IT 4504
Section 6.0

Local Area Networks

Section 6.1

Introduction to LANs

Introduction to LANs

See Section 4.3 for details.

Section 6.2

LAN Architectures

LAN Architectures

LAN topologies define the manner in which network devices are organized. few common LAN topologies exist, e.g. bus, ring, star, and tree. These topologies are logical architectures, but the actual devices need not be physically organized in these configurations. Logical bus and ring topologies, for example, are commonly organized physically as a star. A *bus topology is a linear LAN architecture in which transmissions from network stations propagate the length of the medium and are received by all other stations.*

Channel Access Methods

- **Two primary access control methods**
  - Token based access
  - Carrier Sense Multiple Access with Collision Detection (CSMA/CD)

CSMA Protocol

A station that wishes to transmit listens to the medium for an ongoing transmission

- Is the medium in use?
  - **Yes**: Station back off for a specified period
  - **No**: Station transmits
- If a sender does not receive an acknowledgment after some period, it assumes that a collision has occurred
- After a collision, a station backs off for a certain (random) time and retransmits

CSMA Protocol (Cont.)

There are a number of variations of CSMA protocols. Each variant specifies what to do if the medium is found busy:

- 1-Persistent CSMA
- Non-Persistent CSMA
- p-Persistent CSMA

CSMA/CD

- Usually used in a bus topology
- Used in *Ethernet* LAN's
- Unlike the token ring, all nodes can send whenever they have data to transmit
- When a node wants to transmit information, it first "listens" to the network. If no one is transmitting over the network, the node begins transmission
- It is however possible for two nodes to transmit simultaneously thinking that the network is clear
- When two nodes transmit at the same time, a *collision* occurs

CSMA / CD (Contd.)

- The first station to detect the collision sends a jamming signal into the network
- Both nodes back-off, wait for a random period of time and then re-transmit
- Use one of the CDMA persistence algorithm
- If a collision is detected during transmission, cease transmission and transmit a ***jam signal*** to notify other stations of collision
- After sending the jam signal, ***back off for a random amount of time***, then start to transmit again

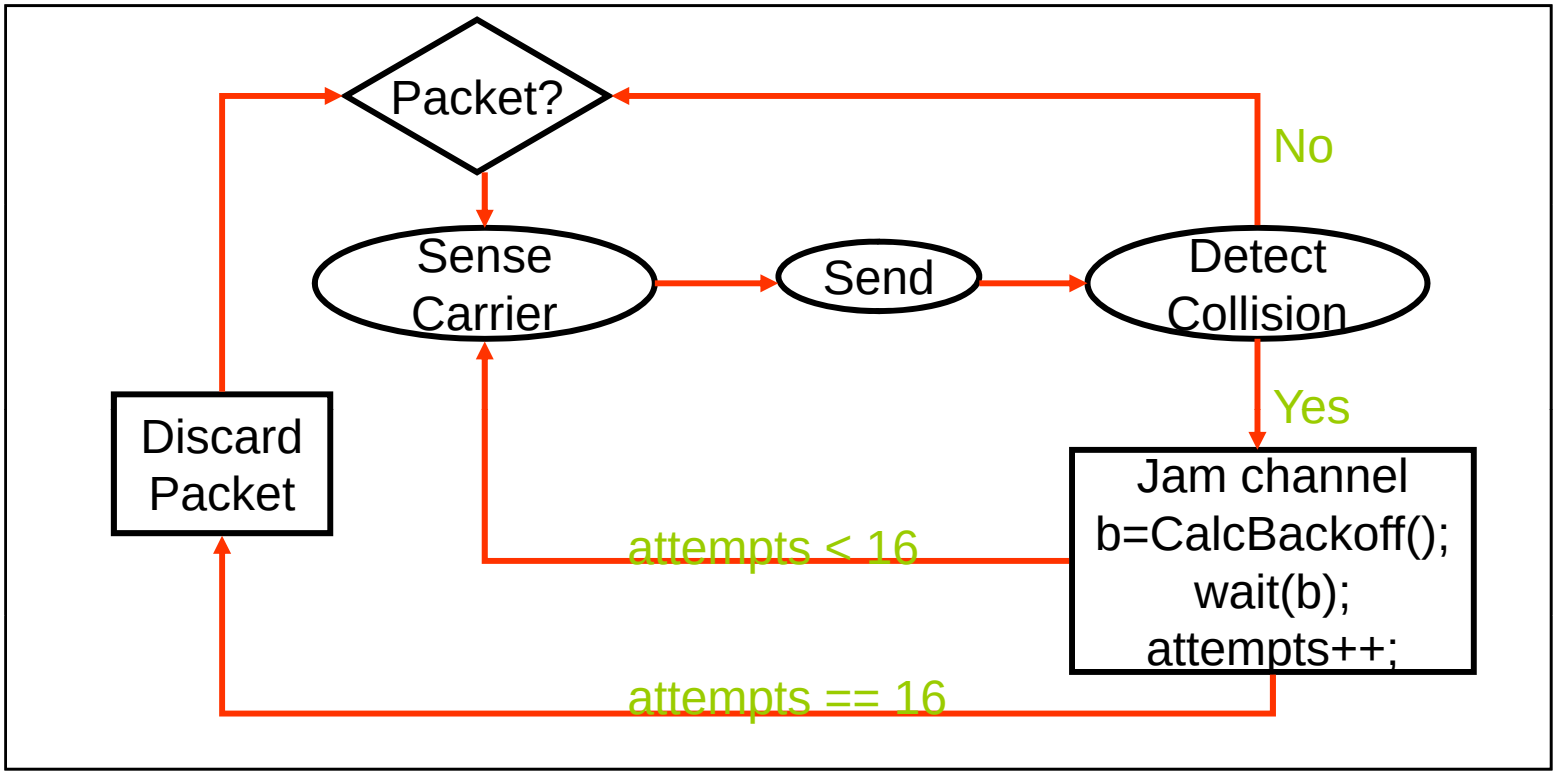
CSMA / CD (Contd.)

Q: How long does it take to detect a collision?

