



The Ethernet Specifications



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Ethernet Basics

Ethernet

Collision Domain

Broadcast Domain

CSMA/CD

Broadband/Baseband



Ethernet Basics



Ethernet

- The technology for connecting devices in a network
- Describes how network devices can format and transmit data
- Uses both Data Link and Physical layer specifications
- Institute of Electrical and Electronics Engineers (IEEE) defines Ethernet as protocol 802.3



What Ethernet Defines

Physical Layer

- Cabling
- Connectors
- ... and more ...

Data Link Layer

- Device addresses ("MAC Address")
- Media access control
- Data frames
- ... and more ...



2

Ethernet at the Physical Layer



Ethernet Basics



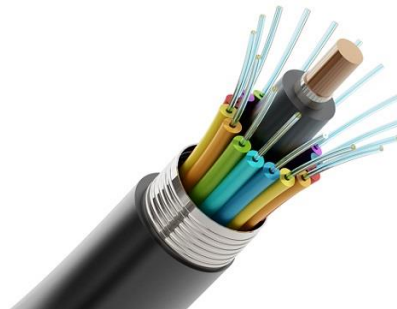
Ethernet

Bandwidth	Common Name	Informal name	IEEE name	Cable Type
10 Mbps	Ethernet	10Base-T	802.3	UTP 100m
100 Mbps	Fast Ethernet	100Base-T	802.3u	UTP 100m
1000 Mbps	Gigabit Ethernet	1000Base-LX	802.3z	Fiber 5000m
1000 Mbps	Gigabit Ethernet	1000Base-T	802.3ab	UTP 100m
10 Gbps	10 Gigabit Ethernet	10GBase-T	802.3an	UTP 100m

Cables & Connector Examples



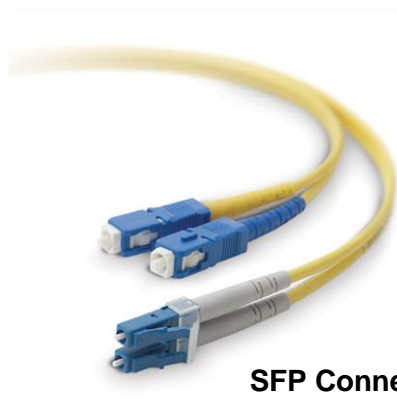
**Unshielded Twisted Pair
"Cat x"**



Fiber Optic Cable



RJ45 Connector



SC Connector

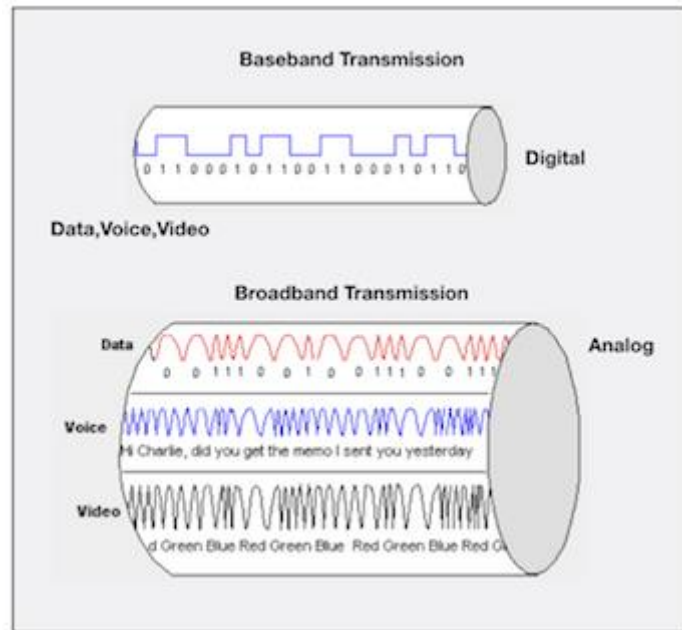
SFP Connector



Ethernet Basics

Broadband/Baseband

- Baseband
 - Uses digital signals and single channel
 - Communication is bidirectional
 - Short distance
- Broadband
 - Uses analog signals
 - Multiple transmissions are possible
 - Communication is unidirectional
 - Long distance



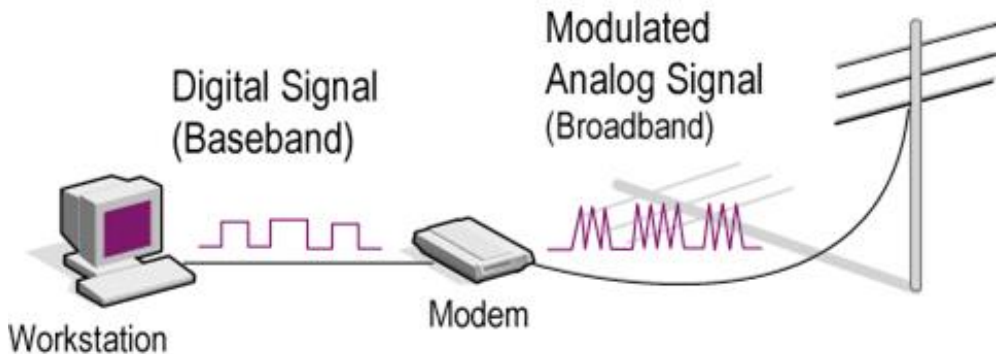


Ethernet Basics



Broadband/Baseband

If you are using a broadband internet connection for your home internet, the signals from your ISP up to your broadband router are broadband signals. But, the signals used inside your Ethernet LAN are baseband signals.



