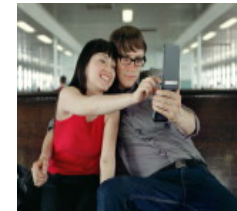
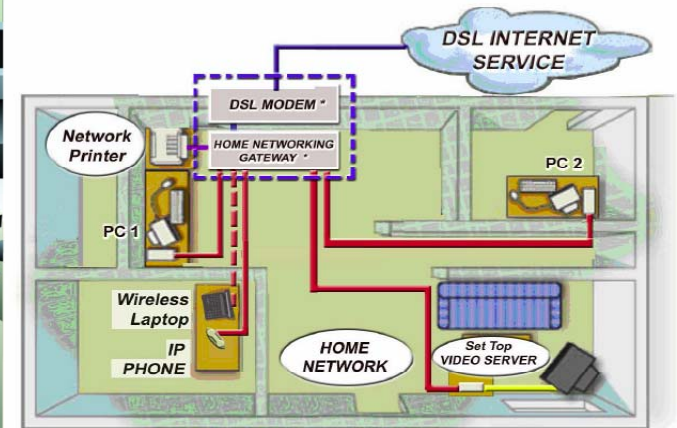
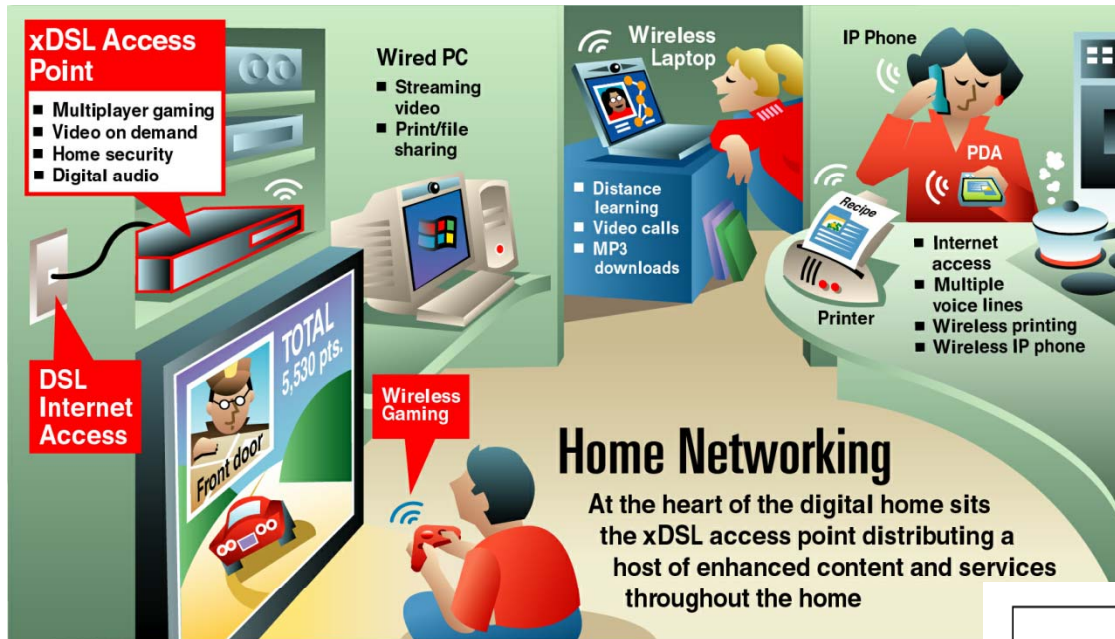

Broadband Access Communications: An Overview

COMMUNICATIONS NEEDS & TRENDS



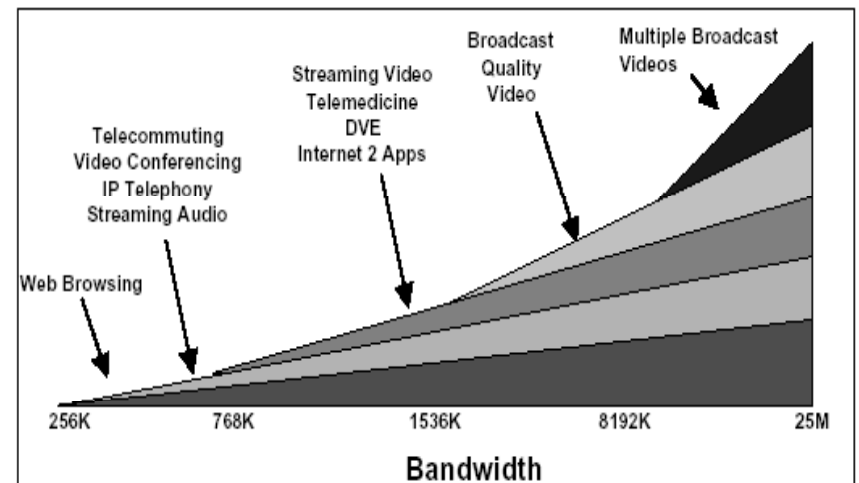
- **multimedia** services: Voice, Video distribution, Real-time videoconferencing, Data,... for both business and residential customers:
 - Explosive traffic growth
 - Internet growth, VoIP, VideoIP, IPTV
- Cell phone popularity worldwide
- **Ubiquitous** communication for people and devices
- Emerging systems opening new applications
- **Unified** network: Single distributed network, multiple services, packet architecture

HOME-USER SERVICES/REQUIREMENTS: an example



* IN MOST CASES DSL MODEM & HOME NETWORKING GATEWAY ARE IN THE SAME BOX.

High Speed Application	Bandwidth
HDTV – MPEG4 per stream	10Mbps
SDTV – MPEG4 per stream	2Mbps
Web browsing	1Mbps
Online gaming	2Mbps
VoIP calls	0.2Mbps
Aggregate bandwidth per average home of 2 HD streams	~25Mbps



Internet Service Evolution

□ Typical Internet Services

- ❖ High-speed Wireline Internet Services (Cable Modem / ADSL / VDSL)
 - ▶ IP service in a home domain
 - ▶ 1 ~ 10Mbps(upgraded to 50Mbps)
- ❖ Medium or Low Speed Wireless Internet Services (CDMA2000, WCDMA)
 - ▶ Cellular-based platform : originating/termination call
 - ▶ Public mobile service, but expensive
 - ▶ 144/384 Kbps (1x, WCDMA), 2.4/10Mbps (Ev-DO, HSDPA)
- ❖ High-speed Wireless Internet Service (IEEE 802.11 series, Private Services)
 - ▶ IP service in a local or private area
 - ▶ Maximum 54Mbps