A: In the worst case, twice the maximum propagation delay of the medium

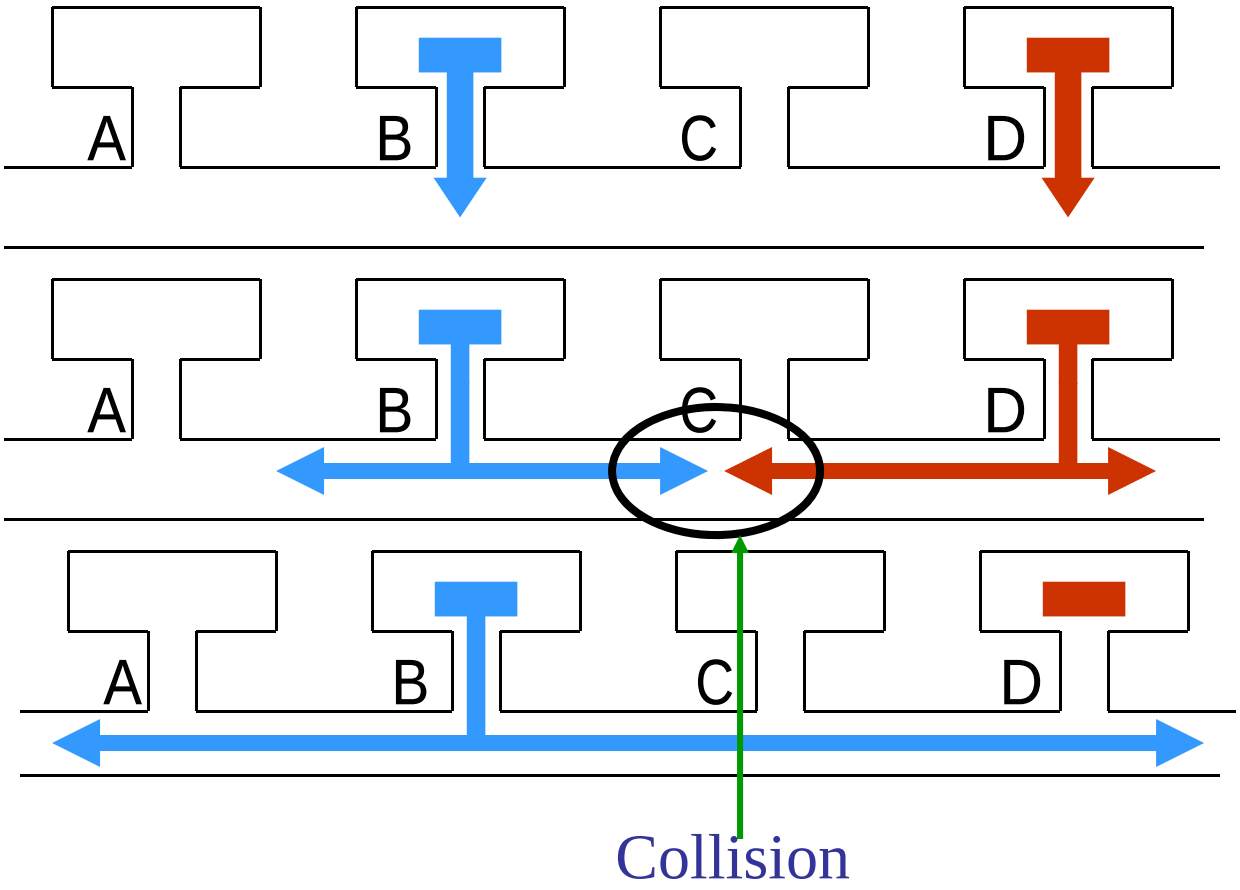
- IEEE 802.3 specifies max value of propagation delay to be 51.2 μs
  - This relates to maximum distance of 2500m between hosts
  - At 10Mbps it takes 0.1μs to transmit one bit so 512 bits (64B) take 51.2 μs to send
  - So, Ethernet frames must be at least 64B long (14B header, 46B data, 4B CRC, Padding is used if data is less than 46B)
- Send jamming signal after collision is detected to insure all hosts see collision (48 bit signal)

State Diagram for CSMA/CD



CSMA/CA (Carrier Sense Multiple Access and Collision Avoidance) is a variation of CSMA/CD used in wireless LANs because it is difficult to detect collisions in such networks.

CSMA/CD



CSMA: Listen Before Talking

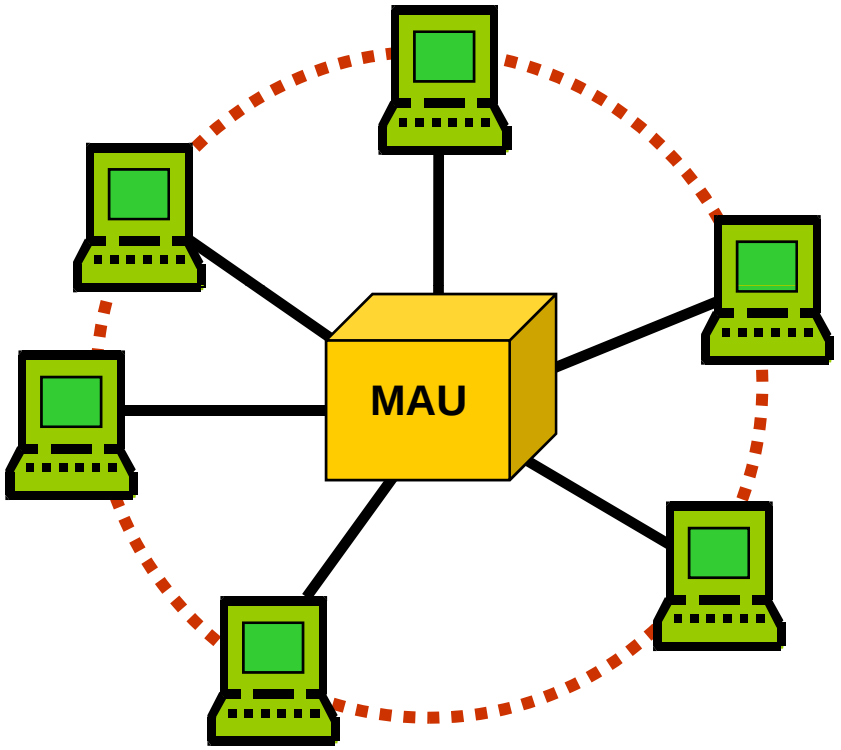
CSMA/CD: Listen While Talking

Token based access

- Used in bus and ring network topologies
- Each computer in the network can only send its data if it has the *token.* This prevents collisions that occur when data is sent at the same time over the network
- The token is a special pattern of bits/bit in a frame that is directly detectible by each node in the network
- A computer may only transmit information if it is in possession of the token
- The message is sent to all other computers in the network

