

Wireless and Mobile Communication Networks

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What is the Interest in Wireless

- **Mobility:** users want to access their E-mail, voicemail, etc., while they are moving “anywhere”.
- **Installation speed and simplicity:** no need to pull cables through walls and ceilings.
- **Installation flexibility:** Wireless technology can go where wire cannot go.
- **Productivity:** gained of using handheld terminals, PDAs and laptops
- **Scalability:** The network topology can be changed very easily to meet the needs of specific applications.

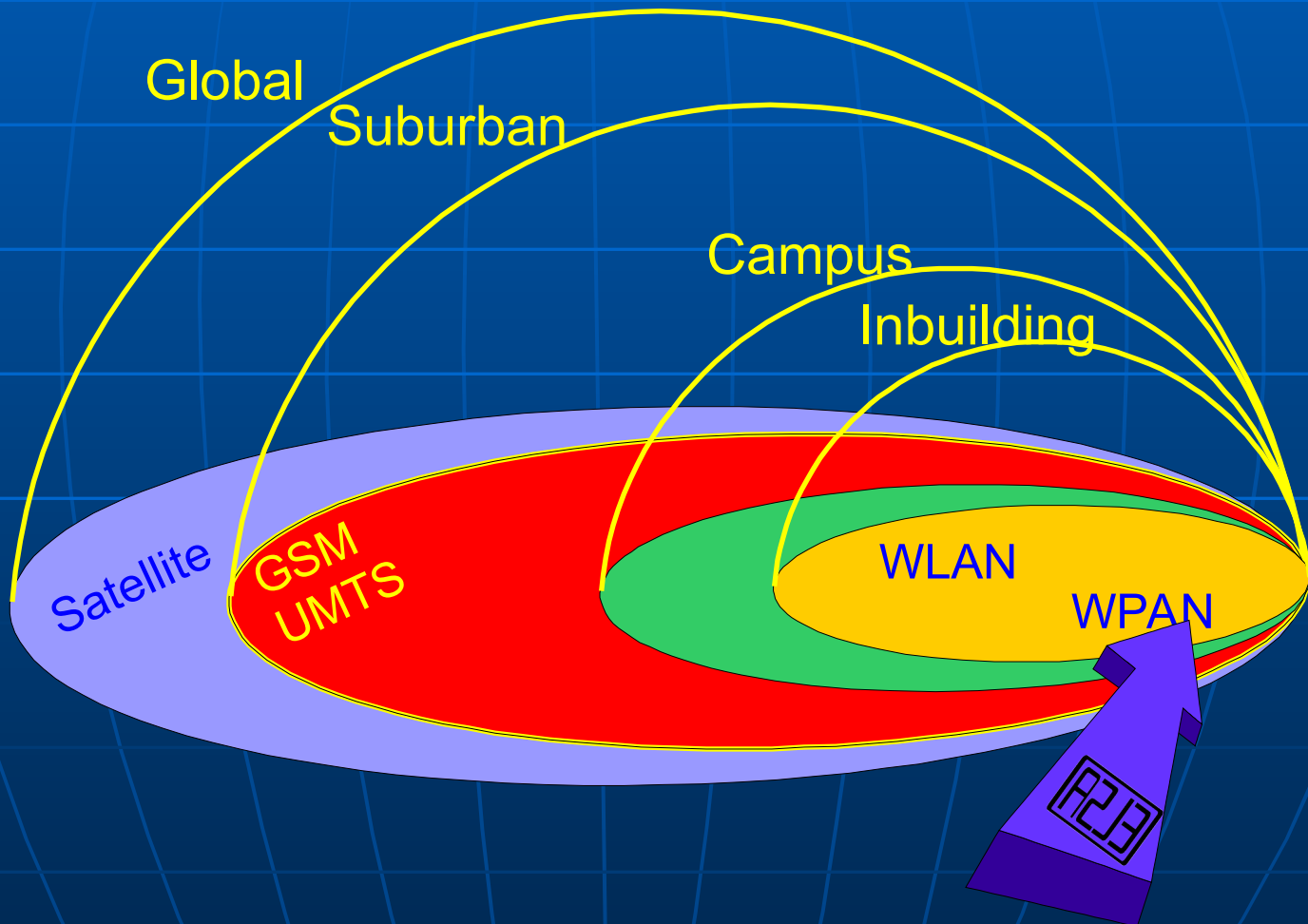
Wireless Networks Overview

- **Wireless technology standards differentiated by:**
 - Bandwidth
 - Geography
 - Supported hardware
 - Switching method
- **Two types of data transmission**
 - Circuit Switched
 - Takes over a voice channel to transmit and receive data, keeping a phone line open during the entire session
 - Packet Switched
 - Compresses data and sends short data bursts between conversations or during gaps in conversations on the voice channels

Wireless – PANs, LANs, and WANs

- **PAN – Personal Area Network**
 - Bluetooth – High-bandwidth/short-range cable replacement
 - Synchronization between devices
- **LAN – Local Area Network**
 - Home RF – Consumer focused
 - Internet connection and file sharing
 - 802.11b – 802.11a - 802.11g – Enterprise class
 - Connecting notebooks to corporate networks
- **WAN – Wide Area Network**
 - Mobile Phone and PDA voice/data connectivity.

Enabling Technologies at a Glance



A Brief Introduction to Bluetooth

Bluetooth: Lose the Cable!



The Obligatory Bluetooth Question



Where Does the Name Come From?

- Ericsson, the principal inventor, borrowed the name from Danish King Harald Bluetooth
 - Who is credited with uniting the Scandinavian people during the 10th century.
- Seemed like a good name for uniting many dissimilar devices from different manufacturers

What is Bluetooth?

