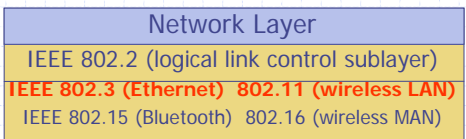


ECE453 – Introduction to Computer Networks

Lecture 8 – Multiple Access Control (II)

1

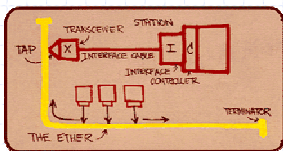
LAN (IEEE 802.x)



2

Ethernet

- ◆ "dominant" LAN technology
- ◆ cheap \$20 for 100Mbps!
- ◆ first widely used LAN technology
- ◆ Simpler, cheaper than token LANs and ATM
- ◆ Kept up with speed race: 10, 100, 1000 Mbps



Metcalf's Ethernet sketch

Read Sec 4.3.10
Retrospective on Ethernet

3

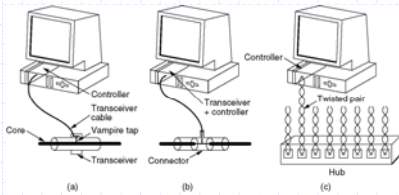
Ethernet

- ◆ Ethernet Cabling
- ◆ Ethernet framing and Manchester Encoding
- ◆ The Ethernet MAC Sublayer Protocol
 - CSMA/CD
 - Binary Exponential Backoff

4

Ethernet Cabling

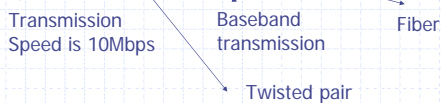
Name	Cable	Max. seg.	Nodes/seg.	Advantages
10Base5	Thick coax	500 m	100	Original cable; now obsolete
10Base2	Thin coax	185 m	30	No hub needed
10Base-T	Twisted pair	100 m	1024	Cheapest system
10Base-F	Fiber optics	2000 m	1024	Best between buildings



5

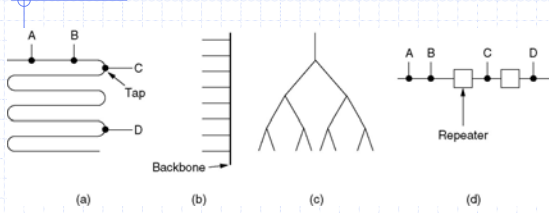
Ethernet Cabling

Name	Cable	Max. seg.	Nodes/seg.	Advantages
10Base5	Thick coax	500 m	100	Original cable; now obsolete
10Base2	Thin coax	185 m	30	No hub needed
10Base-T	Twisted pair	100 m	1024	Cheapest system
10Base-F	Fiber optics	2000 m	1024	Best between buildings



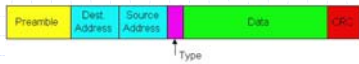
6

Ethernet Cabling – Wiring a Building



7

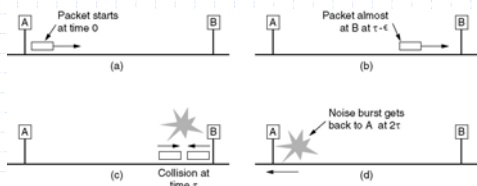
Ethernet Frame Structure



- ◆ Preamble:
 - 7 bytes with pattern 10101010 followed by one byte with pattern 10101011
 - used to synchronize receiver, sender clock rates
- ◆ Type: upper layer protocol
- ◆ Data
 - maximum length 1500 bytes
 - Minimum length 64 bytes (from dest. to CRC)

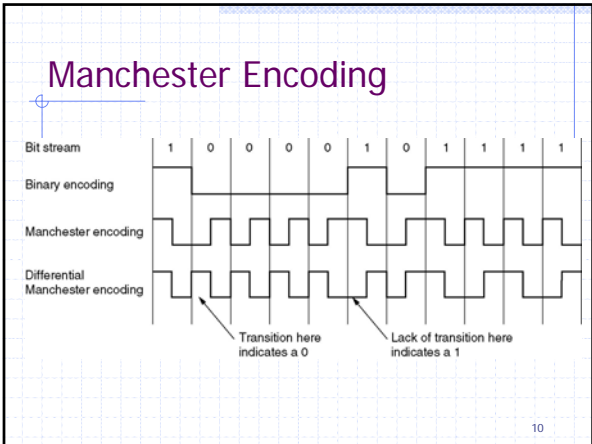
8

Ethernet MAC Sublayer Protocol



Collision detection can take as long as 2τ .

9



- ### Ethernet's CSMA/CD – Binary Exponential Backoff
- ◆ Goal: adapt retransmission attempts
 - heavy load: random wait will be longer
 - ◆ first collision: choose K from {0,1}; delay is K x 512 bit transmission times
 - ◆ after second collision: choose K from {0,1,2,3}...
 - ◆ after ten or more collisions, choose K from {0,1,2,3,4,...,1023}
- 11

10Base2 Ethernet

transmitted packet travels in both directions

see connector

terminator

node node node node node adapter

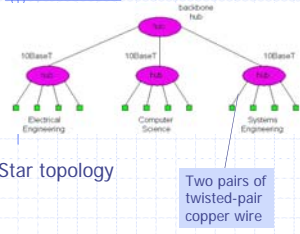
Bus topology

Without a repeater, the maximum length of a 10Base2 bus is 185 meters, the maximum number of nodes is 30.

Repeater can be used to connect 10Base2 segments in a linear fashion. Up to 4 repeaters can be included in a 10Base2 Ethernet

How to connect a dozen PCs in your office using 10Base2 Ethernet?