Ethernet - Layer 1 meet Layer 2





2

Ethernet at the Data Link Layer

Device addresses (“MAC Address”)

Data frames

Media access control

MAC Addresses



- Ethernet cable plugs into a “**network interface card**” (**NIC**)
- Each NIC has a unique “**MAC**” address
- Ethernet at the Data Link layer is responsible for **Ethernet addressing** (hardware or MAC addressing)
- Ethernet MAC addresses are made up of hexadecimal addresses



2

Ethernet at the Data Link Layer

Binary to Decimal and Hexadecimal Conversion

Ethernet Addressing

Ethernet Frames

Ethernet II Frames



Ethernet at the Data Link Layer



Binary to Decimal and Hexadecimal Conversion

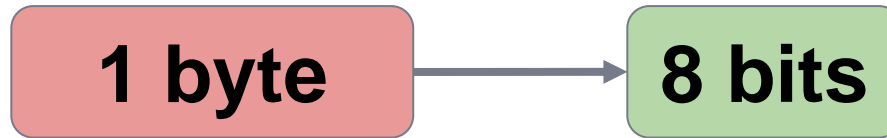
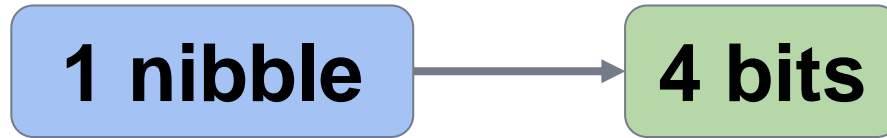
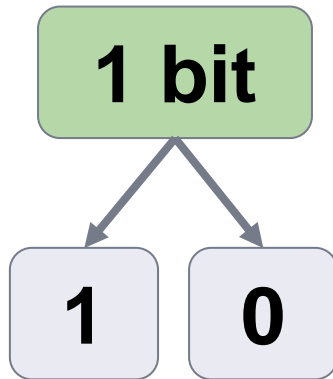
- Ethernet at the Data Link layer is responsible for:
 - **Ethernet addressing** (hardware or MAC addressing)
 - **framing packets** received from the Network layer
- Ethernet MAC addresses are made up of hexadecimal addresses



Ethernet at the Data Link Layer



Binary to Decimal and Hexadecimal Conversion





Ethernet at the Data Link Layer



Binary to Decimal Conversion

Binary Value	Decimal Value
10000000	128
11000000	192
11100000	224
11110000	240
11111000	248
11111100	252
11111110	254
11111111	255



Ethernet at the Data Link Layer



Binary to Decimal and Hexadecimal Conversion

Binary Value	Hexadecimal Value	Decimal Value
0000	0	0
0001	1	1
0010	2	2
0011	3	3
0100	4	4
0101	5	5
0110	6	6
0111	7	7

Binary Value	Hexadecimal Value	Decimal Value
1000	8	8
1001	9	9
1010	A	10
1011	B	11
1100	C	12
1101	D	13
1110	E	14
1111	F	15



Ethernet at the Data Link Layer



Binary to Decimal and Hexadecimal Conversion

Example:

What is the binary value of **0x4E** (or **4Eh**)?

(0x and h means that the value is hexadecimal or hex)

binary:

4 = 0100

E = 1110



01001110

Ethernet at the Data Link Layer

Binary to Decimal and Hexadecimal Conversion

What is the binary value of **27h**?



Students, write your response!

Ethernet at the Data Link Layer

Binary to Decimal and Hexadecimal Conversion

What is the binary value of **0xF9**?



Students, write your response!

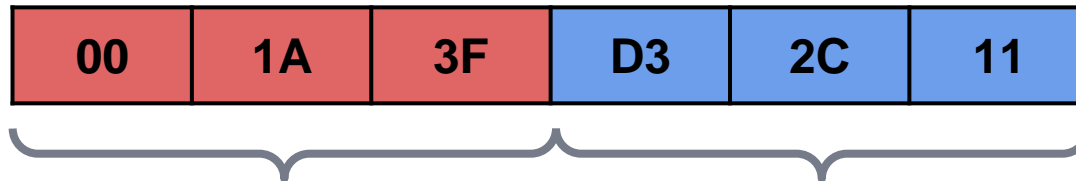


Ethernet at the Data Link Layer



Ethernet Addressing

- MAC (Media Access Control) Address
 - 48-bit (6 bytes or 12-digit hex) hardware number
 - unique
 - embedded into the network card, not changeable
 - represented as **00:1A:3F:D3:2C:11** or **00-1A-3F-D3-2C-11**