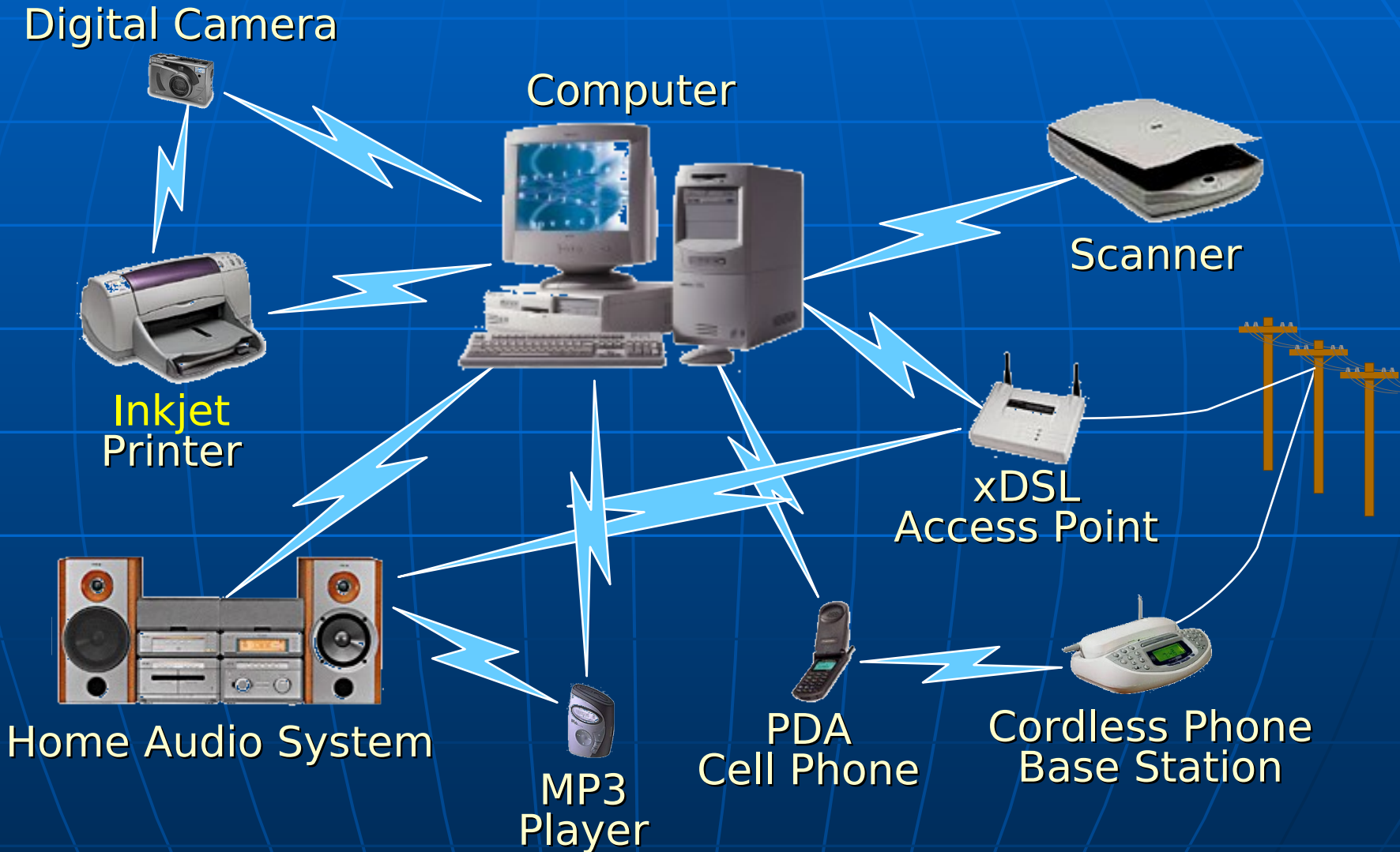
A world without wires

- Eliminates the need for numerous cable attachments for connecting computers, mobile phones and other peripherals.
- Inexpensive, Short-range wireless capability to replace cable and wires that connects portable and/or fixed devices.
- Bluetooth operates in a globally available unlicensed ISM radio band 2.4GHz.
- Requires low power which is well suited to handheld devices.
- Supports for both voice and data
- IEEE Standard through 802.15 (PAN)



Bluetooth in the Home

No Wires

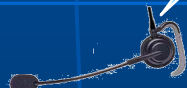


And On the Road

Car Audio System



PDA
Cell Phone



Headset



MP3
Player



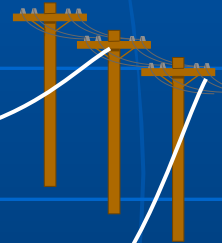
Laptop



Pay Phone
& Access Point



Hotel Phone
& Access Point



Bluetooth Products

Computers Peripheral connectivity

- Keyboard/mouse/remote
- Printer
- Scanners
- PDAs
- Broadband access points
 - Ethernet/xDSL/cable
 - Packet radio cellular phones
- Video projectors

Telephone devices

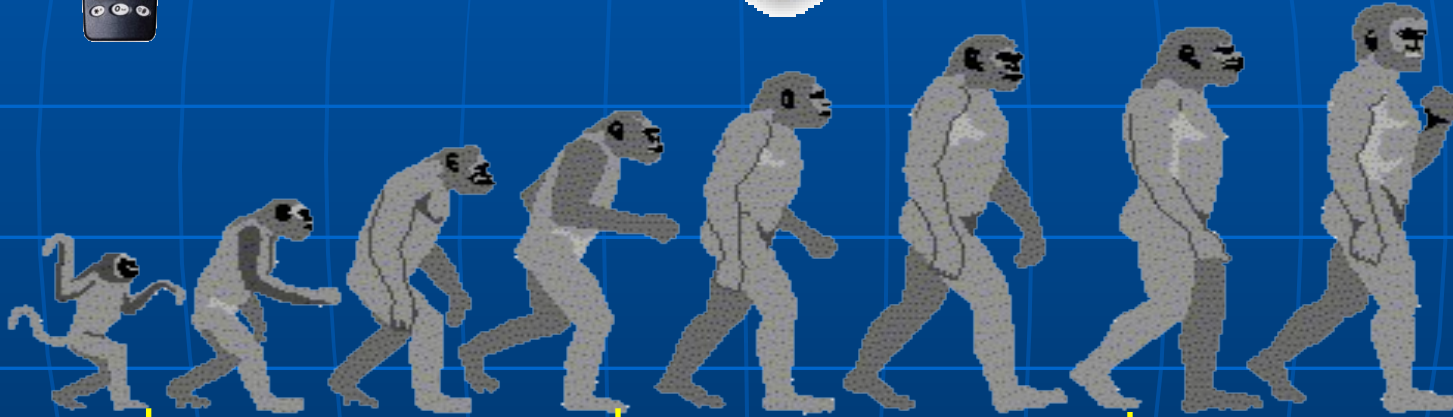
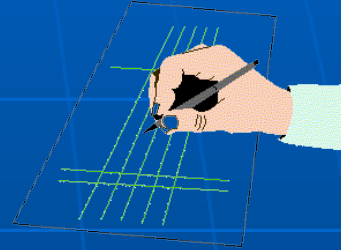
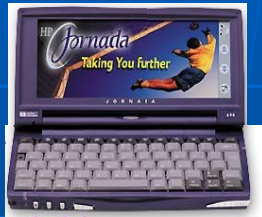
- Cellular handsets
- Wireless headsets
- PSTN access points
 - Payphones
 - Hotel/home phones
- Digital cameras
- MP3 audio players
- Home audio systems

Bluetooth Power

- Bluetooth supports three different power options.

