Networking and Internet Services

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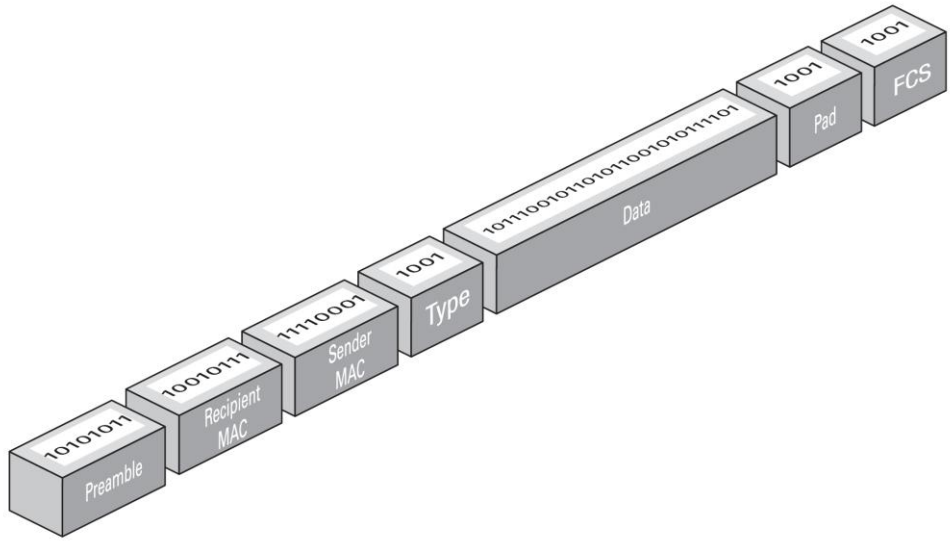
An Ethernet Frame

- Preamble + SFD (7 + 1 = 8 bytes)
- Destination MAC (6 bytes)
- Source MAC (6 bytes)
- Type (2 bytes)
- Data (from 46 to 1500 bytes))
- Padding (added if data is less than 46 bytes) Why?
- FCS (4 bytes)



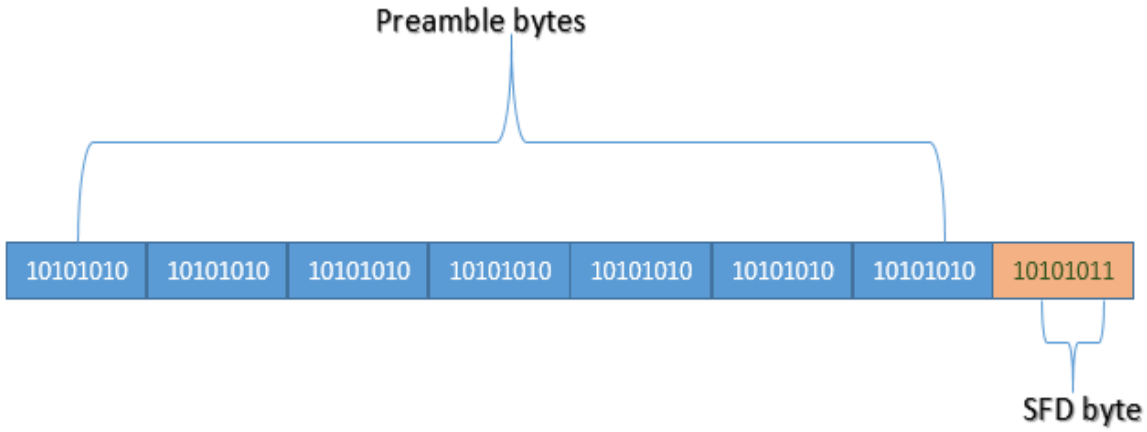
Overhead Calculation
6 (Dest MAC) + 6 (Source MAC) + 2 (Type) + 4 (FCS) = 18 bytes

Frame

- Preamble
  - All Ethernet frames begin with a *preamble*, a 7-byte series of alternating ones and zeroes followed by a 1-byte Start Frame.
  - The preamble gives a receiving NIC time to realize a frame is coming and to know exactly where the frame starts.
- Type
  - This way the receiving computer can tell if the frame contains IPv4 data, for example, or IPv6 data.

Preamble and SFD

In an Ethernet frame, the preamble and Start Frame Delimiter (SFD) are two key components that prepare a receiving device for the actual data transmission.



