Learning Objectives

- Discuss the purpose of LAN transmission equipment
- Explain how LAN equipment works

LAN Transmission Equipment

- NICs
- Repeaters
- MAUs
- Hubs
- Bridges
- Routers
- (Brouters)
- Switches
NIC

- Enables network devices (computers, etc.) to connect to network
  - Convert data into some form of signal and transmit
  - Might be designed to handle more than one cabling system
- Include a MAC address
- 48-bit address represented in Hexadecimal notation
  - 24 first bits for OUI* and 24 other bits for Device ID
  - Example: 00 E0 98 51 9B 03
- NIC components
  - Appropriate connector port (RJ-45, BNC, DB-15, SC, ST)
  - Transceiver (Convert, Transmit and Receive signals)
  - MAC Controller
  - Firmware/Driver

- Requires 2 Transceivers to accommodate 2 different cabling media

Role of MAC Controller

- Works with firmware/driver to correctly encapsulate:
  - Source and destination address information
  - Data to be transported
  - CRC error control information

<table>
<thead>
<tr>
<th>Layer</th>
<th>Function</th>
</tr>
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<tbody>
<tr>
<td>1 Physical</td>
<td>Physical layer functions</td>
</tr>
<tr>
<td>2 Data Link</td>
<td>Data Link layer functions</td>
</tr>
<tr>
<td>3 Network</td>
<td>Network layer functions</td>
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<tr>
<td>4 Transport</td>
<td>Transport layer functions</td>
</tr>
</tbody>
</table>

Q: At which layer(s) of the OSI Model does a NIC operate?

NIC Transport and Transmission Options

- Transport options
  - Unique-speed
  - Combined transport option make it easy to upgrade a network for high-speed communication. Example: 10/100BaseT NIC

- Transmissions options
  - Half-duplex transmissions
  - Full-duplex transmissions
**Expansion slots (bus types) and NICs**

- Industry Standard Architecture (ISA)
- Extended Industry Standard Architecture (EISA)
- Peripheral Computer Interface (PCI)
- Universal Serial Bus (USB)
- SPARC (for Sun Microsystems computers)
- NuBus (for Apple Macintosh computers)

**Choosing a NIC**

Factors to consider when purchasing a NIC:

- Network media and network Access methods in use
- Manufacturer (Brand-name versus non Brand-name)
- Computer or network equipment bus type
- Operating system used by the computer
- Use of half- or full-duplex communications

**Repeater**

- Device that performs the following functions:
  - Filter out signal disturbance and noise
  - Amplify incoming signal
  - Retime signals
- Could be used for interconnecting of 2 or more network segments
Repeater

- Used to reach nodes that are beyond the IEEE standards in use
- Increases number of nodes beyond limit of one segment
- Operates at the Physical layer of the OSI Model: receive & retransmit signals

A Multiport Repeater

Multistation Access Unit (MAU)

- Central collection point that links Token Ring nodes into a topology that physically resembles a star but in which data signals are transferred in a logical ring pattern
MAUs Are Used to…

- Move token and frames around the ring
- Amplify data signals
- Shut down ports to malfunctioning nodes

MAUs operates…

- At the ________ layer of the OSI Model

MAUs and Daisy-Chain configuration

- MAUs have Ring In (RI) and Ring Out (RO) ports

- RI and RO ports enable MAUs to connect with additional MAUs in a daisy-chained manner to expand Token Ring network

(Ethernet) Hub

- Central wiring point that connects network nodes in physical star topology and logical bus topology
- Used in Ethernet networks
- Operates at the ________ layer of the OSI Model

- Receive at a port
- Broadcast out all ports

Q: 3 stations are connected to a 10BaseT hub. What would be the maximum transmission speed in the segment?
Types of Network Hubs

- Managed hubs
- Unmanaged hubs
- Dual-speed hubs
- Stackable hubs
- Active vs. Passive hubs

(Ethernet) Switch

- Central collection point that connects network nodes in physical star topology and logical bus topology
- Operates at the __________ layer of OSI Model
- Receives frame at a port (Physical layer)
- De-encapsulates frame to read Dest. Address (Data Link layer)
- Uses Switching table to determine the destination port
- Transmit frame out destination port to destination station

Switching Techniques

- Cut-through switching
  - Portions of frame sent as soon as Dest. Address read and Dest. Port determined
- Store-and-forward switching (buffered switching)
  - Switch receives the entire frame
  - Switch examines frame for errors using the CRC
  - Switch reads Dest. Address & determine Dest. port
  - Frame is buffered until Dest. port is available
  - Switch transmit frame out Dest. Port

Reduces collisions
Bridge

- Connects different LANs or LAN segments that (usually) use the same access method
- Looks at MAC address and forward packets
- Operates at Physical layer and MAC sublayer of OSI Model

Bridges Are Used to...