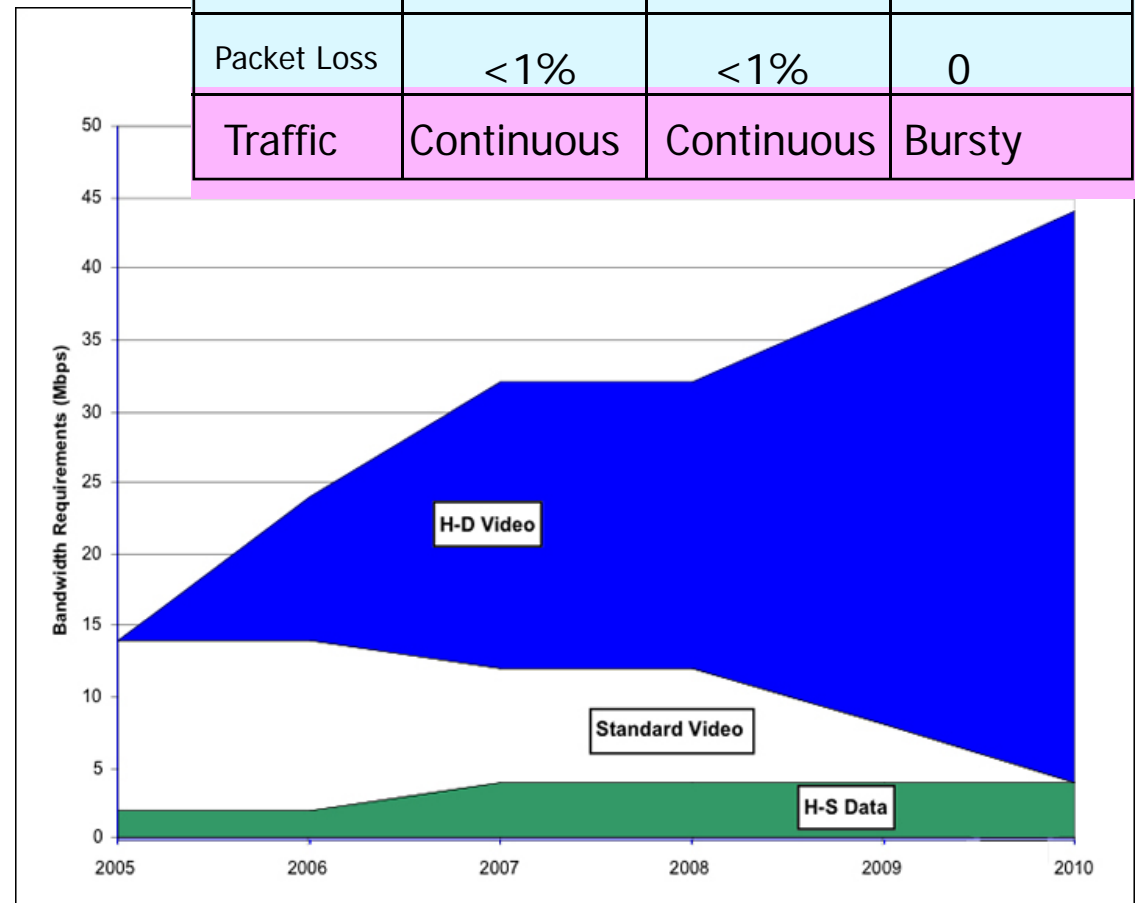
□ Demand on a High-speed Portable Internet (PI) Service

- ❖ High-speed data, Low-cost, Portable (Low-mobility) Service
 - ▶ Easy service connectivity.
 - ▶ Wireline and wireless network convergence.
 - ▶ Multimedia services.

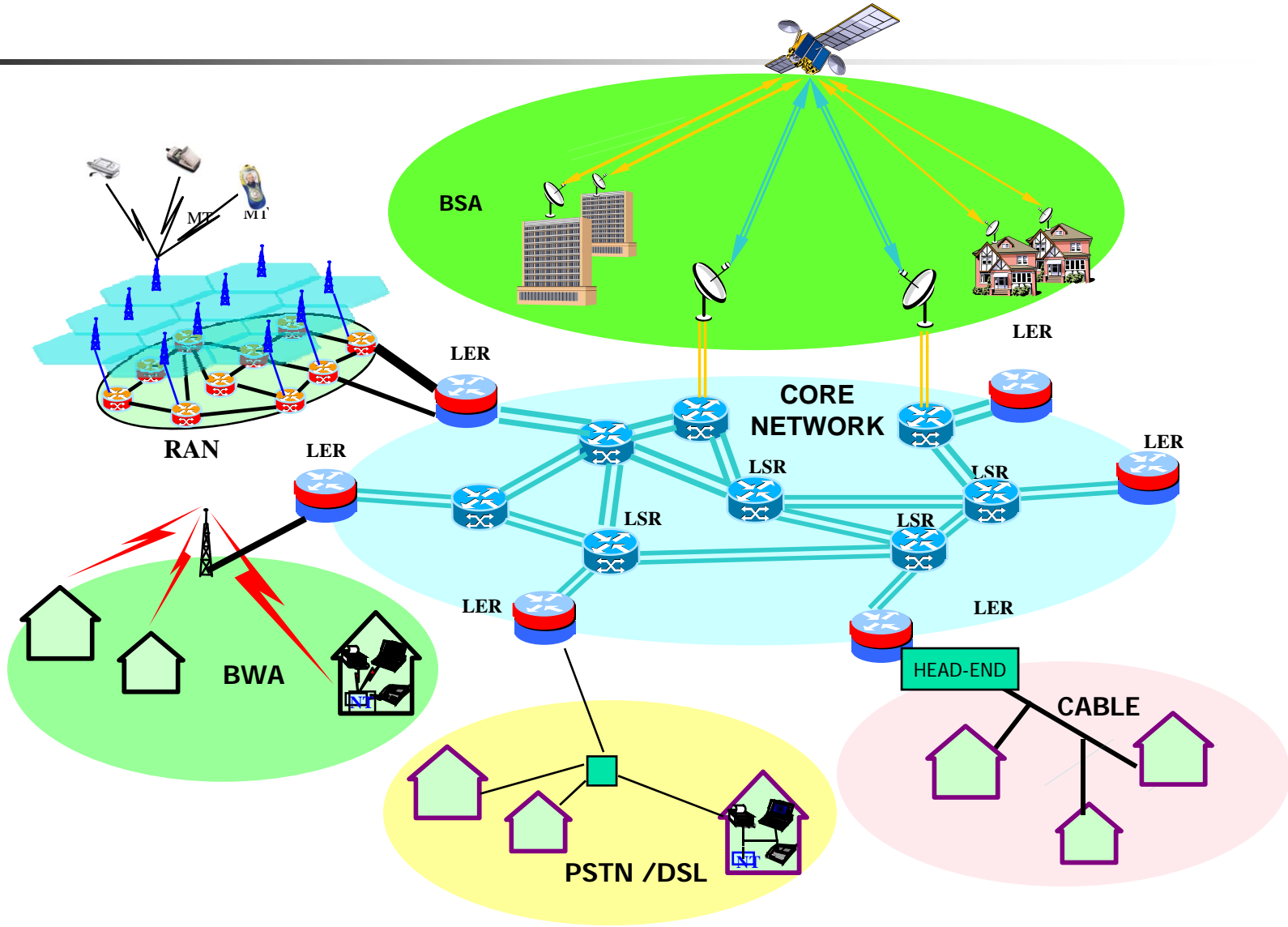
Multimedia Services: Requirements

- attributes: high-speed, bursty traffic, various QoS requirements, mobility
- technical requirements: efficient use of broadband transmission resources
- fiber can provide high capacity but fiber to every user is expensive
- for major areas covered by fiber this is the **last mile** issue.