- The preamble (7 bytes) consists of alternating 1s and 0s, used for clock synchronization between the transmitter and receiver.
- The SFD (1 byte) follows the preamble and signals the end of the synchronization sequence and the beginning of the frame's data. Structure: A specific byte sequence (10101011 in Ethernet) where the last bit is a 1 instead of a 0, breaking the alternating pattern.

More about frames

- Why break up data into frames anyway?
  - To give chance to other computers to communicate over the network by splitting data into smaller chunks rather than one huge message.
  - Minimum size is 64 bytes.
  - Maximum size is 1518 bytes. *You should know why it's this size from the previous slides.*

Frame

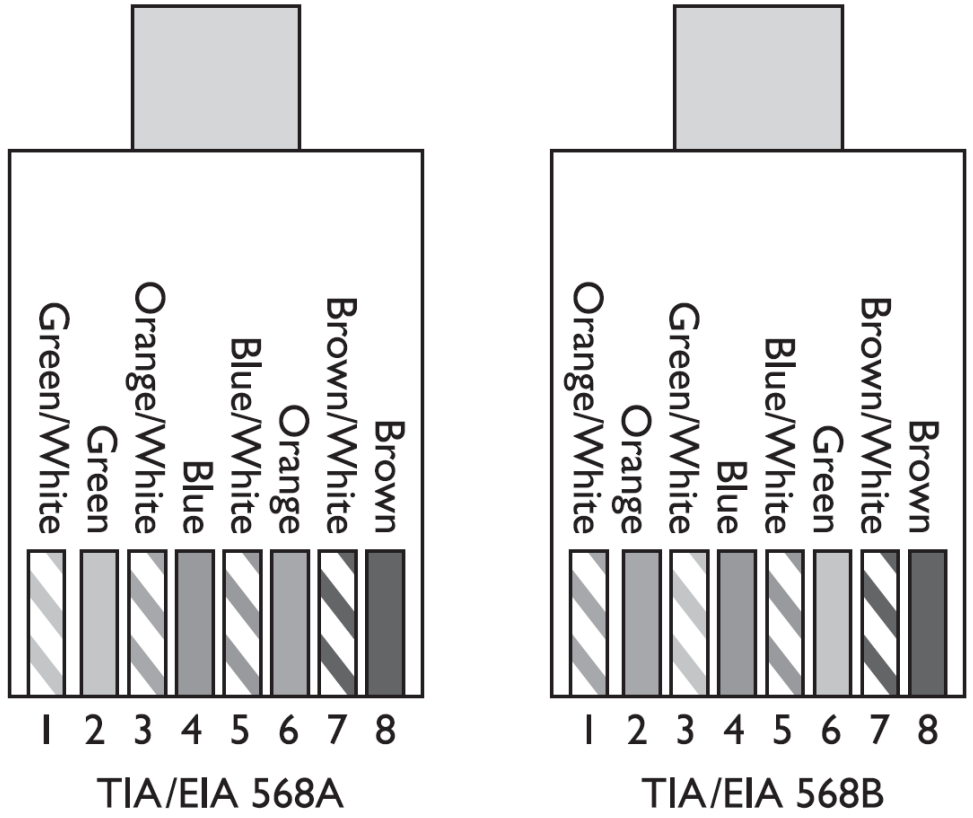
Building block	Size	Function
PreambleStart frame delimiter (SFD)	8 bytes	Synchronization of the receiversBit sequence that initiates the frame
Destination address (MAC)	6 bytes	Hardware address of the destination network adapter
Source address (MAC)	6 bytes	Hardware address of the source network adapter
Tag	4 bytes	Optional VLAN tag for integration in VLAN networks (IEEE 802.1q)
Type	2 bytes	Ethernet II: labeling of layer 3 protocols
Length	2 bytes	Length information about the record
Control	1 byte	Defines the LLC frame (logical link)
Data	44-1,500 bytes (limit depending on frame structure)	The data to be transmitted
Frame check sequence (FCS)	4 bytes	Checksum that computes the entire frame
Inter frame gap (IFS)	-	Transmission break of 9.6 µs

Ethernet Standards

- Initial standard (10BASE2) Introduced in 1985.
- 10BaseT (IEEE 802.3) Introduced in 1990
  - T stands for twisted pair, more on this later.
- Generally, uses routers and switches to extend the network (or switch).
- A switch or hub consists of 2^x ports (8, 16, 24, 48).

