

Networking Devices

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

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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
- [animation](#)
- Scalability, Collision, inefficient

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Switches

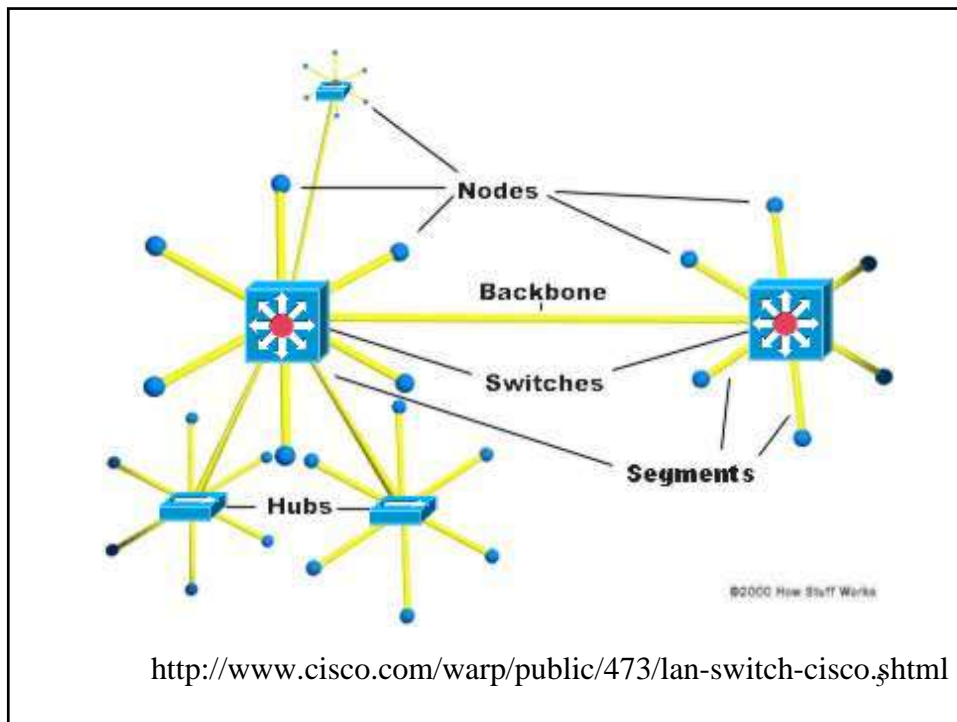
- Like hub, connectivity points of Ethernet network
- Forward only to the port that connects to the destination device
 - knows MAC address
 - Match the MAC address in the data it receives.
- Fully switched network, a dedicated segment for each device is connected to switch. Expensive.

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Switches

- Allow full duplex Ethernet
 - It was half duplex before – one device can transmit at one given time
 - 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.
 - double the capacity, 100Mbps become 200Mbps
- Most LAN are mixed with hubs and switches.

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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 packets are different
 - For example, switch will forward broadcast, so does hub, not router- the address has to be specific.

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
 - 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

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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

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Switch physical design

LAN switches vary in their physical design

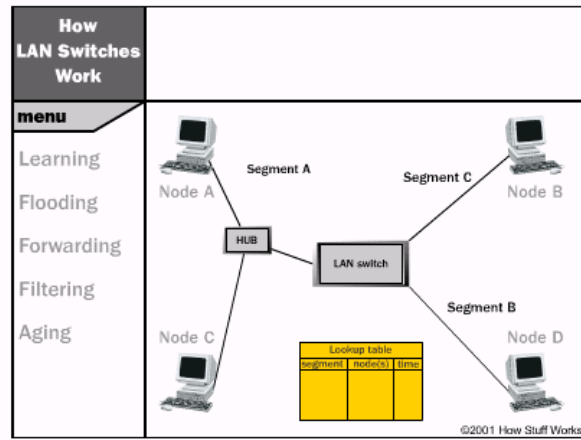
- Shared-memory
 - Common buffer for all ports
- Matrix
 - Internal grid with input port and output crossing each other
 - First check MAC, then switch makes a connection where two ports (input/output) intersect
- Bus-architecture
 - Common-bus
 - Dedicated buffer for each port and a circuit to control the bus access

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Switch and Transparent Bridging

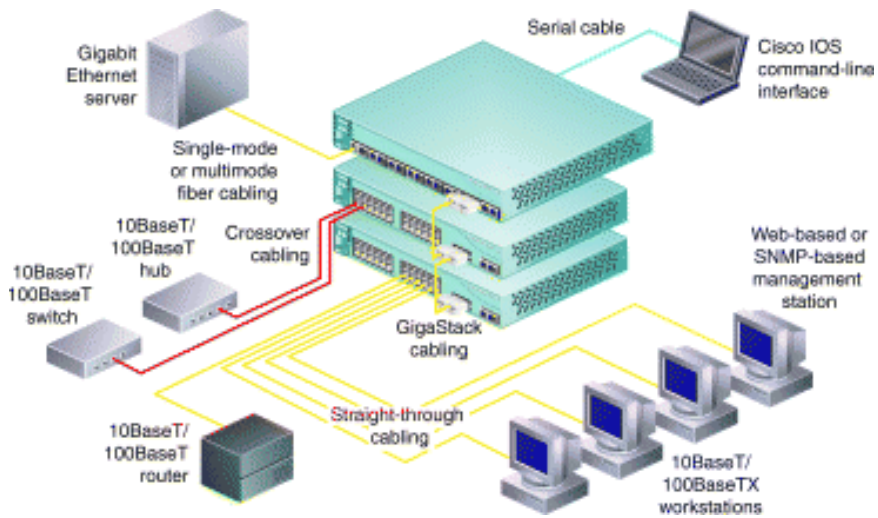
- Most LAN switches use transparent bridging to create address lookup tables
- Transparent bridging is a technology that allows a switch to learn everything it needs to know about the location of nodes on the network within the network administrator having to do anything. Has five parts:
 - Learning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