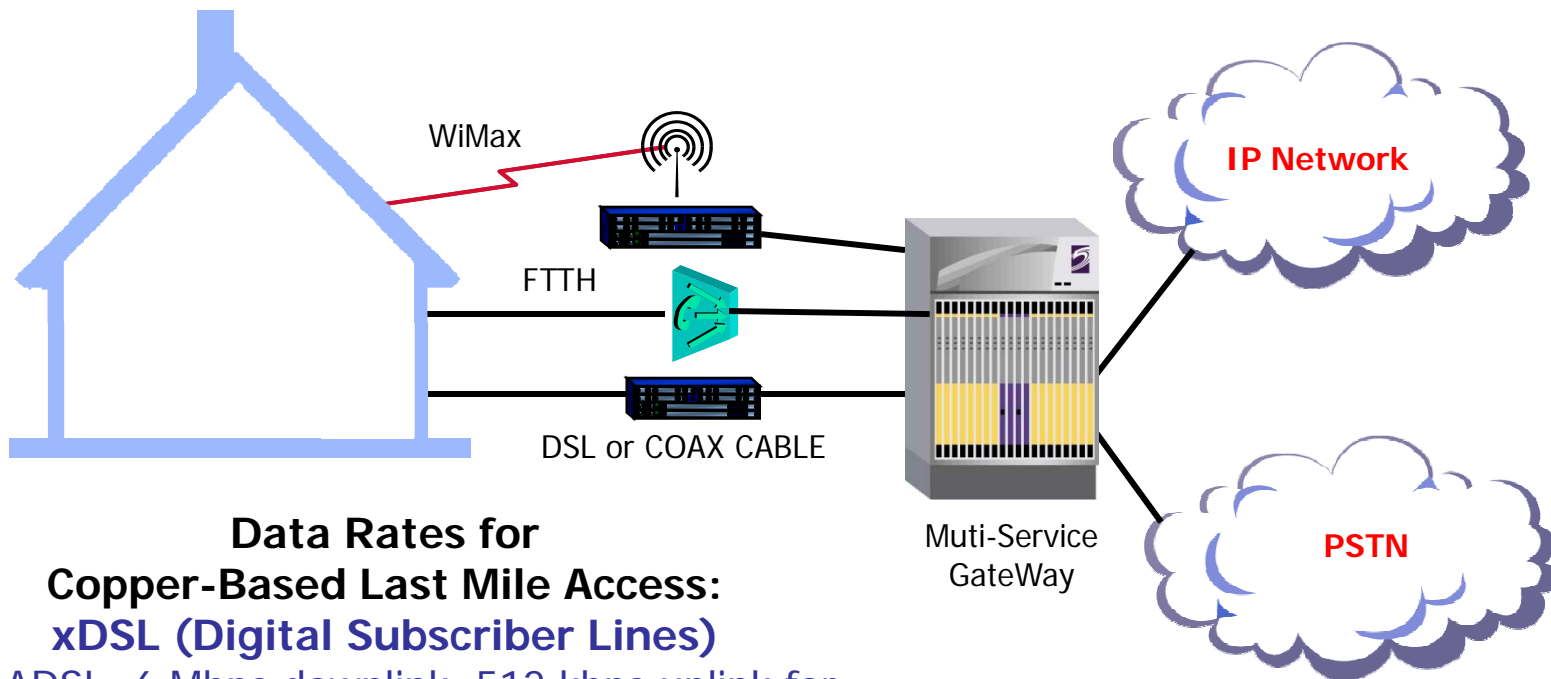
	Voice	Video	Data
Rate	8-32 Kbps	1-20 Mbps	1-100 Mbps
BER	10^{-3}	10^{-6}	10^{-6}
Delay	<100ms	<100ms	-
Packet Loss	<1%	<1%	0
Traffic	Continuous	Continuous	Bursty



CORE & ACCESS TECHNOLOGIES: EXAMPLES



Broadband Local Access

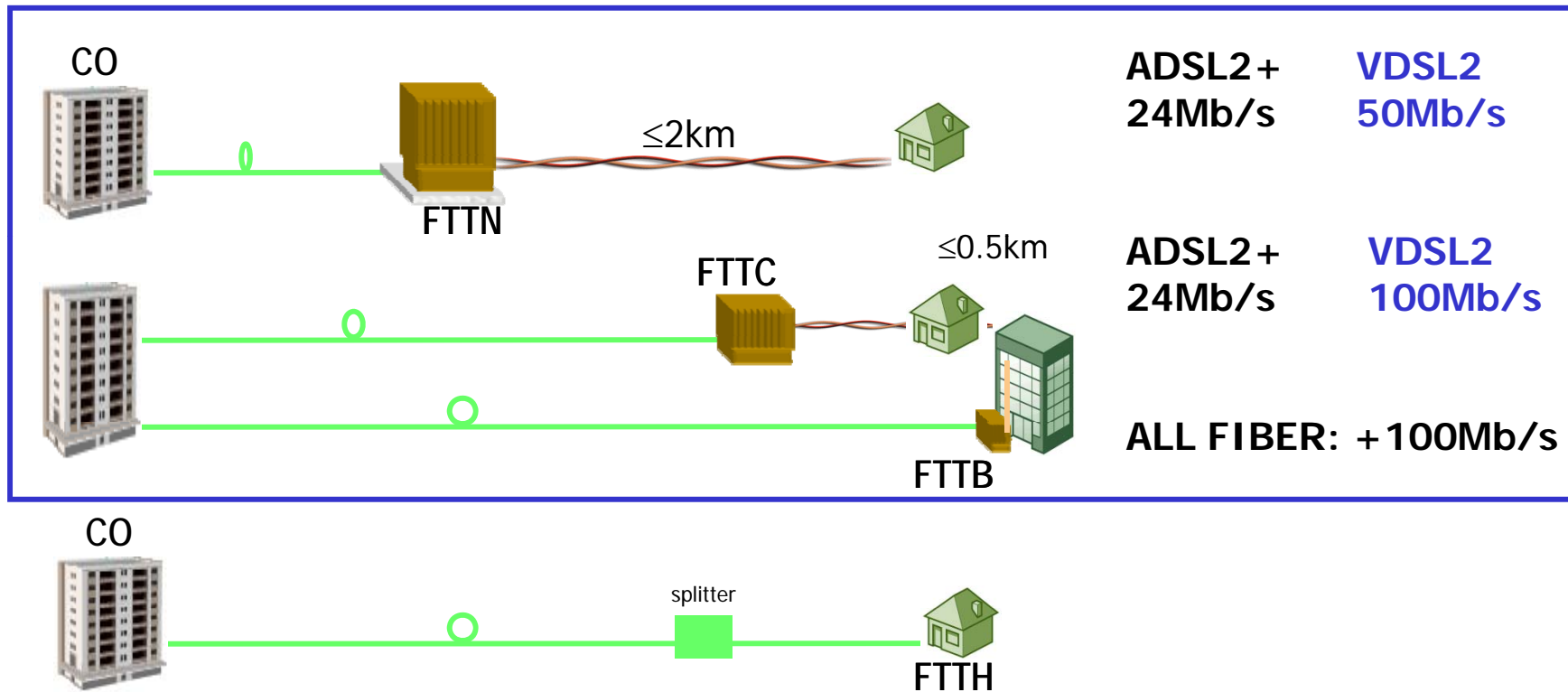


Data Rates for Copper-Based Last Mile Access: xDSL (Digital Subscriber Lines)