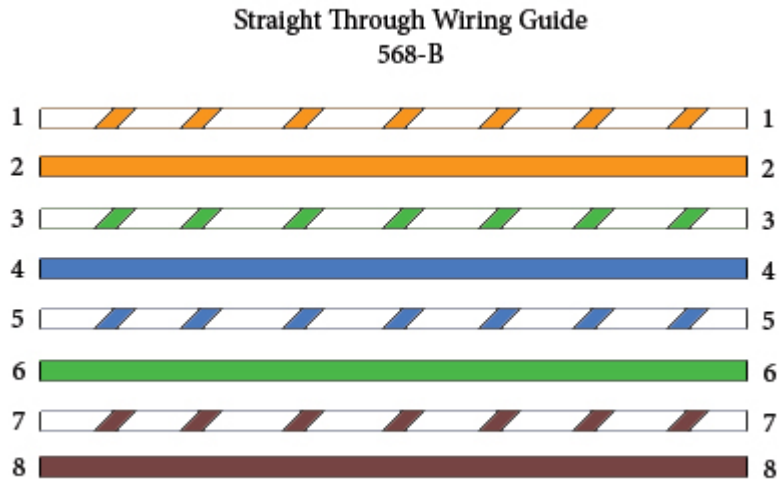
RJ-45 Connector Specifics

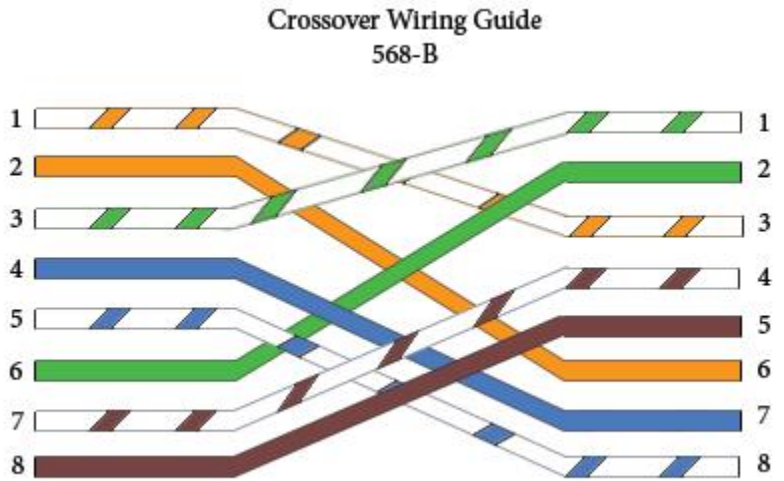
- An easy trick to remembering the difference between 568A and 568B is the word "GO." The green and orange pairs are swapped between 568A and 568B



