Wired internetworking devices

Unit objectives

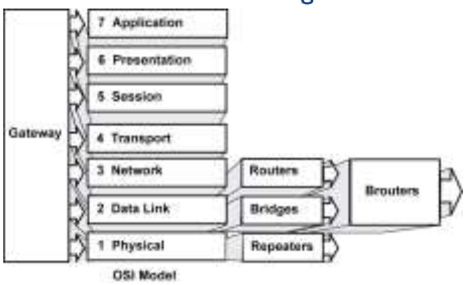
- Differentiate between basic internetworking devices
- Identify specialized internetworking devices

Topic A

- Topic A: Basic internetworking devices
- Topic B: Specialized internetworking devices

1. List two things that could cause the network not to function.
2. What could you do to resolve each of the two possible causes you listed above?
3. How would each of your solutions repair the problems you identified (assuming that they are able to repair the problems)?

Common internetworking devices



Gateway

7 Application

6 Presentation

5 Session

4 Transport

3 Network

2 Data Link

1 Physical

OSI Model

Routers

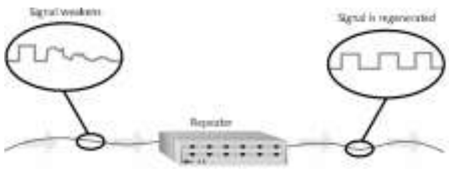
Bridges

Repeaters

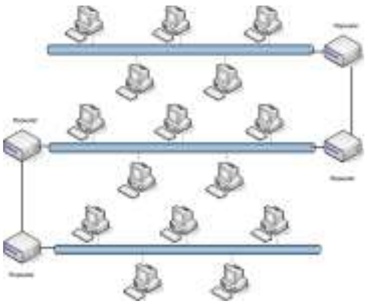
Brouters

Repeaters

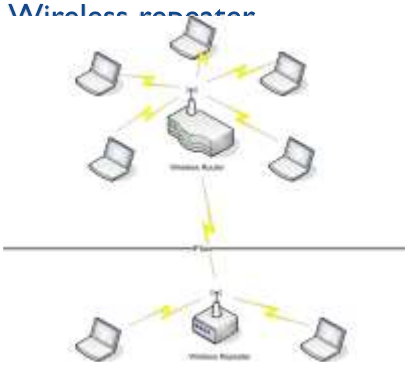
- Boost signal from one segment to another
- Two types
  - Amplifier
  - Signal-regenerating



Repeater placement

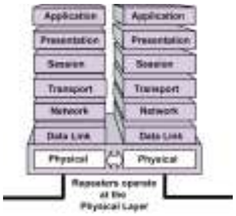


Wireless repeater



Repeater operation

- Physical layer (OSI Layer 1)
- Amplifies signal
- Amplifies noise
- Limited in number of repeaters per segment
- Intelligent repeaters regenerate signal and are immune to attenuation

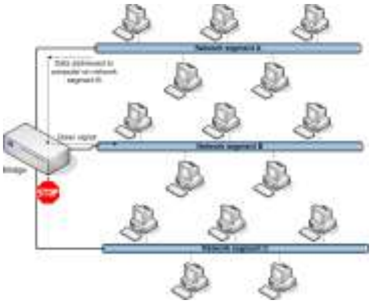

Application
Presentation
Session
Transport
Network
Data Link
Physical

Repeaters operate at the Physical Layer

Repeater issues

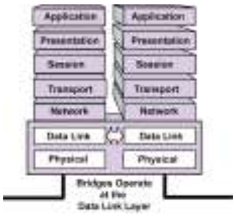
- Signal quality
- Time delays
- Network traffic
- Node limitations

Bridges



Bridge operation

- Data Link layer (OSI Layer 2)
  - Specifically MAC sub-layer
- Transparent to higher-level protocols
- Filter traffic based on addresses


