Introduction To Data Comm & Networking Chapter 2 - Ethernet

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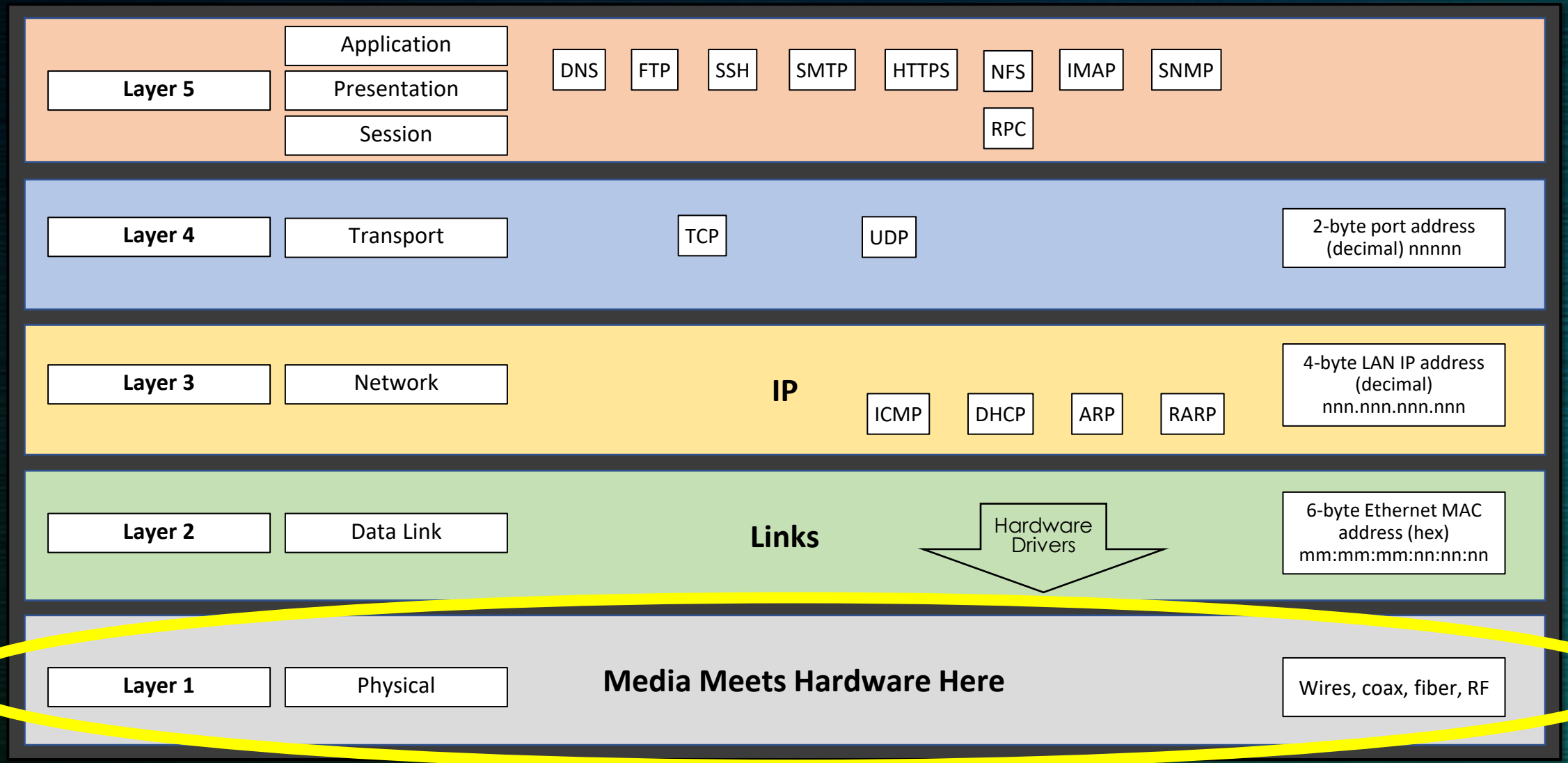
Ethernet – Layer 2