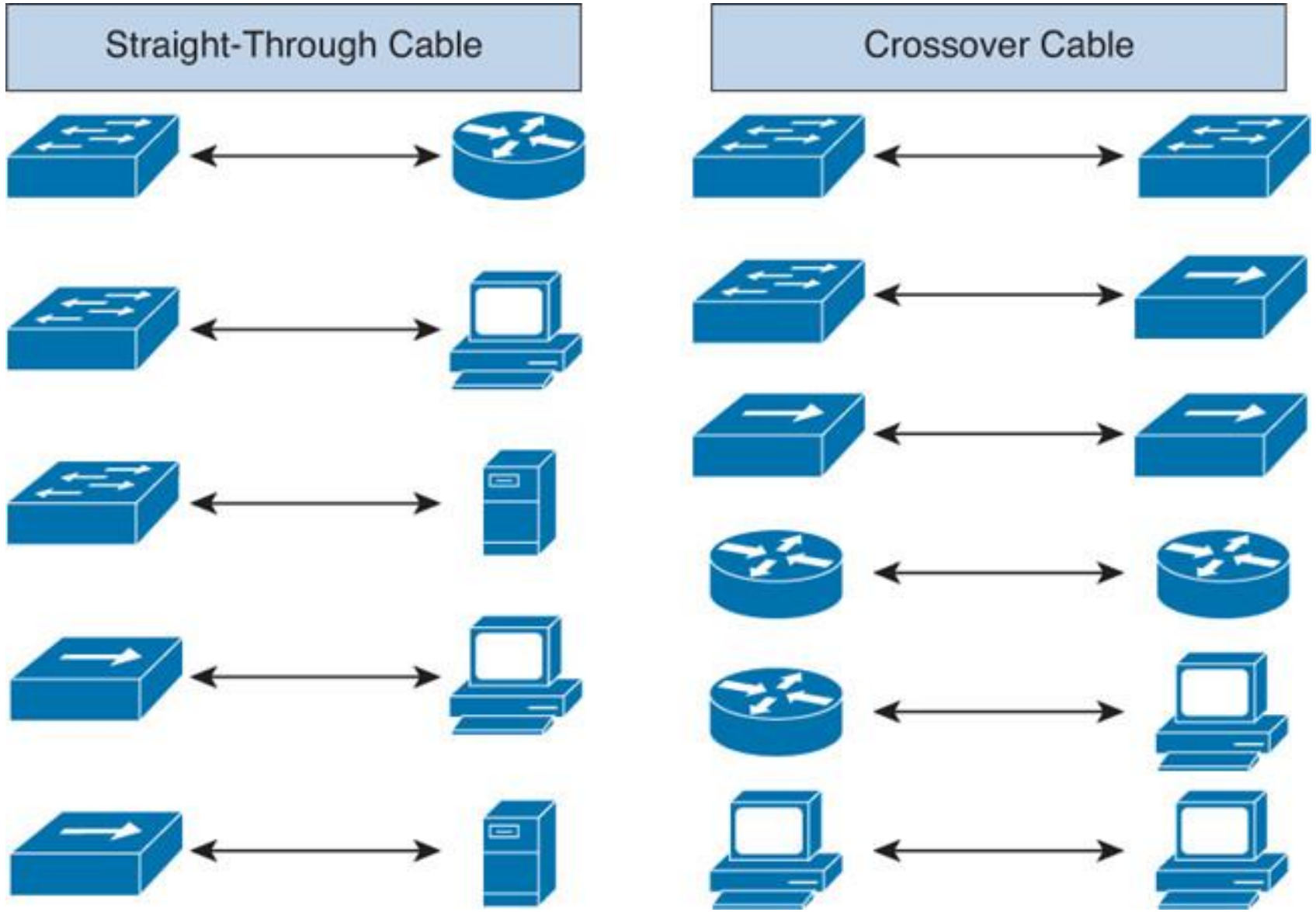
Guided transmission media – Twisted pairs - Ethernet

