Networking Devices

- Punch_down panels
- Hubs
- Switches
- Bridges
- Routes
- Gateways
- Network Interface Cards (NICs)
- Wireless access points
- Modems

Punch_down panels

- Wiring closets
- Labeling schemes
Hubs

- The bottom of the networking food chain
- Connect device and create larger networks
- Small hubs 5-8 ports (workgroup hubs)
- Some hubs have more ports, up to 32 normally
- Direct data packets to all devices connected to the hub - shared bandwidth
- Scalability, Collision, inefficient

Bridges

- Divide larger networks into smaller sections
- Check MAC address, forward or block the data
- Learning bridge builds list of MAC address by watching the traffic on the network.
- Two issues to consider:
  - Placement 80/20 rule
  - Bridging loops
    - IEEE 802.1d Spanning tree protocol
- Types of bridges
  - Transparent bridge
  - Source route bridge
  - Translational bridge
Bridges

- **Source Route Bridge**
  - Used in Token Ring networks.
  - The entire path (ring number and bridge number) is embedded within Packet
    - Search frame
    - Route discovery frame

- **Translational bridge**
  - Used to convert one networking data format to another.
    - For example, from Token Ring to Ethernet and vice versa.

Switches

- Like hub, connectivity points of Ethernet network
- Forward only to the port that connects to the destination device
  - knows MAC address
  - Match the MAC address in the data it receives.
- Fully switched network, a dedicated segment for each device is connected to switch. Expensive.
Switches

• Allow full duplex Ethernet
  – Nodes only communicate with switch, never directly to each other
  – Use twisted pair or fiber optic cabling, using separate conductors for sending and receiving data.
    • collision pair is used to transmit data
    • It was half duplex before – one device can transmit at one given time,
  – double the capacity, 100Mbps become 200Mbps

• Most LAN are mixed with hubs and switches.

Switch routing method

Packet-based switches use one of the following method to route packet.

• Cut-through
  – Forward as soon as it received the destination MAC –
    first 14 bytes
  – Can cause propagation of error

• Store-and-forward
  – Error checked before being forwarded
  – Errors are not propagated through network
    • Bad frames are discarded
  – Error checking takes time.
  – Considerably slower

Switch Routing Method

• FragmentFree
  – Take the advantage of both.
  – Check errors by reading the first 64byte of
    packets where collision most likely happens
  – Offer near cut-through switching performance
Switch physical design

LAN switches vary in their physical design

- **Shared-memory**
  - Common buffer for all ports

- **Matrix**
  - Internal grid with input port and output crossing each other
  - First check MAC, then switch makes a connection where two ports (input/output) intersect

- **Bus-architecture**
  - Common-bus
  - Dedicated buffer for each port and a circuit to control the bus access

Switch and Transparent Bridging

- Most LAN switches use transparent bridging to create address lookup tables
- Transparent bridging is a technology that allows a switch to learn everything it needs to know about the location of nodes on the network within the network administrator having to do anything. Has five parts:
  - Learning
  - Flooding
  - Filtering
  - Forwarding
  - Aging
Virtual LANS

• Network other than physical location
• Reasons:
  – security,
  – projects/Special application
  – Performance/Bandwidth
  – Broadcast/Traffic flow
  – Department/Specific job types
• Login to switch via telnet

• VLANs can span across multiple switches.
• You can have more than one VLAN on each switch.
• To communicate, use process called trunking.
• VLAN Trunking Protocol (VTP) is the protocol that switches use to communicate among themselves about VLAN configuration.
Hub and switch cabling

- To create larger networks, connect hubs and switches using
  - Standard port with special cable
  - Special ports with a standard cable
- Standard port - Medium Dependent Interface-Crossed (MDI-X)
  - Two wires are crossed internally
- Medium Dependent Interface (MDI)
  - To see each other as an extension, no signal to be crossed
- Using crossover cable between two MDI-X ports
  - To uncross the internal crossing
• Check out this page for how to make cat5 cable.
  http://www.tomax7.com/aplus/cat5.htm

• Color codes

<table>
<thead>
<tr>
<th>Pin Number Designations</th>
</tr>
</thead>
<tbody>
<tr>
<td>There are pin number designations for each color in T568B</td>
</tr>
<tr>
<td>The pin designations are as follows:</td>
</tr>
<tr>
<td>Color Codes for T568B</td>
</tr>
<tr>
<td>Pin</td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>1</td>
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<tr>
<td>2</td>
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<td>3</td>
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<td>4</td>
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<td>6</td>
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<tr>
<td>7</td>
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<tr>
<td>8</td>
</tr>
</tbody>
</table>
• The pinouts for a crossover cable

Routers

• Create larger networks by joining two networks segments.
• Dedicated hardware device or computer systems with more than one network interface and routing software.
• Routing table
  – Static routing
  – Dynamic routing
    • Use special routing protocols to pass info to other routers.
    • Distance Vector Routing (RIP)
    • Link state routing (OSPF)
Switch and Router

• Different with router
  – Typically switch works on lower level (Data link Layer) while Router works in higher level (Network Layer)
  – Algorithms for router and switch about how to forward packers are different
    • For example, switch will forward broadcast, so does hub, not router- the address has to be specific.

