Mobile Communication

GSM, GPRS, EDGE, UMTS and beyond

Ralf Keller
Ericsson Research, Corporate Unit
Ericsson Eurolab Deutschland GmbH

Ralf.Keller@ericsson.com

Overview

- Services
- GSM
- GPRS & EDGE
- UMTS
- Beyond

Services

Personal and Secure Services

Mobile Messaging

- **e-mail**
- **Voice-mail**
- **SMS/EMS + MMS**
- **Instant Message**

Mobile -WWW
(Browsing/streaming)

- **Information**
  (news, sport, etc)
- **Entertainment**
  (Music, Games…)
- **Location Services**

Mobile Commerce
(Transactions)

- **Banking**
- **Trading**
- **Ticketing**
- **Shopping**

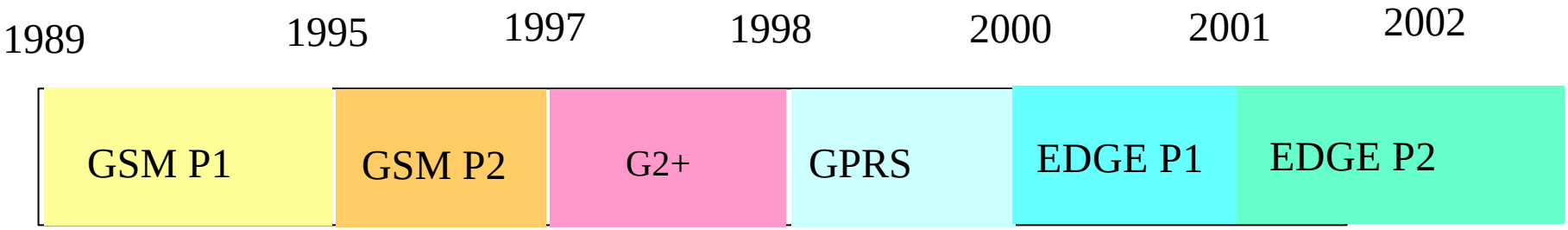
UMTS

GSM / EDGE / GPRS / HSCSD

GSM

Global System for Mobile communication

GSM Evolution



Basic
CS domain:
voice
fax
SMS
data (9.6 kbps)

Suppl
Services:
call waiting
conf call

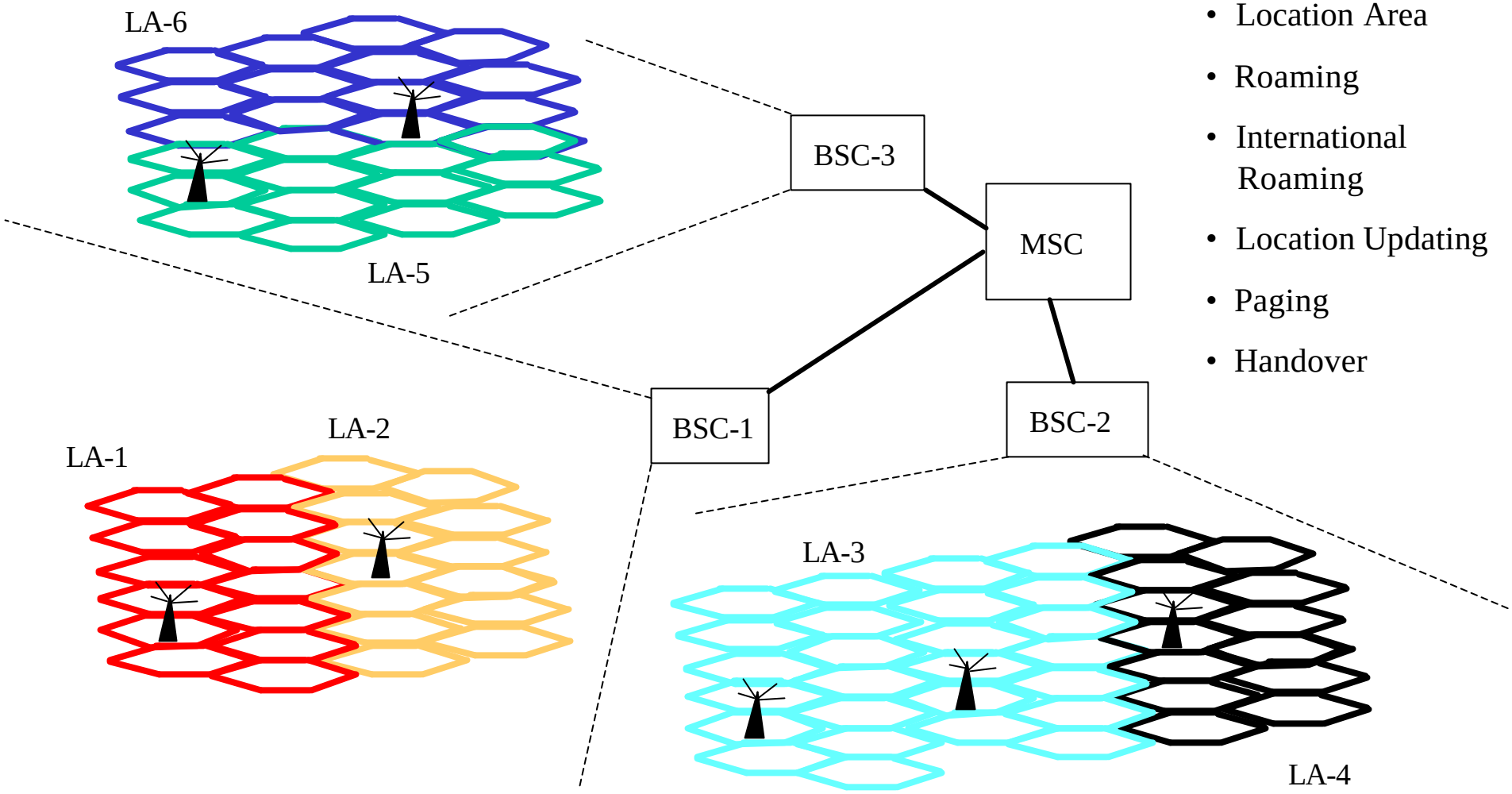
Interw.
with
GSM 1800
GSM 1900
14.4 kbps
HSCSD
57.6 kbps

PS domain
data
160 kbps

8PSK
data
384 kbps
EGPRS
ECSD

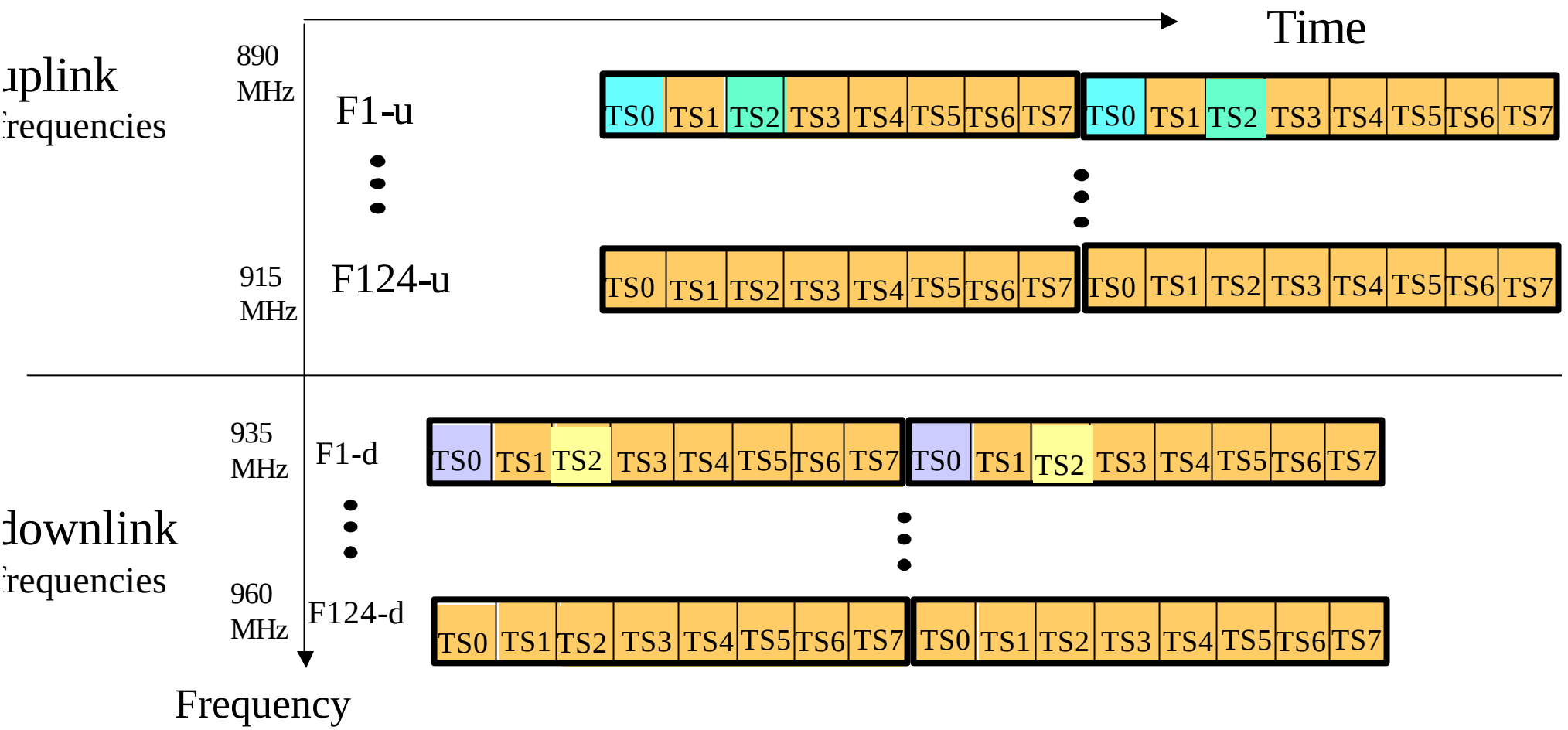
Voice over
PS-domain
all-IP

Key Terms



- Location Area
- Roaming
- International Roaming
- Location Updating
- Paging
- Handover

GSM900 Air Interface (TDMA)



GSM Frequency Bands

	GSM 900	eGSM	GSM 1800	GSM 1900
Uplink	890-915 MHz	880-890 MHz	1710-1785 MHz	1850-1910 MHz
Downlink	935-960	925-935	1805-1880	1930-1990
carrier separation	200 kHz			
carrier pairs	124	+50	374	299

