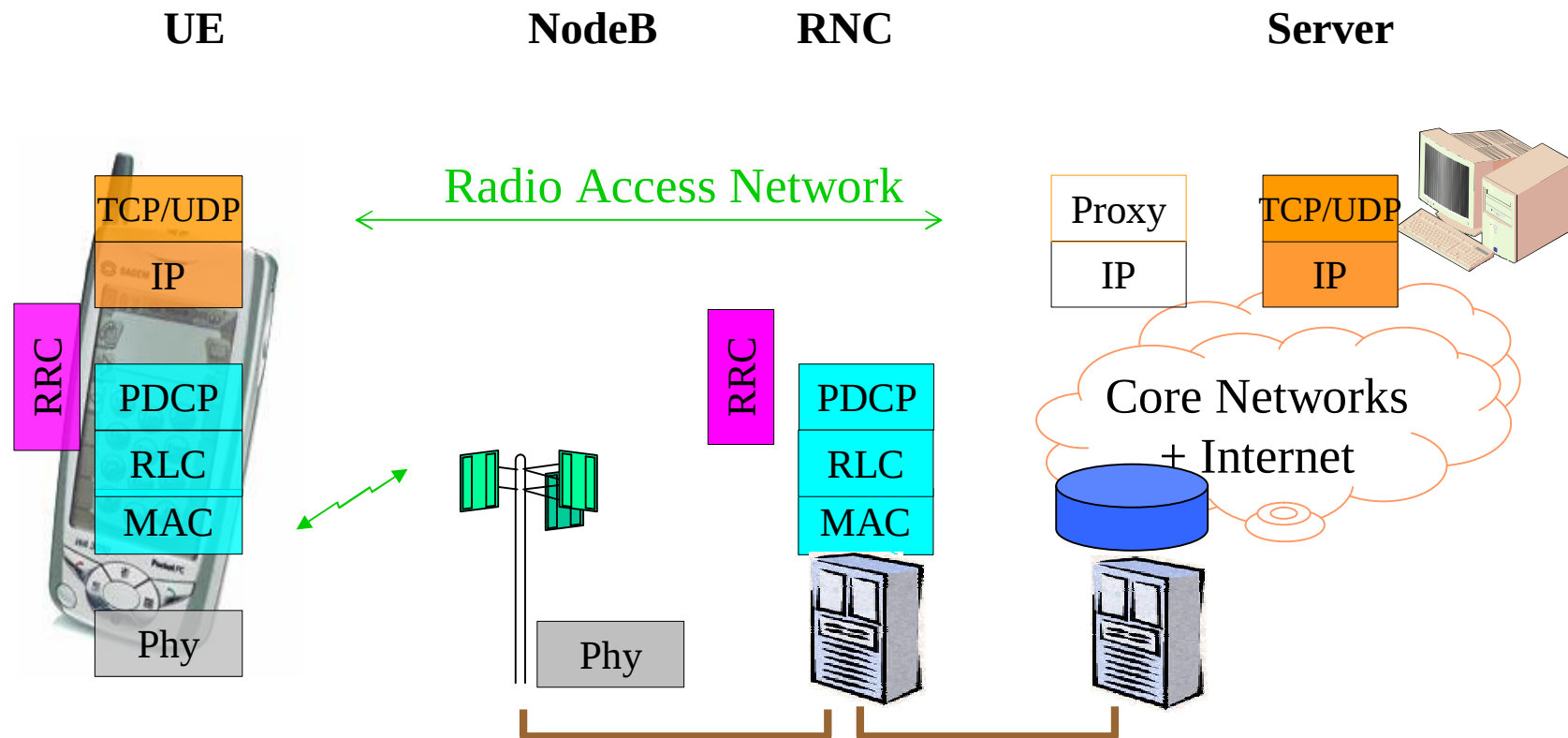
PDCP: Packet Data Convergence Protocol

BMC: Broadcast/Multicasts Control Protocol

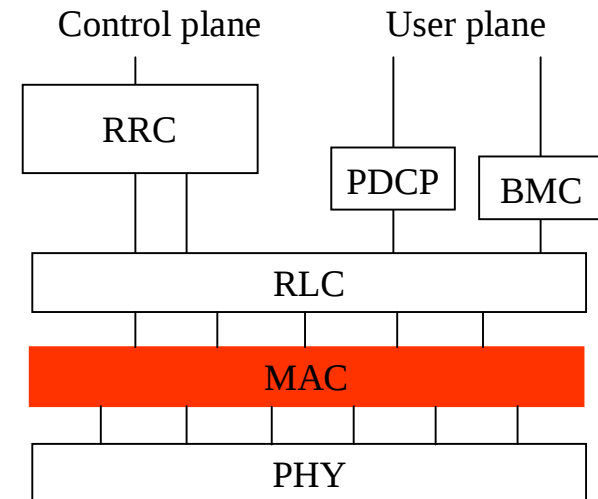
Protocol architecture (2/2)



