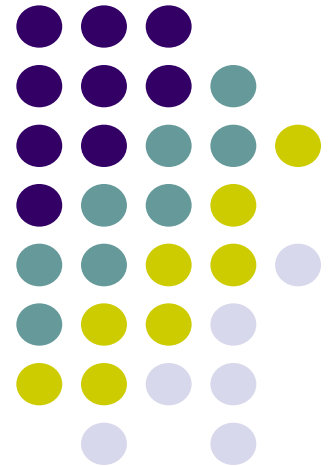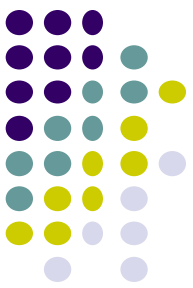# CME 3004 Computer Networks

LAN Active Devices

Distance Limitation in LANs

- A maximum length specification is a fundamental part of LAN technologies

- LAN hardware is engineered for a fixed maximum length cable, and the hardware may not work correctly over a cable exceeding this length

- Electrical signal weakens with distance

- Network designers choose a combination of capacity, delay and distance that can be achieved within a given cost
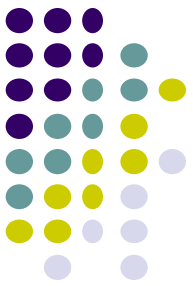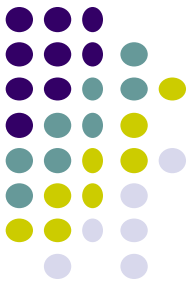
Fiber Optic Extensions

