



3G wireless
systems and
beyond

Dr. Kourosch Parsa
October 7, 2005

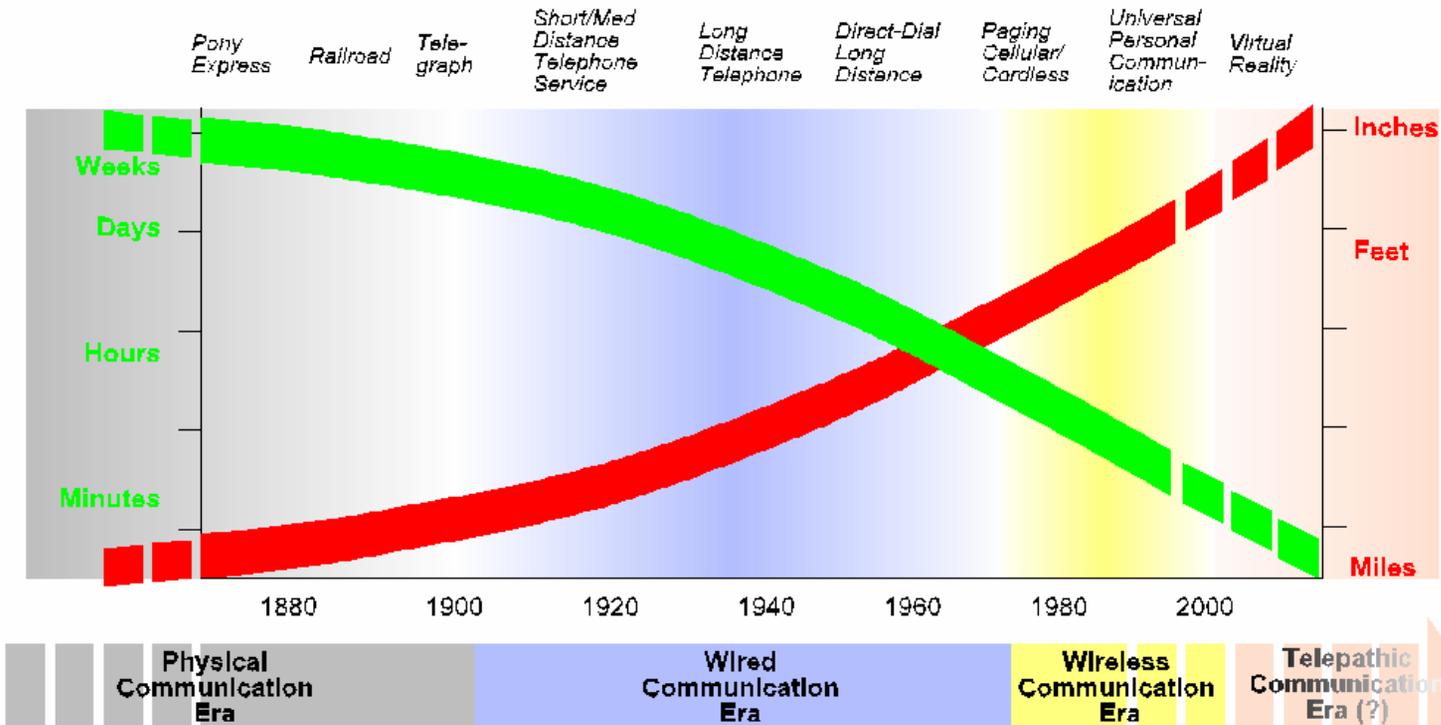
Outline

- Telecommunication trends
- Mobile market trend
- Mobile technology trends
- Mobile standards trends
- B3G:Evolution of WLAN
- Comparison

Telecom Technology Trends

"Half-Life" of Perceived Personal Information Value

"Inconvenience Threshold" Travel Distance to Obtain Valuable Information



Each communication technology advance has shortened the useful life of information and increased the need to obtain new information more rapidly regardless of the situation or location...



Digital Convergence

- Telecom: 3GPP/2
 - Advanced IP-based services
 - WCDMA, CDMA2000
- Datacom: IETF
 - IPV6, QoS
 - Mobile IP
- New radio technologies
 - WPAN: BT, 802.15, UWB
 - WLAN: 802.11a/b/g, 802.11N
 - WMAN: 802.16

- **New applications / services**
 - Bit rate / QoS / VoIP
 - Rich call, entertainment
 - Video telephony
 - Digital mobile TV



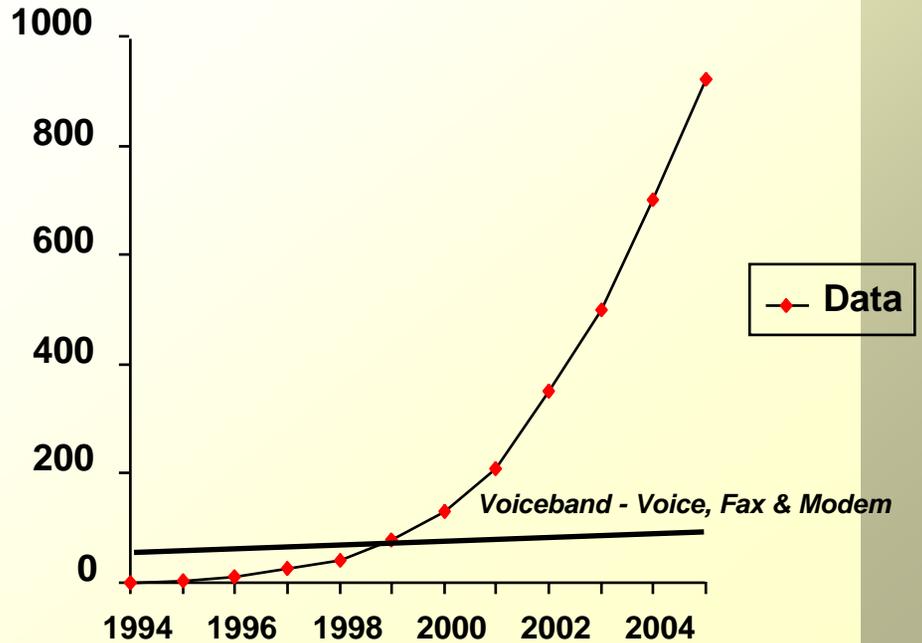
Telecom Technology Trends

Post Year 2000: "Transition from a voice focused network supporting data, to a data focused network supporting voice"

Projected Volumes For Wide Area Communications In US By Type Of Traffic, 1994-2005

Source: IDC, AT&T Labs, Geopartners Analysis

Average Bandwidth
Gbits /Sec



Wireless versus landline users

- As of December 2004 (source: FCC):
Number of cell phone users in the US (181 Million) has surpassed the number of landline users (178 Million users)

Wireless Data Evolution

Convergence of 4 technologies

Computer

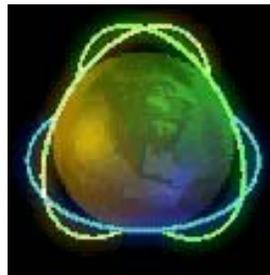
TV, video



Wireless Data - "Providing the information you want, when you want it, delivered to the device you want..."

Internet

Wireless
Telecommunications



Outline

- Telecommunication trends
- Mobile market trend
- Mobile technology trends
- Mobile standards trends
- B3G:Evolution of WLAN
- Comparison

Macro-trends: Wireless Network Technology Trends

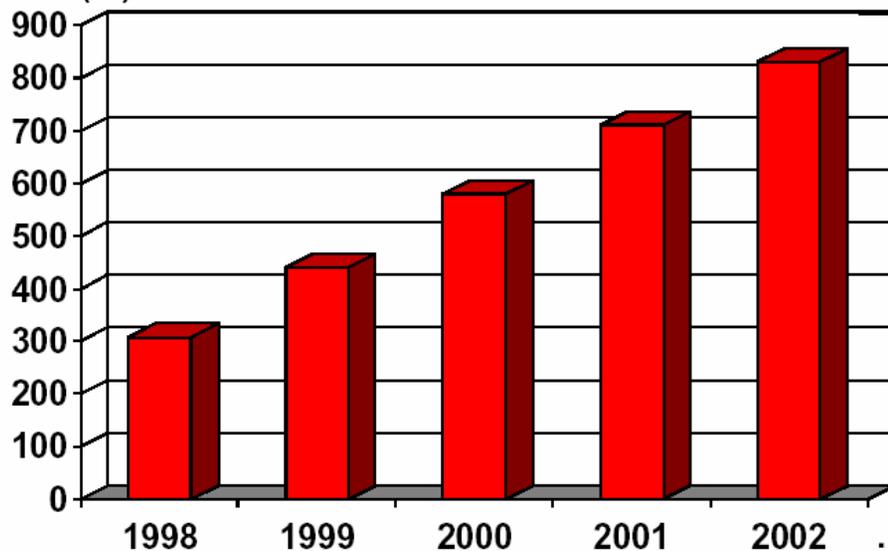
- Global 3G system: 3G is a commercial reality now
- Global WiFi/Cellular technology (WLAN): A reality
- Global dominance of WiFi in the segment
- Global IP mobility:
- Mobile Multimedia revolution: A reality
- Global seamless service provision: Future



Wireless Market Growth

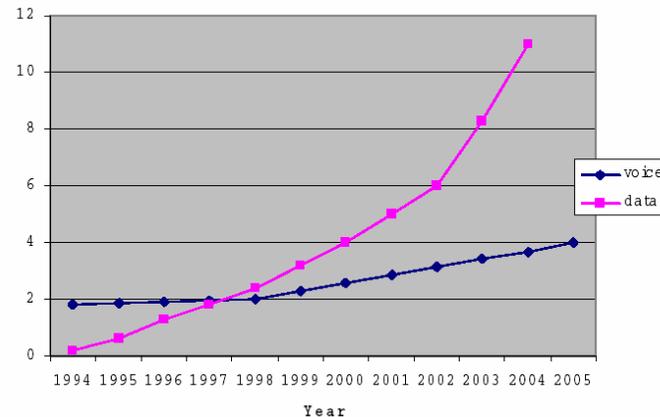
The Turning Point ...
Data centric, IP networking

Subscribers (m)