- ADSL: 6 Mbps downlink, 512 kbps uplink for 4 Km or less
- ADSL2+, VDSL: 30 MBPS downlink, 1 Mbps uplink for 700m

Cable Modem: 10-40 Mbps downlink and 512 to 1Mbps uplink (shared both ways)
(Most operators put a separate cable since the TV coax is of poor quality to support data)

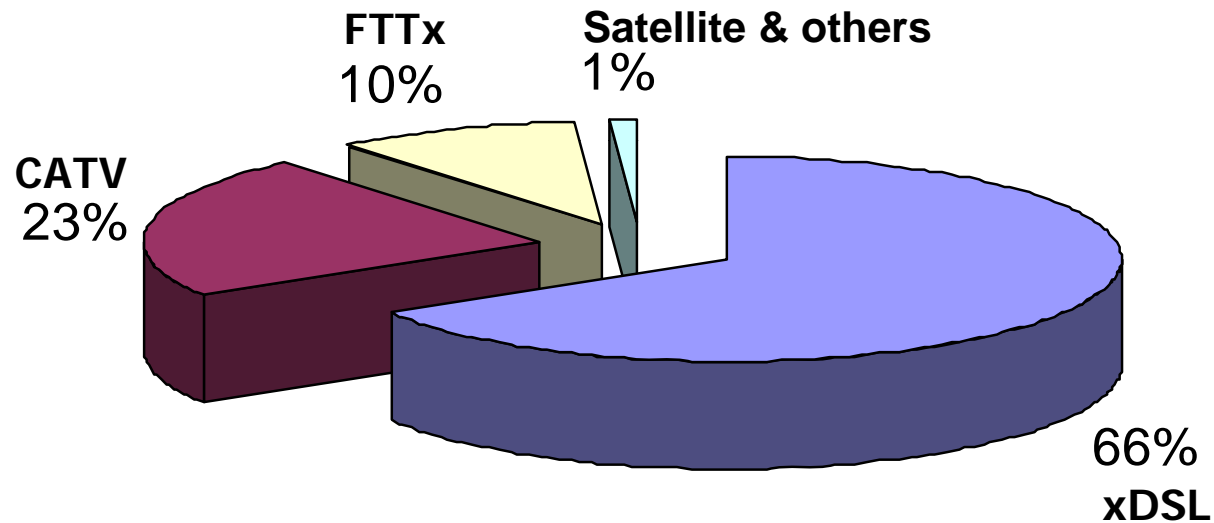
FTTx Extension & DSL



DSL FOR THE LAST MILE/KM (0.1-2km) IS STILL MORE COST-EFFECTIVE

xDSL: an outlook

xDSL: digital subscriber loop/line, a family of broadband access technologies provide digital transmission over the copper wires of a local telephone network



total number of broadband connections worldwide:
281.3 million at the end of 2006.

growth/week: +1.25 Million with **+800,000 DSL** installs

DSL "remains the most popular broadband access technology"

Information from Point Topic, March 2007

WIRELESS ?

WHY?

- **ubiquitous** communication among people and devices for multimedia services.
- mobility
- fast deployment
- easy reconfiguration

CONSUMER:

Wireless DSL (WiMAX)
Voice / Data / Video
Inter-device communications
(UWB)
Streaming Video / 3D Gaming

TRENDS:

- growing traffic and service shift in wireless.
- wireless traffic will be dominated by data
- wireless internet will pass wireline internet
- cell phone popularity worldwide (exponential growth since 1988, with almost 1 billion users today)
- military and security wireless needs

ENTERPRISE:

Unwired Offices and
Factories
Connected Mobile
Devices
Ubiquitous Wireless
Connectivity

INFRASTRUCTURE:

Voice and Data Last Mile
Wireless Backhaul
Wireless Service
Convergence

BAD WIRELESS

HISTORY NOTE:

hype in 1990s, but failures around 2000!

WIRELESS COMMUNICATIONS:

ADVANTAGES:

- fast deployment
- easy reconfiguration

TECHNICAL CHALLENGES:

- Narrow vs broadband
- Propagation: multipath frequency-selective fading, Near-LOS (line-of-sight), Non-LOS
- Limited frequency bands.
- Interference limitation

NEEDS:

- adaptive strategies for better use of resources
 - Adaptive QoS.
 - Dynamic resource allocation, Mobility support.
 - Adaptive modulation, coding, antennas.
 - Low-power, low-cost intelligent processing

Spectrum Regulation & Standards

- Worldwide spectrum controlled by ITU-R
- In US, spectrum controlled by FCC (commercial) or OSM (defense):
 - FCC auctions spectral blocks for set applications.
 - Some spectrum set aside for universal use
- WARNING: Regulation may limit innovation and slow down system deployment

- standardization is needed for system interworking
- Worldwide standards determined by ITU-T
- Companies want their systems adopted as standard (or try for de-facto standards)
- In US, standards determined by TIA/CTIA (IEEE standards often adopted)
- In Europe, ETSI is equivalent of IEEE

EXAMPLES OF FREQUENCY BAND ALLOCATION:

Centimeter-Wave Bands

- International: 3.5 GHz, 10.5 GHz
- U.S.: MMDS & ITFS: 2.5-2.7 GHz, *Non-Line-of-Sight*
- License-Exempt Bands for Wireless MAN 5.725-5.825 GHz (U-NII)
- 2.4 GHz License-Exempt: Wireless LANs