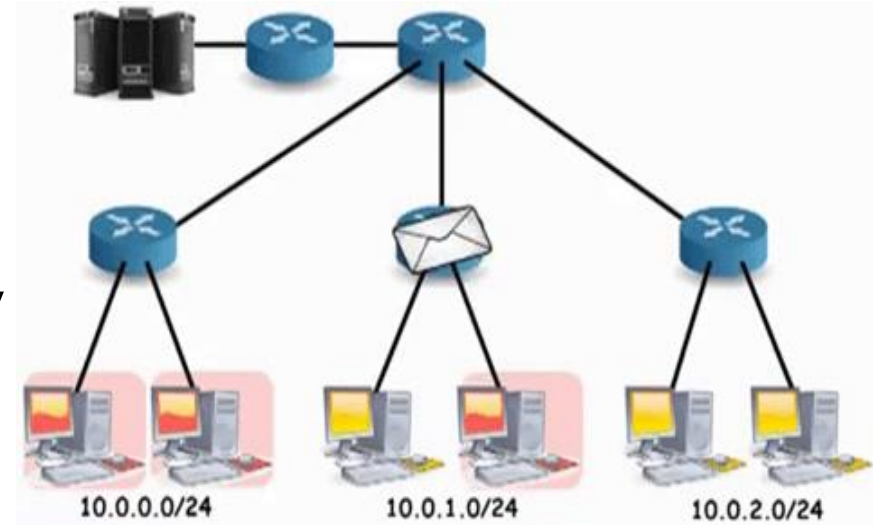
Ethernet at the Data Link Layer



Types of MAC Address

1. Unicast:

- A specific NIC on the network
- Only one sender and only one receiver



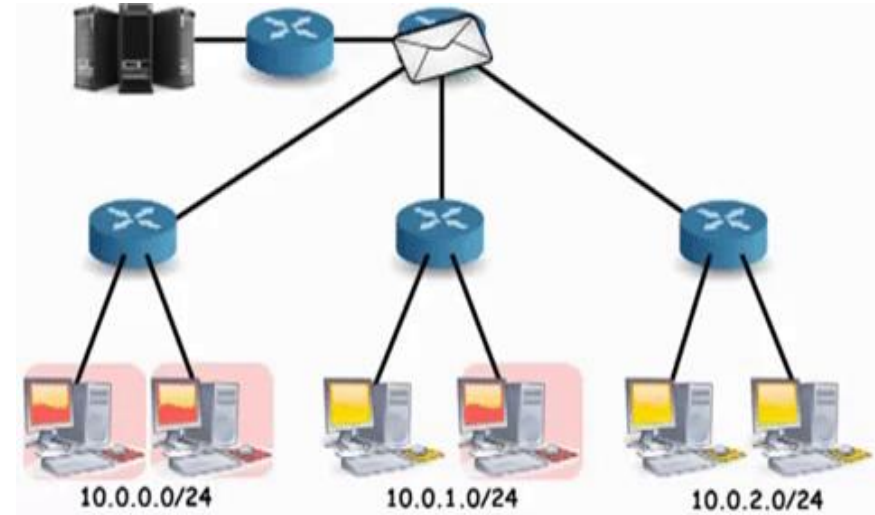
Ethernet at the Data Link Layer



Types of MAC Address

2. Multicast:

- A group of receivers
- OUI is **01:00:5E**



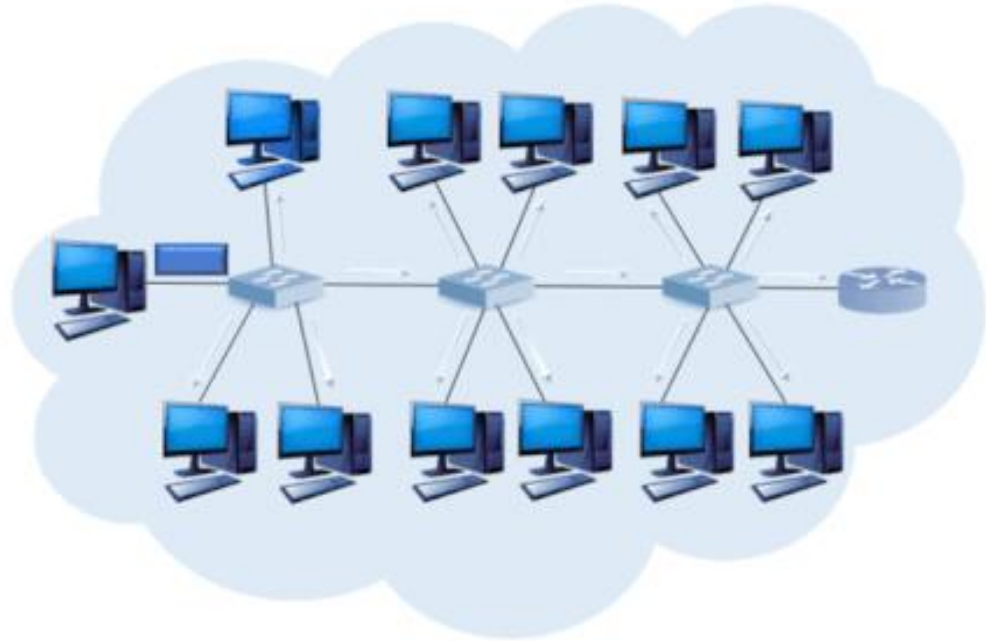
Ethernet at the Data Link Layer



Types of MAC Address

3. Broadcast:

- All devices on the network are recipients
- MAC Address is:
FF:FF:FF:FF:FF:FF





Ethernet at the Data Link Layer

Device addresses ("MAC Address")

