


18-345 – Fall 08

Lecture 15

**Local Area Networks Wrap up  
Home Connectivity**

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reading: Chapter 6



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## Ethernets

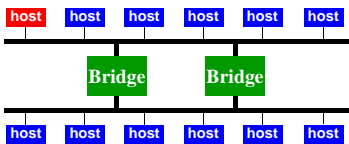

- Original 10 Mbs coax-based Ethernet
- Extend range using
  - Repeaters: still a single collision domain
  - Bridges: separate collisions domains
  - Learning bridges: zero management
- Increase links rates 100Mbs, 1 Gbs, ..
  - Ethernet beats out competitors (FDDI, ..)
- How do we deal with rich topologies?



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## Spanning Tree Bridges

- More complex topologies can provide redundancy.
  - But can also create loops.
- What is the problem with loops?





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## Spanning Tree Protocol Overview

Embed a tree that provides a single unique path to each destination:

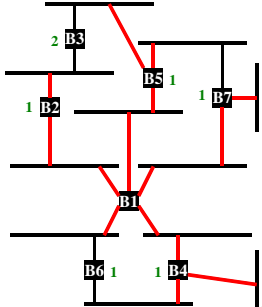

- 1) Elect a single bridge as a root bridge
- 2) Each bridge calculates the distance of the shortest path to the root bridge
- 3) Each LAN identifies a *designated bridge*, the bridge closest to the root. It will forward packets to the root.
- 4) Each bridge determines a *root port*, which will be used to send packets to the root
- 5) Identify the ports that form the spanning tree



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## Spanning Tree Algorithm Steps

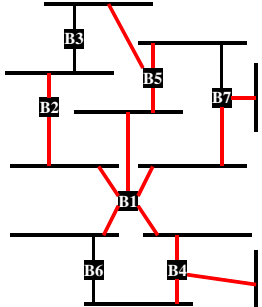

- Root of the spanning tree is the bridge with the lowest identifier.
  - All ports are part of tree
- Each bridge finds shortest path to the root.
  - Remembers port that is on the shortest path
  - Used to forward packets
- Select for each LAN the designated bridge that has the shortest path to the root.
  - Identifier as tie-breaker
  - Responsible for that LAN

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## Spanning Tree Algorithm

- Each node sends configuration message to all neighbors.
  - Identifier of the sender
  - Id of the presumed root
  - Distance to the presumed root
  - E.g. B5 sends (B5, B5, 0)
- When B receive a message, it decide whether the solution is better than their local solution.
  - A root with a lower identifier?
  - Same root but lower distance?
  - Same root, distance but sender has lower identifier?
- After convergence, each bridge knows the root, distance to root, root port, and designated bridge for each LAN.

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## Spanning Tree Algorithm - Part 2

- Each bridge B can now select which of its ports make up the spanning tree:
  - B's root port
  - All ports for which B is the designated bridge on the LAN
- Bridges can not configure their ports.
  - Forwarding state or blocked state, depending on whether the port is part of the spanning tree
- Root periodically sends configuration messages and bridges forward them over LANs they are responsible for.

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## Spanning Tree Algorithm Example

- Node B2:
  - Sends (B2, B2, 0)
  - Receives (B1, B1, 0) from B1
  - Sends (B2, B1, 1) "up"
  - Continues forwarding forever
- Node B1:
  - Will send notifications forever
- Node B7:
  - Sends (B7, B7, 0)
  - Receives (B1, B1, 0) from B1
  - Sends (B7, B1, 1) "up" and "right"
  - Receives (B5, B5, 0) - ignored
  - Receives (B5, B1, 1) - better
  - Continues forwarding the B1 messages forever to the "right"

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## Ethernet Switches

- Bridges make it possible to increase LAN capacity.
  - Packets are no longer broadcasted - they are only forwarded on selected links
  - Adds a switching flavor to the broadcast LAN
- Ethernet switch is a special case of a bridge: each bridge port is connected to a single host.
  - Simplifies the protocol and hardware used (only two stations on the link) - no longer full CSMA/CD
  - Can make the link full duplex (really simple protocol!)
  - Can have different port speeds on the same switch
    - Unlike in a hub, packets can be stored
    - An alternative is to use cut through switching