Frequency Planning in GSM Cells

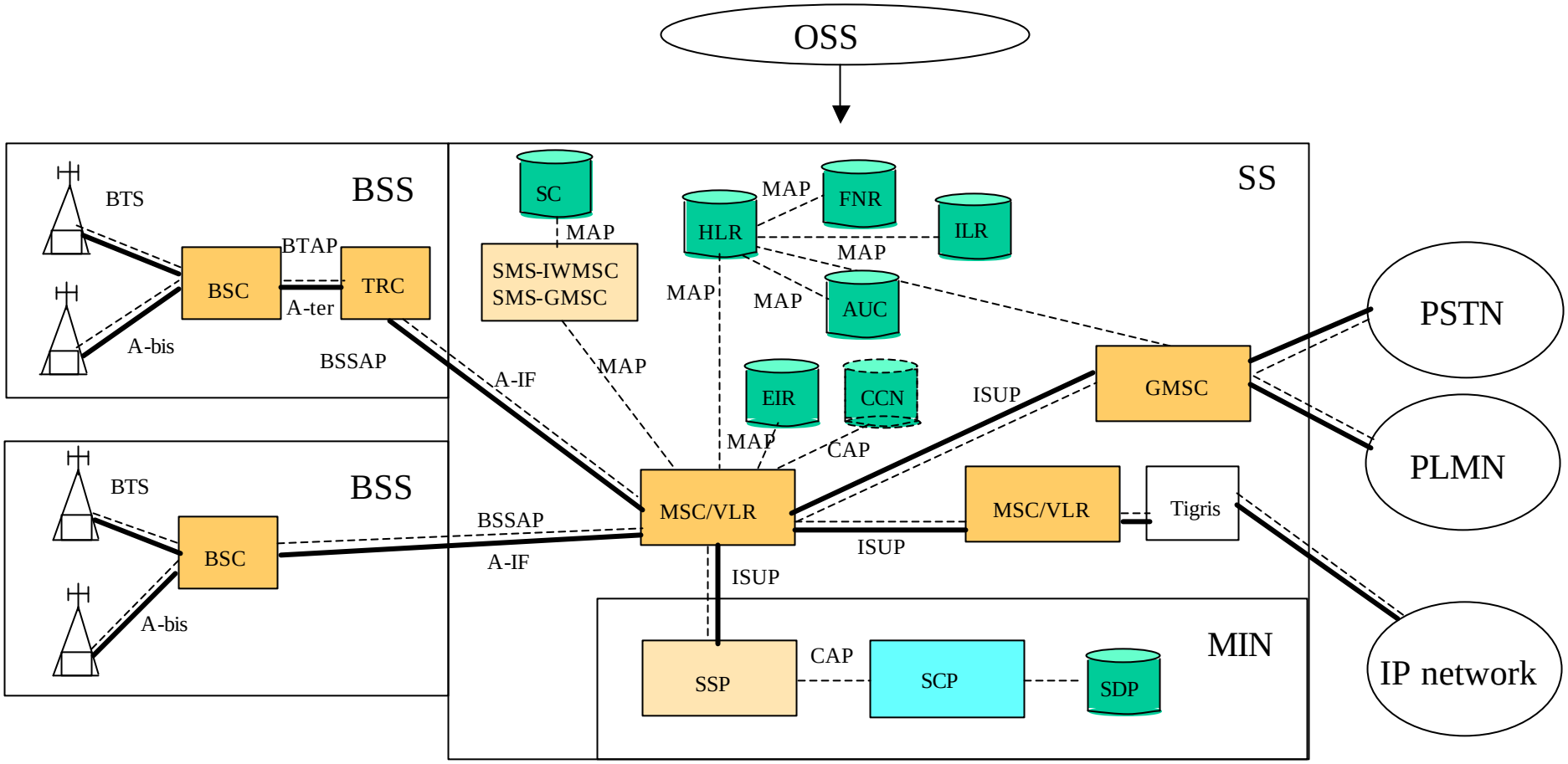
Multiple Reuse Pattern

Frequency Hopping

Micro cell usage for further capacity increase

Half rate calls for further capacity increase

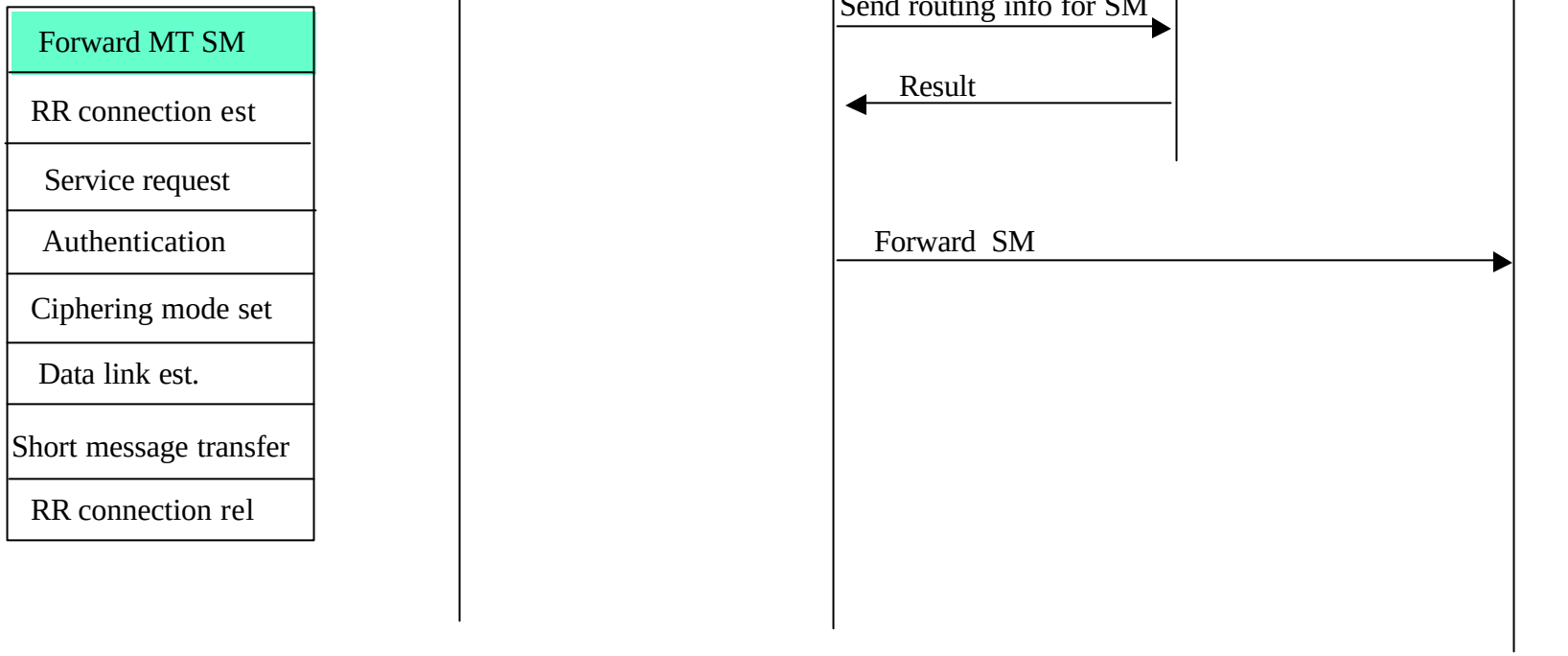
GSM Network


OSS
BSS
BTS
BSC
TRC
BTAP
A-ter
A-bis
BSSAP
BSS
BTS
BSC
A-bis
BSSAP
A-IF
SS
SC
MAP
SMS-IWMSC
SMS-GMSC
HLR
MAP
FNR
ILR
MAP
MAP
MAP
AUC
A-IF
MAP
EIR
CCN
ISUP
GMSC
MAP
CAP
MSC/VLR
MSC/VLR
Tigris
ISUP
ISUP
MIN
SSP
CAP
SCP
SDP
PSTN
PLMN
IP network

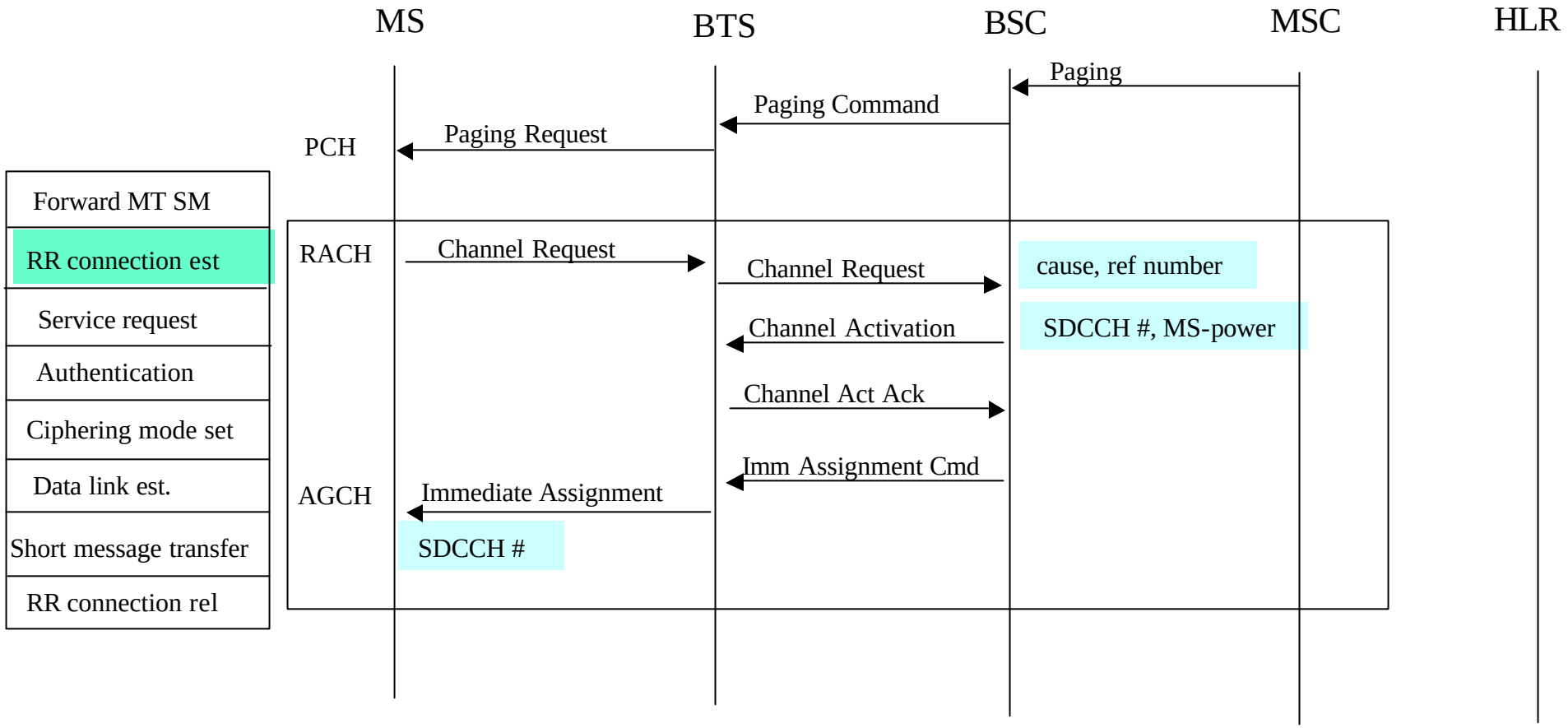
Most Important Traffic Cases

- Location Update with or without registration in HLR
- SMS-Mobile Terminating call
- SMS-Mobile Originating call
- Mobile Originating call
- Mobile Terminating call
- Handover (intra BSC, inter BSC, intra MSC, inter MSC)

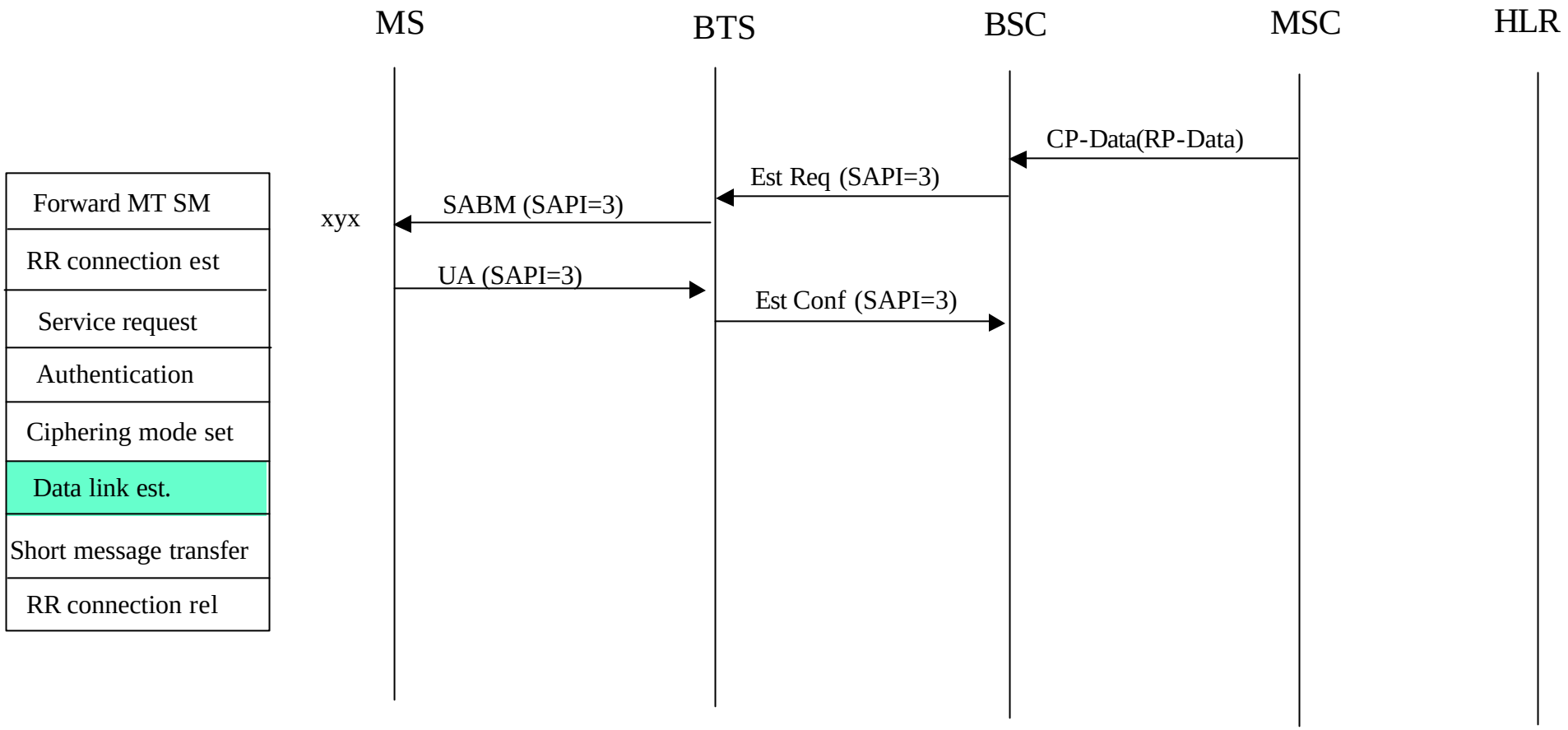
SMS MT (Forw MT SM)



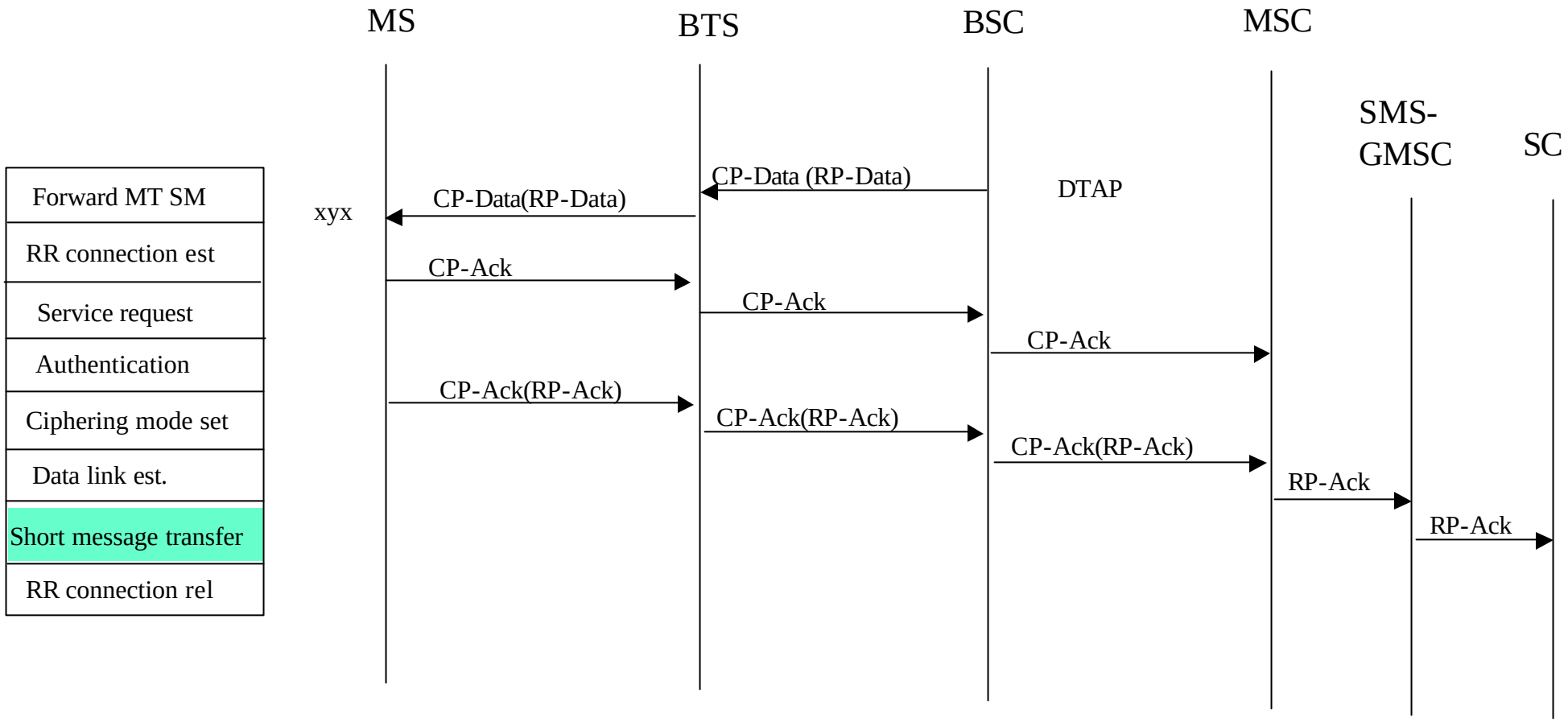
SMS MT (RR conn est)



SMS MT (Data link est)



SMS MT (SM transfer)



