"3G and Beyond: The Convergence of Mobile Telephony and Computing"

SFM-05: Moby
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Bertinoro, 28 April 2005
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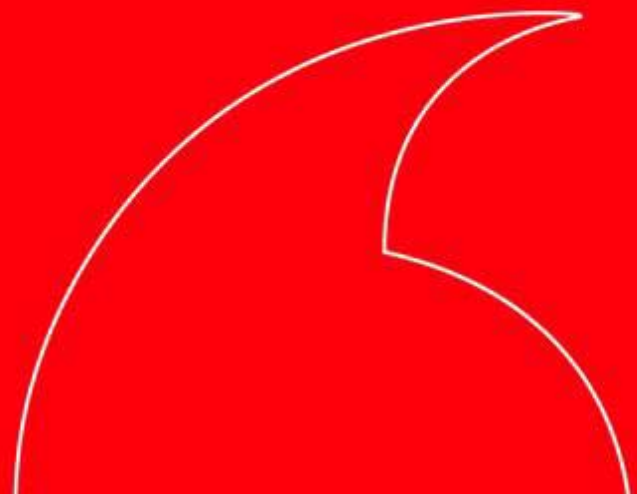

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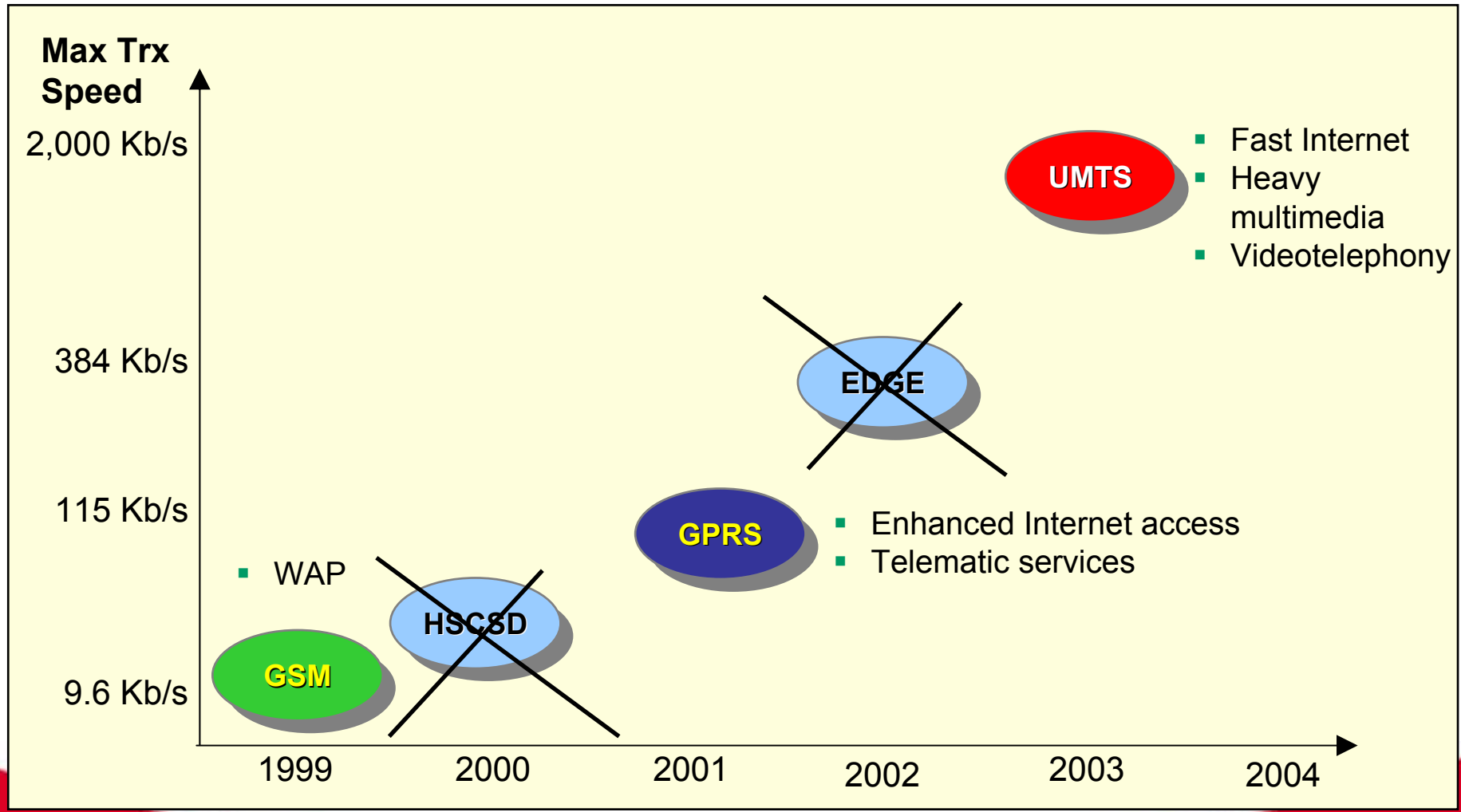
Technology Evolution

Data Transmission Technology Roadmap



GPRS as Real "Data Wave" Enabler

- Efficient data traffic management
- Higher transmission speed
- Volume and content-based billing (alongside time-based)
- Continuous network connection

Real possibility of new data service offer

Pricing well fitted with new data services

Full usage support for data/info services

Data applications best adapted to the GPRS

GPRS Constraints	Implications
• Every time a “data object” is downloaded to a GPRS handset, the handset and the network open a transfer session and allocate radio resources • Opening this transfer session takes some time, from half a second to a few seconds depending on the network configuration and the load on the network • Therefore, highly transactional applications where many objects of small size are transferred create a few seconds of delay for each object transferred	• A typical web page contains 30 “data objects” which will be downloaded successively, with a few seconds delay for each object (in addition to the actual download time) • GPRS is therefore well adapted for applications requiring few transfer sessions of rather large objects -e.g. email download • For transactional applications, observed performance might actually appear weaker than with CSD

Why UMTS ?

- Increased efficiency in the use of spectrum, bringing more capacity

Long term cost saving

- Improved quality in service offer

Customer satisfaction and loyalty

- More flexibility in offering current and new services

New revenues from new services

Service Transmission Times: New business opportunities

Service Data Volume	Transfer Time					
	2nd Generation GSM - GPRS		Fixed PSTN / ISDN	3rd Generation UMTS		
	9,6 kbps	50 kbps	≤ 64 kbps	128 kbps	384 kbps	2 Mbps
E-mail 5 kbyte	8 s	1,7 s	1,6 s	1,2 s	0,5 s	<0,5s
SMS with photogr. 5 kbyte (JPEG 2000)	8 s	1,7 s	1,6 s	1,2 s	0,5 s	<0,5s
Web page 20 kbyte	20 s	4,5 s	4 s	2,4 s	0,8 s	<0,5s
Document 100 kbyte	2 min	35 s	25 s	12 s	4 s	<1s
3 min Audio CD 2 Mbyte MP3	40 min	9 min	6,5 min	3 min	---[1)]	---[1)]
10s Videoclip 600 kbyte MPEG4	10 min	2,5 min	1,5 min	45 s	15 s[2)]	

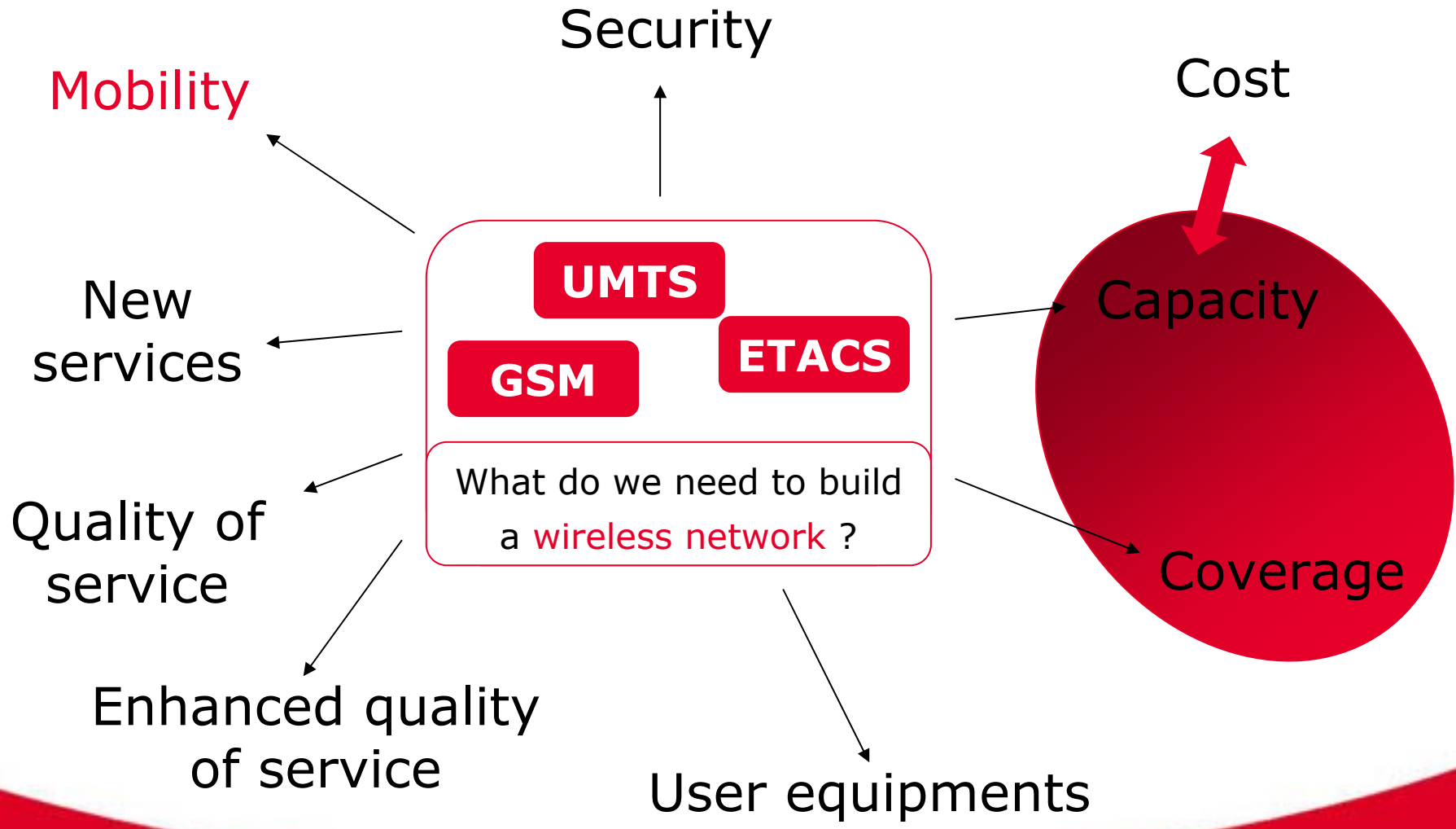
User acceptance

[1)] Optimal CD Quality Streaming = 128 kbps

[2)] Videostreaming

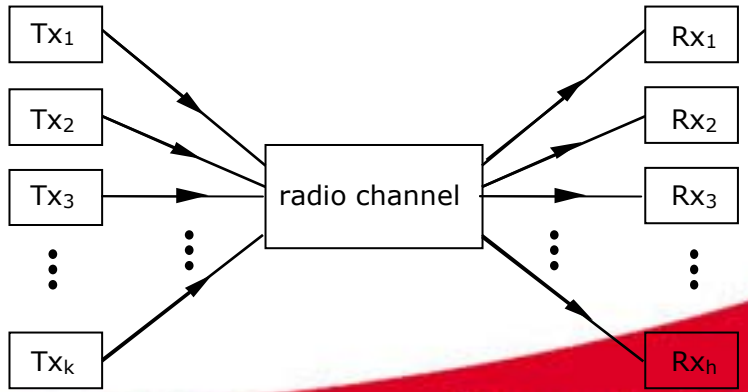
Mobile Networks
Basic concepts

The requirements for a wireless network



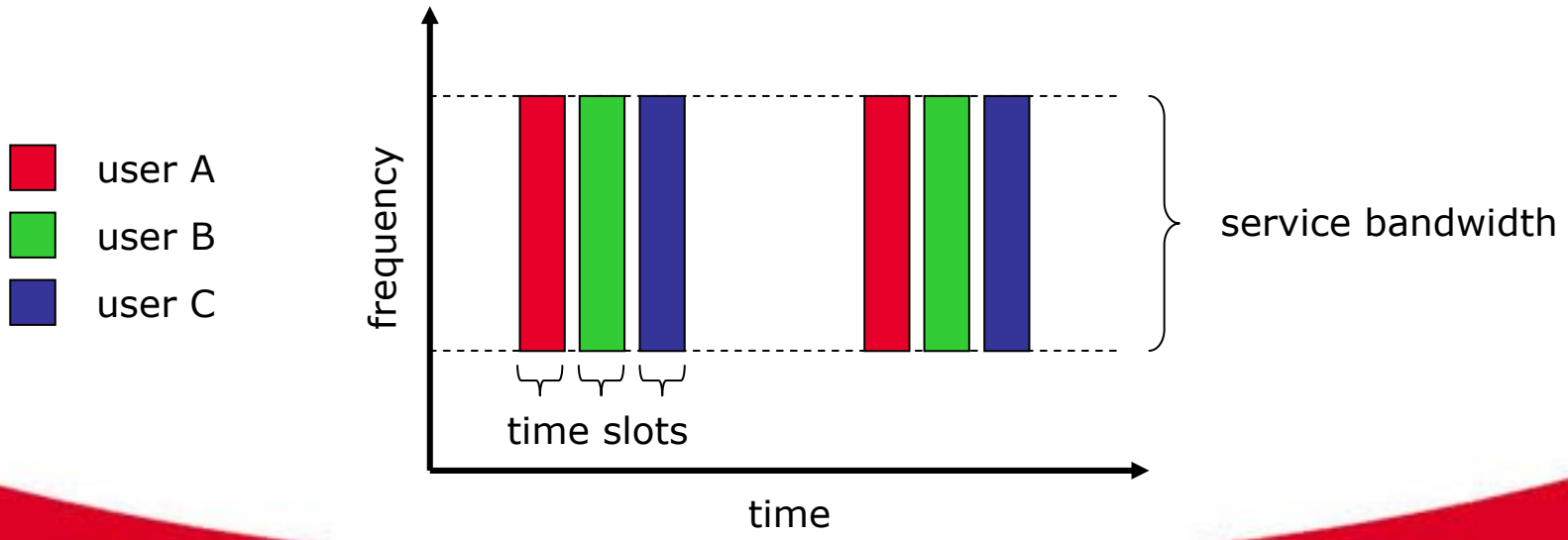
Radio channel access policy

- Since different users have to share the same band, it is necessary to define an access policy with the aim of maximizing the number of served users and minimizing the bandwidth and power usage
- An access policy has to be chosen and optimized according to the required system performance and to the operating scenarios of the provided service
- The main access policies are:
  - FDMA (Frequency Division Multiple Access)
  - TDMA (Time Division Multiple Access)
  - CDMA (Code Division Multiple Access)



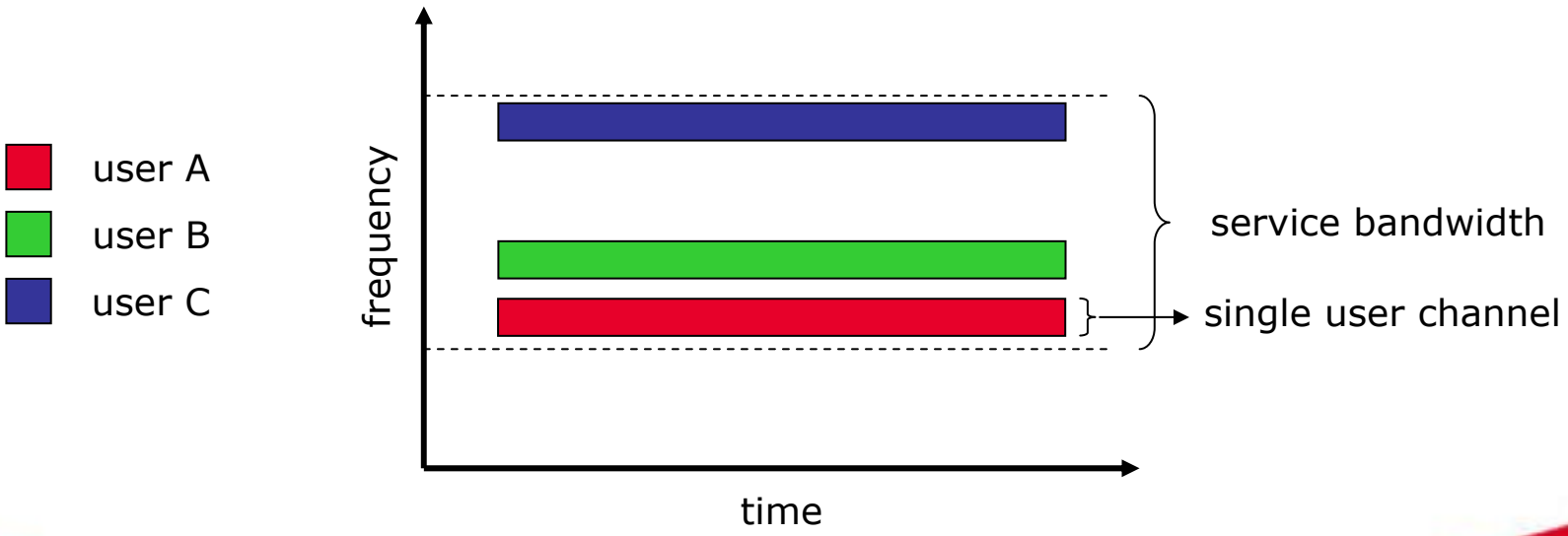
TDMA

- In TDMA systems the available radio resource is temporally divided in *time slots*, during which only one user at a time is allowed to access the channel
- Time slots are periodically assigned to users, that cannot have a continuous access to the channel, but have to perform a *buffer-and-burst* policy



