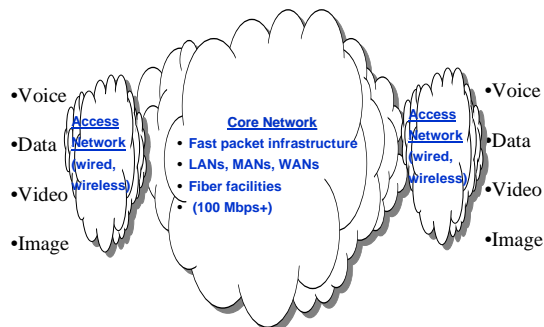


Wireless and High speed Networks

- Converged Networks (NGN)
- Residential broadband (DSL, cable modems)
- Core network (ATM, Frame Relay, SONET)
- Wireless Networks
- Satellites and wireless local loops
- Cellular networks
- Wireless LANs (wireless Ethernet, Bluetooth)

Amjad Umar

Broadband Network (Next Generation Network)



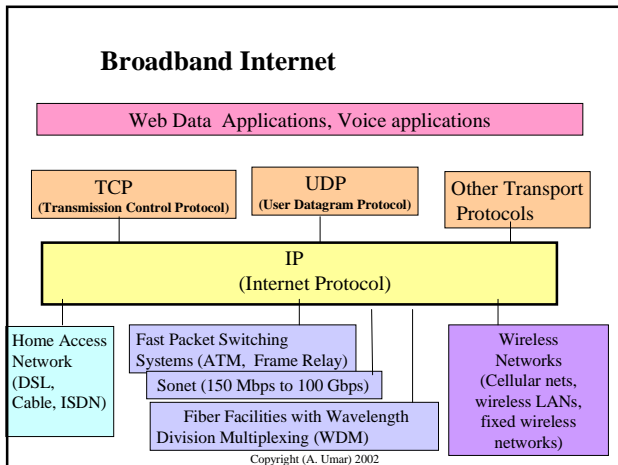
Note: disk to CPU transfer rate is around 100 Mbps

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Key NGN Components

- **Access** (e.g., XDSL, Cable Modem, Wireless)
- **WAN Core Network** (e.g., WDM, SONET, ATM, Frame Relay, IP)
- **LAN** (e.g., Gigabit and 100 Mb/s Ethernet, Wireless LAN)
- **Services** (e.g., IP VPN, voice over IP, web-enabled call center, unified messaging)
- **Appliance** (e.g., computer, POTS phone, IP phone, cell phone, Fax, building controller, facility sensor)

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Bandwidth Consumers

- Example: How much is 150 Mbps?
 - . 3,000,000 typists at 50 words/minute
 - . 30,000 FAX terminals
 - . 16,000 High speed asynchronous terminals
 - . 2400 High quality voice channels
 - . 100 High quality stereo audio channels
 - . 100 video teleconferences
 - . 15 High speed local area networks (Ethernets)
 - . 6 high resolution color images/second
 - . 3 studio quality TV channels
 - . 1 High definition TV Channel

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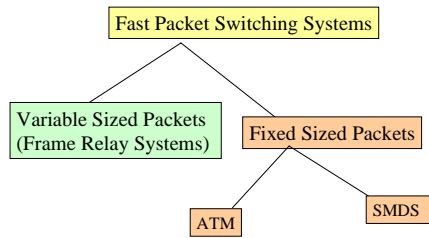
Why are networks getting so fast?

Examples of these common principles are:

- Use of fiber optic versus copper facilities
- Better modulation techniques
- Increased use of packet switching
- Less error checking
- Consolidate redundant functions
- More functions moving to hardware
- Faster computer chips
- Use of bandwidth on demand

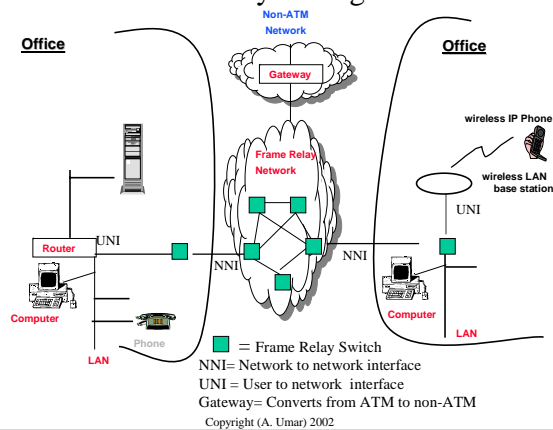
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Fast Packet Switching Systems