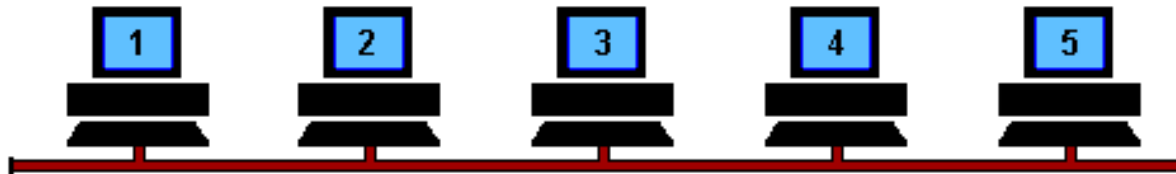
Media access control

Data frames

CSMA/CD



- Carrier Sense Multiple Access/Collision Detection is the protocol that is used to transmit frames
- **Multiple** devices can **simultaneously access** the same media, only **one** can **transmit**
 - Protocol must **sense** existing transmissions
 - Protocol must **detect collisions** and retransmit

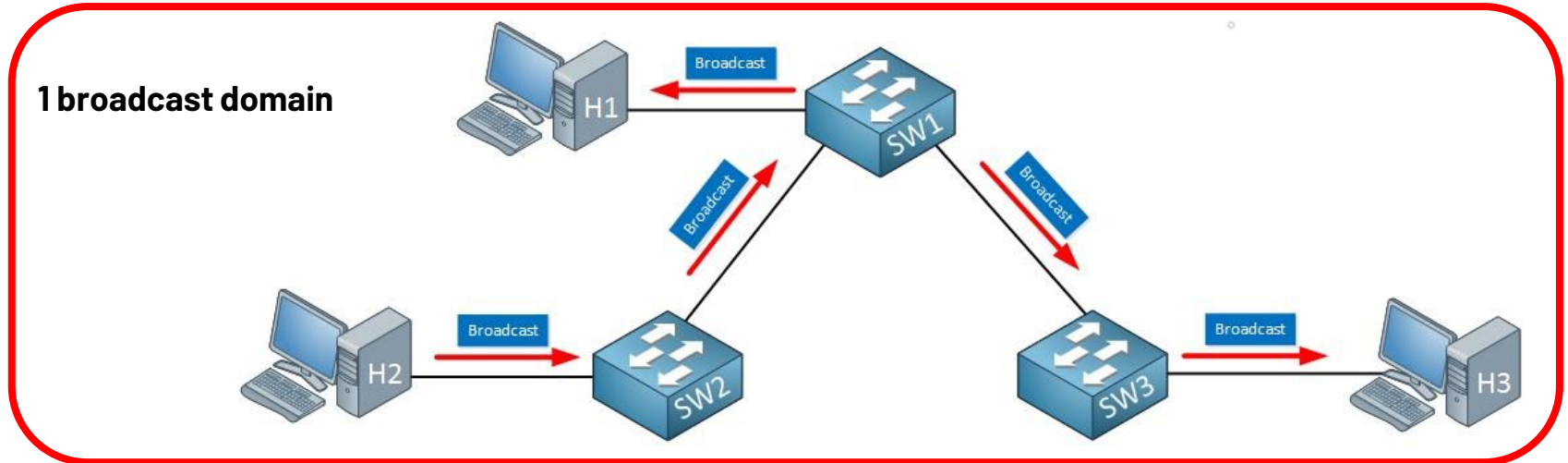


Ethernet Basics



Broadcast Domain

A broadcast domain is a collection of network devices that receive broadcast traffic from each other