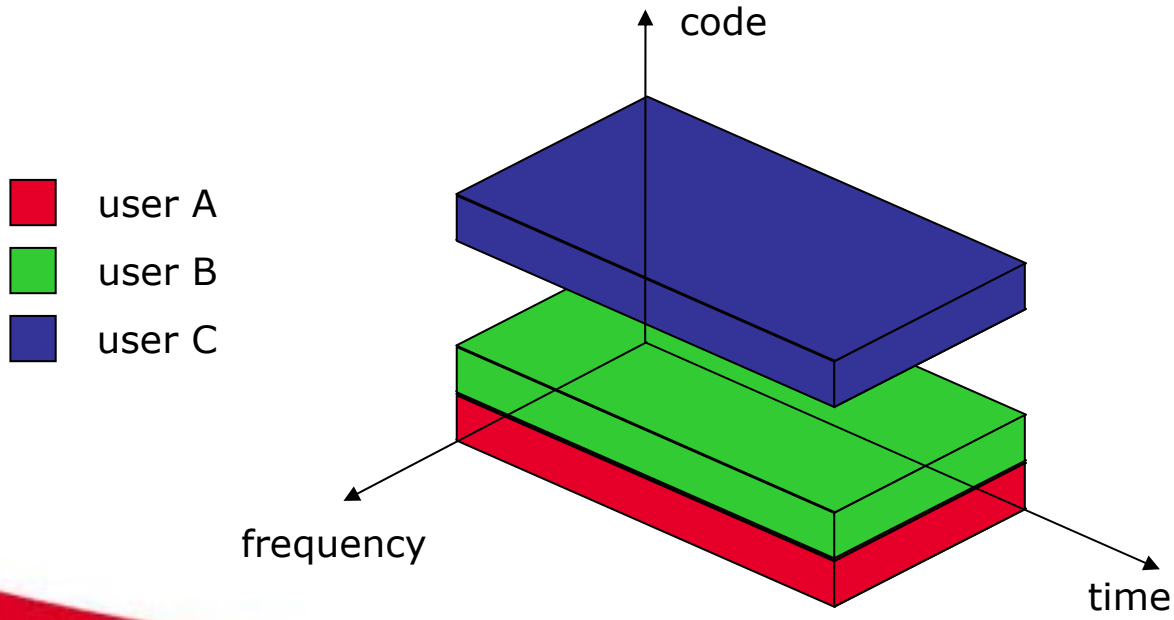
FDMA

- In FDMA systems the available radio resource is divided in *sub-bands* that are assigned one per user for the whole duration of the user connection
- This technology requires narrowband modulation methods and selective receive filters



CDMA

- In CDMA systems the whole available radio resource (both in the frequency and in the time domain) is shared by any user at the same time
- The single user channel is identified by a code that is univocally assigned to the connected users



Duplexing

- Telecommunications systems usually require data exchange both from mobile terminal to base station (uplink or reverse link) and from base station to mobile terminal (downlink or forward link)
- Duplexing is the capability of a system to perform this operation for both links together

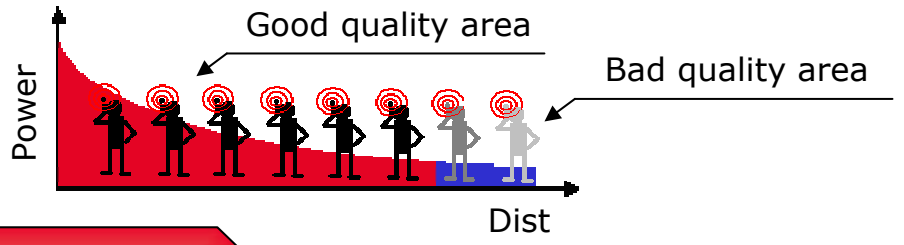
- The main techniques for duplexing are:
  - FDD (Frequency Division Duplexing)

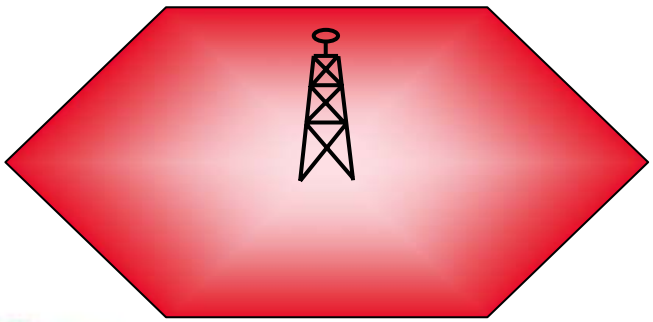
    uplink and downlink data exchange are performed in two different frequency bands
  - TDD (Time Division Duplexing)

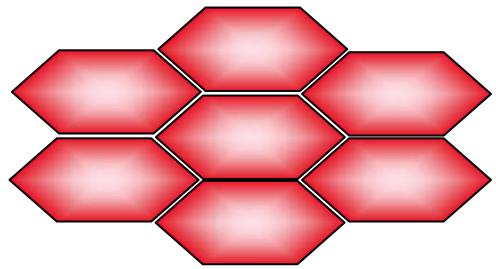
    uplink and downlink data exchange are performed in the same frequency band, but in different time slots

Cellular systems

- Since a radio signal propagates into the space with an attenuation increasing with distance, the coverage area of a base station is spatially limited
- Hence to provide a telecommunication service on wide areas, it is necessary to have different base stations (cells), that make a cellular system



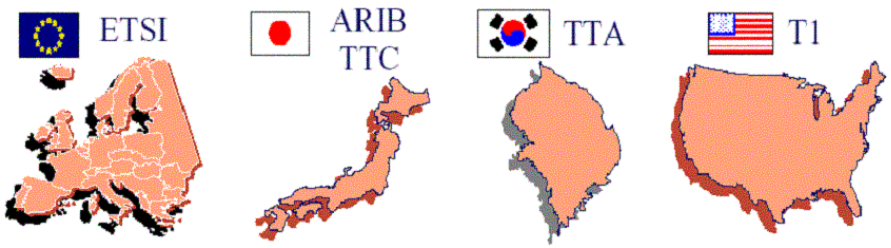


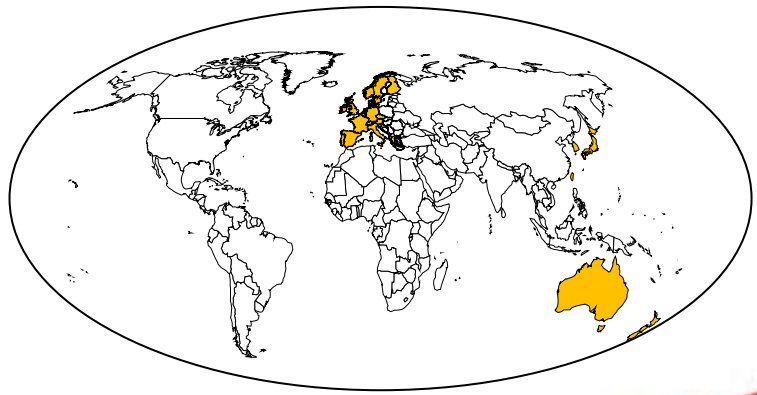


Standards: UMTS as our 3G choice

- *The target of a single 3G standard has vanished mainly for geopolitical reasons*
- UMTS has been specified by 3GPP, the regulatory forum which includes many national/continental regulators
  - *FDD radio access network (W-CDMA: UMTS) and TDD radio access network (TD-CDMA)*
  - *Core network evolved from GSMGPRS system*
- Manifacturers, operators, scientific communities, regulation boards

3GPP founder members 'P





Countries with **UMTS** Licensed Spectrum at 2.1 GHz

W-CDMA multiple access

- This approach does not attempt to allocate disjoint frequency or time resources to each user
- The power transmitted by each user must be controlled to the minimum required to maintain a given signal-to-interference ratio for the required level of performance (***Power Control*** procedure)

The ONU party:

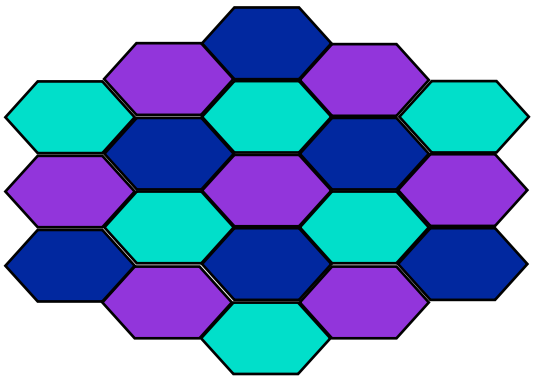
All the participants share the same resources (they speak at the same time), but, if the volume of everyone is controlled

It is possible to communicate with one of them, simply knowing his language (the channel key), that is different for any participant

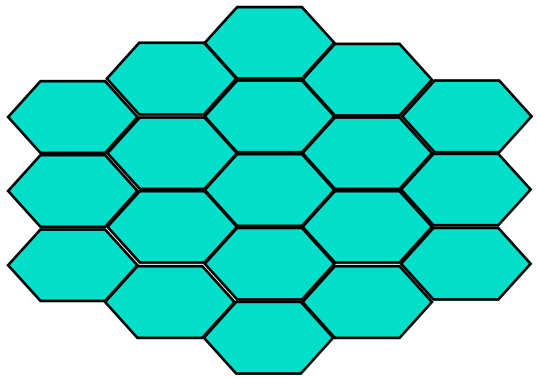
CDMA key paradigms

- Channel separation is achived by means of orthogonal codes
- Each carrier frequency can be shared by all the users ⇒ frequency reuse factor = 1
  - Soft degradation
  - Users are interfered also by other users in their own cell and by users of adjacent cells

GSM: reuse factor>1



UMTS: reuse factor=1

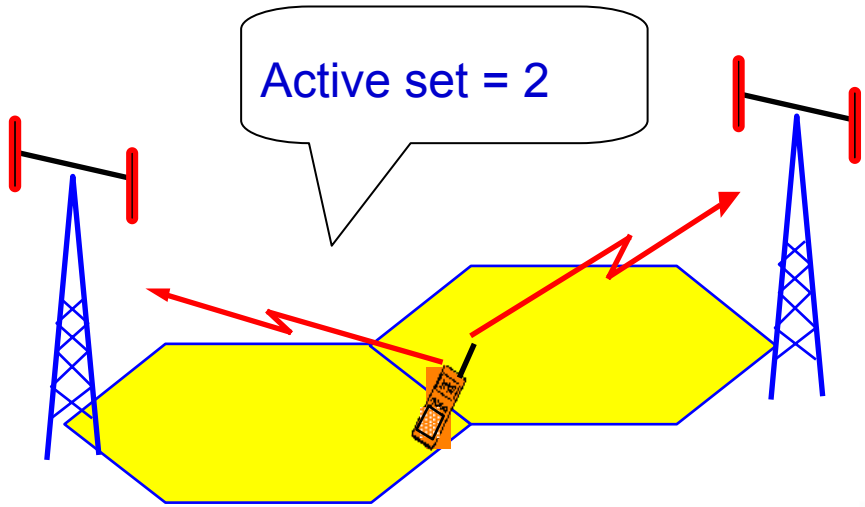


- Transmitted power is strictly controlled to cause minimum amount of interference

Soft handover

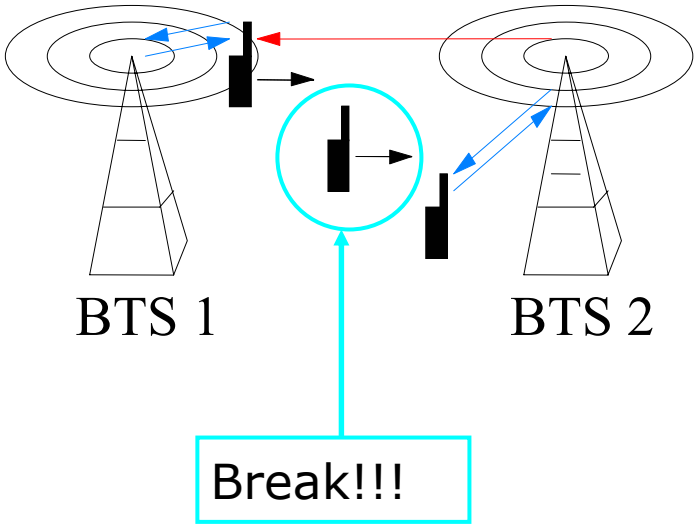
- W-CDMA system: all cells work on the same carrier frequency ⇒ the mobile terminal can be connected to more than one cell at the same time
- Consequences:
  - *SOFT HANDOVER*: minimize the risk of call dropping when mobile users change cell
  - *MACRODIVERSITY*: Better quality and reliability

Active set:
set of cells to witch
a terminal is connected
at the same time

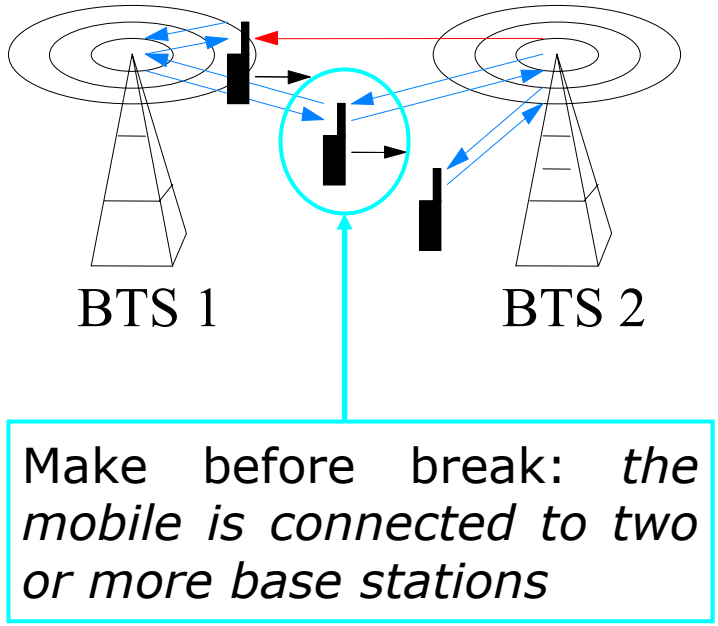


Soft vs hard handover

Hard Handover



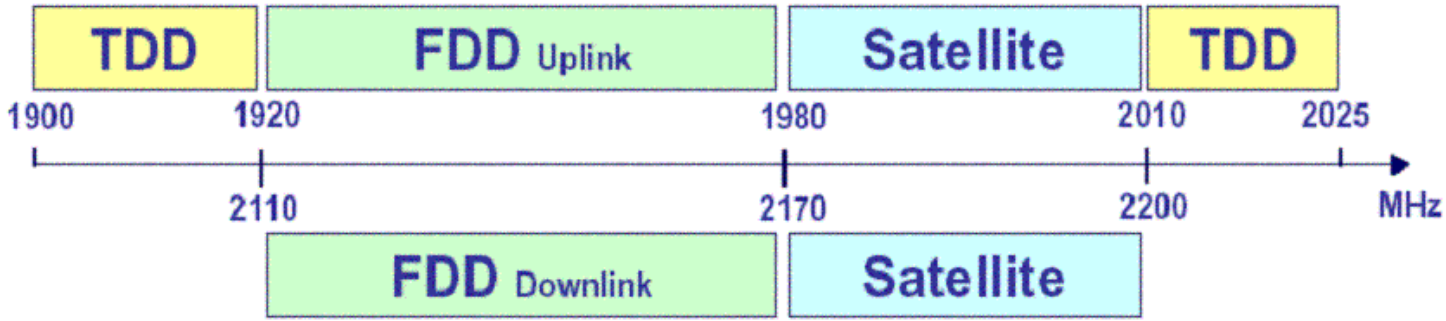
Soft Handover



Frequency allocation

Europe:

- FDD: 1920-1980 MHz and 2110-2170 MHz
- TDD: 1900-1920 MHz and 2010-2025 MHz



Spectrum assignement in Italy

- 15+15 MHz FDD, 5 MHz TDD: H3G
- 10+10 MHz FDD, 5 MHz TDD: Vodafone, Tim, Wind

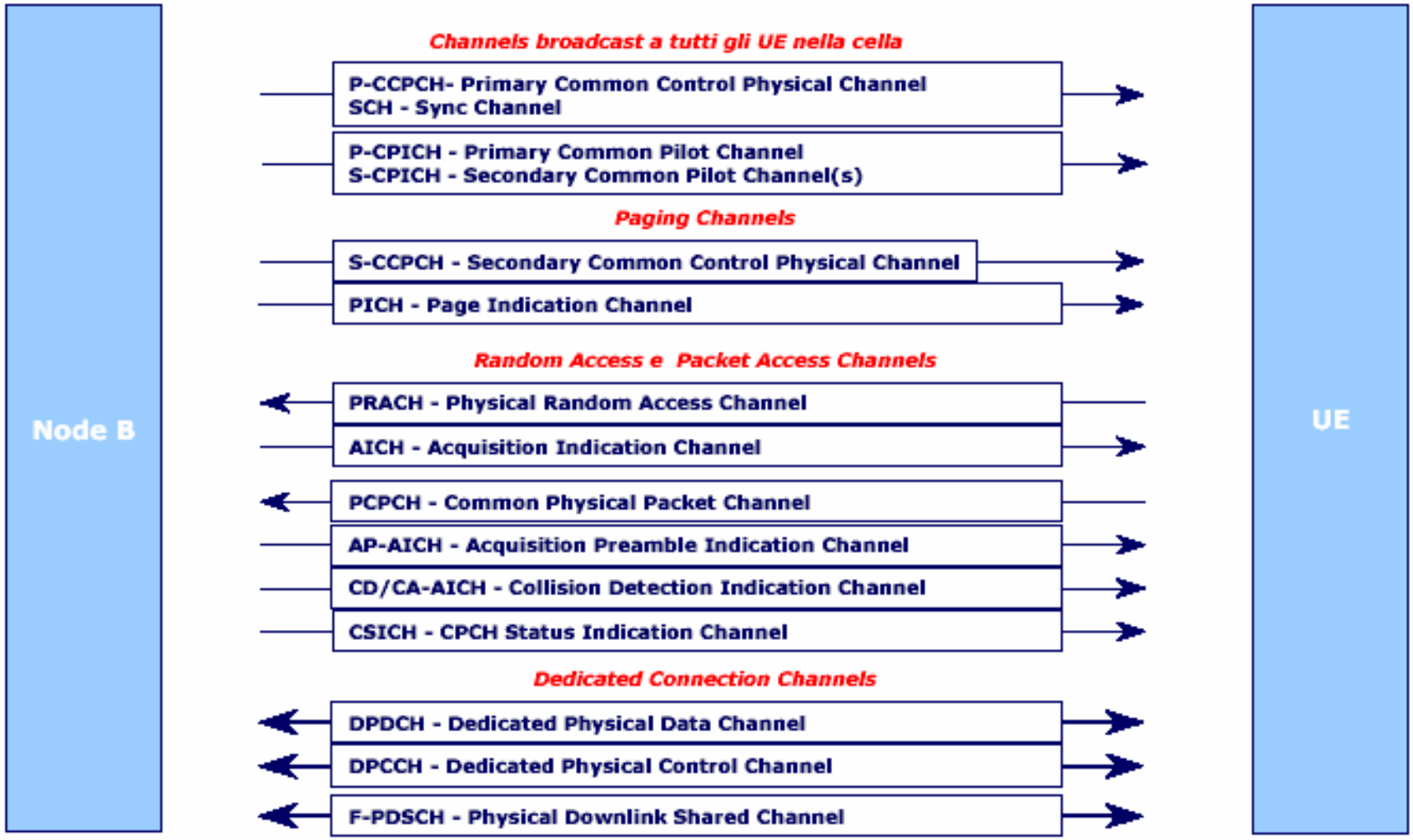
Accesso radio

- Velocità di trasmissione
  - 2 Mbps per utenti quasi-fermi e vicini alla stazione base (<10 kmph)
  - 384 kbps in ambiente urbano (<120 kmph)
  - 128 kbps in ambiente rurale (<500 kmph)
  - velocità e QoS variabili dinamicamente
- Tecnica CS o PS in base al servizio
- Utilizzo di celle di differenti dimensioni (satellite, macro, micro, pico) per ambienti out/ o indoor.
- Accesso radio con stazioni base non sincronizzate
- Gestione flessibile ed efficiente dello spettro radio
- Coesistenza di tecniche FDD e TDD

Funzionalità del livello fisico

- Elaborazione dati ed RF
  - FEC encoding/decoding dei canali di trasporto
  - Error detection sui transport channels e notifica ai livelli superiori
  - Adattamento del bitrate tra canali di trasporto codificati e canali fisici
  - Bilanciamento e combinazione dei canali fisici
  - Controllo di potenza "Closed-loop"
  - Modulazione/demodulazione e *spreading/de-spreading* dei canali fisici
  - *Multiplexing/de-multiplexing* deicanali di trasporto combinati e codificati
  - *Mapping* dei canali di trasporto sui canali fisici
  - Combinazione/distribuzione per *macrodiversity*
- Funzionalità operative
  - Funzionalità di *cell search*
  - Sincronizzazione (chip, bit, slot, trama)
  - Supporto per il Soft Handover
  - Misure caratteristiche radio (FER, SIR, Interference Power, ecc.) e notifica ai livelli superiori
  - Gestione del timing advance (uplink TDD mode)

Canali fisici WCDMA



Canali fisici in downlink (1)

- Common Downlink Physical Channels
  - **P-CCPCH** **Common Control Physical Channel (Primary)**
    - Broadcast delle informazioni della cella
    - Broadcast della SFN e Timing reference per tutti i canali DL
  - **SCH** **Synchronization Channel**
    - Fast Synch. codes 1 and 2; time-multiplexed con P-CCPCH
  - **S-CCPCH** **Common Control Physical Channel (Secondary)**
    - Trasmette l'informazione di segnalazione e controllo per gli UE in idle-mode
  - **P-CIPCH** **Common Pilot Channel**
  - **S-CIPCH** **Secondary Common Pilot Channel (for sectored cells)**
  - **PDSCH** **Physical Downlink Shared Channel**
    - Trasmette dati ad alta velocità a più utenti

- Dedicated Downlink Physical Channels
  - **DPDCH** **Dedicated Downlink Physical Data Channel**
  - **DPCCH** **Dedicated Downlink Physical Control Channel**
    - Trasmette la segnalazione e il controllo per i mobili in connessione

Canali fisici in downlink (2)

- Downlink Indication Channels
  - AICH (Acquisition Indication Channel)
    - Acknowledges that BS has acquired a UE Random Access attempt
    - (Echoes the UE's Random Access signature)
  - PICH (Page Indication Channel)
    - Informs a UE to monitor the next paging frame
  - AP-AICH (Access Preamble Indication Channel
    - Acknowledges that BS has acquired a UE Packet Access attempt
    - (Echoes the UE's Packet Access signature)
  - CD/CA-ICH
    - Confirms that there is no ambiguity between UE in a Packet Access attempt
    - (Echoes the UE's Packet Access Collision Detection signature)
    - Optionally provides available Packet channel assignments
  - CSICH
    - Broadcasts status information regarding packet channel availability

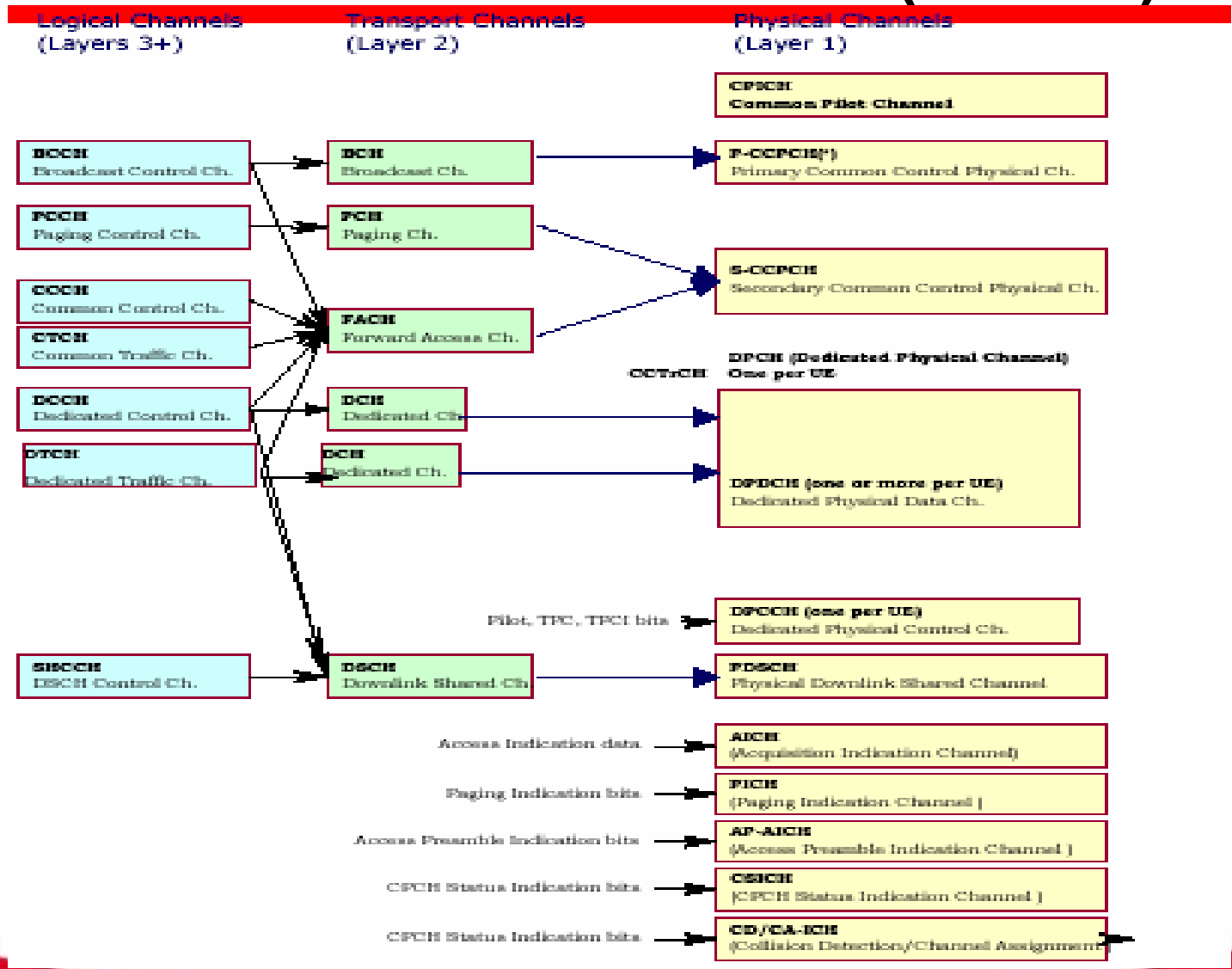
Canali fisici in uplink

- Common Uplink Physical Channels
  - **PRACH Physical Random Access Channe**
    - Used by UE to initiate access to BS
  - **PCPCH Physical Common Packet Channel**
    - Used by UE to send connectionless packet data
- Dedicated Uplink Physical Channels
  - **DPDCH Dedicated Uplink Physical Data Channel**
  - **DPCCH Dedicated Uplink Physical Control Channel**
    - Transmits connection-mode signaling and control to BS

Tipi di codice per WCDMA

- Channelization Codes (Orthogonal Codes)
  - Used to orthogonally code different data channels from BS, UE
- Scrambling Codes (Spread Spectrum Codes)
  - BS Scrambling Codes: Used by UE to distinguish the desired BS
  - UE Scrambling Codes: Used by BS to distinguish the desired UE
- Synchronization Codes
  - Primary Sync. Code: Fixed 256-bit code
Helps UE identify the presence of a WCDMA BS
Helps UE achieve Slot Synchronization
  - Secondary Sync. Codes: Group of 256-bit codes
Helps UE achieve Frame Synchronization
- Pilot Codes
  - A full-time common Pilot (CPICH) provides coherent reference for UE receiver
  - Pilot data bits are embedded into each timeslot of the Dedicated Data Channel
- Random Access Preamble Codes
  - Preamble Signatures; Used by BS to distinguish between UE making access attempts

WCDMA downlink (FDD)



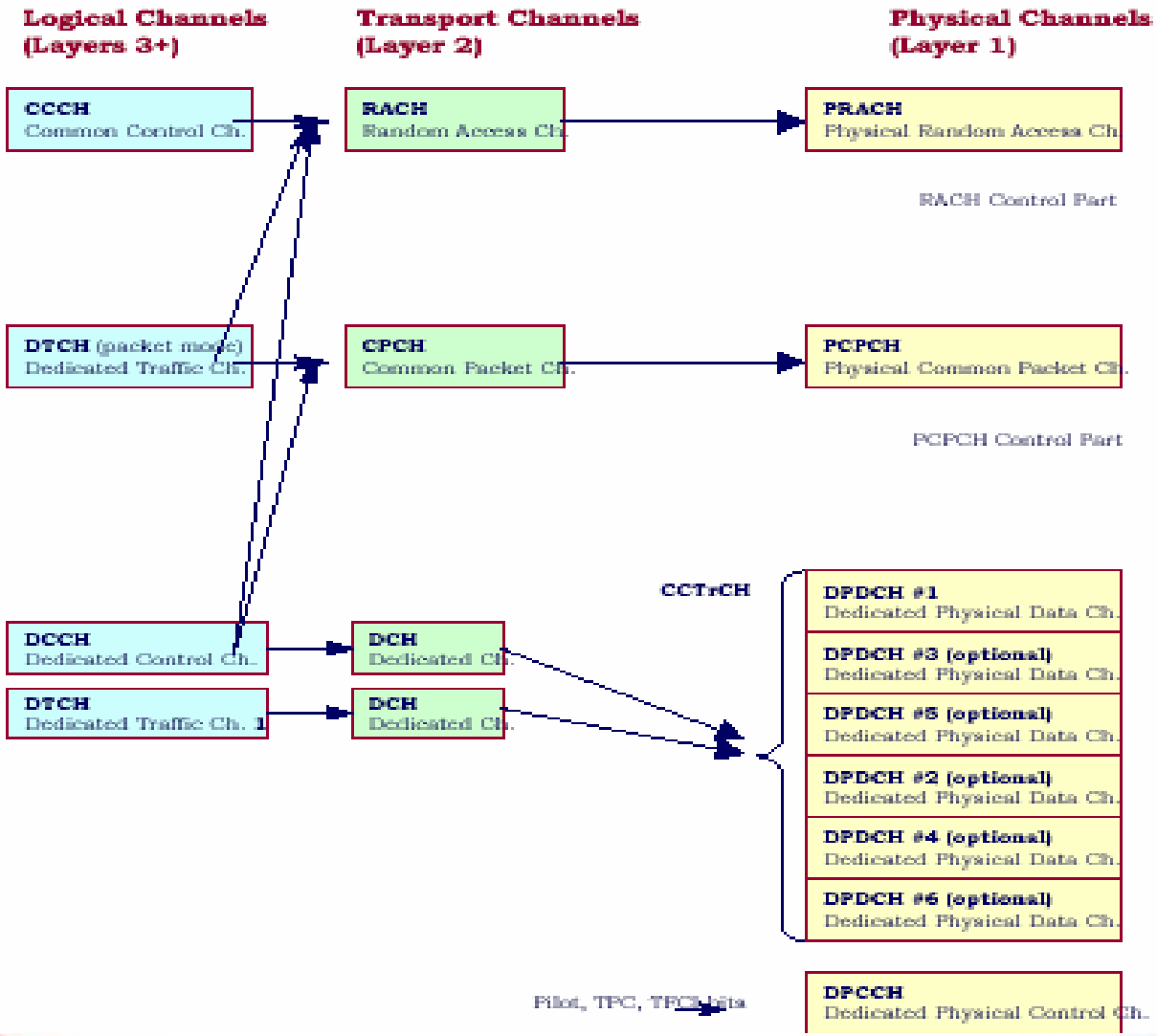
Canali logici in downlink

- Common Downlink Logical Channels
  - **BCCH (Broadcast Control Channel)**
    - Broadcasts cell site and system identification to all UE
  - **PCCH (Paging Control Channel)**
    - Transmits paging information to a UE when the UE's location is unknown
  - **CCCH (Common Control Channel)**
    - Transmits control information to a UE when there is no RRC Connection
  - **SHCCH (Shared Channel Control Channel)**
    - Control channel associated with shared traffic channels (TDD mode only)
  - **CTCH (Common Traffic Channel)**
    - Traffic channel for sending traffic to a group of UE's.
- Dedicated Downlink Logical Channels
  - **DCCH (Dedicated Control Channel)**
    - Transmits control information to a UE when there is a RRC Connection
  - **DTCH (Dedicated Traffic Channel)**
    - Traffic channel dedicated to one UE