*Strategis, Herschel Shosteck, Dataquest, Nokia, Ericsson

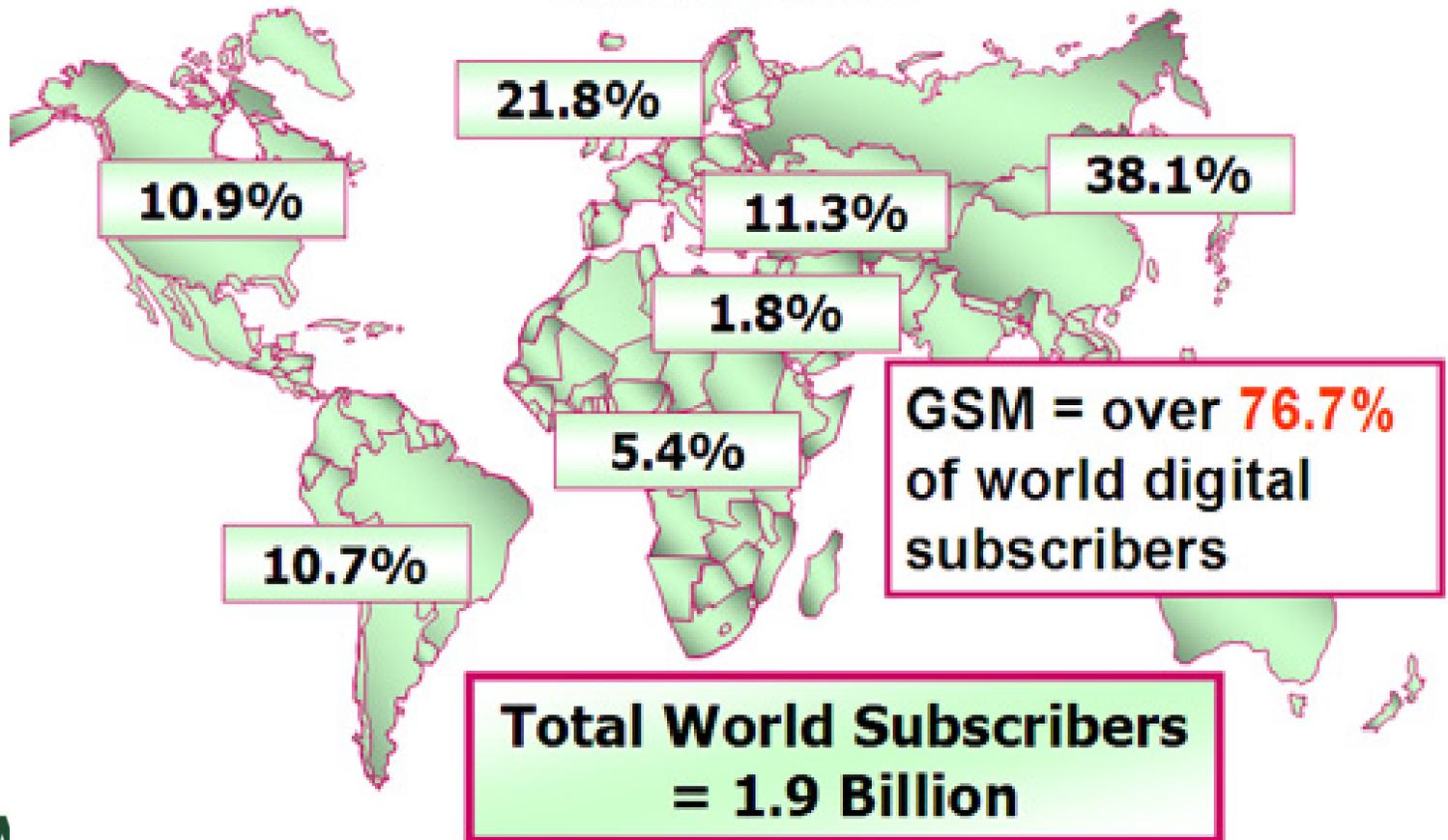
Billions of Gbits/year



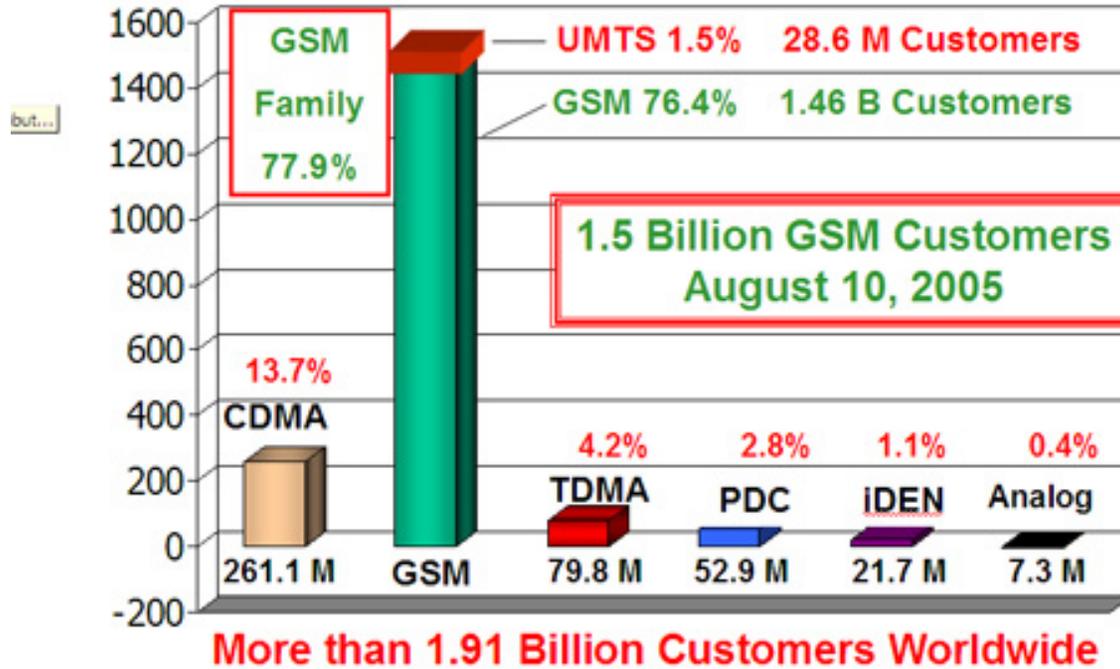
Source: BT Alex Brown, Nortel, Lucent, Telcordia

800 m -WW subscribers
2002
1.9 Billion – WW subscribers
2005

World Cellular Subscriber Distribution June 2005



World Cellular Subscribers by Technology June 2005



Source: Informa Telecoms & Media, WCIS, Aug 2005



Technology Drivers?

- Superior technology
- Global standard
 - To provide uniform platform for mobile multimedia applications
 - To guarantee global acceptance and success
 - To provide economy of scale
- Market and consumer requirement
- Low Cost
- Regulatory environment
 - Licensed versus unlicensed
 - New regulatory paradigm?

Wireless Technology Market Trends

- 1.9 Billion subscribers globally today (1.5 Billion GSM)
- Europe 85%, US 49%, India 1%
- 2003: I-Mode – 34 Million in Japan: Total of mobile internet users exceed 60 Million in Japan
- Picture messaging in Japan (9 M) J-Tel : March 2003
- DoCoMo picture messaging in Japan (5 M): March 2003
- KDDI camera phone 6 Million: 2003
- 3G is a commercial reality with 50 M users globally
 - 33 M UMTS users
 - 16.5 M in Japan
 - 6.75 M in Italy
 - 4 M in UK
 - 17 M EVDO users mostly in Japan and Korea

GSM-GPRS-Edge-UMTS Family

- 500 GSM operators in 195 countries
- 150 GPRS operators in 58 countries, 6.4 Million in 2002
- 2003: 600 GSM handset types are out there
- 270 GPRS operators // 270 operators have introduced MMS
- 180 Edge operators (100+ in service)
 - 70 devices

Status of UMTS deployment in the world

- First 3GPP compliant network was deployed by Jphone in Japan in December 2002.
- 82 operators have launched service
- 9 pre-commercial trials
- 61 networks are being planned for deployment
- 134 licenses were awarded globally as of December 2004 in 48 countries spanning 500 M subscribers.
- 25 manufacturers are committed to UMTS handsets
- More than 180 device models are in the market.
 - 1H 2003:20
 - 1H 2004:40
 - 2H 2004:100
 - 2H 2005:180

Is HSDPA next?

- 36 networks have planned or are in HSDPA deployment.
- First device 4Q 2005: MOT D1100PC card
- Many devices are planned for 2006
- Cingular is planning to deploy HSDPA in most US cities by the end of 2006

Why HSDPA?

- 2.5-3.5 times faster than UMTS
- Theoretical peak rate of 14 Mbps
- Average download speed per user 550-1100 kbps
- DVD quality film/video

Wi-Fi is Becoming the dominant wireless technology of choice in the enterprise segment



- Most companies have or are looking to deploy Wi-Fi
 - Mobility is increasing productivity
 - Centrino ready laptops are ubiquitous
- Most companies are still concerned about security
- Most deployments
 - Start simple – guest access only
 - Grow rapidly
 - Centrino ready laptops (65% of laptops in Q2 2005)
 - User awareness
 - CEO requirement
 - Quickly become unmanageable
 - Unplanned/uncoordinated growth
- Wireless is one of the primary IT investment areas
 - The numbers and benefits are becoming simply too compelling
- It is becoming a primary connection medium for Voice, Video, and Data

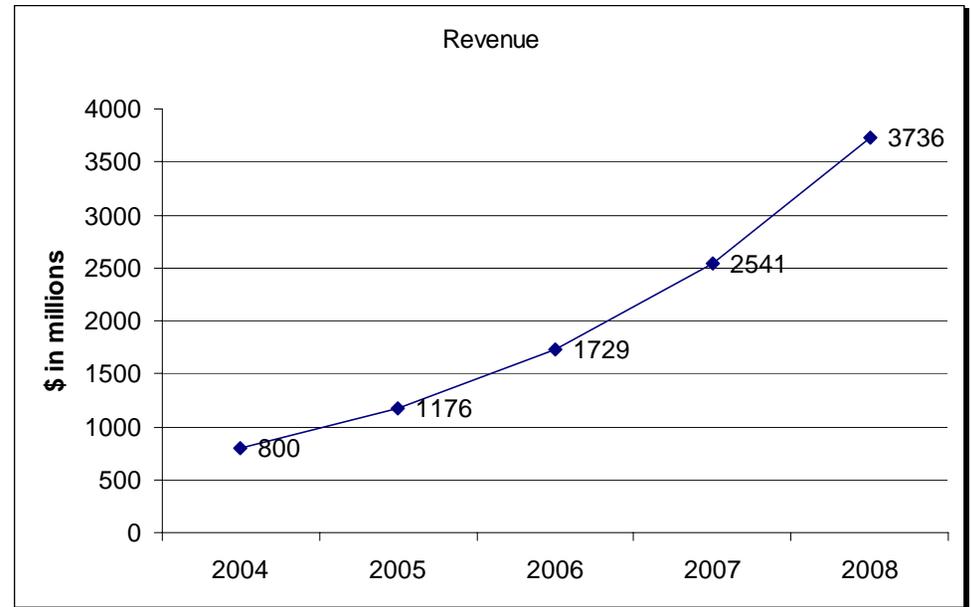
Global WiFi Markets

Applications

- ➔ VoWiFi
- ➔ Location Tracking
- ➔ RFID Management

Delivery

- ➔ WLAN's global forecast to grow at over 47% per year to \$3.8B in 2008



VoWiFi, Location Tracking and RFID management are becoming the killer applications for Wi-Fi

WiFi and WLAN

- 1200 hotspots in 2001
- 71,000 hotspots in 2003
- 5 Million WLAN users in the US:2003

- 2002: \$700M
- 2003: \$1.7 B
- 2004: \$2.8 B
- 2005: \$5.2 B (projected by Forward Concept)
- 2006: \$5.9 B (projected by Forward Concept)

WiFi Cellular convergence data points

- Examples: T-Mobile hotspot, SBC freedom Link, Telia Homerun in Scandinavia, Vodafone D2 in Germany.
- BT and Korea Telecom to offer by the end of 2005
- Device examples: HP H6315 iPaQ PDA GPRS/WiFi, Sony EricssonGC79 PC card GPRS/WiFi, 2 Motorola models, Nokia 9500 communicator, 3 Samsung models.
- Infrastructure side: Ericsson, Nokia, Transat Technology.
- Dual mode WiFi/Cellular: projected to be 100 M by 2010 (ABI research)

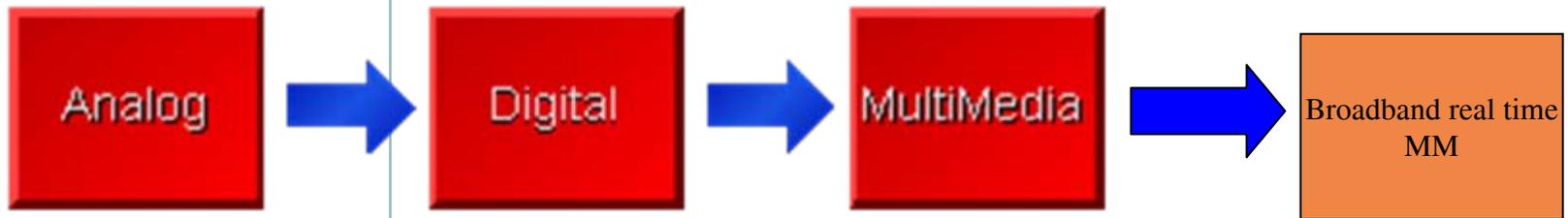
WiMax

- 2005: \$72 M
- 2009: \$2B (source: Beyond WiFi, 802.11n, VoWiFi & WiMax)

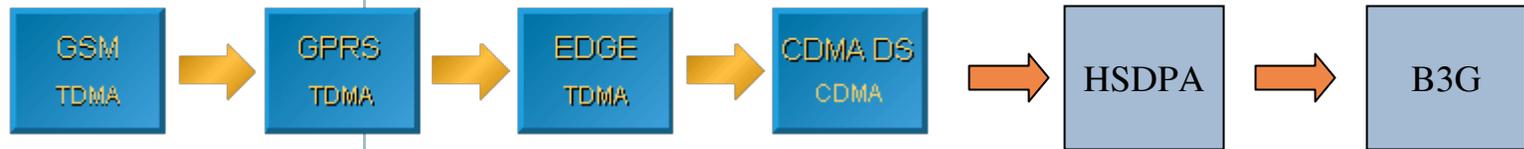
Outline

- Telecommunication trends
- Mobile market trend
- Mobile technology trends
- Mobile standards trends
- B3G:Evolution of WLAN
- Comparison

