

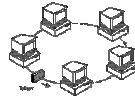
COMP476
Networked Computer Systems

Interconnecting
Networks

LAN – Local Area Networks

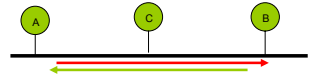
• There is a Limit to the Maximum Length of a LAN

- Ethernet cables (segments) can be up to 500m.
- The restrictions are due to power and propagation delay.



Example: Ethernet and Token Ring

Undetected Collision



A and B might transmit short frames at the same time. They could be done transmitting before they received the other's frame. The transmitters do not detect a collision, but nodes in the middle cannot receive the frame.



A has started to transmit a frame. The first bit of the frame has almost reached node B.



B starts to transmit a frame and immediately notices a collision. A does not know of the collision yet.



A must still be transmitting when the first bits of B's aborted transmission reaches it.

CSMA/CD restriction

- The time to transmit a frame must be greater than twice the time for the frame to travel to the end of the cable.
- If the cable is too long, collisions might go undetected.

$$\frac{\min PacketSize}{transRate} > \frac{2 * length}{2.0 * 10^8}$$

Max Ethernet Cable Length

- Consider a 100 Mbps Ethernet with 72 byte frame.

$$\min length = \frac{\min PacketSize * 10^8}{transRate}$$

$$length = \frac{72bytes * 8bits / byte * 10^8 m / sec}{10^8 bits / sec} = 576m$$

Methods of Interconnecting
Networks

Repeaters

- Physical Layer

Bridges

- Data Link Level

Gateways/Routers

- Network and Higher Level

Repeaters

- Repeaters operate at the Physical Layer.
- Copy individual bits between cable segments.
- Every bit is copied to all segments, including collisions.
- Functions as an amplifier.
- Invisible to computers.
- Ethernet can be extended to 1500m and no more than 4 repeaters between hosts.

Bridges

- Bridges operate at the Data Link Layer.
- Store and forward frames between LANs. Bridges receive a packet and then transmit it on the other side.
- Collisions are not seen on the other side.
- Bridges only forward frames that need to go to the other side (Frame Filtering).
- Bridges *learn* the location of hosts.
- Each segment is shielded from local traffic on the other segments (reduces collisions).

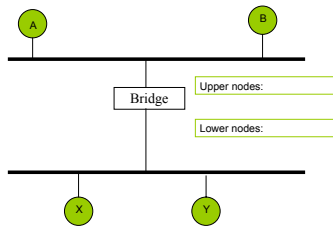
Long Distance Bridging

- Bridges (designed for this purpose) can be connected by a point to point connection (fiber optic line, leased phone line or satellite).

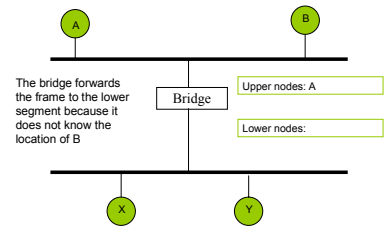
Learning Bridges

- Bridges do not need to be configured. They can be used straight from the box.
- Bridges automatically learn which side of the bridge a computer is located.
- Bridges look at all source addresses to determine where a computer is located.
- If the bridge does know that the destination is on the same side as the source, it will forward the frame.

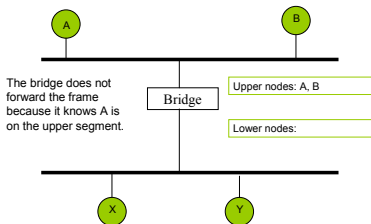
Bridge Learning



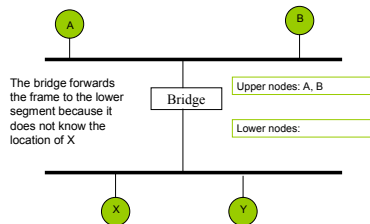
A sends a frame to B



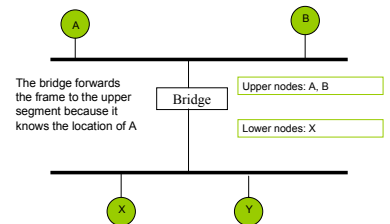
B sends a frame to A



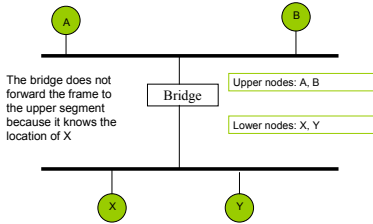
A sends a frame to X



X sends a frame to A



Y sends a frame to X



Gateways/Routers

- Gateways and Routers operate at the Network Layer.
- Store and forward frames between dissimilar networks
- May perform protocol conversion.
- The name Router and Gateway can be used synonymously.

Cycles of Bridges

- **Cycles** of bridges have to be avoided.
- A packet could circulate forever.
- Sometimes it is advantageous to have extra bridges for robustness and performance.
- When a Bridge starts, it communicates with other bridges to learn the configuration.
- Bridges form a *Distributed Spanning Tree* to determine how frames will be forwarded.

Bridge Cycle