Application
Presentation
Session
Transport
Network
Data Link
Physical

Bridges Operate at the Data Link Layer

Bridge types

- Heterogeneous (translating)
  - Ability to link between dissimilar MAC layer protocols
- Encapsulating
  - Packages frames of one format into the format of another
  - Faster than translation
- Learning (transparent)
  - Automatically identify devices on the segments they connect
  - Listens to replies and creates a table of addresses originating on each segment

Bridge routing management

- Two critical issues
  - Need to know capacities of bridge segments
  - Routing control to protect against redundant messages
- Two common bridge routing algorithms
  - Spanning tree
  - Source routing

Bridge filtering and intelligence

- Looks for other patterns within the frame
- Uses patterns to selectively control forwarding of frames

Local and remote bridges

- Local
  - Has a LAN link directly attached on each side
  - Comparable input and output channel capacities
- Remote
  - Links a local network across a wide area segment
  - Output channel from the remote bridge is usually of lower bandwidth capacity

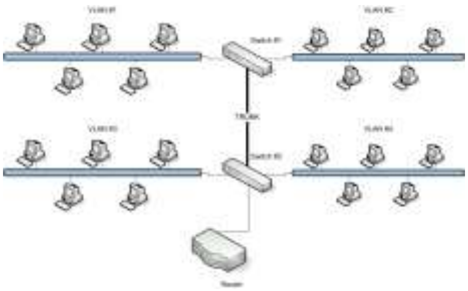
Layer 2 switch

- Also known as data switch or switch
- Operates at Data Link layer
- Implement advanced filtering techniques to optimize performance
- Virtual LAN (VLAN)
- Filtering includes
  - Port-based grouping
  - Address-based grouping
  - Protocol-based grouping
  - Subnet-based grouping
- Can use Power over Ethernet (PoE) technology

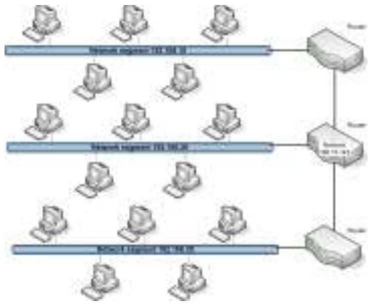
Bridges versus switches

- Bridges have fewer ports to connect network segments
- Modern switches have capability for VLAN trunking
  - Virtualize "n" number of network adapters
  - "n" has a theoretical limit of 4096
  - "n" typically limited to 1000 different VLAN network segments

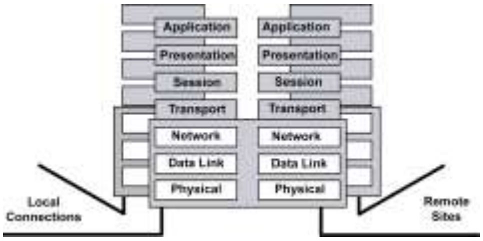
Trunking example



Routers



Router operation



About routers

- Protocol support
  - Early routers supported a single protocol
  - Today multiple-protocol routers support 15 to 20 protocols simultaneously
- Uses tables to route traffic
  - Static or dynamic
- Wide area links need
  - Flow control
  - Multiple-path management
  - Routing decision rules

continued

About routers, continued

- Wide area connection needs a routable protocol
- Multiple (redundant) paths between locations provides
  - Backup
  - Load balancing
  - Full use of available bandwidth
- Use to subnet
  - Increases security
  - Reduces traffic congestion
- Includes programmable management features

Router features

- Inclusion of processor/memory/storage
- Multiple physical interfaces (ports) support
- Multiple protocol support
- Configuration/management (open/proprietary) interface

Key points

- Router connects two or more subnetworks
- Router can be configured to support a single protocol or multiple protocols
- Router only processes packets specifically addressing it as a destination
- Packets destined for a locally connected subnetwork are passed to that network
- Packets destined for a remote subnetwork are passed to the next router in the path
- Router that exists in the same subnet as a host can be configured as a default gateway

Types of routers

- Static
  - Mostly replaced by dynamic
  - Manual configuration
  - Manual updates
  - Can't compensate for changing environments
- Dynamic
  - Use an Interior Gateway Protocol (IGP) to communicate with each other
    - RIP
    - OSPF
    - IGRP and EIGRP
- Path vector protocols
- Default gateways