GSM Enhancements: GPRS and EDGE

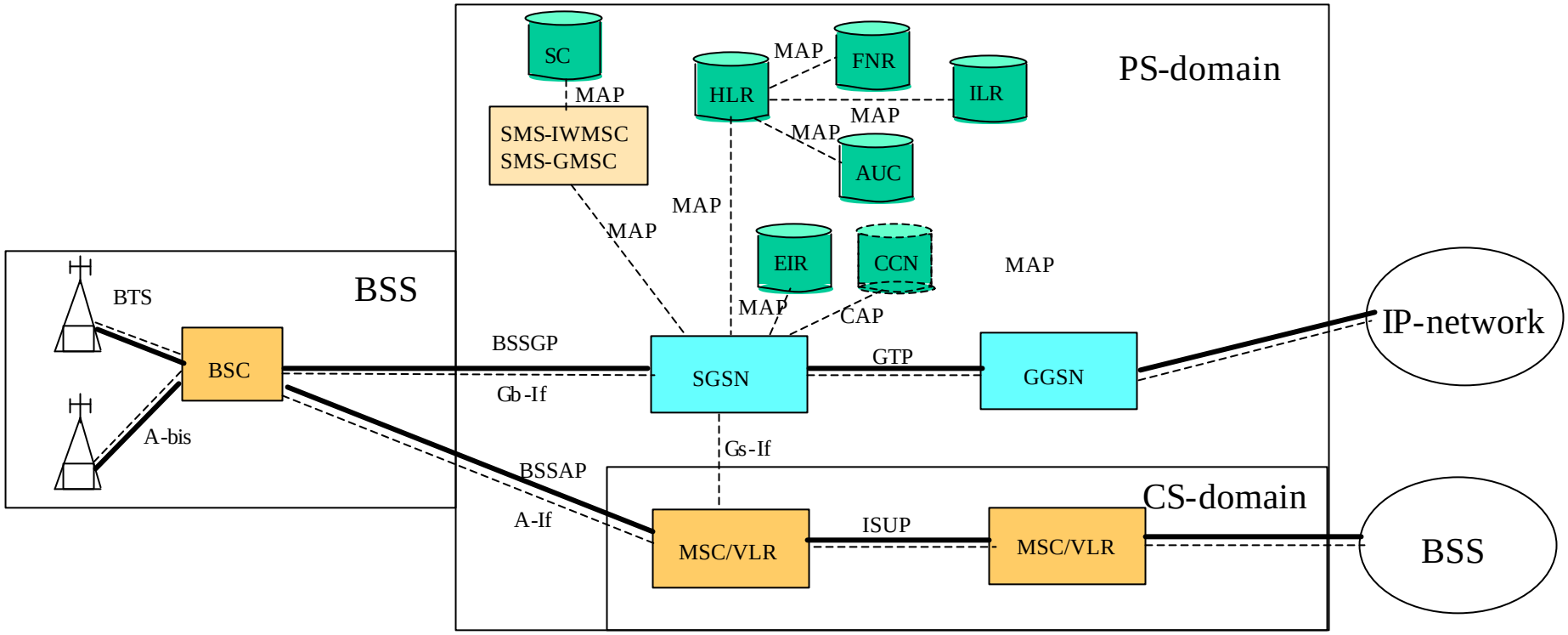
GPRS = General Packet Radio System

EDGE = Enhanced Data rates for Global Evolution

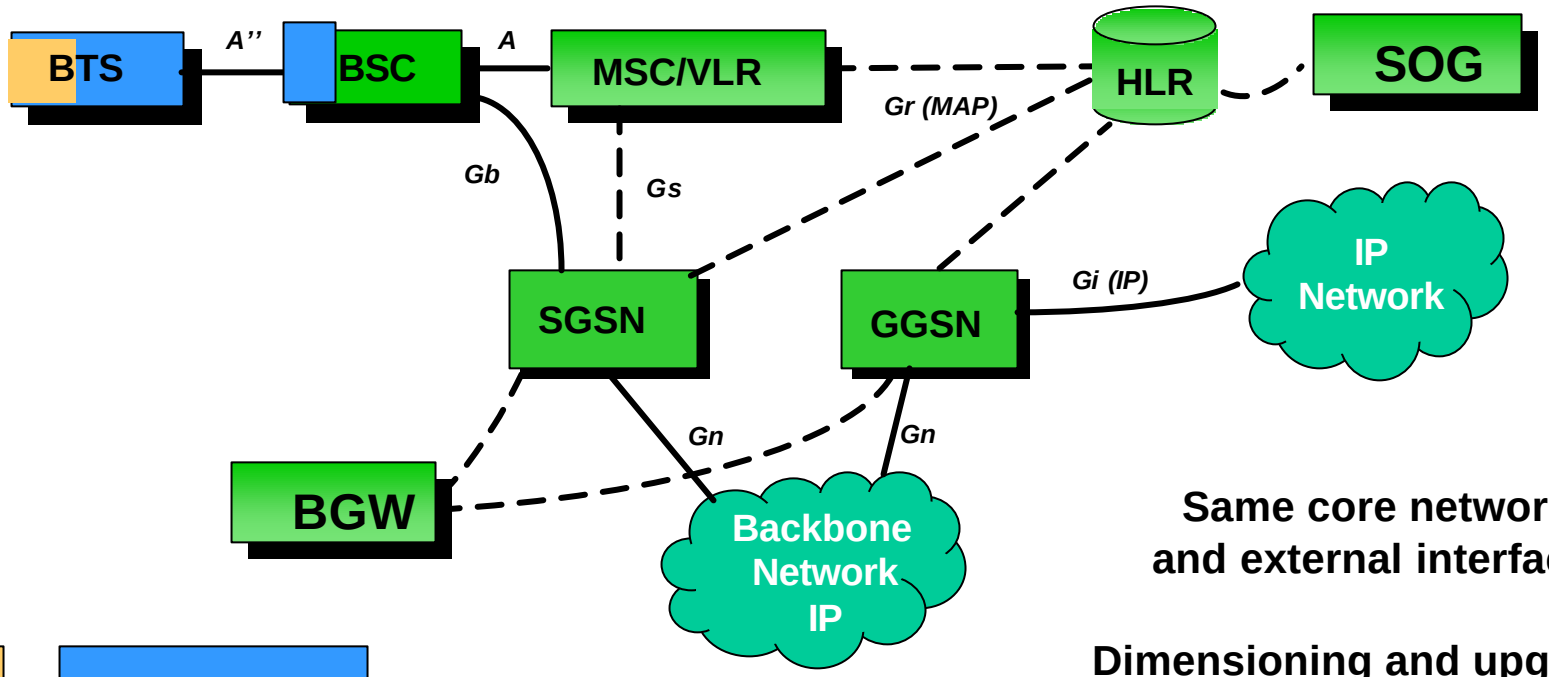
Why GPRS??

- Packet-oriented services over circuit-switched bearers is often not resource-efficient
- New Services become possible …
- Always Connected, Always On-line

GSM Enhancements
GPRS



GSM Enhancements
EDGE



New HW

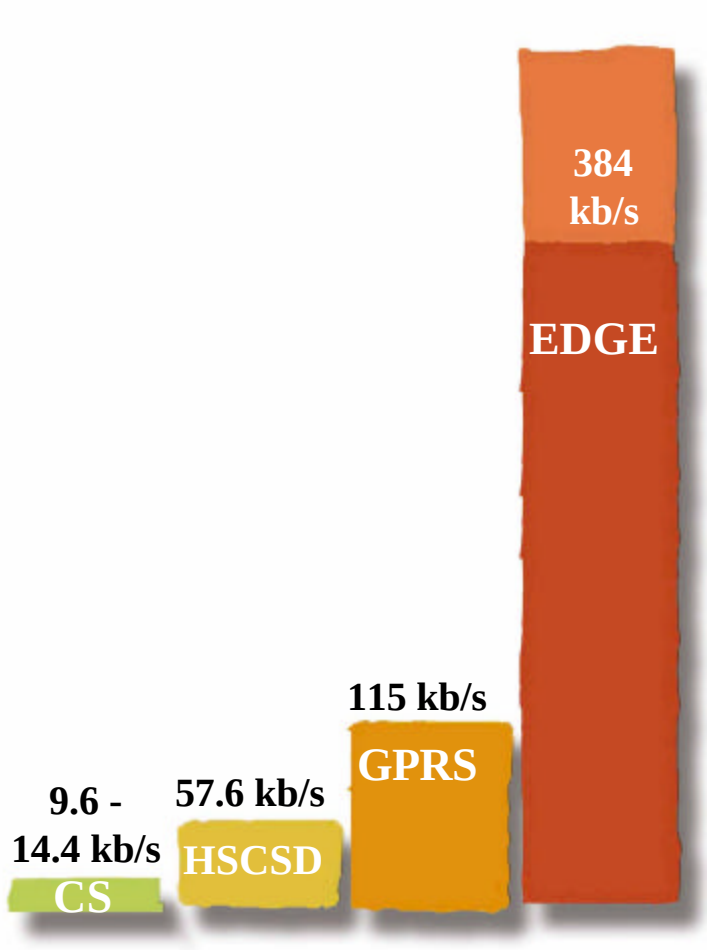
New SW

Same core network and external interfaces

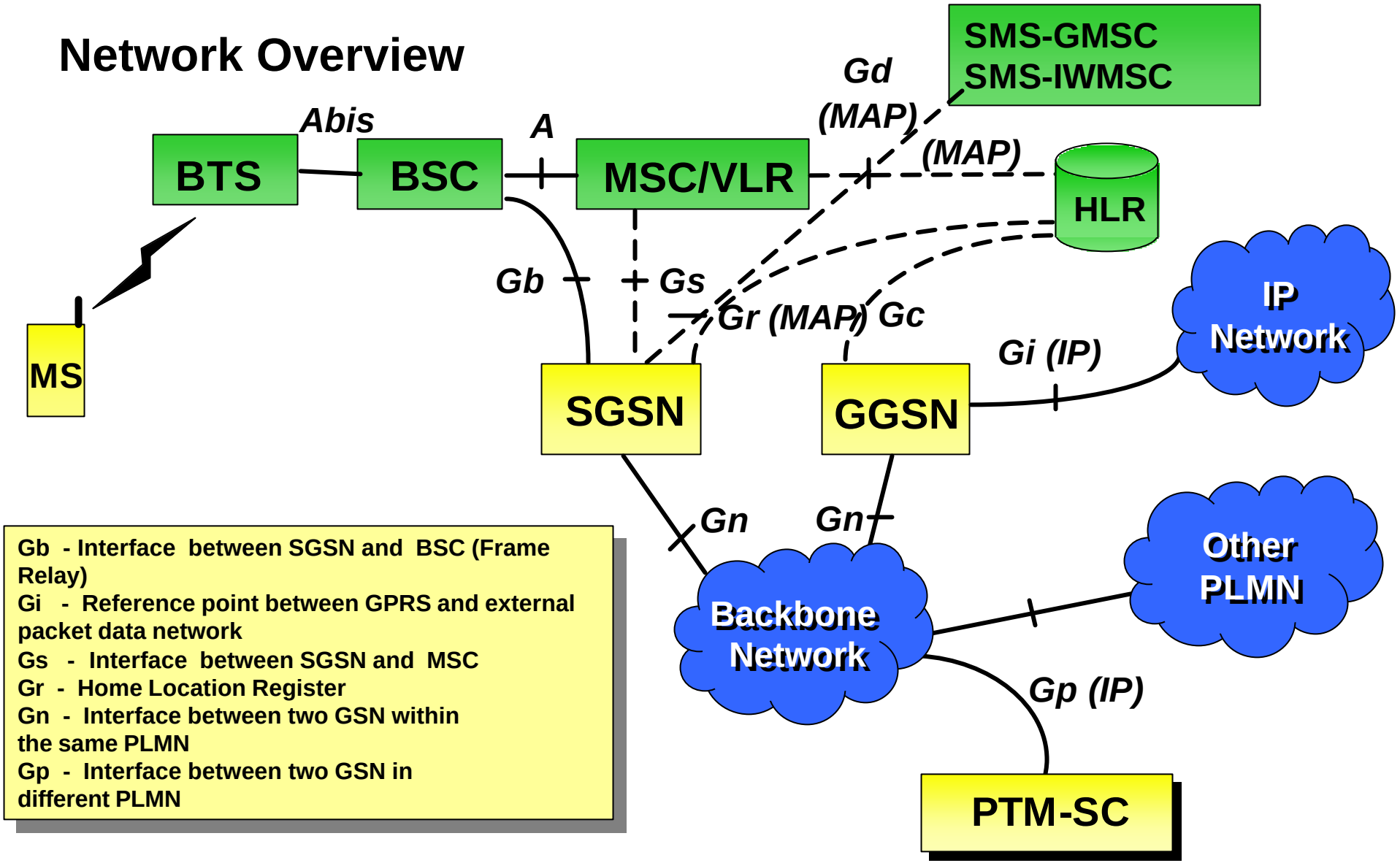
Dimensioning and upgrades might be required

GSM Bit Rates

- **Channel coding**
  (error detection and correction)
- **Interleaving**
- **Burst formation**
- **Modulation**
  GMSK and 8PSK

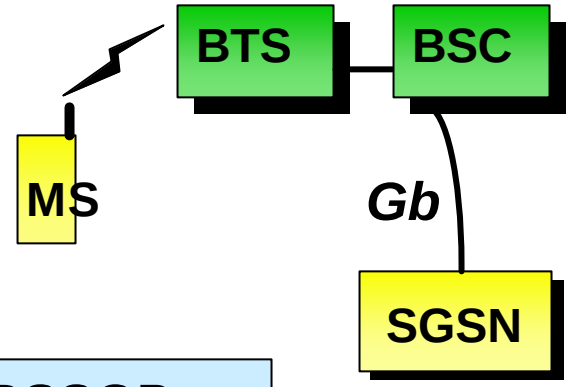


Network Overview



Gb - Interface between SGSN and BSC (Frame Relay)
Gi - Reference point between GPRS and external packet data network
Gs - Interface between SGSN and MSC
Gr - Home Location Register
Gn - Interface between two GSN within the same PLMN
Gp - Interface between two GSN in different PLMN

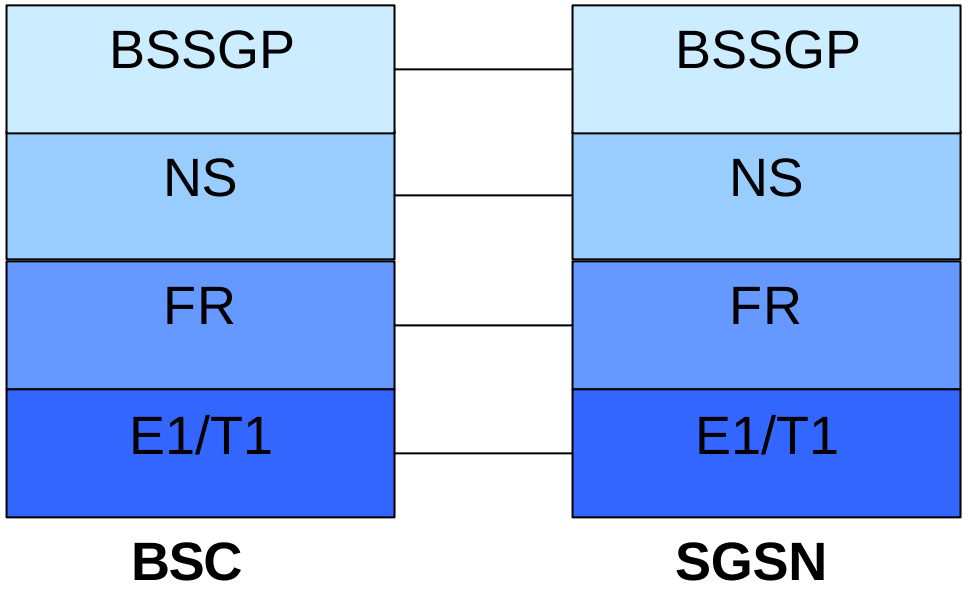
Gb Interface (BSS-SGSN)