Class	Range	Power	Power
Class I	50 - 100 meters	100 mW	7 dBm or higher
Class II	30 meters	2.5 mW	4 dBm
Class III	10 meters	1 mW	0 dBm

Really Personal Communications

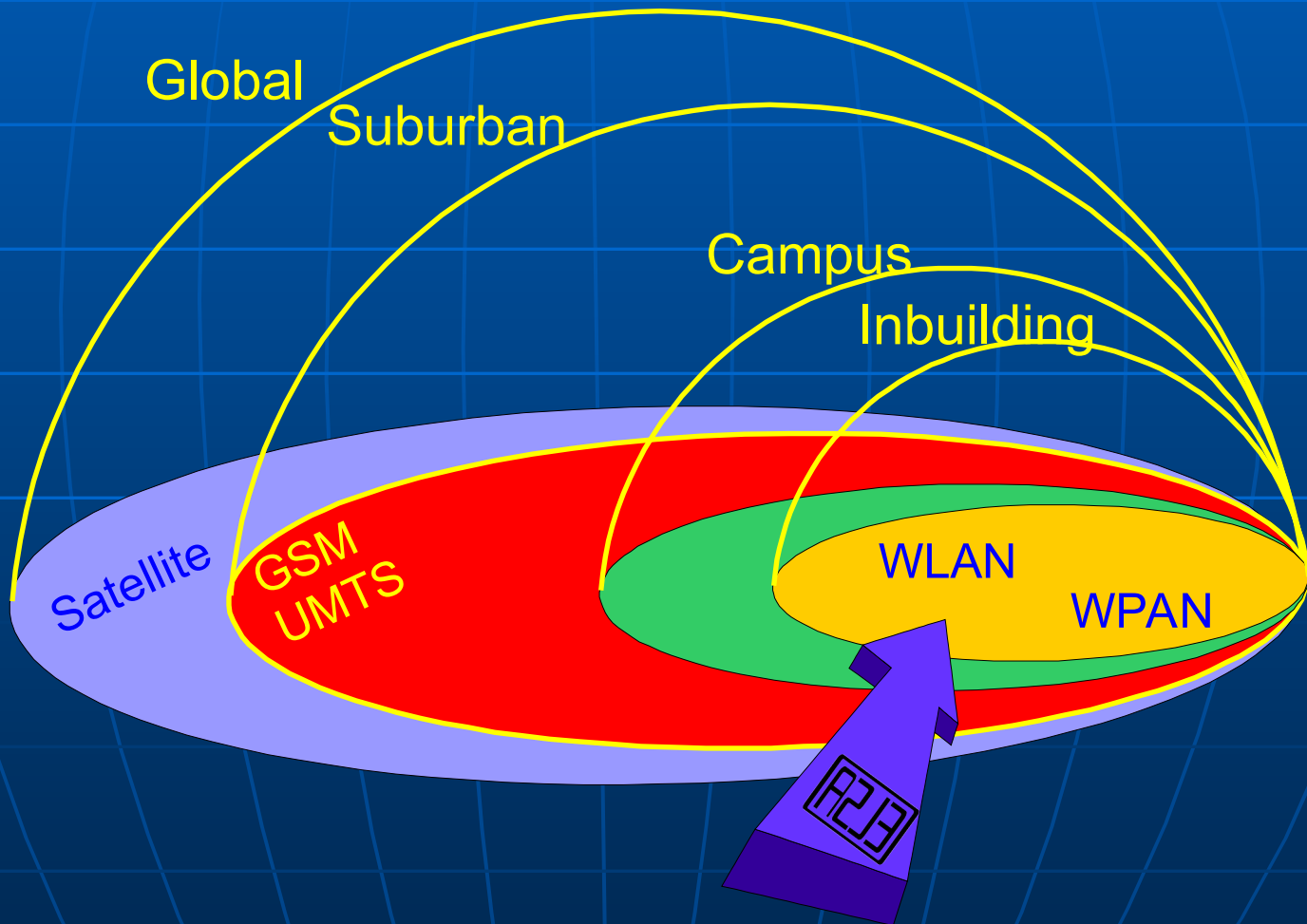


2001 Bluetooth:
1 Mbps

2003 Bluetooth 2:
At least 2 Mbps

2006 UWB:
20 Mbps

Enabling Technologies at a Glance



Wireless LANs

- Provide users with wireless connectivity to an enterprise or corporate network.
- They seamlessly provide the business user a connection to the Internet and to access data.
- Worldwide wireless LAN hardware revenue totaled \$1.68 billion in 2002, hitting \$455.4 million in 4Q02, according to Infonetics Research's quarterly worldwide market share and forecast service, Wireless LAN Hardware revenue is expected to reach \$2.72 billion in 2006.

WLAN Standardization

- There are two popular WLAN technologies in the market:
 - In USA (IEEE 802.11) .
It is an IEEE standard that defines the specifications for WLANs.
 - IEEE 802.11a: based on OFDM technology.
 - IEEE 802.11b: based on CSMA/CD technology.
 - IEEE 802.11g: Similar to 802.11a features with added 802.11b compatibility.
 - In Europe (HiperLAN) based on OFDM technology.

IEEE 802.11g

- Achieve full compatibility with IEEE 802.11b which is widely used.
- Still under development.
- Final version expected to appear in the middle of 2003.
- The technology doesn't wait for standard bodies and companies have already started to ship equipment based on draft version of 802.11g.

Comparison between IEEE Standards

	802.11a/g	802.11b
Frequency Band	5.0 GHz	2.4 GHz
Speed	54 Mbps	11 Mbps
Distance Coverage	Up to 20 m	Up to 100 m
Number of AP required in each direction	Every 15m	Every 60m
Cost	Expensive	Cheaper

When should we use IEEE 802.11a/g?