Canali di trasporto in downlink

- Common Downlink Transport Channels
  - **BCH (Broadcast Channel)**
    - Continuous transmission of system and cell information
  - **PCH (Paging Channel)**
    - Carries control information to UE when location is unknown
    - Pending activity indicated by the PICH (paging indication channel)
  - **FACH (Forward Access Channel)**
    - Used for transmission of idle-mode control information to a UE
    - No closed-loop power control
  - **DSCH (Downlink Shared Channel)**
    - Carries dedicated control and/or traffic data; shared by several UE's
- Dedicated Downlink Transport Channels
  - **DCH (Dedicated Channel)**
    - Carries dedicated traffic and control data to one UE

WCDMA uplink (FDD)



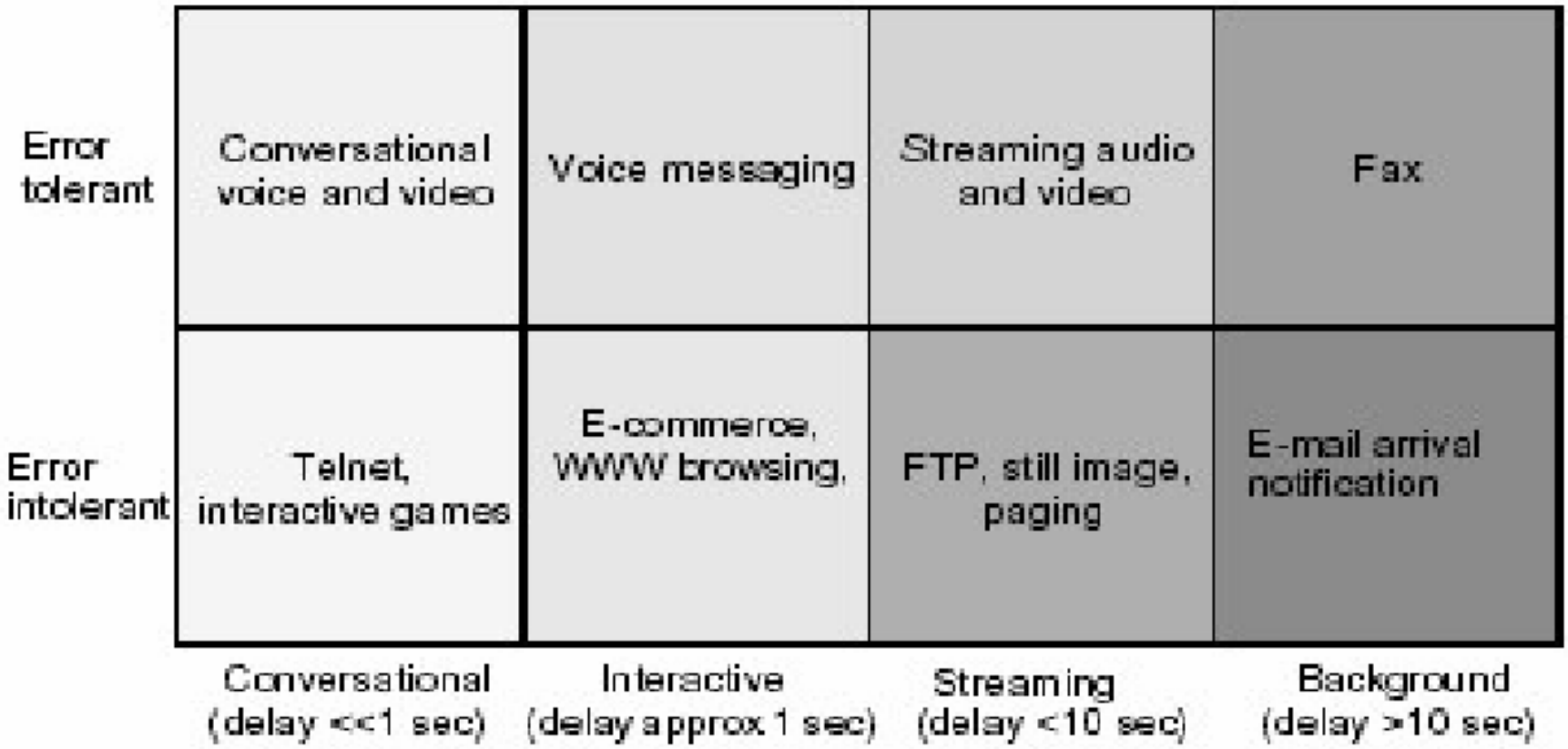
Canali di trasporto in uplink

- Common Uplink Transport Channels
  - **RACH** **Random Access Channel**
    - Carries access requests, control information, short data
    - Uses only open-loop power control
    - Subject to random access collisions
  - **CPCH** **Uplink Common Packet Channel**
    - Carries connectionless packet data to PCPH
- Dedicated Uplink Transport Channels
  - **DCH** **Dedicated Channel**
    - Carries dedicated traffic and control data from one UE

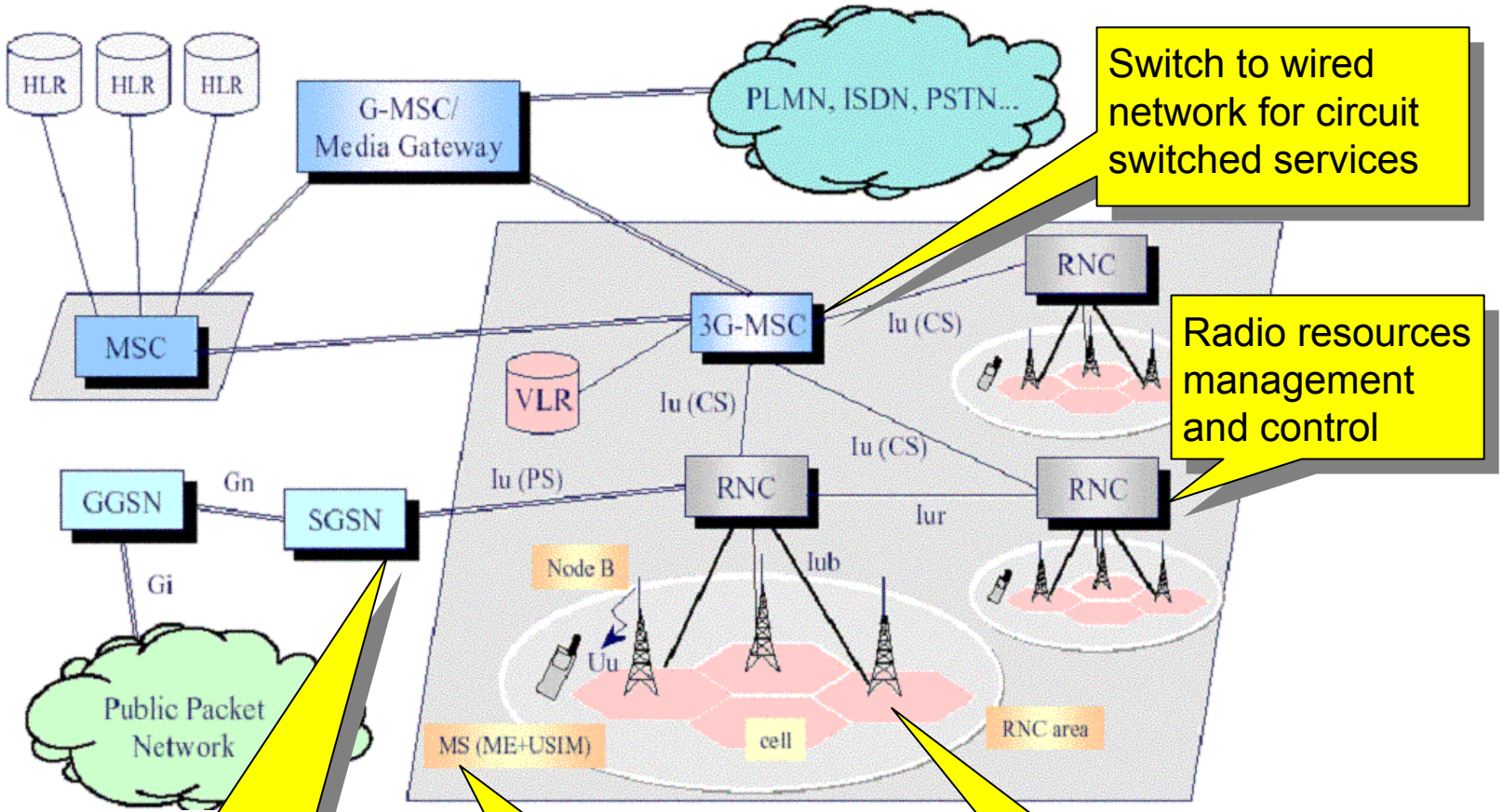
Classi di QoS (1)

- **Conversational**
  - Ritardo end-to-end basso, traffico simmetrico o quasi
  - Voce, Video telefonia, …
- **Streaming**
  - Flusso dati continuo, BER non stringente, asimmetrico
  - Video/audio news, musica, movie-trailers, …
- **Interactive**
  - Interazione tra utenti e apparati remoti
  - Web browsing, machine-to-machine (es. tele-meccanica,..)
- **Background**
  - traffico non real-time e a "best-effort"
  - e-mail, SMS, MMS, …

Classi di QoS (2)

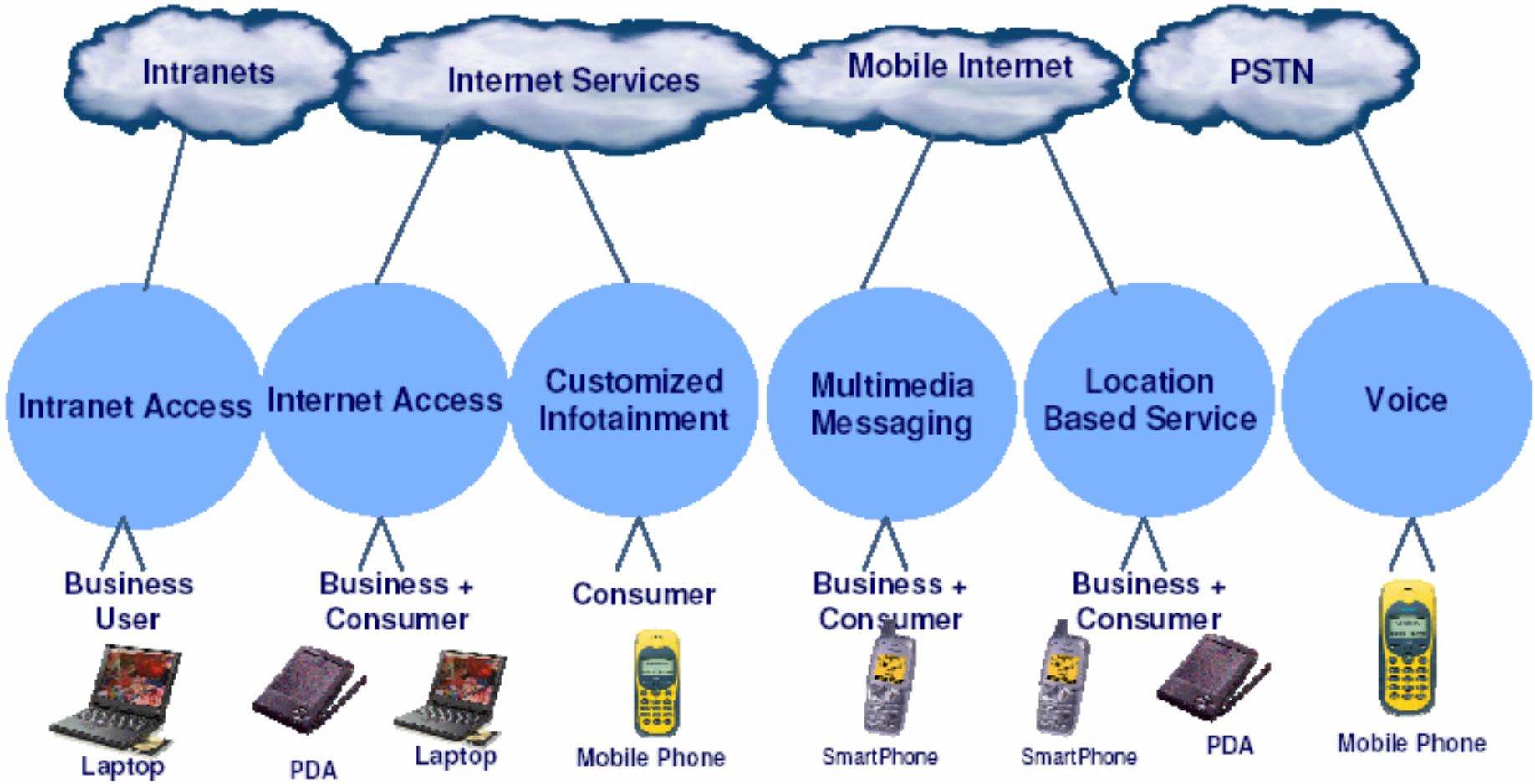


UMTS Network architecture (I)