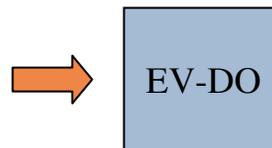
Wireless WAN System Evolution



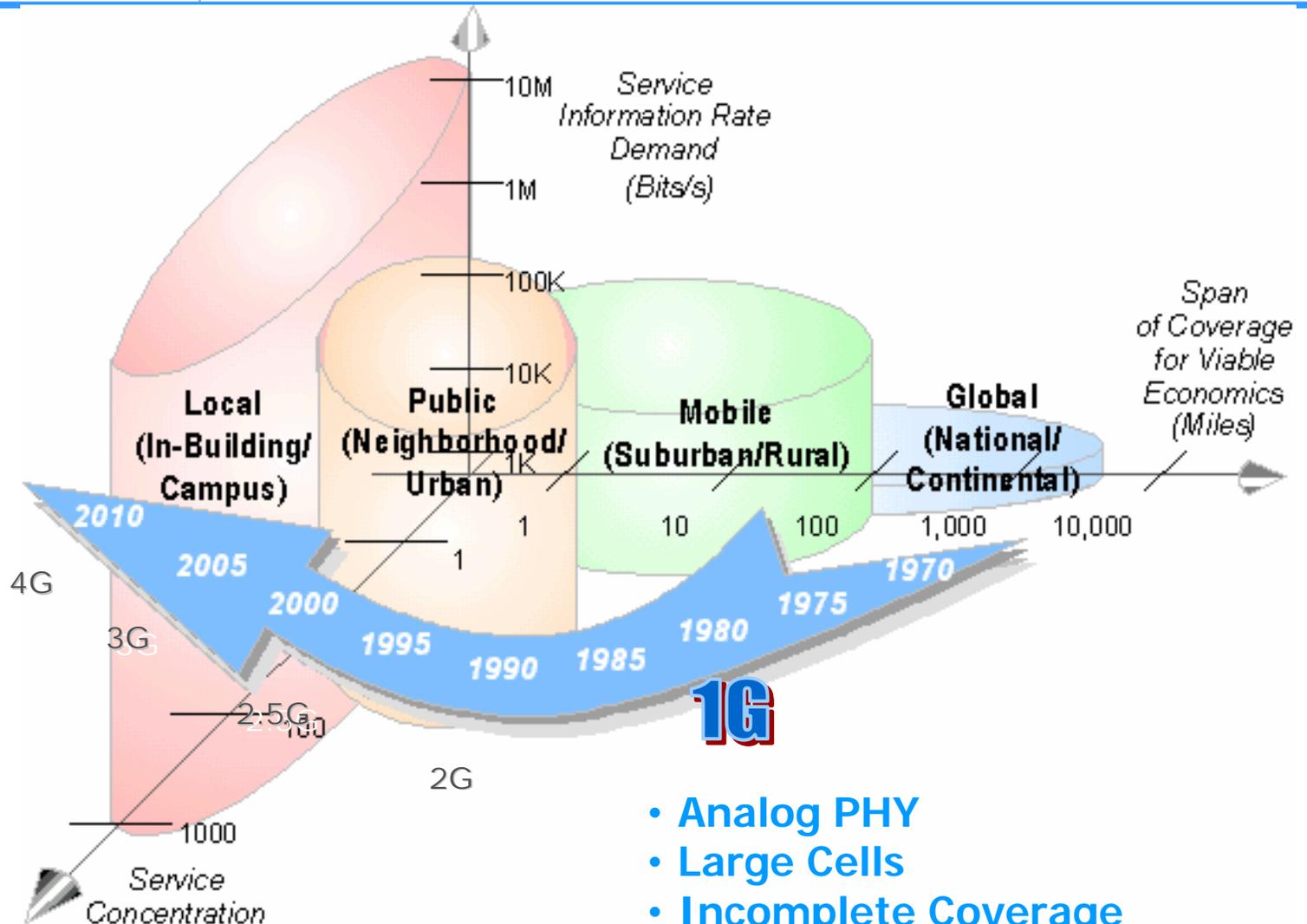
GSM path to 3G CDMA



CDMA path to 3G CDMA

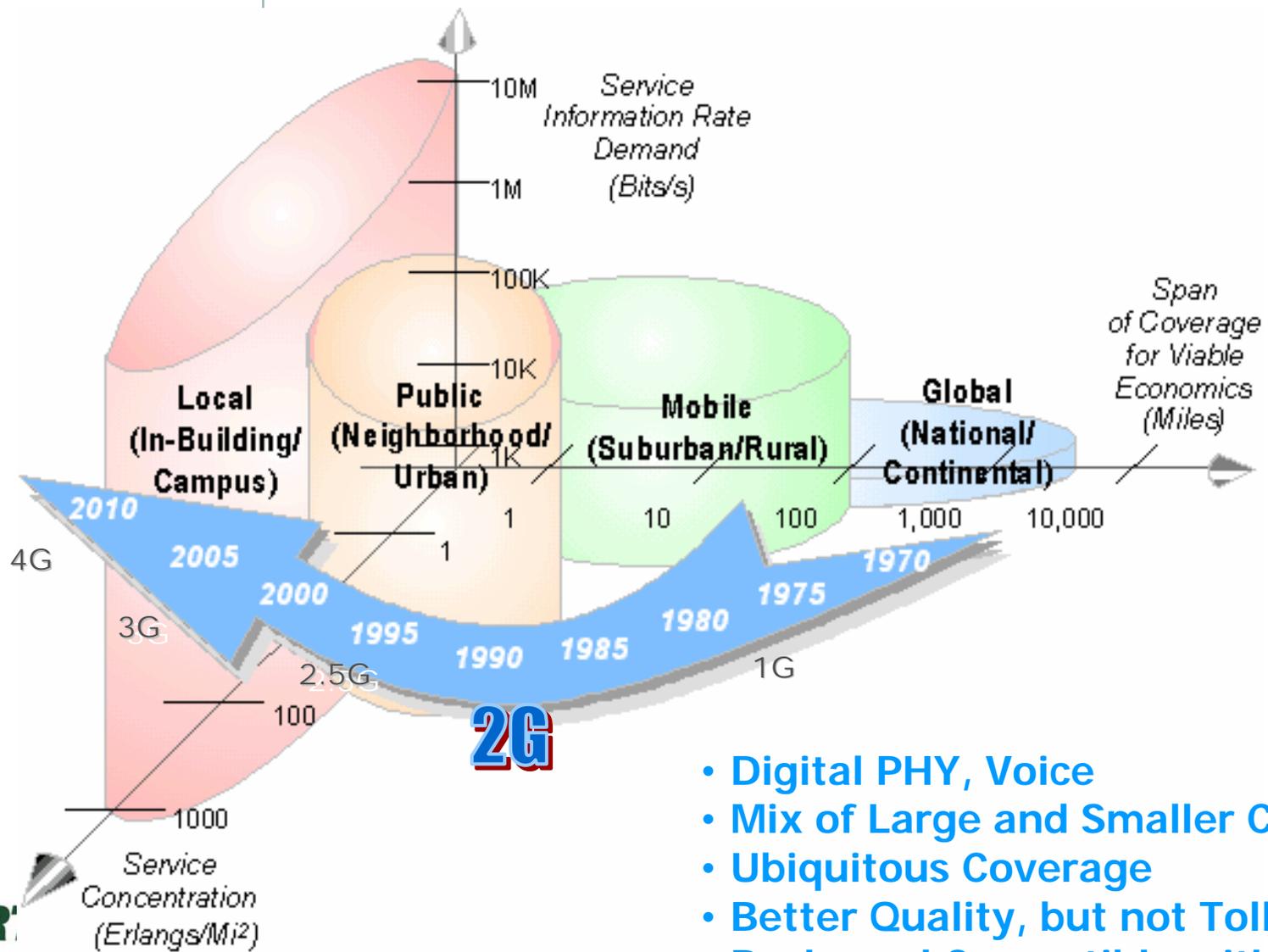


Mobile Technology Trends



- Analog PHY
- Large Cells
- Incomplete Coverage
- Non-Uniform Quality
- Call Drops

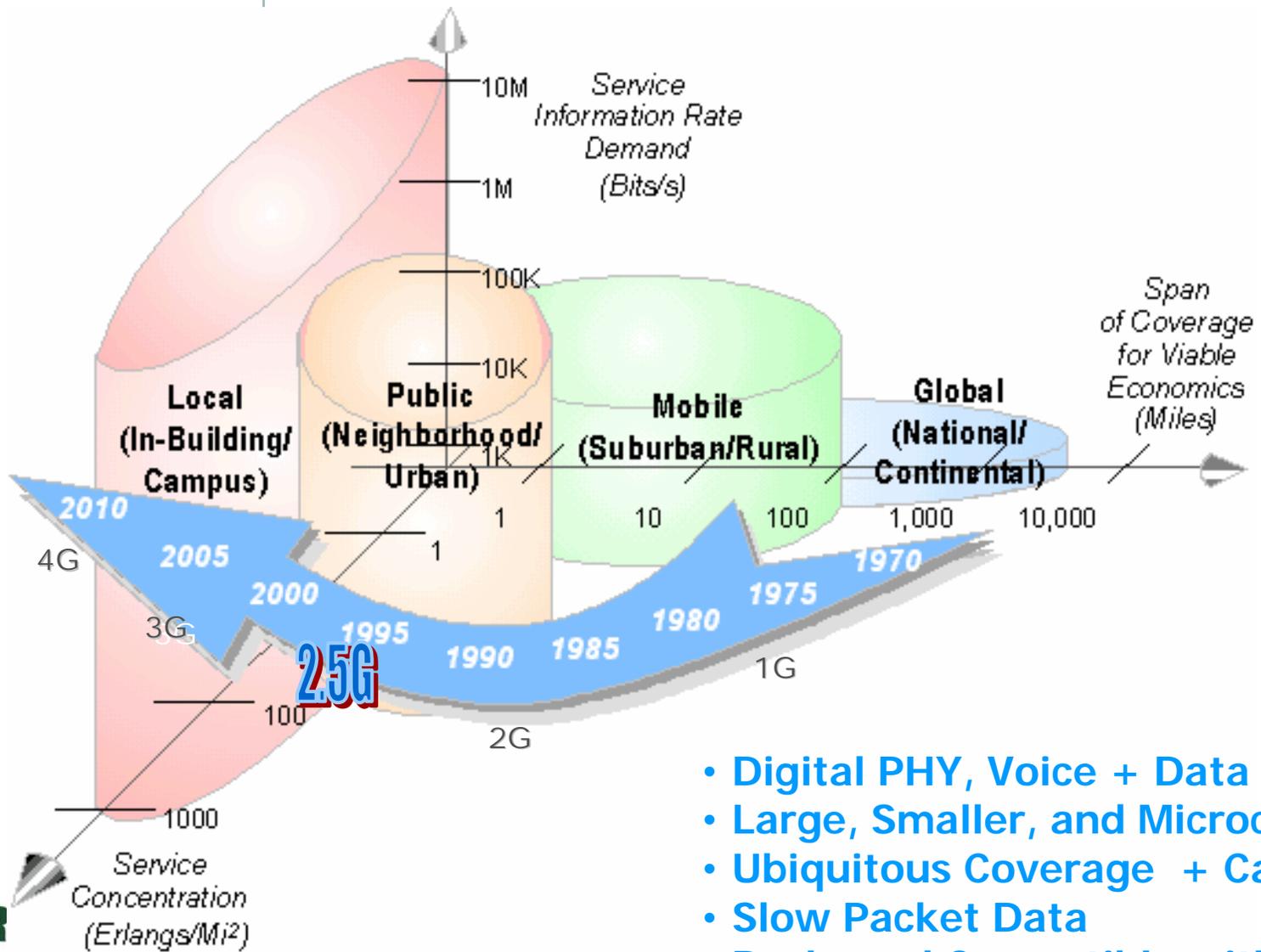
Mobile Technology Trends



- Digital PHY, Voice
- Mix of Large and Smaller Cells
- Ubiquitous Coverage
- Better Quality, but not Toll quality
- Backward Compatible with 1G