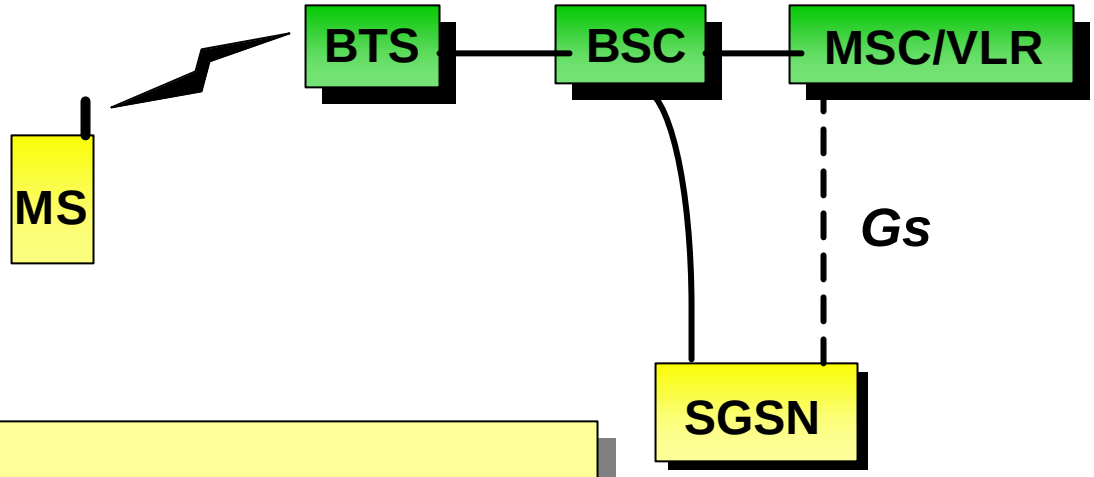
BSS GPRS Protocol

Network Service

Frame Relay

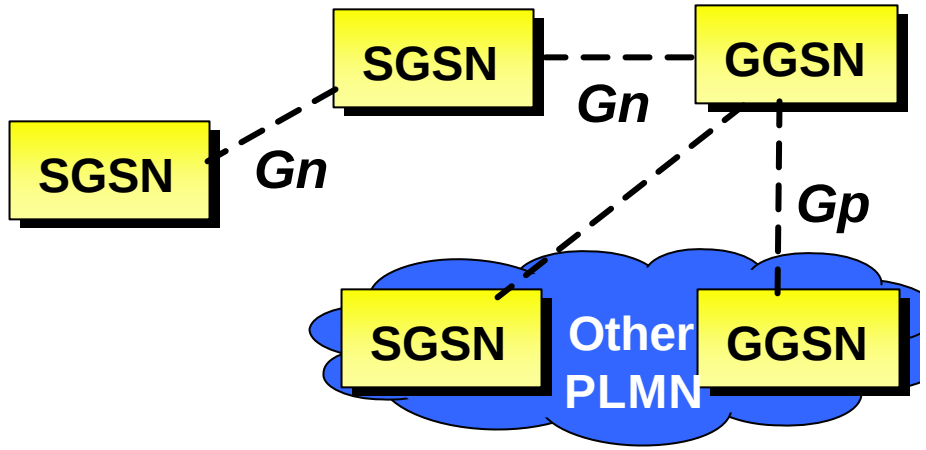


Gs Interface (SGSN to MSC)



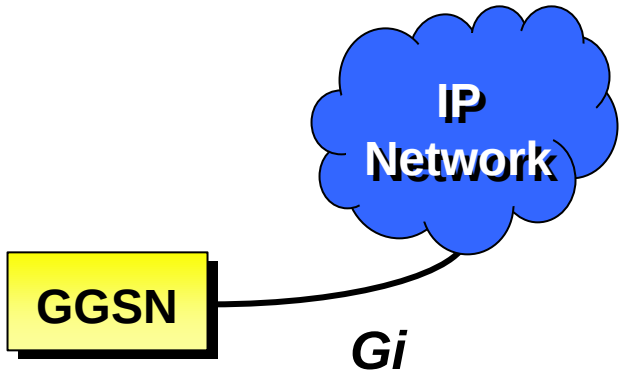
- SS7/BSSAP+ based
- Carries all paging of class A and B terminals
- Combined attach/detach for class A and B terminals
- Combined routing/location area update

Gn and Gp Interfaces (SGSN to GGSN and SGSN to SGSN)



- GTP protocol carries payload as well as signalling (PDP context activation)
- SGSN to SGSN transfer buffers in case of inter-SGSN routeing area update
- Gp is the same as Gn, but inter-PLMN

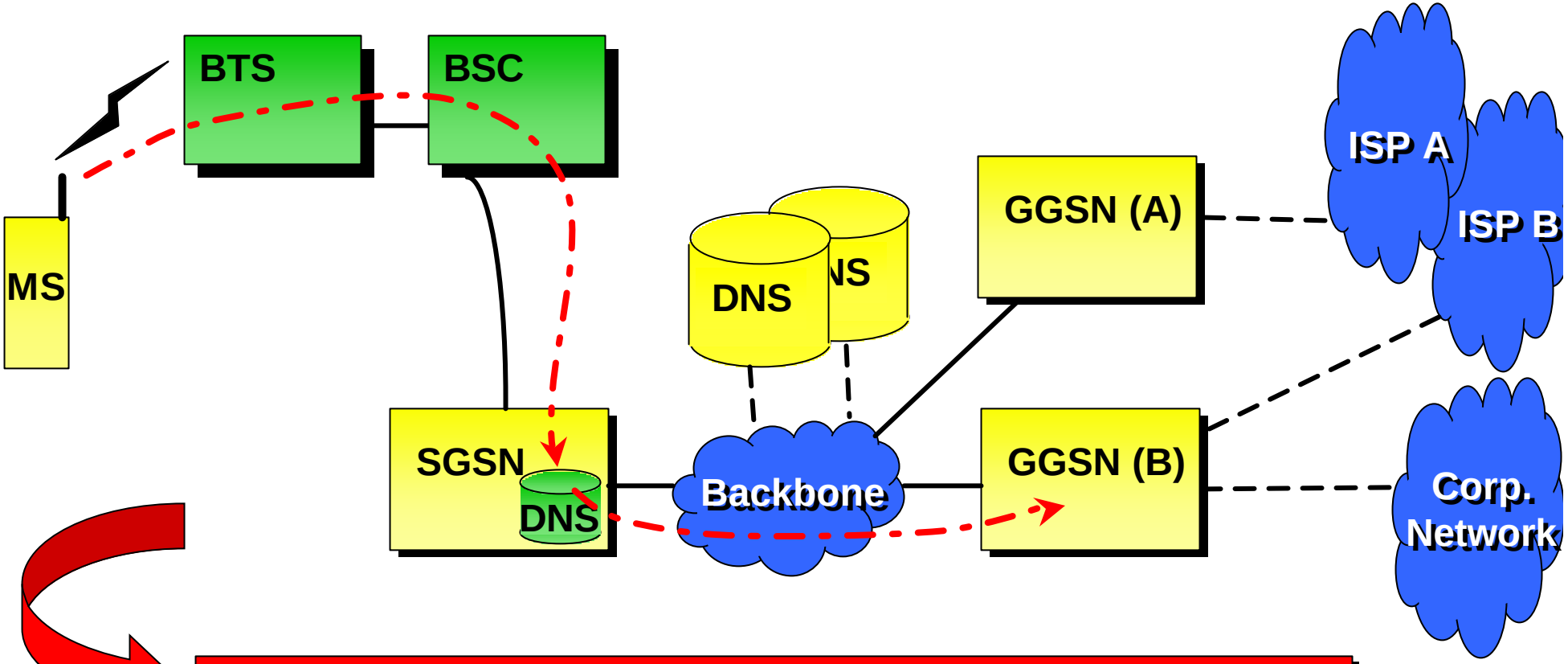
Gi Interface (GGSN to ISP/corporate network)



- Interfaces to ISPs (and corporates) using standard IP-based protocols.
- Security functions
  - Firewall (packet filtering)
  - Authentication, integrity and confidentiality (IPSEC, tunneling, key exchange)
- Routing functions
  - Static/dynamic routing supported

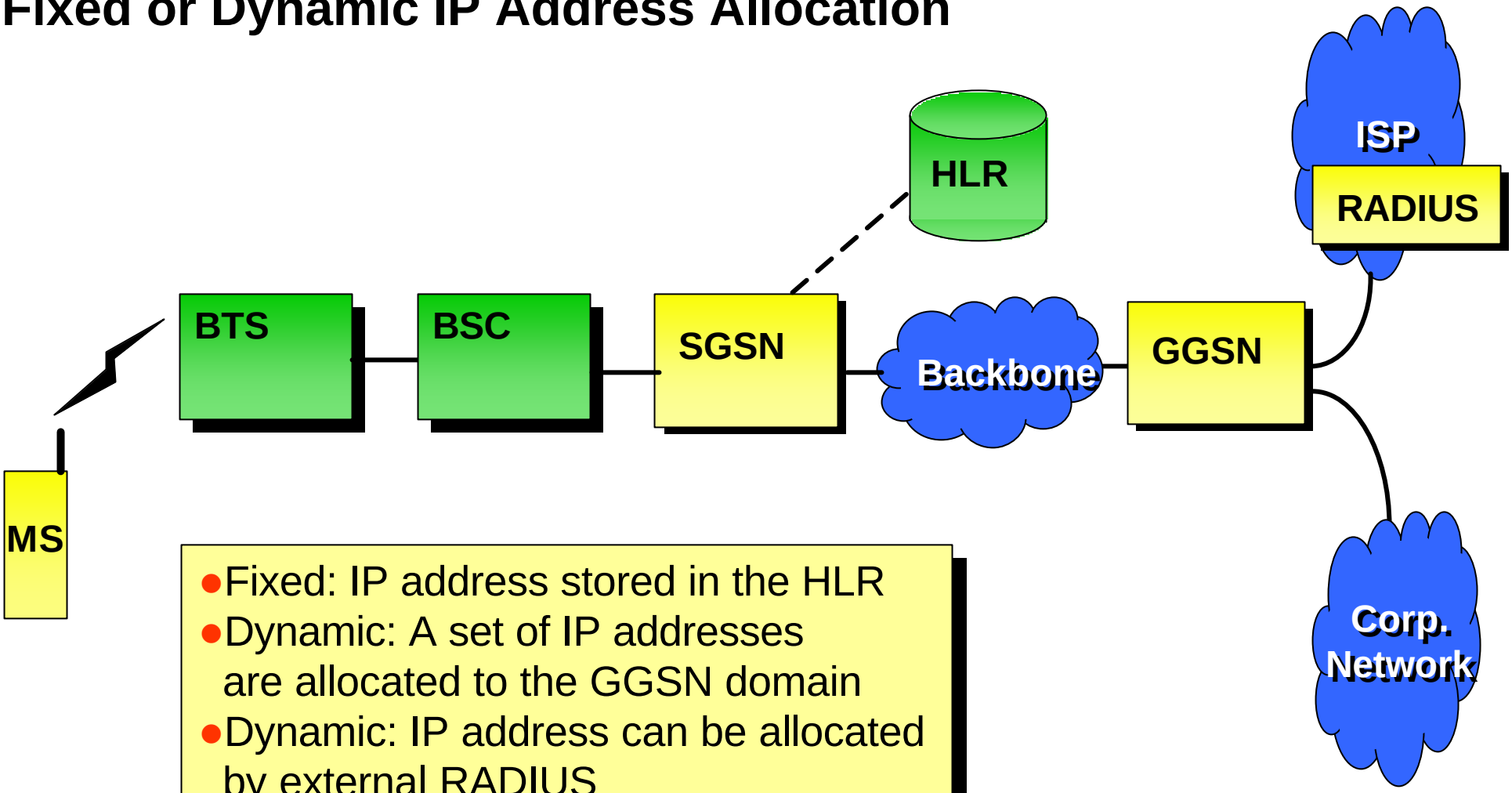
PDP Context Activation

How to Locate Correct GGSN



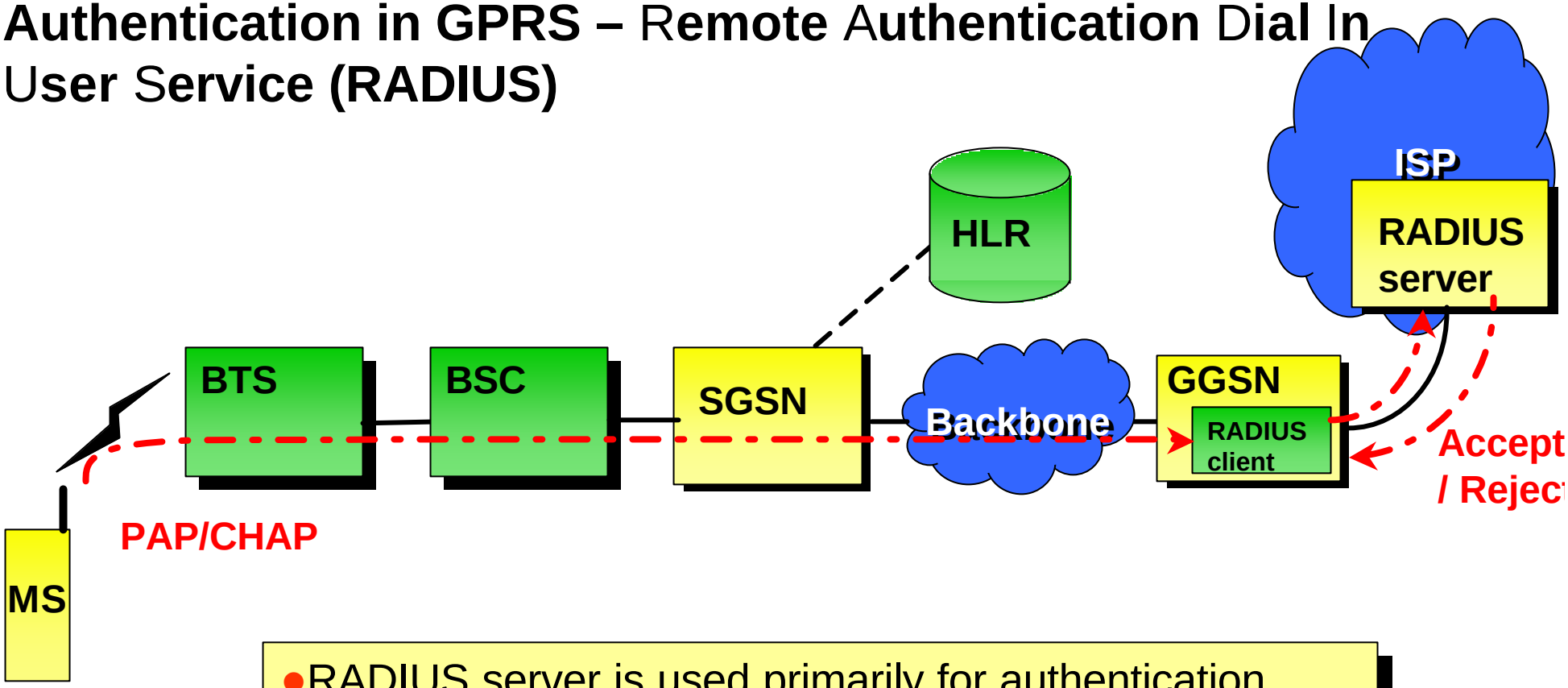
SGSN resolves an Access Point Name (APN) into the IP address for the GGSN connected to the target network