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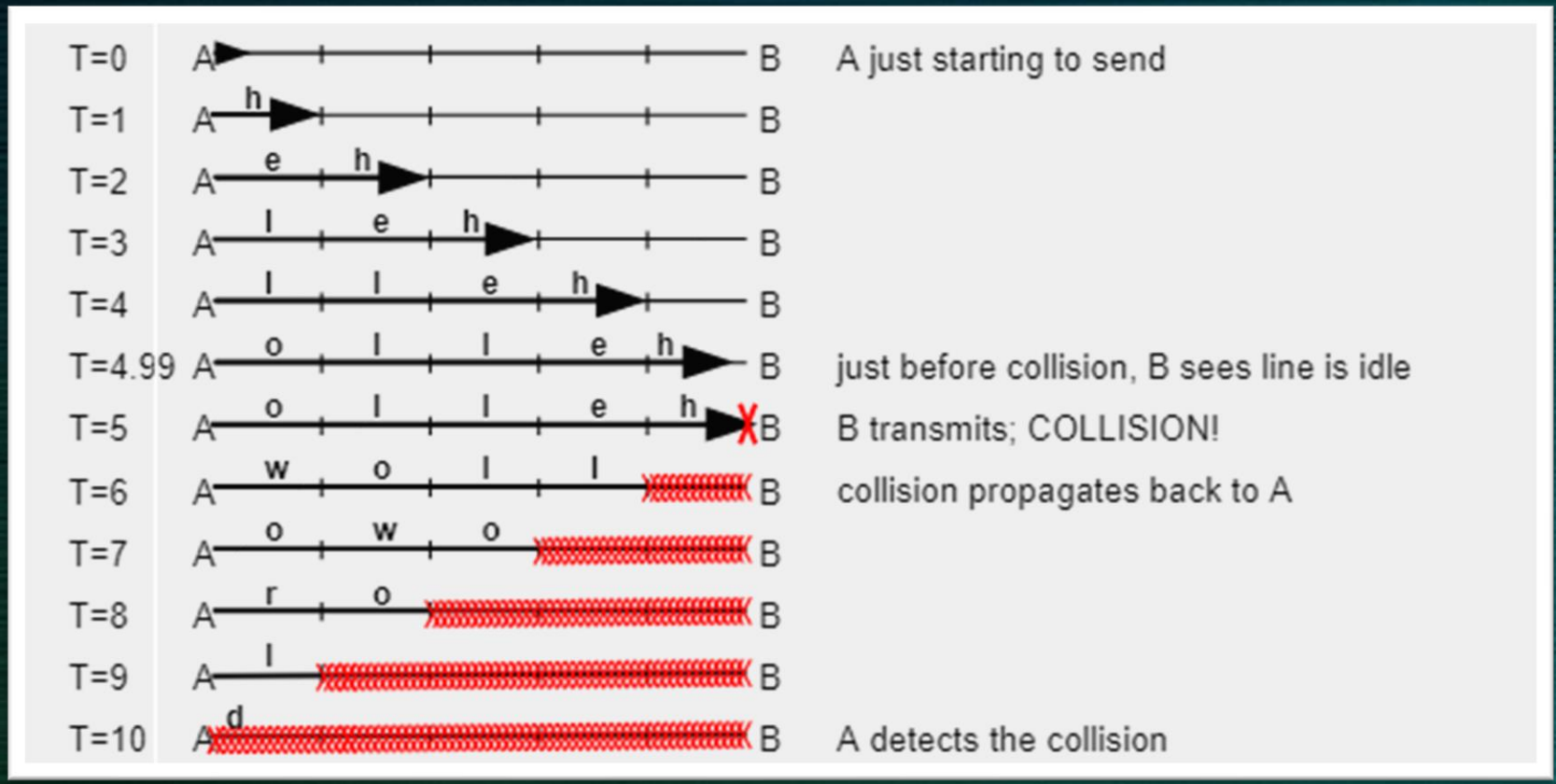
Old 10Mbps Ethernet

- Multi-node model on same media
- Collision domain with hubs
- Limited in size – slot time
- WiFi today



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The Evolution of Ethernet Standards to Meet Higher Speeds

