

Network Hardware Components

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Transceivers

- Function : transmit and receive signals simultaneously
- Serve as :
 - Physical connection
 - Electrical interface between a node and the physical medium





Transceivers (2)

- Usually integrated into NIC (network interface cards)
- Support UTP, ThinWire or Fiber-optic cable connection
- AUI : Attachment Unit Interface → allows a device to be connected to UTP, thick or thin coaxial, or fiber-optic cable via external transceiver

Transceivers (3)

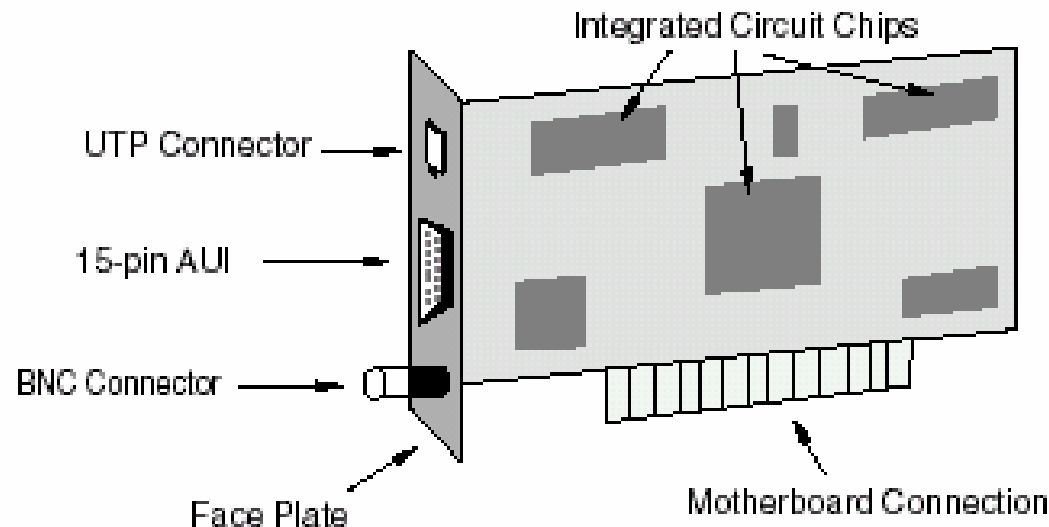
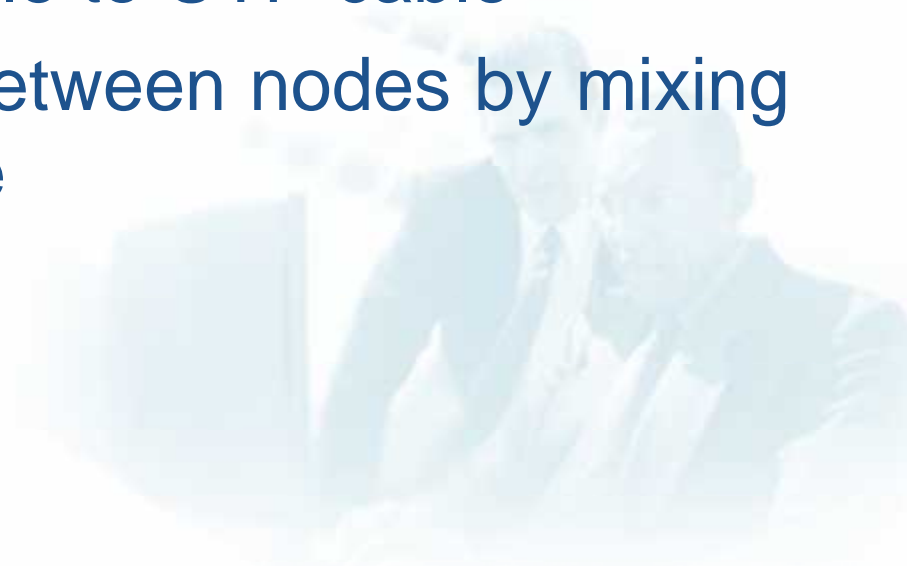


FIGURE 6.5 Sample Ethernet network interface card. This NIC can support any one of three media types: UTP, transceiver cable via an AUI, and ThinWire. NICs are installed into a node by inserting them into an expansion slot on the motherboard.