Fixed or Dynamic IP Address Allocation



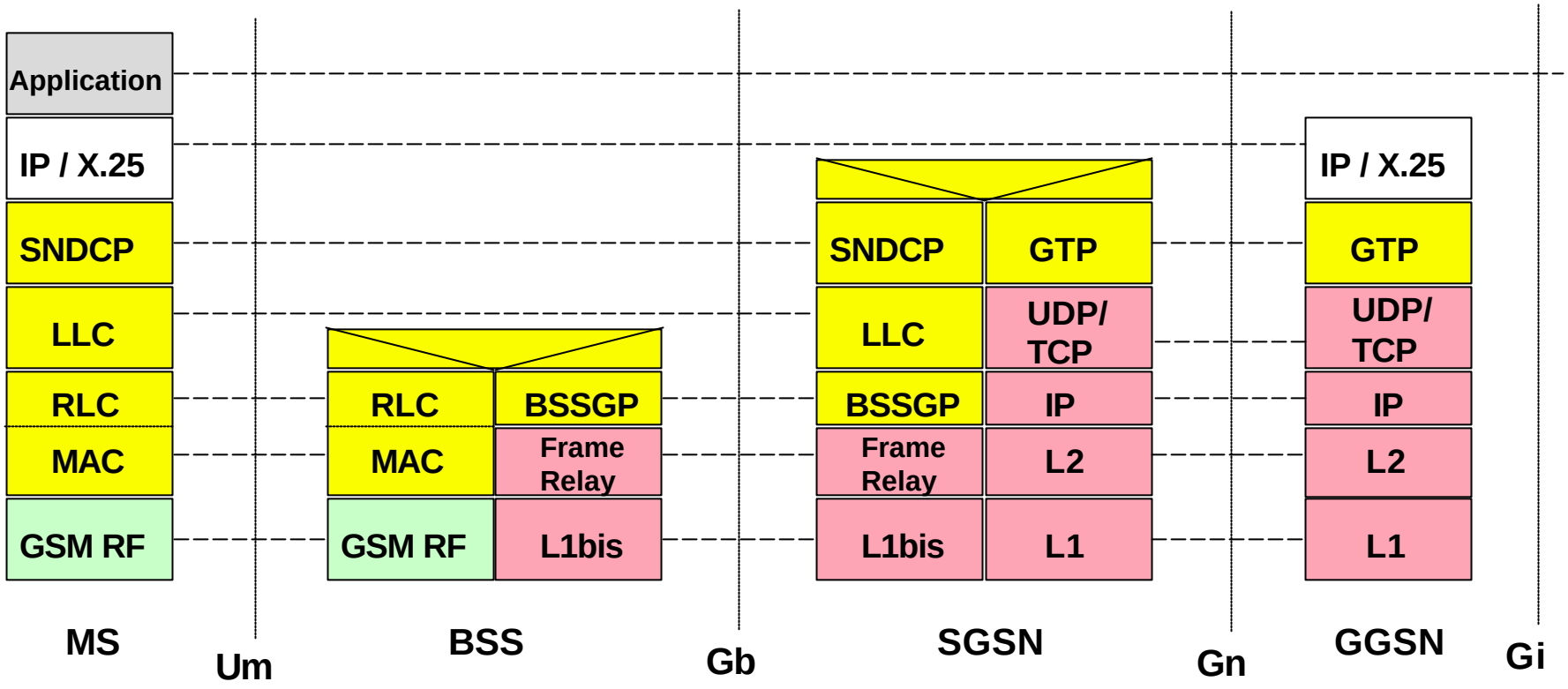
- Fixed: IP address stored in the HLR
- Dynamic: A set of IP addresses are allocated to the GGSN domain
- Dynamic: IP address can be allocated by external RADIUS

Authentication in GPRS – Remote Authentication Dial In User Service (RADIUS)



- RADIUS server is used primarily for authentication
- IP address allocation is optional
- RADIUS server validates PAP/CHAP sent from MS and returns Access -Accept/-Reject

Transmission Plane in GPRS



Interaction of GPRS services with CS connections

- **Class A:**
  Simultaneous usage of Circuit- and Packet switched services (two TRX).
- **Class B:**
  Automatic choice of service, Circuit- or Packet switched, but only one at a time (one TRX). Suspension/resumption of GPRS services at setup/release of CS connection.
- **Class C:**
  Manually selected use of either Circuit- or Packet switched service. Special case is a packet only MS (one TRX).

GPRS High-Level Functions

- Network Access Control Functions
- Packet Routing and Transfer
- Mobility Management
- Logical Link Management
- Radio Resource Management
- Network Management

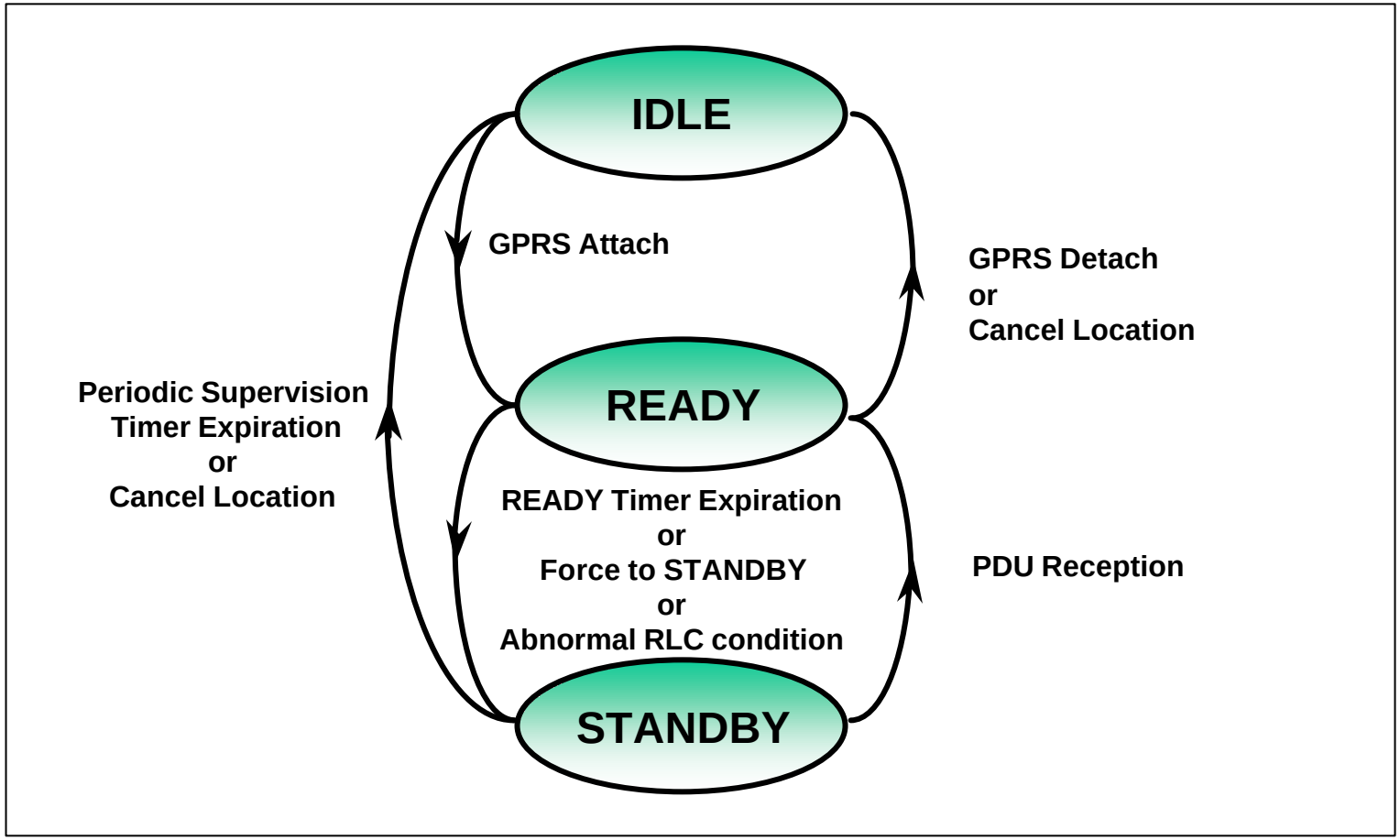
Packet Routing and Transfer

- Routing
- Address Translation
- Encapsulation and Tunneling
- Compression
- Ciphering

Mobility Management

- Attach
- Detach
- Location Management procedures
  - Cell Update
  - Routing Area Update
- Security functions

Mobility Management "State Diagram"



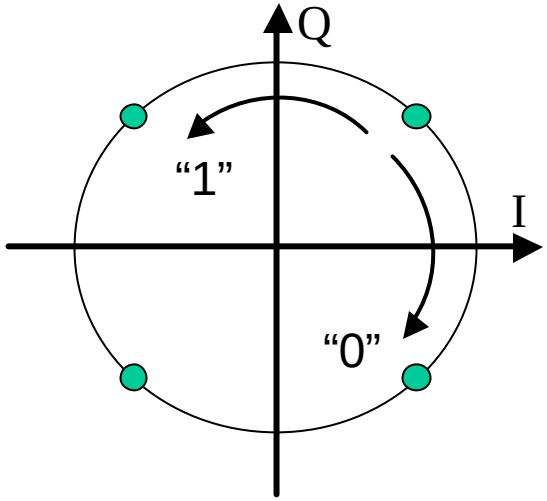
EDGE

- Enhanced Data Rate for GSM Evolution -

EDGE Modulation Principle

Currently:

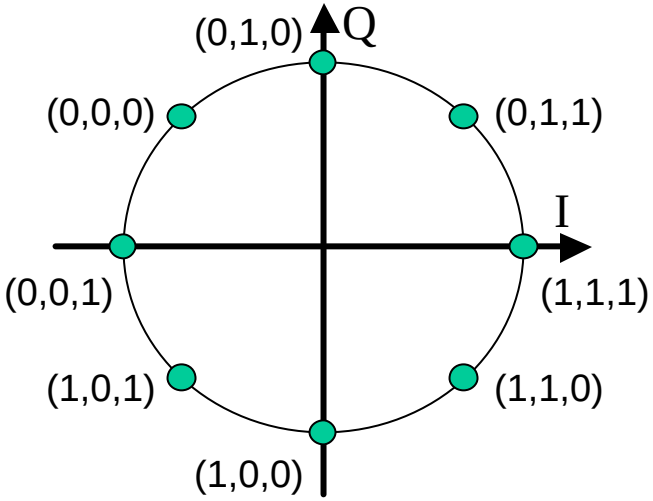
GMSK Modulation



“1 bit per symbol”

EDGE:

8PSK Modulation



“3 bits per symbol”

Comparison of Data Rates

GPRS

CS4 = 20.0 kbps
CS3 = 14.4 kbps
CS2 = 12.0 kbps
CS1 = 8.0 kbps

EGPRS

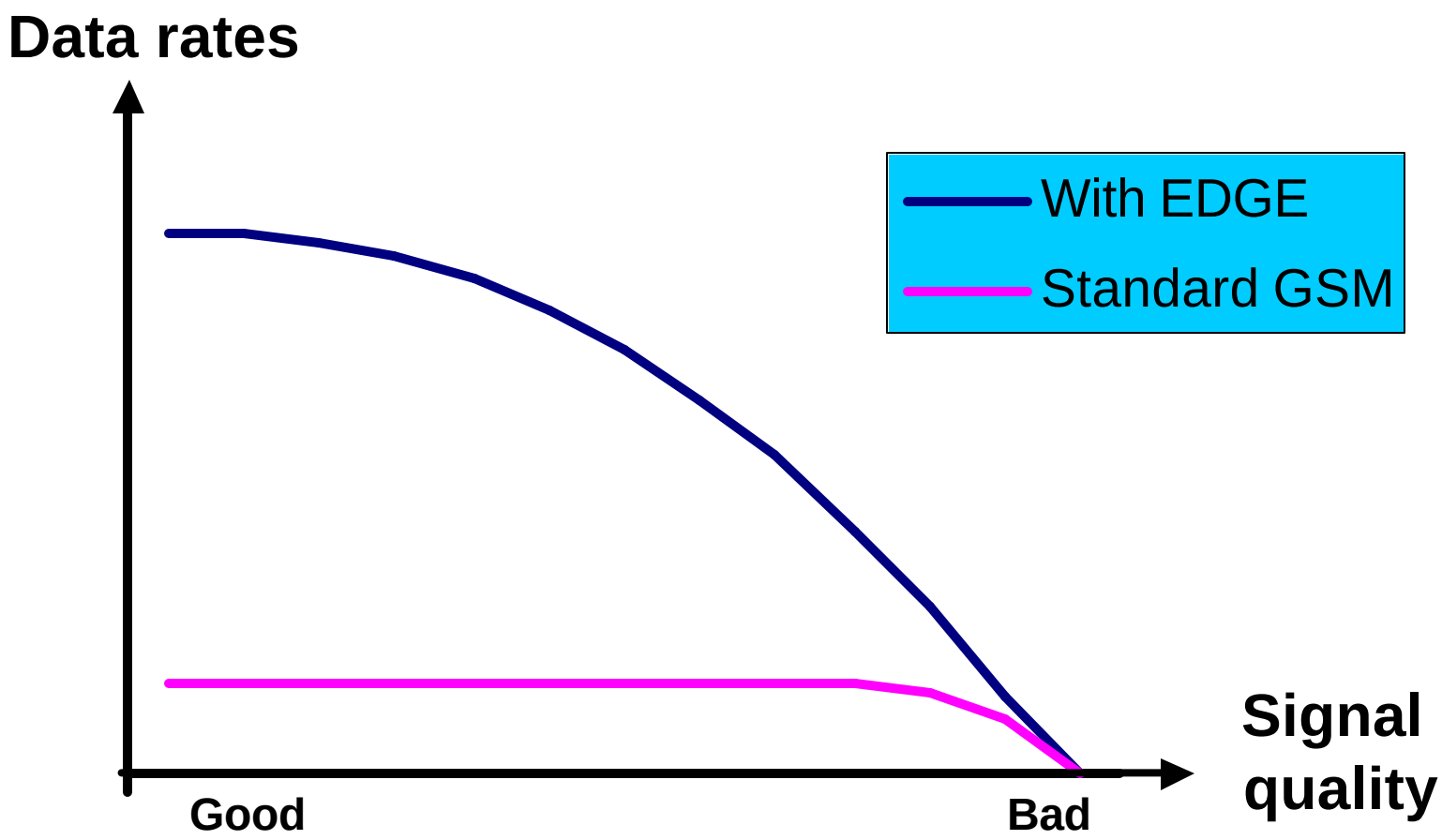
8PSK modulated

MCS9 = 59.2 kbps
MCS8 = 54.4 kbps
MCS7 = 44.8 kbps
MCS6 = 29.6 kbps
MCS5 = 22.4 kbps

MCS4 = 16.8 kbps
MCS3 = 14.8 kbps
MCS2 = 11.2 kbps
MCS1 = 8.4 kbps

Note:
Both GMSK modulated but not the same !