10/100BaseT Ethernet



Star topology

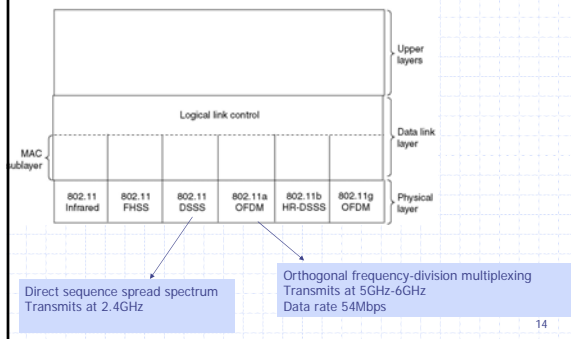
The maximum length of the connection between an adapter and the hub is **100** meters.

Hub has **network management** features

Both 10/100BaseT Ethernet technologies can employ **fiber links**.

13

The 802.11 Protocol Stack

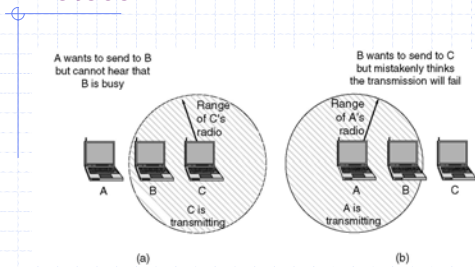


Direct sequence spread spectrum
Transmits at 2.4GHz

Orthogonal frequency-division multiplexing
Transmits at 5GHz-6GHz
Data rate 54Mbps

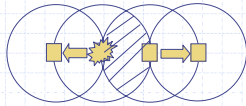
14

The 802.11 MAC Sublayer Protocol



15

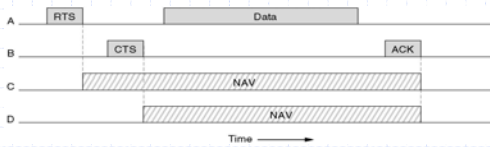
The Exposed Station Problem



16

The 802.11 MAC Sublayer Protocol – CSMA/CA

- ◆ DCF mode (distributed coordination function)
 - RTS, CTS, NAV
 - MACAW
- ◆ PCF mode (point coordination function)
 - Polling frame (beacon frame)



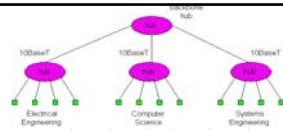
Data Link Layer Switching

- ◆ Hub
- ◆ Repeater
- ◆ Bridge
- ◆ Switch
- ◆ Router

Application layer	Application gateway
Transport layer	Transport gateway
Network layer	Router
Data link layer	Bridge, switch
Physical layer	Repeater, hub

18

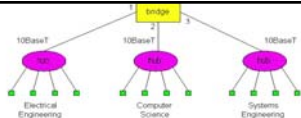
Hub



- ◆ Repeaters with some network management functionality
- ◆ All of the LAN segment belong to the same collision domain
- ◆ The use of backbone hub
 - Provides interdepartmental communication
 - Extends the maximum distance between any pair of nodes
 - A degree of graceful degradation
 - One large common collision domain
 - Cannot interconnect various departments using different Ethernet technologies
 - Restrictions on the maximum allowable number of hosts connected

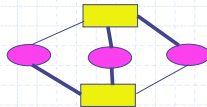
19

Bridges



- ◆ Examines the layer-2 destination address of the frame and attempts to forward the frame on the interface that leads to the destination
- ◆ Each LAN segment is an isolated collision domain
- ◆ Can interconnect different LAN technologies
- ◆ No limit to how large a LAN can be
- ◆ Bridge forwarding and filtering
 - Bridge table
 - Runs CSMA/CD
- ◆ Self-learning
 - Plug and play device
 - Example
- ◆ Spanning tree

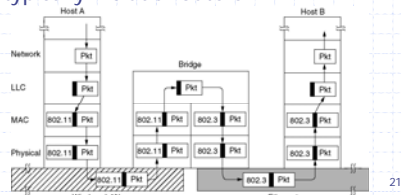
Address	Interface	Time
DD-DD-DD-DD-DD-DD	1	9:32
EE-DE-DE-DD-DD-DD	2	9:45



20

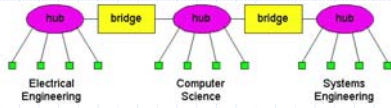
Bridges vs. Routers

- ◆ Typically, small networks consisting of a few hundred hosts having a few LAN segments use bridges.
- ◆ Large networks consisting of thousands of hosts typically include routers



21

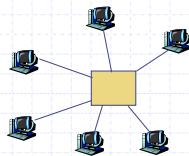
Interconnecting without a Backbone



22

Switches vs. Bridges

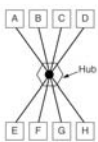
- ◆ More interfaces (dozens of vs. 2/4)
- ◆ No need for medium-access protocol
 - Two pairs of twisted-pair cooper wire
- ◆ Cut-through switching vs. store-and-forward switching



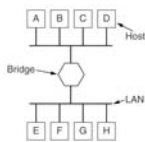
23

A Comparison

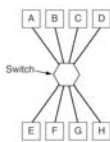
	hubs	bridges	routers	switches
Traffic isolation	no	yes	yes	yes
Plug and play	yes	yes	no	yes
Optimal routing	no	no	yes	no
Cut-through	yes	no	no	yes



(a)



(b)



(c)

24