- Straight through and crossover cables



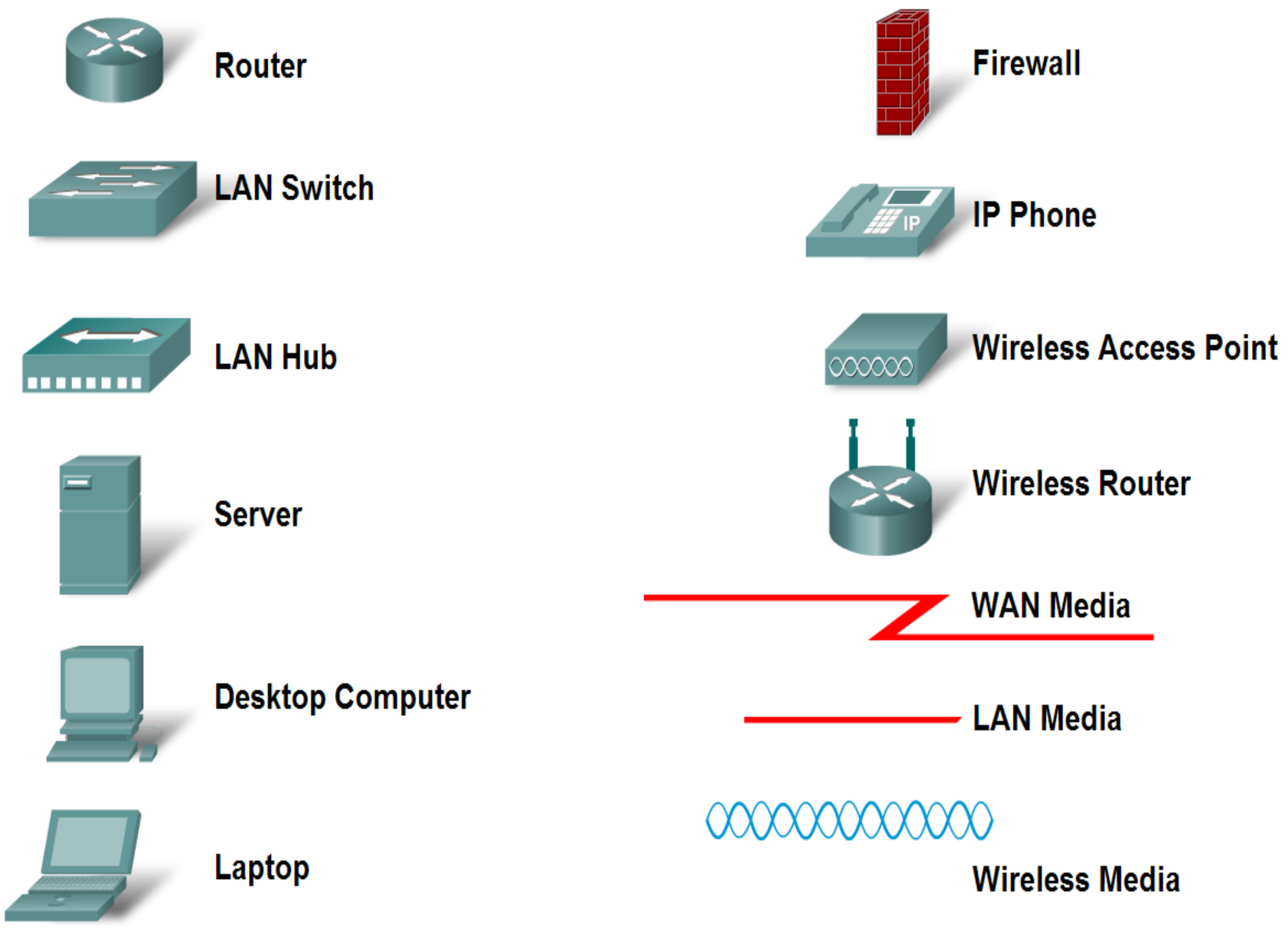


Cable Usage



Network Components Using Industry recognized icons and symbols

Common Data Network Symbols



More on Network Diagram Symbols

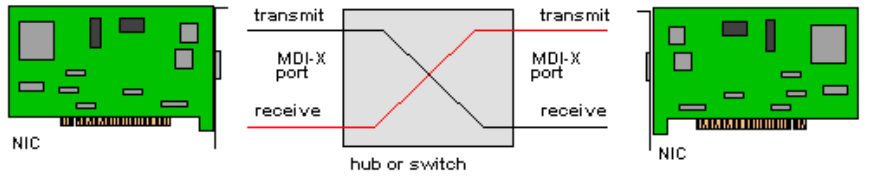
- https://www.pearsonitcertification.com/articles/article.aspx?p=1804868

MDI-X

- MDI-X automatically takes care of cabling issues by automatically adjusting the crossover/non-crossover physical attributes for you.
- Generally with MDI-X you use only straight-through (patch) cables.
- In CISCO packet tracer, you need to know which models of routers/switches use MDI-X and which don't

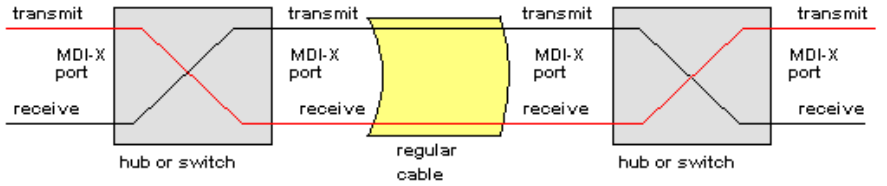
NORMAL CROSSOVER WITHIN HUB OR SWITCH

The transmit line from one node must be accepted by the receive line of the recipient machine. The crossover port (MDI-X port) performs this reversal.