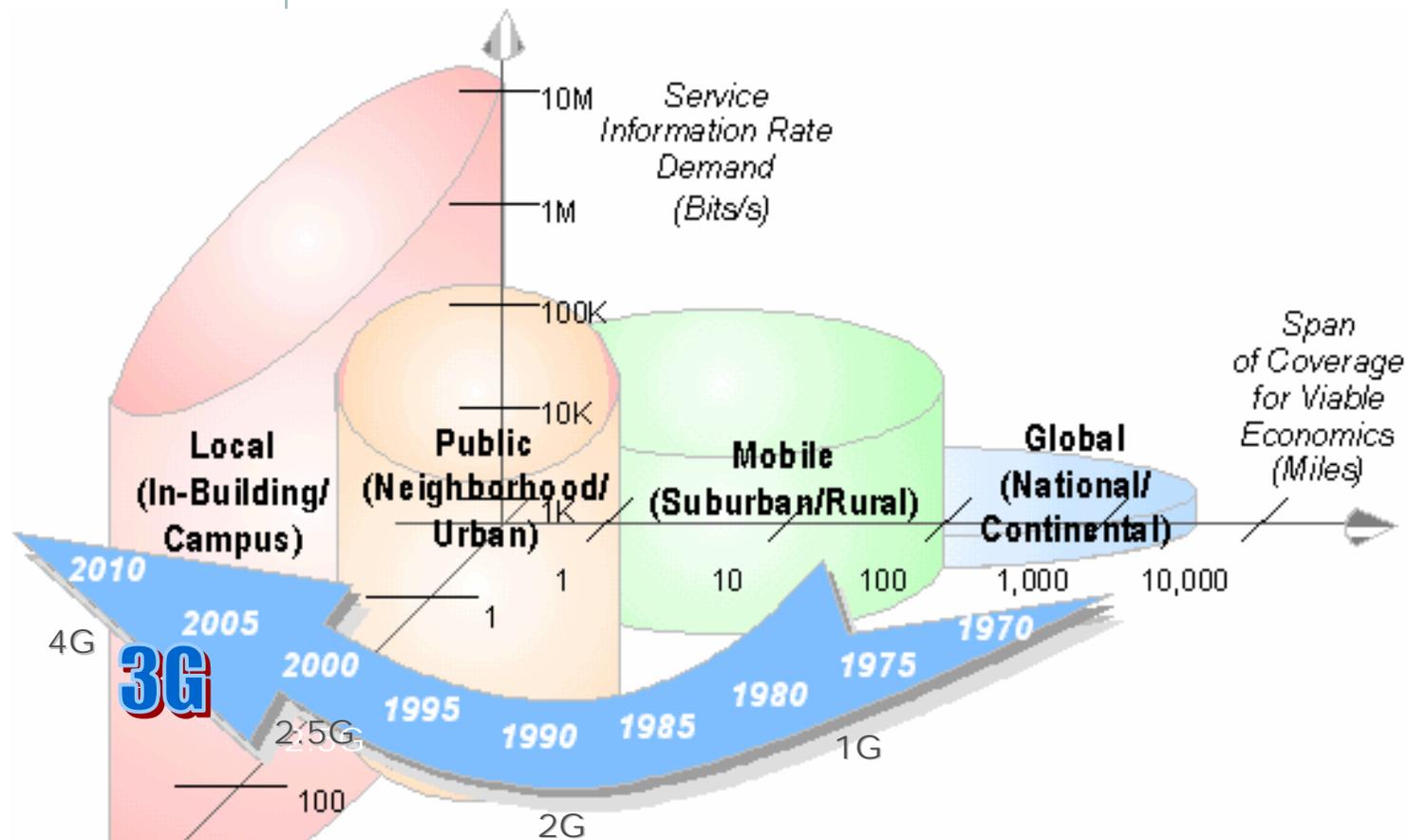
Mobile Technology Trends



- Digital PHY, Voice + Data
- Large, Smaller, and Microcells
- Ubiquitous Coverage + Capacity
- Slow Packet Data
- Backward Compatible with 1G, 2G



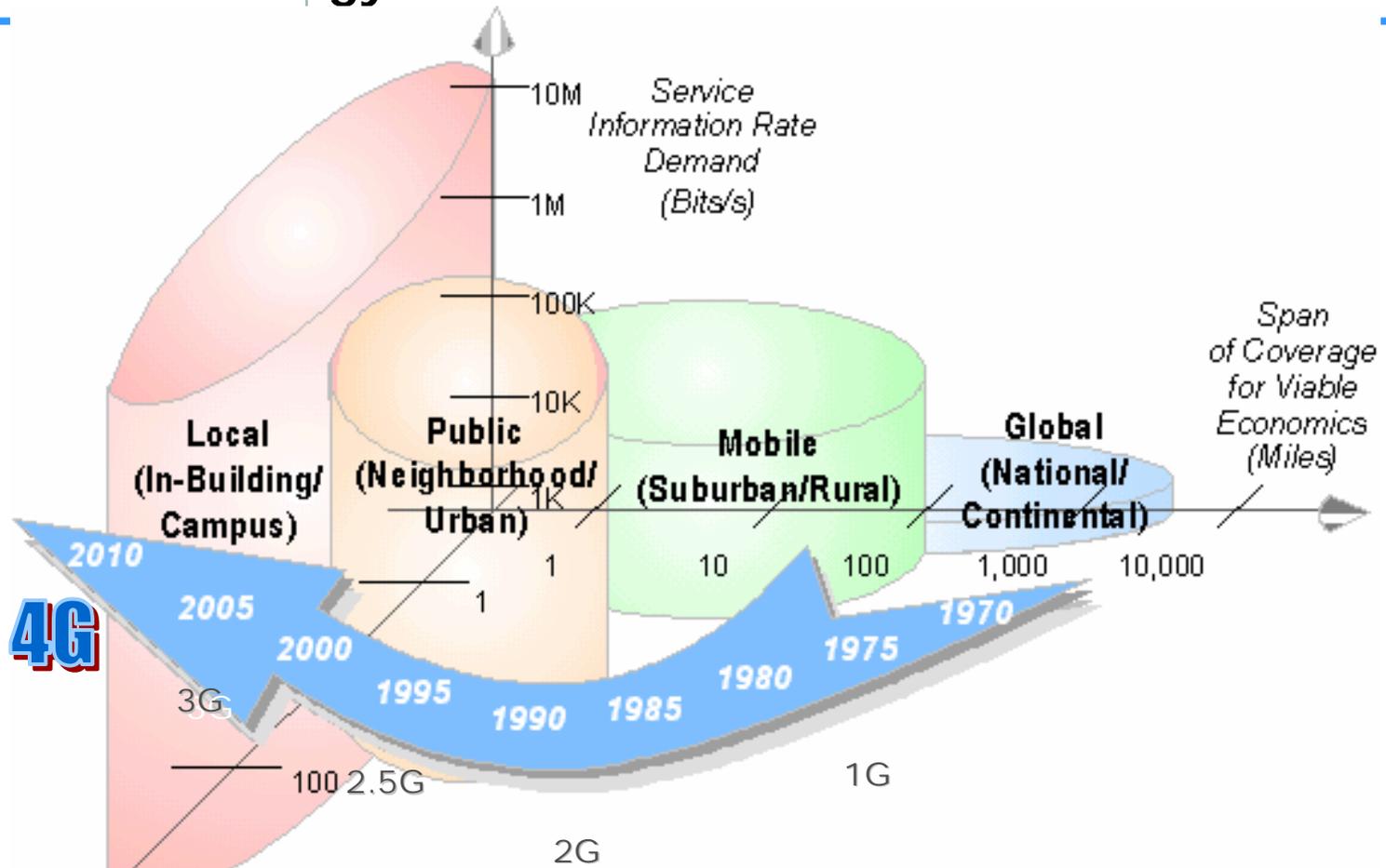
Mobile Technology Trends



- Wideband Digital PHY
- Smaller Cells
- Packet + Circuit modes
- Support of Multimedia
- Video telephony
- Digital mobile TV
- Backward Compatible to 2.5G

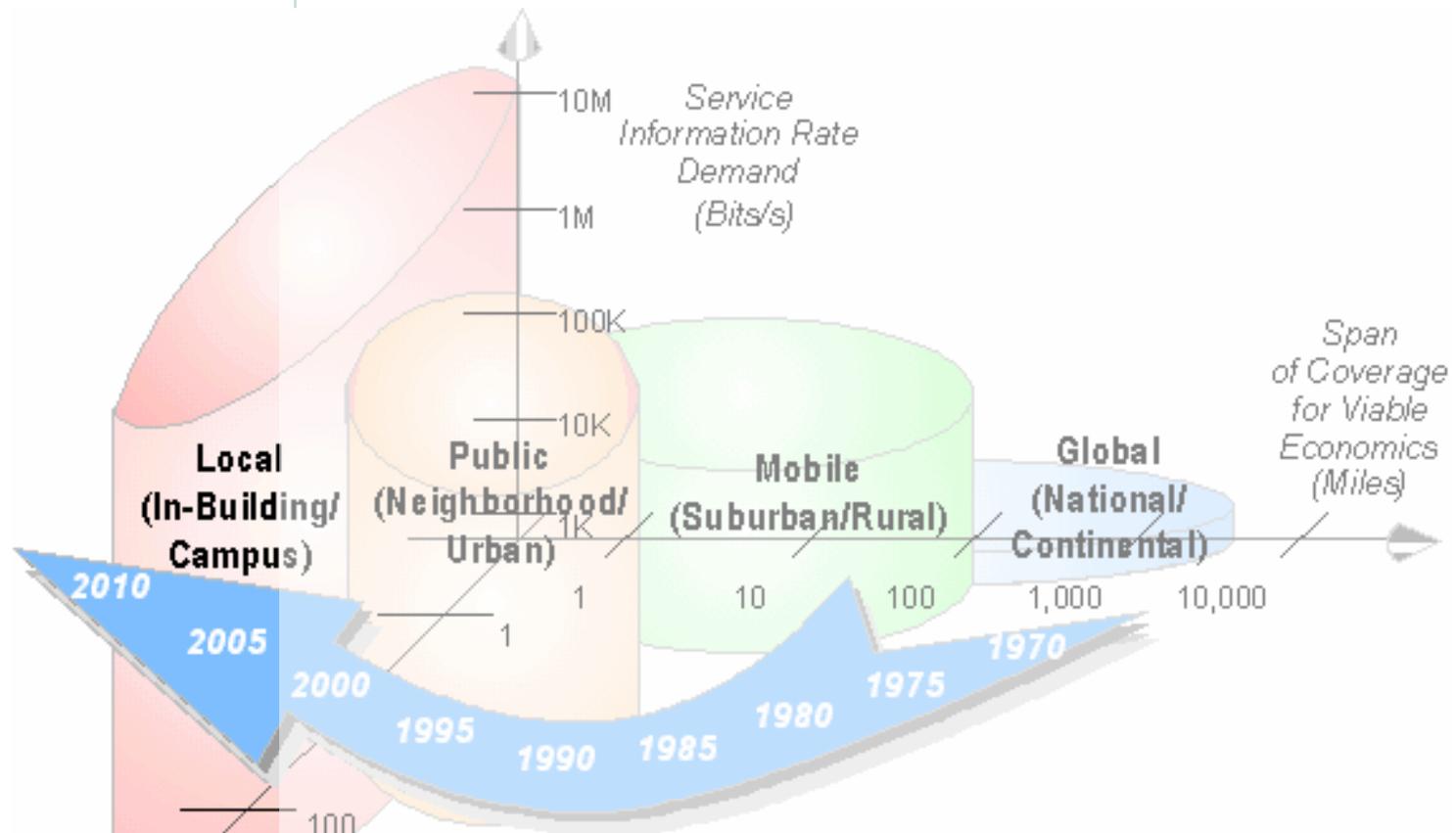


Mobile Technology Trends



- Broadband Digital PHY
- Micro & Pico cellular (?)
- Wired-Like Multimedia Speed
- Computer Network Paradigm
- Global seamless service provision

Mobile Technology Trends

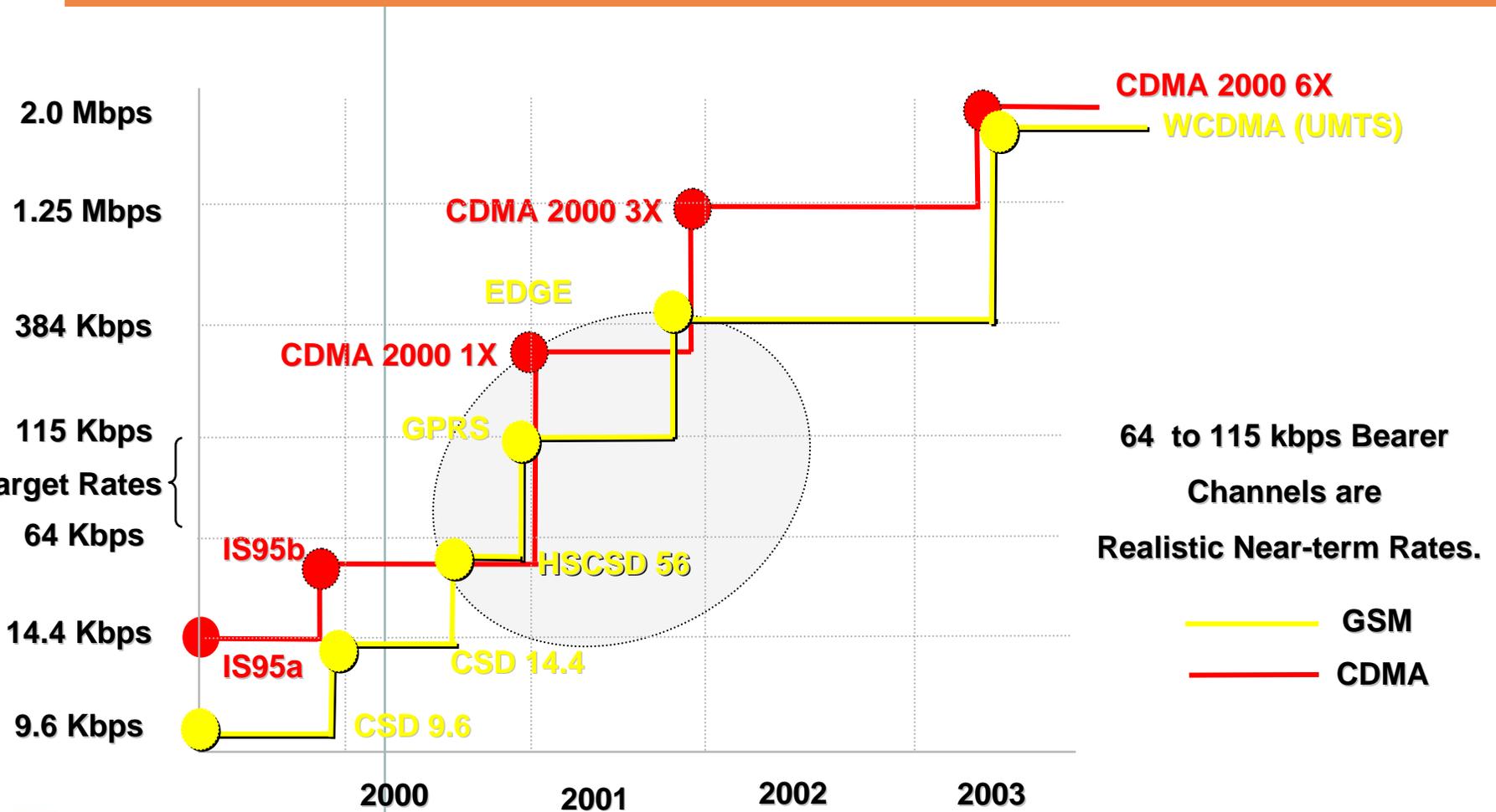


Important Migration Drivers:

- Higher Capacity /lower cost
- Better Communication Quality
- More Throughput / User



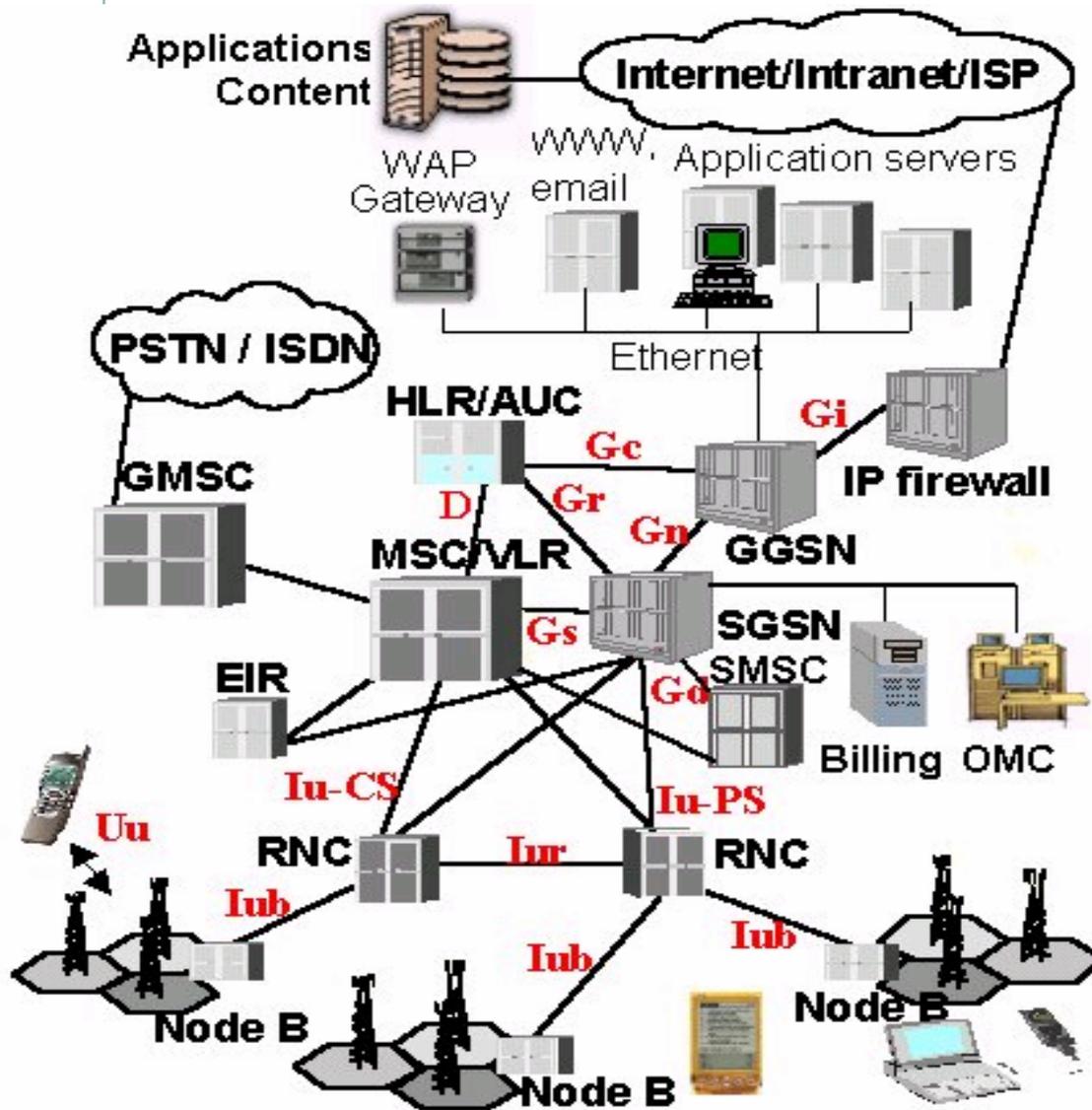
Wireless Data Evolution: towards higher data rates



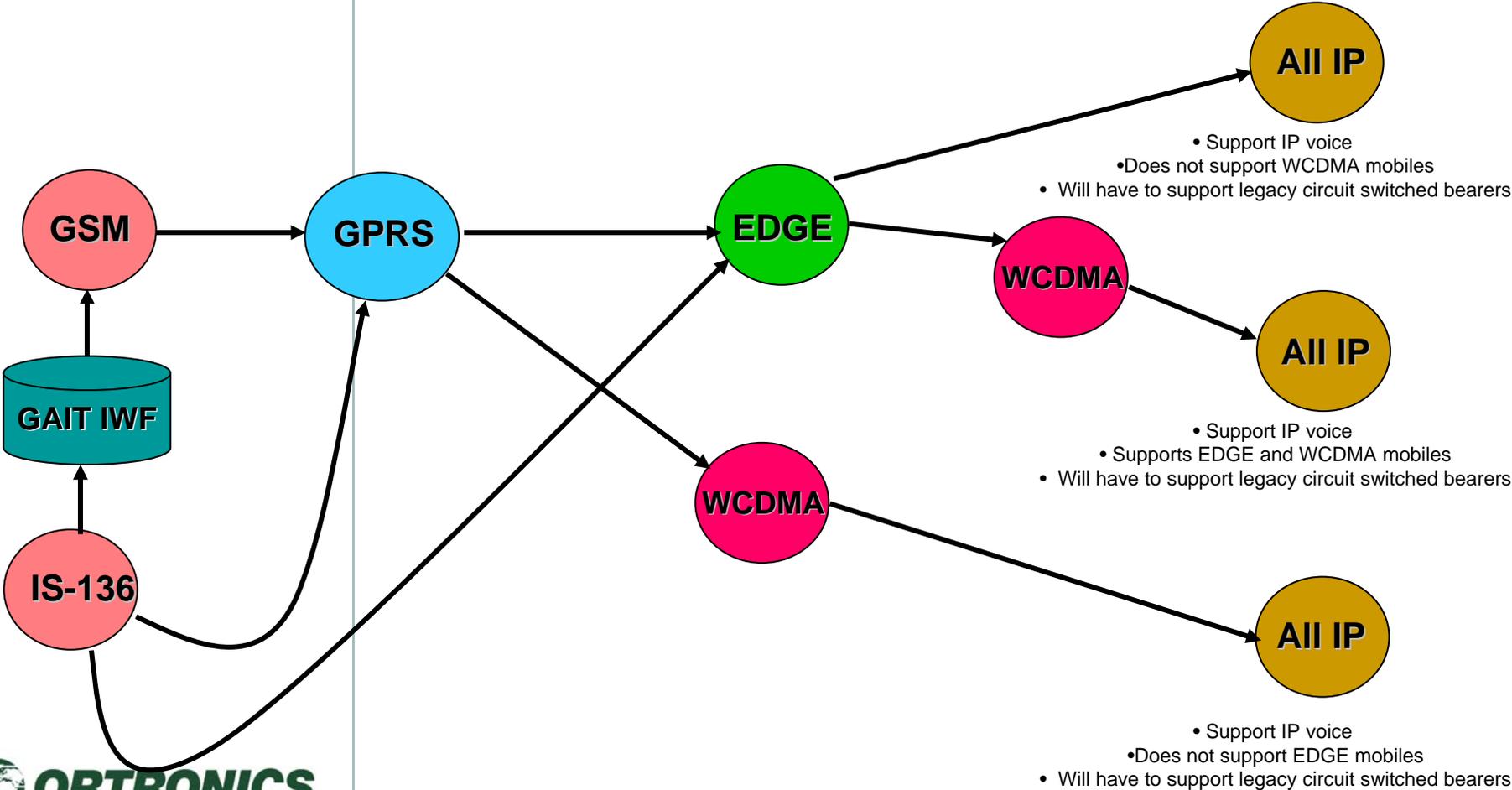
64 to 115 kbps Bearer Channels are Realistic Near-term Rates.