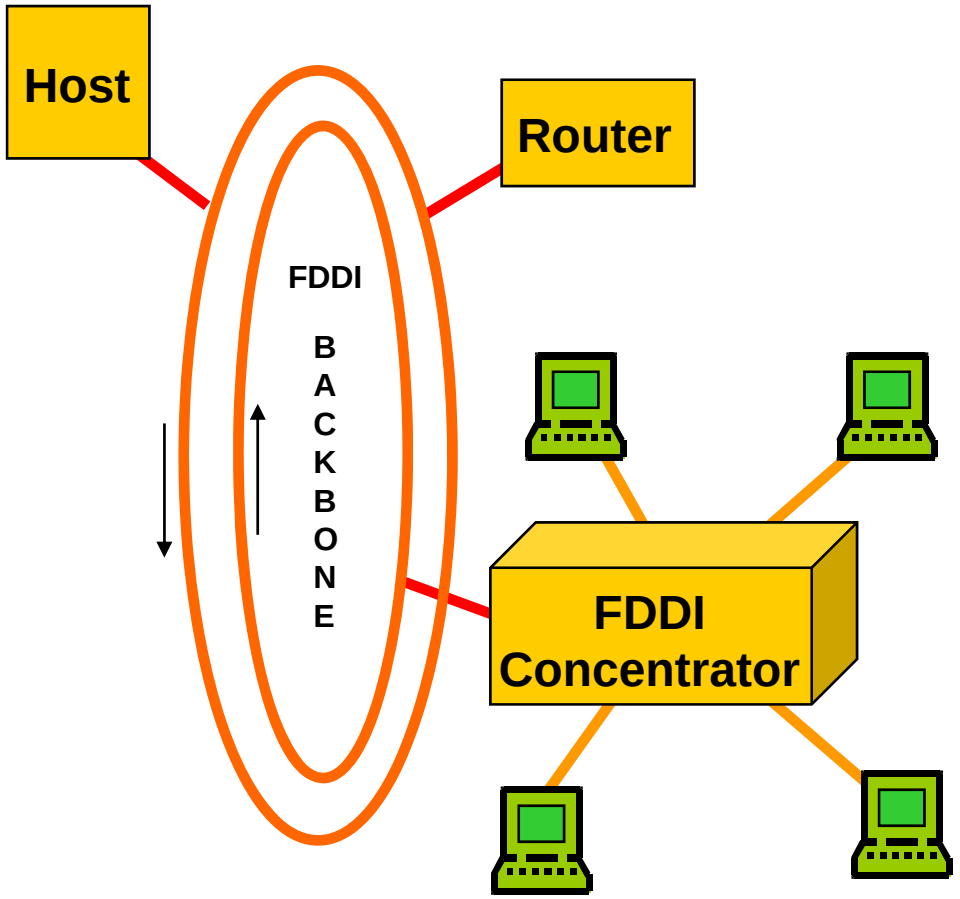
Token Ring

- Logical ring, physical star
- Uses token passing
  - Station can only transmit when it has token
- 4 or 16 Mbps
- UTP, STP, or fiber cable
- IEEE 802.5 standard
- Few Token Ring installs today



FDDI
(Fiber Distributed Data Interface)

- Logical ring, physical ring, or star
- Dual counter-rotating rings
- 100 Mbps
- Fiber, UTP, or STP
- Older backbone technology



LAN devices

- **Hub** –is a device for connecting multiple twisted pair or fiber optic Ethernet devices together and making them act as a single network segment

- **Ethernet switch**-is a device which switch data packets freely or based on given criteria/ criteria's

Hubs

- Advantages & usage
  - Low cost comparing with Switching devices.
  - Non filtered packet applications (i.e. packet analysis for trouble shooting).
  - Easy to deploy.

- Disadvantage
  - Does not isolate traffic.
  - Shared bandwidth.

Switch

- Advantages & usage
  - Port based bandwidth
  - Traffic isolation.
  - Higher degree of management on traffic.(QOS, ACL, filtering)
  - Segmentation of switch ports and amalgamation(aggregation) of ports depend on requirement.
  - Multilayered switchers provide a combination of advance switching and management options. (ToS, QoS,MPLS,) and operate in a range of OSI layers

Switches *(Contd.)*

- Varieties
  - Cut-through switch
    - Simply reads the address of a received frame and then immediately routes the frame to the destination port associated with the recipient
  - Store-and-forward switch
    - Waits until the entire frame is received and then checks for errors before sending the frame on to its destination port

Switch variations based on OSI model

- Layer 1
  - Basic switch more used as the replacement of hub,
- Layer 2
  - Used MAC based switching for very high throughput .
  - Isolations and advance options like VLAN, link aggregation are possible.
  - used as final stage network devices to connect end user equipment.
  - used for high speed applications (i.e. SAN, Server aggregation).
- Layer 3
  - Can apply routing mechanism to route traffic based on requirements .
  - Isolations and advance options like VLAN, link aggregation, filtering are possible.
  - Used as Core switching device in LAN.
- Layer 4
  - Higher level of manageability depend on the payload of the packet.
  - Used in security devices (firewall .VPN devices, TCP session based load distributors and balancing).
- Layer 7
  - Application level manageability on network traffic. Used for very specific application (i.e. web cache, content accelerators,)