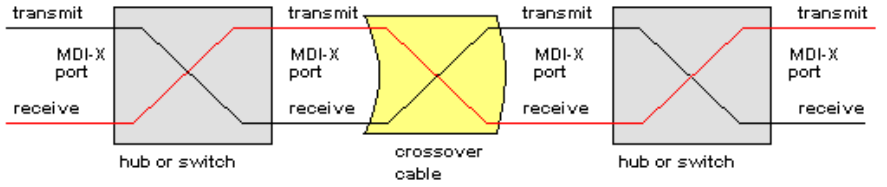
CROSSOVER NOT CORRECTLY MAINTAINED BETWEEN TWO HUBS OR SWITCHES

When two hubs or switches are connected, a regular cable cannot be used. Trace the route below, and note that transmit and receive do not wind up reversed as they should be.



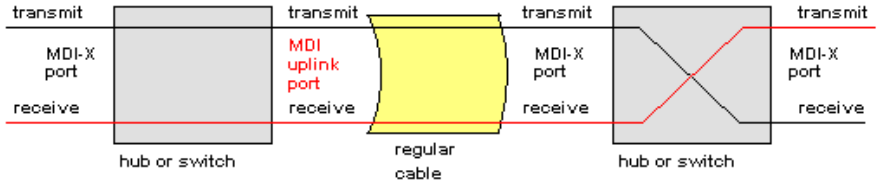
CROSSOVER MAINTAINED CORRECTLY WITH CROSSOVER CABLE

A crossover cable crosses the lines so that it reverses the reversal performed by the MDI-X ports.



CROSSOVER MAINTAINED CORRECTLY WITH MDI PORT AND REGULAR CABLE

An MDI port (uplink port) does not reverse the lines, allowing two devices to be connected.



Ethernet Network Devices

Switch

- A hub works by causing collisions. It's not the most efficient way
  - More computers on the network = more collisions.
  - More collisions = slower network.
- Switch intelligently routes information around.
- Creates stable point-to-point connections between nodes (computers).
- Point-to-point connection enjoys full bandwidth.
- A bridge and switch are very similar.

CSMA/CD

- *Carrier sense multiple access/collision detection (CSMA/CD)*
- *Carrier sense*
  - means that each node using the network examines the cable before sending a data frame
  - **If another machine is using the network**, the node detects traffic on the segment, waits a few milliseconds, and then rechecks.
  - **If it detects no traffic**—the more common term is to say the cable is "free"—the node sends out its frame.

- *Multiple access*
  - All machines have equal access to the wire.
  - If the line is free, any Ethernet node may begin sending a frame.

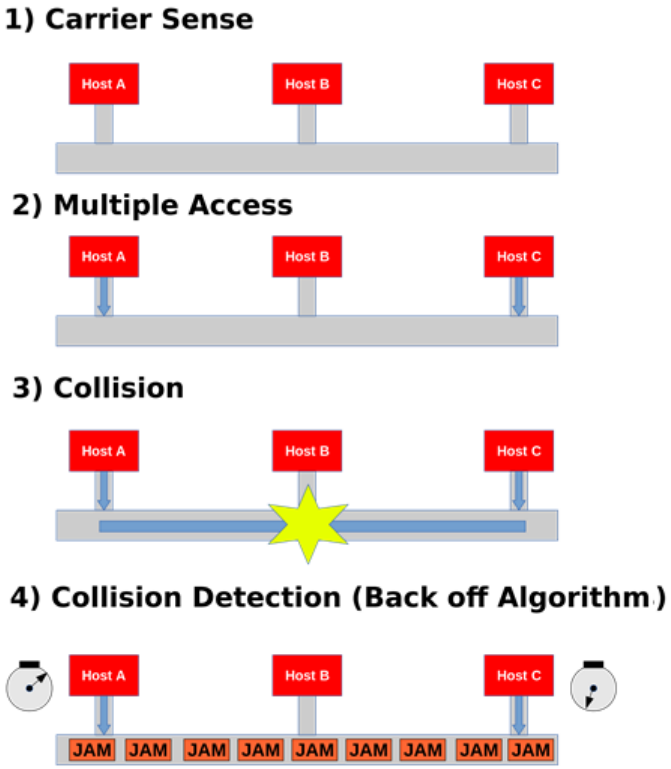
Collisions

- If two machines decide to send data (for Multiple Access) at the same time, it's called a collision.
  - Acceptable collision level is 10%

1. Upon collision both computers stop transmitting
2. They then each generate a random number to determine how long to wait before trying again.