— GSM
— CDMA

Core Network Trend: Towards All IP

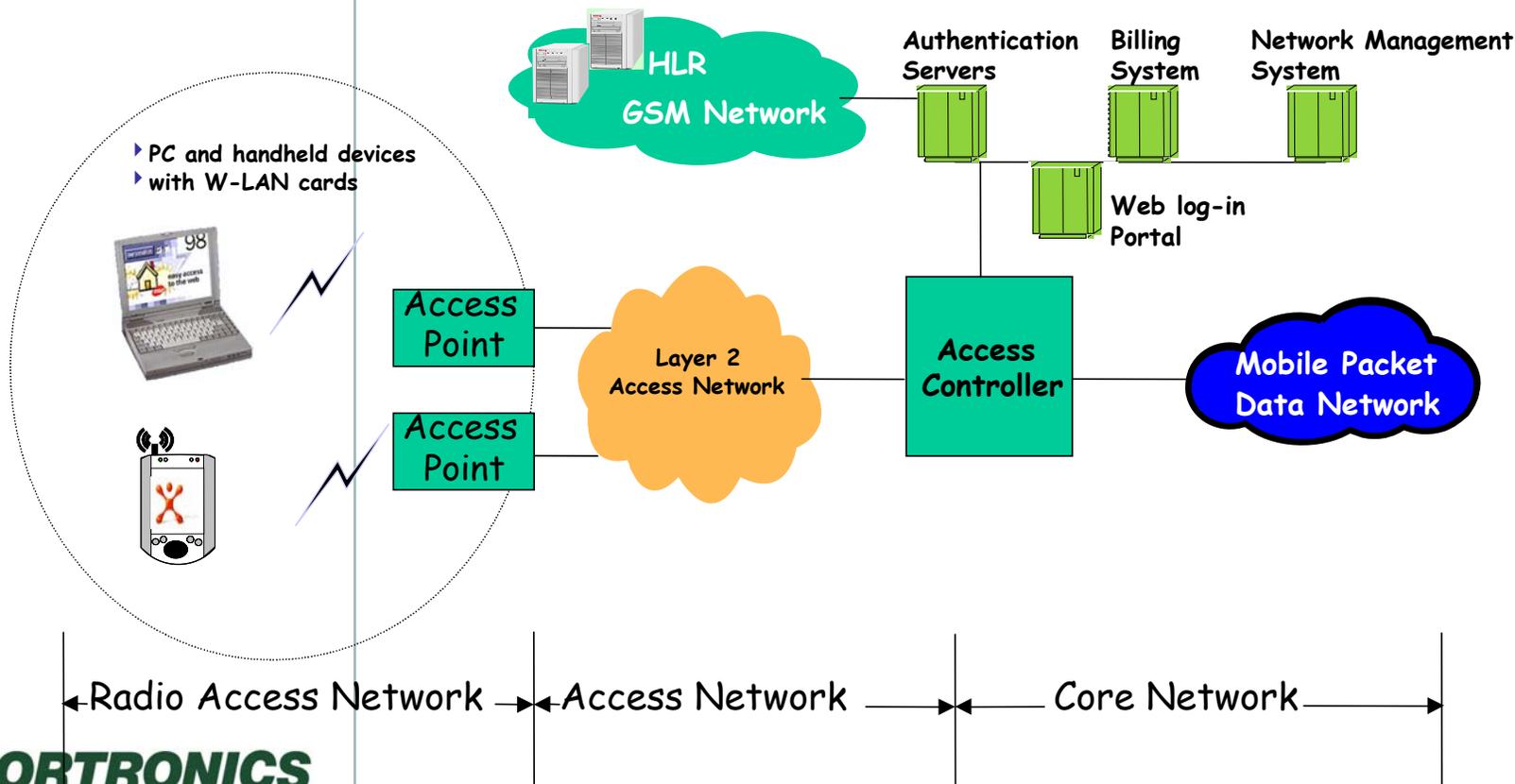


Core Technology Trend Evolution Towards all IP

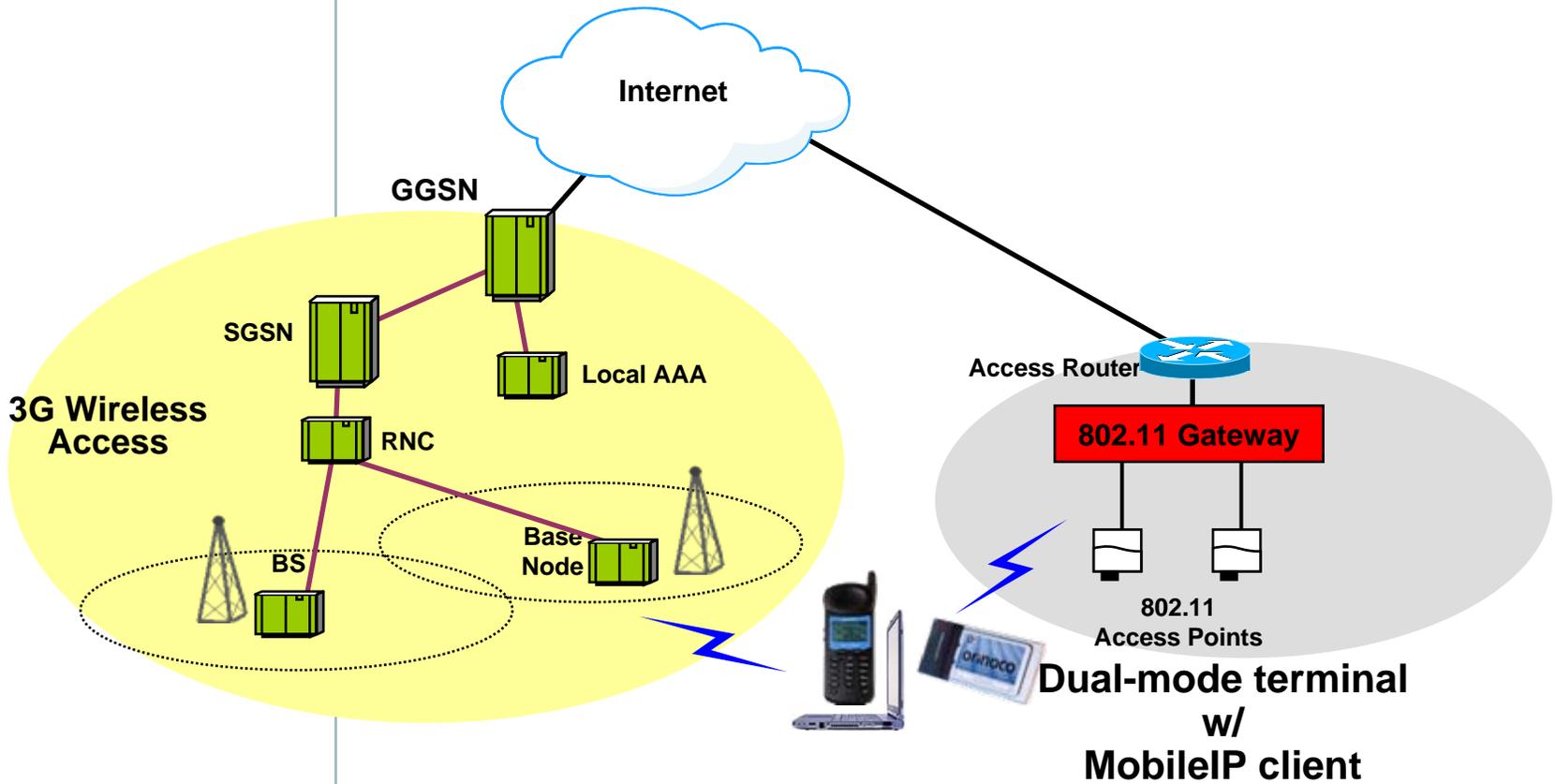


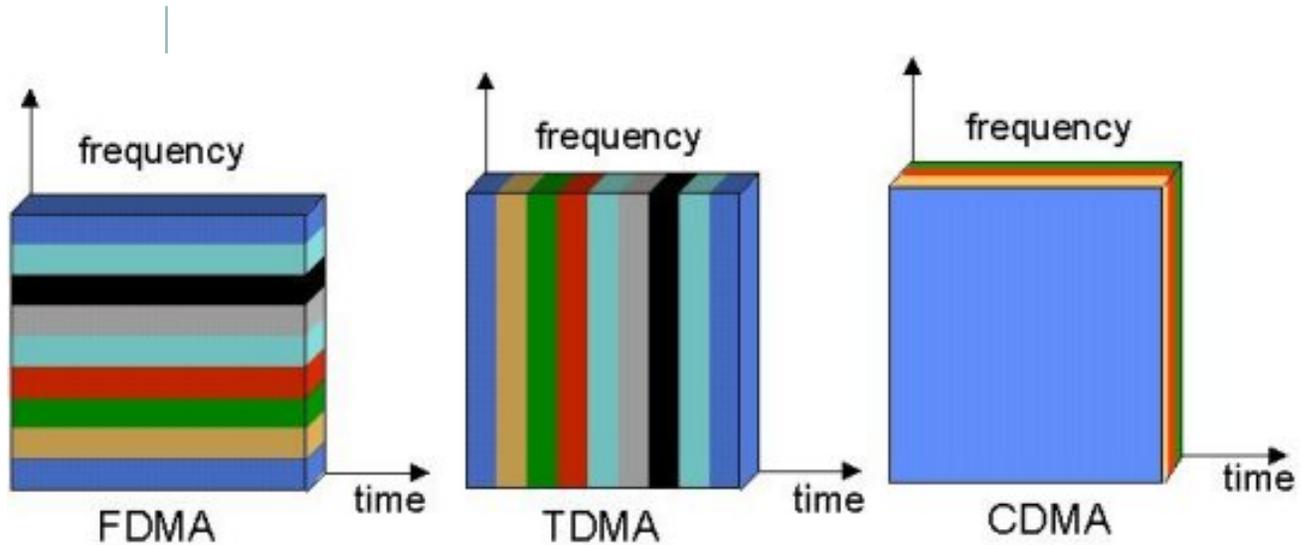
Generic Architecture

Public WLAN Hot Spot integrated with GSM trend towards more network integrations

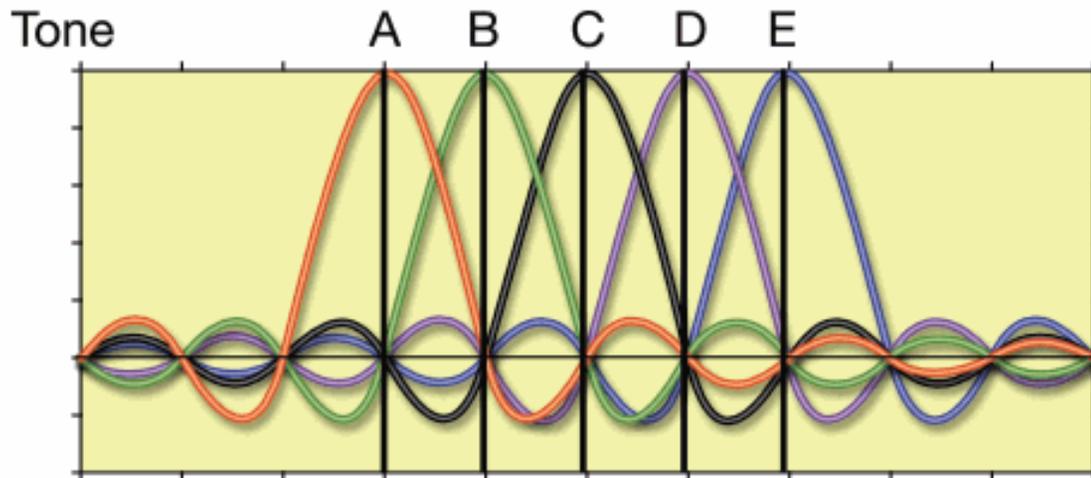


802.11/3G Integration and convergence





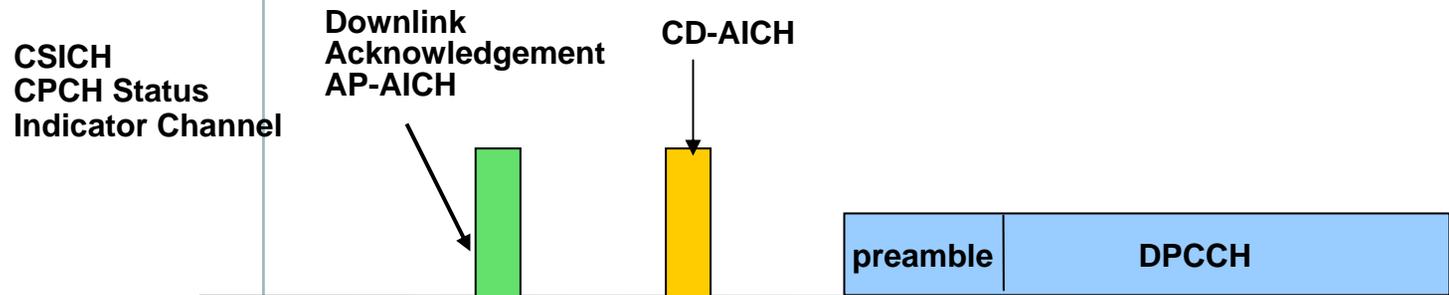
OFDM Tones



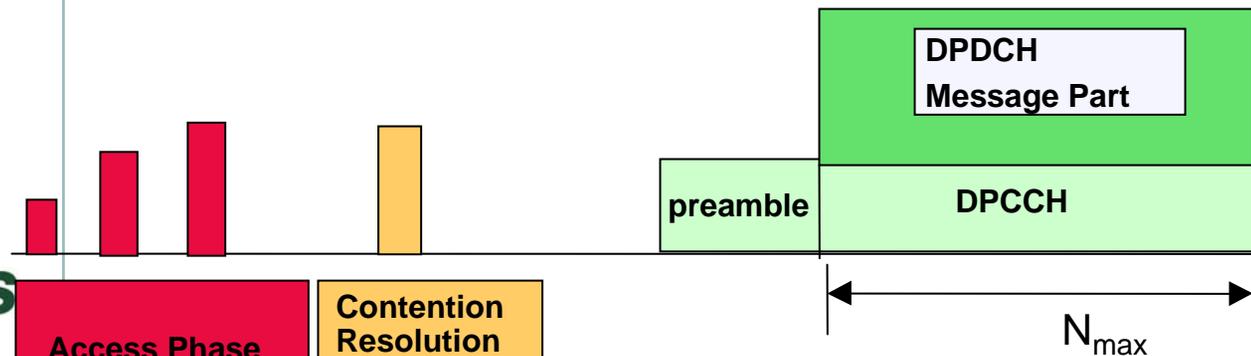
Uplink Packet Access Schemes

ALOHA, Slotted ALOHA, DSMA/CD, CSMA/CA

DOWNLINK



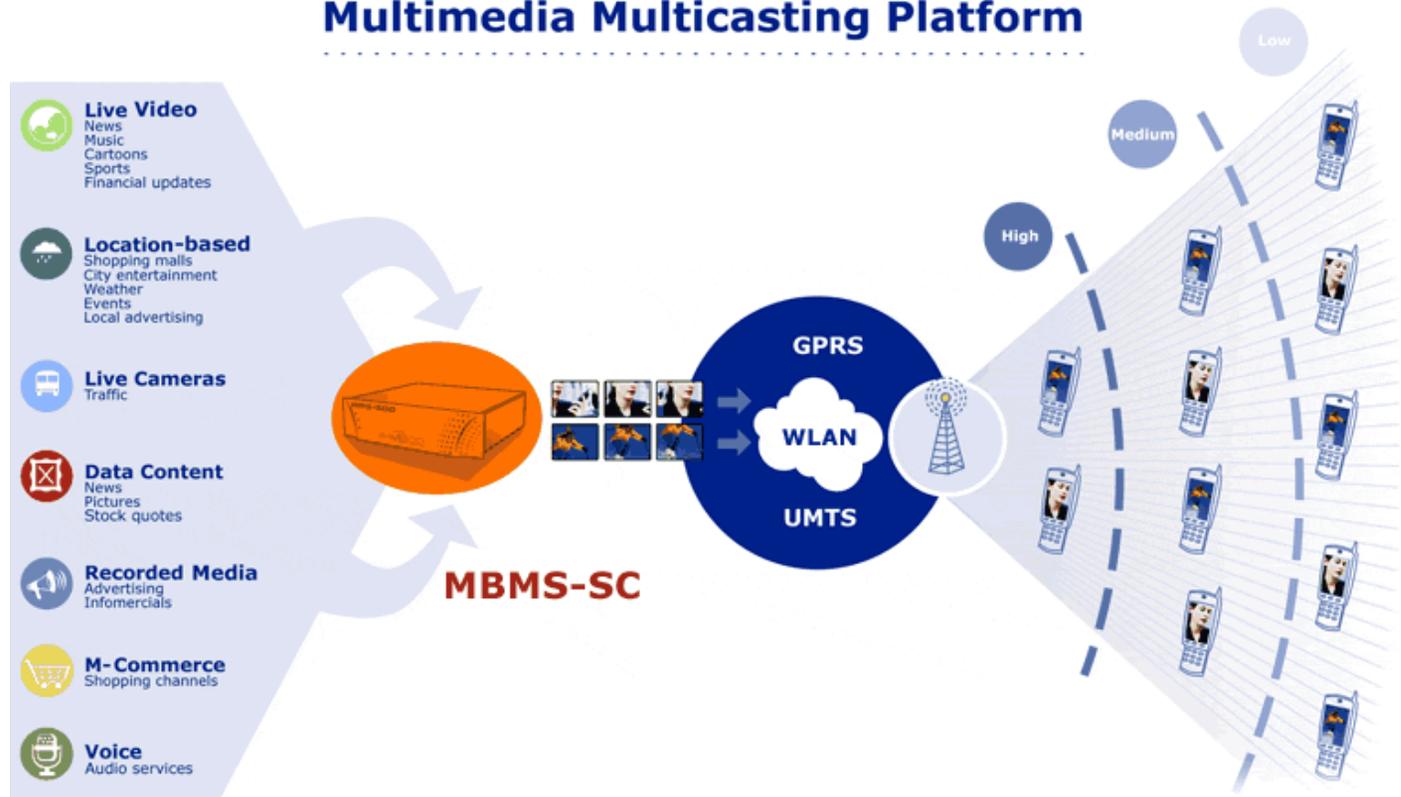
UPLINK



MBMS: Digital TV example in UMTS

Source: Bamboo

Multimedia Multicasting Platform



Evolution in Wireless Handsets



New 3G features successful 3G services

- Simultaneous voice and data
 - High data rate GPRS
 - Higher capacity compared to GPRS/EDGE
 - Less battery drain as compared to 2.5G (post optimization)
 - **Multimedia streaming**
 - **Video conferencing**
 - Computer – Video camera – TV
- Instant video messaging
 - Video telephony
 - mobile music
 - Mobile TV
 - HQ audio/video streaming
 - Online games
 - Sports News

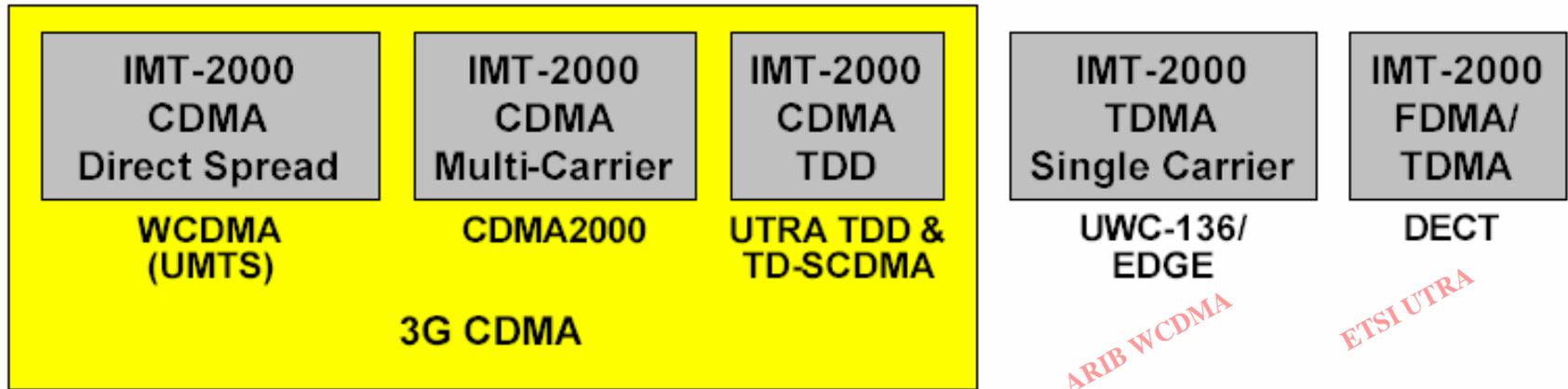
Technology innovations beyond 3G

- SDR
- MIMO
- Beam forming
- OFDMA
- Hybrid CDMA/OFDMA
- New and innovative architectures for multi-mode devices