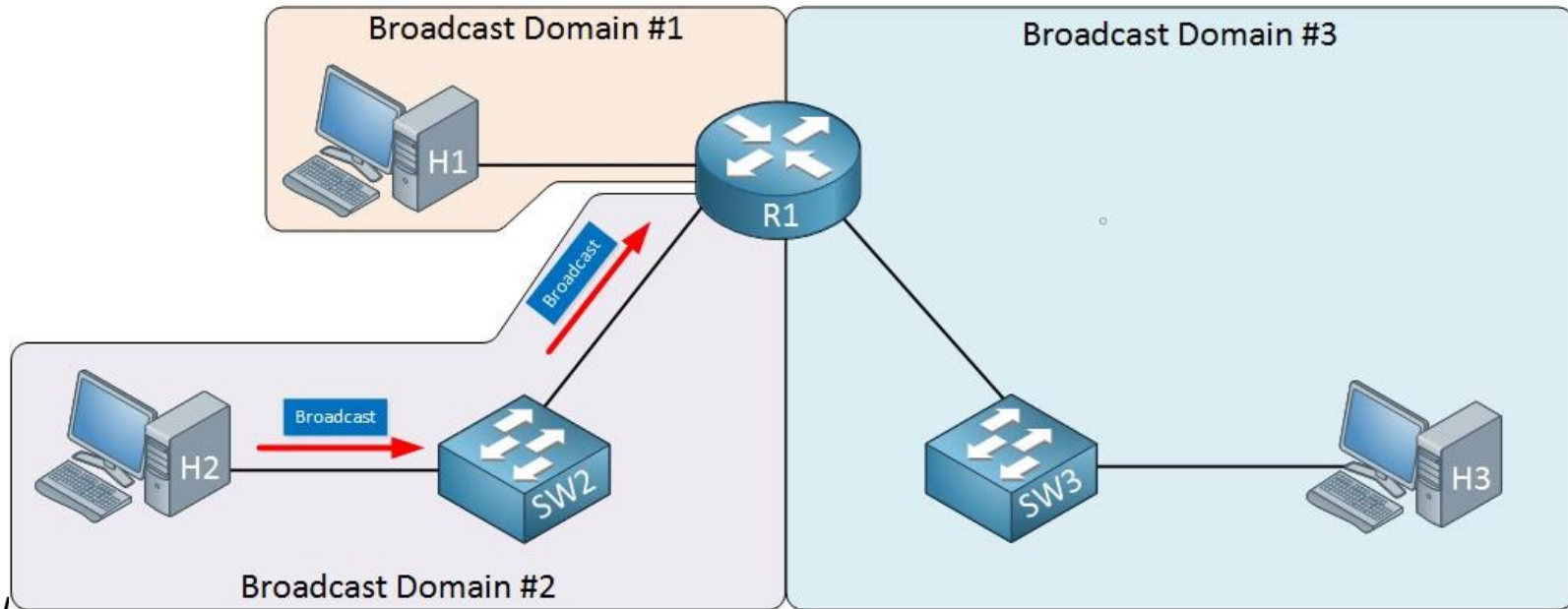




Ethernet Basics

Broadcast Domain

The more broadcast domains the more efficient network





Ethernet at the Data Link Layer

Device addresses ("MAC Address")

Media access control

Data frames

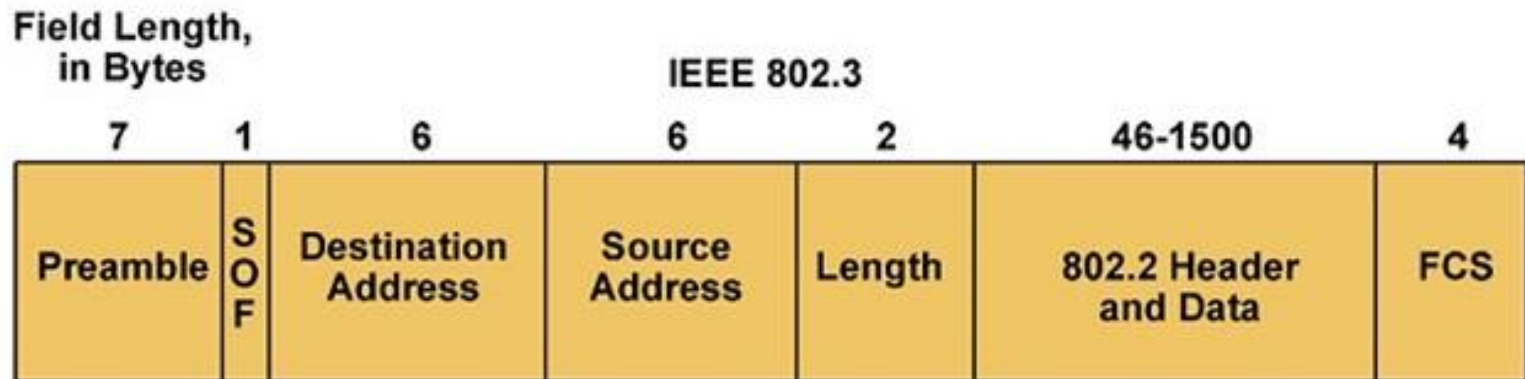


Ethernet at the Data Link Layer



Ethernet Frames

- Encapsulated data defined by the Network Access layer is called an Ethernet frame
- The Ethernet frame structure is defined in the IEEE 802.3 standard





THANKS!

Any questions?