Data transmission in UMTS



- **M**edium **A**ccess **C**ontrol
- Functions
 - Ø Mapping
 - Logical channels $\Leftrightarrow$ Transport channels
 - Ø Multiplexing/Demultiplexing
 - RLC blocks $\Leftrightarrow$ transport blocks
 - Ø Scheduling
 - Data flows of one UE
 - UEs
 - Ø Traffic measurement
 - Status of RLC transmission buffer
 - Ø Ciphering
 - TM RLC mode
 - Ø ...

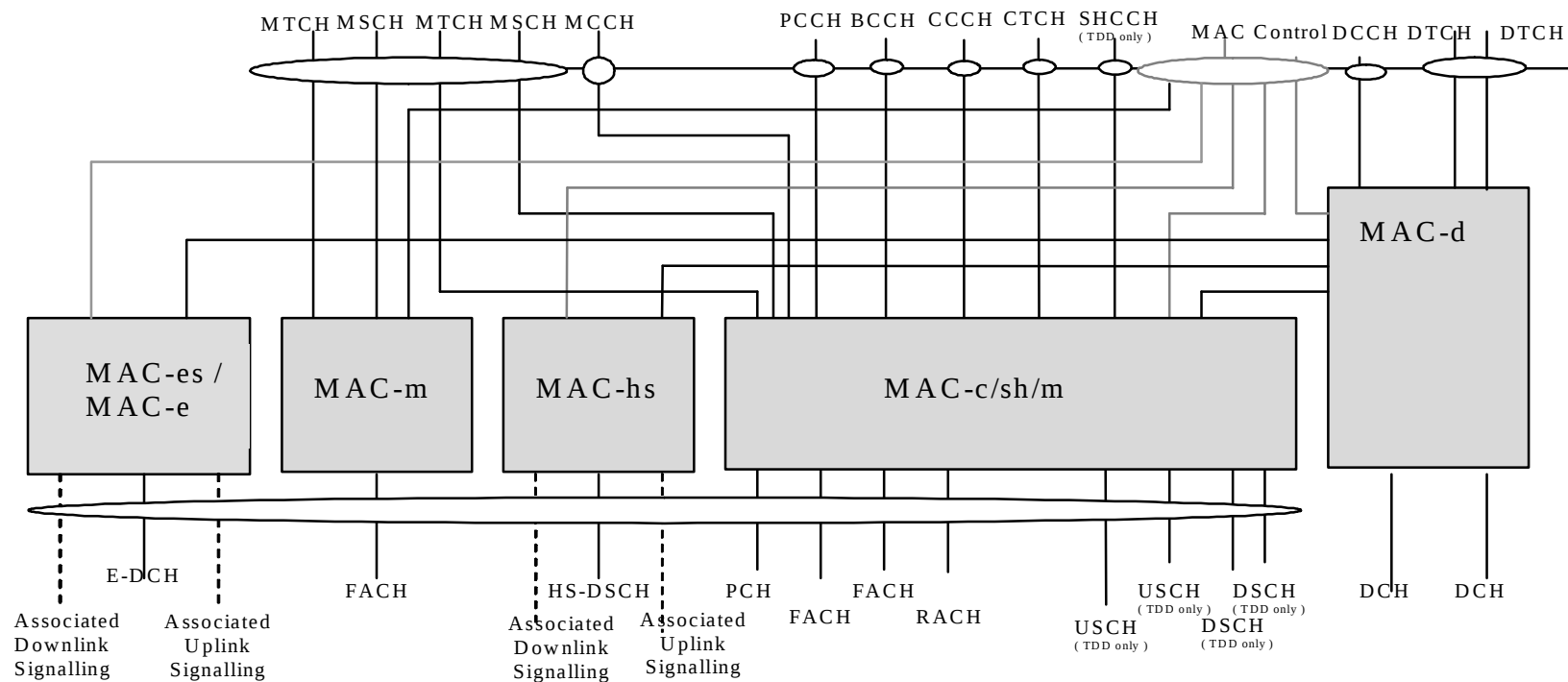


MAC ...entities

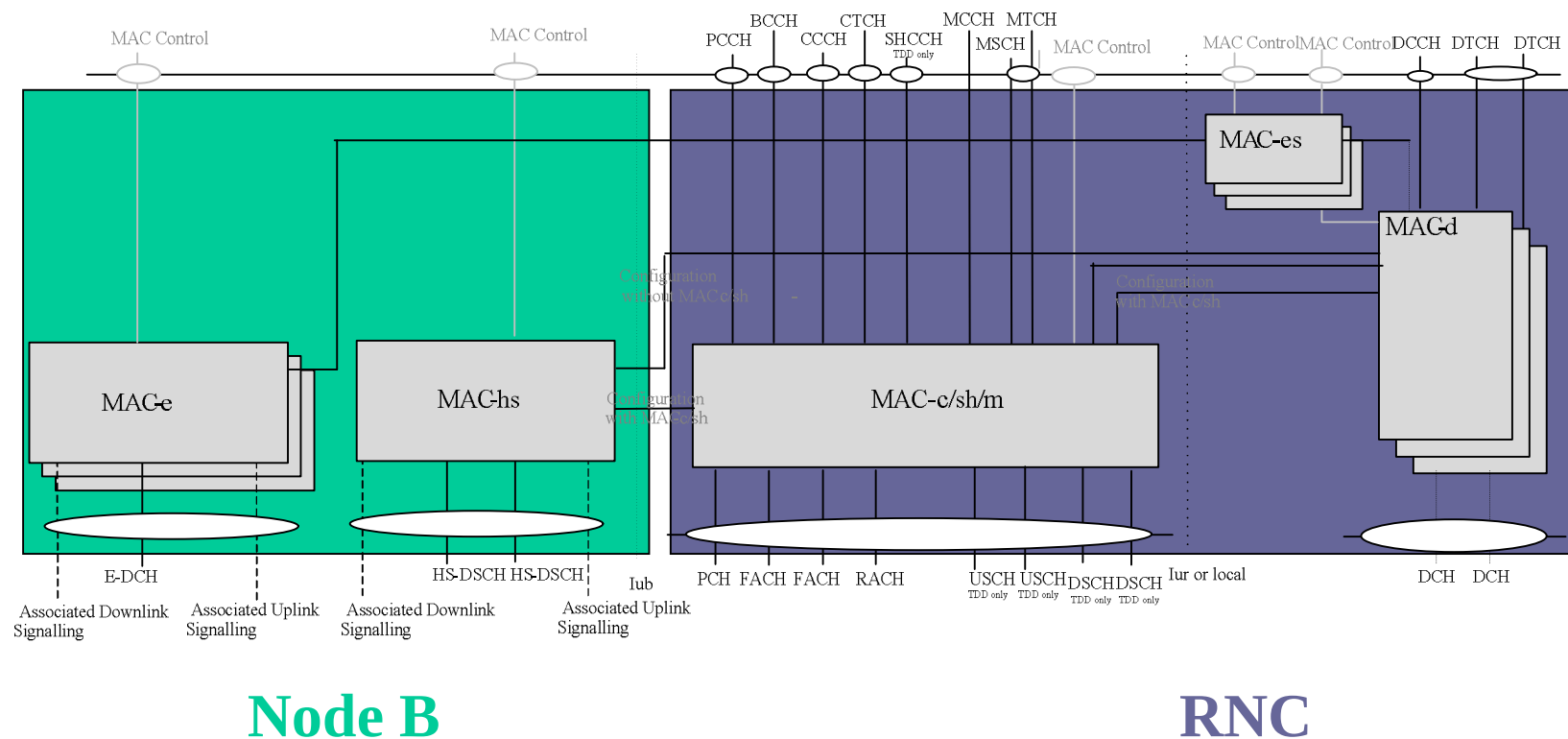
MAC entity	Transport channel		Release
MAC-b	Broadcast ch.	BCH (Broadcast channel)	Rel'99
MAC-c/sh/m	Common ch.	PCH (Paging channel) FACH (Forward Access channel) RACH (Random Access channel) DSCH (Downlink Shared channel) USCH (Uplink Shared channel)	Rel'99
MAC-d	Dedicated ch.	DCH (Dedicated channel)	Rel'99
MAC-hs	HSDPA	HS-DSCH (HS Downlink Shared channel)	Rel'5
MAC-e/es	HSUPA	E-DCH (Enhanced Dedicated channel)	Rel'6
MAC-m	Common ch.	FACH (Forward Access channel) ...MBMS*	Rel'6