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<http://www.cisco.com/warp/public/473/lan-switch-transparent.swf>

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<http://www.cisco.com/warp/public/473/lan-switch-cisco.shtml>

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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

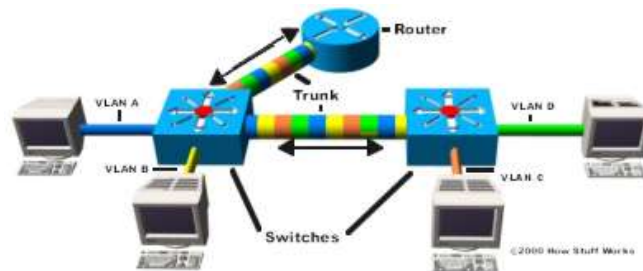
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Virtual LANS

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

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- 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.



<http://www.cisco.com/warp/public/473/lan-switch-cisco.shtml>

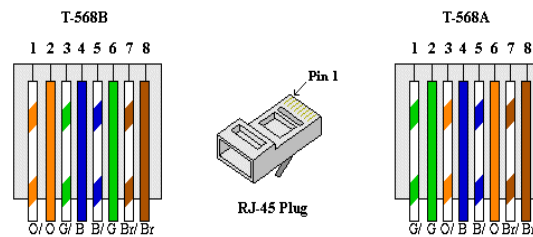
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Hub and switch cabling

- 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

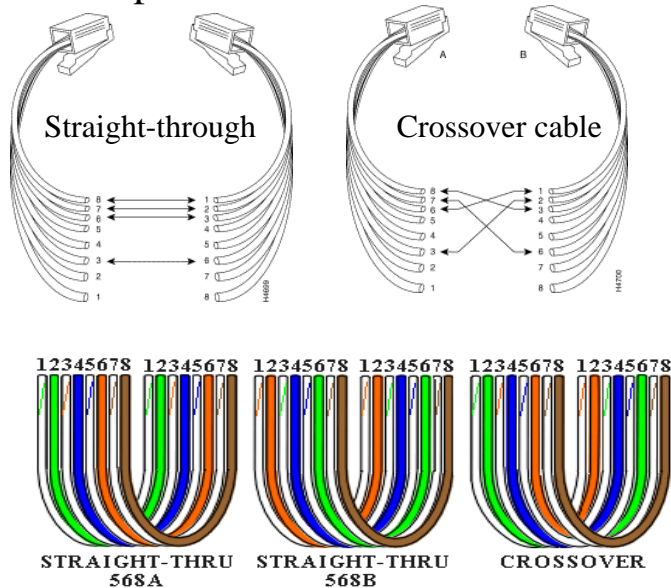
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- Check out this page for how to make cat5 cable.
<http://www.tomax7.com/aplus/cat5.htm>
- Color codes



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- The pinouts for a crossover cable



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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

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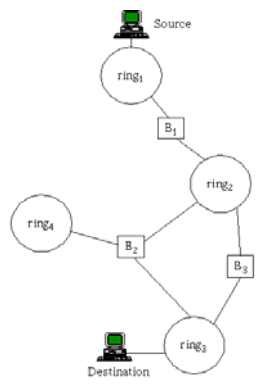
Source route bridge

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.



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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)

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Gateways

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

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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

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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.

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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 921,600kbps

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Network cards

- Called Network Interface Cards (NIC)
- 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

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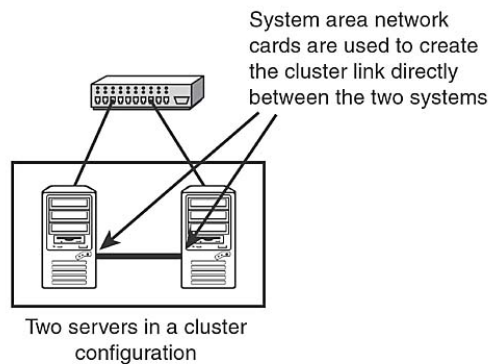
ISDN adapters

- 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 considerable faster.
- Require ISDN terminal adapter
 - Although digital signal, different format with the those used on LAN.
 - Create multiple communication channels on a single line.

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System area network cards

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

MAC addresses

- Unique 6-byte address burned into 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

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- Watch the Intel Gigabit demo.
 - <http://www.intel.com/network/connectivity/resources/demos/gigabit/base.swf>