Servizi ed applicazioni: categorie

- Ulteriore classificazione servizi UMTS



UMTS System Evolution

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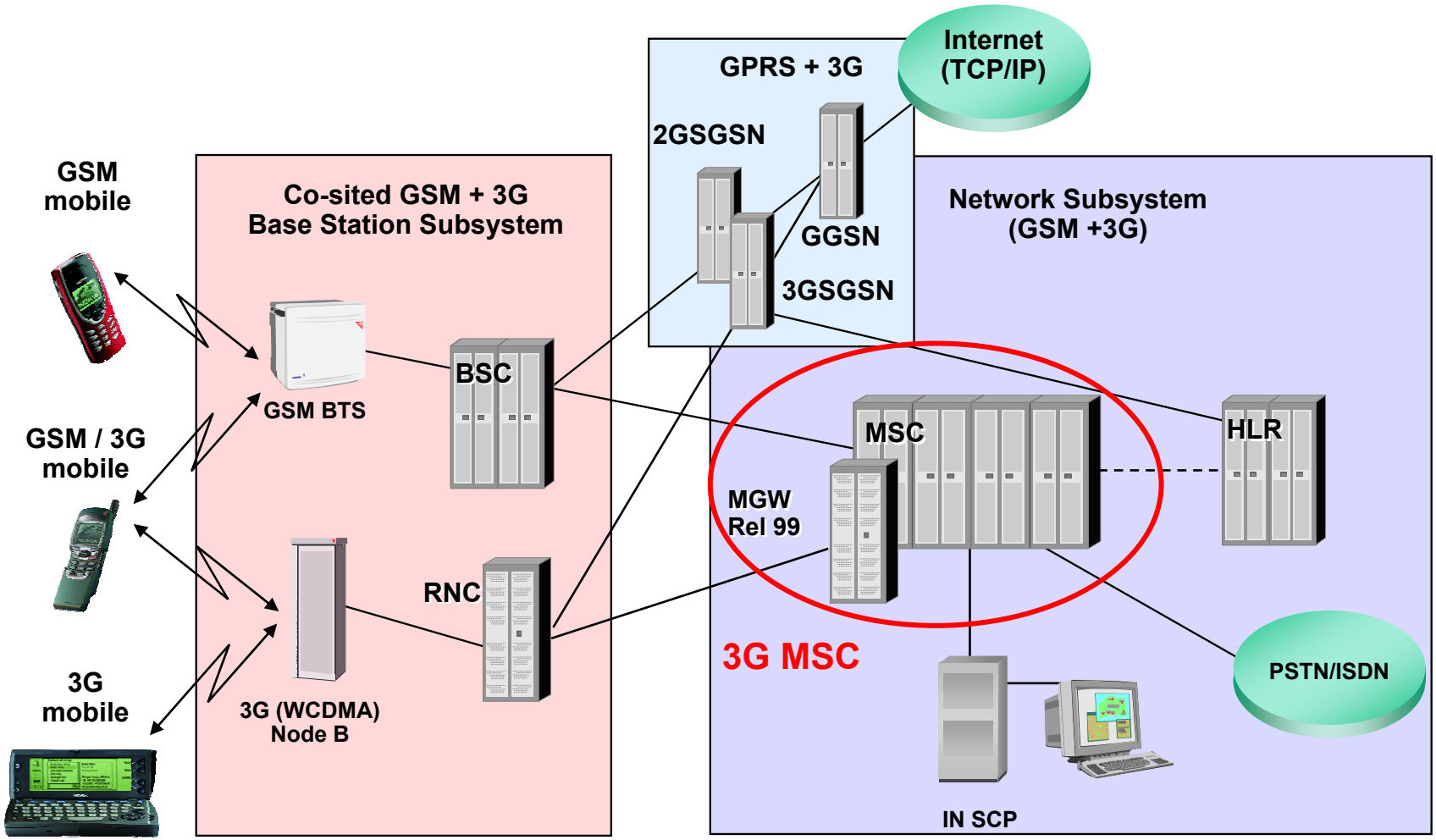
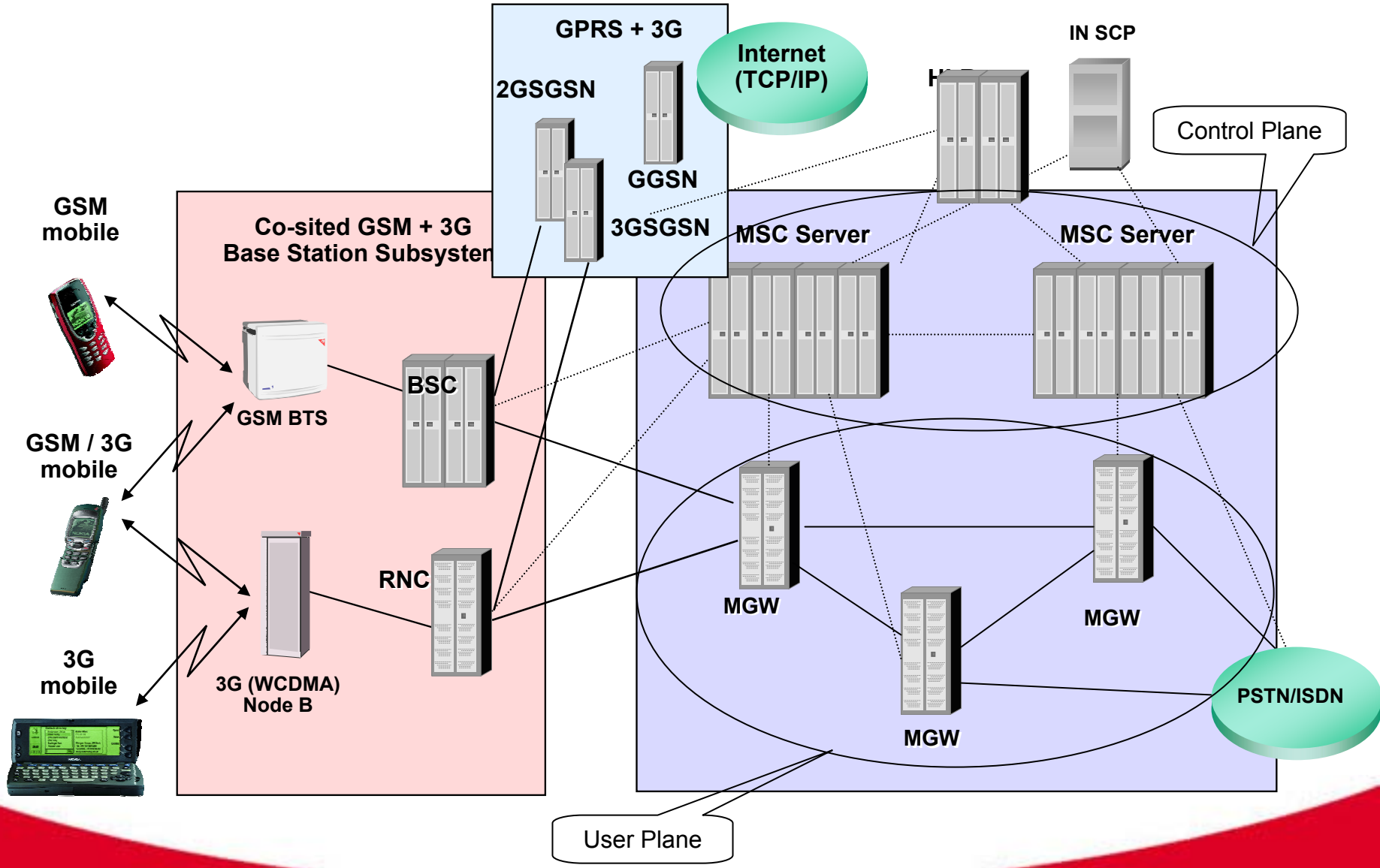
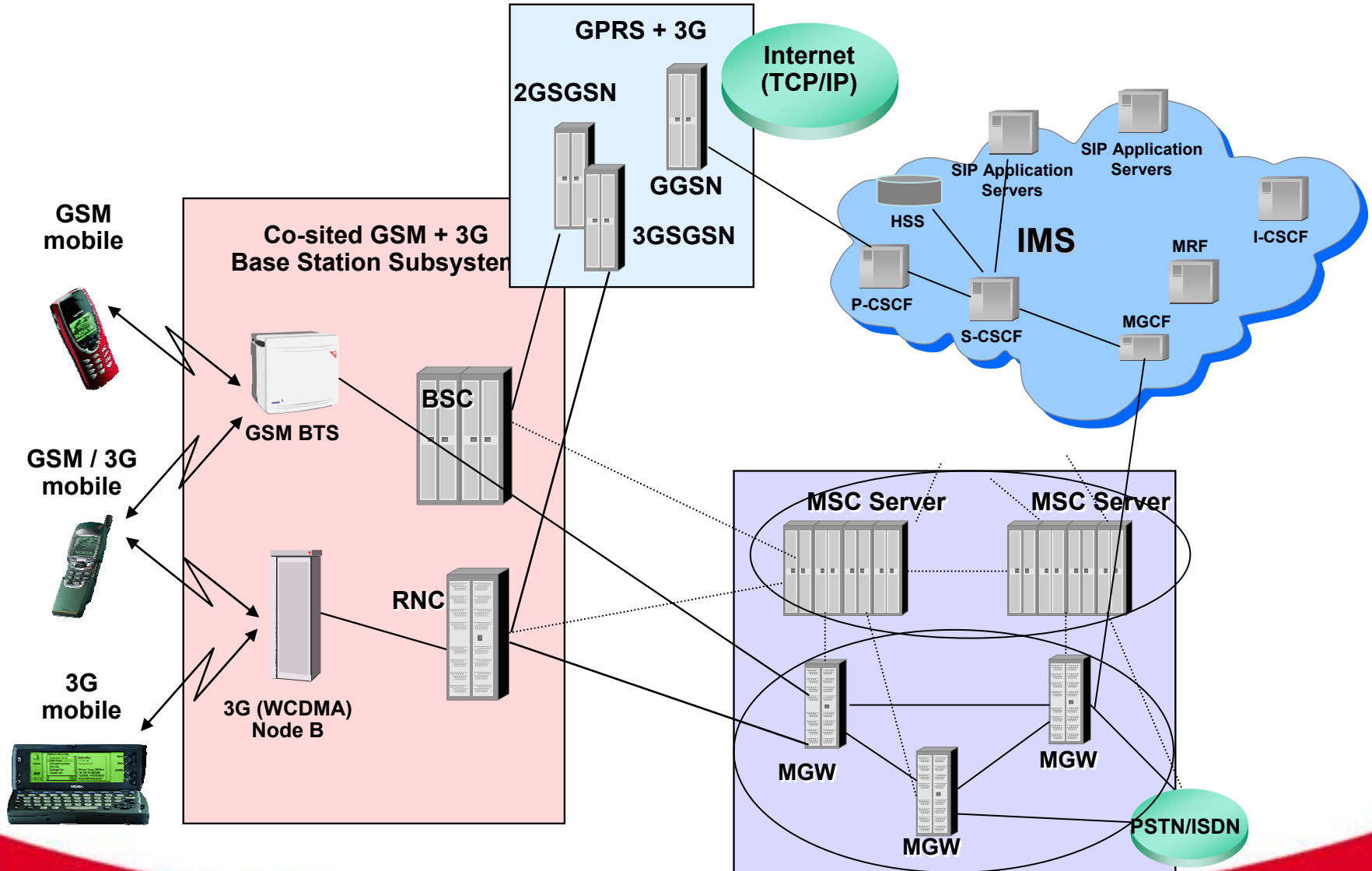
Rel-99 Network Architecture



Rel-4 Network Architecture

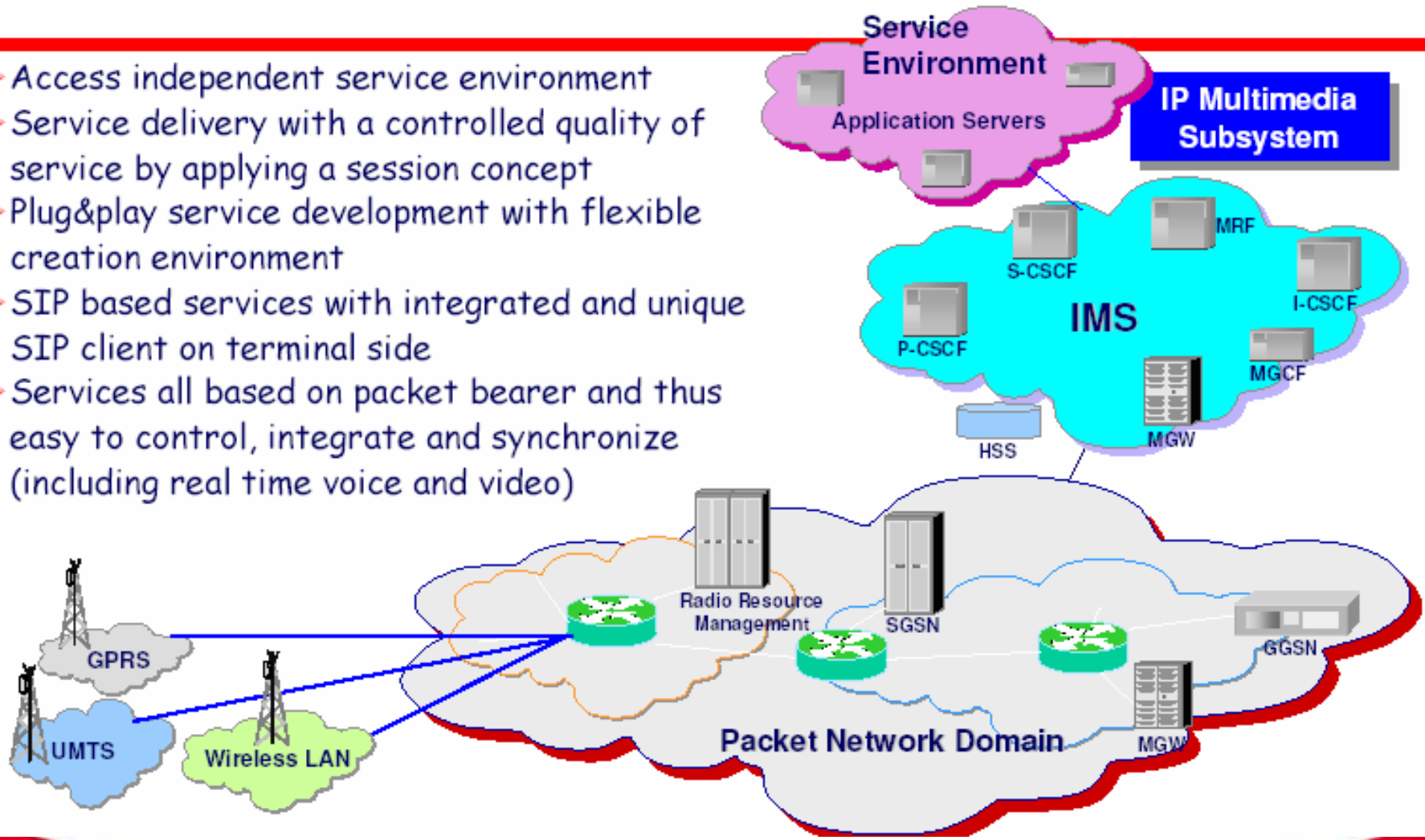


Rel-5 Network Architecture

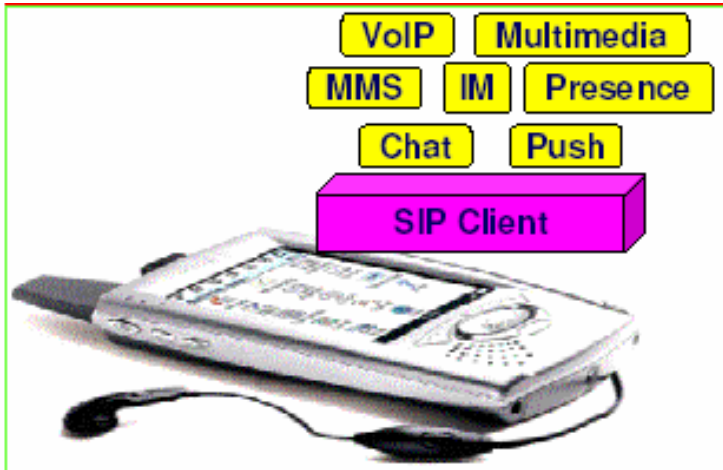


All-IP e IP Multimedia Systems

- Access independent service environment
- Service delivery with a controlled quality of service by applying a session concept
- Plug&play service development with flexible creation environment
- SIP based services with integrated and unique SIP client on terminal side
- Services all based on packet bearer and thus easy to control, integrate and synchronize (including real time voice and video)



Integrazione dei servizi (SIP)

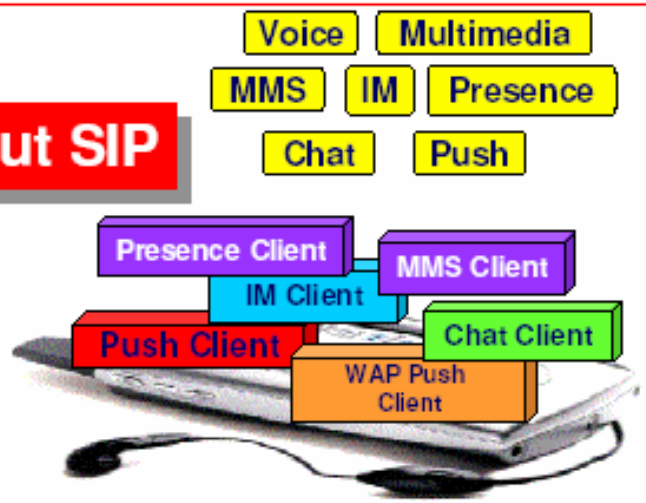


With SIP

- **With SIP:**
  - Single client supports wide range of service capabilities
  - Service integration mostly in the network.
  - Service synchronization possible
  - Service growth simplified

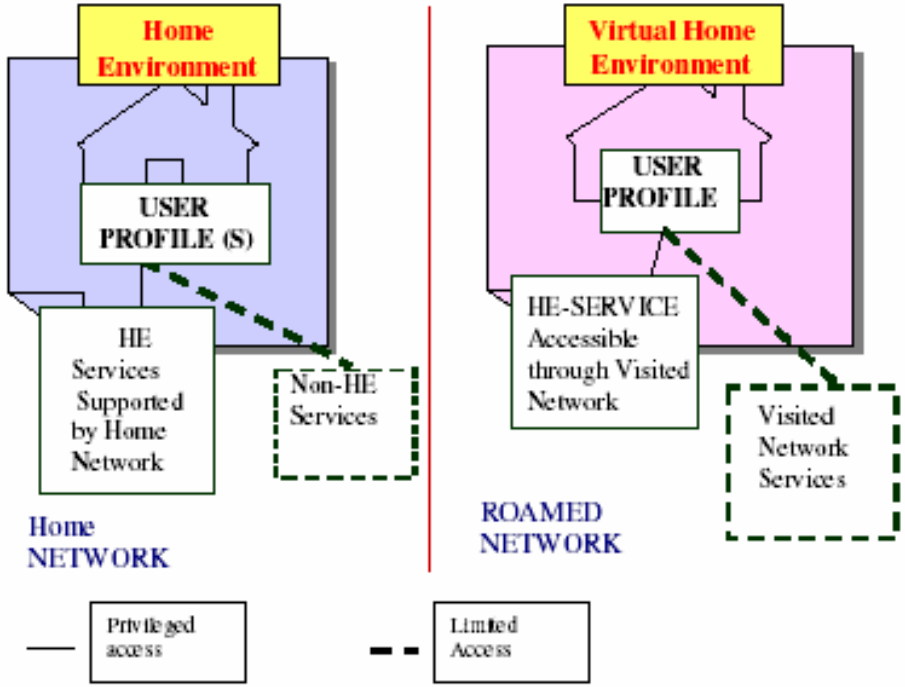
- **Without SIP:**
  - Each service capability requires a new client
  - Multiple interfaces to applications
  - Service synchronization limited to asynchronous services
  - New services require new clients to be downloaded
  - Service integration in terminal

Without SIP



UMTS Virtual Home Environment (VHE)

- Provides portability for the Personal Service Environment
- Users presented with same personalized features regardless of network and terminal
- VHE components
  - User Profile
  - Generic QoS bearer services
  - Call control (e.g. IMS)
  - Service Toolkits
    - CAMEL* (IN in GSM)
    - OSA (API for 3rd party service development)



*CAMEL: Customized Application for Mobile Network Enhanced Logic

IMS Features

- **Real time person-to-person communications on PD**
- **Convergence of all media communications on to the packet network**
- **Service Integration**
- **Service control by introducing service signalling**

IMS Benefits

- **Rapid Service Development and Deployment**
  - Light weight and relatively open tool and APIs for service creation
  - Smaller creation effort and time
  - Reduced integration effort thanks to the horizontal layer on which services are built
  - Possibility for the Operator to tap into the large service creation resources available in the Internet space
- **Economies of scale**
  - The access to the large Internet service development community will allow more cost efficient development of services
  - Cost of the network infrastructure: cost of IP equipment (such as routers, servers, etc) are considerably lower than their counterparts based on ATM or TDM technologies
  - Cost of operating the network: once all traffic has converged on to IP, the cost of running a network is considerably lower as only a single technology needs to be managed against the situation today where a typical mobile network supports a multitude of transport technologies (such as ATM, FR, TDM, IP).