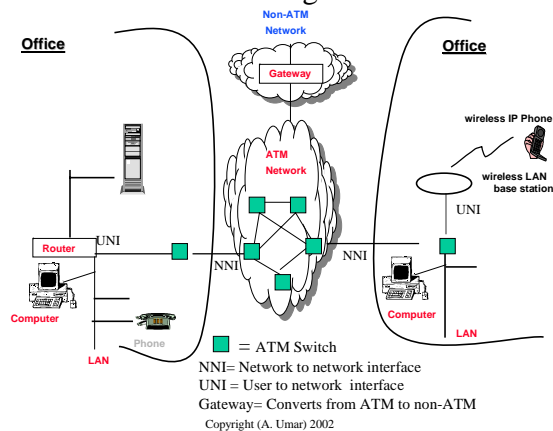


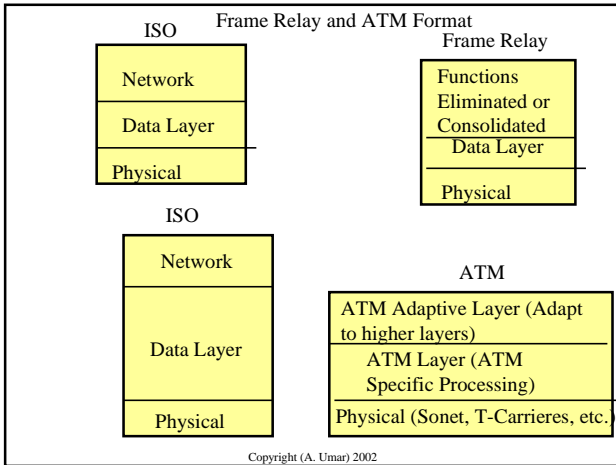
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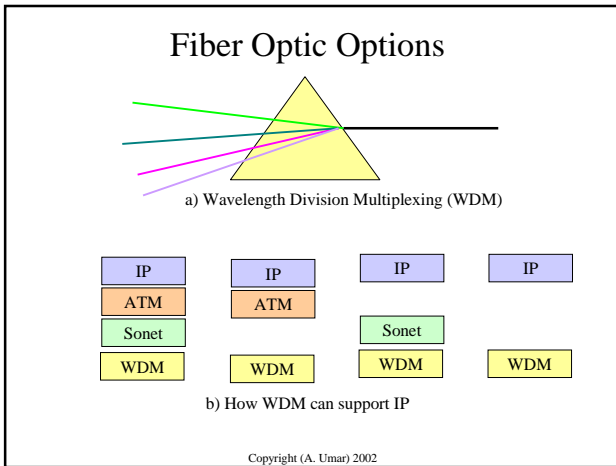
Frame Relay Configuration

