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OPTIMIZING IMT-2000 DEPLOYMENT STRATEGIES

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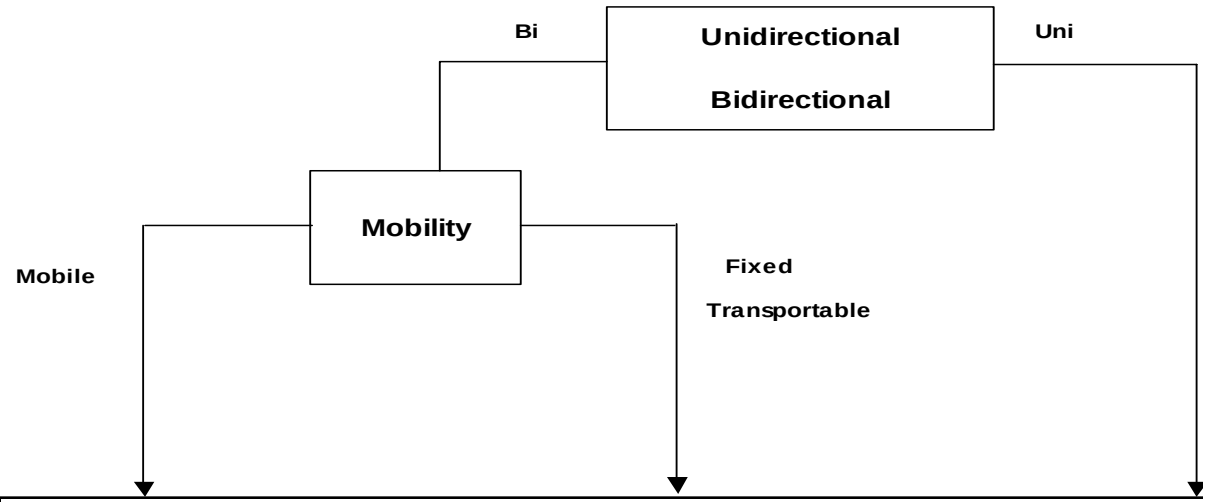
Classification of cellular wireless networks regarding their mobility

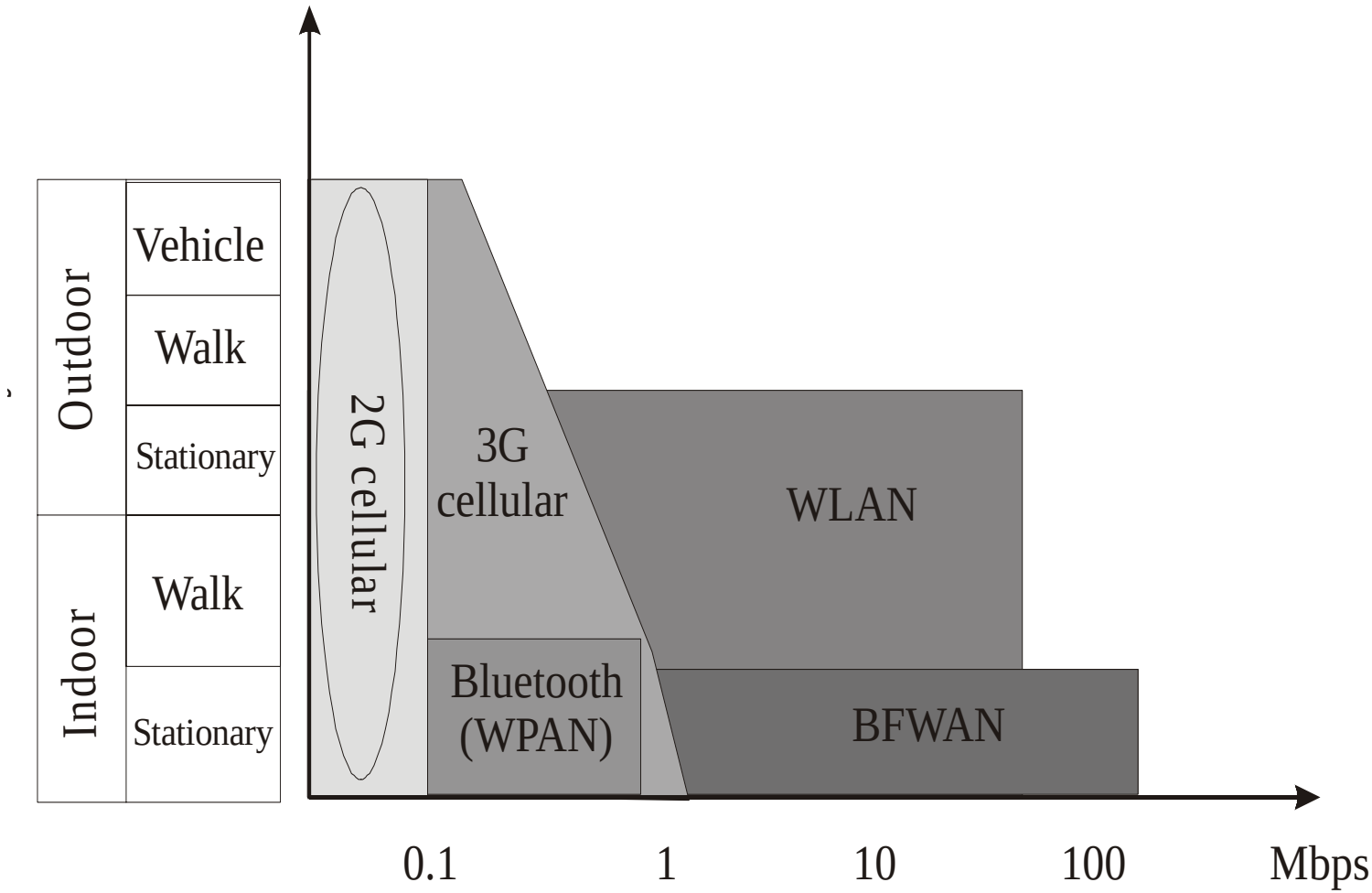
- **WITH GLOBAL MOBILITY**
- **Cellular networks**
  - **2nd generation (2G)**
  - **2nd plus generation (2.5G)**
  - **3rd generation (3G) and beyond (3.5G and 4G)**
  - **Cordless (DECT)**
- **Satellite networks**
- **Broadcasting network**
  - **DAB (Digital Audio Broadcasting)**
  - **DVB (Digital Video Broadcasting)**
- **WITH LOCAL MOBILITY**
- **Fixed wireless access networks (FWAN)**
- **Wireless local area networks (WLAN)**
- **Wireless personal area networks (WPAN)**

Different wireless networks regarding mobility

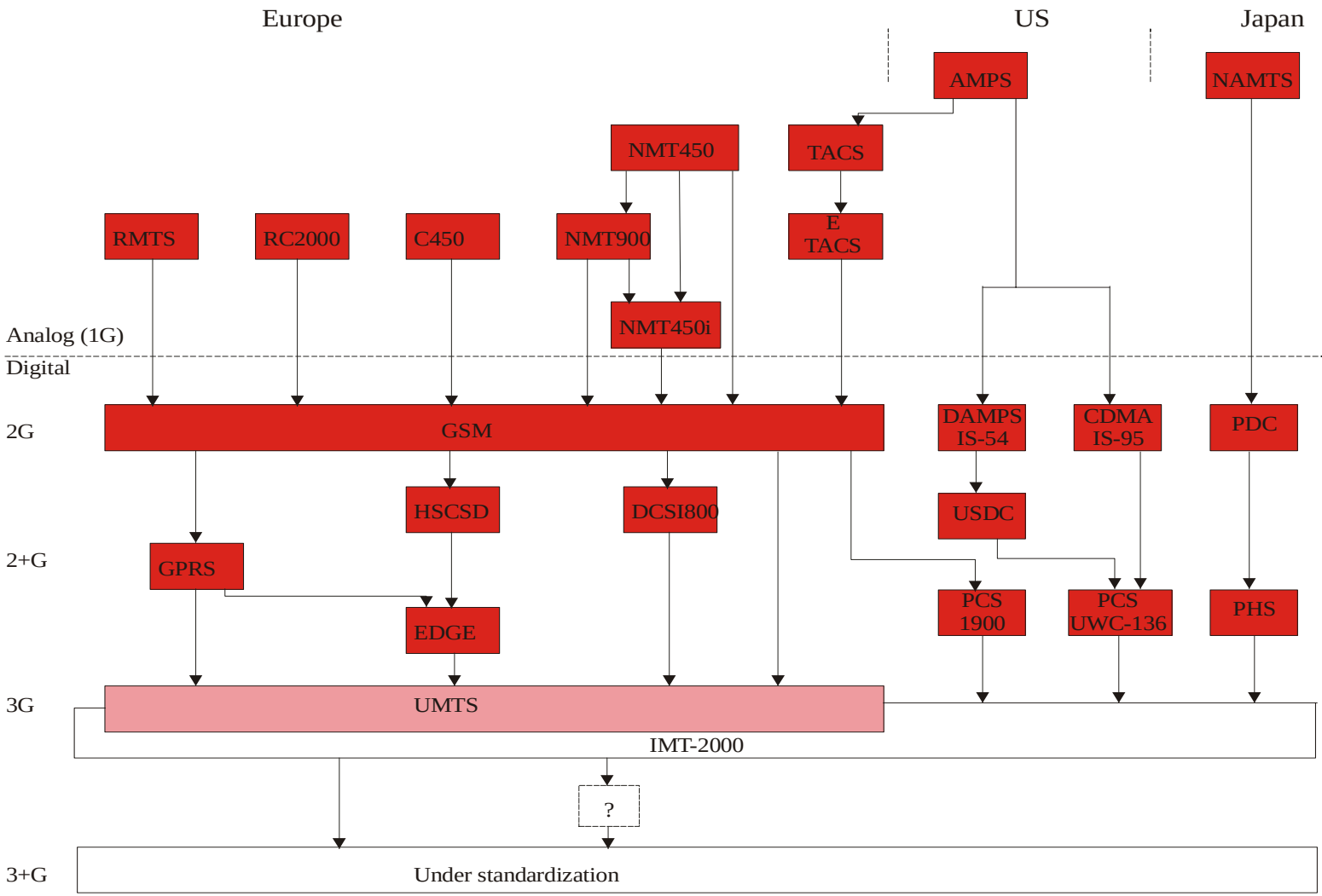


Worldwide	Skybridge Teledesic	
Continental	UMTS	DVI DAI
National	DECT	DECT DAI DVI
Local	MMDS/LMDS DAWS Hiperaccess	
In situ	Hiperlan WLAN	