- For bandwidth hungry applications like streaming video.
- For end users who are densely populated: computer Labs, airports

HiperLAN

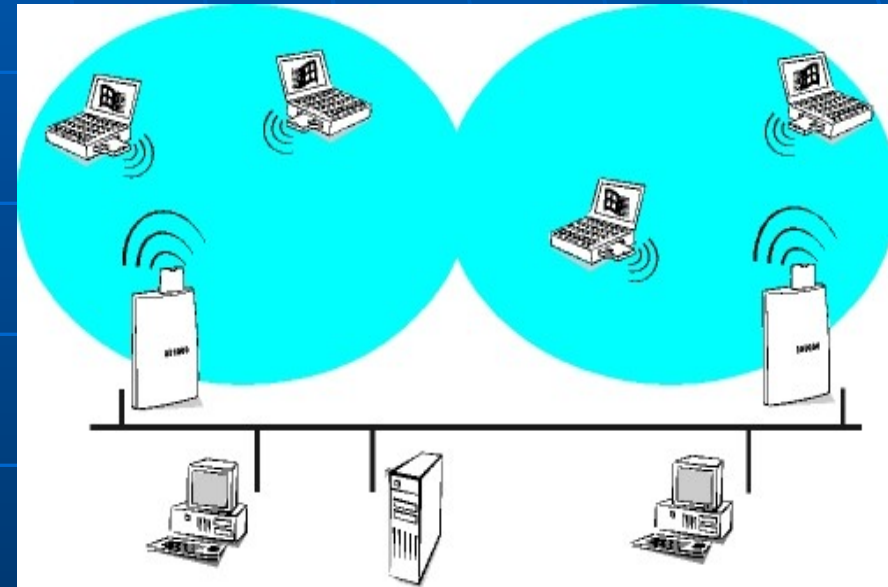
- The current version of HiperLAN is HiperLAN2 based on ETSI standard.
 - Operates at 5 GHz frequency band.
 - Provides high speed of 54 Mbps.
 - Offers QoS for Voice and Video applications.

Wireless LAN Applications

- LAN Extension
- Cross-Building Interconnection
- Ad Hoc Networks

LAN Extension

- Infrastructure network where the Wireless AP provides the connectivity to wireless terminals within the coverage area.
- Saves the cost of the installation of LAN cabling
- Eases the task of relocation and other modifications to network architecture.
- Offers roaming capabilities by using more than one AP.

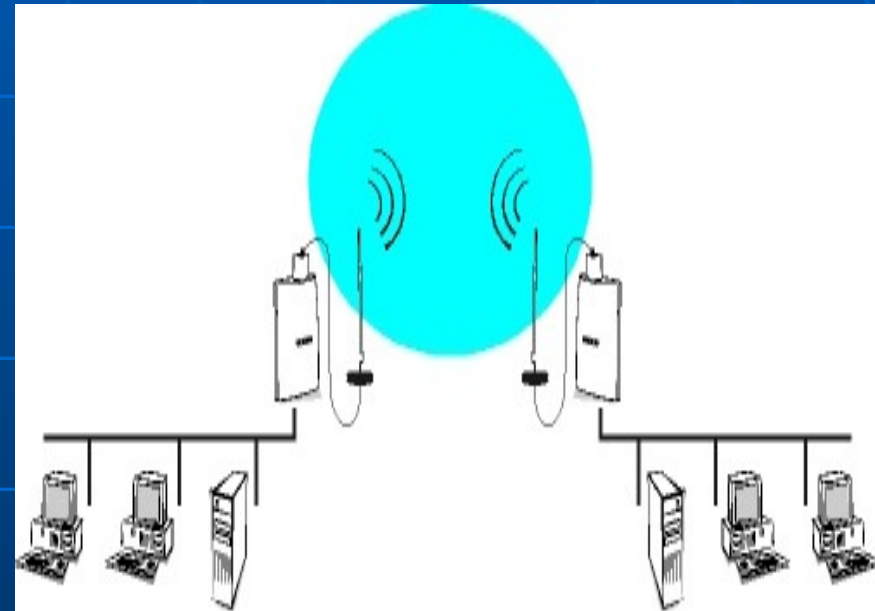


WLAN Application

- Building with large open areas such as manufacturing plants, stock exchange trading floors, and warehouses.
- Historical buildings with insufficient twisted pair and where drilling holes for new wiring is prohibited
- Small offices where installation and maintenance of wired LANs is not economical

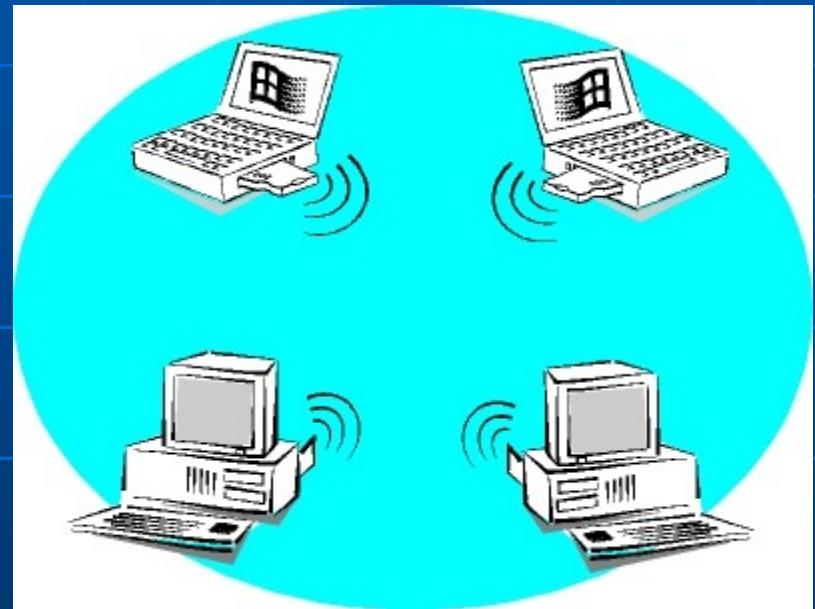
Cross-Building Interconnect

- WLAN connects existing LANs in nearby buildings, by using Point-to-Point wireless link.
- It is used where cable connections are not possible, e.g across street.

