

## Extending LAN Networks

- LAN technologies are designed with constraints of speed, distance and costs
- Typical LAN can span a maximum distance of 500 meters
  - ❖ Length of medium affects strength of electrical signals and noise immunity
  - ❖ Length of medium affects fair share access
- How can a network be extended to cover longer distances: campus, base, and office building?

1

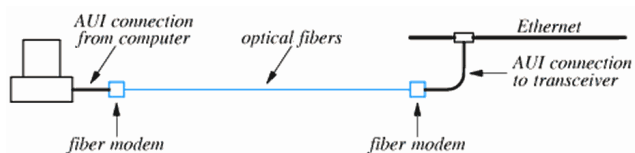
## Extending LAN Networks

- Several techniques extend distance of LAN
  - ❖ Fiber Modem
  - ❖ Repeaters
  - ❖ Bridges
  - ❖ Switches
- LAN signals relayed between LAN segments
- Resulting mixed technology stays within original engineering constraints while spanning greater distance

2

## Fiber optic extensions

- Can extend connection to a computer using fiber optic cable
- Insert fiber modems and fiber optic cable into AUI cable



3

## Repeaters

- Repeater - bidirectional, analog amplifier that retransmits analog signals
- Simply copies signals between segments
  - ❖ Does not understand frame formats
  - ❖ Does not have hardware addresses
- One repeater can effectively double the length of a LAN segment to 1 km



## Limits on repeaters

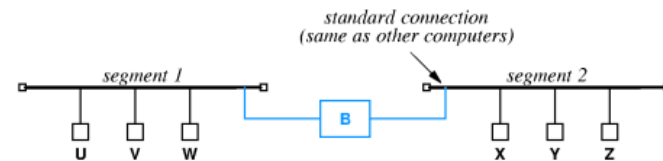
- Repeater simply re-transmit analog signals
  - ❖ Collisions affect entire network
  - ❖ Transient problems - noise - propagates throughout network
- Ethernet standard limited to 4 repeaters between any two Ethernet stations



5

## Bridges

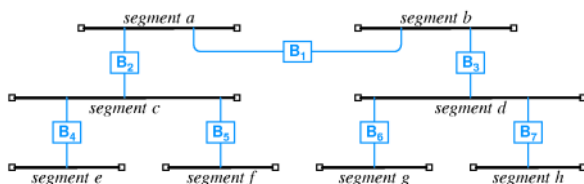
- Also connect two LAN segments
- Both segments must use same protocol.
- Reduces congestion
  - ❖ Doesn't forward frame if destination on LAN segment from which frame received



6

## Multiple bridges

- Can use multiple bridges to interconnect many LAN segments
- Station of segment c sends frames to station on segment g through B2, B1, B3 and B6



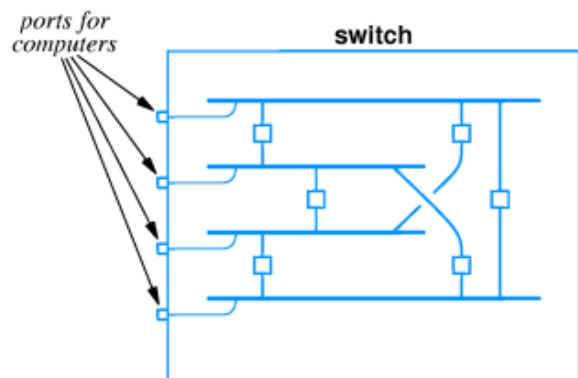
7

## Switch

- Effectively a separate LAN segment for each port
- Similar to hub - hub shares single segment among all ports
- With switching, multiple stations can transmit simultaneously
- Provides much higher aggregate bandwidth but also higher cost per port
- All connected networks must use same protocol

8

## Switch



9

## Gateways

- Used to connect networks that use different protocols
  - ❖ Ethernet to Token Ring
  - ❖ Ethernet to Appletalk
- Operate at OSI Layer 4 and higher

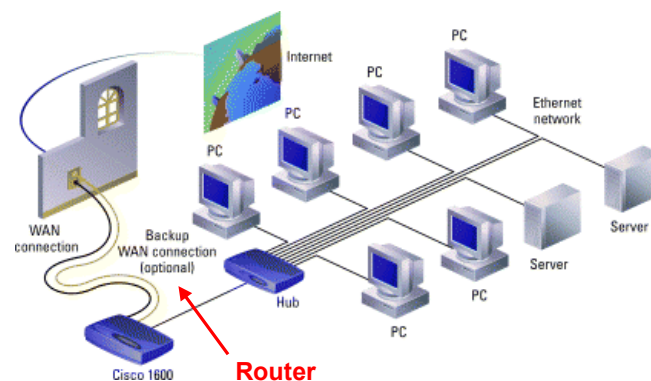
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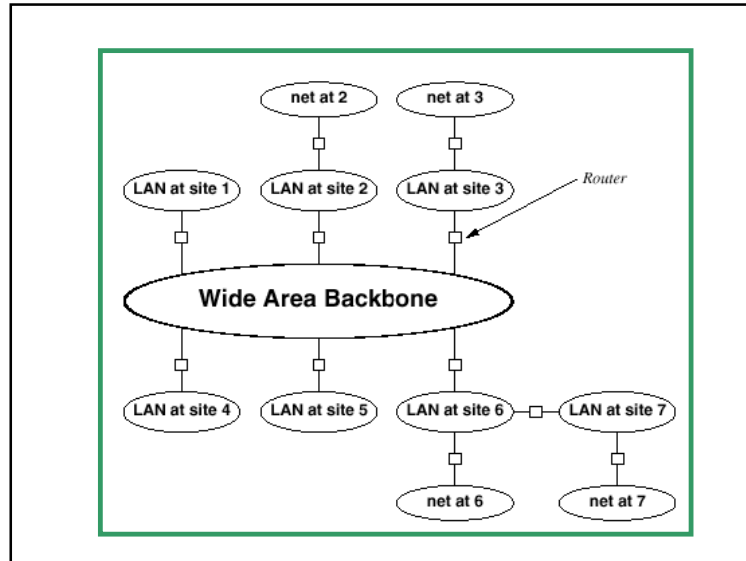
## Routers

- Routers can interconnect different network technologies.
- Routers Can Interconnect WANs and LANs
  - ❖ Least expensive to connect to the Internet
  - ❖ Connect a router to an existing network with Internet connection
- Routers operate at Layer 3 of the OSI model
  - ❖ Used for internetworking using IP protocol
- A dedicated computer used to interconnect multiple networks

11

## Network with Router





## Store and forward

- Data delivery is accomplished through store-and-forward technology
  - ❖ Routers stores incoming packet
  - ❖ Routers forward the packet to another router or computer
- Routers have internal memory
  - ❖ Can hold packet if outgoing connection is busy
  - ❖ Packets for each connection held on queue
- Animation available:  
[http://www.islandman.org/umuc/ifsm450/anim12\\_1.htm](http://www.islandman.org/umuc/ifsm450/anim12_1.htm)

14

## Source independence

- Next hop to destination does not depend on source of packet
- Called source independence
- Allows fast, efficient routing
- Packet switch need not have complete information, just next hop
  - ❖ Reduces total information
  - ❖ Increases dynamic robustness - network can continue to function even if topology changes without notifying entire network

15

## Dynamic route computation

- Network topology may change dynamically
  - ❖ Routers may be added
  - ❖ Connections may fail
  - ❖ Costs for connections may change
- Routers must update routing tables based on topology changes
  - ❖ Switches periodically broadcast topology data
  - ❖ Other switches update routing table based on received information

16