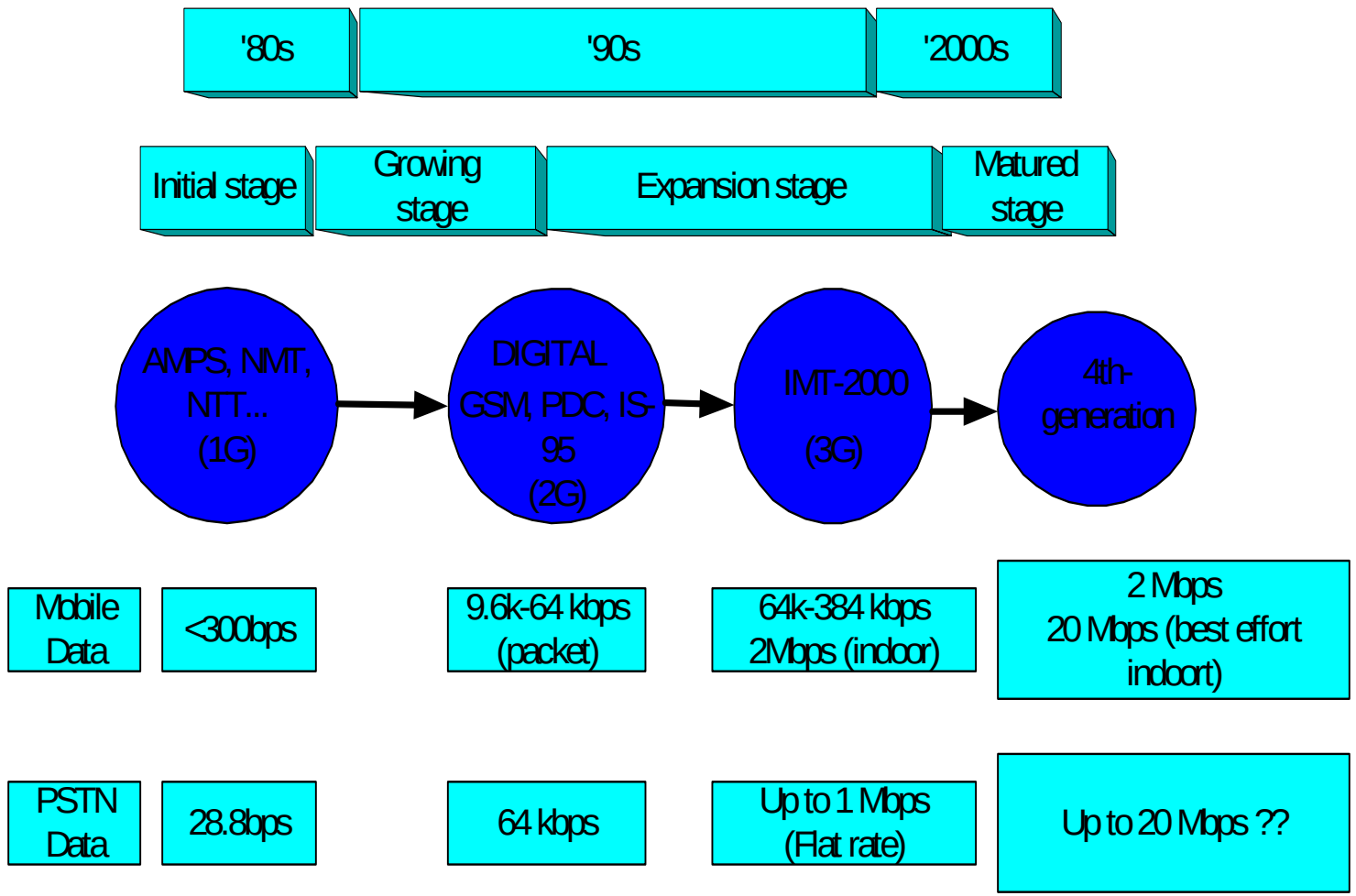
Wireless networks regarding transmission speed



Worldwide distribution of cellular standards



Cellular networks data capabilities



Characteristics of cellular systems development

- **Since its inception the cellular system**
  - Experienced enormous growth
- **Need for high rate data capacity**
  - Recognized by various standards bodies
- **Efforts in way to add additional data rate capabilities to existing cellular standards**
  - GSM (GPRS, EDGE)
  - IS-95A (IS-95 B)
  - IS-136 (GPRS, EDGE)
- **Needs are becoming more data centric**
  - Need Internet capable connection
  - e-mail, short message services
  - web browsing
- **Connection becoming more and more packet switched**

Why not 2G anymore?

- **1G and 2G systems were developed**
  - to accommodate mainly voice services
  - 2G added the limited data capabilities
  - applications were voice centric
  - utilized the circuit switched connection
- **Limited roaming**
  - communication any where, any time still far from reality
  - Localized standards inhibits global roaming and seamless communication
    - North America (AMPS, IS-136, IS-95, PCS-1900)
    - Japan (PDC, PHS, IS-95), Asia (GSM, IS-95, AMPS and others)
    - Europe (GSM, DCS 1800 etc.)
- **Capabilities still below par to its landline rival**
  - Data Throughput
  - Web Browsing
  - Multimedia services/support
- **Basic services**
  - unaffordable to majority of the world population

Driving factors for 3G implementation (1)

- **Unified global cellular standard**
  - One standard covers the globe
- **Wireless Service offerings**
  - Matching to the Public Switched Telephone Network (PSTN)
- **Efficient usage of the available spectrum**
  - Wide coverage, Large Capacity
  - Affordable
- **Flexible to accommodate any future requirements**
  - Easy to add-on new services

Driving factors for 3G implementation (2)

- **Wireless connectivity to Internet**
- **Phenomenal growth in cellular subscribers**
- **Multimedia capable terminals**
  - Video streaming
  - Simultaneous voice/data/browsing capability
- **Killer application**
  - Multimedia capable service offering
- **New source of Revenue**
  - Voice market is saturating
  - Demand for data services increasing

Global situation

- **Year 2002**
  - Reached almost 1 billion wireless subscribers
- **Two major wireless network architectures**:
  - ANSI-41 and
  - GSM/MAP
- **Large investment requires each to have an evolutionary path to 3G**
- **Hence, adoption of ITU "family of systems" approach**

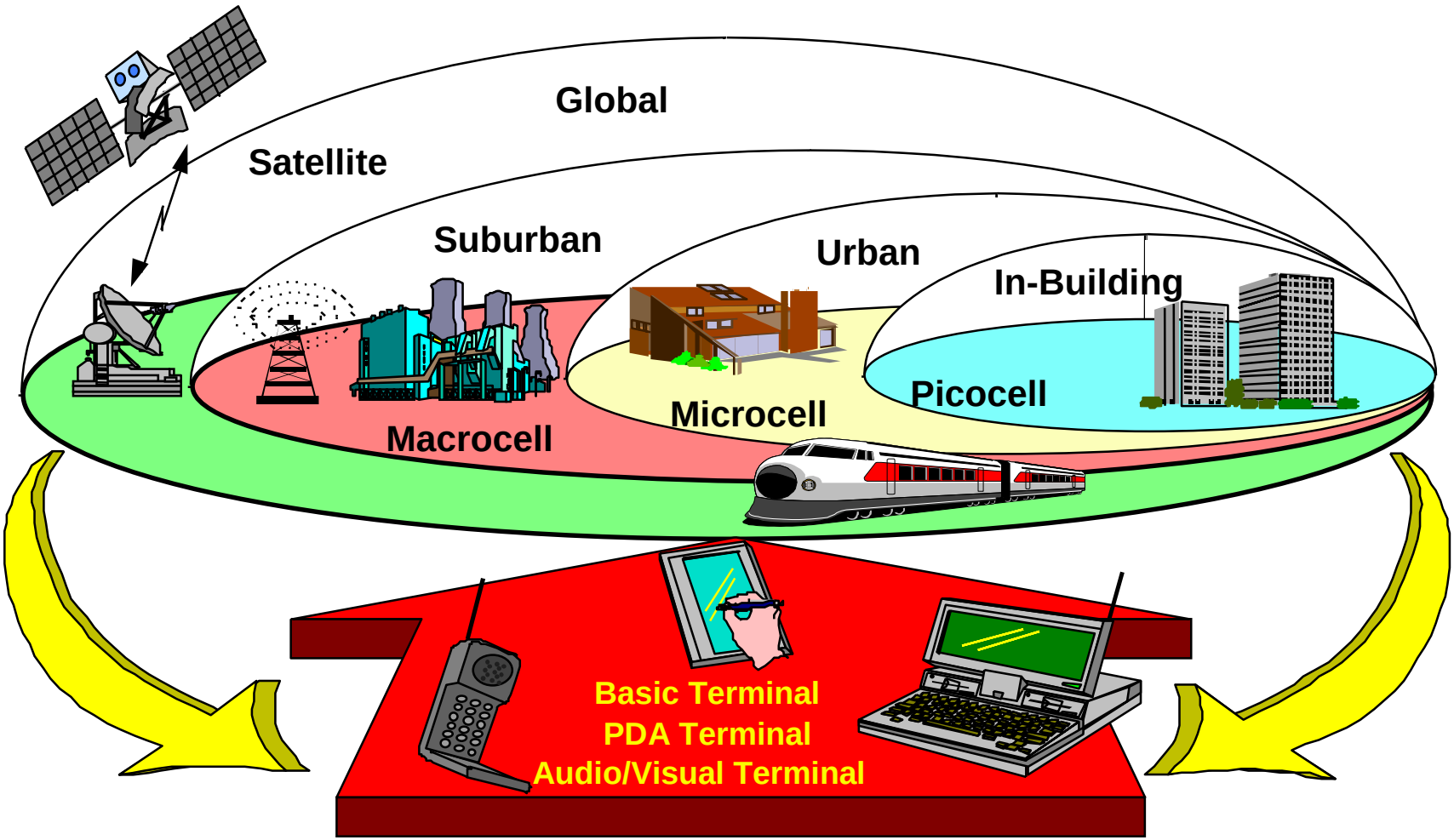
ITU objectives for IMT-2000

IMT-2000 networks should provide access, by means of one or more radio links, to a wide range of telecommunications services supported by the fixed telecommunication networks (e.g. PSTN/ISDN/IP), and to other services which are specific to mobile users.