- Fiber modems extend connection between computer and transceiver.
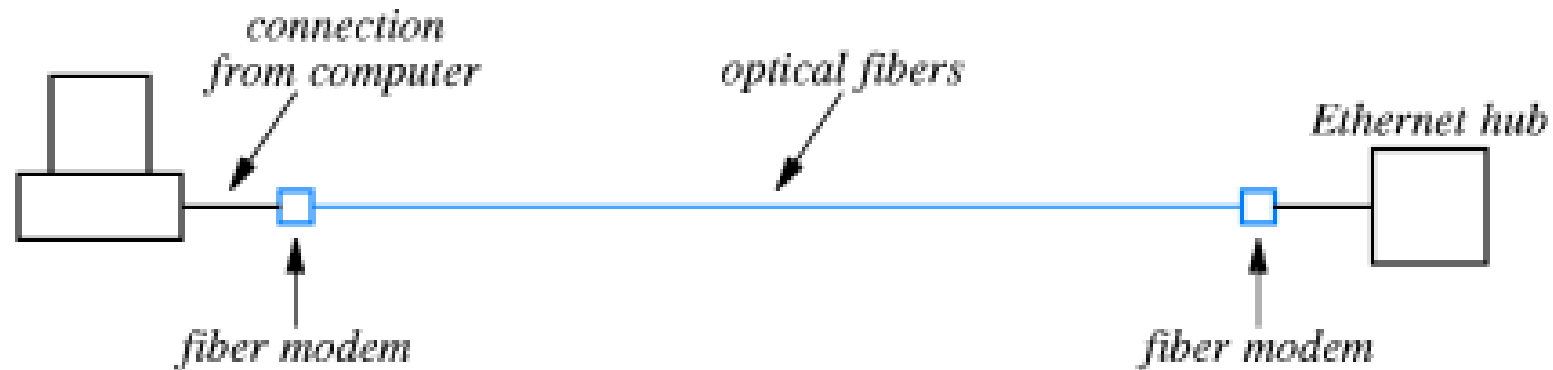
- Because fiber has low delay and high bw, such a mechanism can allow computer to connect to a transceiver that is attached to remote network.
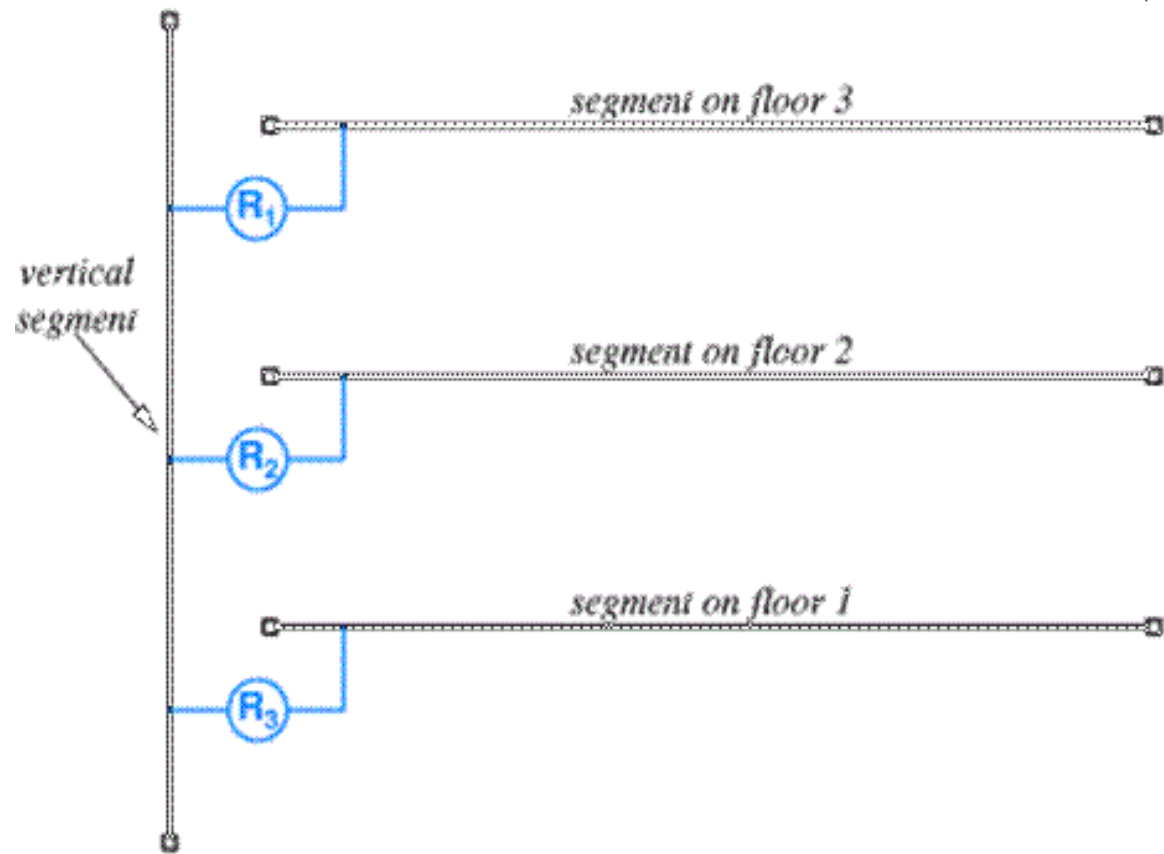
Repeaters

- Repeater is an analog electronic device that continuously monitors electrical signals on each cable
- Join Ethernet cables (segments) together
- Amplified signal - no knowledge of frames
- Deals with signal strength, but not delay

maximum-size Ethernet segment   *maximum-size Ethernet segment*
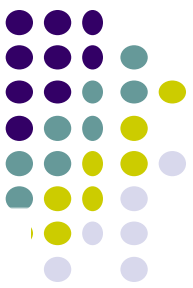
R