Routers and Layer 3 Switch

• While most switches operate at the Data link layer (layer2), some incorporate features of a router and operate at the network layer (layer3).
• Layer 3 switches are faster because they are build on “switching” hardware
  – a router is needed for VLANS communication
  – Why not build a router in the switch itself and do the forwarding in hardware
  – EX: IP forwarding – all in hardware
    • Route lookup
    • Decrement the Time to Live (TTL)
    • Recalculation the checksum
    • Forward the frame the frame to correct output port
Gateways

- Any device that translates one data format to another is called a gateway.
  - Router
  - Bridge
  - Software
- Gateway and default gateway
CSU/DSU

- Channel Server Unit/Digital Service Unit (CSU/DSU) or Data Service Unit
- Convert digital format on LAN into signal used on WAN
  - Sit between LAN and access point provided by telecom company
  - Many routers have CSU/DSU functionality

Wireless access points

- Devices that provide connectivity between wireless LAN devices and in most cases a wired network.
- Antennae
- Convert signal from radio wave or other to that used on the LANs.
Modems

- Modulator/Demodulator, convert digital signal generated by computer into analog signals that can travel over conventional phone line.
- Connect to ISP
- Dialing up to a LAN
- Internal add-in expansion cards or external devices connect to serial or USB port
  - PCMCIA cards for laptop
- Speed
  - Modem itself
  - Speed of the Universal Asynchronous Receiver/Transmitter (UART) chip,
    - UART 16950 has the speed of 921,600kbp

Network cards

- Called Network Interface Cards (NIC)
  - Attached to external port
  - PC card
  - Internal Network card
    - System bus compatibility
      - Peripheral Component Interconnect (PCI)
      - Industry Standard Architecture (ISA)
- System Resources – device conflict
- Media compatibility
  - Twisted pair, coaxial or fiber-optic connection?
- Driver
ISDN adapters

- Integrated Services Digital Networking (ISDN) is a remote access and WAN technology that can be used in place of a Plain old telephone systems dial-up link
- Greater speeds than modem, pick up and drop the line considerably faster.
- Require ISDN terminal adapter
  - Although digital signal, different format with the those used on LAN.
  - Create multiple communication channels on a single line.

System area network cards

- Connecting computer systems in a cluster
- High-performance unit.
<table>
<thead>
<tr>
<th>Device</th>
<th>Function/Purpose</th>
<th>Key Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hub</td>
<td>Connects devices on a twisted-pair network.</td>
<td>A hub does not perform any tasks besides signal regeneration.</td>
</tr>
<tr>
<td>Switch</td>
<td>Connects devices on a twisted-pair network.</td>
<td>A switch forwards data to its destination by using the MAC address embedded in each packet.</td>
</tr>
<tr>
<td>Bridge</td>
<td>Divides networks to reduce overall network traffic.</td>
<td>A bridge allows or prevents data from passing through it by reading the MAC address.</td>
</tr>
<tr>
<td>Router</td>
<td>Connects networks together.</td>
<td>A router uses the software-configured network address to make forwarding decisions.</td>
</tr>
<tr>
<td>Gateway</td>
<td>Translates from one data format to another.</td>
<td>Gateways can be hardware or software based. Any device that translates data formats is called a gateway.</td>
</tr>
<tr>
<td>CSU/DSU</td>
<td>Translates digital signals used on a LAN to those used on a WAN.</td>
<td>CSU/DSU functionality is sometimes incorporated into other devices, such as a router with a WAN connection.</td>
</tr>
<tr>
<td>Network card</td>
<td>Enables systems to connect to the network.</td>
<td>Network interfaces can be add-in expansion cards, PCMCIA cards, or built-in interfaces.</td>
</tr>
<tr>
<td>ISDN terminal adapter</td>
<td>Connects devices to ISDN lines.</td>
<td>ISDN is a digital WAN technology often used in place of slower modem links. ISDN terminal adapters are required to reformat the data format for transmission on ISDN links.</td>
</tr>
<tr>
<td>System area network card</td>
<td>Used in server clusters to provide connectivity between nodes.</td>
<td>System area network cards are high-performance devices capable of coping with the demands of clustering applications.</td>
</tr>
<tr>
<td>WAP</td>
<td>Provides network capabilities to wireless network devices.</td>
<td>A WAP is often used to connect to a wired network, thereby acting as a link between wired and wireless portions of the network.</td>
</tr>
<tr>
<td>Modem</td>
<td>Provides serial communication capabilities over phone lines.</td>
<td>Moderns modulate the digital signal into analog at the sending end and perform the reverse function at the receiving end.</td>
</tr>
</tbody>
</table>

**MAC addresses**

- Unique 6-byte address burned info network interface, expressed in hexadecimal
- No matter which protocol is used, MAC address is the means by which the network interface is identified on the network.
- IEEE managing MAC address assignment
  - IEEE has a system Identifying the manufacturer by looking at the MAC address
- Discover MAC address, depend on the OS
  - `Ifconfig /all` on WINDOWs NT/2000
  - `Ifconfig -a` on Linux/UNIX
• Watch the Intel Gigabit demo.