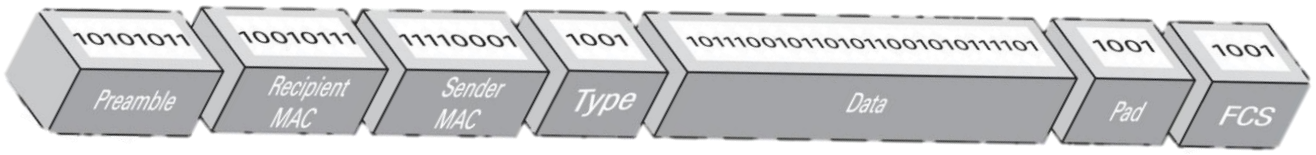
Carrier Sense Multiple Access with Collision Detection (CSMA/CD)

1. Node listens to the medium.
2. If the channel is idle, node starts to transmit. If the channel is busy, the node will wait until the channel is idle and transmit.
3. If the entire frame is sent without detecting another transmission, the transmission is done. If another transmission is detected, collision is detected.
4. Transmission is aborted and a jam signal is sent. The node enters a binary backoff.



Switch Source Address Table (SAT)

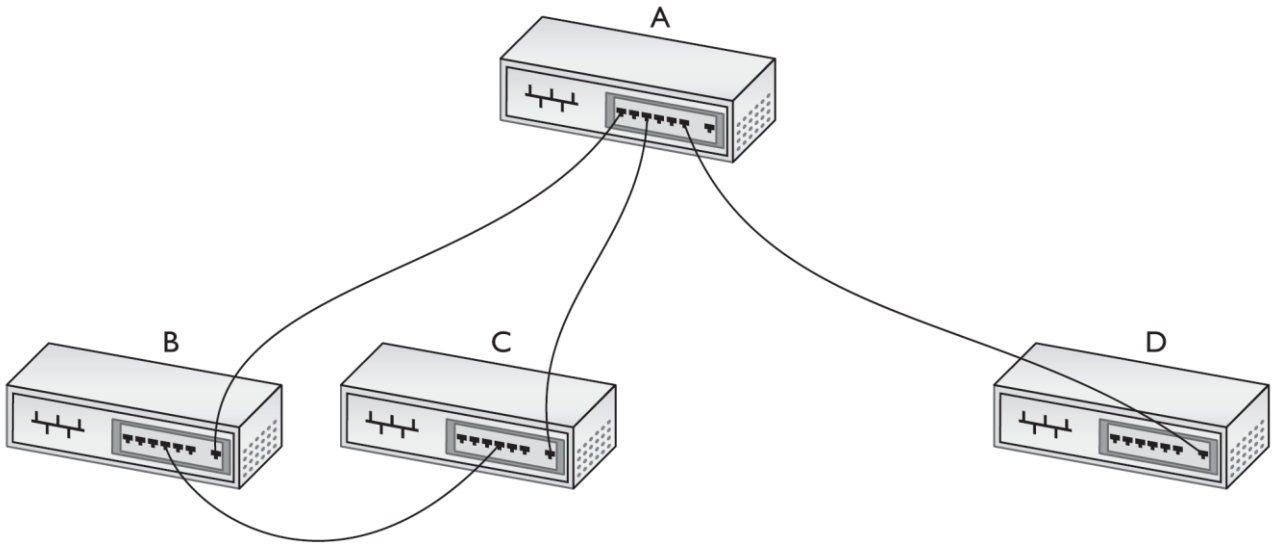
- The switch creates a table called SAT (Source Address Table) that allows it to know what mac address lives on what port.
- So, Frames with MAC destinations go to the right port unlike a hub.



Port	MAC Address
1	None
2	28-4F-C2-31-22-B2
3	None
4	45-9D-84-D2-AA-10
5	F1-E2-A9-9C-41-BC
6	None
7	AD-83-F2-90-D2-36
8	None

Bridging Loops (On switches)

- Communication between B-C is much less expensive when over direct link
- B ▶ C
- B ▶ A ▶ C



Bridging Loops

- Used to create redundant connections
- In the above picture, you see that switch BC can communicate with each other rather than going to the center of the star network.
- Also called "Switching Loops"
- Spanning Tree Protocol (STP) is used to ensure that loops like this work (and endless loops are not formed).
- See: https://www.youtube.com/watch?v=Op5PyvFUAXA

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