Media Converters

- Function : enable different network media to be connected to one another
- Position : layer-1 devices
- Examples :
 - Connect a coaxial cable to UTP cable
 - Extend the distance between nodes by mixing copper and fiber cable





Repeaters

- Also called concentrators
- Function : to regenerate and propagate a signal
- Examples : to extend the length of the LAN, because cables have a maximum length, in order to provide good signal quality





Repeaters (2)

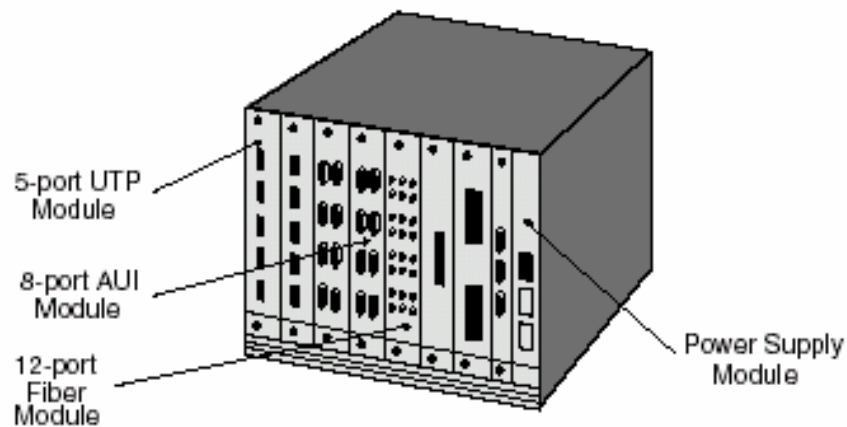


FIGURE 6.8 This multislotted chassis-based repeater hub (also called a concentrator) can accommodate several different media types, including UTP, coax, and fiber. Since each interface module shares the same backplane as the repeater module, the Ethernet ports on each module use the same repeater. Thus, repeater hubs are capable of supporting many Ethernet connections using only a single repeater. For example, if one of the modules is a 12-port ThinWire board, then this one board can support 12 separate 185-meter ThinWire segments. Since 30 devices can be connected to one ThinWire segment, this board can support $12 \times 30 = 360$ nodes.



Repeater vs Hub

- Hub is a device that connects two or more network segments
- Functions : repeater hub, switching hub, bridging hub, etc
- Not all hubs are repeaters, but every repeater is a hub





Repeater vs Hub (2)

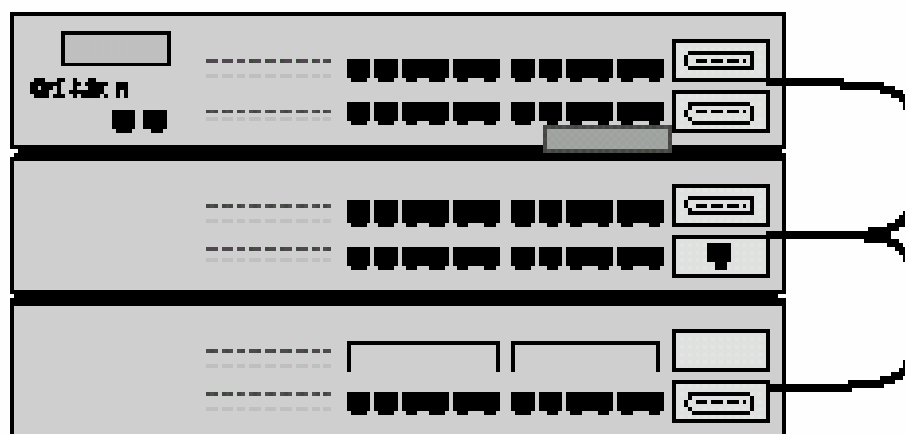


FIGURE 6.9 Stackable hubs are daisy-chained together using an external cable, which enables them to function as a single hub.

Repeater vs Hub (3)

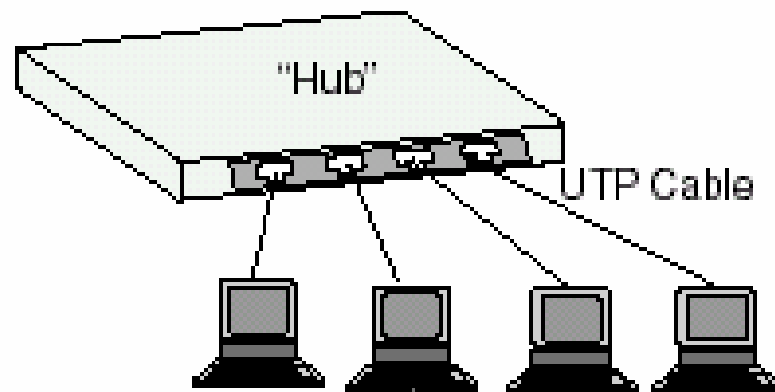


FIGURE 6.10 A four-port "hub." Without any type of qualification, we do not know if this is a repeater hub or a switch hub.