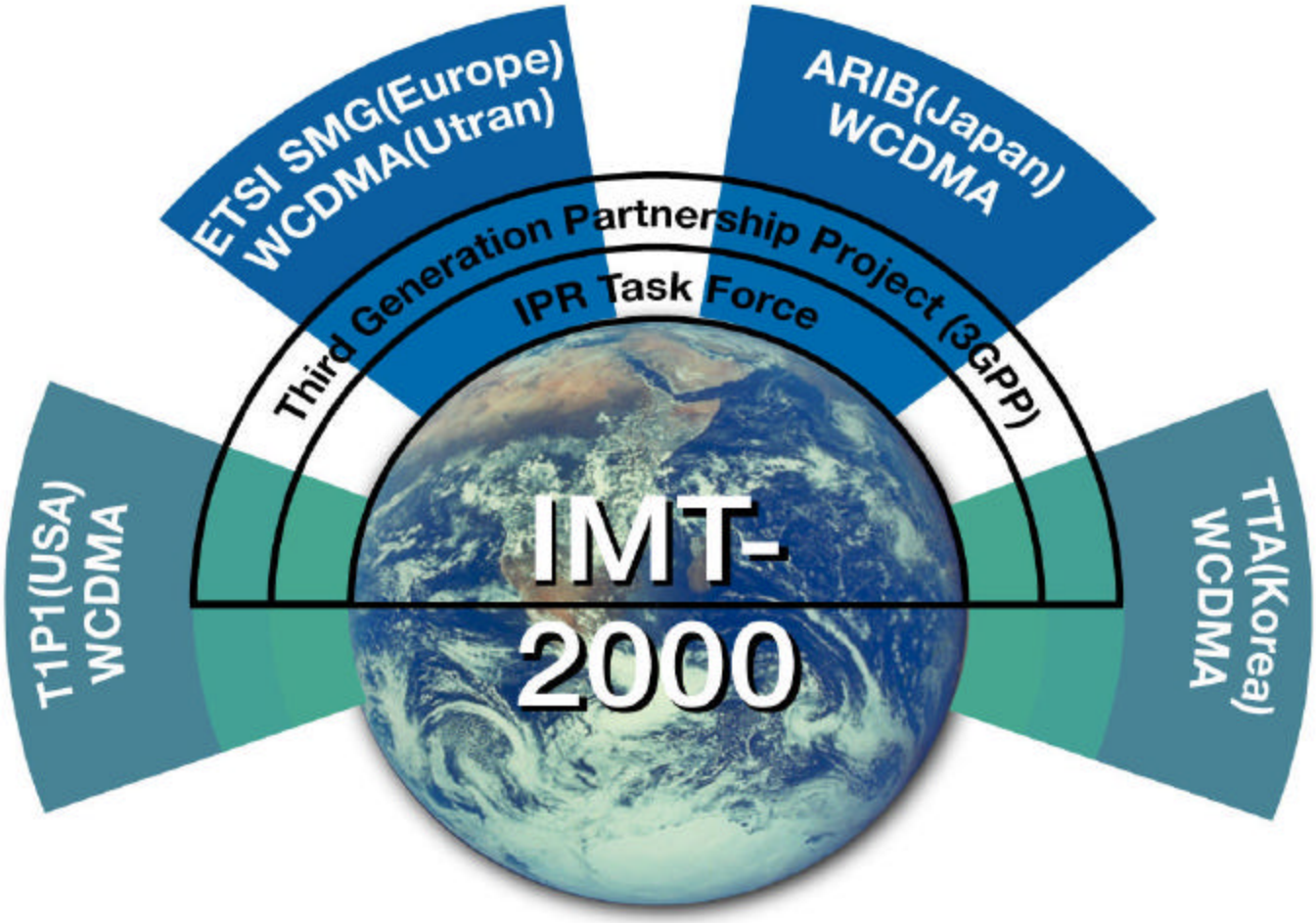
EDGE Link Adaptation



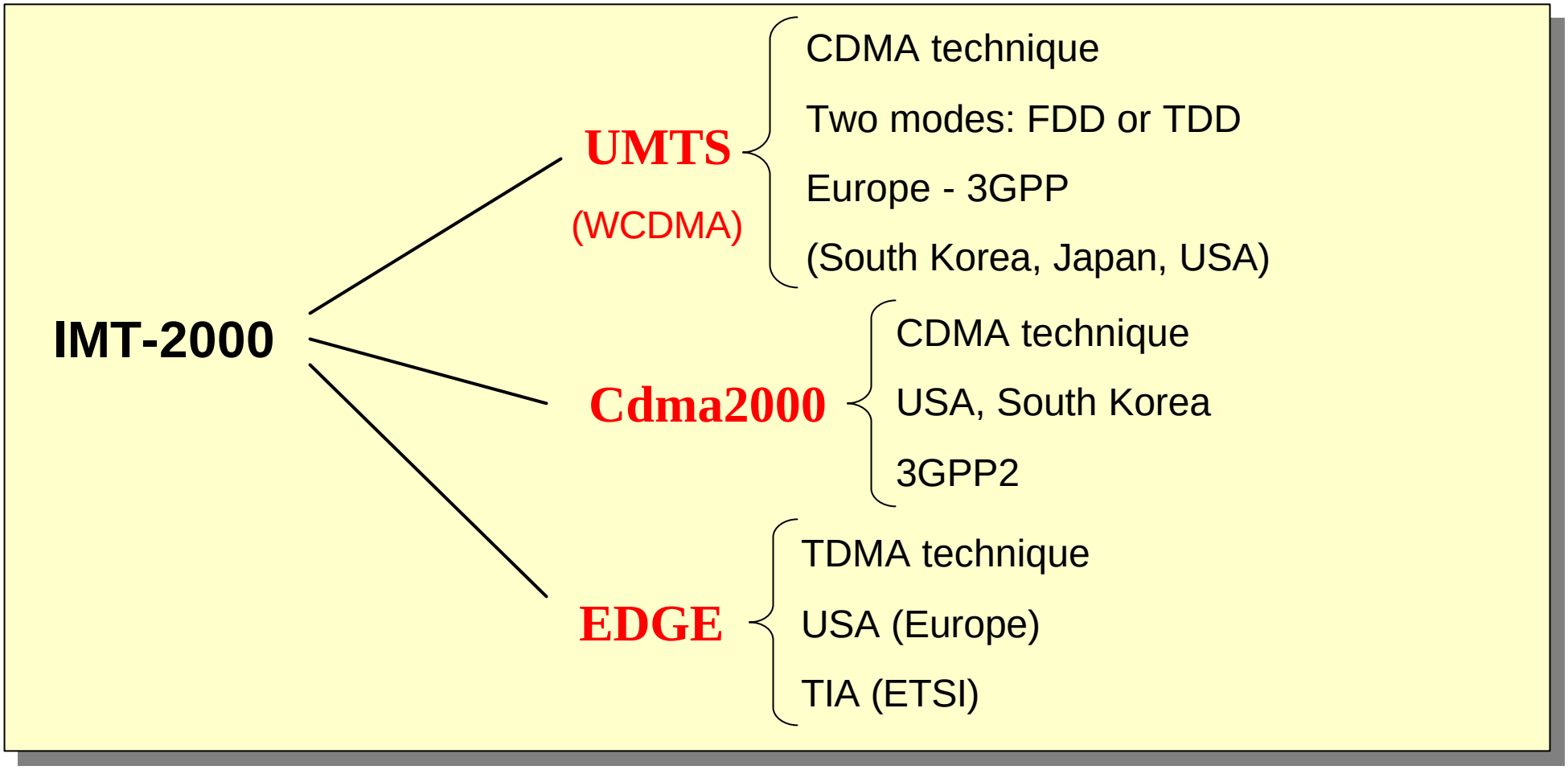
Universal Mobile Telecommunication System

UMTS

Standardization Bodies



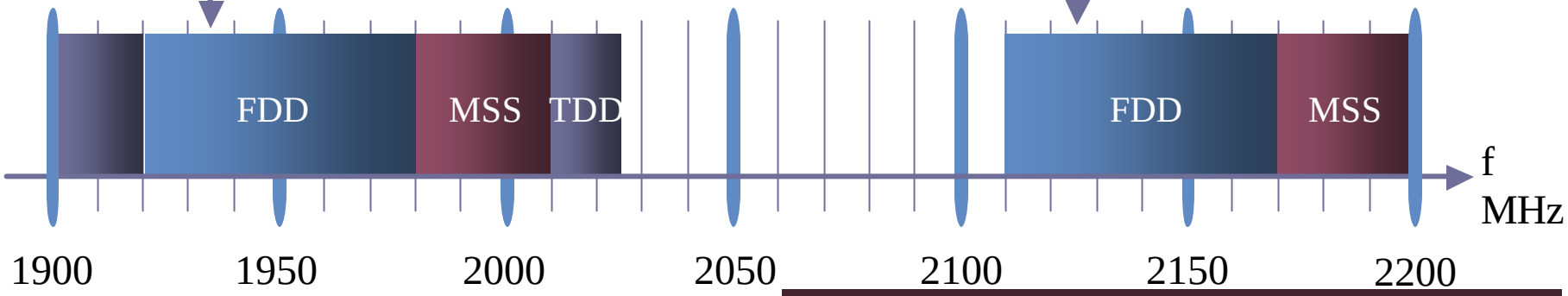
3G Systems


IMT-2000
UMTS
(WCDMA)
CDMA technique
Two modes: FDD or TDD
Europe - 3GPP
(South Korea, Japan, USA)
Cdma2000
CDMA technique
USA, South Korea
3GPP2
EDGE
TDMA technique
USA (Europe)
TIA (ETSI)