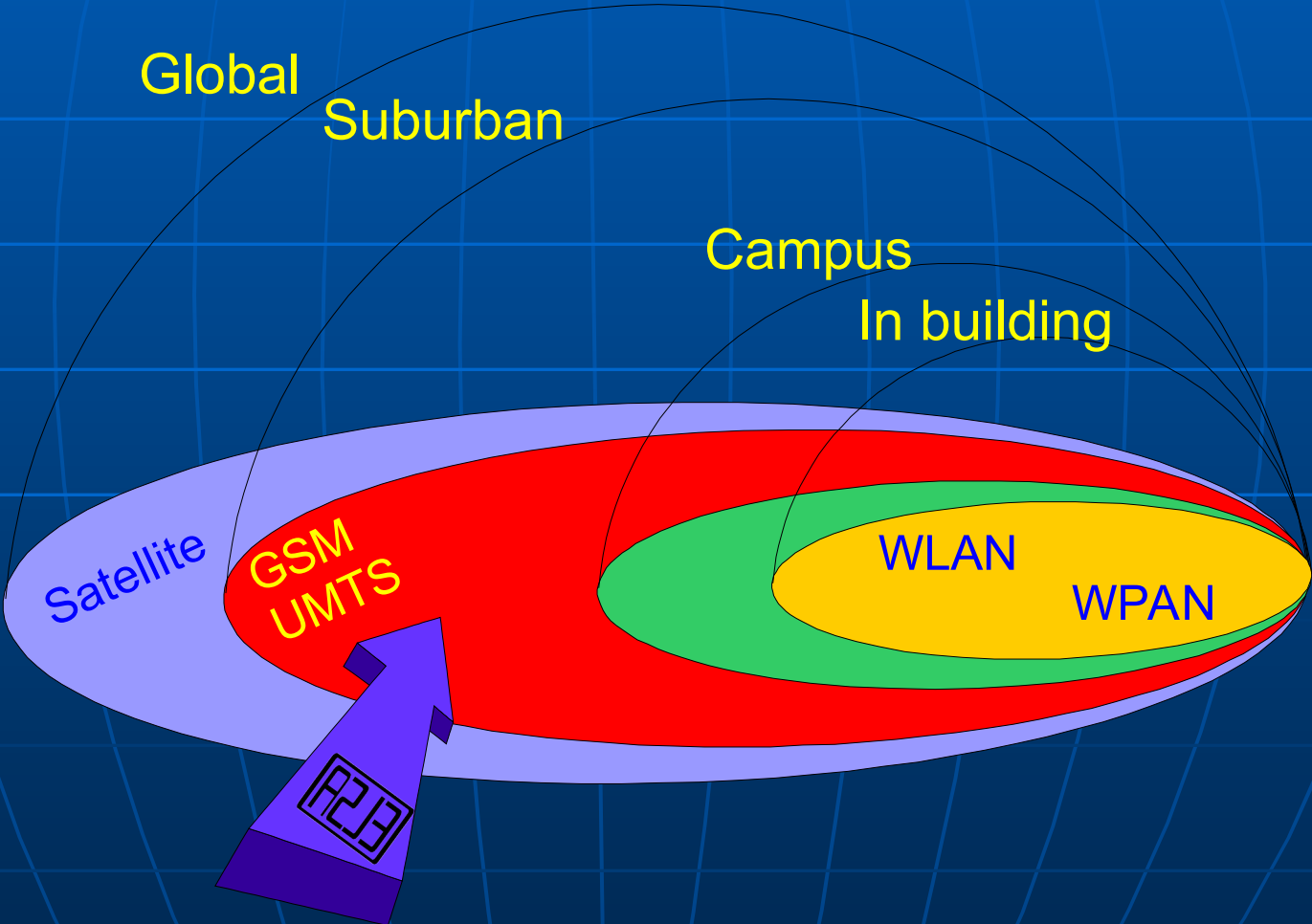


Ad Hoc Network

- A wireless standalone network, and isn't connected to any infrastructure network..
- No centralized server.
- Used for temporary business meeting where all employees can connect each other.



Enabling Technologies at a Glance



Mobile Network Systems

Overview

- Wireless telephones come in two basic varieties:
 - Cordless phones (Never used in networking)
 - Mobile phones (widely used for voice and data communication)
- Mobile phones have gone through three distinct generations, with different technologies:
 - Analog voice.
 - Digital voice.
 - Digital voice and data (Internet, e-mail, etc).

Mobile Network Generations

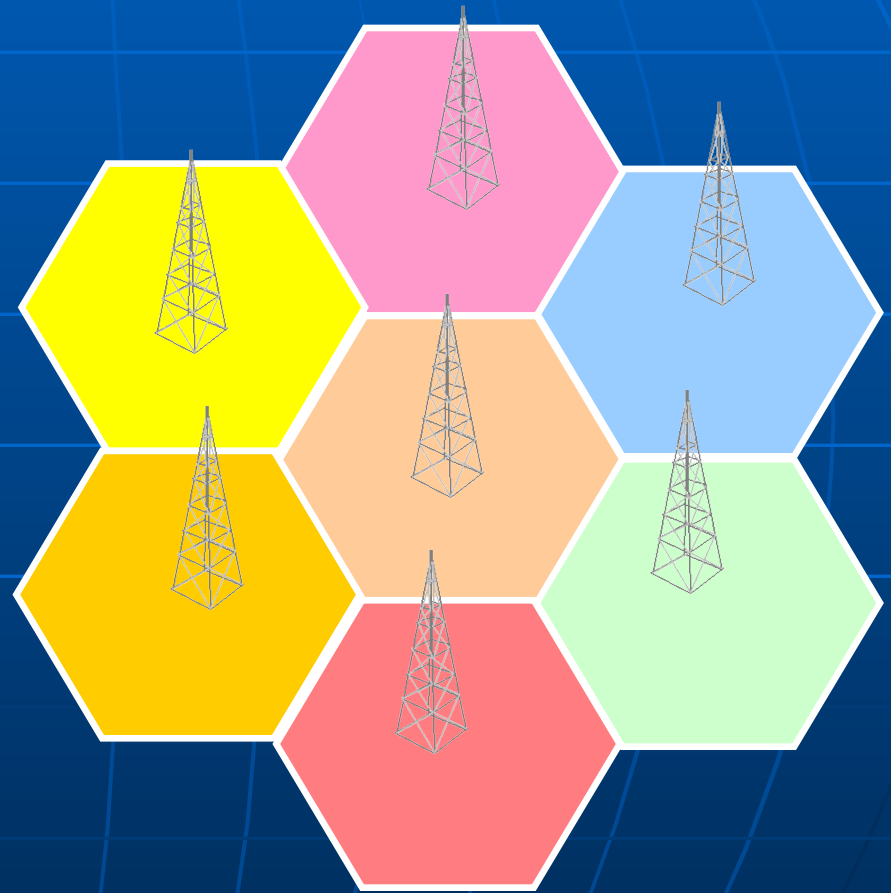
- First Generation (1G) mobile systems were designed to offer an analogue single service, i.e., speech.
- Second Generation (2G) mobile systems were also designed primarily to offer speech with a limited capability to offer data at low rates.
- Third Generation (3G) mobile systems are expected to offer services that have traditionally been provided by fixed networks, including wideband services (e.g. high-quality multimedia services).