Repeater vs Hub (4)

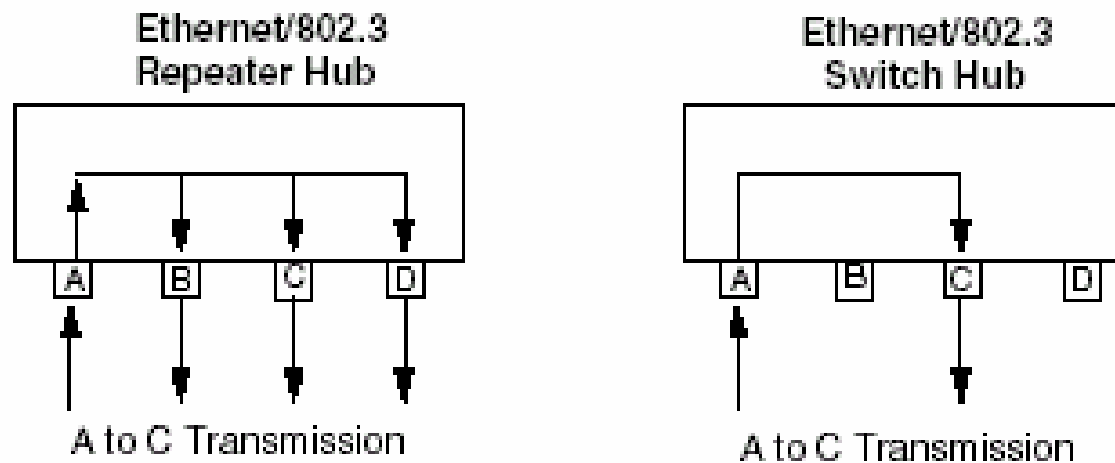


FIGURE 6.11 In a repeater hub, if data on port A are destined to port C, all ports receive the data. In a switch hub, if data on port A are destined to port C, only port C receives the data.



Network Interface Cards

- Abbreviated as NIC
- Also called LAN adapters, network adapters, network cards, network boards
- Operate at layer-2 of the OSI Model (data link layer)
- NIC also have layer-1 components, and hence perform layer-1 activities in addition to layer-2 activities
- Not all computer boards have NIC as integral parts, usually NIC are in form of expansion cards



Purchasing Considerations

- Data bus : 8/16/32 bit → must match the processor (XT, 386 or Pentium)
- On board Processor, RAM or both : provide better performance
- On board LEDs : provide diagnostic information and activities
- Auto sensing of 10/100 Mbps ethernet
- Support full duplex networking
- Compatible with system bus architecture (ISA/PCI)
- Availability of software drivers for O/S requested



PC Cards

- Also known as PCMCIA (Personal Computer Memory Card International Association) Cards
- Multipurpose plug-in devices : network adapter (LAN/Modem/Fiber optic) or storage
- Types :
 - Type I : 3,3 mm thick for memory expansions
 - Type II : 5 mm thick for network adapters
 - Type III : 10.5 mm thick for miniature hard disks or wireless NICs
 - Type IV : 16 mm thick for large hard disks

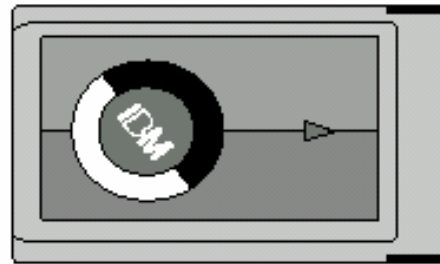


FIGURE 6.12 PC cards are multipurpose plug-in devices for portable computers and can be used as memory devices, modem and network adapters, or hard disk drives.