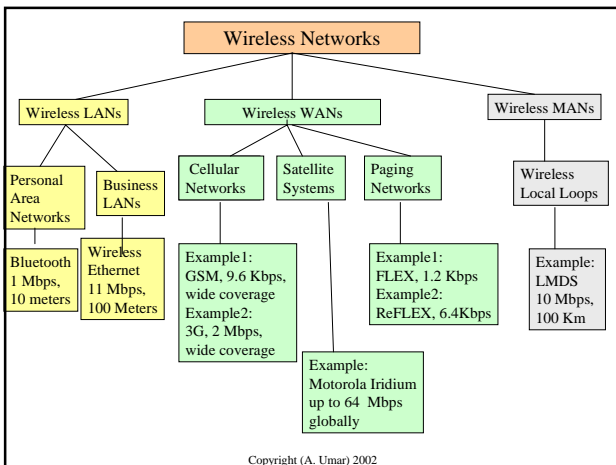


ATM Configuration







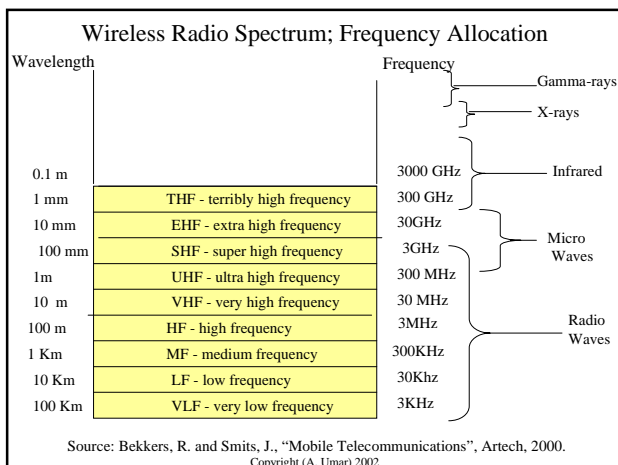


Wireless Versus Wired Networks			
	Local Area Networks (LANs)	Metropolitan Area Networks (MANs)	Wide Area Networks (WANs)
Wired	Wired LANs Ethernet (10-100 Mbps, 100 meters) Token Ring (4-16 Mbps, 100 meters)	Wired MANs FDDI (100 Mbps, 50 Kilometers)	Wired WANs ATM (44 Mbps to 140 Mbps) Frame Relay (44 Mbps)
Wireless	Wireless LANs Bluetooth (1 Mbps, 10 meters) IEEE 802.11 LANs (2-11 Mbps, 100 meters)	Wireless MANs wireless local loops (10 Mbps, 100 Kilometers)	Wireless WANs Current GSM systems at 9.6Kbps, future 3G systems at 2 Mbps
<p>Issues unique to wireless</p> <ul style="list-style-type: none"> •Frequency allocation •Multiple Access •Location 			
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General Frequency Ranges

- Radio frequencies range from 9KHz to 400GHZ (ITU)
- Microwave frequency range
 - 1 GHz to 40 GHz
 - Directional beams possible
 - Suitable for point-to-point transmission
 - Used for satellite communications
- Radio frequency range
 - 30 MHz to 1 GHz
 - Suitable for omnidirectional applications
- Infrared frequency range
 - Roughly, 3×10^{11} to 2×10^{14} Hz
 - Useful in local point-to-point multipoint applications within confined areas

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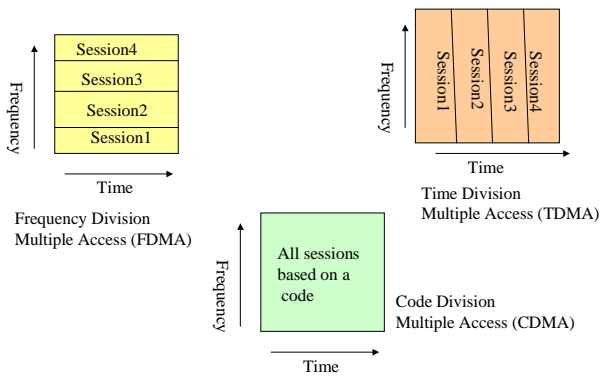


Frequency Regulations

- Frequencies from 9KHz to 300 MHz in high demand (especially VHF: 30-300MHz)
- In wireless, lower frequencies (omnidirectional)
- Regional, national, and international issues
- Choice depends on ease of generation, detection, and propagation
- Procedures for military, emergency, air traffic control, etc
- Different agencies license and regulate
 - www.fcc.gov - US
 - www.open.gov.uk/radiocom -- for UK
 - Others (e.g., ETSI, five agencies in Japan)
- Interferences across national borders handled through Radio Communications Bureaus

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Multiple Access Techniques: How to allocate users



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Overview of Location Services

- Cell-id based location.
 - assigned an id of the cell that you are in.
 - cell-id is stored in a database.
 - As you move from one cell to another, you are assigned a different cell-id and the location database is updated.
 - most commonly used in cellular networks.
- Angle of arrival (AOA). the angle at which radio waves from your device "attack" an antenna is used to calculate the location of the device.
- Time taken. In this case, the time taken between the device and the antenna is used to calculate the location of the device.
- Network assisted Global Positioning System (GPS). a GPS chip is installed inside a phone and thus the location of the user is tracked.