Date	IEEE Std.	Name	Data Rate	Type of Cabling
1990	802.3i	10BASE-T	10 Mb/s	Category 3 cabling
1995	802.3u	100BASE-TX	100 Mb/s*	Category 5 cabling
1998	802.3z	1000BASE-SX	1 Gb/s	Multimode fiber
	802.3z	1000BASE-LX/EX		Single mode fiber
1999	802.3ab	1000BASE-T	1 Gb/s*	Category 5e or higher Category
2003	802.3ae	10GBASE-SR	10 Gb/s	Laser-Optimized MMF
	802.3ae	10GBASE-LR/ER		Single mode fiber
2006	802.3an	10GBASE-T	10 Gb/s*	Category 6A cabling
2015	802.3bq	40GBASE-T	40 Gb/s*	Category 8 (Class I & II) Cabling
2010	802.3ba	40GBASE-SR4/LR4	40 Gb/s	Laser-Optimized MMF or SMF
	802.3ba	100GBASE-SR10/LR4/ER4	100 Gb/s	Laser-Optimized MMF or SMF
2015	802.3bm	100GBASE-SR4	100 Gb/s	Laser-Optimized MMF
2016	SG	Under development	400 Gb/s	Laser-Optimized MMF or SMF

Note: *with auto negotiation

https://i.pinimg.com/originals/2e/9a/31/2e9a31d28e978eb9bf20cb4954af13e7.jpg

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Ethernet Frame 802.3 (most popular)

802.3 Ethernet packet and frame structure

Layer	Preamble	Start frame delimiter	MAC destination	MAC source	802.1Q tag (optional)	Ethertype (Ethernet II) or length (IEEE 802.3)	Payload	Frame check sequence (32-bit CRC)	Interpacket gap (IPG)
	7 octets	1 octet	6 octets	6 octets	(4 octets)	2 octets	46-1500 octets	4 octets	12 octets
Layer 2 Ethernet frame			← 64–1522 octets →						
Layer 1 Ethernet packet & IPG	← 72–1530 octets →								← 12 octets →

4 major versions with slightly different frames (Ethernet 2, 802.3, 802.3SNAP, 802.1q)
Preamble SFD = Start Frame Delimiter <for hardware - not really a part of the Ethernet frame>
Dest. Addr. & Source Addr. = MAC addresses
Tag = optional VLAN tag
Length = Type
FCS = Frame Control Sequence checksum
Inter Frame Gap < for hardware - not really a part of the Ethernet Frame>