Section 6.3

IEEE 802 MAC Layer Standards

802.3 – CSMA/CD Ethernet

Consist of 5 sections

Section 1 -10Mb/s

Section 2- multiple protocol ,multiple speed management ,100Mb/s

Section 3- 1000Mb/s operational and Physical layer information

Section 4-10Gb/s operational and Physical layer information

Section 5- Subscriber access from 512Kb/s to 1000Mb/s and 10 Gb/s ,Ethernet over power

802.11 – Wireless LAN

802.11 a/b/g/n -*refers to LAN and MAN stanards in wireless networks. The 802.11n refers to enhance Higher Throughput.*

802.11k -*Radio Resource Measurement of Wireless LANs.*

802.11p- *Wireless Access in Vehicular Environments*

802.11z- *Extensions to Direct-Link Setup (DLS)*

802.15 – Wireless Personal Area Networks (WPAN)

802.15.1- *Specifications for Wireless Personal Area Networks (WPANs).*

802.15.2- *Coexistence of Wireless Personal Area Networks with Other Wireless Devices Operating in Unlicensed Frequency Band.*

802.15.3- *Specifications for High Rate Wireless Personal Area Networks (WPAN).*

802.15.4- *Specifications for Low Rate Wireless Personal Area Networks (LR-WPANs).*

802.15.5- *Mesh Topology Capability in Wireless Personal Area Networks (WPANs).*

Section 6.4

Switched Ethernet

Ethernet

- First network to provide CSMA/CD
- Developed in 1976 by Xerox PARC (Palo Alto Research Center) in cooperation with DEC and Intel
- Is a fast and reliable network solution
- One of the most widely implemented LAN standards
- Can provide speeds in the range of 10Mbps - 10 Gbps
- Used with a bus or star topology

Types of Ethernet LANs

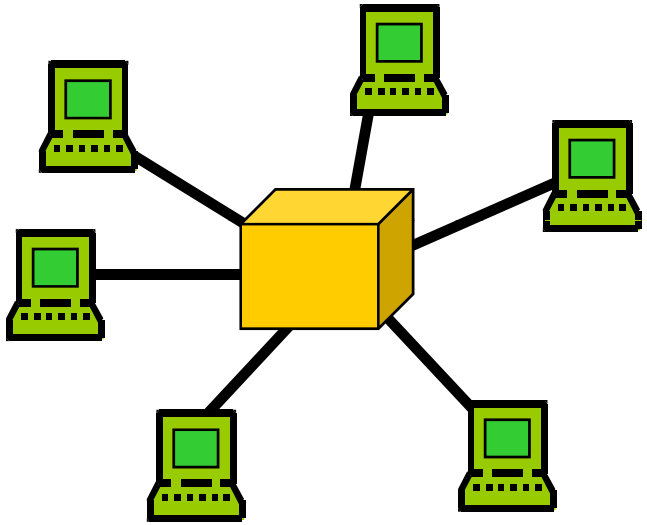
- 10Base-T
  - Operates at 10 Mbps
  - IEEE 802.3 standard
- Fast Ethernet (100Base-T)
  - Operates at 100 Mbps
- Gigabit Ethernet
  - Operates at 1 Gbps
  - Uses fiber optic cable

Types of Ethernet LANs (Contd.)

- 10 Gbps Ethernet
  - Latest development of Ethernet
  - Uses fiber optic cable
  - Developed to meet the increasing bandwidth needs of the LAN market
- Wireless Ethernet
  - IEEE 802.11 standard
  - Operates at around 50 Mbps

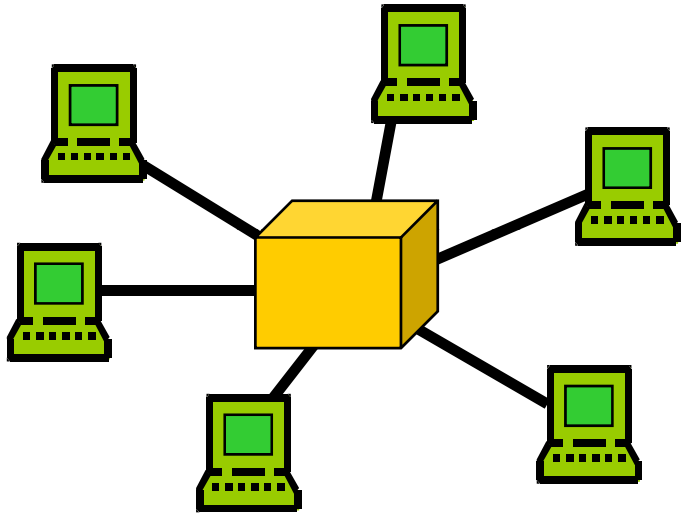
Ethernet

- Logical bus, physical star, or bus
- Uses CSMA/CD
- 10 Mbps of shared bandwidth
- UTP, coax or fiber cable
- IEEE 802.3 standard
- Most common LAN technology