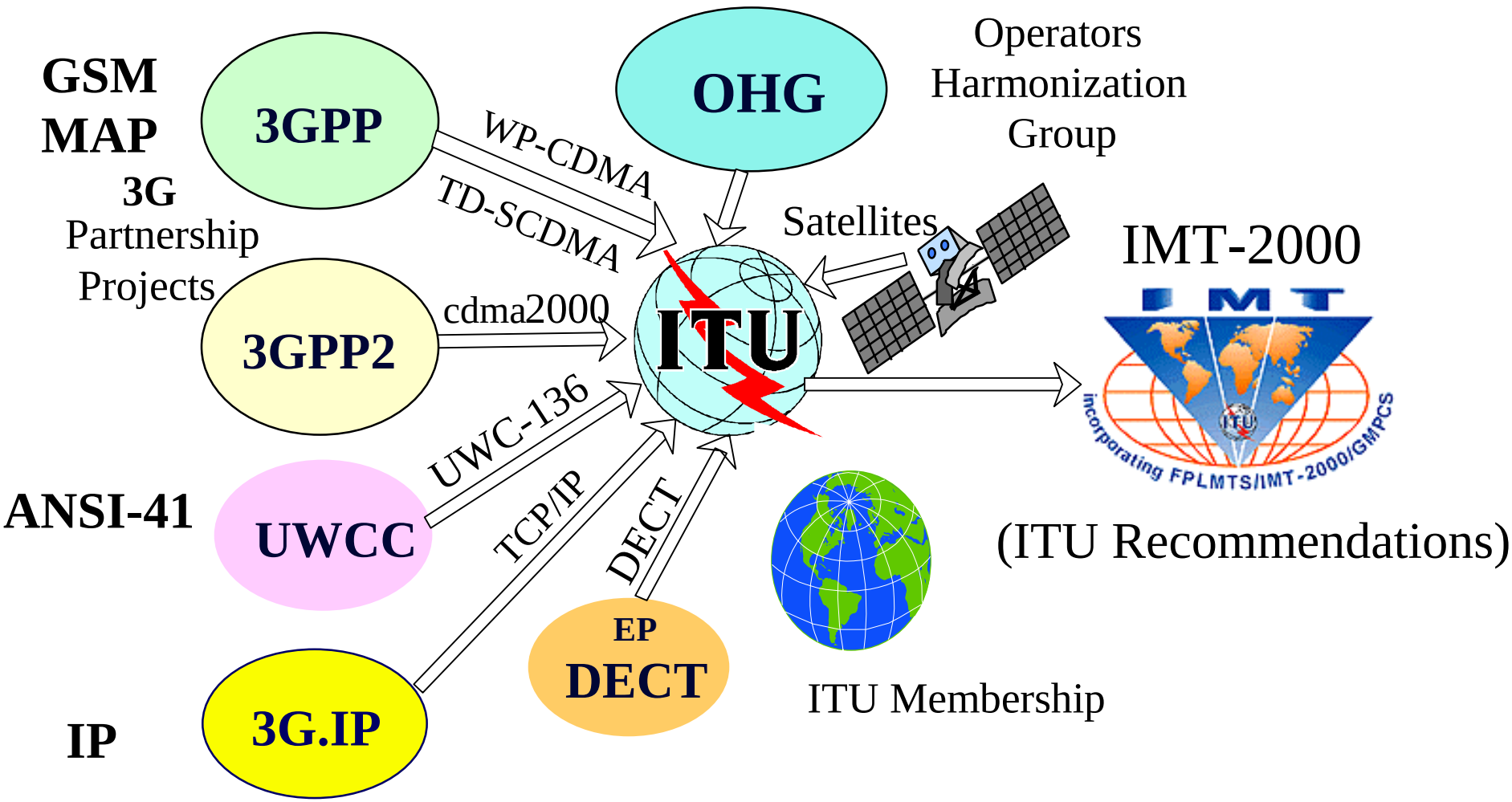
Key features of such wireless cellular systems should be:

- high degree of commonality of design world-wide;
- compatibility of services within 3G standards and with the fixed networks;
- high quality;
- small terminal for world-wide use;
- world-wide roaming capability;
- capability for multimedia applications, and a wide range of services and terminals;
- support of a limited number of different radio interface technologies within the 3G family.