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Satellite Systems

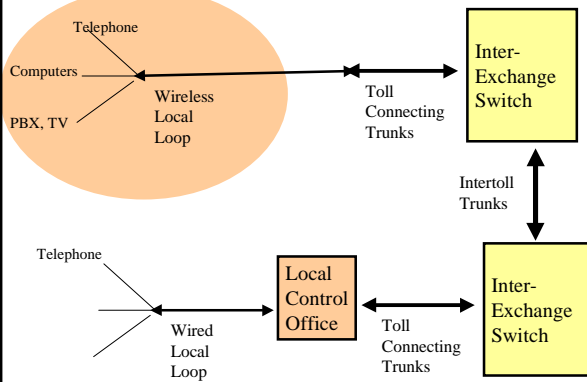
GEO= 35,000KM
MEO= 12,000 KM
LEO = 2,000 KM
(Big LEO > 1GHZ,
Little LEO < 1GHZ)



- Teledesic, funded by Microsoft and McCaw Cellular,
 - is a \$9 billion low-earth orbit (LEO) satellite network project.
 - A typical Teledesic user will operate at 64 Mbps downlink and 2 Mbps uplink.
 - Iridium, initiated by Motorola, is another LEO project
 - Goal: cover every spot on earth plus 50 miles above
 - Customers have been luke warm (high cost and technical problems). .
- Very valuable for some parts of world, also for fast links

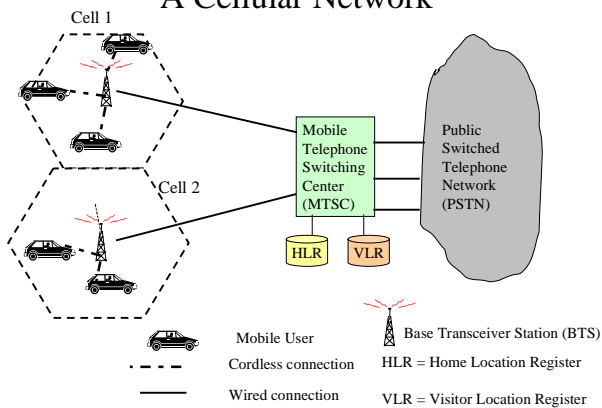
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Wireless Local Loops

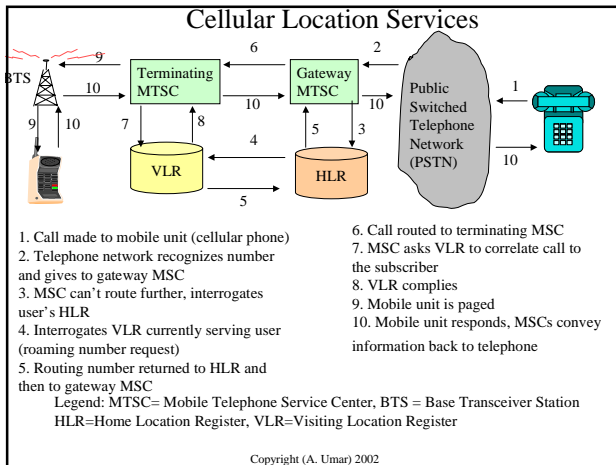


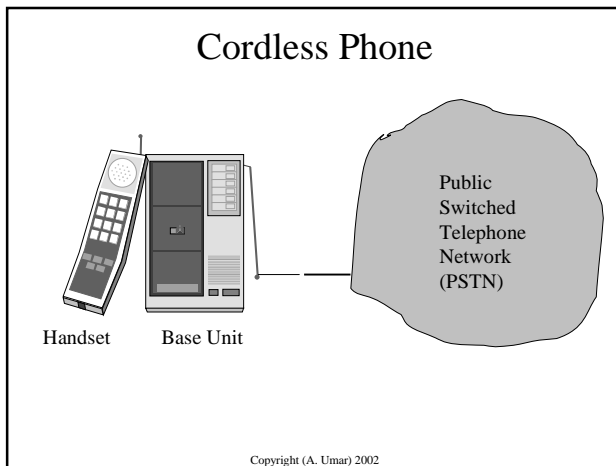
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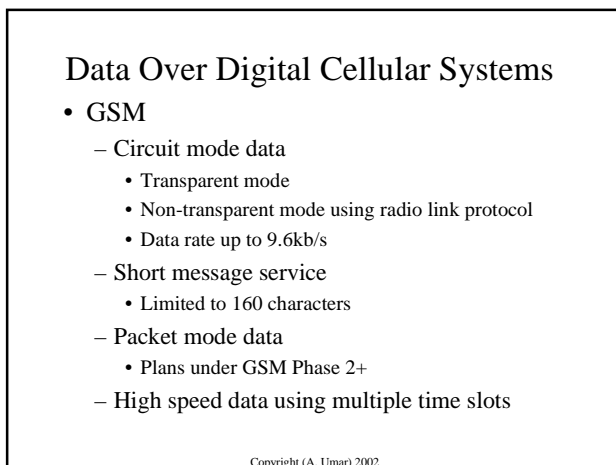
A Cellular Network