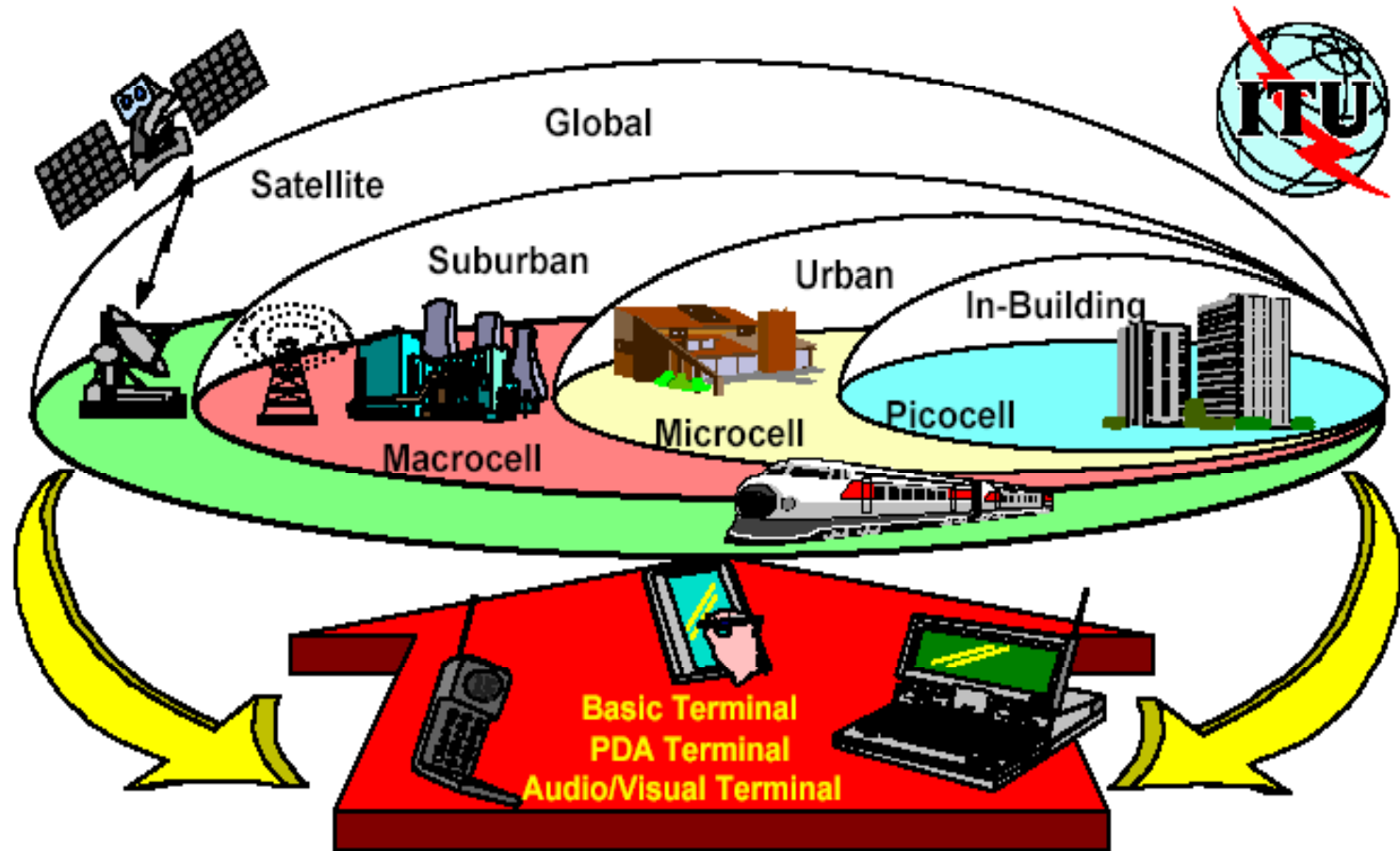
59-64 GHz

PMP Frequency Bands											
Country	10 GHz ETSI	18-24 GHz	24 GHz DEMS	26 GHz ETSI	25-27 GHz	27.5-29.5 GHz	28 GHz Like US	31 GHz	38 GHz US	38 GHz ETSI	38 GHz Other
North America											
USA			X				X	X	X		
Canada			X		X		X		X		
Asia Pacific											
Australia							X	X			
Japan		X			XU						X
Korea					XU						
Malaysia	P										
New Zealand					X						
Philippines	X	X?			X		X				
Singapore						X?	X				
Taiwan				X							X
Thailand						X					
Central & South America											
Argentina	X		X		X		X	X	X		
Bolivia							X				
Brazil	P			P							
Chile					X		X				
Colombia					X		X				
Ecuador						X					
Mexico	X			X							
Paraguay						X					
Peru						X					
Venezuela						X					
Europe, Middle East, Africa											
Czechoslovakia						X					
France						T					
Germany				X							
Hungary				X							
Ireland				X							
Israel				P?							
Netherlands				X							
Norway				X							
Poland						X					
Romania							X				
South Africa						X					
Spain				X			X	X			
United Kingdom	X										

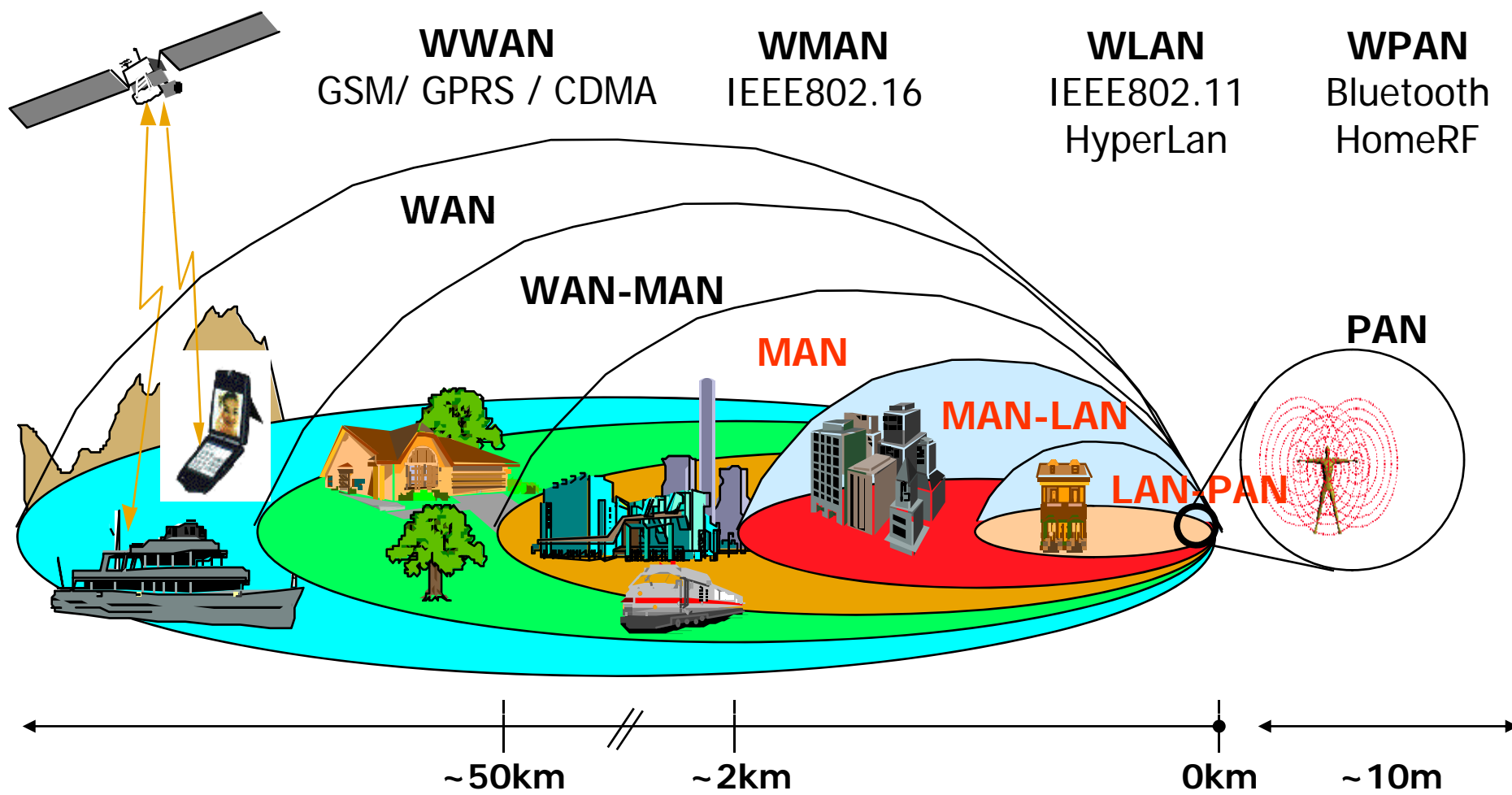
Example of frequency allocation: License-Exempt Bands