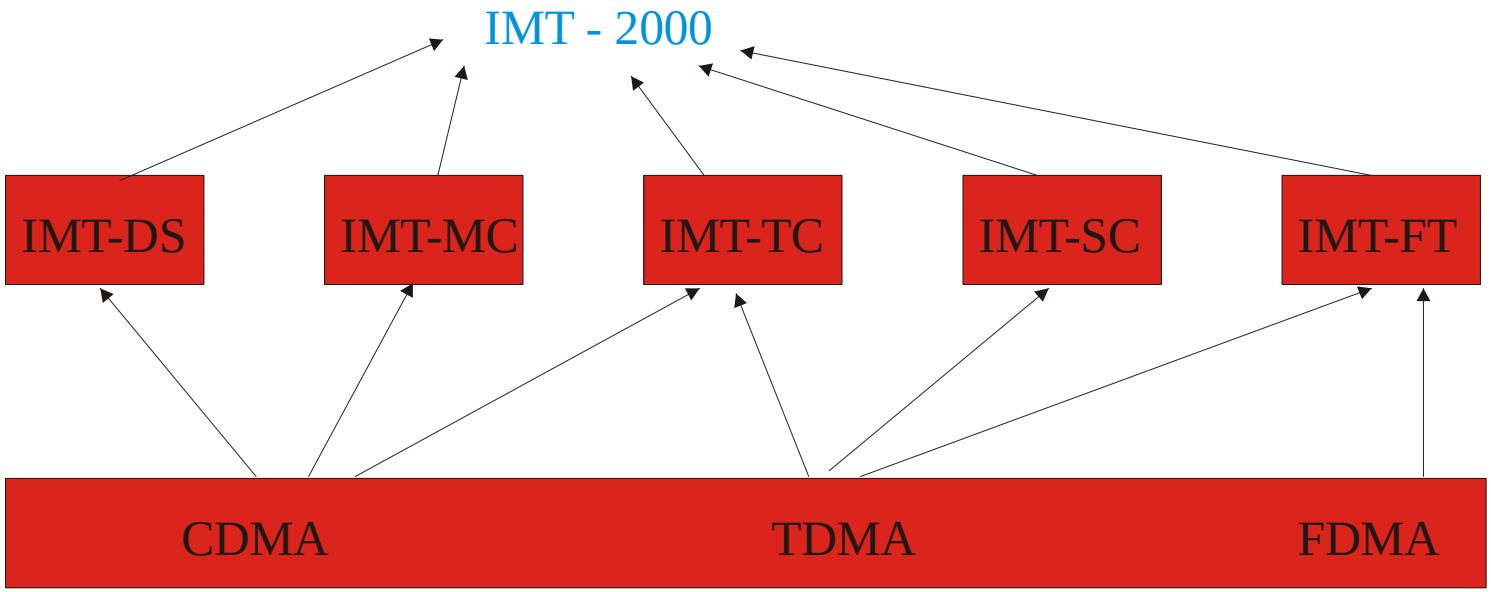
ITU vision of IMT-2000 world



Standardization of 3G cellular systems

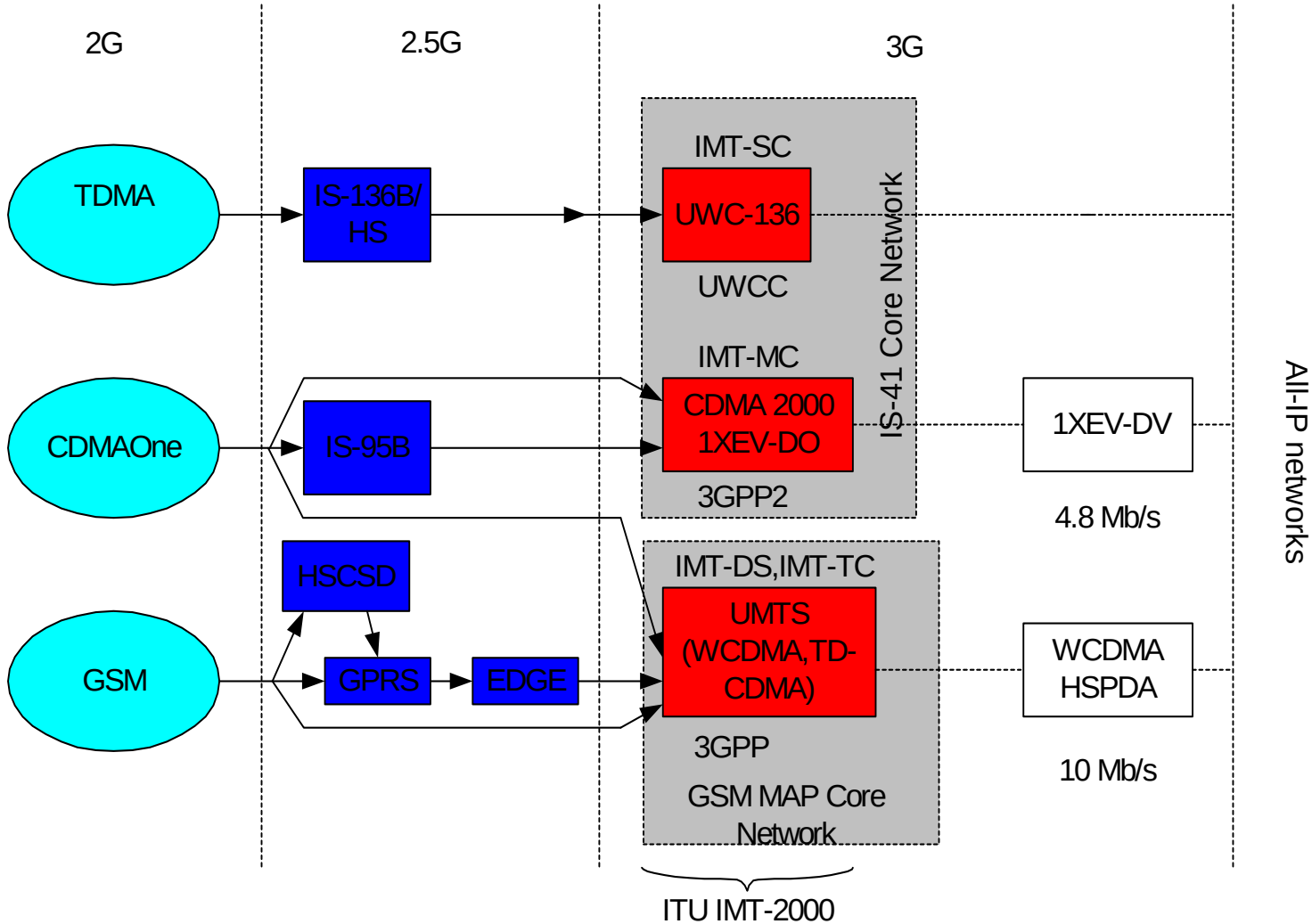


IMT-2000 Terrestrial Radio Interfaces



IMT-DS (Direct Spread)=W-CDMA (FDD)
IMT-MC (Multi Carrier)=cdma 2000
IMT-TC (Time-Code)=UMTS TDD, TD-SCDMA
IMT-SC (Single Carrier)=UWC-136
IMT-FT (Frequency Time)=DECT

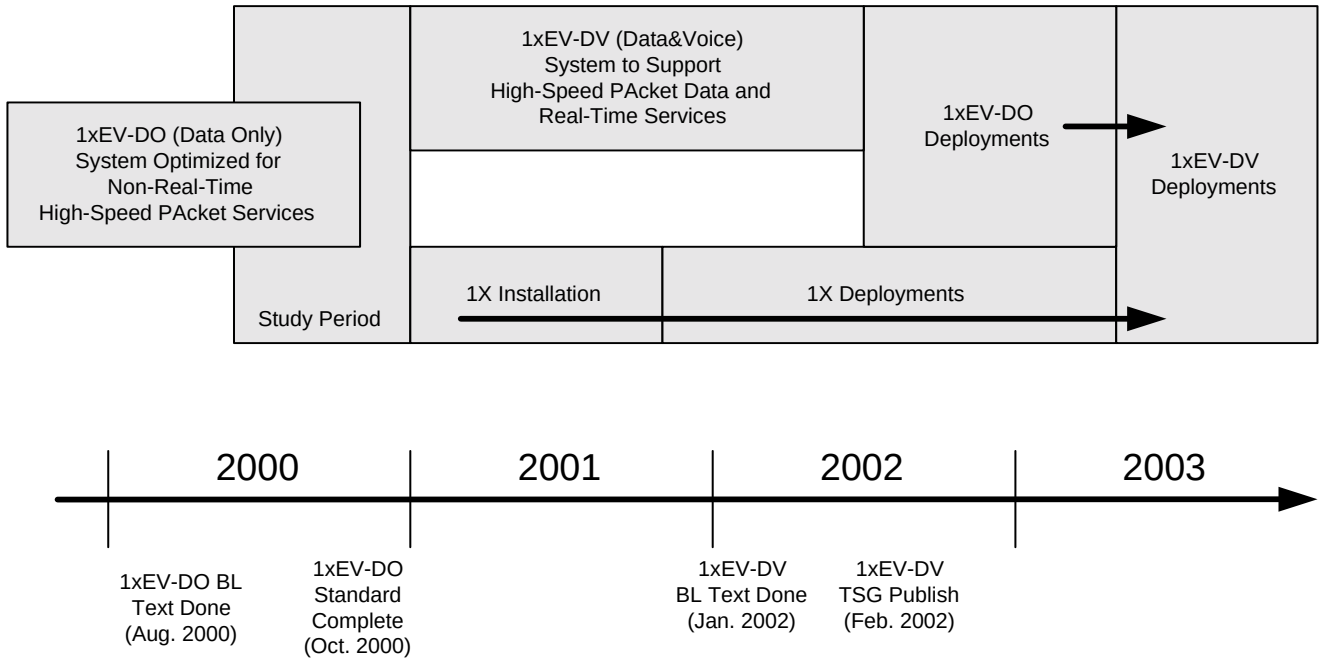
Migration scenarios towards IMT-2000



Development of 3GPP2 standards

- **IS-95-A**
  - Standardized by Telecommunications Industry Association (TIA) in July 1993. Networks utilizing IS-95 CDMA air interface and ANSI-41 network protocol are branded as cdmaOne networks. IS-95 networks use one or more 1.25MHz carriers, operate on 800 and 1900MHz bands. Data rates of up to 14.4kb/s and soft handoffs are supported.
- **IS-95-B**
  - Improvements for hard-handoff algorithms in multicarrier environments and in parameters that affect the control of soft handoffs. Higher data rates of up to 115kb/s can be supported by bundling up to eight 14.4 or 9.6 kb/s data channels.
- **Cdma2000**
  - Developed to support 3G services. This standard is divided into two phases:
    - **Cdma2000 1X** – 1X stands for standard carrier (1.25MHz) at air interface. It delivers twice the voice capacity of cdmaOne with average data rates of 144kb/s.
    - **Cdma2000 3X** – 3X stands to signify 3x1.25MHz with data rates of up to 2Mb/s

Evolved Cdma2000 1X standards



1xEV-DO can provide customers with peak data rates of 2.4Mb/s and its implementation requires installation of separate carrier that is dedicated to data-only use at each cell location where high-speed data services are demanded.

It is expected that 1xEV-DV has the following features:

- Peak data rate of 4.8 Mb/s
- Reverse link peak data rate of 614 kb/s
- Backward compatibility with IS-95A/B and 1X
- Supports voice, mixed voice/data, and real-time, 2-way on a single carrier
- Flexibility to deploy data only carriers to maximize end-user data rates
- Background, interactive, streaming, and real-time/1-way services

Development of 3GPP standards

- **GSM (Global System for Mobile Communications)**
- **GSM + standard**
  - Enables packet mode extensions to GSM using the same air interface but with a new physical channel. It could be done through the following three possibilities:
    - **HSCSD** (High Speed Circuit Switched Data Service)
    - **GPRS** (General Packet Radio Service) (and EGPRS)
    - **EDGE** (Enhanced Data Rates for GSM Evolution)
- **UMTS (Universal Mobile Telecommunications System)**
  - European version of IMT-2000 which is composed of a core network (CN) connected with interface (I_u) to the radio access network called the UMTS Terrestrial Radio Access Network (UTRAN). This standard supports two integrated CDMA-based radio access techniques: W-CDMA for FDD (frequency-division duplex) mode and TD-CDMA for TDD (time-division duplex) mode.

Comparison of GSM/GSM+ with UMTS

System Aspects	Existing GSM and GSM+ standards	UMTS
Use of digital technology	Already used for modulation, speech and channel coding as well as implementation and control of data channels	Increased use of digital technologies
Commonality between different operating environments	Each systems is primarily optimised for its specific operating environment	Optimisation of radio interfaces for multiple operating environments such as vehicular, pedestrian, intro-office, fixed wireless access and satellite, via a single flexible or scalable radio interface.
Frequency bands	Operate in frequency bands ranging from 800 MHz to 1.9 GHz, depending on the country	Use a common global frequency band
Data services	Limited to data rates below 115 kb/s (WAP-GRPS-SMS)	Transmission speeds up to 2 Mb/s
Roaming	Generally limited to specific regions, Handsets not compatible between different systems	Global frequency coordination and ITU standards will provide true global roaming and equipment compatibility
Technology	Spectrum efficiency, cost and flexibility limited by technology in use at time of system design	Spectrum efficiency, flexibility and overall costs all significantly improved.
Radio interfaces	TDMA, CDMA	W-CDMA, TD-CDMA
Data speed	9.6 kb/s with evolution up to171.2 kb/s (or 384kb/s) (2.5 G)	144 kb/s – 2 Mb/s