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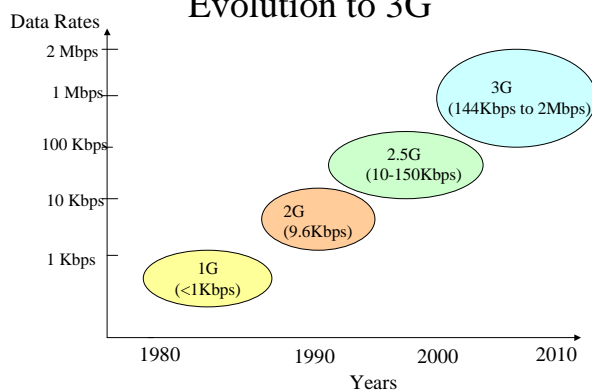


Cellular networks: What is 3G Anyway?

- 1G: First generation wireless cellular: Early 1980s
 - Analog transmission, primarily speech: AMPS, TACS, NMT
- 2G: Second generation wireless cellular: Late 1980s
 - Digital transmission
 - Primarily speech and low bit-rate data
 - High-tier: GSM, IS-95 (CDMA), etc
 - Low-tier (PCS): Low-cost, low-power, low-mobility e.g. PACS
- 2.5G: 2G evolved to medium rate (< 100kbps) data
- 3G: future: Broadband multimedia
 - 144 kbps - 384 kbps for high-mobility, high coverage
 - 2 Mbps for low-mobility and low coverage

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Evolution to 3G



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Web sites

- Bekkers, R. and Smits, J., "Mobile Telecommunications", Artech, 2000.
- www.pcsdata.com: PCS web site
- www.gsmdata.com: GSM web site
- www.wlana.com: wireless LAN Association
- www.pcca.org: portable computers and communications association
- **Online Magazines**
 - Mobile Computing & Communications (www.mobilecomputing.com)
 - Wireless Design Online (www.wirelessdesignonline.com)
 - Wireless Design & Development (www.wirelessdesignmag.com)
 - Wireless & Mobility (www.wirelessmag.com)
 - Wireless Review (www.wirelessreview.com)
 - Wireless Systems Design (www.wsdmag.com)
 - Wireless Week (www.wirelessweek.com)

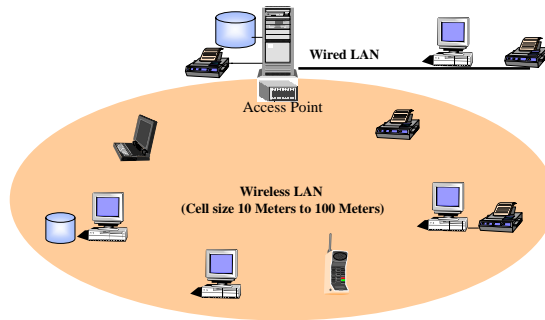
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Wireless LANs

- First generation of products at about 1-2 Mbps
 - Lucent's WaveLAN, RadioLAN, etc.
 - factor of 10 less bandwidth than current Ethernet
- Next generation of products at 10-11 Mbps
 - factor of 10 less bandwidth than 100 Mbps Ethernet
- IEEE 802.11 standard
- Important niche and enterprise applications (e.g. hospitals)
- Increasing horizontal market interest (e.g. SOHO)
- Forecast: Total worldwide wireless LAN market revenues: \$305.4M (1998) to \$1.63B by 2005 -- Frost & Sullivan.
- Good Web site: www.lana.com

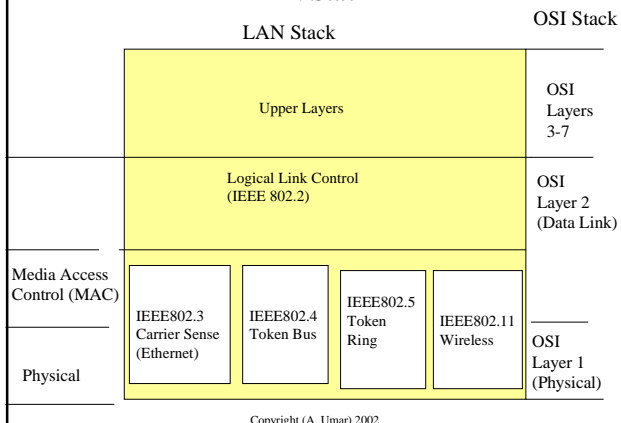
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Wireless LANs