Outline

- Telecommunication trends
- Mobile market trend
- Mobile technology trends
- Mobile standards trends
- B3G:Evolution of WLAN
- Comparison

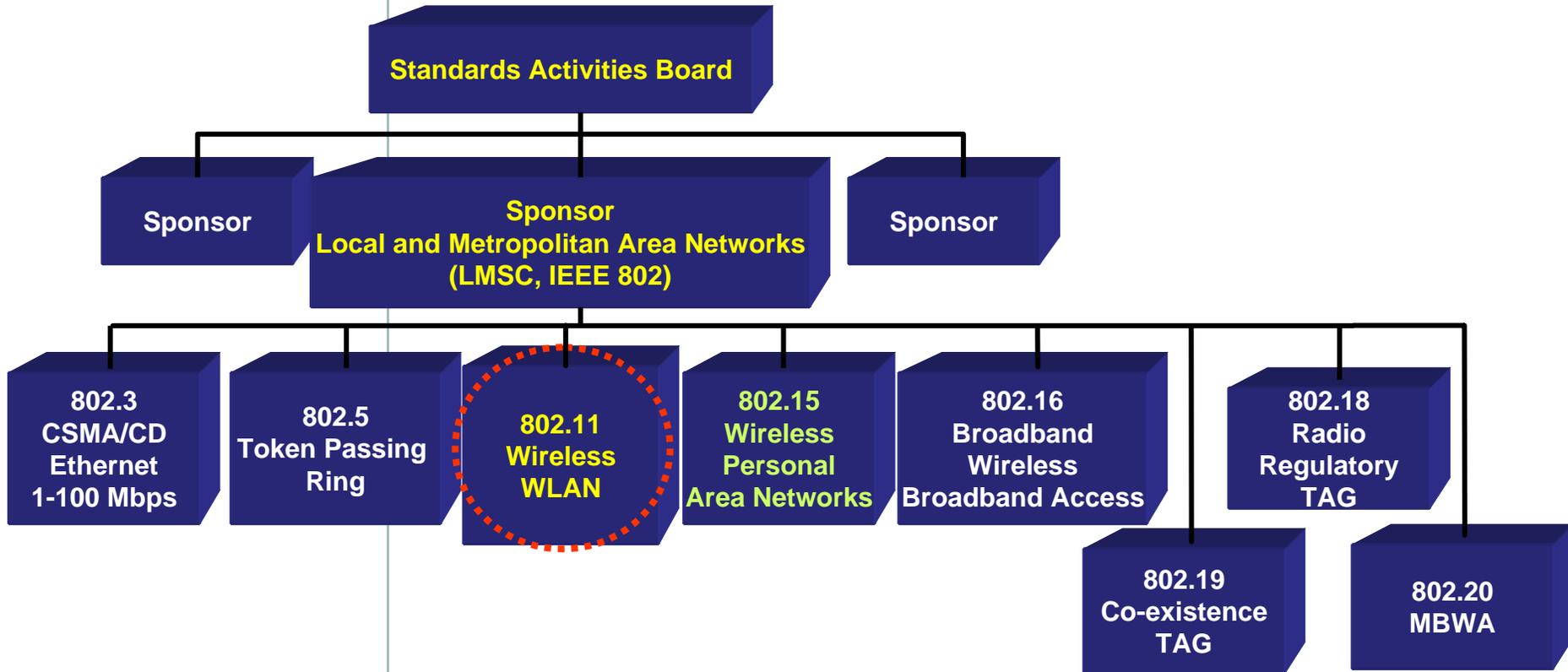
3G Standards



Although there are five terrestrial standards, most of the attention and energy in the industry has been toward the CDMA standards

802.11: Standards Organization in IEEE

IEEE Standards Association



- IEEE 802.11: ~350 Members, 250+ supporting companies
- www.ieee802.org/11

Basics of WiMAX 802.16a

- Specified for MAN
- 2-11 GHz (fixed for 3.5 GHz, 5.8 GHz, Mobile version 802.11e for 2.5 GHz)
- Broadband Wireless Access
- PHY (OFDM)
- MAC
- Jan 2003 by IEEE
- NLOS environment
- 802.16 -10-66 GHZ LOS published in April of 2002

Basics of WiMAX 802.16a

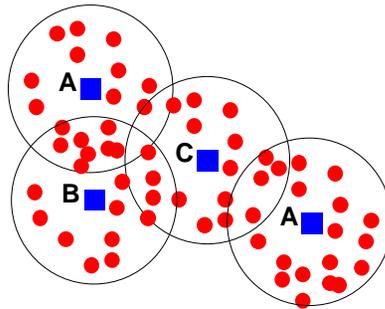
- Air interface between subscriber and base station for ranges longer than WLAN
- Backhaul for hotspot 802.11 technology
- Wireless alternative to DSL, Cable, T1
- Alternative to wire-line first mile connection to public network
- Licensed and license exempt spectrum is supported
- ETSI is using this as a standard as well

Outline

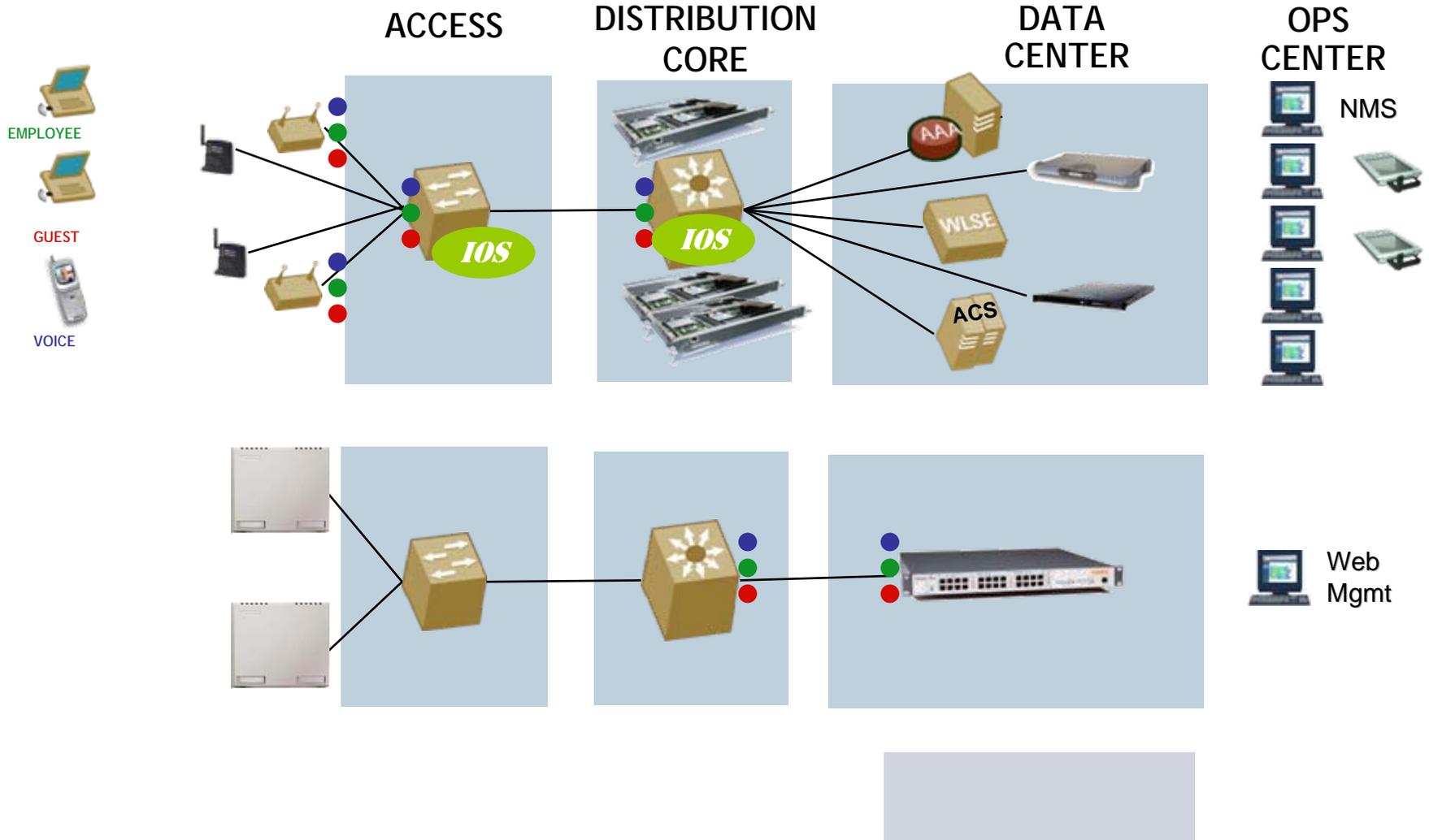
- Telecommunication trends
- Mobile market trend
- Mobile technology trends
- Mobile standards trends
- B3G: Evolution of WLAN
- Comparison