Networking Devices



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- ▶ Common Network Connectivity Devices
- ▶ Other Specialized Devices



1

Common Network Connectivity Devices

Common Network Connectivity Devices



Network Interface Controller (NIC)

- A hardware that connects computers to a network
- Every NIC has a unique MAC address

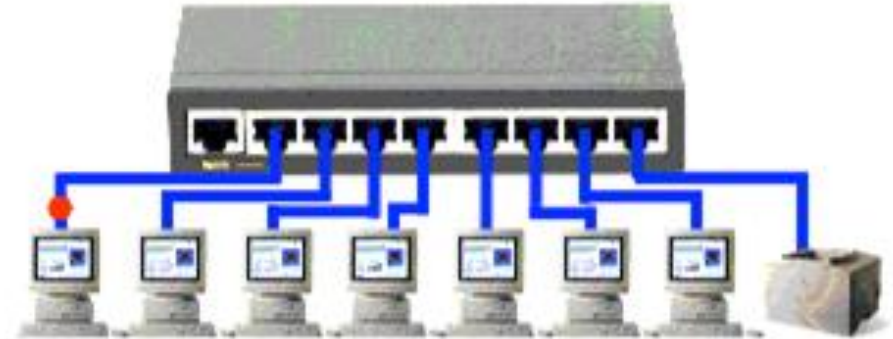


Common Network Connectivity Devices



Hub

- Broadcasts data to every computer connected to it
- Suitable for small LANs
- Not secure because all traffic can be captured
- No routing capability
- Creates a collision domain
- Half-duplex

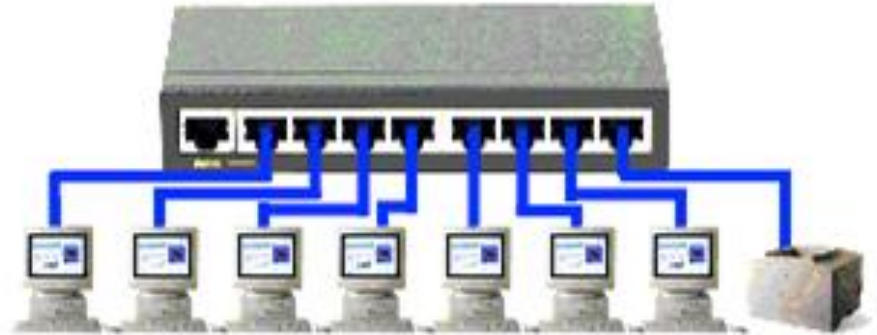


Common Network Connectivity Devices



Switch

- Connects multiple hosts together (*like Hub*)
- Works on Data Link Layer (Layer 2) (*unlike Hub*)
- Can inspect received traffic and forwards only to recipient(s) (*unlike Hub*)
- Each port on a Switch is a separate collision
- Full-duplex (*unlike Hub*)

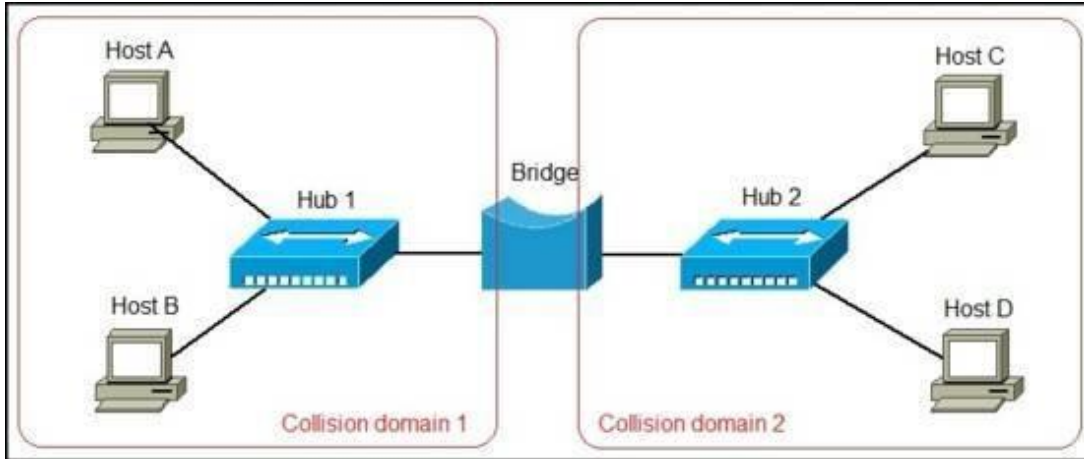


Common Network Connectivity Devices



Bridge

- Divides a network into segments
- Works at Data Link Layer (Layer 2)
- Forwards or filters the Ethernet frames