Unlicensed Bands	Spectrum	Typical Applications
ISM: Industrial, Scientific and Medical 902-928 MHz, 2.4-2.4835 GHz & 5.725-5.85 GHz)	234.5 MHz	Cordless Phones, Wireless LANs (WLAN) and Wireless PBXs (WPBX)
UPCS: Unlicensed PCS Asynchronous: 1910-1920, 2390-2400 MHz Isochronous: 1920-1930 MHz	20 MHz 10 MHz	WLAN WPBX
U-NII: Unlicensed National Information Infrastructure U-NII (5.15-5.25 GHz)	100 MHz	Indoor applications WLAN,WPBX
U-NII (5.25-5.35 GHz)	100 MHz	Short outdoor links, campus applications
U-NII (5.725-5.825 GHz)	100 MHz	Long outdoor links, Point-To-Point links
Millimeter Wave (59-64 GHz)	5 GHz	Home networking applications

IMT-2000 Vision Includes LAN, WAN and Satellite Services



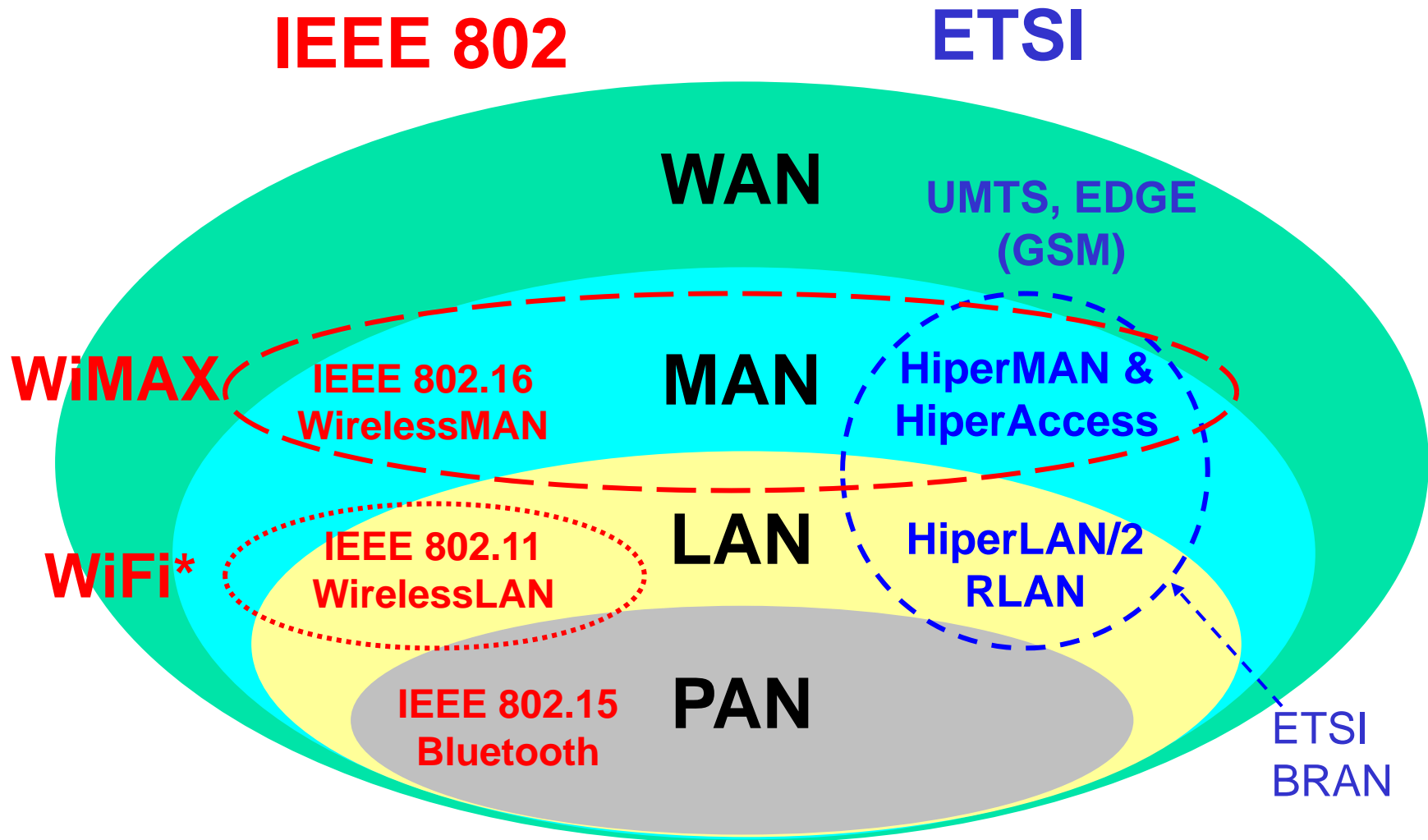
Wireless Standard Classification



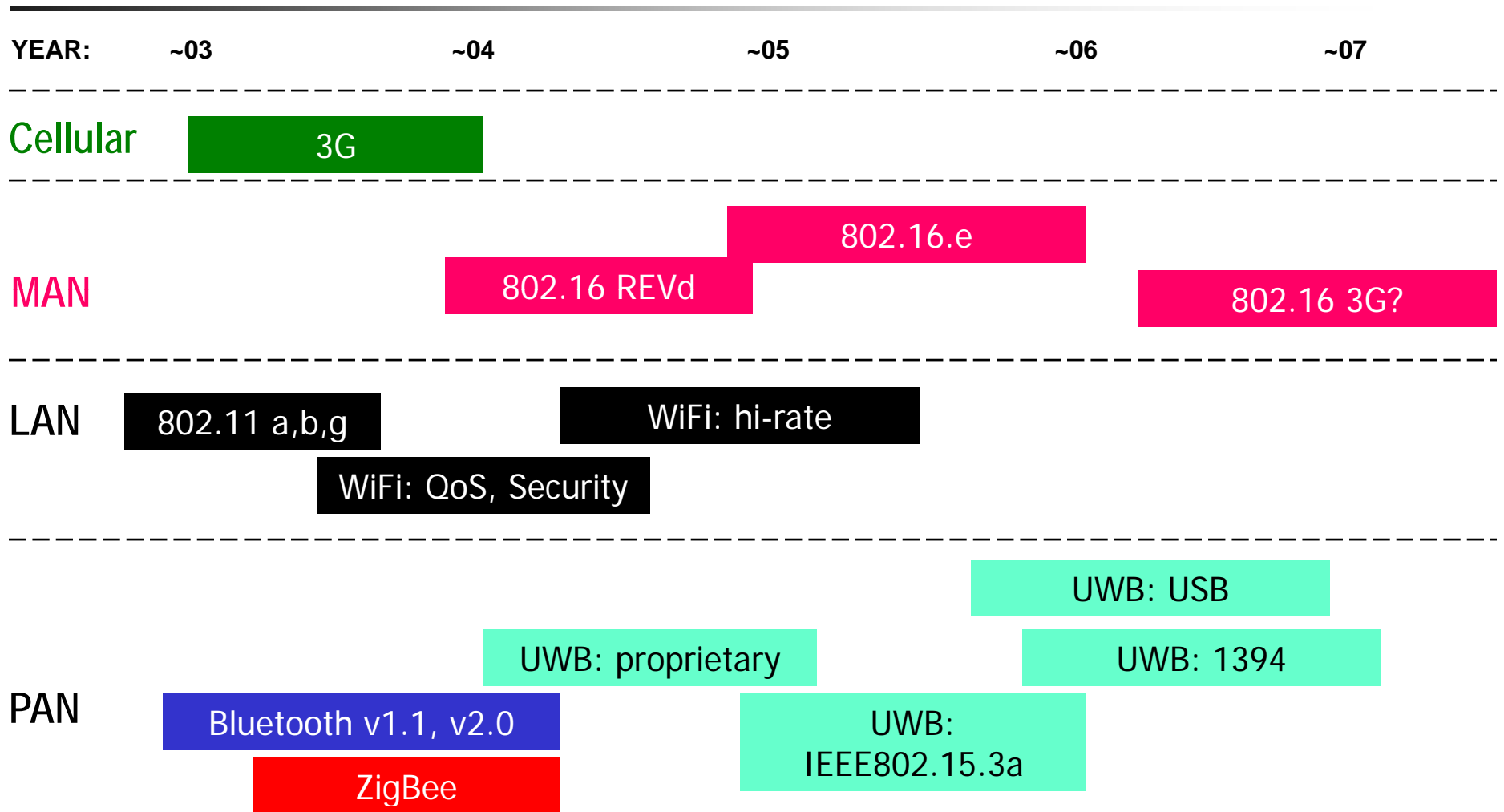
Distance-based Wireless Standard Classification

Interprocessor distance	Processors located in same	Example
1 m	Square meter	Personal area network
10 m	Room	Local area network
100 m	Building	
1 km	Campus	
10 km	City	Metropolitan area network
100 km	Country	Wide area network
1000 km	Continent	
10,000 km	Planet	The Internet