Routing table contents

- Destination network IP address
- Destination network subnet mask
- Router interface used to get to the network
- IP address of the next router in the path to the destination
- Number of hops to the destination

Routing examples

- Local destination
- Remote destination, next hop known
- Remote destination, next hop unknown
  - Destroys packet
  - Returns ICMP message

Brouters

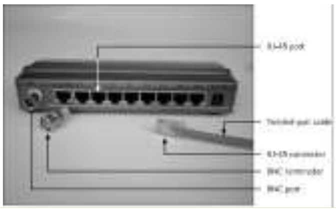
- Operate at
  - Network layer for routable protocols
  - Data link layer for non-routable protocols
- Allows mix of routable and non-routable protocols in a network

Bridges vs. routers

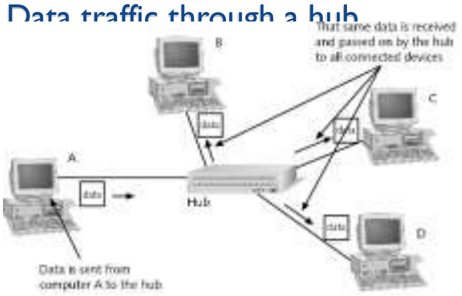
- Preference for routers in WANs
- Bridges can escalate a transient reliability problem into a serious network failure
- Routers don't propagate broadcasts
- Remote bridges pass on all broadcasts
- Network performance problems can lead to broadcast storm

Ethernet hub

- Hubs used to wire Ethernet star
- Operate at Physical layer
- Connects devices that use BNC or RJ-45 connector
- Easy to configure



Data traffic through a hub


That same data is received and passed on by the hub to all connected devices
B
C
A
data
Hub
data
data
data
D
Data is sent from computer A to the hub

Hub types

- Passive
- Active
- Switching
- Intelligent

Token Ring MSAU

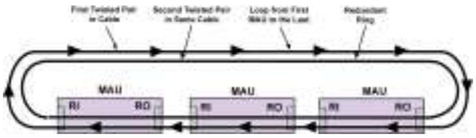
- Supports up to 8 nodes
- Maximum 12 MSAUs per ring
- Local Ring Hub permits four node connections on one MSAU port cable
- 64 - 72 (max.) nodes recommended per ring for optimal performance

Token Ring distances

- Station to MSAU: 45 m
- MSAU to MSAU: 120 m
- MSAU to repeater: 600 m
- Maximum Network Length: 750 m (Type 1 cabling)
- MSAU to Fiber Optic Repeater: 1.5 km

MSAU functions

- Looks like a star, works as a ring
- Two rings
  - One used for token passing between the devices
  - Second is loop of all of the MSAU backup paths, known as a redundant ring
- Redundant ring used when there's a cable break


First Twisted Pair in Cable
Second Twisted Pair in Same Cable
Loop from First MAU to the Last
Redundant Ring
MAU
RI
RO
MAU
RI
RO
MAU
RI
RO

Media converters

- Provides a connection between one network media type and another without changing the channel access method
- Typically a small box approximately 3 × 2 × 0.5 in
- Has an AUI port on one side and any one of a number of connectors on the other side
- Also referred to as media filters

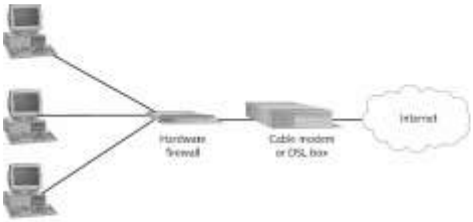
Firewalls

- Hardware or software
- Controls information sent and received from external network
- Resides on gateway
- Gateway might be
  - Router
  - Server
  - Computer