Bridges

- Function : interconnect two or more individual LANs or LAN segments having different physical layers.
- Bridges also connect networks using either the same or different type of architecture (ethernet to ethernet, token ring to token ring, or ethernet to token ring)
- Position : Layer-2



Bridges (2)

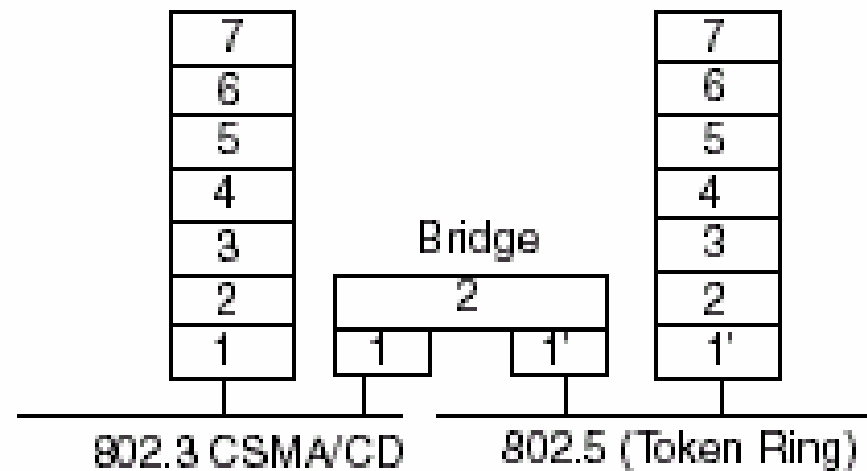


FIGURE 6.13 OSI representation of a bridge. Bridges can connect networks using different architectures such as Ethernet and token ring.



Bridges (3)

- Bridges are transparent to protocols operating at higher layers → two networks based on different protocols connected to the same bridge are viewed as a single logical network
- Bridges are susceptible to broadcast storm (several broadcasts are transmitted at the same time). Broadcast storm can use up a substantial amount of network bandwidth, can cause a network to crash or shut down



Bridges (4)

- Bridges are *store-and-forward* devices. They capture an entire frame before deciding whether to filter or forward the frame.
- This provides a high level of error detection





Bridge Standards

- Transparent Bridge : used in IEEE 802.3 ethernet and 802.5 token ring networks
- Source-routing bridge : introduced by IBM, using extensively in token ring networks





Transparent Bridges

- Operating in promiscuous mode : captures every frame that is transmitted on all the networks to which the bridge is connected
- The bridge examines every frame it receives and extracts each frame's source address, which is then added to a "learned address" maintained by the bridge. Eventually this table contains an entry for each unique source address and the port on which the frame is received

Transparent Bridges

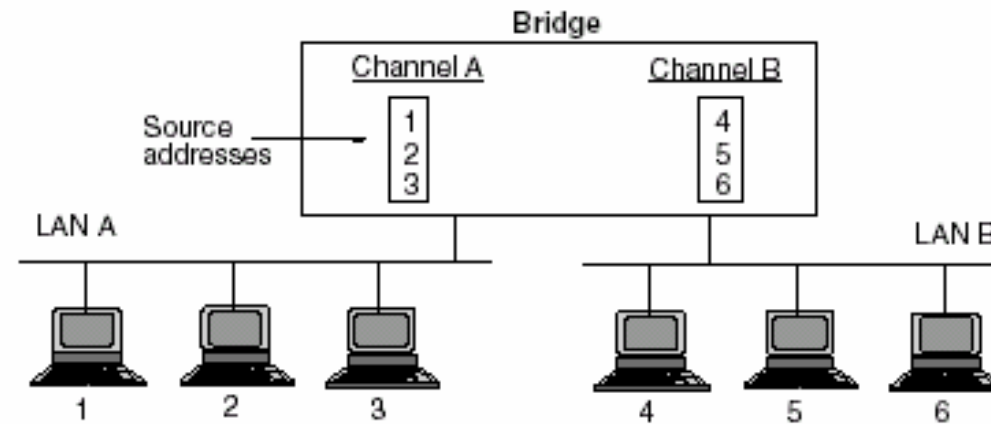


FIGURE 6.14 Bridges interconnect separate networks, making them appear as a single network. Operating at the data link layer, a bridge builds a table of hardware addresses that identifies the address of each node and the segment to which a node is attached. Using this table, a bridge either forwards a frame from one network to the other or discards the frame depending on whether the destination node is local or remote. For example, a frame from node 3 to node 1 does not get forwarded to channel B. Thus, none of the nodes on LAN B “sees” node 3’s transmission.