UTRAN Evolution
- Air Interface -

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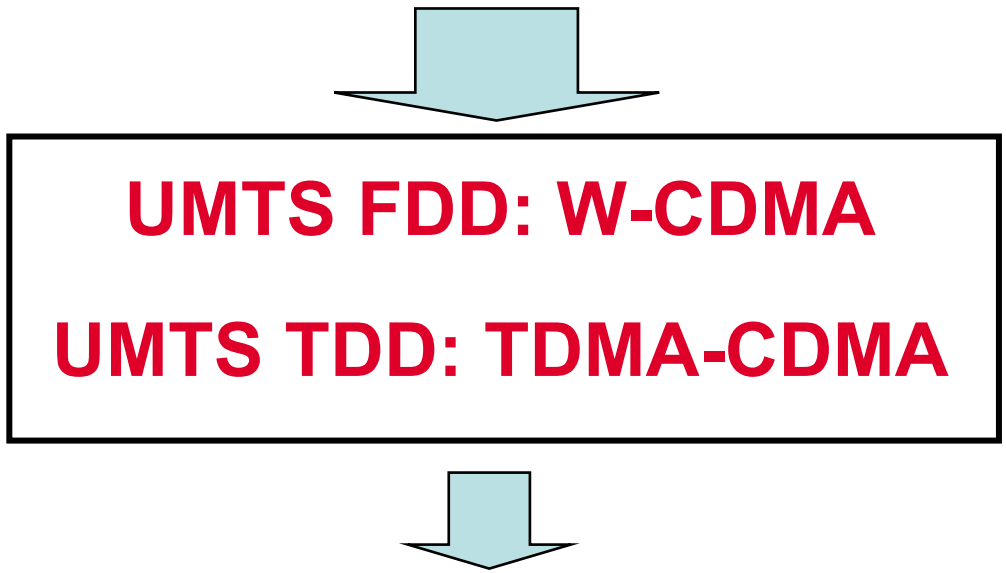
Historical Perspective: SMG2 Group (1997 – 1998)

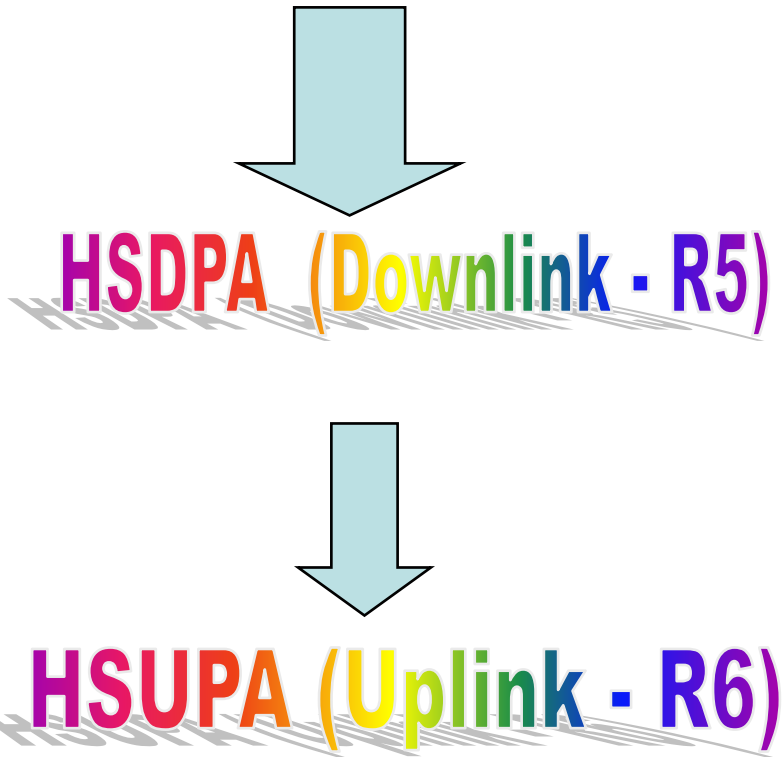
UMTS Timeline:

- Initial GSM deployment phase: 1989 – 1993
- A-TDMA, CODIT and FRAMES projects from 1997 – 1999
- SMG2 Concept Groups. 1997 – 1998: led to UMTS FDD and TDD



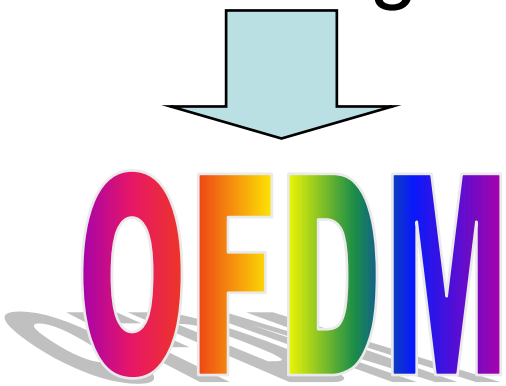
3GPP UMTS after Release 99

- Higher data rates to support packet services



What is next? – Potential requirements

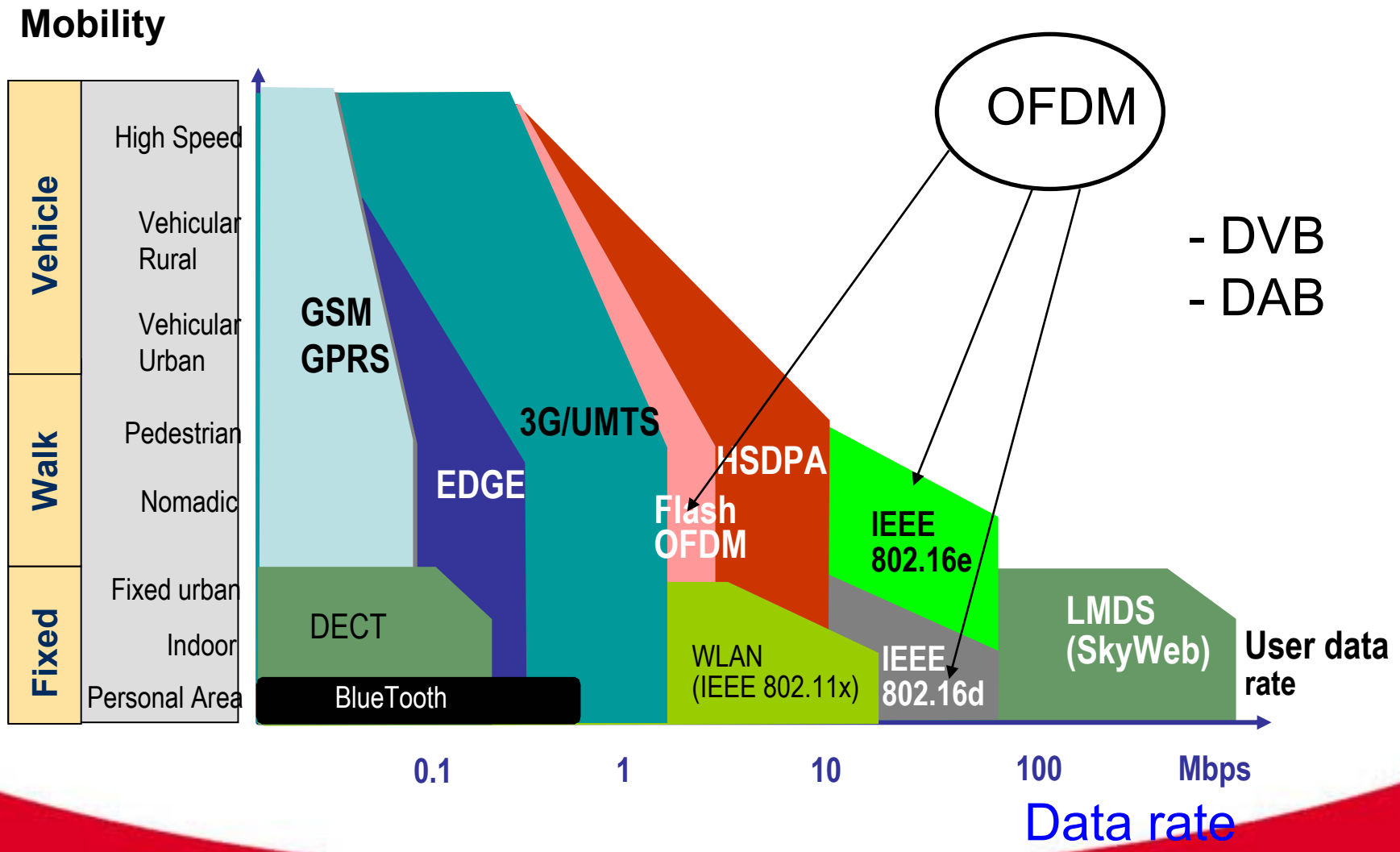
- Improvement of spectral efficieny
- High data rates in wide areas
- High data rates in high speed areas



(Orthogonal Frequency Devision Multiplexing)
(Former UMTS candidate technology of the SMG2 Beta Group)

Already used in various wireless technologi

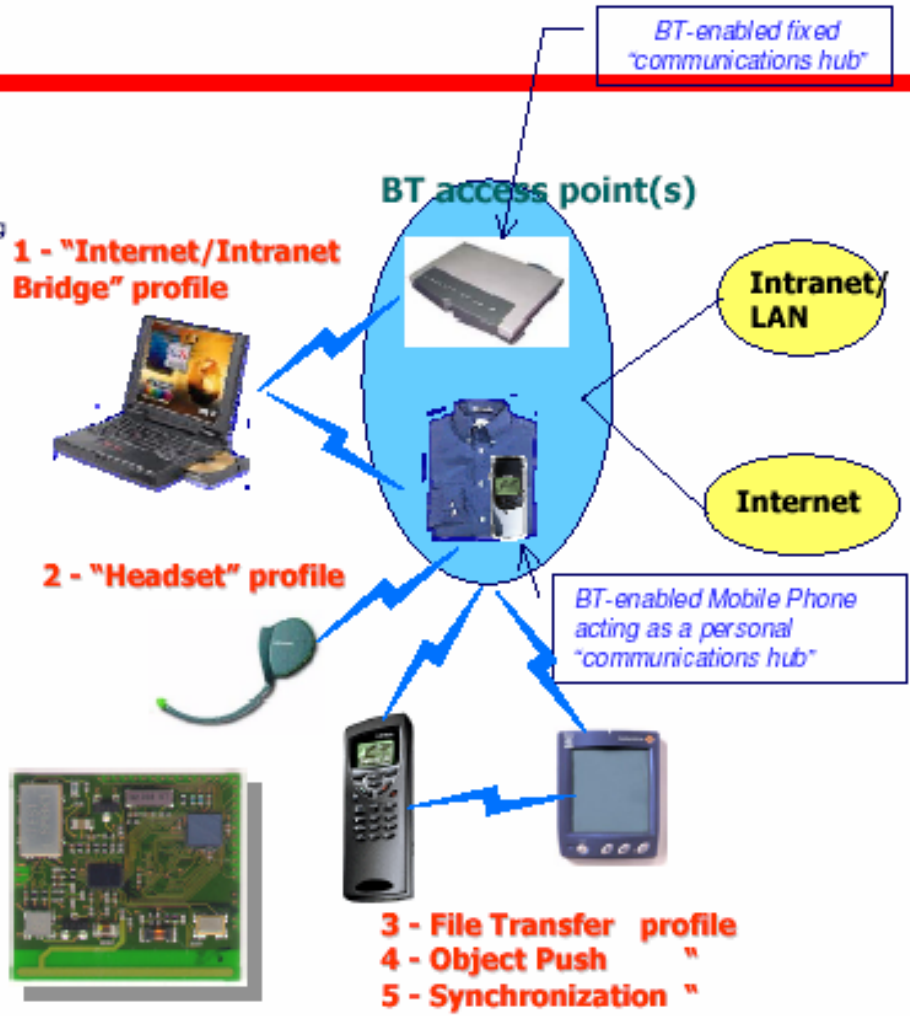
Wireless Technology evolution



Nuovi sistemi radiomobili

Bluetooth

- **Bluetooth Consortium**:
  - 1000+ members from cellular, computer and consumer electronics industries
- **Spec. 1.0** (July '99) specifies "Office type" profiles:
  - "Internet Bridge" profile: dial-up (modem) networking, LAN access point, including peripheral connection (printer, keyboard)
  - "Headset" profile
  - "File Transfer" profile (e.g. presentations)
  - "Object Push (OBEX)" (e.g. business cards, emails, notes...): point-to-multipoint conference table
  - "Synchronization" profile (e.g. phonebooks, agendas..):
- **Bluetooth radio module**:
  - low power consumption
  - "today" size: 1.27 square cm
  - target size: single chip, 5 USD
- **Technical characteristics**:
  - Gross rate 1Mb/s
  - Symmetric channel: 423 Kb/s (effective bit rate)
  - Asymmetric channel: 721Kb/s downlink, 54 Kb/s uplink (effective bit rate)
  - Reliability/robustness: frequency hopping 1600 hops/s
  - Security: authentification (Challenge/Response system), encryption of data between two devices
- **Network architecture/topology**:
  - flexible Master/Slave relationship
  - within a "piconet" (or personal 'bubble'):
    - 3 simultaneous circuit-switched voice connections
    - max 7 simultaneous packet-switched data connections to master
    - an arbitrary number of devices in standby with respect to a master
  - gross bandwith: 1Mb/s per piconet
  - flexibly scalable to a group of piconets (or "scatternet")

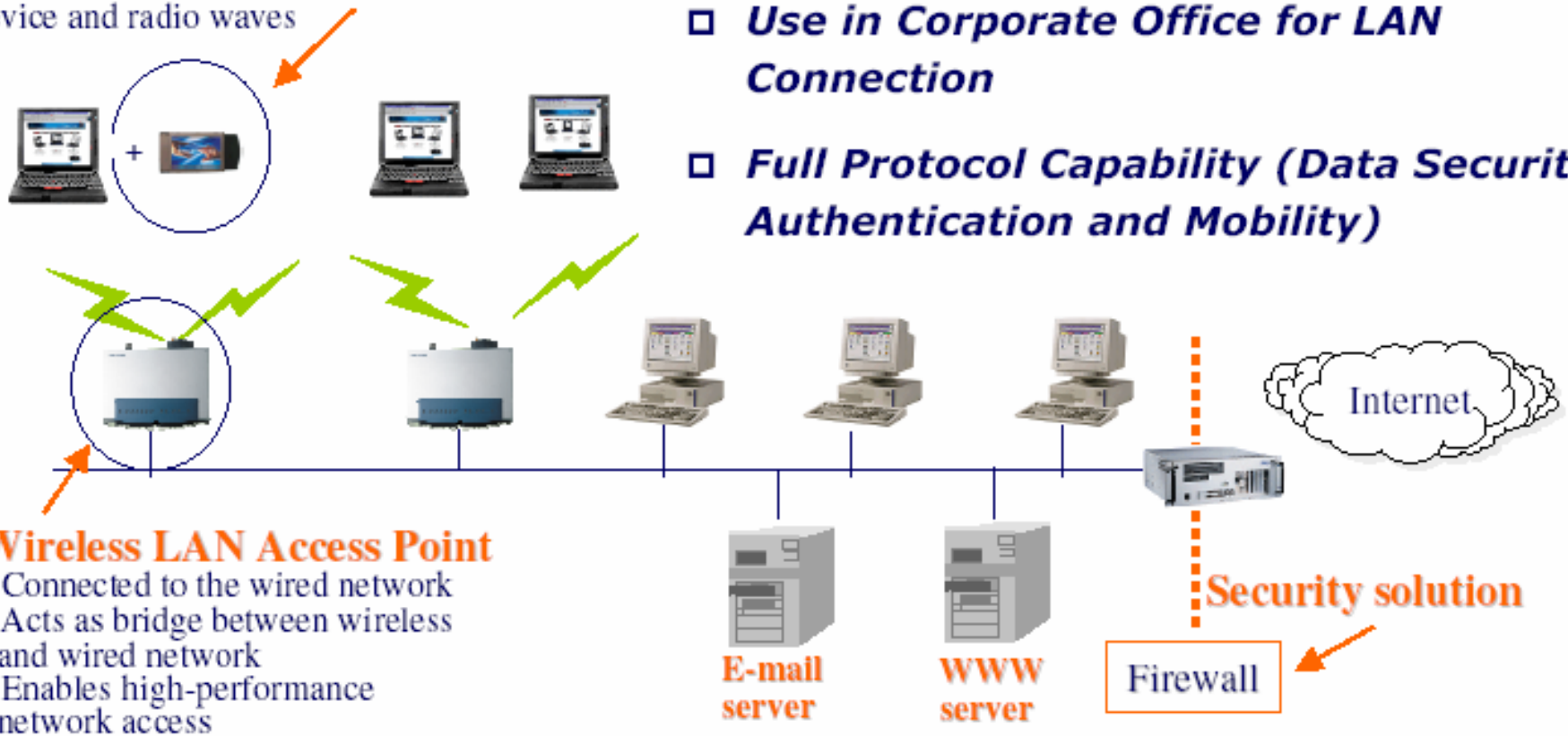


How Does Wireless LAN Solution Work?