First Generation Mobile Phones(1G)

- In 1946, the first system for a car-based telephones was set up in St. Louis.
 - This system uses a large single transmitter on a top of tall building with single channel.
- In the 1960s, IMTS (**Improved Mobile Telephone System**) was installed.
 - This system too uses high powered transmitter on top of a hill, with two frequencies.
- In 1982, The cellular network revolution was started, the Advanced Mobile Phone System (AMPS) was invented and first installed in the USA

First Generation Mobile Phones(1G) Cont.

- In AMPS, the geographic region is divided up into **Cells**, that is why we are call them cell phones.
- In AMPS a Cellular radio technique was developed to increase the capacity available for mobile radio telephone service.
- Cells are typically 10 to 20 Km.
- Each cell uses a set of frequencies not used by any of its neighbors.
- The cells are same size and normally roughly circular, but they are easier to be modeled as hexagonal.



First Generation Mobile Phones(1G) Cont.

- They are grouped in units of seven cells. Each color indicates a group of frequencies.
- Adjacent cells are assigned different frequencies to avoid interference or crosstalk.
- Because of the limited bandwidth resources, the same frequency have to be reused in other nearby cells.



Second Generation mobile Phones

- The Second generation is digital.
- 4 systems are being used to 2G: D-AMPS, GSM, CDMA (IS-95), and PDC.
 - D-AMPS: Digital Advanced Mobile Phone system. Is widely used in the USA and in the modified form in Japan.
 - PDC is used only in Japan, which is basically D-AMPS modified for backward compatibility with 1G.
 - GSM: The Global System for Mobile Communication, is used everywhere else in the world.
 - CDMA: Code Division Multiple Access, which is works completely different from the above mentioned systems, it is considered the best technical solution around, it is widely used in USA.

Third Generation Mobile Networks

3G is referred to as Universal Mobile Telecommunications System (UMTS) in Europe and International Mobile Telecommunications 2000 (IMT2000) worldwide.

The basic services that 3G network supposed to provide:

- High quality voice.
- Messaging
- Multimedia.
- Internet access.

Third Generation Mobile Networks

- In 1992, ITU tried to get 3G to reality and they issued IMT-2000. the number 2000 stood for 3 things:
 1. The year it supposed to go,
 2. The frequency it supposed to operate at,
 3. The bandwidth the service should have.
- Non of the above was implemented by 2000.

Third Generation Mobile Networks

- 3G may be a bit less than originally hoped for and a bit late, but surely happen.
- In Europe, W-CDMA was proposed by Ericsson, it has been designed to interwork with GSM, they call it UMTS.
- IN USA, CDMA2000, proposed by Qualcomm, it is an extension to IS-95 and backward compatible, but it has been designed to interwork with GSM.
- The trouble is that the real problem is not engineering, but politics!
- While waiting for the fighting over 3G to stop, some operators are taking a cautious small step in the direction of 3G by going to 2.5G.

First Step Toward 3G

2.5G

- A fact that no other wireless voice and data technology will threaten GSM's dominance in Europe through 2005.
- The wireless system in widespread use today goes by the name of 2.5G-an "in between".
- Technology to converge mobile communications and the Internet
- Utilizes packet-switched functionality and delivers speeds above 100Kbps with continuous Internet connection for mobile phones and computer users.
- Leads to way to 3G technology

First Step Toward 3G

2.5G

- 2.5G technology is identified as being fueled by General Packet Radio Services (GPRS) along with GSM.
- GPRS technology is based on existing GSM infrastructure.
- GPRS services launched in mid-2001 with speed around 14 Kbps to 28 Kbps ; these have doubled by the last half of 2002.

Evolution Of Mobile Data

2G

Wireless access to existing applications

- ◆ E-mail
- ◆ Messaging
- ◆ PIM tools
- ◆ Simple information services (sports, news, weather)

2.5G

New wireless-specific applications

- ◆ Location-based
 - ◆ Interactive city guides
 - ◆ Proximate people finders
 - ◆ Instant coupons/promotions and push advertising
- ◆ Personalized
 - ◆ Ability to control contacts based on phone state and location
 - ◆ Phone as wallet/ATM card
- ◆ Always connected
 - ◆ Pushed calendar updates
 - ◆ Perishable information

3G

Innovative applications that exploit added bandwidth

- ◆ Rich media Web browsing via wireless-enabled PC or tablet PC
- ◆ Streaming audio and video
 - ◆ Camera phones
 - ◆ MP3 players
- ◆ Real-time, multi-player games

Today

Enabling factors developed in parallel

- ◆ Security and Privacy
- ◆ Coverage and capacity
- ◆ Data roaming
- ◆ Data hosting/storage

3G Products

- The first Sony Ericsson handset, named Z1010 will be out on the market in the second half of 2003.
- It is dual mode UMTS/GSM-GPRS phone.
- Sony Ericsson also released its first EDGE products, GC82 EDGE PC card for dual band 859/1900 MHz, which provides up to 3 times faster than GPRS.