https://en.wikipedia.org/wiki/Ethernet_frame

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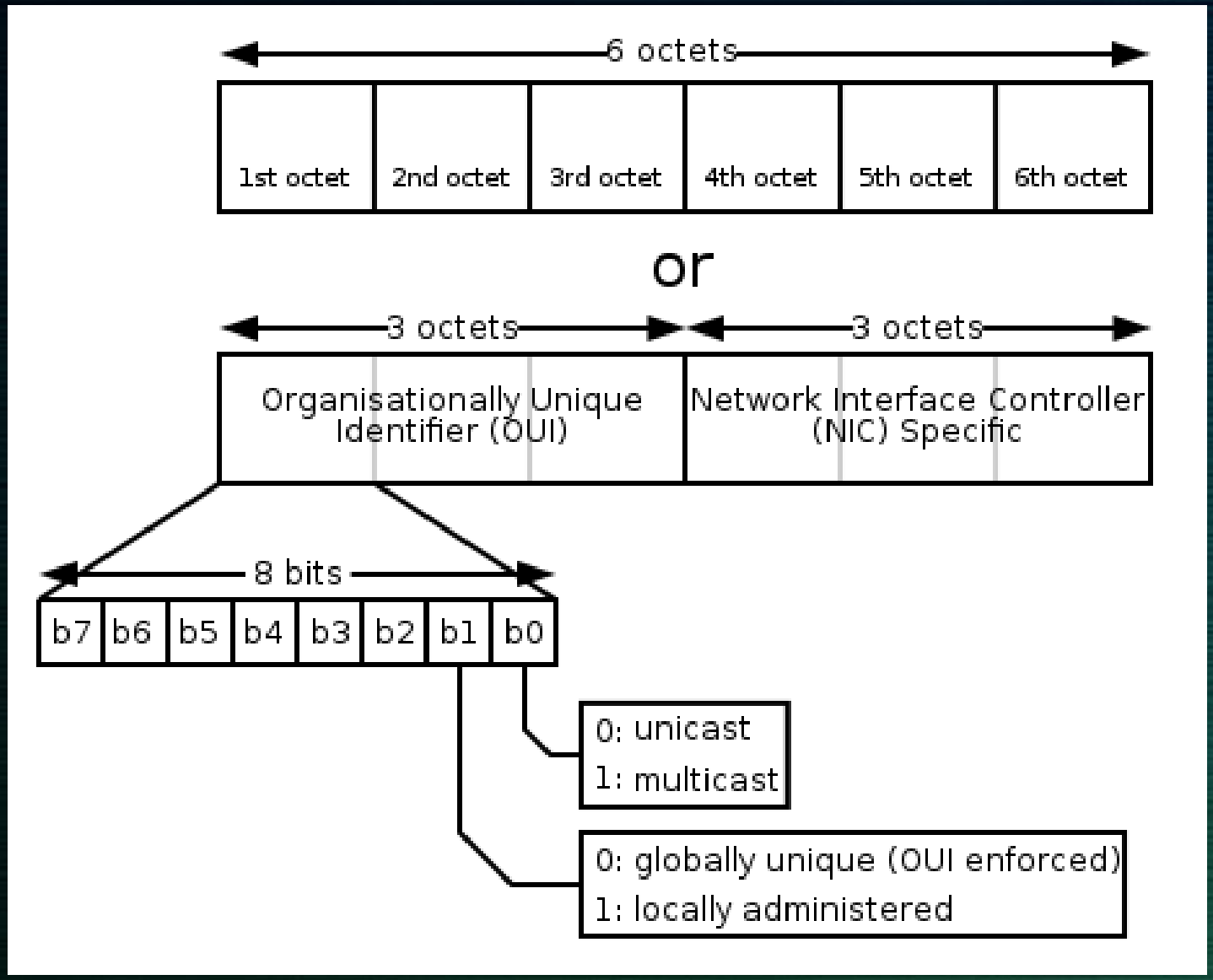
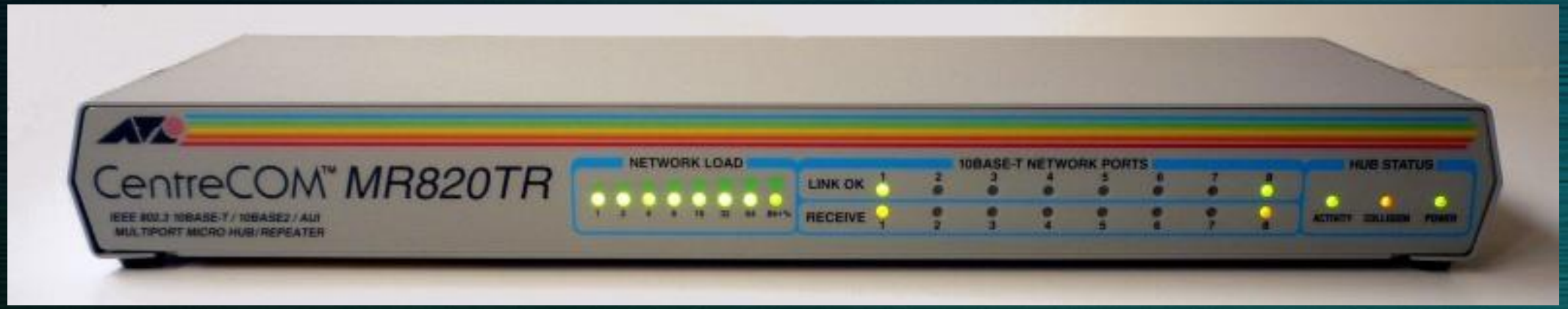
Anatomy of an Ethernet MAC address



https://upload.wikimedia.org/wikipedia/commons/9/94/MAC-48_Address.svg

Old 10Mbps Ethernet - Collisions

- Special algorithms needed to coordinate transmission
- Exponential backoff
- Capture effect = unfair prioritization



https://upload.wikimedia.org/wikipedia/commons/0/09/AlliedTelesis_Hub_MR820TR.jpg