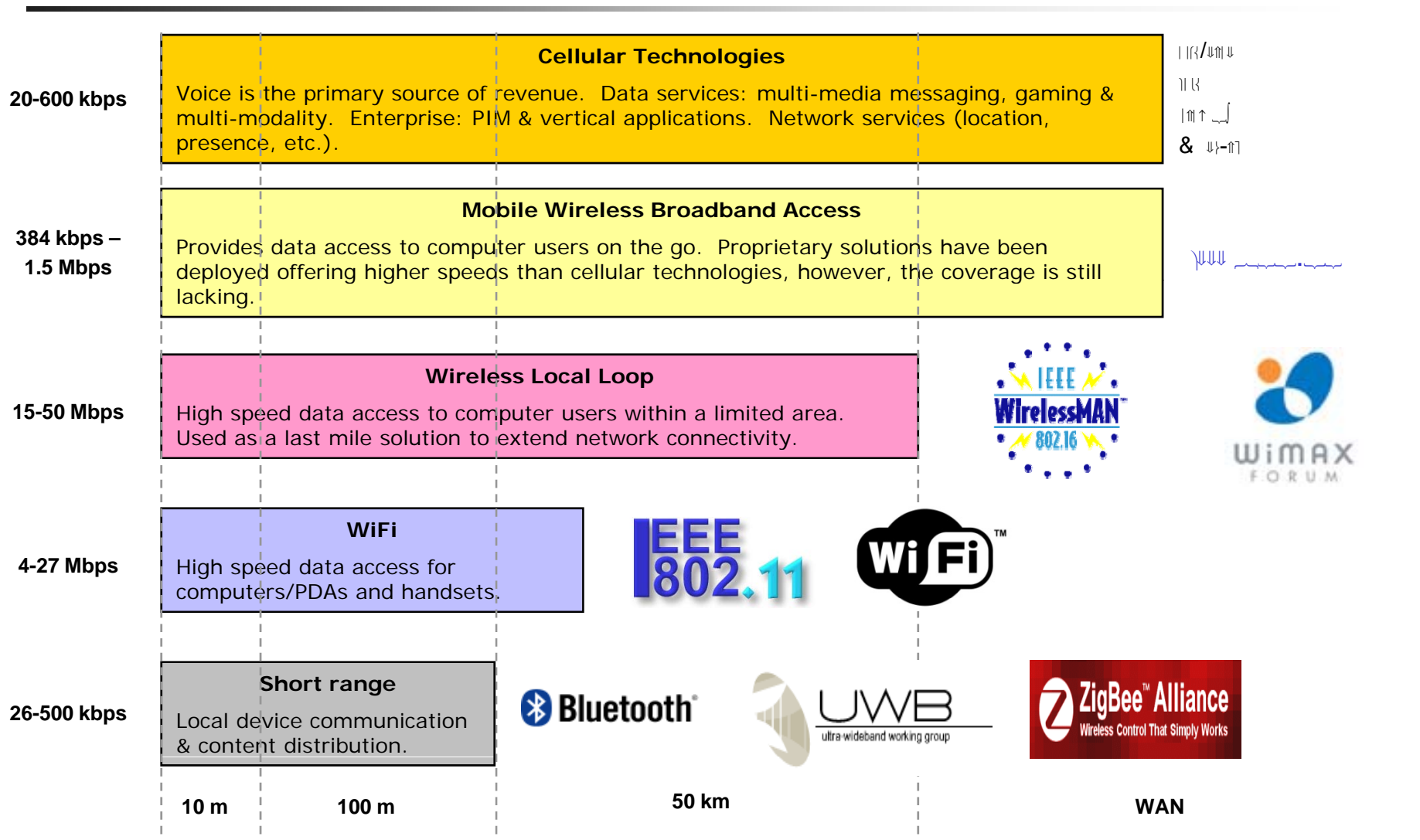
Wireless Standards: IEEE & ETSI



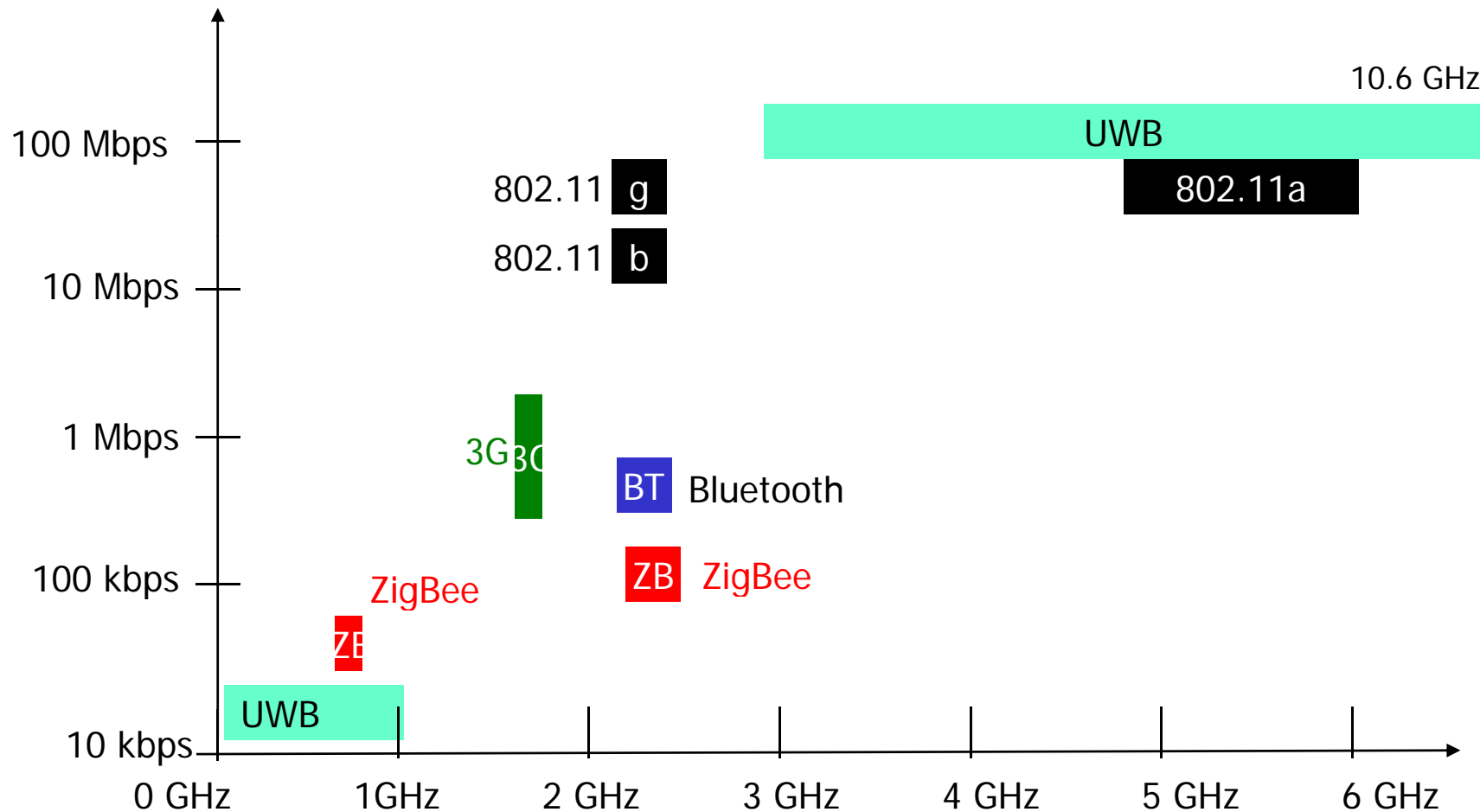