*MBMS – Multimedia Broadcast Multicast Service

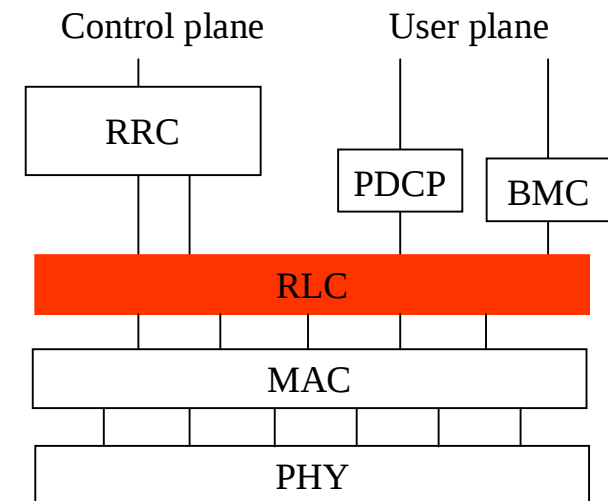
MAC ...entities - UE



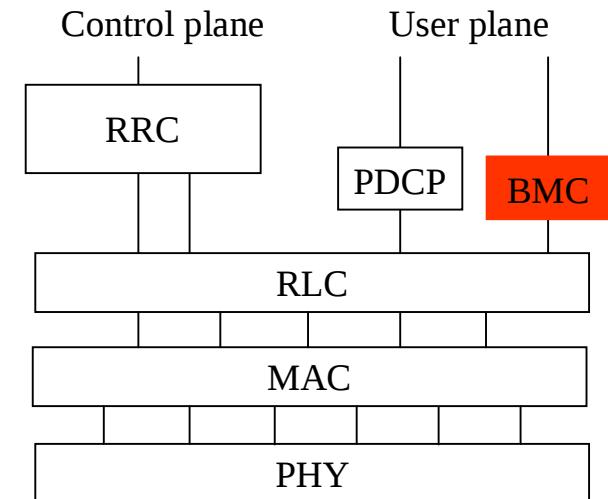
MAC ...entities - UTRAN



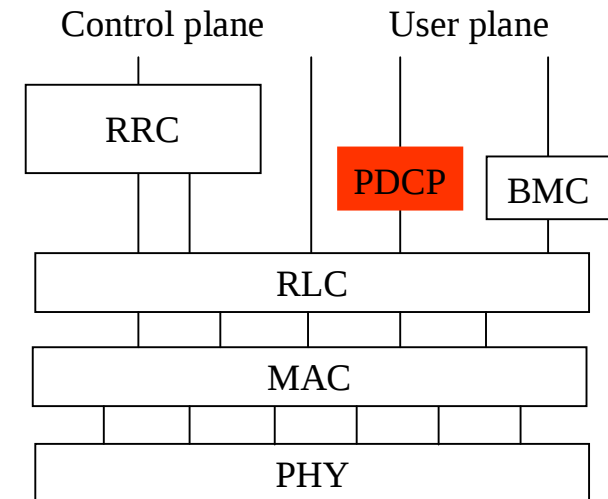
- **R**adio **L**ink **C**ontrol
- Functions
 - Ø Segmentation/Reassembly
 - Upper layer blocs $\Leftrightarrow$ RLC blocks
 - Ø Error corrections
 - ARQ (Selective Repeat)
 - Ø Flow control
 - Ø In-sequence delivery to upper layer
 - Ø Ciphering
 - Ø Protocol error detection and recovery
 - Ø ...



- **B**roadcast/**M**ulticast **C**ontrol protocol
- Functions
 - Ø Storage of cell broadcast messages
 - Ø Scheduling of BMC messages
 - Ø Transmission of BMC messages to UEs
 - Ø ...



- **P**acket **D**ata **C**onvergence **P**rotocol
- Functions
 - Ø Compression (decompression) of TCP/IP & RTP/UDP/IP headers
 - Ø ...



- **R**adio **R**esource **C**ontrol protocol
- Control plane
- Control all lower layer
- RRC units
 - Ø Signaling of RRC
 - Ø Signaling of upper layer (Mobility & Session manag., Call control, etc.)
- Functions
 - Ø Controls measurements
 - Ø Establishment/maintenance/release RRC conn.
 - Ø Power control
 - Ø ...