Firewall functions

- Filter data packets by
  - Examining the destination IP address
  - Source IP address
  - Type of protocol used by the packet
- Filter ports so outside clients can't communicate with inside services listening at these ports
- Filter applications so that users inside the firewall can't use particular service over the Internet
- Filter information such as inappropriate Web content for children or employees
- Able to:
  - Set alarms when suspicious activities happen
  - Track suspicious activity in log files
- Range of variations:
  - Personal firewalls to protect a single computer
  - Expensive firewall solutions for large corporations

Hardware firewall

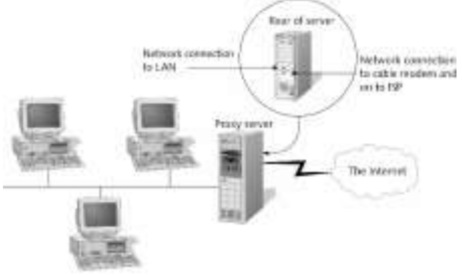


- Stands between a LAN and the Internet

Software firewall

- Good practice for
  - "Always on" computers
  - Computers connected directly to Internet
- Use in conjunction with hardware firewall
- Windows XP SP2 and above includes Windows Firewall

Proxy server


Rear of server
Network connection to LAN
Network connection to cable modem and on to ISP
Proxy server
The Internet

Port and packet filtering

- Port filtering – prevents external software from using particular ports
- Router acting as firewall called screening router
  - Uses stateful inspection
  - Allows only internally requested information through
- Can temporarily disable port and packet filtering, but leaves opening for attack

Topic B

- Topic A: Basic internetworking devices
- Topic B: Specialized internetworking devices

Higher-level switches

- multilayer switch (MLS)
  - Operates at OSI Layer 2 like a basic switch
  - Also provides additional functions at higher OSI layers
- Uses an application-specific integrated circuit (ASIC)
- Operates at wirespeed
- Other terms
  - Layer 4-7 switches
  - Content switches
  - Content services switches
  - Web switches
  - Application switches

Content switches

- Balance HTTP, HTTPS, VPN, and TCP/IP traffic among servers
- Avoid single point of failure
- Uses one of three methods
  - Least connections
  - Round robin
  - Weighting
- Perform NAT at wirespeed
- Provide other higher-level services
  - SSL encryption/decryption
  - Centralizing digital certificate management

IDS and IPS

- IDS installed inside your network
  - Monitors internal traffic and traffic that has passed through your firewall
- IPS installed on perimeter of network
  - Monitors for and stops threats before they are passed on your network
- Both are recommended

IDS

- Uses a monitoring port
- Port mirroring
- Compares traffic to rules you've configured
- Sets alarm for network administrator of suspicious activity
- Most identify threats using:
  - Signature-based detection methods
  - Anomaly-based detection methods
  - Stateful protocol analysis

Malicious traffic detected by IDS

- Network attacks against services
- Data-driven attacks on applications
- Host-based attacks such as unauthorized logins
- Malware such as viruses, Trojan horses, and worms

IPS

- IPS can shut down suspicious traffic on the wire by
  - Terminating network connection or user session
  - Blocking access to targeted host, service, or application from specific user account, IP address, or other attribute
  - Blocking all access to targeted host, service, or application
  - Reconfiguring other devices, such as a firewall or router, to block an attack
- Some higher-end IPS devices can
  - Apply security patches for known vulnerability to network hosts
  - Remove malicious content of an attack

Traffic shapers

- Also called a bandwidth shaper
- Software that controls network traffic to
  - Optimize performance
  - Increase usable bandwidth
- Configure by categorizing traffic and then setting rules for categories

Multiprotocol Label Switching (MPLS)

- Protocol that operates between Layer 2 and Layer 3
- Referred to as a Layer 2.5 protocol
- Can transports data for both circuit and packet-switching clients in IPv4 or IPv6 network
- Works with the IP protocol and IGP routing protocols
- Provides networks with a more efficient way to manage applications and move information between locations
- Features include
  - Simple traffic shaping
  - Ability to create Layer 3 VPNs

Multifunction network devices

- Combines several device functions into one
- Saves space
- More complicated management
- Creates single point of failure risk

Unit summary

- Differentiated between basic internetworking devices
- Identified specialized internetworking devices