High-Speed LANs

http://www.it.usyd.edu.au/~comp5416/
Introduction

- Fast Ethernet and Gigabit Ethernet
- High-speed Wireless LANs
Emergence of High-Speed LANs

- 2 Significant trends
  - Computing power of PCs continues to grow rapidly
  - Network computing
- Examples of requirements
  - Centralized server farms
  - Power workgroups
  - High-speed local backbone
Classical Ethernet

- Bus topology LAN
- 10 Mbps
- CSMA/CD medium access control protocol
- 2 problems:
  - A transmission from any station can be received by all stations
  - How to regulate transmission?
Solution to First Problem

- Data transmitted in blocks called frames:
  - User data
  - Frame header containing unique address of destination station
Figure 6.1

C transmits frame addressed to A

Frame is not addressed to B; B ignores it

A copies frame as it goes by
CSMA/CD

Carrier Sense Multiple Access/ Carrier Detection

1. If the medium is idle, transmit.
2. If the medium is busy, continue to listen until the channel is idle, then transmit immediately.
3. If a collision is detected during transmission, immediately cease transmitting.
4. After a collision, wait a random amount of time, then attempt to transmit again (repeat from step 1).
Figure 6.2

C detects a collision!

A detects a collision!
Preamble: 7 octets of 10101010

SFD: 10101011

Length: the maximum frame size is 1518 octets, excluding the preamble and SFD.

Pad: octets added to ensure that the frame is long enough for collision detection

FCS: 32-bit CRC, based on all fields except preamble, SFD, and FCS
Medium Options at 10Mbps

- **<data rate> <signaling method> <max length>**
- **10Base5**
  - 10 Mbps
  - 50-ohm coaxial cable bus
  - Maximum segment length 500 meters
- **10Base-T**
  - Twisted pair, maximum length 100 meters
  - Star topology (hub or multipoint repeater at central point)
Hubs and Switches

Hub
- Transmission from a station received by central hub and retransmitted on all outgoing lines
- Only one transmission at a time

Layer 2 Switch
- Incoming frame switched to one outgoing line
- Many transmissions at same time
Figure 6.5

(a) Shared medium bus

(b) Shared medium hub

(c) Layer 2 switch
Bridge
- Frame handling done in software
- Analyze and forward one frame at a time
- Store-and-forward

Layer 2 Switch
- Frame handling done in hardware
- Multiple data paths and can handle multiple frames at a time
- Can do cut-through
Layer 2 Switches

- Flat address space
- Broadcast storm
- Only one path between any 2 devices

Solution 1: subnetworks connected by routers

Solution 2: layer 3 switching, packet-forwarding logic in hardware
Figure 6.6
Wireless LAN

- Forming LAN without wires has taken off big time
  - License-free operation
- Specified as IEEE 802.11
- Started with link rate: 1 Mbps → 300 Mbps
  - Different PHYs available 802.11b, a, g, n
- Quality of service is being introduced thru 802.11e → 4 classes
- Mesh networks are formed for broader coverage
IEEE 802.11 Wireless LAN

- **802.11b**
  - 2.4-2.5 GHz unlicensed spectrum
  - up to 11 Mbps

- **802.11a**
  - 5-6 GHz range
  - up to 54 Mbps

- **802.11g**
  - 2.4-2.5 GHz range
  - up to 54 Mbps
  - highly popular

- **802.11n**
  - both 2.4GHz and 5GHz
  - up to 300 Mbps

- All use CSMA/CA for MAC protocol
- All have infrastructure and ad-hoc network versions
Infrastructure Approach

- Wireless host communicates with an access point
- Basic Service Set (BSS) (a.k.a. “cell”) contains:
  - wireless stations
  - one access point (AP)
- BSSs combined to form a distribution system (DS)
Ad Hoc Approach

- No AP!
- Wireless stations communicate with each other
- Typical usage:
  - “laptop” meeting in conference room, car
  - interconnection of “personal” devices
  - battlefield
- IETF MANET (Mobile Ad hoc Networks) working group looks into this approach
  - Special needs such wireless routing, security
IEEE 802.11 MAC Layer

- Two medium access control schemes
  - Distributed Coordination Function - DCF
  - Point Coordination Function - PCF
IEEE 802.11: MAC protocol

- Collision if 2 or more nodes transmit at same time as the wireless channel is shared
- CSMA makes sense:
  - get all the bandwidth if you’re the only one transmitting
  - shouldn’t cause a collision if you sense another transmission
- Thus, it uses CSMA with collision avoidance (CSMA/CA)
  - Not CD because detecting collision is difficult in wireless environment
  - Two-handshaking used
DCF

- Basic access method
- Contention based,
- distributed protocol

- DCF uses CSMA/CA and a random backoff time following a busy medium condition

- Uses RTS/CTS extension
  - to combat the hidden terminal problem
  - to reduce the BW wastage due to packet collision
PCF

- Contention free, centralised access protocol
- Channel access is controlled using polling
- Point coordinator will switch the access mode between DCF and PCF
- Unpopular with vendors, mostly not used!
Summary

- Wired networks have become really fast
- Everything is Ethernet
- End to end is Ethernet
- Wireless networks supplementing wired nets for mobility