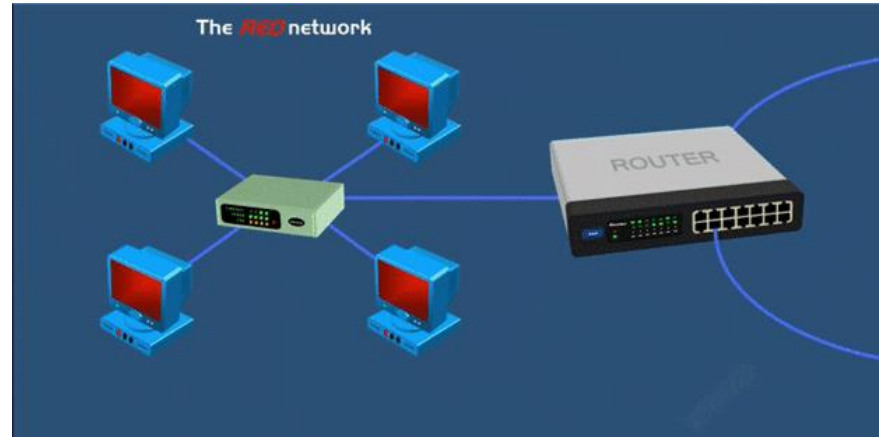


Common Network Connectivity Devices



Router

- Connects multiple segments together
- Uses IP addresses to make decisions about the best way to get the data to its destination
- Works on Network Layer (Layer 3)
- Combination of hardware and software

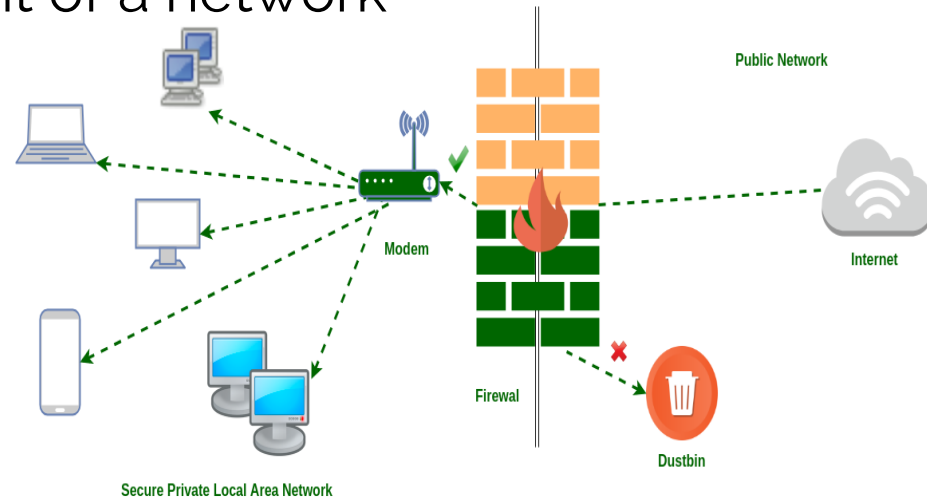


Common Network Connectivity Devices



Firewall

- Prevents unauthorized access to or from a private network
- Protects a network's data and resources from outside access and threats
- Usually placed at the end point of a network
- Either a hardware (black box) or a software



✓ = Specified Traffic Allowed

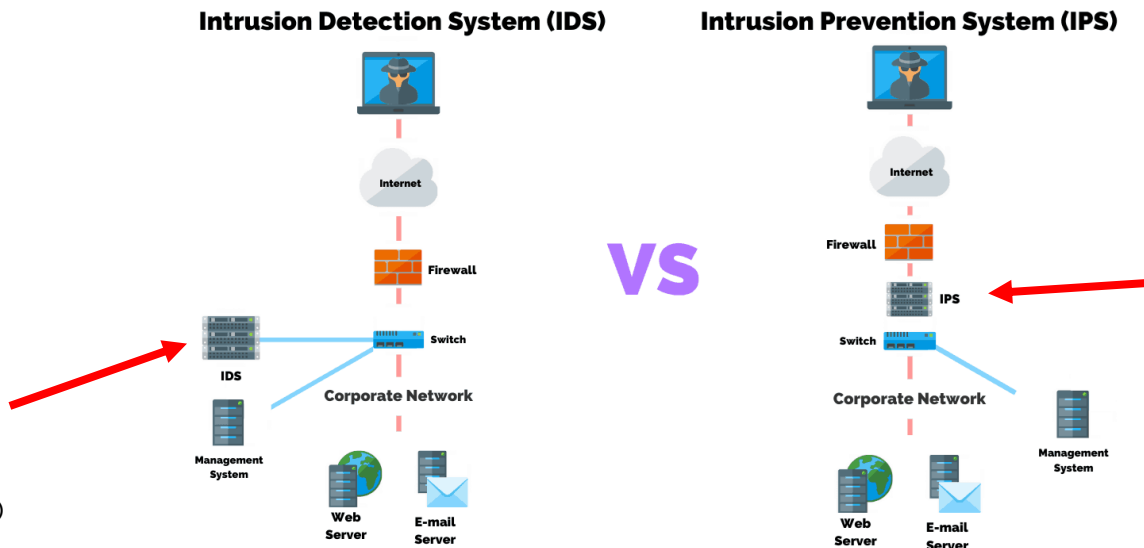
✗ = Restricted Unknown Traffic

Common Network Connectivity Devices



IDS/IPS

- Intrusion Detection System (IDS) monitors traffic and report malicious activities
- Intrusion Prevention System (IPS) stops threats in real-time as they occur