UMTS within IMT 2000 Family Concept Global 2G and 3G standards

Europe

2G: GSM + MAP

3G: UTRAN + MAP+

Asia

2G: GSM + MAP

3G: UTRAN + MAP+

2G: IS-95 + ANSI - 41

3G: cdma2000 + ANSI – 41+

2G: PDC

3G: UTRAN+MAP+

USA

2G: PCS + MAP

3G: UTRAN + MAP+

2G: IS-95 + ANSI - 41

3G: cdma2000 + ANSI – 41+

2G: IS-136 + ANSI - 41

3G: TDMA/136, EDGE ANSI-41+

(2+3)G Operator needs

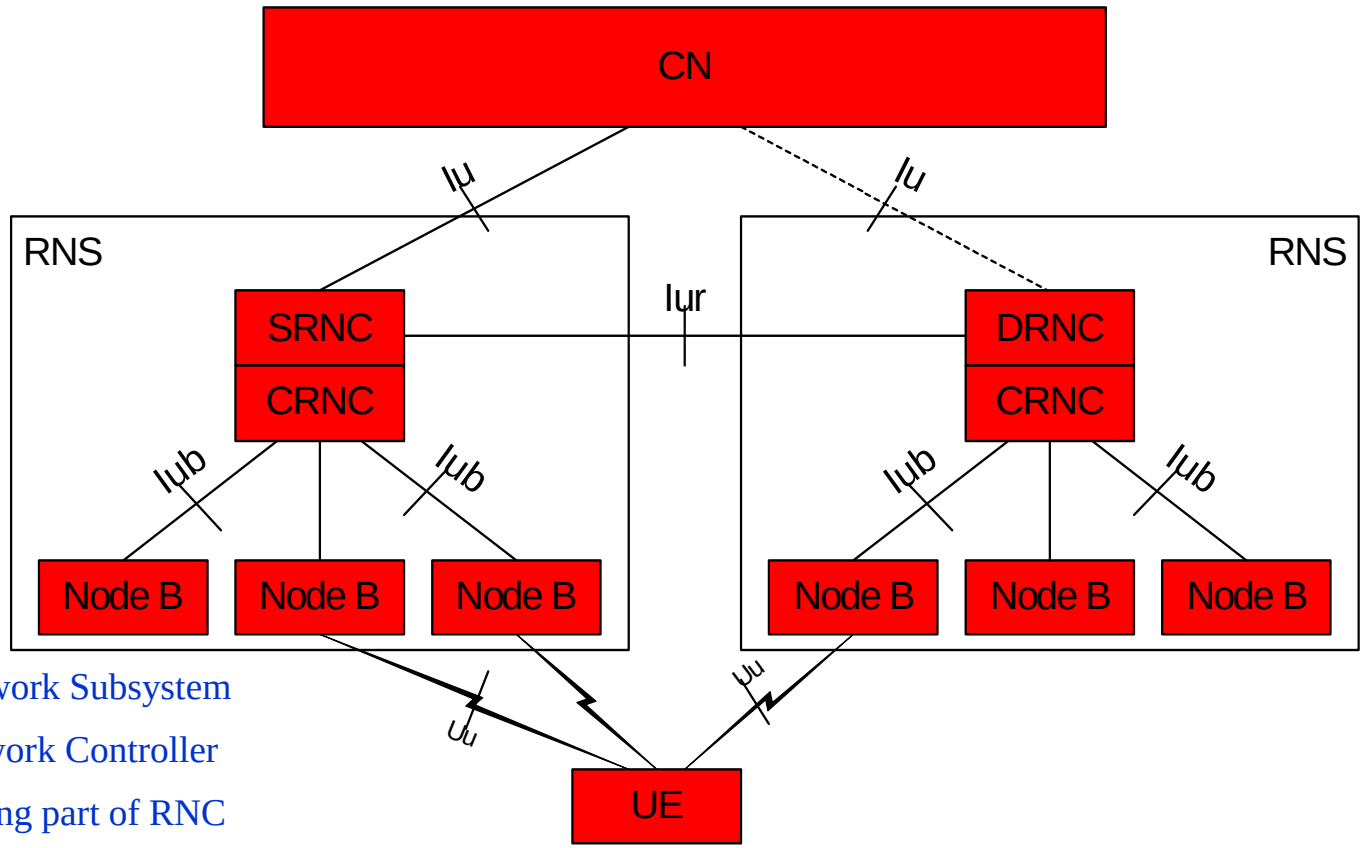
- Dual mode 3G/2G terminals
- 3G/2G coverage
- 3G/2G service handover
- Reuse of 2G cell site grid
- Reuse of 2G networks
- Reuse of 2G spectrum due to later refarming

UMTS characteristics

Channel bandwidth	8 MHz
Duplex mode	FDD and TDD
Downlink RF channel structure	Direct spread
Chip rate	3.84 Mbps
Frame length	10 ms
Spreading modulation	Balanced QPSK (downlink) Dual-channel QPSK (uplink) Complex spreading circuit
Data modulation	QPSK (downlink) BPSK (uplink)
Channel coding	Convolutional and turbo codes
Coherent detection	User dedicated time multiplexed pilot (downlink and uplink), common pilot in the downlink

Channel multiplexing in downlink	Data and control channels time multiplexed
Channel multiplexing in uplink	Control and pilot channel time multiplexed I&Q multiplexing for data and control channnel
Multirate	Variable spreading and multicode
Spreading factors	4-256 (uplink), 4-512 (uplink)
Power control	Open and fast closed loop (1.6 kHz)
Spreading (downlink)	OVSF sequences for channel separation Gold sequences 2^{18}-1 for cell and user separation
Spreading (uplink)	OVSF sequences for channel separation Gold sequences 2^{41} for user separation
Handover	Soft handover Interfrequency handover

UTRAN architecture



RNS- Radio Network Subsystem

RNC-Radio Network Controller

CRNC- Controlling part of RNC

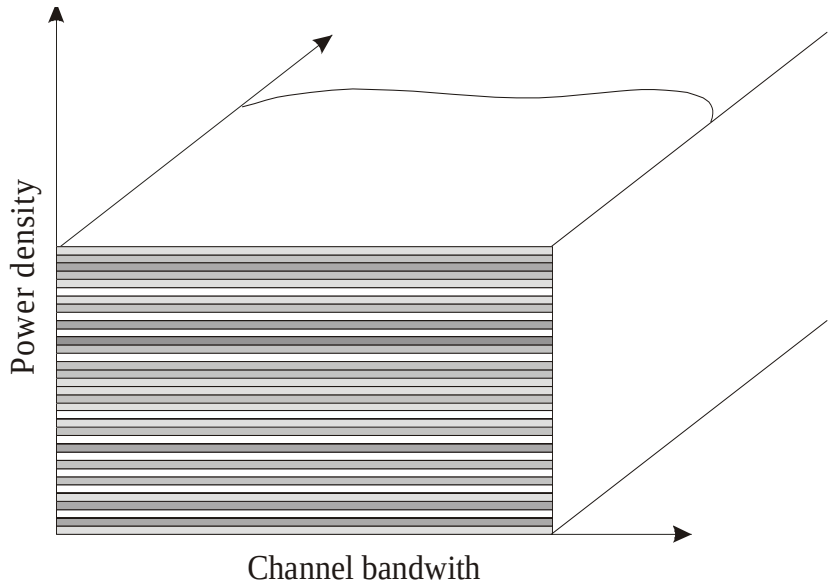
SRNC-Serving RNC

DRNC-Drift RNC

UE-User Equipment

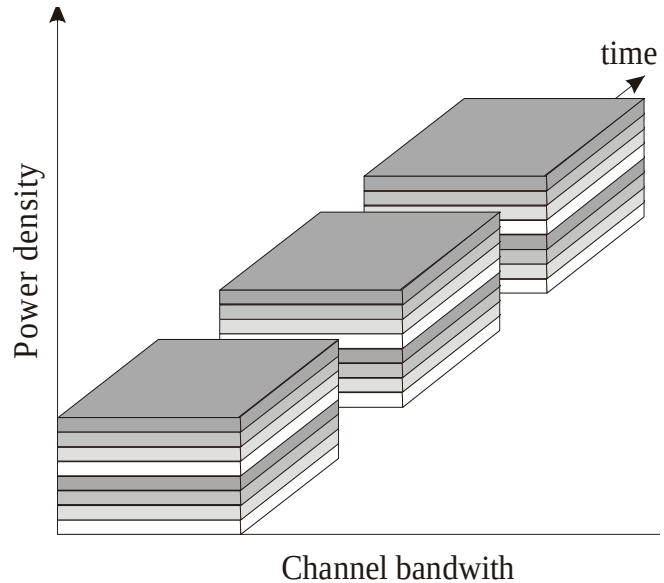
UTRA (Uu Interface) concept

UTRA combines two radio access technologies: W-CDMA for the paired frequency bands and TD-CDMA for the unpaired frequency bands.