UMTS Spectrum Division Europe

Frequency Division Duplex; 2x60 MHz

UTRA Paired Band: WCDMA
Uplink: 1920-1980 MHz
Downlink: 2110-2170 MHz



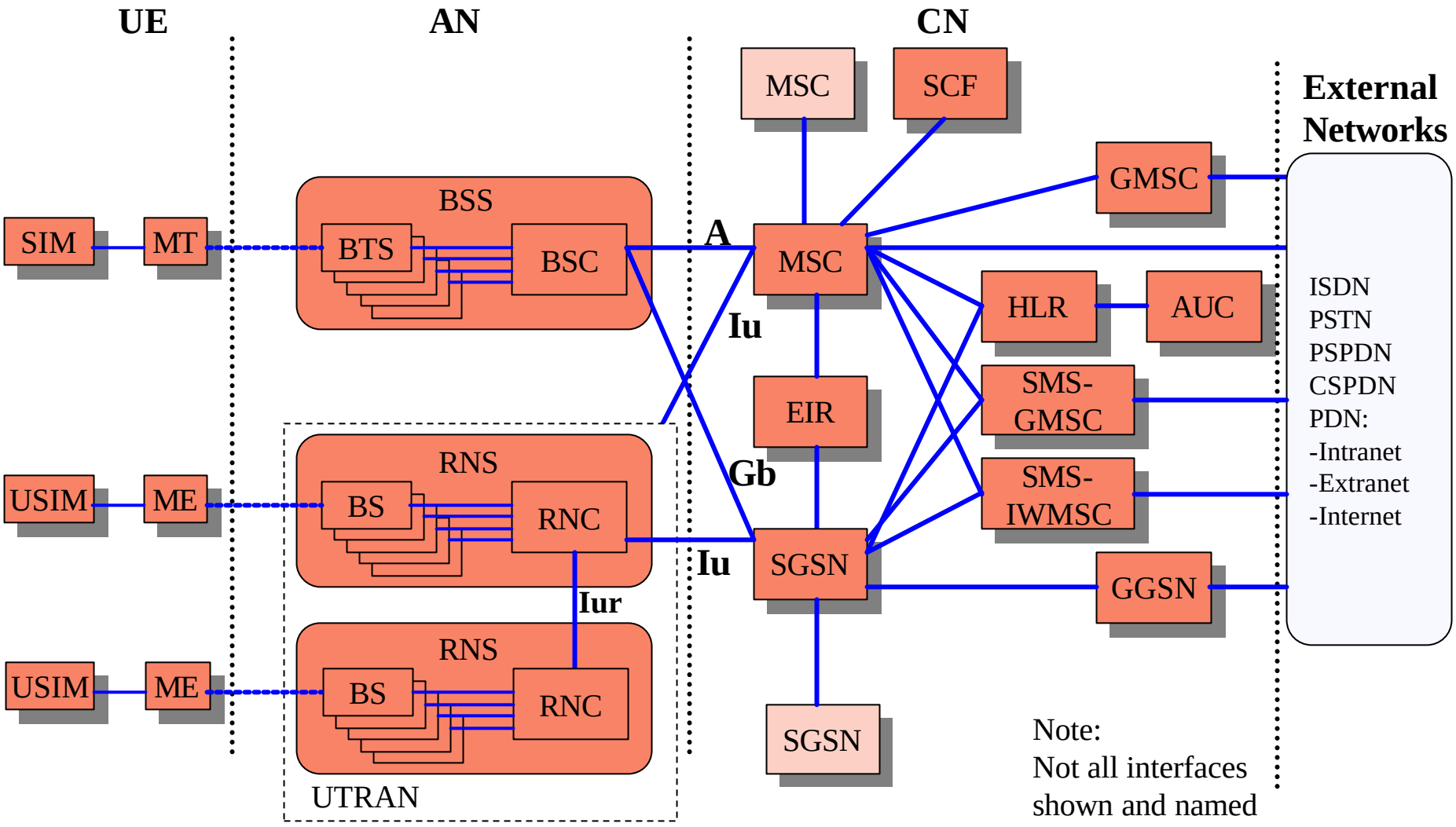
Time Division Duplex

UTRA Unpaired Band: TD-CDMA
1900-1920 MHz and 2010-2025 MHZ

Mobile Satellite Service; 2x30 MHz

Uplink: 1980-2010 MHz
Downlink: 2170-2200 MHz

UMTS/GSM Reference model



WCDMA

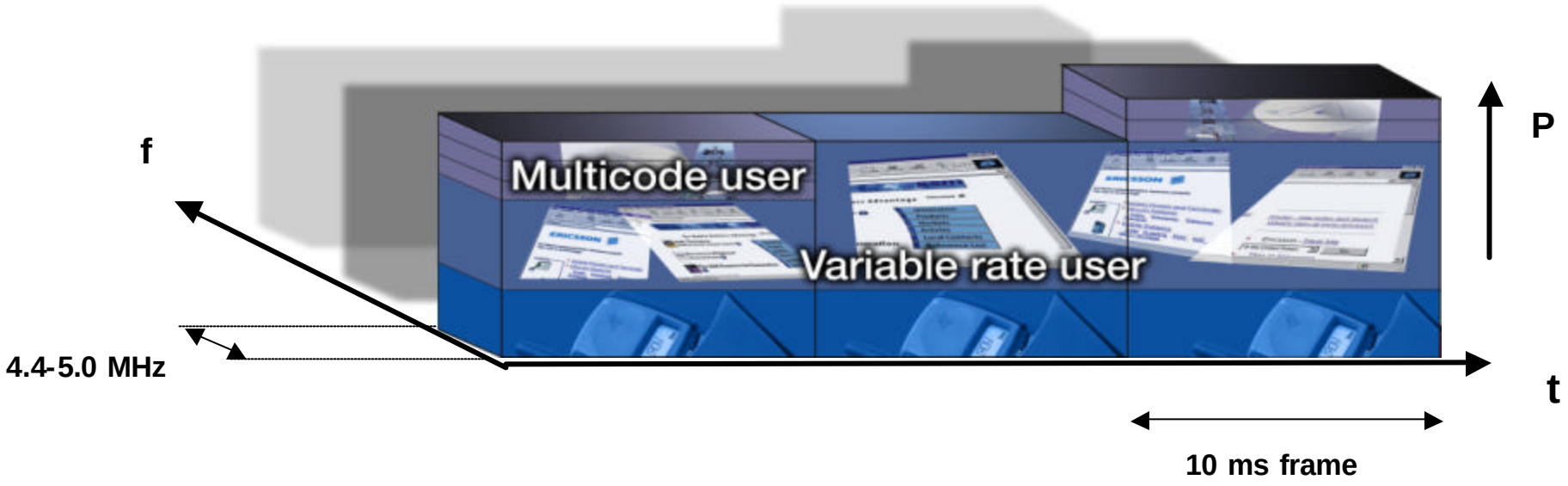
Wideband Code Division Multiple Access

- **High data rates in 5 MHz**
  - 384 kbps with wide-area coverage
  - 2 Mbps with local coverage
- **High service flexibility**
  - support for services with variable rate
  - support for simultaneous services
  - support of multiple parallel variable-rate services on one connection
  - packet and circuit switched services
- **Fast and efficient packet access**
- **Higher capacity**

WCDMA
Technical characteristics

- 5 MHz carriers
- Frequency Division Duplex, FDD
- 3.84 Mcps chip rate
- Variable spreading codes

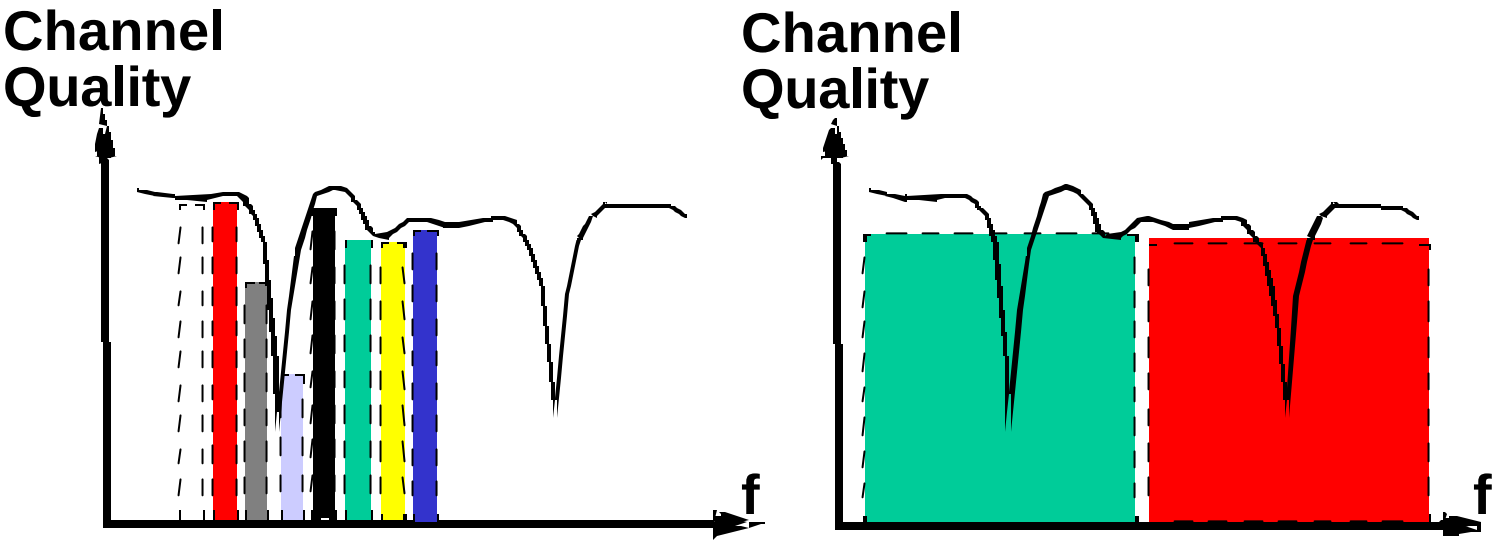
- Optimised packet access on common or dedicated channel
- High spectrum effiency



Why Spread Spectrum ?

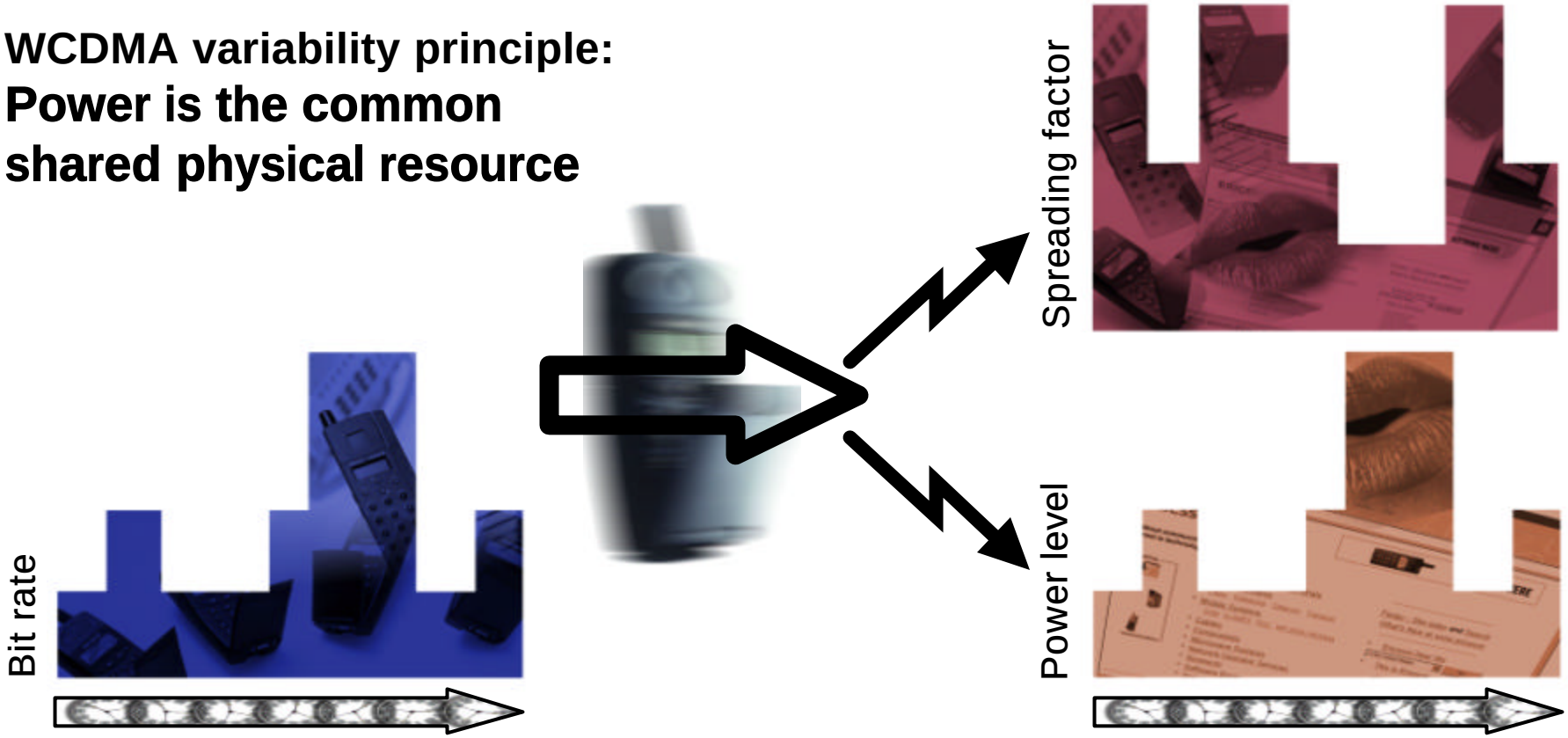
Frequency selective fading - Frequency Diversity

Interference Averaging



Bit-rate Flexibility

WCDMA variability principle:
Power is the common shared physical resource

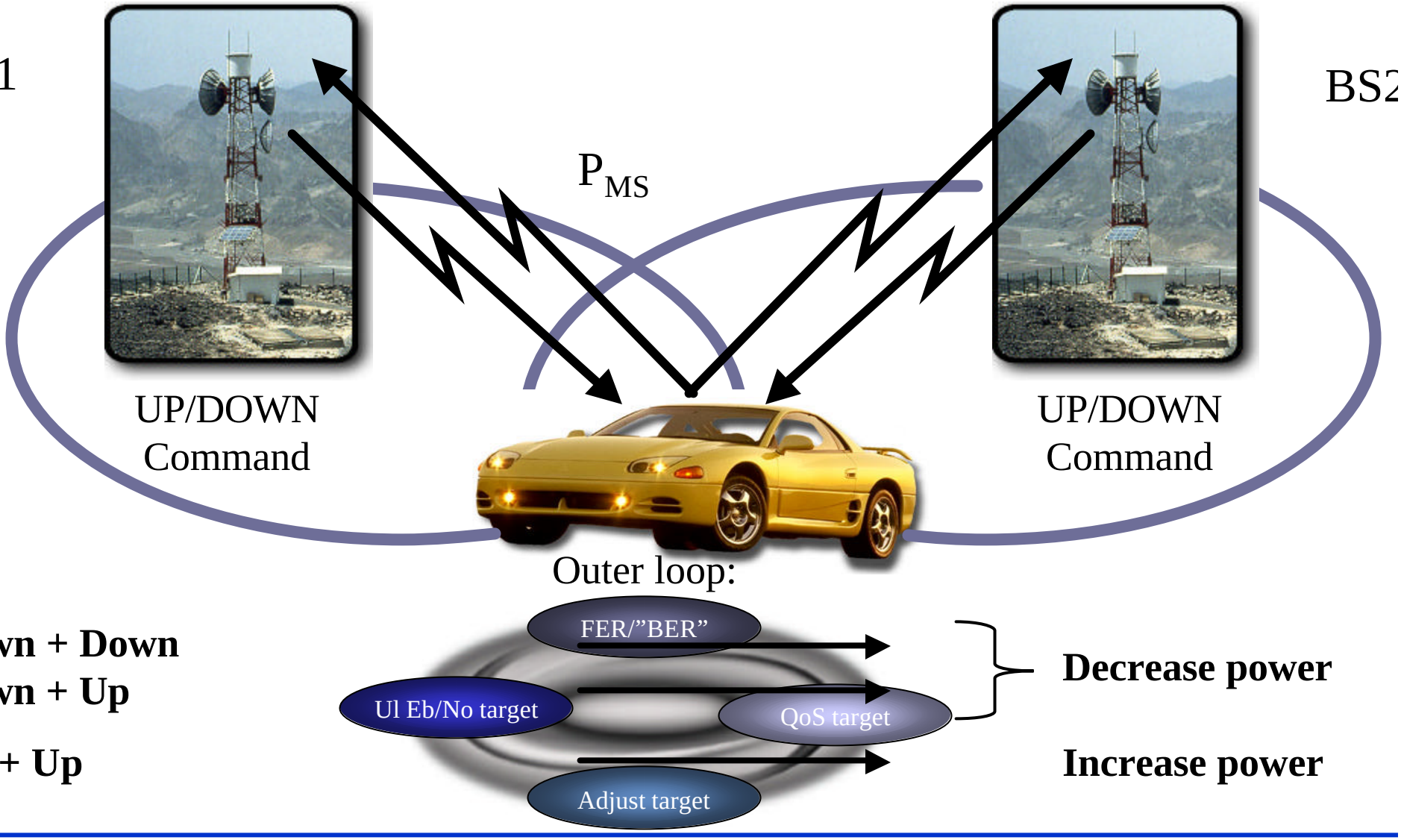


Varying user bit rate	Translates into	◆ Varying power level ◆ Varying spreading factor

Power Control

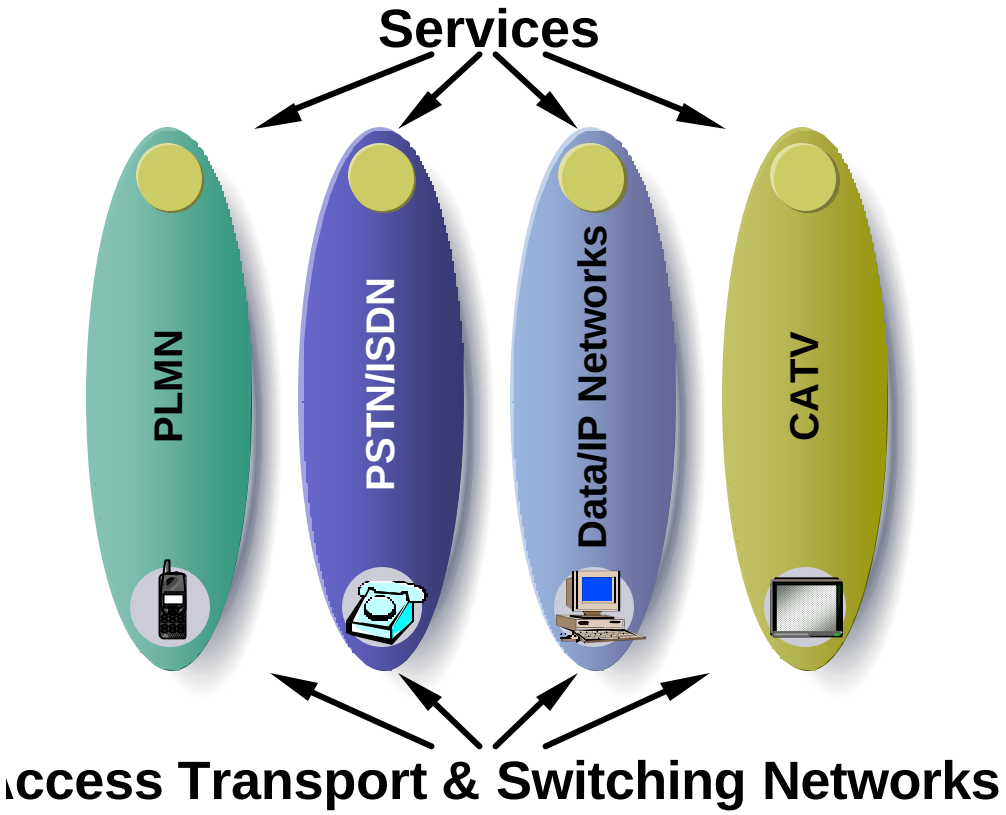
- What?
  - The Transmitter adapts the output power according to Path Loss
- Why?
  - Mainly to solve the “Near-Far” problem
  - Goal is that all users should experience the same SIR
- How?
  - Open Loop Power control (Initially, No signaling)
  - Inner Loop Power control (Signaling channel, continuously: 1500 times/s, relative changes: up or down)
  - Outer loop Power control (Between BTS and RNC)