However, a frame from node 3 to node 5 is forwarded from channel A to channel B. A bridge will, however, forward any broadcast frames from LAN A to LAN B, and vice versa.



Source Routing Bridges

- The sending machine is responsible for determining whether a frame is destined for a node on the same network or on a different network
- If for different network → the sending machine designates high-order bit of the group address bit of the source address to 1.
- A source routing bridge can ignore frames that have not been marked

Source Routing Bridges

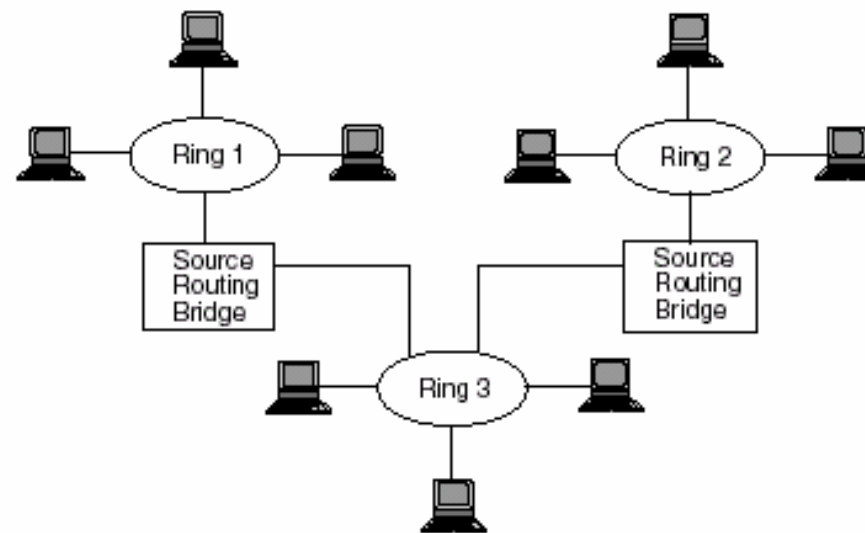


FIGURE 6.15 Bridges used to interconnect separate token ring networks are called source routing bridges. As is the case with transparent bridges used in Ethernet/802.3 networks, source routing bridges copy frames from one ring to another. They also retransmit frames to the next station on the same ring. Unlike transparent bridges, source routing bridges depend on the sending station to provide routing information for frames destined for a different network.



Spanning Tree

- Networking loops can occur on a network having more than one bridge.
- To prevent loops, the bridges communicates with each other and establish a map of the network to derive what is spanning tree of the network



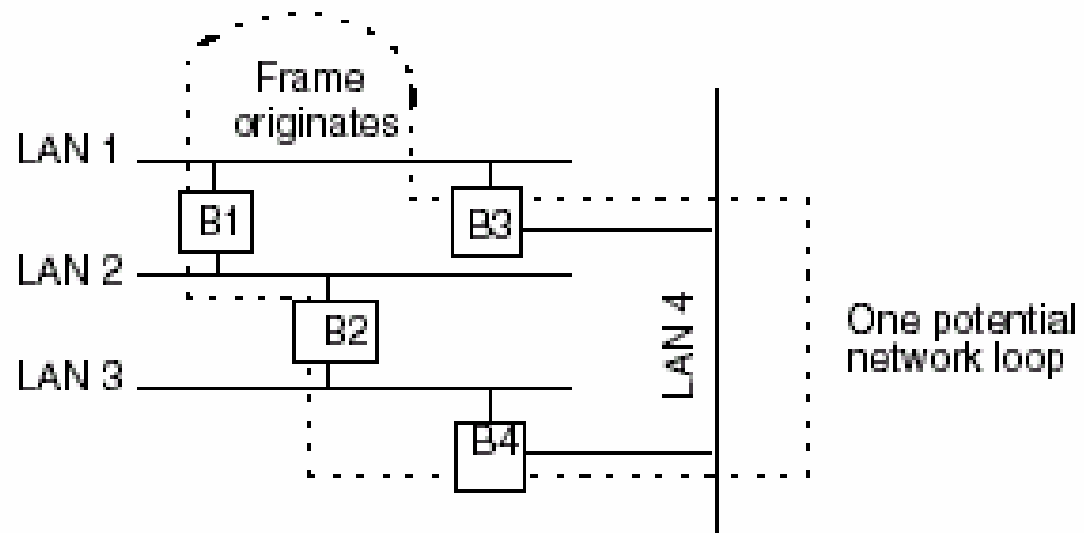


FIGURE 6.16 A possible network loop.