2

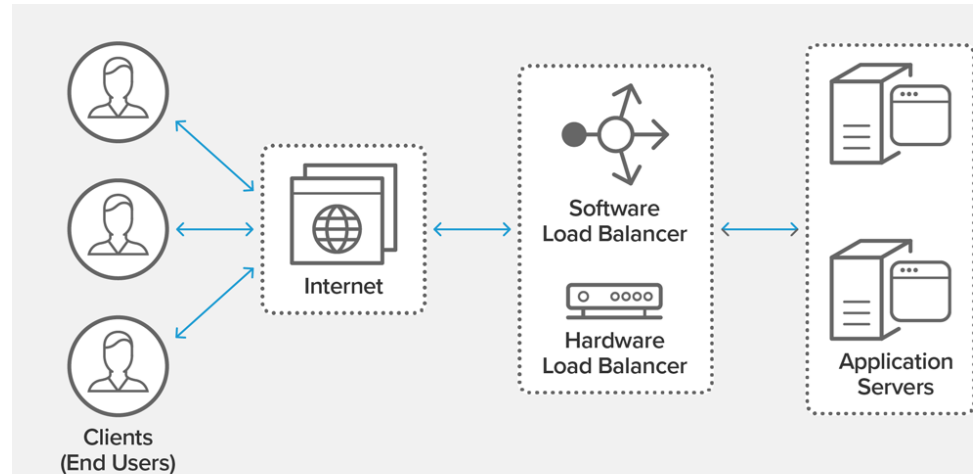
Other Specialized Devices

Other Specialized Devices



Load Balancer

- Distributes client requests or network load efficiently across multiple servers
- Ensures high availability and reliability by sending requests only to servers that are online
- Provides the flexibility to add or subtract servers as demand dictates



Other Specialized Devices



Domain Name Service (DNS) Server

- Finds the IP addresses of hostnames
- Computers use IP addresses, humans use names
- Easier to remember **www.clarusway.com** than **13.35.253.82**
- There are thousands of DNS servers
- Managed and controlled by *The Internet Assigned Numbers Authority (IANA)*
- IANA is operated by *the Internet Corporation for Assigned Names and Numbers (ICANN)*

Other Specialized Devices



Domain Name Service (DNS) Server

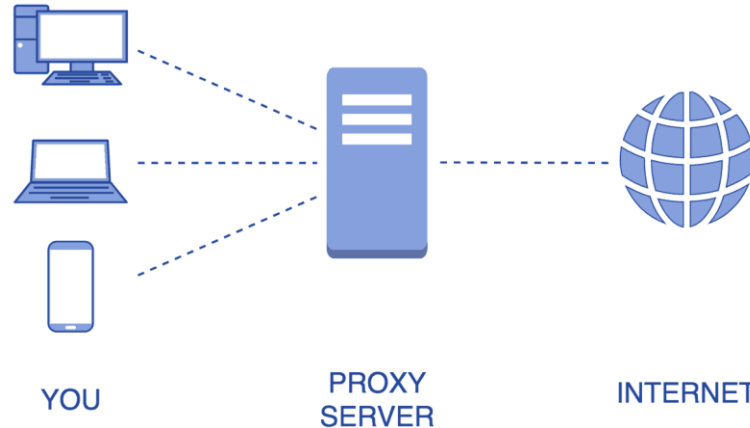
- **.com** A commercial organization
- **.edu** An educational establishment, such as a university
- **.gov** A branch of the U.S. government
- **.int** An international organization, such as NATO or the United Nations
- **.mil** A branch of the U.S. military
- **.net** A network organization
- **.org** A nonprofit organization
- Some DNS names end with country name like:
 - .jp** (Japan)
 - .ca** (Canada)
 - .uk** (Great Britain)

Other Specialized Devices



Proxy Server

- Acts as a gateway between you and the internet
- Acts as a firewall and web filter
- Provides shared network connections
- Caches data to speed up common requests
- Provides privacy



Other Specialized Devices



Encryption Devices

- Allows you to create secure connections over insecure channels
- Sometimes called *encryption gateway*



Other Specialized Devices



Packet Shaping (Traffic Shaping)

- Traffic shaping (*or packet shaping*) is a congestion management method that regulates network data transfer by delaying the flow of less important or less desired packets.
- Used to optimize network performance by prioritizing certain traffic flows and ensuring the traffic rate doesn't exceed the bandwidth limit.



Other Specialized Devices



Packet Shaping (Traffic Shaping)

Common uses of traffic shaping include:

- Time-sensitive data may be given priority over traffic that can be delayed briefly
- In a corporate environment, business-related traffic may be given priority over other traffic
- A large ISP may shape traffic based on customer priority
- An ISP may limit maximum bandwidth consumption for certain applications to reduce costs and create the capacity to take on additional subscribers

Other Specialized Devices



VPN Concentrator

- Provides secure creation of VPN connections
- A type of router device
- It can:
 - Establish and configure tunnels
 - Authenticate users
 - Assign tunnel/IP addresses to users
 - Encrypt and decrypt data
 - Ensure end-to-end delivery of data





THANKS!

Any questions?