100Mbps Ethernet and newer

- Modern Ethernet switch speeds 100, 1000, 10000 Mbps
- Point-to-point full duplex
- No collision domain with switches (wired)

https://upload.wikimedia.org/wikipedia/commons/b/b9/2550T-PWR-Front.jpg

Switches

- Operate at Data Link Layer (Layer 2) of Ethernet
- Interfaces with the hardware layer (TP, Coax, Fiber)
- Typically, from 2 to 48 ports
- 2 port type is called a “bridge”
- Forwards frames
- Does not rebroadcast collisions = collision free domain
- Unmanaged = plug and play = no management console
- Managed = has console via port 80, RS232, or SNMP

Managed Switches

- Allow configuration via onboard web page (port 80) or RS-232 terminal or SNMP or combination
- Manual port enable/disable selection
- Manual port speed selection
- Trunking
- Allow logical virtual local area networks (VLAN's)
- Quality of service
- Redundancy (Spanning Tree Protocol [STP])
- Port mirroring

Some Common Networking Design Symbols

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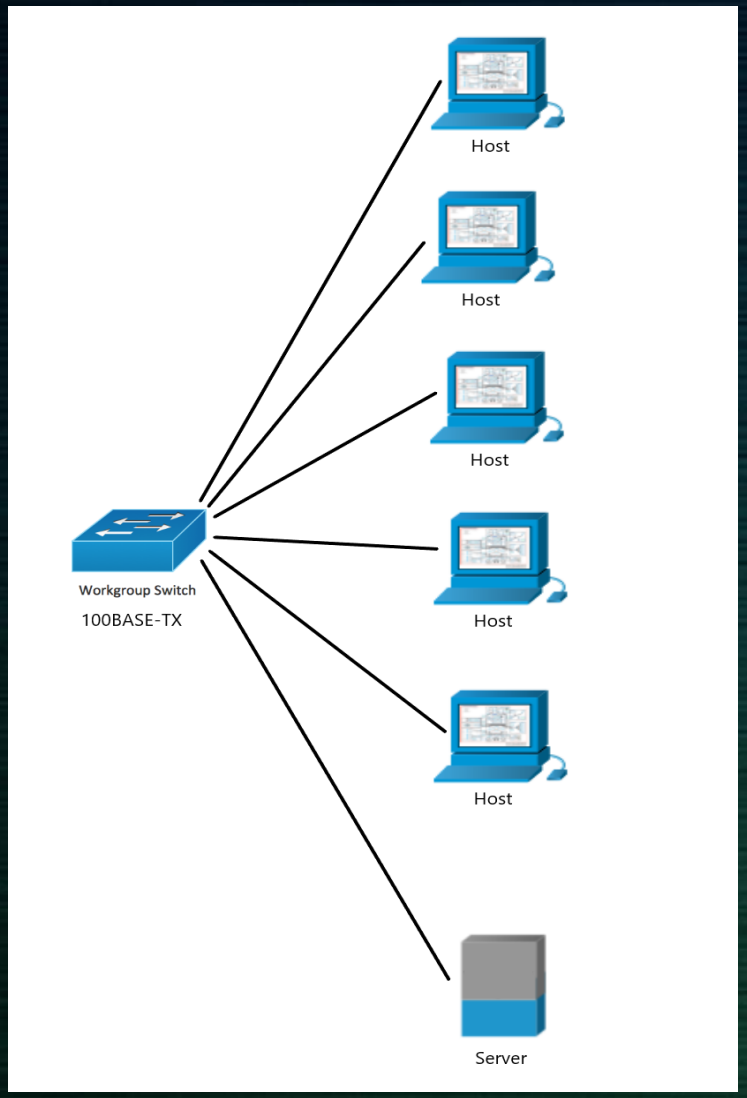
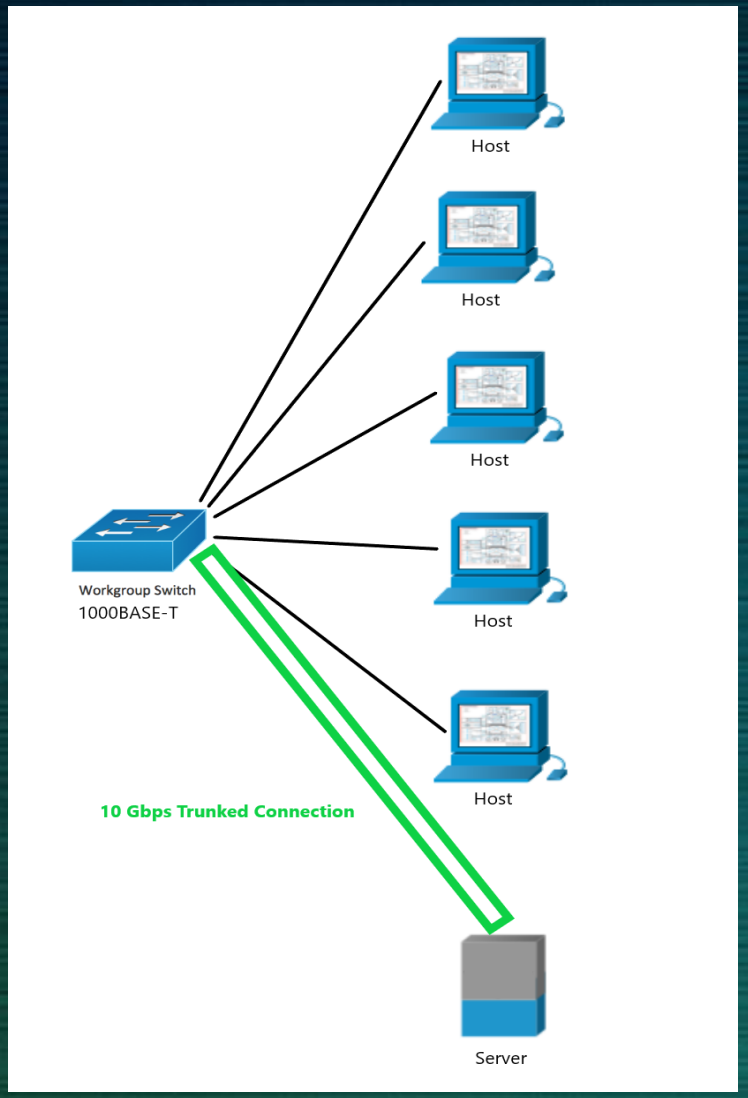
Port speed, fabric, and trunking