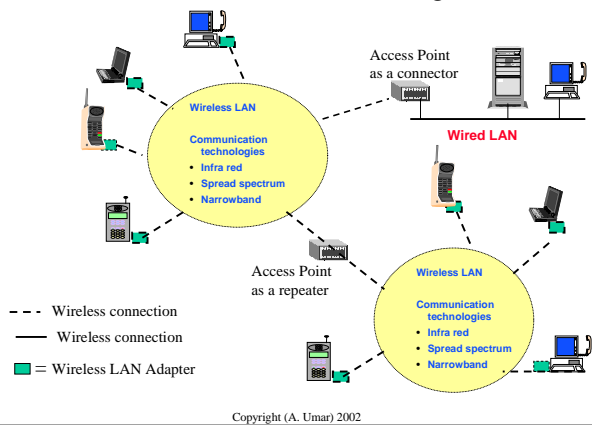
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LAN Stack

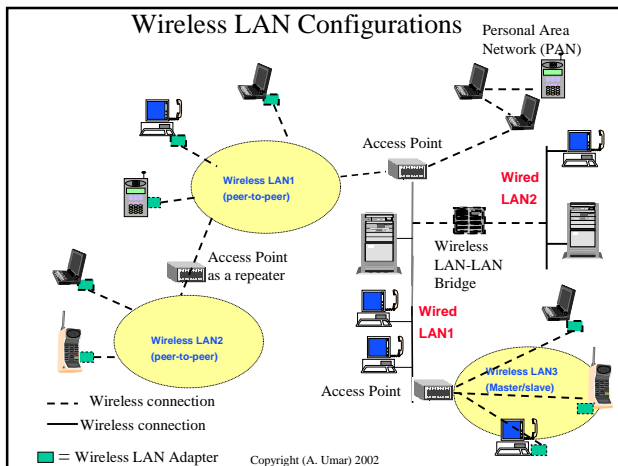


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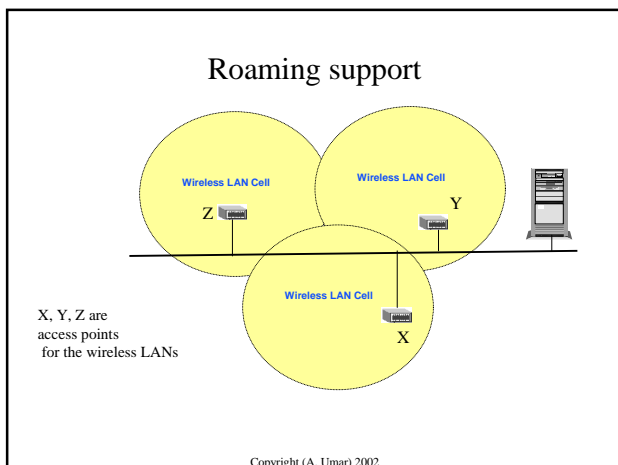
Wireless LAN Technologies