direct connection
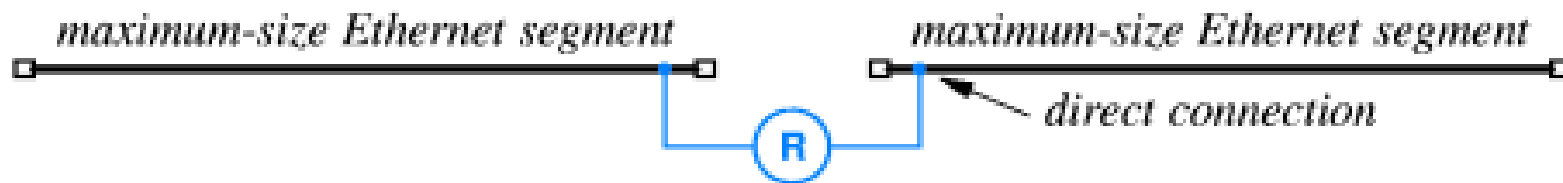
Repeaters

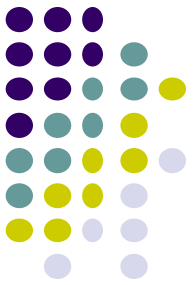● Ethernet standard says no more than four repeaters between two computers

Repeaters used to connect Ethernet segments on three floors of an office building. Each floor has one segment, and one segment is placed vertically in the building.

Repeaters

- Fiber modems can be used between repeaters for long distance extensions

- Biggest problem with repeaters is that they transmit all signals including collisions and noise which limits scalability

- Does not distinguish between the signals that correspond to a valid frame and other electric signals

Bridges

- Connect two segments, but work at the frame level
- Use promiscuous mode and forward all frames
- Don't forward erroneous frames (e.g., collisions and noise)

standard connection
(same as other computers)

segment 1   segment 2

U   V   W   X   Y   Z

B
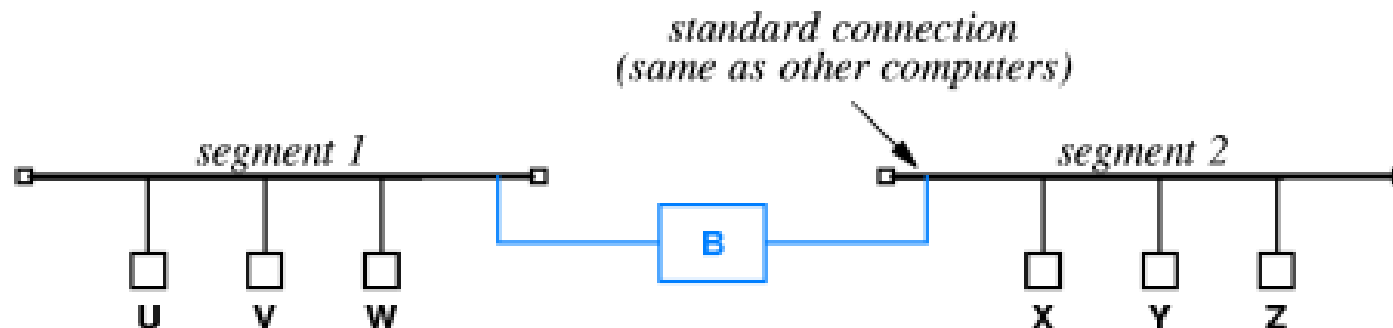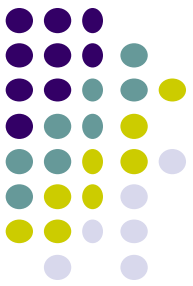
Frame Filtering

- A bridge performs *frame filtering* - it only forwards frames if necessary.

- It uses the source and destination addresses to build up a table of computers attached to each segment.

- Figure illustrates how such an *adaptive* or *learning* bridge learns the locations of computers.

- Bridge Events:

| Event	Segment 1 List	Segment 2 List
Bridge boots	–	–
U sends to V	U	–
V sends to U	U, V	–
Z broadcasts	U, V	Z
Y sends to V	U, V	Z, Y
Y sends to X	U, V	Z, Y
X sends to W	U, V	Z, Y, X
W sends to Z	U, V, W	Z, Y, X

Bridged Network

- Propagation Principle for Bridged Network: In the steady state, a bridge forwards each frame only as far as necessary.