Challenges – Wireless Network Choices

**Big Leos
(Satellite)**

**Little Leos
(Satellite)**

**Teledesic
(Satellite)**

**Iridium
(Satellite)**

**3G Networks
(Multiple)**

**AMPS/CDPD
Cellular**

Nextel

**AMPS
Cellular**

GSM-PCS

**CDMA/AMPS
Cellular**

TDMA-PCS

**Wireless
LANs**

**TDMA/AMPS
Cellular**

CDMA-PCS

Metricom

**Personal
Wireless
Network**

**PageMart
Two-Way**

**SkyTel
Two-Way**

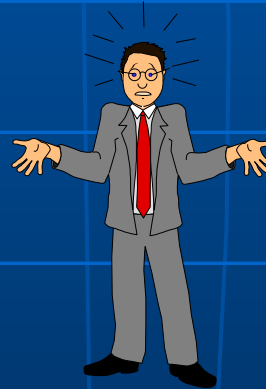
**PageNet
Voice Paging**

**One-Way
Paging
(multiple)**

**BSWD
Mobile Data**

**ARDIS/
AMSC**

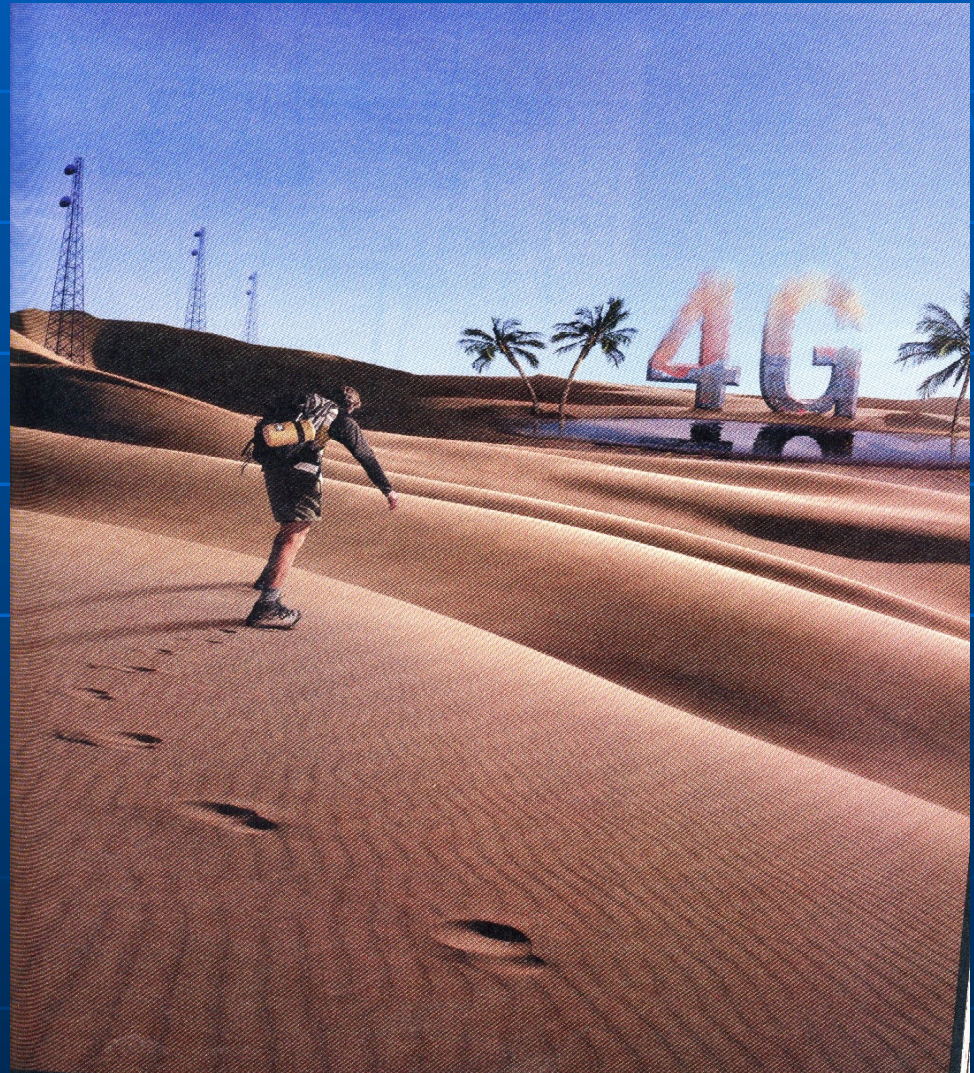
**PCSI
Voice Paging**



Beyond 3G

■ Towards 4G

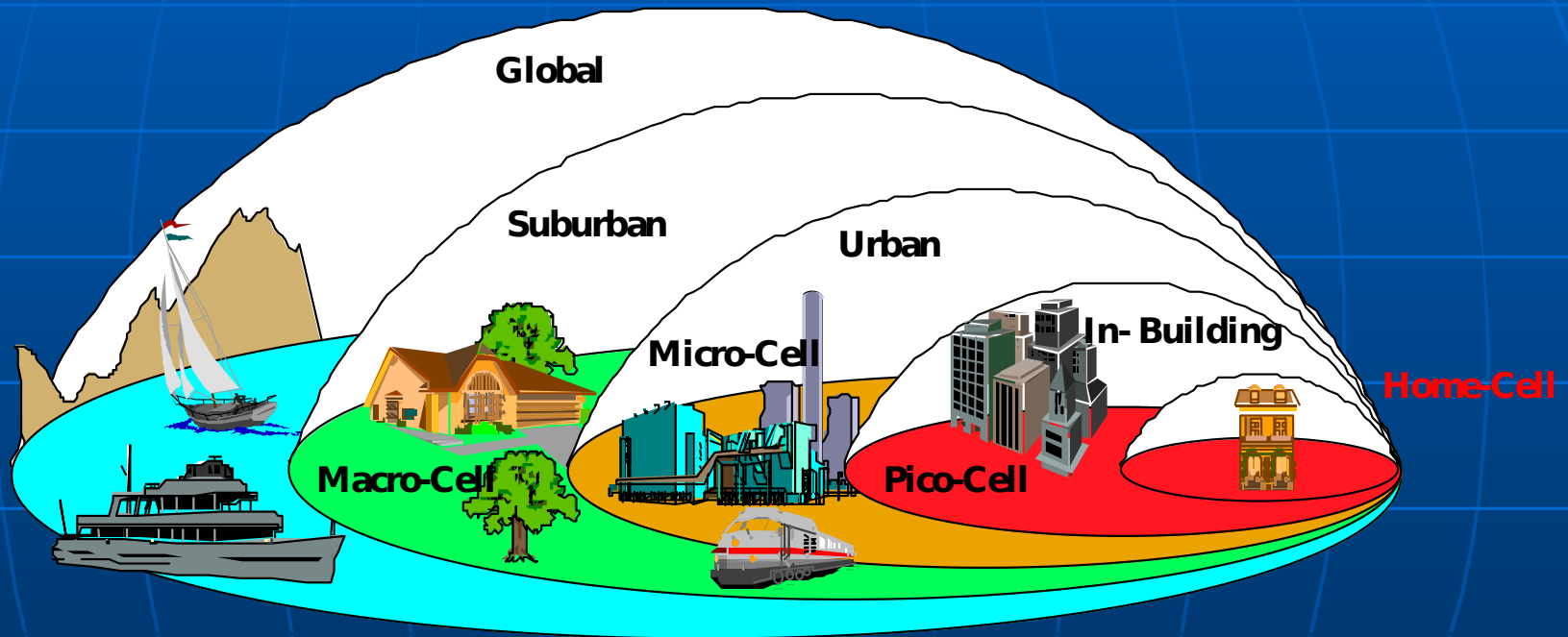
- No hard and fast definition for 4G yet!.
- 4G's goal is to replace the current proliferation of core cellular network with a single worldwide cellular core network.
- Its standard based on IP for video, data and voice over IP (VoIP).