Uplink Power Control in Soft Handover

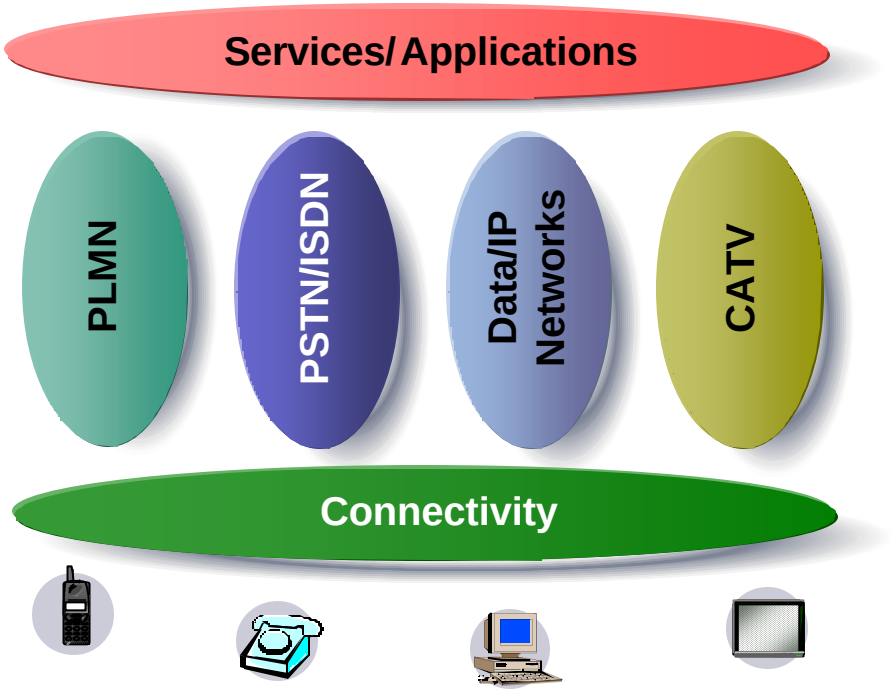


Technical Vision
Vertical vs Horizontal Integration

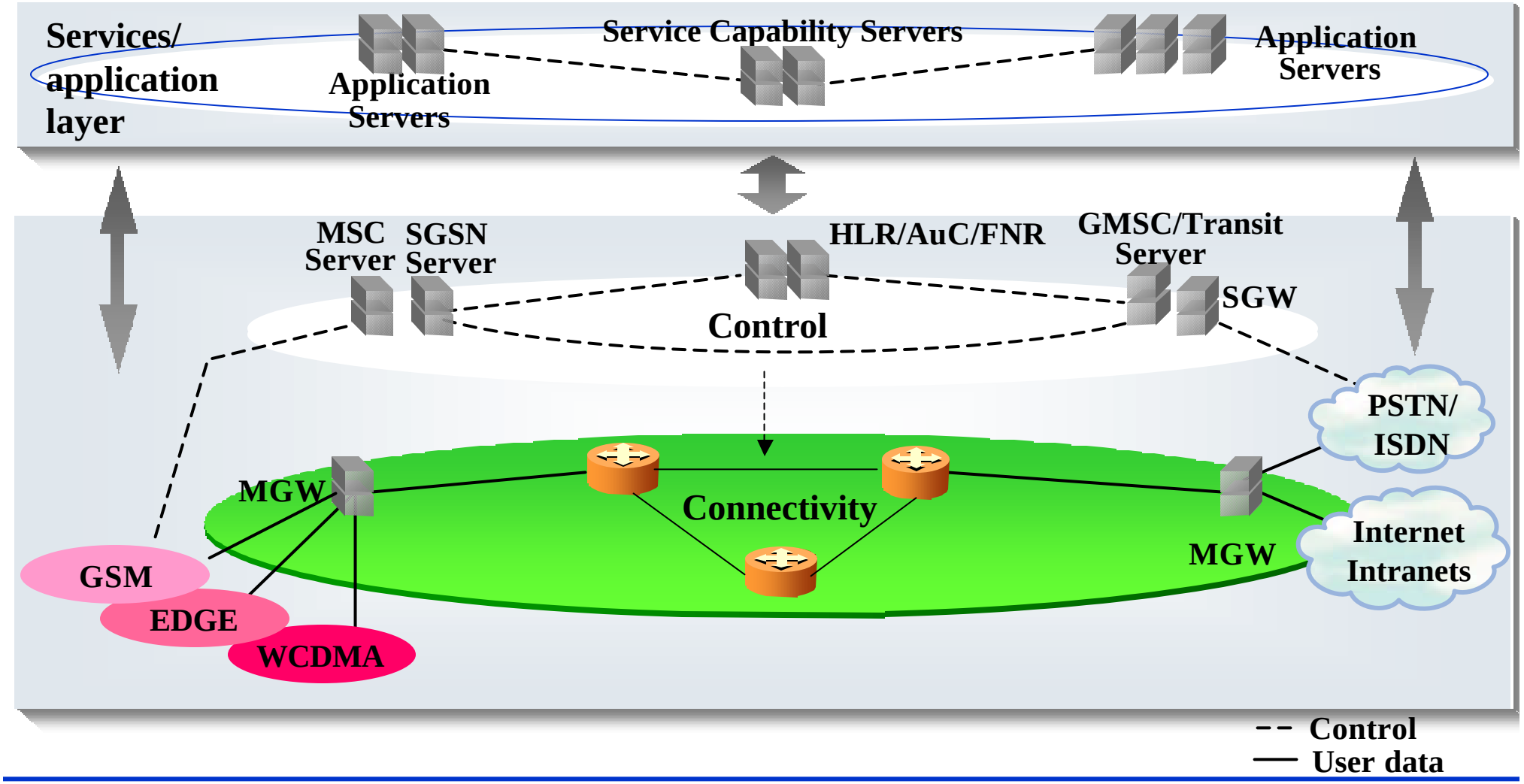
Today's Solutions



Future Solutions

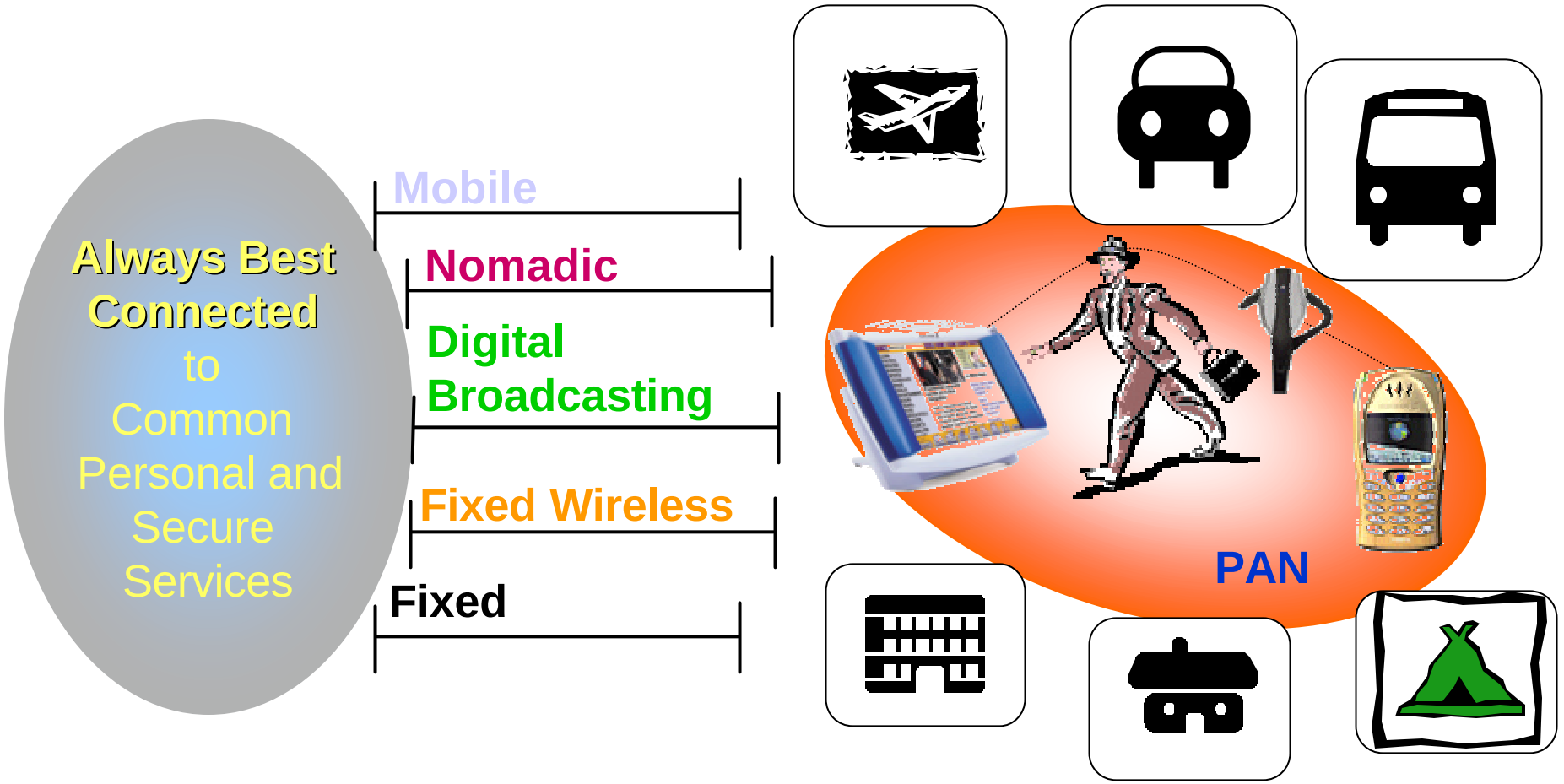


Connectivity Layer

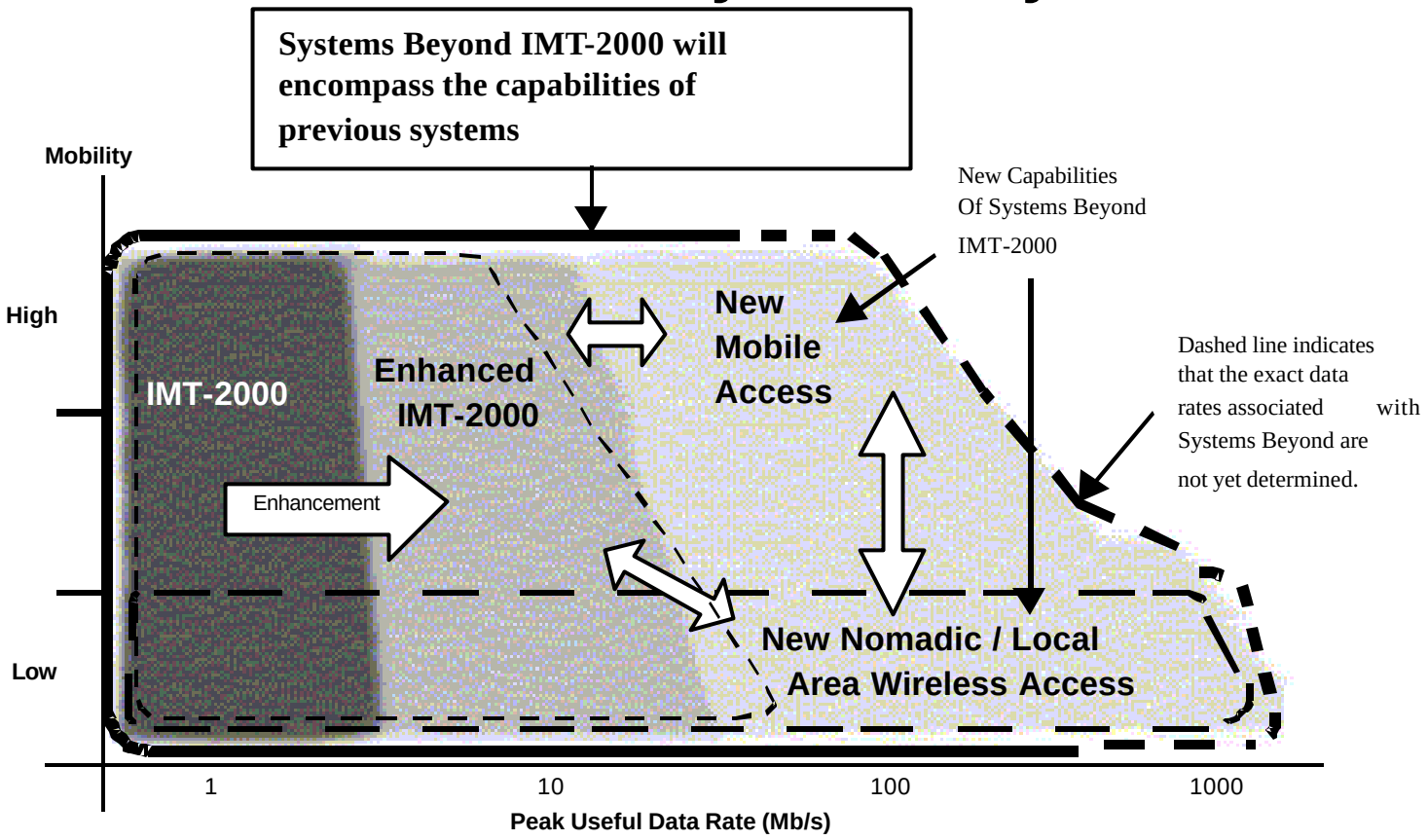


And beyond?

The future Telecommunication Environment is Multi-Access



Capabilities of IMT-2000 and Systems Beyond



KEY: ⇔ denotes interconnection between systems via networks or the like, which allows flexible use in any environments without making users aware of constituent systems.

Nomadic / Local Area Access Systems

Digital Broadcast Systems

Questions?