- Because a bridge follows the propagation principle and permits simultaneous activity on attached segments, computers on one segment can communicate at the same time as computers on another segment.

- Performance of bridged network can be maximized by attaching a set of computers that interact frequently to the same segment.

Bridged Network

- Bridges can be used to extend LANs over longer distances, such as between buildings. However, if the buildings are separated by a significant distance, a single LAN may not reach both buildings.

- Optical fibers and fiber modems are used to extend one of the connections between a bridge and a LAN segment.
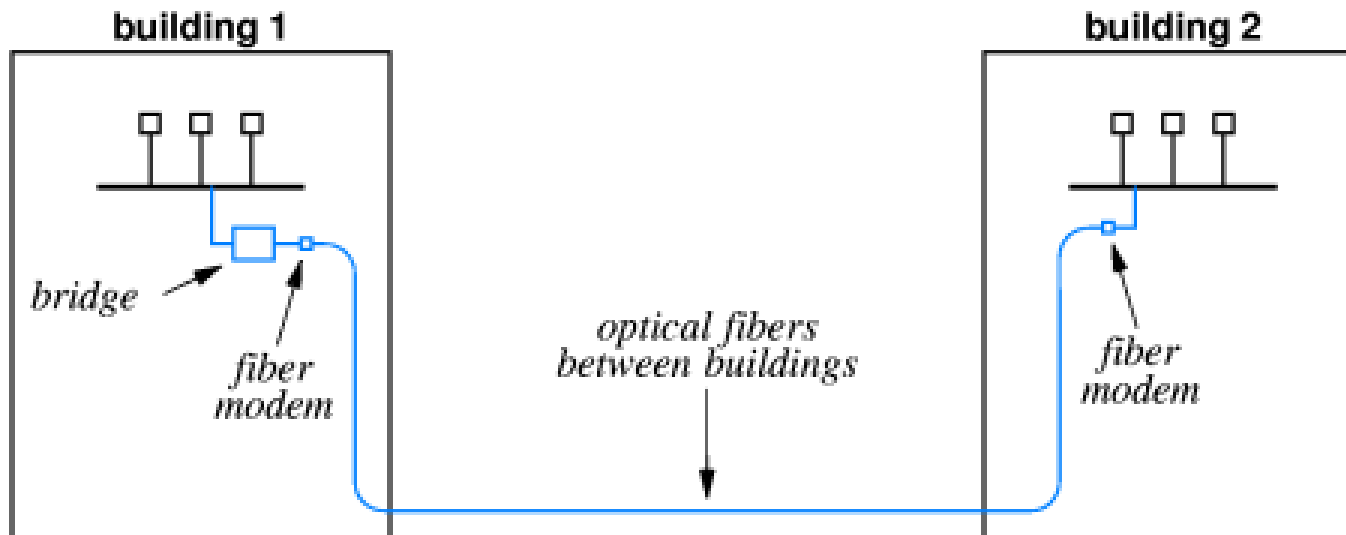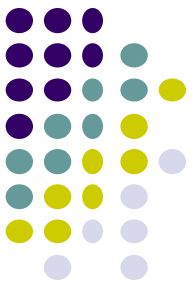
- This use of a bridge and optical fibres has three advantages:
  - Only one fibre connection is required, so the bridge solution is less expensive than using a separate fibre for each computer.
  - Computers can be added or removed from the segments without changing the wiring.
  - The bridge allows simultaneous communication on the two segments.
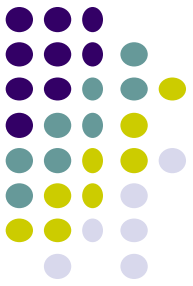
Bridging Across Longer Distances

- In many countries, laws prevent organizations using private optical fibers that cross public streets. It may also be impractical to run optical fibers over long distances.