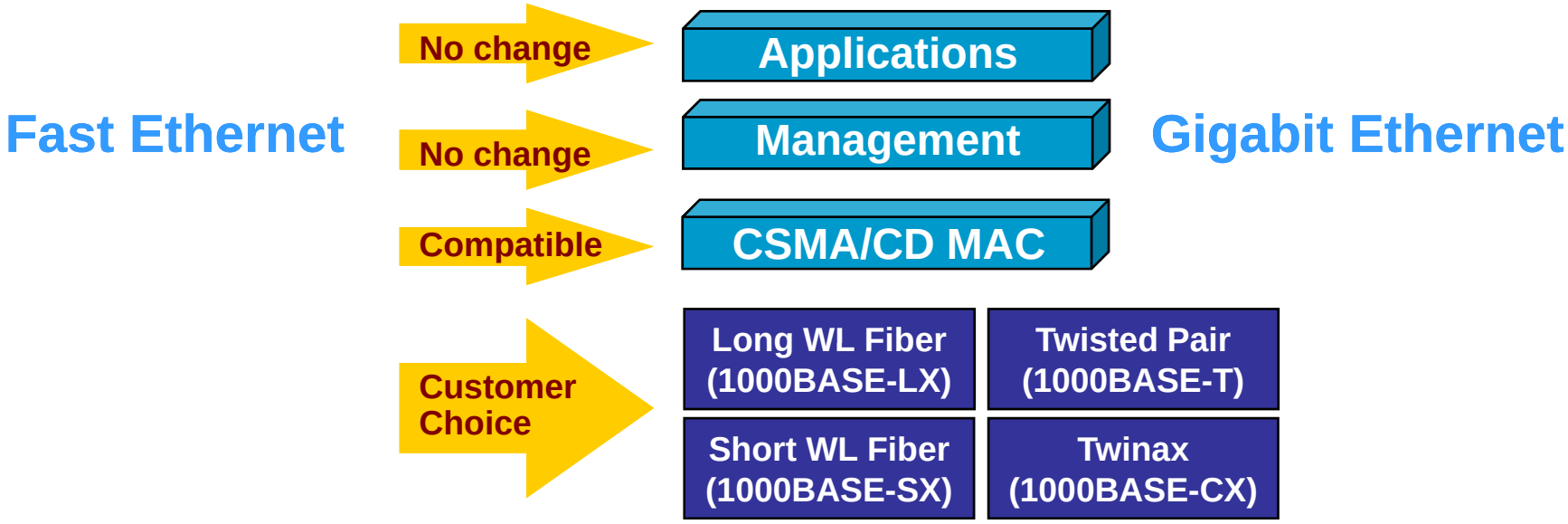
Fast Ethernet

- Like 10 Mbps Ethernet except:
  - 100 Mbps instead of 10 Mbps
  - UTP, STP, or fiber (no coax)
- IEEE 802.3u standard
- Use for Desktops and backbone



Gigabit Ethernet

- Easy migration without disruption
- Low cost of ownership
- Scalability to high performance
- The next generation frame-based backbone technology



10G Ethernet

Under the International Standards Organization's Open Systems Interconnection (OSI) model, Ethernet is fundamentally a Layer 2 protocol. 10 Gigabit Ethernet uses the IEEE 802.3 Ethernet Media Access Control (MAC) protocol, the IEEE 802.3 Ethernet frame format, and the minimum and maximum IEEE 802.3 frame size.

Just as 1000BASE-X and 1000BASE-T (Gigabit Ethernet) remained true to the Ethernet model, 10 Gigabit Ethernet continues the natural evolution of Ethernet in speed and distance. Since it is a full-duplex only and fiber-only technology, it does not need the carrier-sensing multiple-access with collision detection (CSMA/CD) protocol that defines slower, half-duplex Ethernet technologies. In every other respect, 10 Gigabit Ethernet remains true to the original Ethernet model.

10G Ethernet (Contd.)

Vendors and users generally agree that Ethernet is inexpensive, well understood, widely deployed and backwards compatible from Gigabit switched down to 10 Megabit shared. Today a packet can leave a server on a short-haul optic Gigabit Ethernet port, move cross-country via a DWDM (dense wave division multiplexing) network, and find its way down to a PC attached to a “thin coax” BNC (Bayonet Neill Concelman) connector, all without any re-framing or protocol conversion. Ethernet is literally everywhere, and 10 Gigabit Ethernet maintains this seamless migration in functionality.

Section 6.5

Wireless LANs

Wireless Advantages?

- Mobility
- No wiring required
  - Can lead to cost savings
  - Some environments prohibit wiring
- Cost savings
  - e.g. Use of satellites for overseas telephony connectivity
- Operational when wired solutions fail or are unavailable (natural disasters, polar regions)

Benefits of Wireless

- Fast installation
  - Improved early revenue opportunities
- Efficient use of resources
  - Provide last mile connectivity only to customers that want service
- Less susceptible to disruption
  - Digging up roads limits risk of services outages
- Capacity can be added, removed or reallocated more easily

Wireless Disadvantages?

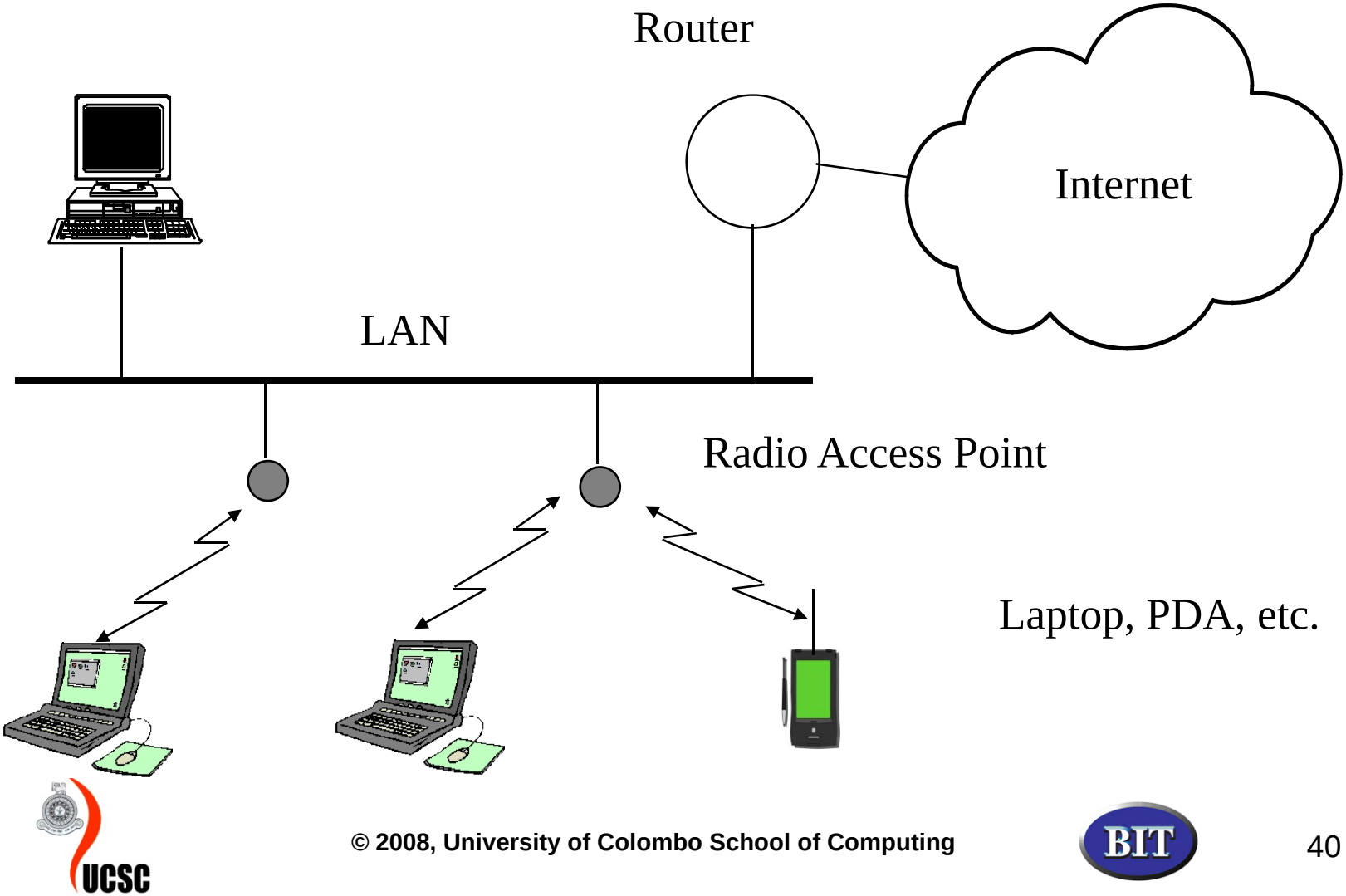
- Cost
  - Technology is newer and more expensive for many applications
- Speed
  - Radio Frequency (RF) characteristics make high data transfer rates more difficult with wireless than with wired
- Security
  - Wireless signals are relatively easy to intercept
- Frequency spectrum saturation