Wireless LAN PC Card

- Each wireless station and access point has a wireless LAN card
- Provides an interface between an end-user device and radio waves

- ***Today Solutions in Unlicensed Spectrum***
- ***Use in Corporate Office for LAN Connection***
- ***Full Protocol Capability (Data Security, Authentication and Mobility)***



Wireless LAN Access Point

- Connected to the wired network
- Acts as bridge between wireless and wired network
- Enables high-performance network access

New insight of WLAN technology

WLAN Today – Characteristics & Performance

- Latest commercial solutions are based on IEEE 802.11b standard

IEEE 802.11b	
Spectrum	**2400 – 2483.5 MHz (in Europe and USA), Unlicensed** - Up to 3 non interfering Frequency Channels simultaneously supported (out of 13 Frequency Channels of 5 MHz)
Data Rate* *** Shared between all cell users**	**11 Mbps** max Physical Layer Data Rate ~ **5 Mbps** max Data Throughput (Layer 3)
Average Cell Radius* *** source: Nokia**	**20 - 35 m**** in open/semi open office environment **20 -30 m**** in closed corridors/office rooms (light walls) environment **Up to 150 –200 m**** in outdoor environment (line-of-sight condition) **Depending on antenna type (omnidirectional / directional)
Output Power	**100 mW (EIRP)** for use in Europe, according to European Regulation

WLAN Cell capacity Examples	Usage Requirements (Example)	Average required Kbps/user	Active Users/cell
	Web Browsing, occasional file download	100 kbps	35
	Web, Corporate intranet Access with VPN, Outlook	200 kbps	20
	Web, Corporate intranet Access with VPN, intensive Office Application use	300 kbps	14

Estimated average -30% simultaneous users under realistic interference conditions

New insights on WLAN technology
WLAN – Next Generation

- Two major standardization initiatives: IEEE 802.11a and ETSI HiperLAN/2

"Low-polluted" Band
Large Spectrum Slots

	802.11a	HIPERLAN/2
Spectrum	- 300 MHz in US 5GHz UNII Band, unlicensed (5.15-5.25 GHz; 5.25-5.35 GHz; 5.725-5.825 GHz) - 12 operating channels	- 455 MHz in Europe, 5GHz license exempt bands (Band B: 5.15-5.135 GHz; Band C: 5.470 - 5.725 GHz) * - 19 operating channel
Data Rate	54 Mbps max Physical Data Rate ~ 32 Mbps Throughput	54 Mbps max Physical Data Rate ~ 32 Mbps Throughput
Connectivity Mode	Connection Less	Connection Oriented
Fixed Network	Ethernet	Ethernet, PPP, ATM, 3G core network
Radio Quality Functions		Link Adaptation, Dynamic Freq. Selection
Security Functions	Encryption	Encryption, Authentication
QoS Support	Point Control Function (PCF) – time slot allocation for time critical applications	ATM/802.1p/RSVP/DiffServ
Output Power	200 mW (EIRP) in 5.15-5.25 GHz band 1 W (EIRP) in 5.25-5.35 GHz band 4 W (EIRP) in 5.725-5.825 GHz band	200 mW (EIRP) in 5.15 - 5.35 GHz 1 W (EIRP) in 5.470 – 5.725 GHz

*Subject to National Allocation Restriction (100 MHz available in Italy)

Versatily in Core Ntw Support

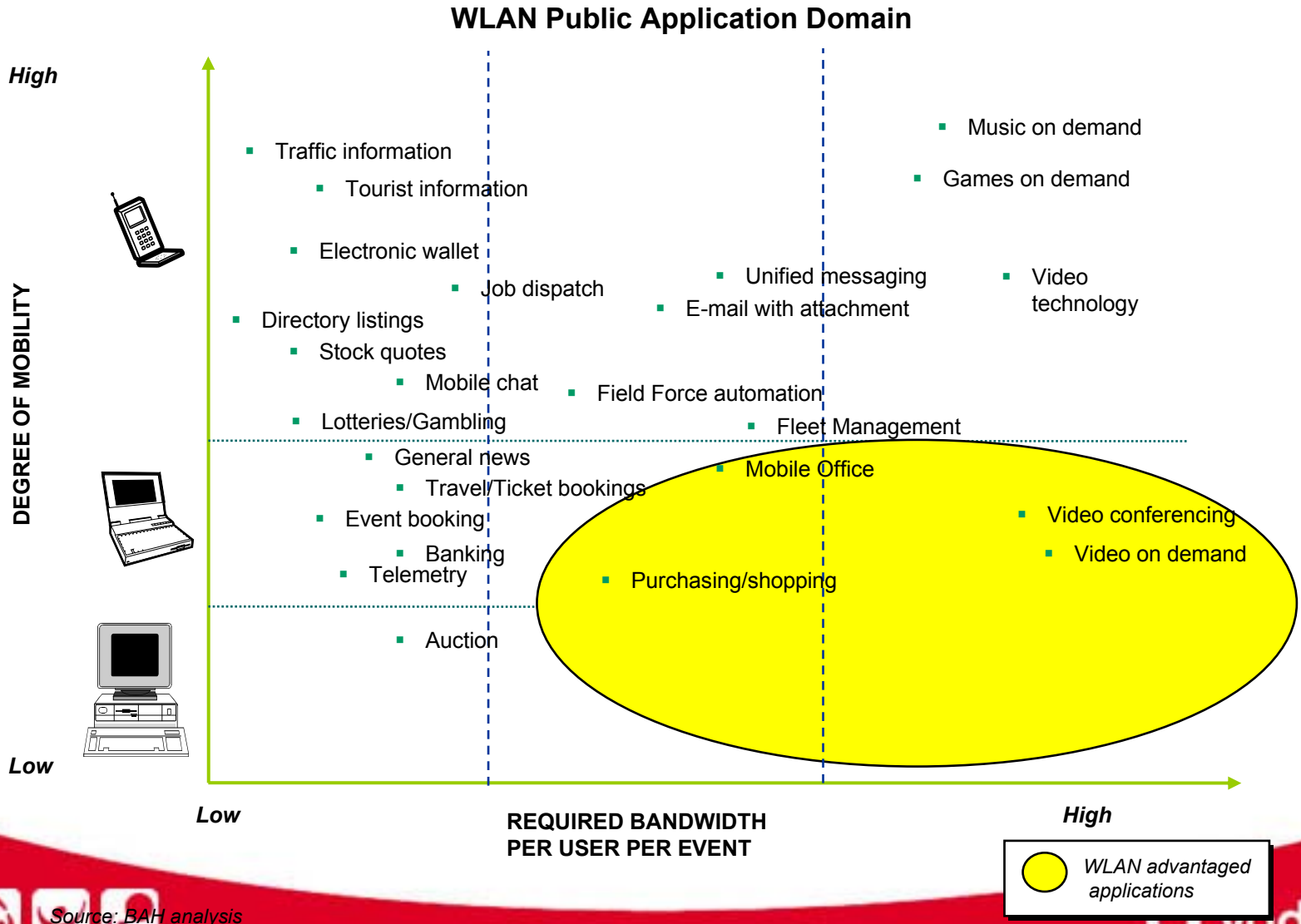
Improved Radio Performance

Service Differentiation, RT and NRT services Support

High Speed Data

- Development ongoing - Products not available yet (during year 2002)

Public domain: WLAN will compete where mobility is less relevant than bandwidth



Source: BAH analysis

WLAN AND 3G: A COMPARISON

Characteristics	*3G*	*802.11b (WiFi)*
Typical End-User Bit Rate	< 2 Mbps	< 5 Mbps
Typical Range – Stationary User (1 cell or access point)	3-5 km (dense urban area)	50-60 metres[9]
Predictability of Data Throughput	High	Low
Handover	Yes	Limited
Roaming	Yes (if networks using same 3G technology)	Planned
Cross System Roaming	Planned	Not yet
Security – Authentication	High	Medium – being improved
Security / Encryption	High	Medium – being improved
Potential for Interference	Low	High
Spectrum	Licensed	Licence-exempt 2.4 GHz
Coverage	Wide area - contiguous	Hot spots / offices / homes – non-contiguous
Deployment	Hierarchical Cell Structure	Ad hoc cells
Mobility	High speed	Essentially stationary
Services	Voice and data	Primarily non-voice

WMAN - Wireless Metropolitan Area Networks
(based on WiMax technology)

- It represents the new evolution of WLAN
- It is based on a new standard technology, ***WiMax*** (802.16), complementing WiFi (802.11) technology by creating ***complete MAN-LAN solution***

  - ***WiFi is optimized for license-exempt LAN operation***
  - ***WiMax is optimized for license-exempt and licensed MAN operation***

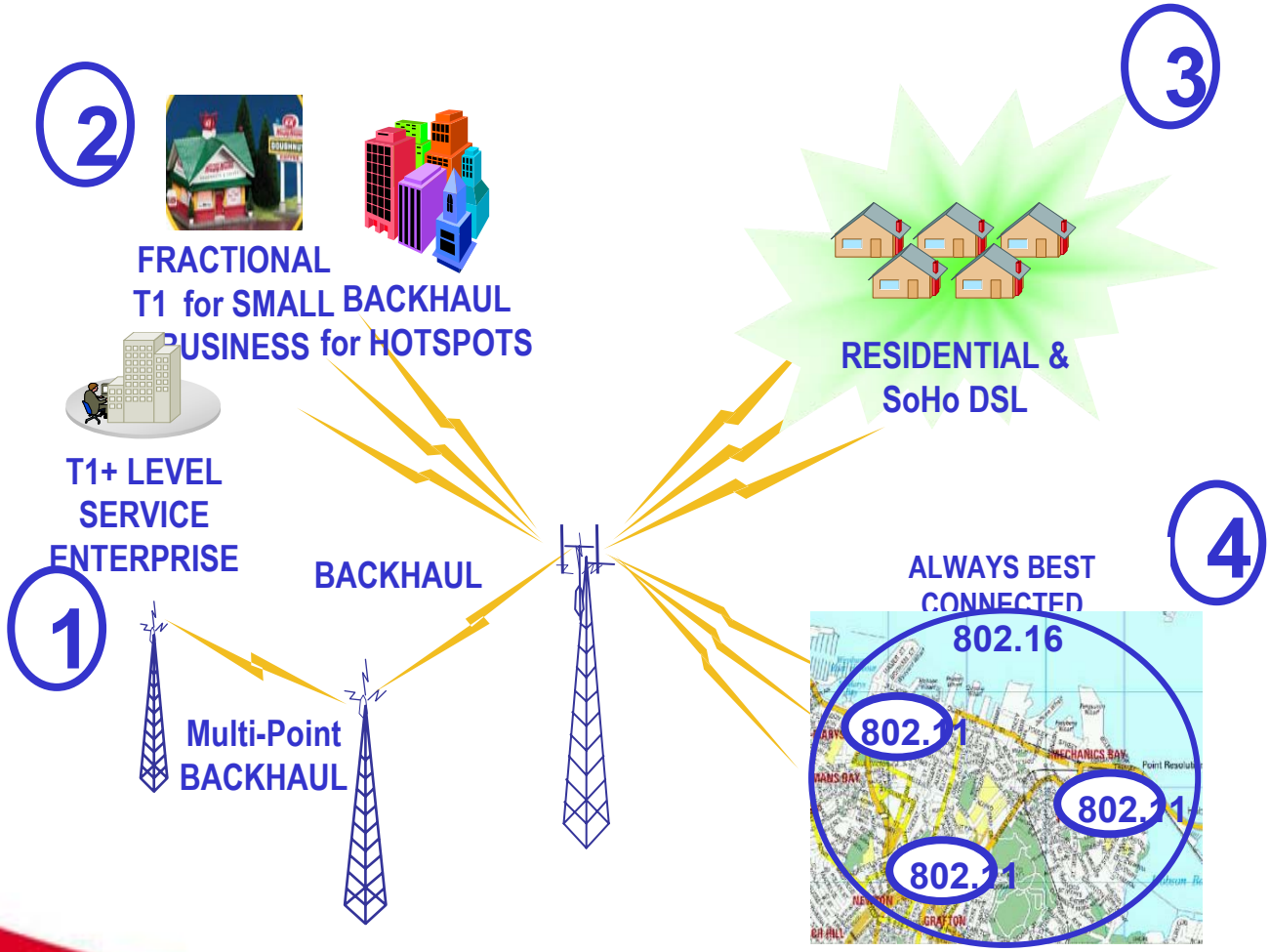
WiMax vs WiFi

- Designed for subscriber density → Scalability
- Designed for distance → Range
- Designed for metropolitan performance → speed
- Designed for market coverage

WiFi	WiMax
• Wide (20MHz) frequency channels	• Channel bandwidths can be chosen by operator (e.g. for sectorization) • 1.5 MHz to 20 MHz width channels.
• Designed to support 10's of users	• Designed to support thousands of users.
• Optimized for ~100 meters	• Optimized for up to 50 Km
• No "near-far" compensation	• Designed to handle many users spread out over kilometers
• Designed to handle indoor multi-path (delay spread of 0.8μ seconds)	• Designed to tolerate greater multi-path delay spread (signal reflections) up to 10.0μ second
• Channel bandwioth: 20MHz	• Channel bandwioth: 10-20MHz; 1.75, 3.5, 7, 14 MHz; 3.6 MHz
• Max Data Rate: 54 Mbps	• Max Data rate: 75 Mbps
• Optimized for indoor performance	• Optimized for outdoor performance
• No mesh topology support within ratified standards	• Standard support mesh network topology

WiMax Application

Source: WiMax Forum 2004



- **WiMAX is designed to support a wide variety of broadband applications ->**

  best effort residential to high capacity backhaul

Handsets

3G terminals

Connection protocols and presentation languages (xHTML, WML, …)

Voice, video, messaging and browsing during the same rich call with **Session Initiation Protocol**

Large high contrast, high resolution colour display

Camera for see what I see

GBytes of mobile memory provides immediate access to all your favourite music tracks, games and data

New form factors and service concepts to match with your personal lifestyle

Always-on high speed data connection to mobile and fixed network services

Optimal access technology choice over 2.5G/3G and WLAN wherever you are

Your choice of programs and services, from simple and easy (**Java**) to graphical and feature rich (**native OS** based)

Gaming and content sharing with your community and devices at **short range**

Handset Categories (1)

- A whole spectrum of different services and application is now available
- Depending on the target user (application), different handset types are required
- Different new handset architectures must be developed

- **Voice-centric**
  evolution from 2G handset provides voice services and basic still picture visualisation. Short video download and audio player are optional.
- **Videophone**
  provides all multimedia services on a large colour display, videotelephony included.
- **PIC**
  A PDA and a multimedia terminal are integrated in this device. Based on a commercial OS and on a high quality display, it also supports office applications, games, Internet suites and other PC-like applications.
- **Radio Module**
  For Machine-to-machine applications or as PCMCIA/CompactFlash Cards for PCs, PDAs, digital cameras etc.