- A *bridged LAN* provides a solution; the organization places a LAN segment at each site and uses a pair of bridges to connect the segments. A leased serial line or satellite channel can be used.

satellite

segment at site 1   bridge

bridge   segment at site 2
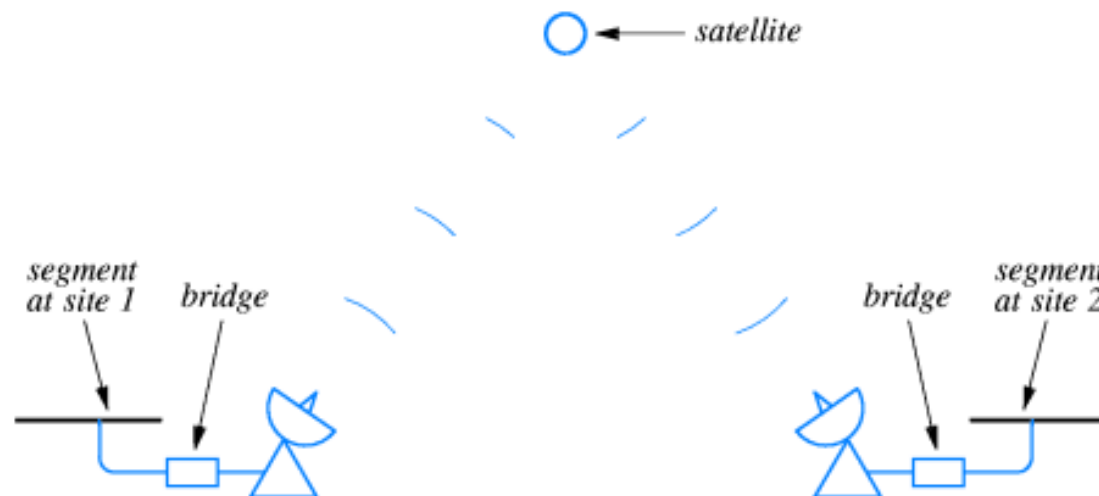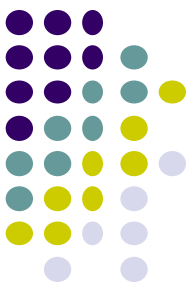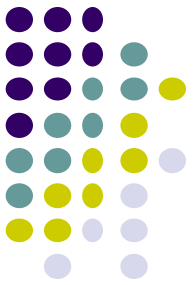
Bridging Across Longer Distances

- A satellite link can span arbitrary distances. Each bridge learns the addresses of local computers and avoids forwarding frames destined for local computers.

- Bridged LANs connected by leased lines often use low-bandwidth connections to save cost, so frame filtering is important.

- Bridges used with long-distance connections may perform *buffering* because frames can arrive from the local segment faster than they can be sent across a satellite link.