Wireless limitations

- Radio waves can be affected by:
  - Distance & directionality
    - *f* (strength) … ↑ distance ⇒ ↑ attenuation
  - Physical obstructions
  - Geographic conditions
    - Terrain/topography, soil composition, etc.
  - Atmospheric conditions
    - Weather/climate, astronomical events, etc.
  - Other radio waves
    - Signal “crowding” (FCC regulates & monitors)
    - RF “bleed” … created by everyday items!

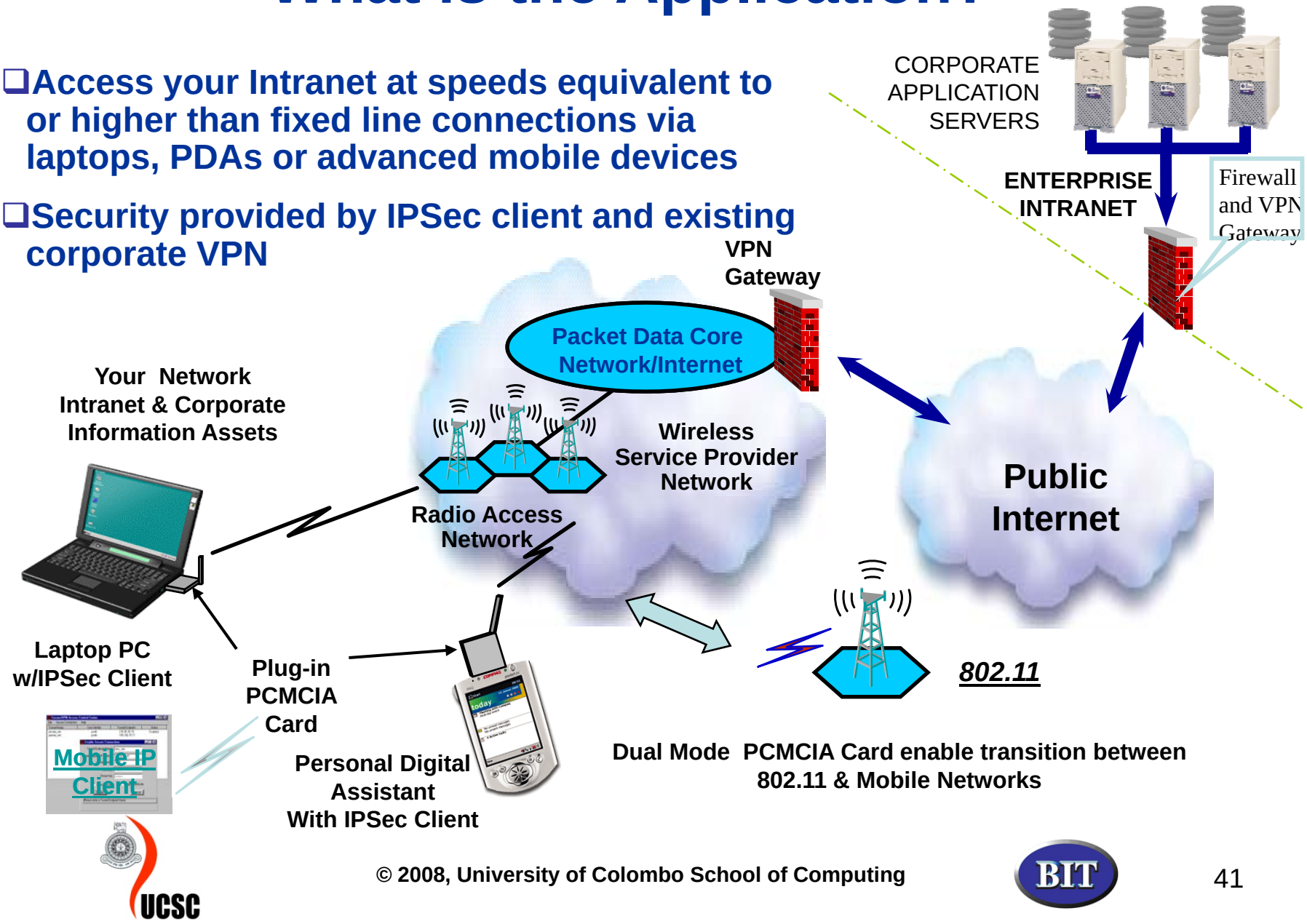
Wireless – LAN (IEEE 802.11)

Wireless Local Area Network



What is the Application?