Wireless Standard Evolution: Examples



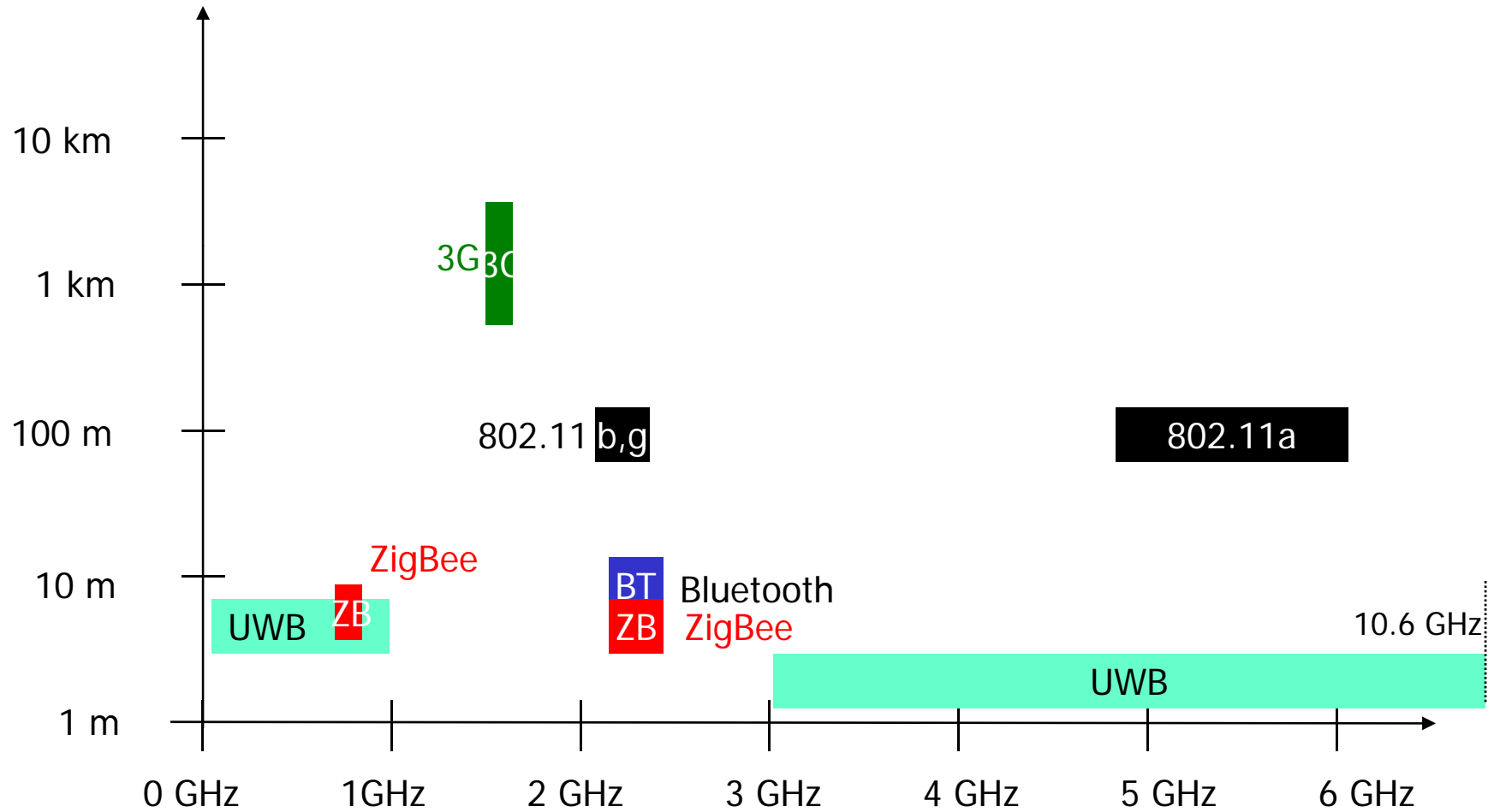
Wireless Co-existence



Data rate



Range



Power Dissipation