WCDMA

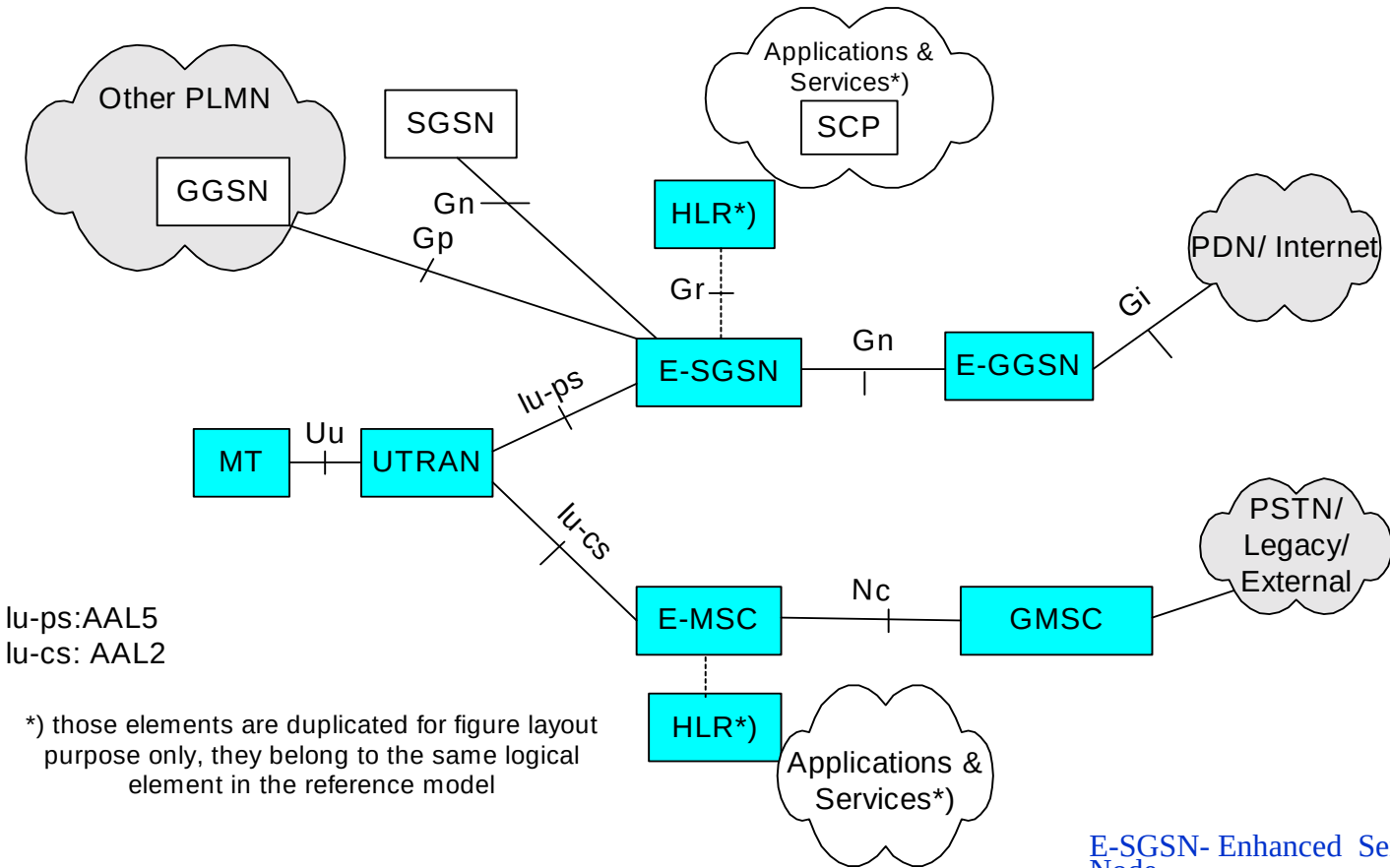
FDD mode



TD/CDMA

TDD mode

UMTS (3GPP) Release 99 (R3)



lu-ps:AAL5
lu-cs: AAL2

*) those elements are duplicated for figure layout purpose only, they belong to the same logical element in the reference model

E-SGSN- Enhanced Serving GPRS Support Node

E-GGSN- Enhanced Gateway GPRS Support Node

E-MSC – Enhanced MSC

UMTS R3 features

UMTS R3 is composed of the UTRAN attached to two separate core network domains:

- Circuit switched domain based on enhanced GSM MSCs consists of the following network elements:
  - 2G/3G mobile-services switching center including the VLR functionality
  - HLR with AC (Authentication Center) functionality
- Packet switched domain built on enhanced GPRS support nodes consists of:
  - 2G/3G serving GPRS support node with subscriber location register (SGR) functionality
  - Gateway GPRS support node (GGSN)

UMTS Release 00

UMTS Release 2000 (Release 00) is split into two releases:

- **Release 4 (00)** and
- **Release 5(00+).**

R00 defines two RAN technologies: GPRS/EDGE radio access network (GERAN) and W-CDMA as in R3.

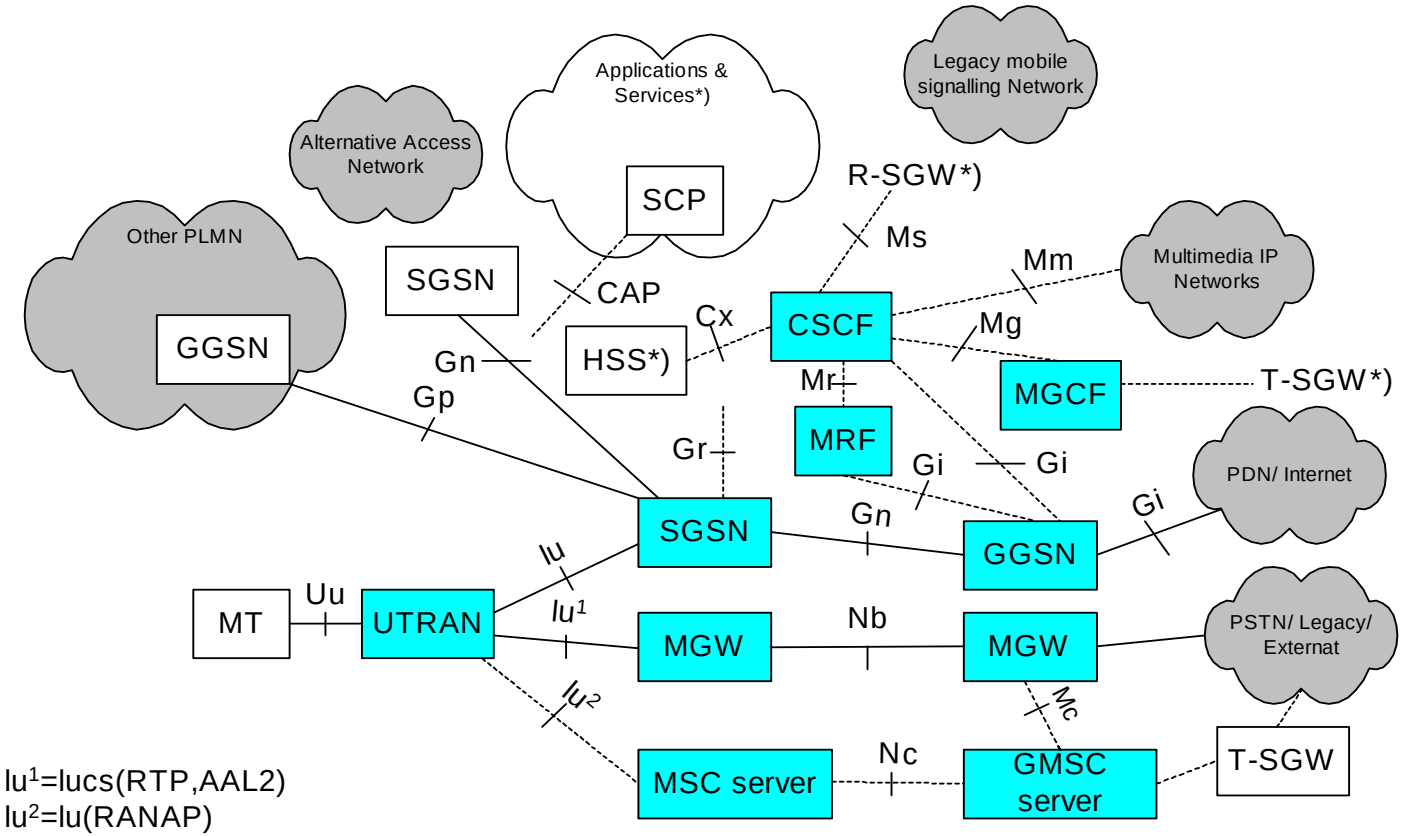
R4 features are:

- Hybrid architecture: ATM-based UTRAN and IP/ATM-based CN
- GERAN: support for GSM radio including EDGE
- Enhancements in QoS
- Circuit-switched domain is split into separate signaling plane (MSC server) and transport plane (Media Gateway).

R5 introduces All-IP environment, including:

- Transport: utilization of the IP transport and connectivity with QoS throughout the network
- End-user services: with Session Initiation Protocol (SIP) possibilities to offer wide range of new services

UMTS (3GPP) Release 5



*) those elements are duplicated for figure layout purpose only, they belong to the same logical element in the reference model

DEPLOYMENT STRATEGIES FOR 3G SYSTEMS

When choosing an adequate approach for 3G systems deployment, the following elements have to be considered:

- **network type (private-public),**
- **coverage (local-global),**
- **mobility (low-high),**
- **data traffic (low-high),**
- **types of services (basic-multimedia).**

Thus, two approaches may be identified:

Scenario 1 – innovative, applied through implementation of the completely new 3G network

Scenario 2 – evolutionary, applied through migration (upgrade) of already existing 2G or 2G+ network

DEPLOYMENT SCENARIO No.1

In this type of scenario the following versions may appear:

- **SCENARIO No.1(a): All-round**

  3G network is implemented where no 2G network exists both in terms of deployment area and the transmission rate

- **SCENARIO No.1(b): Complement**

  3G network is implemented in the region with already existing 2G network(s) in a way that it could be:

  - **Area-complement** – 3G covers the whole range of the transmission rate and is located in the position not covered by 2G networks in the terms of the deployment area
  - **Rate-complement** – 3G covers the whole range of the deployment area and is located in the position not covered by 2G networks in terms of the transmission rate.