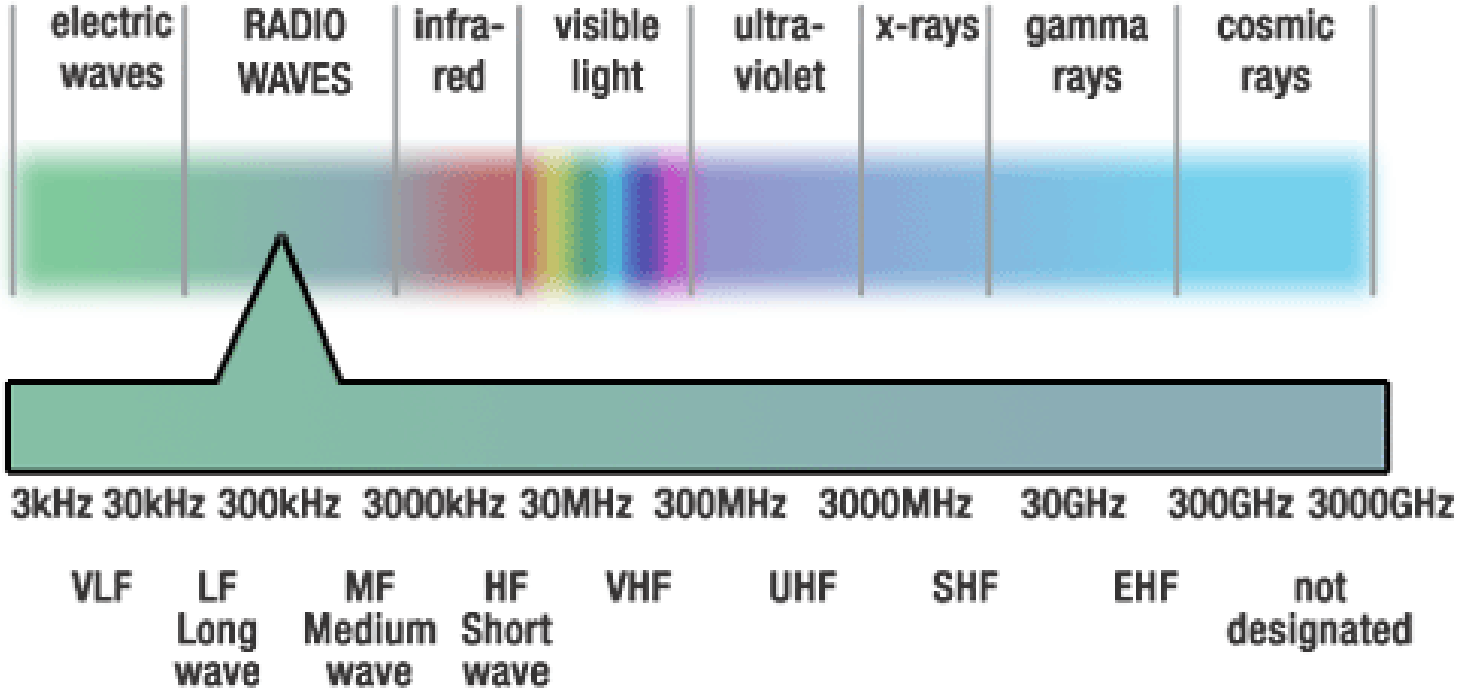
- Access your Intranet at speeds equivalent to or higher than fixed line connections via laptops, PDAs or advanced mobile devices
- Security provided by IPSec client and existing corporate VPN



Wireless Access methods

- CSMA/CA
- Carrier sensing: Listen before talking
- Handshaking to infer collisions
- Collision Avoidance
  - RTS-CTS-DATA-ACK to request medium
  - Duration information in each packet
  - Random back off after collision is detected
  - Net Allocation Vector (NAV) to reserve bandwidth
  - Hidden nodes use CTS duration information

Electromagnetic Spectrum
Showing the Radio Frequency Spectrum



VLF: Very Low Frequency, LF: Low Frequency, MF: Medium Frequency,
HF: High Frequency, VHF: Very High Frequency, UHF: Ultra High Frequency,
SHF: Super High Frequency, EHF: Extremely High Frequency

Wireless – LAN (IEEE 802.11)

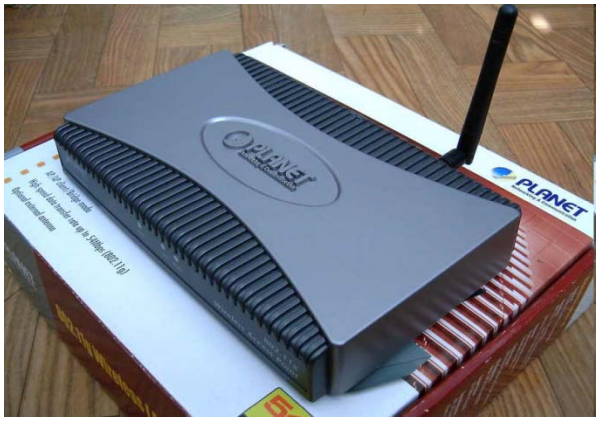
- 2.4GHz High Speed IEEE- 11 mbps
  - Available 2H99
- 5.2GHz
  - OFDM: scalability - Kbps to 30 Mbps

Note:
ISM Band - ……..

Wireless Access Point

A wireless access point (WAP or AP) is a device that allows wireless communication devices to connect to a wireless network. The WAP usually connects to a wired network, and can relay data between the wireless devices (such as computers or printers) and wired devices on the network.

Some prefer to use an ad-hoc network rather than an Access Point. This is because the stations can exchange data directly in the former. There is no need for a station to send data to the middle-man, i.e., the Access Point, and then have it resent to the destination station. Direct data transfer increases the bandwidth available.