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Classes of Managed Switches

- Classic Layer 2 (Access Class)
- Multi-Layer switch Layer 3 (Distribution/Aggregation Class)
- Audio/Video
- Voice

Packet Addressing (L2)

- Unicast = one specific target address interprets the packet
- Broadcast = all nodes on the segment interpret the packet
- Multicast = a later innovation allowing groups of nodes to interpret the packet

- Packets that are not relevant to an addressee are ignored IF a switch delivers the packet.

Switch learning mechanisms

- When switches do not know a destination address, they send the packet to all ports known as “fall-back-to-flooding”. The learning process is called “transparent bridging”.
- Switches learn where MAC addresses are when a device sends a packet that has not yet been seen by a switch; the switch updates an internal memory table.
- Once a switch learns a MAC address and port, it can then forward packets appropriately.

Switch efficiency

- Switches replaced dumb hubs which simply retransmitted everything to all ports.
- Switches reduce traffic on networks by sending packets only to known destinations (once learned).
- Switches do not transmit collisions (hubs do).
- Switches increase privacy.

Switch security

- Switches are susceptible to MAC Flooding which causes them to revert to “fall-back-to-flooding” mode. Once this happens, a switch then broadcasts packets making the network susceptible to man-in-the-middle attacks as well as reducing network performance.
- A slow network may be an indication.
- Some switches have MAC-Flooding defense which may need to be enabled.
- Application layer encryption can help prevent man-in-the-middle vulnerabilities.

How a switch works

https://www.youtube.com/watch?v=DukuFSZH9Qw

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Good network design concepts

https://youtu.be/wwwAXlE4OtU