Expanded 4G feature Set

Although not yet defined, some of expected features in a 4G system include the following

- Global access, service portability, and scalable mobile service.
- Seamless switching, and a variety of QoS-driven service.
- Support for interactive multimedia, voice, streaming video Internet, and other broadband services.
- Seamless network of multi-protocol and air interface (since 4G will be all-IP, look for 4G to be compatible with all common network technologies, including 802.11, WCDMA, Bluetooth, and HyperLAN).
- High speed, high capacity, Better spectral efficiency, and low cost-per-bit.
- An infrastructure to handle pre-existing 3G systems along with other wireless technologies, some of which under development,

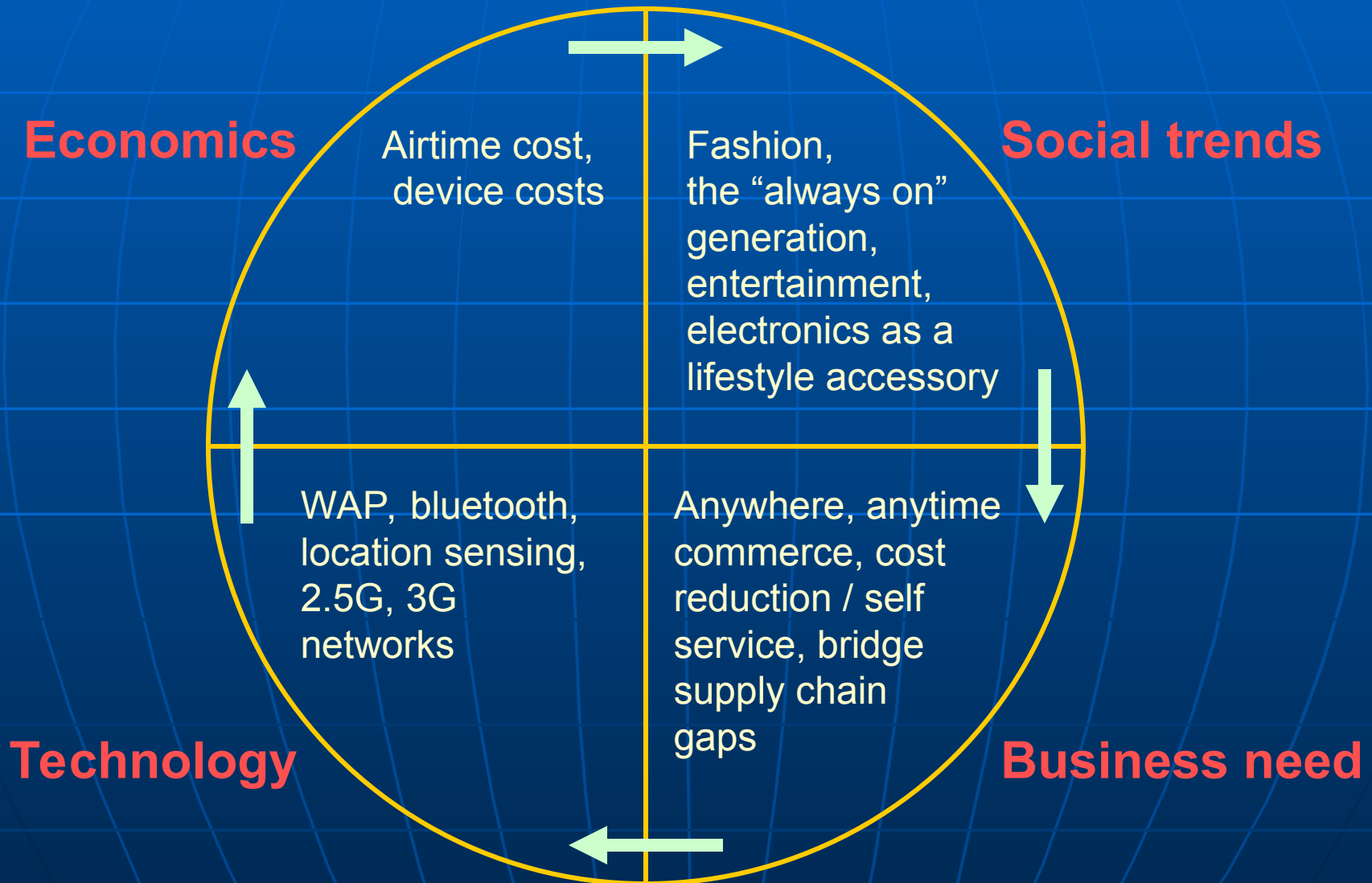


Different Environments for 4G

Comparison of Probable 4G and 3G

	3G	4G
Key requirement	Primary for voice, data is an add-on-feature	Data and voice converged over IP
Architecture	Wide-area cell based	Wireless LAN and WAN
Frequency band	1.8-2.5GHz	2-8GHZ
Bandwidth	5-20MHz	5-20 MHz (might go up to 100MHz)
Data Rate	Up to 2Mbps	Up to 20Mbps
Access Technology	WCDMA	Multicarrier CDMA OFDM
Switching	Circuit/Packet	Packet
Deployment	In progress	2006-2010

What is Driving the Mobile Phenomenon?



Next Generation of Mobile Networks

Some Challenges to Consider

- Wireless spectrum availability
- Tower site limitations
 - Service quality
 - Churn
- Billing challenges
 - Multiple unrelated vendors in revenue chain
 - Collections ?
 - Identities and brands blur

1G, 2G, 3G, and Beyond!

Past, Present, and Future