Section 6.6

Wireless Personal Area Networks (PAN)

Personal Area Network (PAN)

- Distance up to 10 m
- Available in both wired and wireless technologies
- IEEE 802.15 is for WPAN standards
- Some example technologies (WPAN)
  - IrDA, Bluetooth, Wireless USB, Z-Wave.

- Some example technologies (wired)
  - USB, Fire wire (IEEE 1394).

PAN application areas

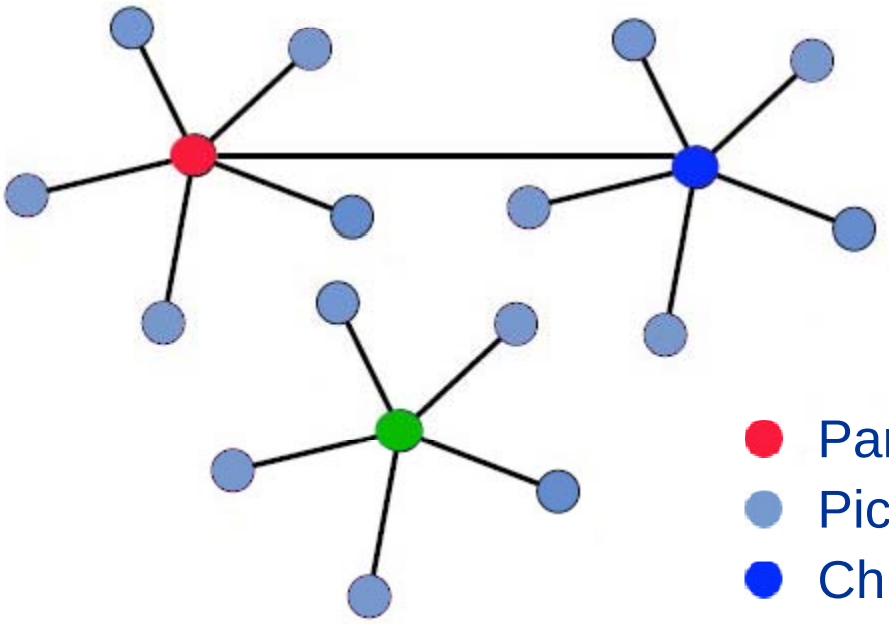
- Personal devices PDA, Smart phone, printers etc
- Health sector devices monitoring and surveillance. (

- Various censer device communication
- Audio and Video systems (i.e. surveillance , monitoring, personal entertainment, home Cinema)

PAN Topologies IEEE 802.15.3

- High rate WPAN(HR-WPAN).
- Data rate up to 100mbps to 10m distance and 400Mbps to 5m distance(current rates are far less than this).
- Dynamic topology based on Piconnet ,
- Mainly peer –to –peer connections
- Short connection time.
- Multiple Power management modes to save power.
- Secure network connections Simple and low cost

PAN Topologies IEEE 802.15.3

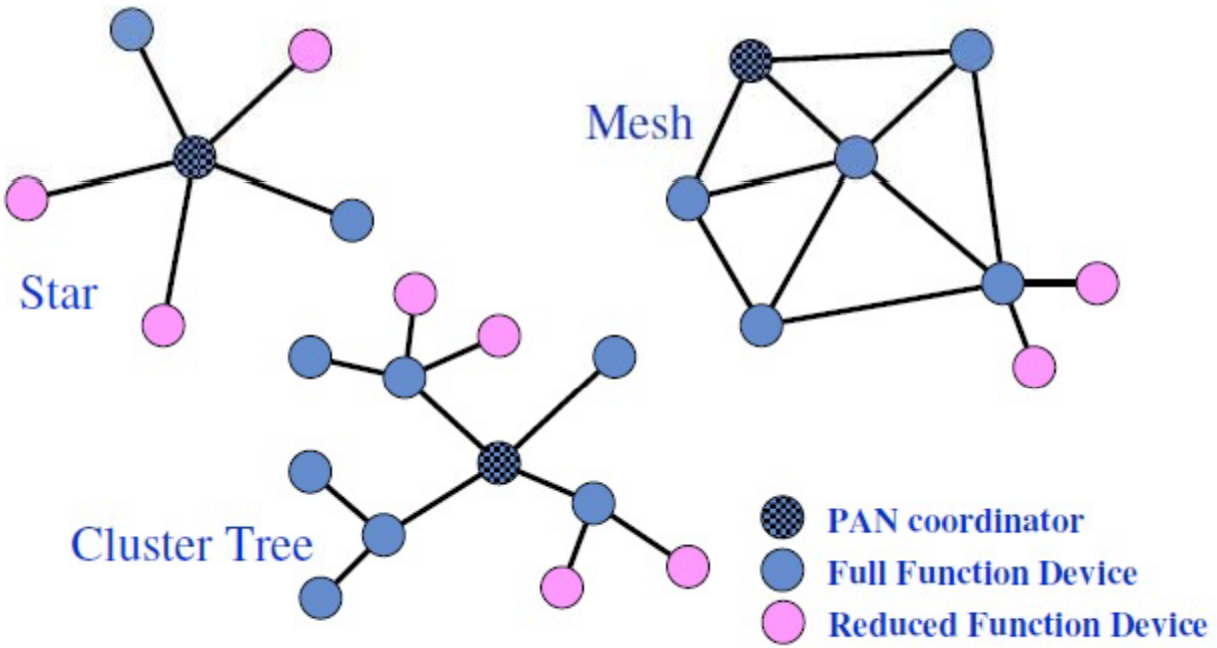


- Parent Piconet Controller
- Piconet device
- Chile/neighbor Piconet Controller
- Independent Piconet controller

PAN Topologies IEEE 802.15.4

- Low rate WPAN(LR-WPAN).
- Data rate 20-250 kbps
- Simple and low cost
- Low power consumption.
- Operate at multiple frequencies
  (i.e. 2.4GHz,868Mhz,915Mhz)
- Widely used for Sensor networks.
- Two types of DEV.s
  - Full functional Device (FFD)
    Coordinator & simple node, support any topology ,can connect to any device.
  - Reduce functional Device (FFD).
    Simple device only, connect to coordinator only, support star topology

PAN Topologies IEEE 802.15.4



End of Section 6.0