Handset Categories (2)

- Even simpler handsets require a thorough internal redesign to support new services and technologies
- Customer acceptance of new handset concepts and services must be looked after
- Large amount of new features

Time to market

Partnership with manufacturers is necessary to limit the handset development to the key features required to support **mobile** strategy

WAP and mobile protocols

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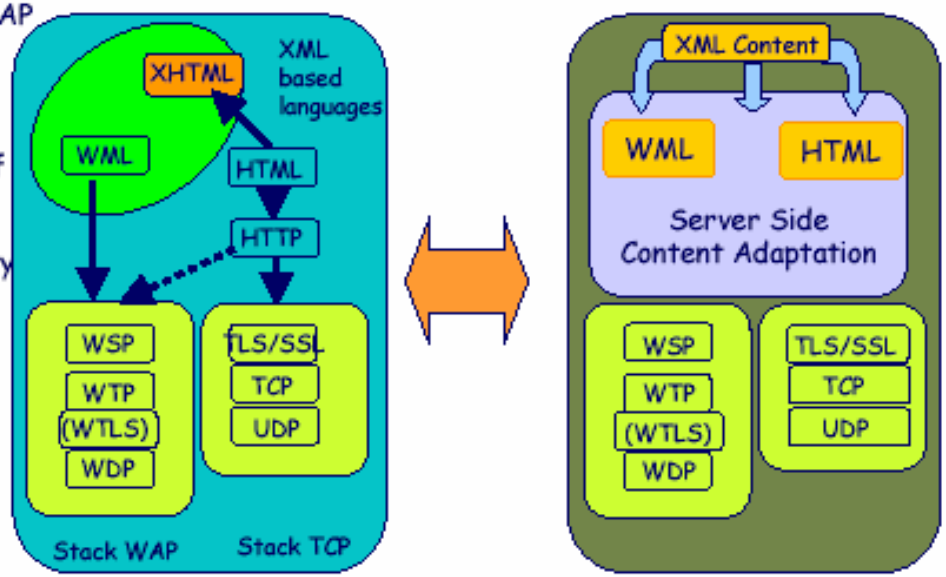
WAP and browsing evolution strategy

- WAP current goals:
  - The WAP Forum is expected to approve Version 2.0 of WAP by 2H/01.
  - Favor convergence with IETF Protocols:
    - Inclusion of the TCP/IP stack in WAP is fundamental to achieve convergence with IETF protocols
    - Possible optimizations of TCP/IP behavior for over-the-air packet transportation built upon WAP standards (WTP and WSP specs).
  - Favor convergence with W3C Specifications:
    - XHTML as defined by W3C is a reformulation of HTML in XML.
  - End to End Internet Standard Transport Layer Security (TLS)

- Evolution: support of XHTML 1.0
  - Modularization
    - elements and attributes are modularized conveniently for use in documents that combine HTML and other tag sets
  - Target mobile device applications
    - fairly minimal build of XHTML modules targeted at mobile applications



Terminal side

Server side

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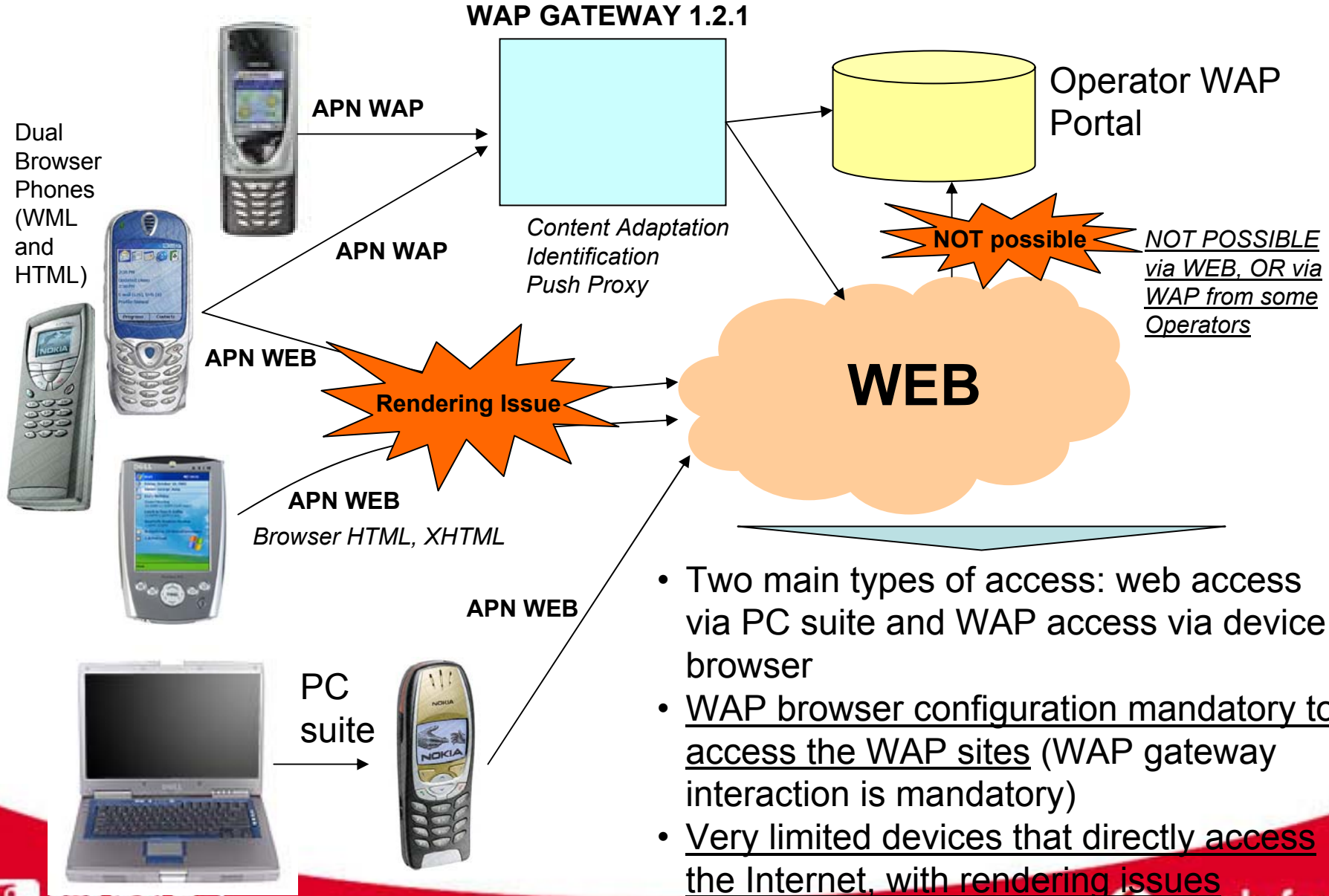
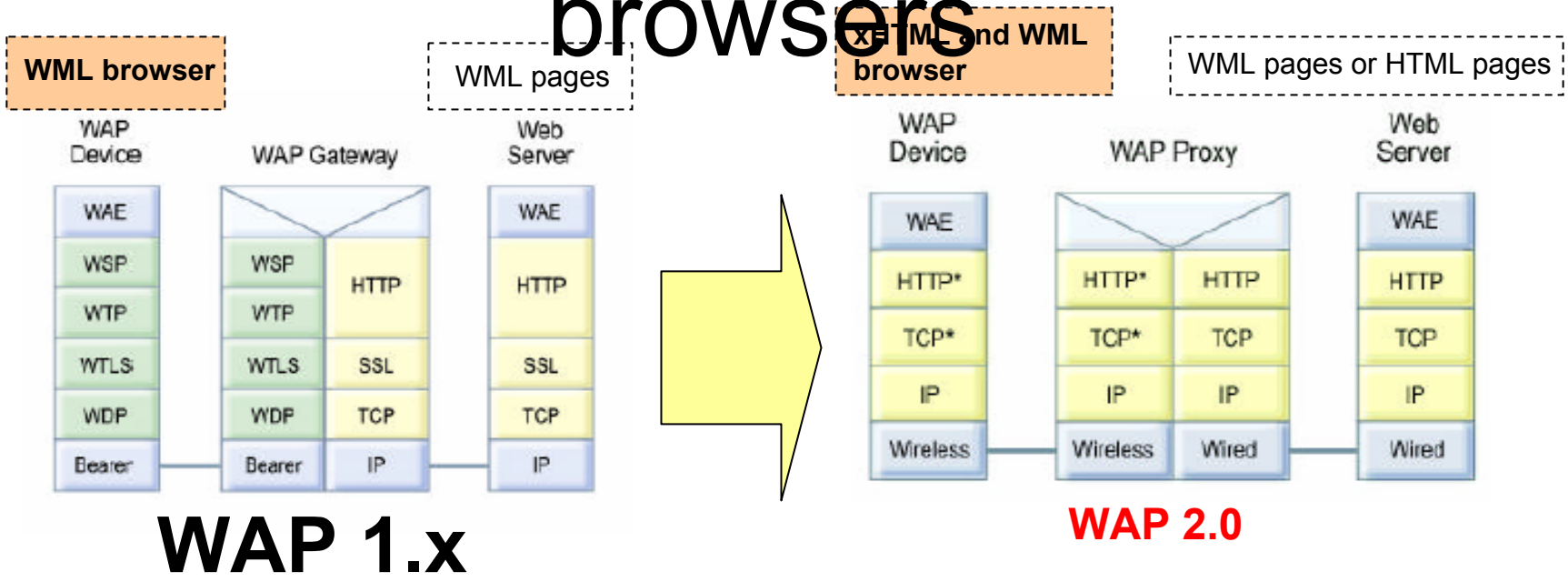
WAP and mobile WEB access



- Two main types of access: web access via PC suite and WAP access via device browser
- WAP browser configuration mandatory to access the WAP sites (WAP gateway interaction is mandatory)
- Very limited devices that directly access the Internet, with rendering issues

Evolution in protocol stacks and browsers



- WAP 2.0 specified in WAP forum standardization environments: future (not avoidable) standard
- Two different aspects need to be considered: **content language support and protocol support**
  - **Content language support:** WAP 2.0 browser must support and manage pages written in xHTML (~WEB pages) and WML (WAP pages)
  - **Protocol support:** WAP 2.0 browser could implement:
    - TCP/IP stack (single stack phones)
    - TCP/IP and WAP stacks (dual stack phones)
    - WAP stack (for instance GD87 supports xHTML but only WAP stack)

WAP 2.0 browser advantages

xHTML advantages

- Greater Graphic capabilities (browser evolution from WML to xHTML)
- Easier rendering among different phones

TCP/IP advantages

- Wireless TCP stack enables faster (20% - 30% advantage of large contents*, no advantage < 6Kbyte) connections
- Greater Graphic capabilities (browser evolution from WML to xHTML) better supported by TCP/IP
- More secure connections (end to end security)

WAP 2.0 gateway (proxy) capabilities

(*rather the same features of WAP 1.2.1 gateway*):

- Service profiling and Personalization
- IP barring
- Authentication
- Wireless optimizer

* source: Nokia

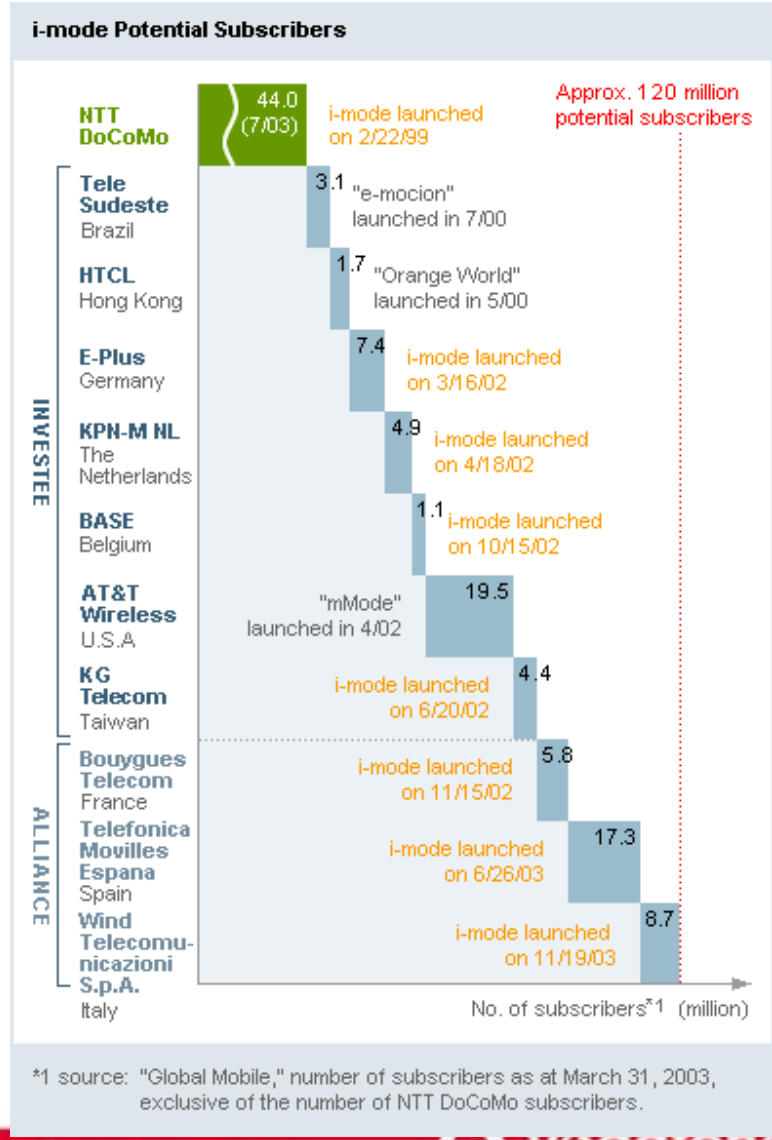
iMODE

A full and new service proposition, involving:

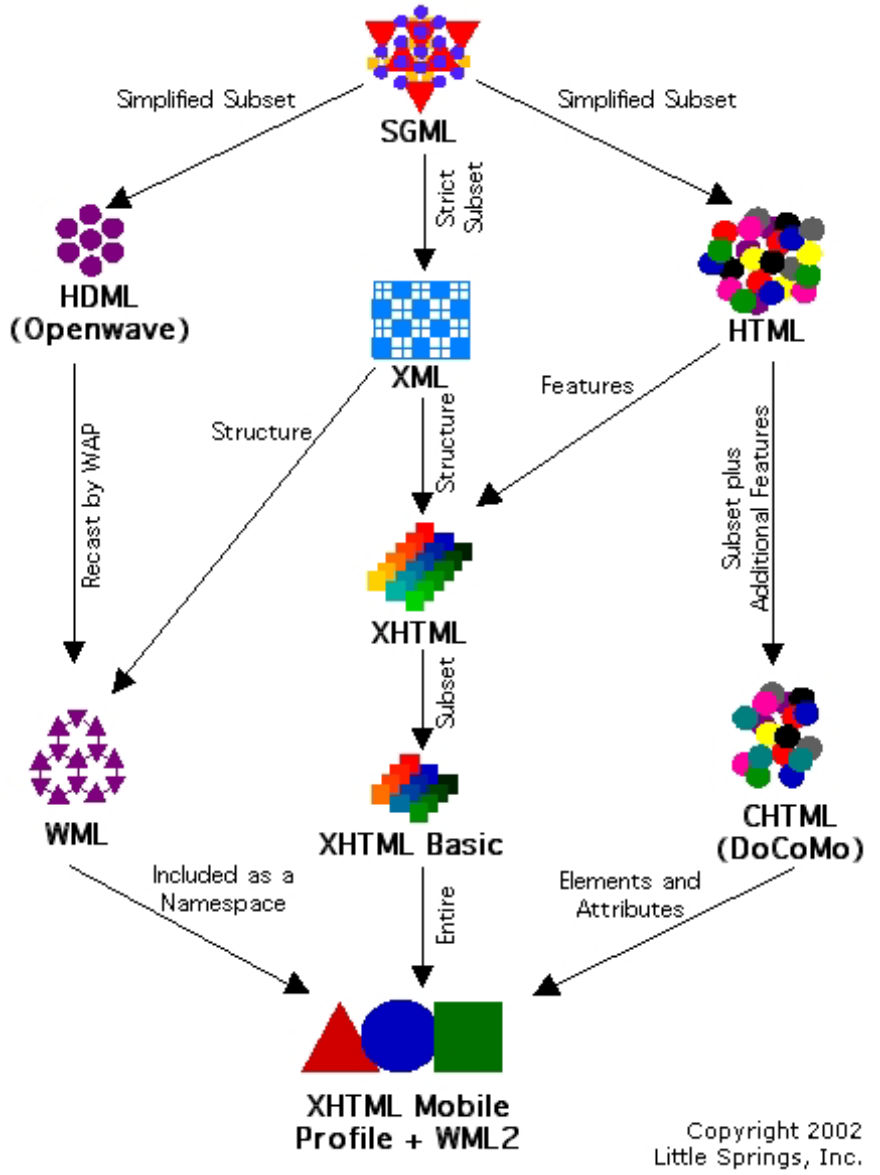
- ***A presentation language***:
  - cHTML (proprietary, but very similar and compatible to common HTML)
- ***A packet-based transport***:
  - Started with 9.6kb, now evolving to standard connex at 64-384kbs
  - Standard HTTP protocol in the phone, no WAP/HTTP Gateway in between
  - HTTPS largely supported to grant end-to-end security (e.g.for premium services)
  - Exploiting the always-on feature of packet-switching for email push
  - Volume-based charging applicable plus possible Subscription (depending on the Partner service;)
- ***Certified and interoperable terminals***:
  - RIGIDLY enforced to i- mode specs. DoCoMo sets the standards, the handset manufacturers comply.
- ***A business model***:
  - an ecosystem of service/content providers → revenue sharing business model
  - certified/partners Content Providers must comply to DoCoMo specs, but then they are granted revenue sharing
  - Certification of partners and of terminals grants interoperability
- ***Service package***:
  - Photo messaging (iShot) and video messaging (iMotion):
  - Location-based info services (cell-ID)
  - Java downloading (DoJa), e.g. games

iMODE export to Europe

- The **i-mode alliance** (European operators deploying i-mode) are developing i-mode according to different phases under the supervision of NTT-DoCoMo
- Basically, iMode in Europe is developed over GPRS and WAP (2.x, i.e. xHTML):
- Consideration:
  - In EU implementations, iMODE terminals shouldn't require relevant modifications thanks to the small differences of the presentation languages.



Markup languages hierarchy



- iMODE and WAP markup languages are converging towards xHTML.
- No longer significant differences.

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