- If frames continue to arrive faster than the satellite can send them, the bridge will run out of memory and start discarding frames. However, most communication software waits for a response after it sends a few frames, allowing the bridge time to recover.
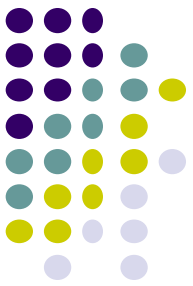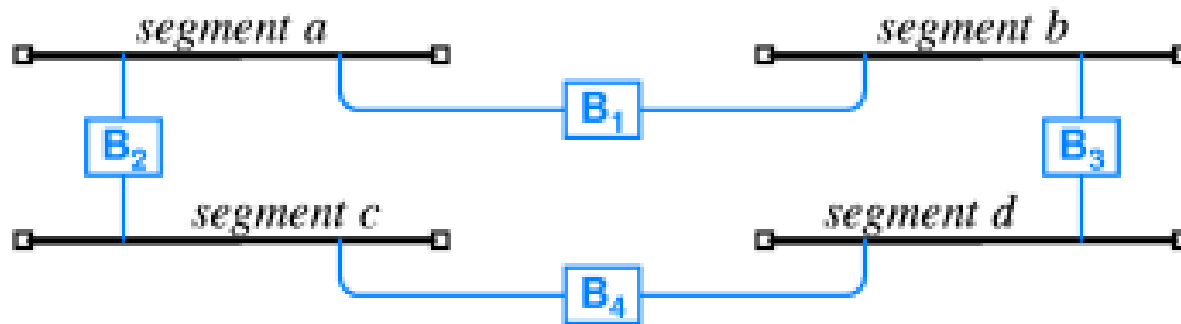
A Cycle of Bridges
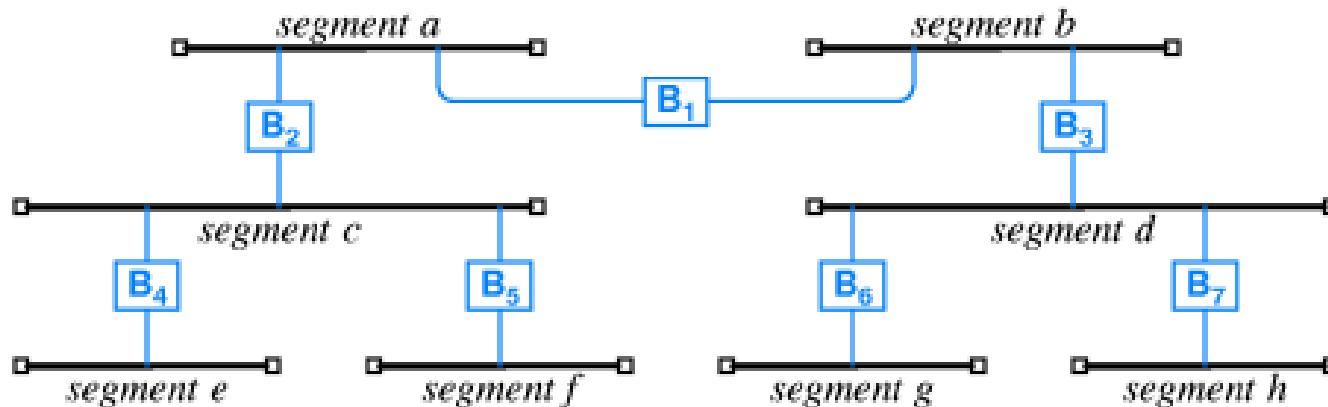
- Altough each bridge introduces a small delay, the network will correctly forward a frame from a computer on any segment to a computer on any other segment.
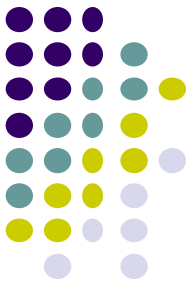
A Cycle of Bridges

- Cycle forever

- To prevent the problem, a bridged network must not allow both conditions:
    - All bridges forward all frames.
    - The bridged network contains a cycle of bridged segments.
- Some of bridges must agree not to forward frames.

Distributed Spanning Tree

- To prevent loops, some bridges automatically agree not to forward frames.

- When a bridge first boots, it communicates with other bridges on the segments to which it connects and the bridges compute the Distributed Spanning Tree (DST) algorithm to determine which bridges will not forward frames.

- DST allows a bridge to determine whether forwarding will introduce a cyle.

- After the DST algorithm completes, the bridges that agree to forward frames form a graph without cycles (i.e., a tree).
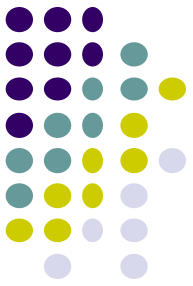
Switching

- A network technology is called *switched* if it includes an electronic device that connects one or more computers and allows them to send and receive data.

- Hub consists of a single box with multiple ports that each attach to a single computer.

Switching

- The difference between switch and hub arises from the way the devices operate: a hub simulates a single shared medium, a switch simulates a bridged LAN with one computer per segment.