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## Ethernet Evolution

Early Implementations

- Ethernet or 802.3
- A Local Area Network
- MAC addressing, non-routable
- BUS or Logical Bus topology
- Collision Domain, CSMA/CD
- Bridges and Repeaters for distance/capacity extension
- 1-10Mbps: coax, twisted pair (10BaseT)

Current Implementations

- Switched solution
- Little use for collision domains
- 80% of traffic leaves the LAN
- Servers, routers 10 x station speed
- 10/100/1000 Mbps, 10Gig coming: Copper, Fiber
- 95% of new LANs are Ethernet

CSMA Carrier Sense Multiple Access  
CD Collision Detection

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## Ethernet in a campus network

Today: x 10

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## Virtual LANs

- Single physical LAN infrastructure that carries multiple "virtual" LANs simultaneously.
- Each virtual LAN has a LAN identifier in the packet.
  - Switch keeps track of what nodes are on each segment and what their virtual LAN id is
- Can bridge and route appropriately.
- Broadcast packets stay within the virtual LAN.
  - Limits the collision domain for the packet

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## Connectivity to the Home

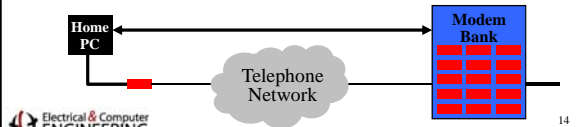

- Modems: leverage end-to-end telephone connections - ubiquitous
- ISDN: ambitious but failed technology
- DSL and Cable Modem: optimize use of existing wires
- Future: wireless?



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## Modems

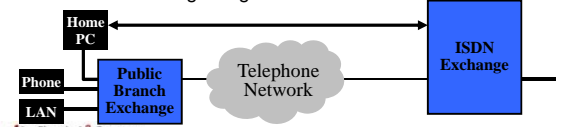

- Modem offers a bit stream.
  - Aggressive signal processing has dramatically increased the available throughput - beats the Nyquist limit!
- SLIP: Serial Line IP.
  - Protocol to sent IP packets with minimum framing
  - Lacks authentication, error detection, non-IP support, ..
- PPP: Point-to-Point Packets.
  - Better framing, error control, and testing support
  - Can negotiate choice of higher layer protocols, IP address
  - Can support unreliable and reliable transmission

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## Integrated Services Digital Network (ISDN)

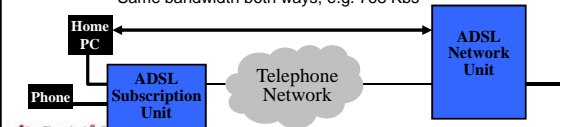

- ISDN integrates voice and data services.
- Provides a set of bit pipes that can be used for voice, data, signaling.
  - Implemented by using time multiplexing
- Basic rate ISDN offers to 64Kbs data bit pipes and one 16 Kbs signaling channel.

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## Digital Subscriber Line

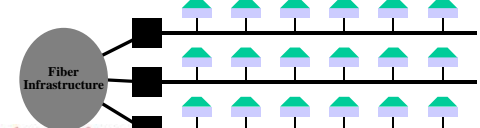

- Squeeze more bandwidth out of the telephone line using advanced signal processing.
- Asymmetric digital subscriber line (ADSL).
  - More "download" bandwidth, e.g. video on demand or web surfing
  - Example: T1 incoming path, 64 Kbs outgoing path
- (Symmetric) digital subscriber line (DSL).
  - Same bandwidth both ways, e.g. 768 Kbs

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## Cable Modem


- Use cable infrastructure for data service.
  - Inherently has more bandwidth
- The last mile is a shared infrastructure that was designed for broadcasting.
  - Meaning: the bandwidth is shared by users
  - Example: 27 Mbs shared incoming path; 768 Kbs common outgoing path

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## Comparison

- Modems use "worst case" technology.
  - Has to fit within any voice channel so encoding suboptimal
- ISDN can be more aggressive.
  - But it is old technology by now
- DSL is highly optimized for the transmission medium.
  - But there are some constraints on distance
- Cablemodem uses a transmission medium that has inherently a higher bandwidth, but the network architecture will limit throughput.
  - Designed for broadcasting, not for point-point connections



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