- Extend a LAN when maximum connection limit has been reached
- Extend a LAN beyond the length limit
- Segment LANs to reduce data traffic bottlenecks
- Prevent unauthorized access to a LAN
Bridge Functions

- Filtering
- Forwarding

Forwarding table
- MAC Address: A1-44-D55-1F-AA-4C
  - LAN A
- MAC Address: B2-CD-13-5B-E4-65
  - LAN A
- MAC Address: C3-2D-55-3B-A9-4F
  - LAN C

LAN A
LAN B
LAN C

Bridge

Router

- Usually used to connect a LAN to a WAN
- Forwards packets to networks by using decision-making process based on IP/IPX address and:
  - Routing table data (Cost of using the transmission line, Time delay for transmitting data, Size of the queue)
  - Preprogrammed information from network administrator
- Operates at the _____________ layer of OSI model

Incoming Frame
Data Link
Router
Routing table
Packet
Network
Routing table
Data Link
Incoming Port
Outgoing Port

Summary Questions

1. At which layer of the OSI Model do NICs operate?
   a) Physical
   b) Application
   c) Physical and Data Link
   d) a and b

2. In the _______ type of switching, portions of a frame can be sent before the entire frame is received.
   a) Preemptive
   b) Cut-through
   c) Store-and-forward
   d) virtual

3. A _______ operates at the Network layer.
   a) Router
   b) MAU
   c) Switch
   d) Network adapter

4. Define the term “Full-duplex”
Summary Questions

5) Routers can connect to
   a) Ethernet LAN
   b) Token ring LAN
   c) T-1 line
   d) All of the above

6) At which OSI layer does a repeater operate?
   a) Network
   b) Physical
   c) Data Link
   d) Transport

7) T or F: The same NIC can be used for a Token Ring and an Ethernet network.

Other slides
(Source: Panko 2002:127-134)

Internal NICs
Motherboard

- Intel D850MV Desktop Board
- PCI Slots
  For Expansion Boards
  (NICs, etc.)
- Slot for Microprocessor
  (Pentium 4)
- Slots for RAM

Internal NICs Fit into Motherboard Slots

- Expansion Board
  (NIC)
- Connector
- Expansion Slots
- RAM Chips
- Microprocessor
- Mother Board

Internal NICs Fit into Motherboard Slots

- Motherboard Slots
  - PCI slots are predominant
    - Higher speeds
    - Shorter slots
    - Most newer mother boards have only PCI slots
  - ISA slots are traditional
    - Too slow for fast NICs
    - Longer slots
PC Card NICs Fit into Notebook PC Card Slots

USB NICs

- Plug into USB port on outside of computer
- USB allows hot connection/disconnection
  - Connect/disconnect while system is running
- USB does not require opening the systems unit
- USB provides electrical power to external NIC
- USB NICs not popular because most desktops come with NICs, while PC Card NICs make notebooks more easily portable

Token Ring MAU Specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Range</th>
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</thead>
<tbody>
<tr>
<td>Maximum number of stations</td>
<td>50 on a small, movable network</td>
</tr>
<tr>
<td></td>
<td>250 on a large, nonmovable network</td>
</tr>
<tr>
<td>Maximum number of MAUs</td>
<td>17 on a small, movable network</td>
</tr>
<tr>
<td></td>
<td>13 on a large, nonmovable network</td>
</tr>
<tr>
<td>Patch cable minimum distance between MAUs</td>
<td>2.5 meters (approximately 8 feet and 8 inches)</td>
</tr>
<tr>
<td>Patch cable maximum distance between MAUs</td>
<td>STP: 200 meters (approximately 660 feet)</td>
</tr>
<tr>
<td></td>
<td>UTP: 45.3 meters (approximately 150 feet)</td>
</tr>
<tr>
<td></td>
<td>Fiber optic: 1 km (approximately 0.6 miles)</td>
</tr>
<tr>
<td>Maximum distance of a loop cable (from MAU to connected stations)</td>
<td>576 meters (approximately 1900 feet)</td>
</tr>
<tr>
<td></td>
<td>UTP: 40.5 meters (approximately 130 feet)</td>
</tr>
<tr>
<td></td>
<td>Fiber optic: 160 meters (approximately 525 feet)</td>
</tr>
</tbody>
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