Switches

- A network switch is a device that performs switching
- Repeaters and bridges are designed for shared media LANs, while switch permits multiple, simultaneous data transmission paths between ports.
- Each port is assigned a specific MAC (Medium Access Control) Address



Store-and-Forward Switch

- Also referring as buffering switch
- It waits until it receives an entire data frame before forwarding it.
- When the switch receive a frame, it performs an integrity check (checking for errors), and then extracts the destination address, performs and address table lookup to identify the destination port

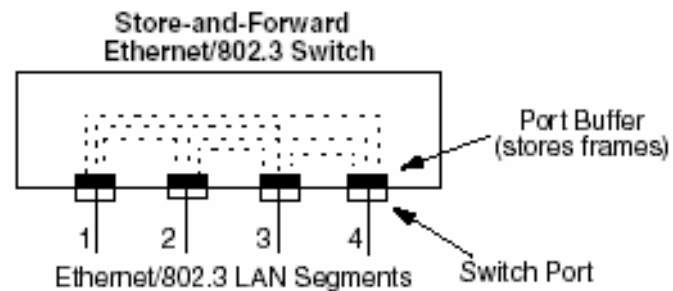


FIGURE 6.17 A store-and-forward Ethernet switch has buffers at each port. When a frame enters a port from a segment, the switch stores the frame in that port's buffer until the entire frame is received and checked for errors. If the frame is error-free, the destination address is identified and the frame is placed at the destination segment's port without any other port seeing the transmission. Source: adapted from Majkiewicz, 1993, and Sharer, 1995.



Cut through switch

- If a frame arriving at one port in the switch is to be transmitted to a different port, the switch begins this transmission as soon as it reads the destination address of the frame
- Improves performance by reducing delays
- Can be implemented using a crossbar or backplane design

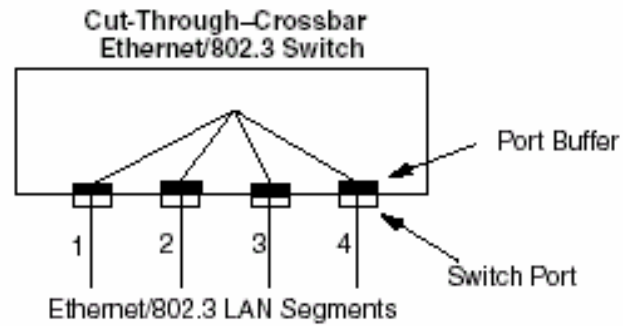


FIGURE 6.18 Cut-through Ethernet switches transmit frames as soon as the destination address is known. In the crossbar design, the data paths connecting the ports are all interconnected. If this path is busy with a current transmission, delays will occur. Source: adapted from Majkiewicz, 1993, and Sharer, 1995.

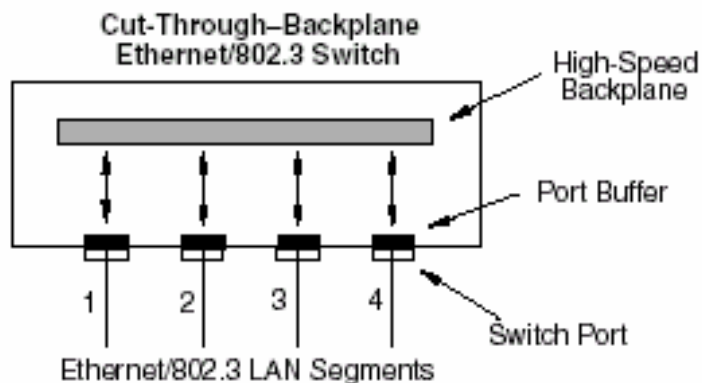


FIGURE 6.19 Backplane-based cut-through Ethernet switches also transmit frames as soon as the destination address is known. In the backplane design, though, data frames are placed on a high-speed backplane for transmission. The speed of this backplane is greater than the aggregate throughput of the switch. If a destination port is busy, the frame remains on the backplane; this eliminates the kind of delays inherent in the crossbar design. Source: adapted from Majkiewicz, 1993, and Sharer, 1995.



Hybrid Switch

- Integrates the best features of the store-and-forward and cut-through designs
- Change automatically from cut-through switch to store-and-forward switch if error rates exceed a user-defined threshold