COMPARISON OF SCENARIOS No.1(a) AND No.1(b)

	All-round-type scenario	**Complement-type scenarios**
Transmission bit rate	From lower to higher rates	Higher rate
Mobility	From static to cellular mobility	Cellular mobility
Deployment Area	From pico to macro cells	Micro and macro cells
Network interface	If necessary	Indispensable
System roaming	If necessary	Indispensable
Radio interface	Single	Multiple
Mobile terminal mode	Single	Multiple
Security	Whole system	Core network
Billing/charging	Unified system	Multiple systems
Core network	Customized	Transparent
Service provider	Single	Multiple
2G, 3G and other mobile systems	Overlap	Complement

DEPLOYMENT SCENARIO No.2

There are two possible ways for mobile operators to migrate from 2G (2G+) to 3G:

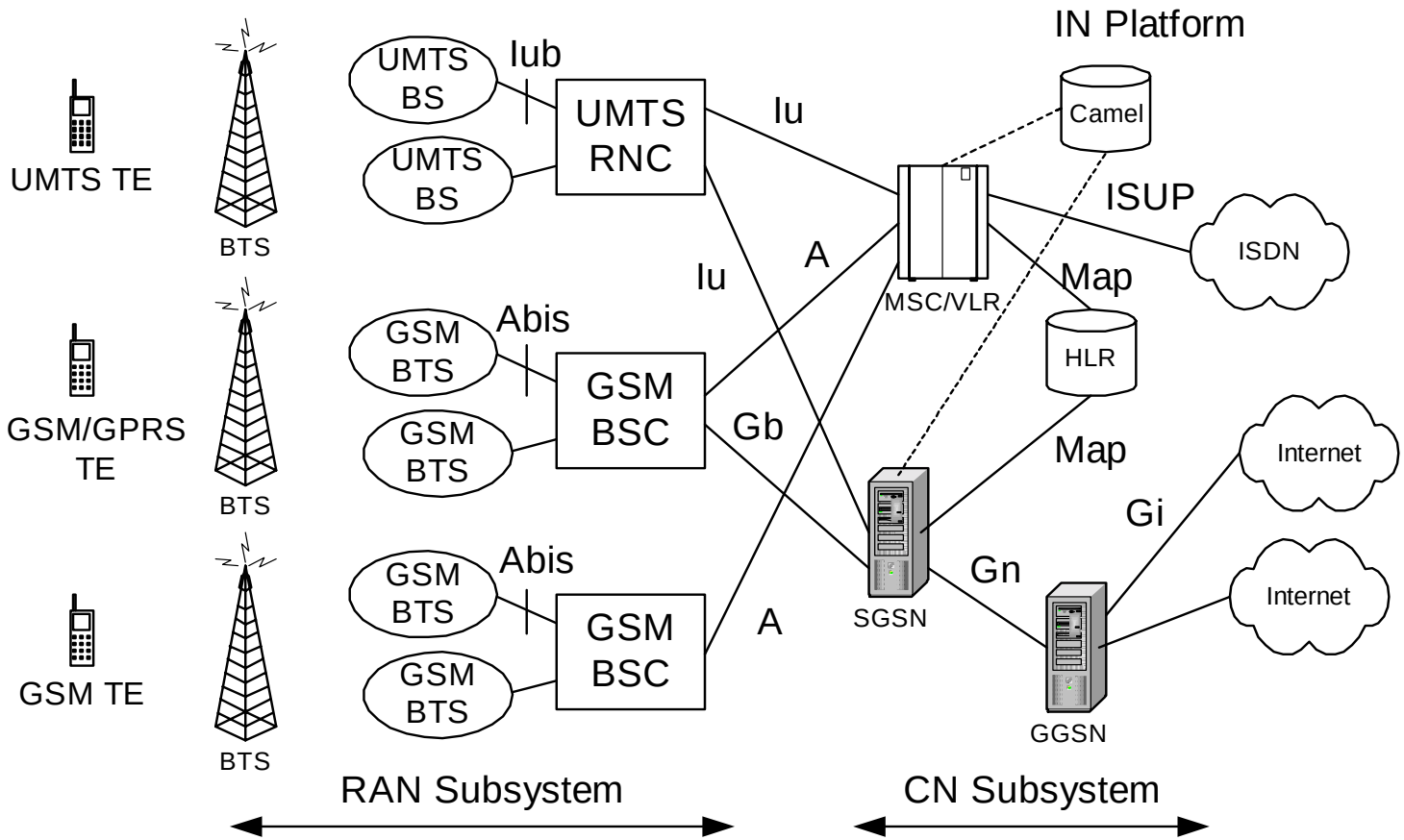
- **Scenario No.2(a):**

Existing 2G or 2G+ core network could be upgraded for 3G use. In this case 2G and 3G networks share the same core infrastructure.

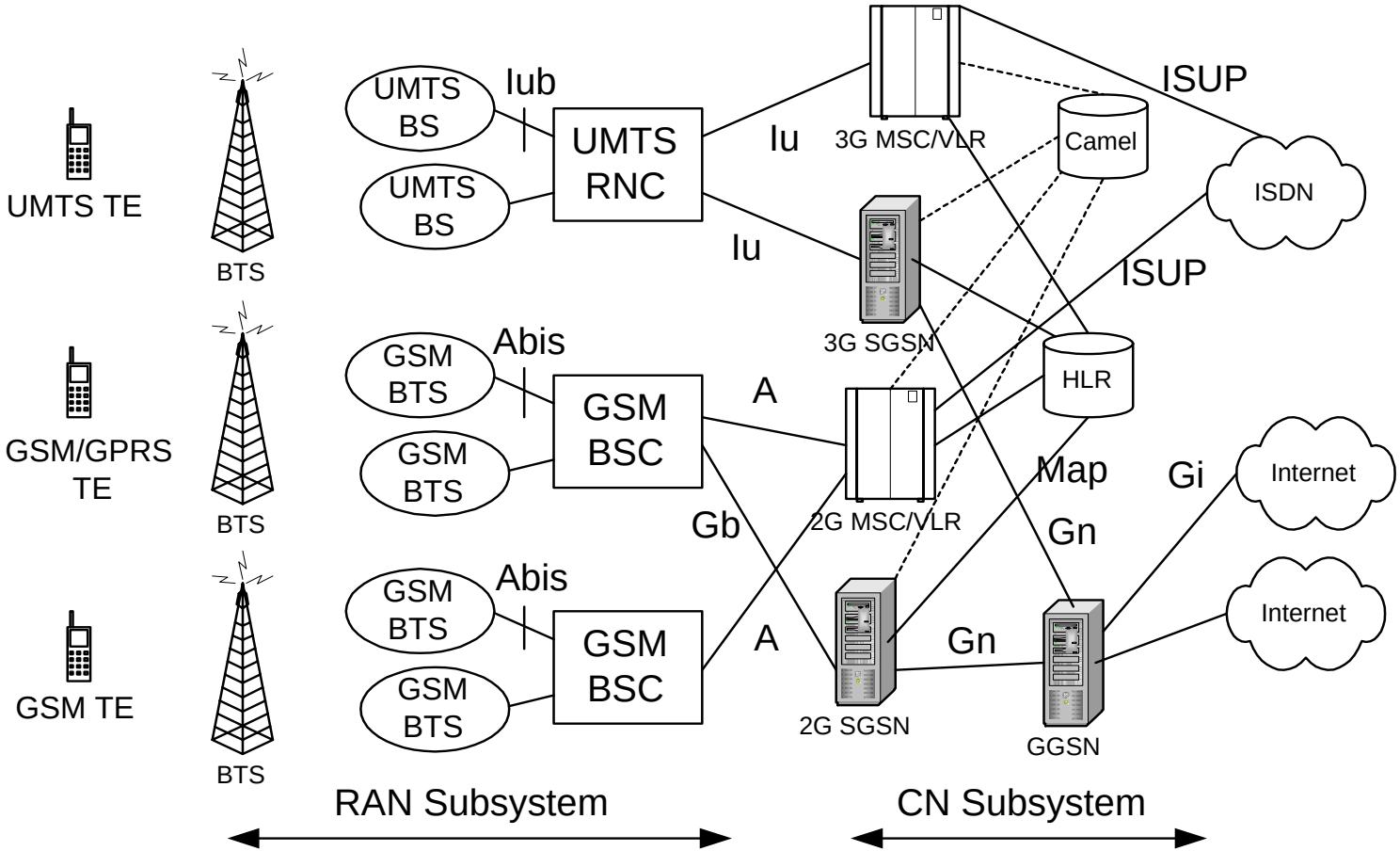
- **Scenario No.2(b):**

Independent 3G core network could be implemented completely independent from the existing 2G core infrastructure.

SCENARIO No.2 (a):
COMMON CORE NETWORK FOR 2G AND 3G



SCENARIO No.2 (b):
INDEPENDENT 2G AND 3G CORE NETWORKS



IMPACTS OF SCENARIOS No.2 ON EXISTING 2G NETWORKS

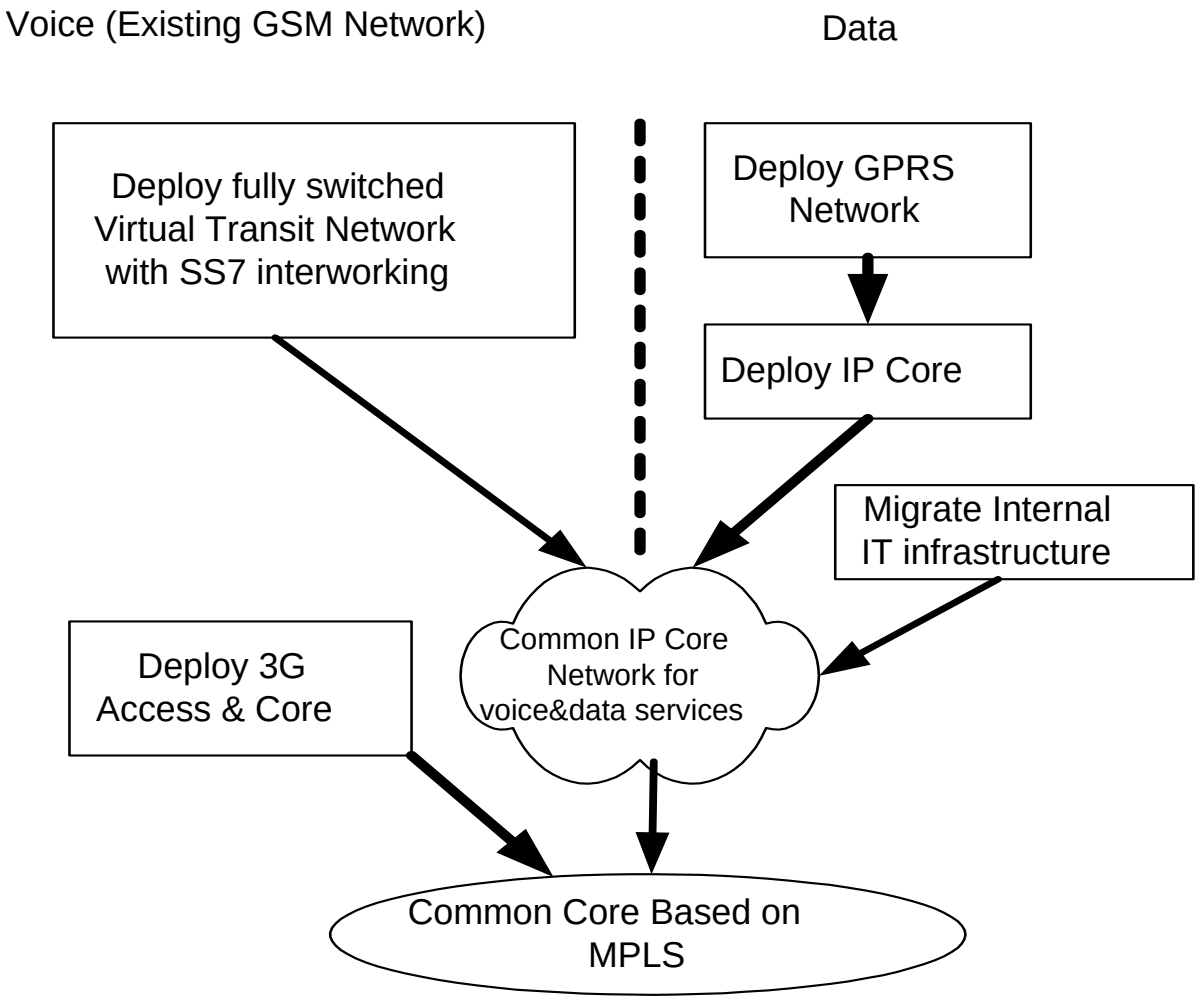
➢ SCENARIO No.2(a):