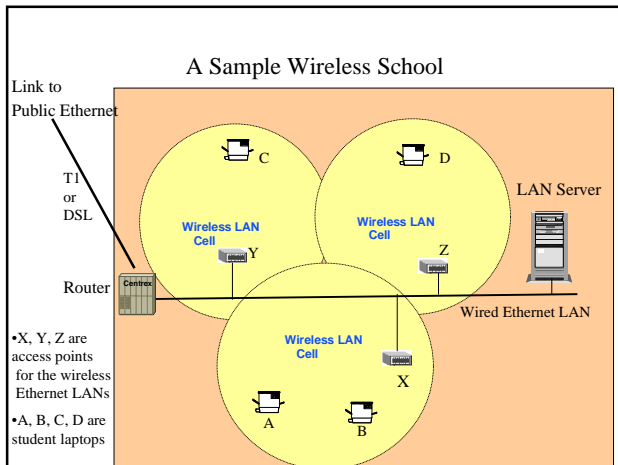


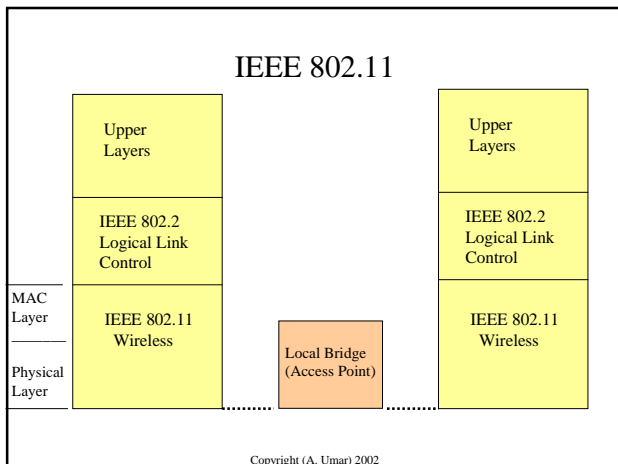
Wireless LAN Configurations



Roaming support



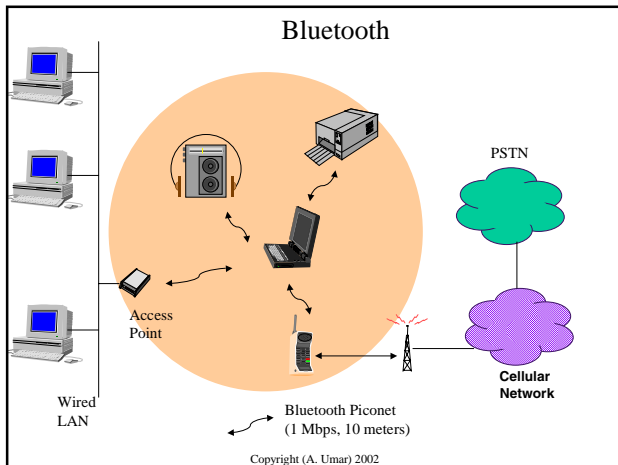


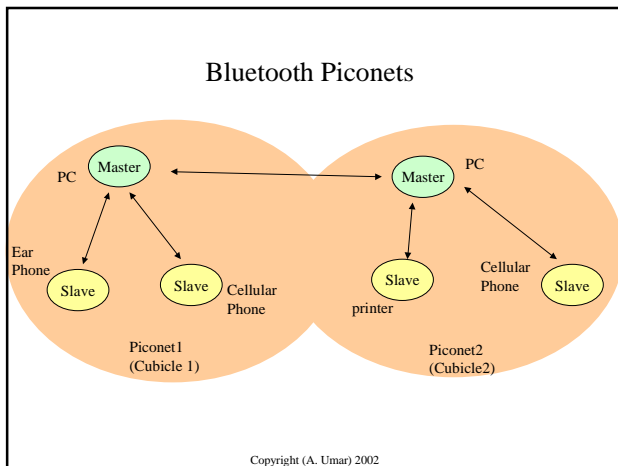


Bluetooth

- Founders: Ericsson, IBM, Intel, Nokia, Toshiba; May 98
- Currently: Over 850 companies, V1.0 spec issued 7/99
- Small form factor, low-cost, short range radio link between mobile PCs, phones and other portable devices
- 2.4 GHz ISM band: Short packets, fast-hopping, and FEC limits impacts of interference
- Software for service and device discovery
- Typical application: cellular phone to PDA or earphone
- Forecast: 79% of digital handsets and > 200 million PCs will use Bluetooth by 2002 -- Dataquest

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References for Wireless LANs

- Books
 - Geier, Jim. "Wireless LANs", MacMillan, 1999
 - WCCN Handbook: RF Terminals & LANs by Tom Polizzi
 - Wireless LAN Systems (The Artech House Telecommunications Library), by A. Santamaria, F.J. Lopez-Hernandez (Editor)
 - Wireless LANs, Raymond P. Wenig
 - Wireless Local Area Networks: Technology, Issues, and Strategies (McGraw-Hill Computer Communications), by Peter T. Davis, Craig R. McGuffin
 - Wireless Networking Handbook, by James T. Geier
- Main Web sites
 - www.wlana.org
 - www.palowireless.com
 - www.bluetooth.com (the Bluetooth Web site)
 - <http://Bluetooth.ericsson.se>

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