802.11: Indoor Wireless LAN Migration

- Larger User Population
- Full Roaming/Handoff Capability
- Contiguous Coverage in Dense Areas
- Wider Area Coverage for Community LANs
- Mix of Async and Isochronous Traffic
- Higher System Utilization
- Enhanced Security



Centralized versus de-centralized approaches in dense WLAN deployments



Complete Integrated Solution

Access Points



Site Survey



Packet capture



Air Monitors



WiFi IDS / IPS



POE Switches



WLAN Switches



Captive Portal



VPN Concentrator



LAN-speed Firewall



Router/QoS Devices



Multiple Management Systems



=Upgrades, Integration



Wireless Controllers and Thin APs



An Integrated, Total Solution

More Secure

More Functional

Easier To Manage

Easier To Deploy

Easier To Grow/Scale

Lower Cost

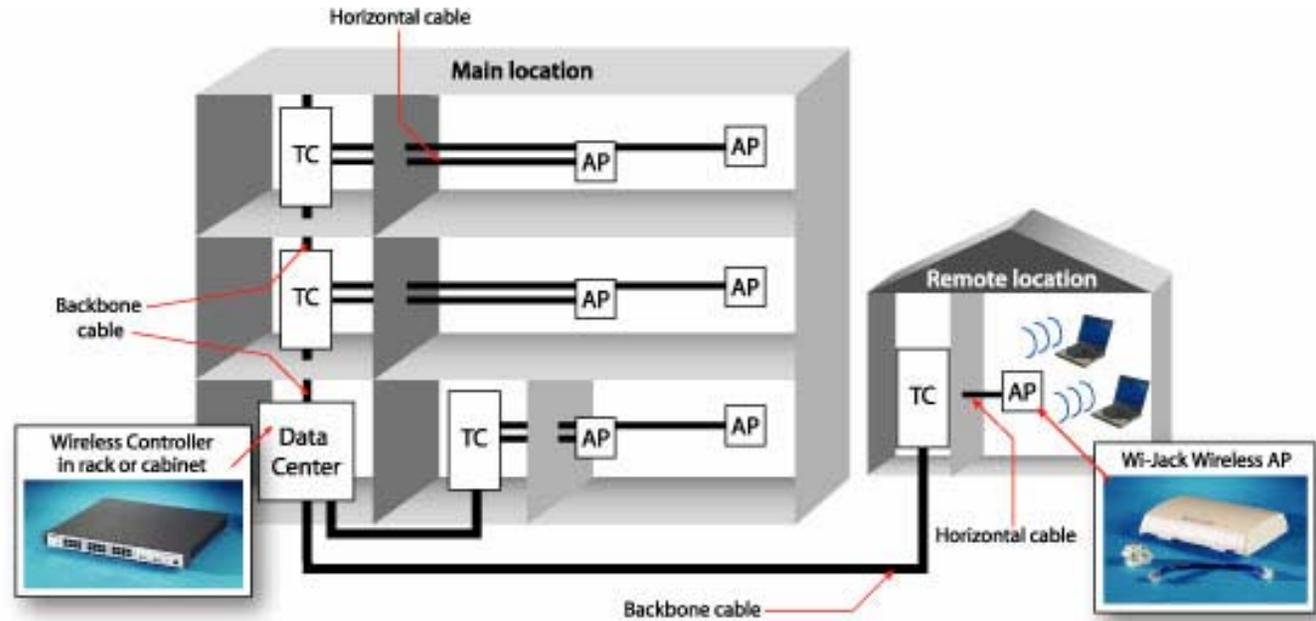
The Old Generation: Fat APs

- The first generation Wi-Fi architecture
- Network intelligence built into the AP
- Each AP individually maintained and monitored
- Ideal for small deployments (5 APs or less)
- Difficult to manage as additional APs are added
- Stolen or hacked Fat AP is a security risk
- No RF management
- No load balancing

Thin APs: Ease of Management

- Intelligence resides in Wireless Controller
- Single, centralized point of management
- Reduced cost
- Advanced RF management
- AP power provided over Ethernet
- Built-in security, VPN, firewall and other advanced features

Thin AP: compatible to existing infrastructure seamless wired/wireless integration



*No change to the existing
wired infrastructure*



Elements of the evolution

- Centralized architecture // lower cost
- Seamless wire line /wireless integration
 - Seamless service provision
- Isochronous services over the wireless IP network
- High level of integration in the architecture
- Dense deployment for very high traffic density and Erlang /square mile
- Concept of community LAN

Outline

- Telecommunication trends
- Mobile market trend
- Mobile technology trends
- Mobile standards trends
- B3G:Evolution of WLAN
- Comparison

Bearer speed comparison chart

Technology	Maximum theoretical rate	Peak rates	Measured device speed
GPRS	170 kbps	114 kbps 114/4 kbps	20-40 kbps
EDGE	470 kbps	384 kbps 384/4 kbps	100-130 kbps
1xRTT	307 kbps	153 kbps 153 kbps	40-60 kbps
EV-DO	2.4 Mbps	2.4 mbps	300-500 kbps
UMTS	2 Mbps	2 Mbps 960 kbps	220-330 kbps
UMTS/HSDPA	14 Mbps	14 Mbps	550-1100 kbps
WiMax	70 Mbps	?	few Mbps per user
WiFi	54 Mbps 100+ Mbps	30 Mbps	20-30 Mbps

Which technology will win?

- What is the key determining factor?
 - Technology superiority
 - Upgrade cost
 - Global roaming – GSM/GPRS
 - Mobile power consumption
 - Economy of scale – GSM/ GPRS
- The mainstream technology will be the winner since it will have the economy of scale.

Cost comparisons

- WCDMA cost efficiency is rooted in higher capacity as compared to GSM: x3
- WCDMA is also more cost efficient than EVDO 1x by a factor of 2.
- UMTS has surpassed CDMA2000 and is enjoying a strong global momentum.
- It is claimed that WiMax is more cost effective than HSDPA and 1x EVDO

WiFi versus WAN wireless data such as HSDPA

- WiFi will be mostly used by business travelers and users for higher data volumes. Heavy downloads are possible here and it will directly cut into the indoor user segment of 3G. WiFi is a great candidate for home networking and fixed broadband wireless access.
- WAN will be mostly used for MMS, streaming and more balanced kind of traffic. Mostly interactive and more time sensitive.

WiFi versus HSDPA

- The winning card for WiFi is the low cost and ease of use and installation.
- Many can become a public WiFi operator.
- Unlicensed band introduces challenges for WiFi and as such limits its ability to cut into the fully mobile and wide area arena
- Only big operators will be the 3G operators. The cost of deployment will be extremely high.

WiMAX versus HSDPA/EVDO?

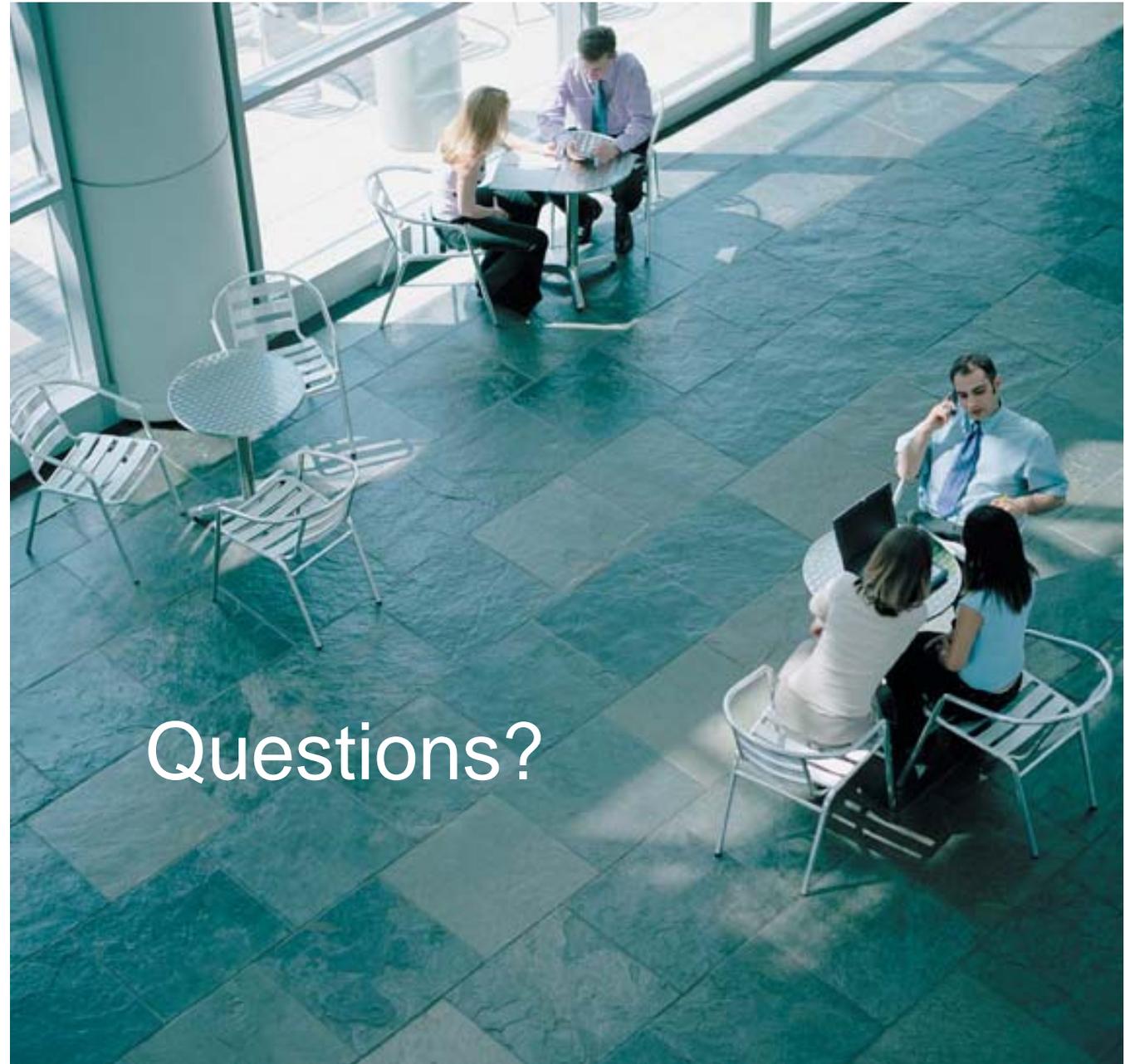
- Competitive nature
- GSM operators will probably go towards HSDPA in the short run.
 - Employment of new technology with new core network require higher capital investment
- WCDMA versus OFDMA
- OFDMA as an access is not proven and fielded yet.
- If WiMax proves to have significantly less cost to deploy, it may turn into a disruptive technology for the growth of 3.5G and become a significant player in the Wireless WAN space.
- WiMax offers much higher speeds as compared to HSDPA or EVDO. WiMax's speed matches the next generation or version of UMTS under study.
- Spectrum issue for WiMax
- Uplink technical issues for OFDMA

WiMax versus WiFi

- Complementary relationship
- WiFi covers LANs whereas WiMax covers WANs.
- WiFi serves the highly dense areas with small cells with high data rate requirements (54 Mbps now and 100+ Mbps with 802.11n)
- WiMax will be much more costly than the WiFi equipment due to complexity and economy of scale.

Beyond 3G

- Evolution towards all IP
- Mobile IP
- Higher speeds beyond 100 Mbps
- Multi-mode devices
- SDR
- MIMO, beam forming
- New air interface multiple access
 - Downlink: OFDMA
 - Uplink: WCDMA or OFDMA?
 - Uplink: 802.11-like random access
- Spectrum issue
- Seamless service provision
- Micro cell, Pico cell, Nano cell or all



Questions?