- Re-dimension of the existing core network to be able to support 3G broadband services
- Optimize transmission network for a suitable traffic mix
- Network management system

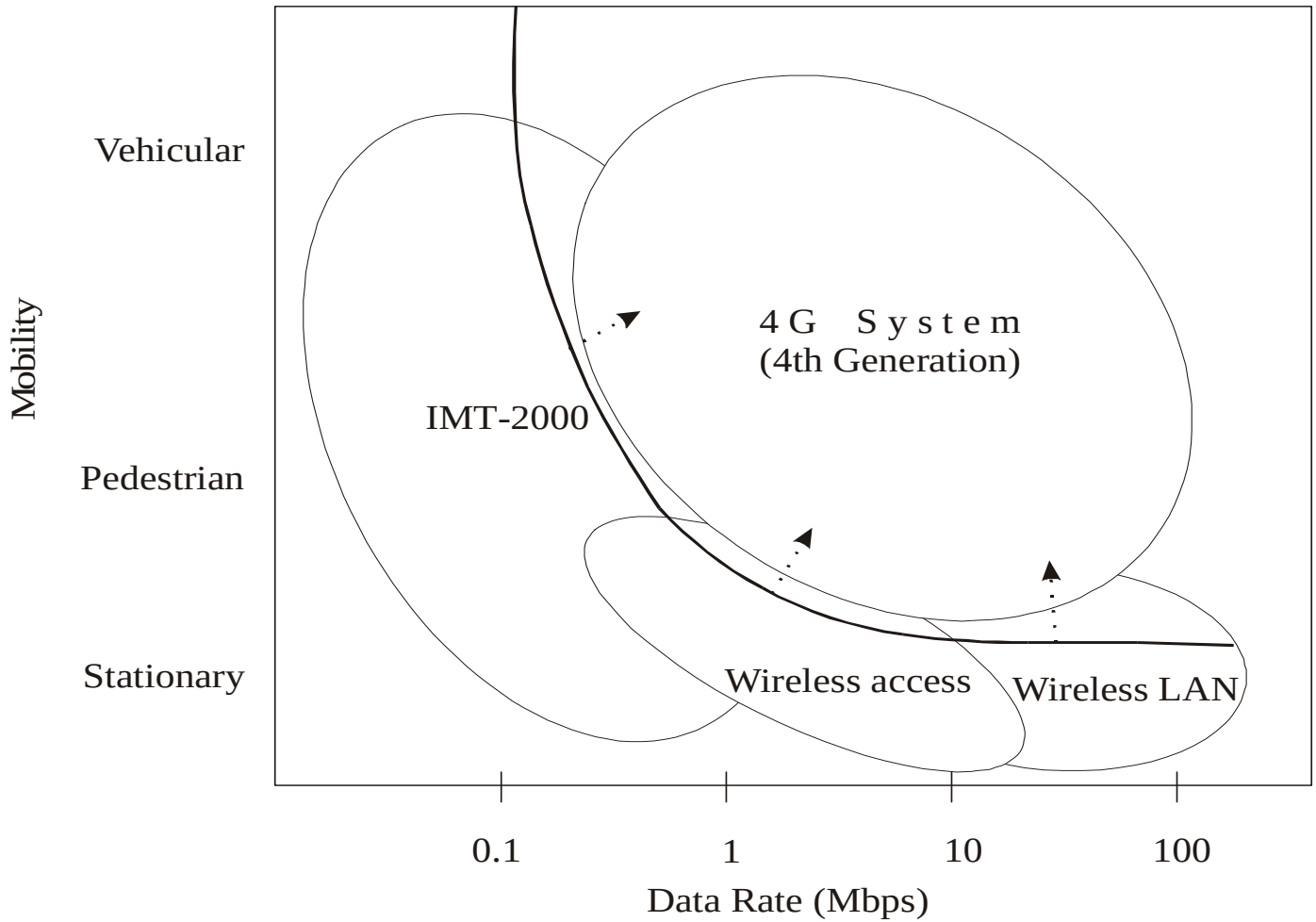
➢ SCENARIO No.2(b):

- 2G and 3G networks have minimum impact on each other

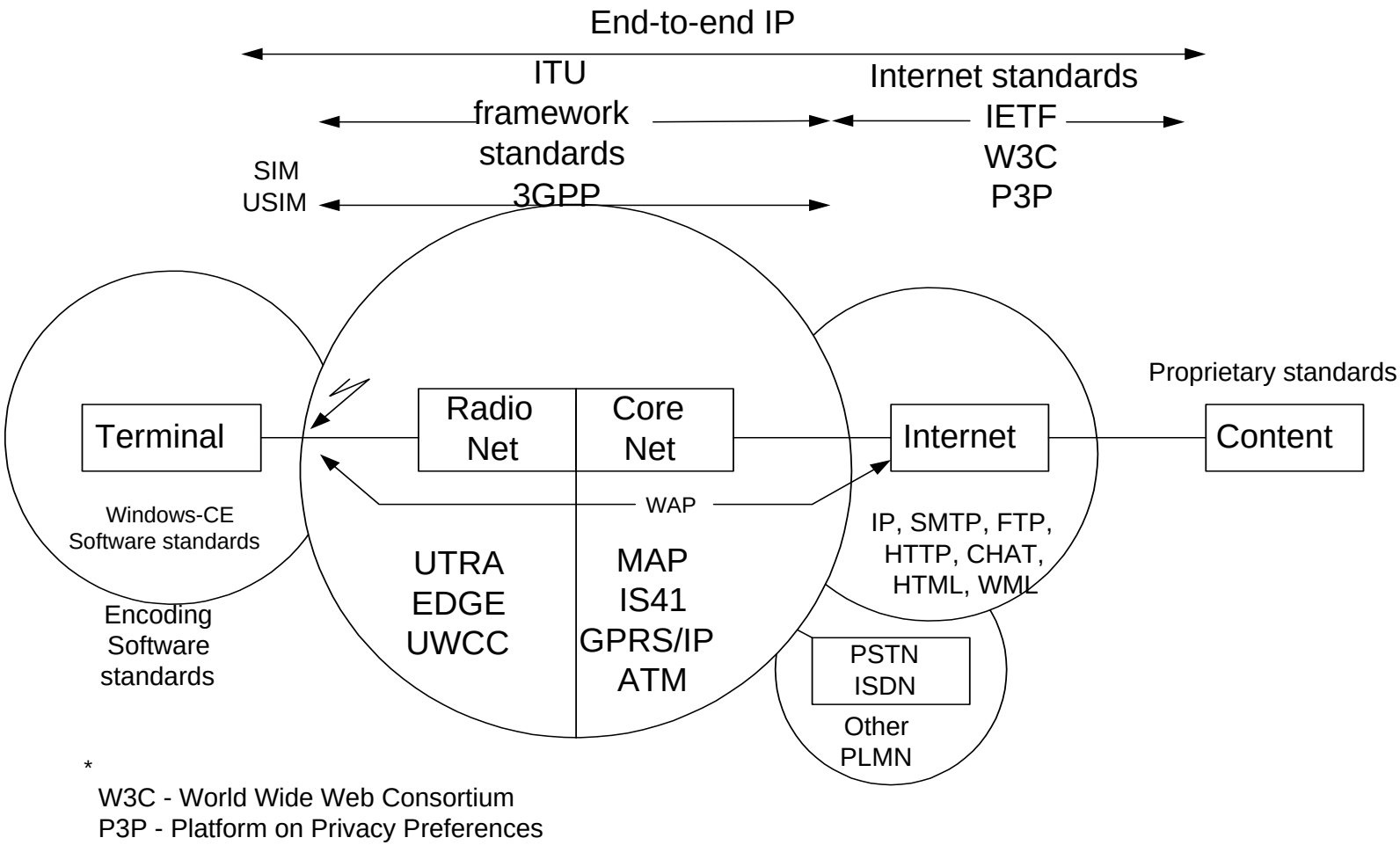
DEPLOYMENT SCENARIO No.2:
Optimized implementation



Trends in future wireless networks development



FUTURE STANDARDIZATION ACTIONS



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W3C - World Wide Web Consortium
P3P - Platform on Privacy Preferences