
Cybersecurity

CSCS

Introduction to Networks

Part 1

Today's Adenda

- A basic intro of
 - Hosts
 - IP Addresses
 - Networks
 - Repeaters
 - Hubs
 - Switches
 - Routers
 - OSI Model

Hosts, IP Addresses Networks

- **Hosts** are any device which **sends** or **receive** traffic



Hosts, IP Addresses Networks

- **Hosts** are any device which **sends** or **receive** traffic



Computer



Laptop



Phones



Printers



Servers



Cloud
Server

- Also any **Internet of Things (IoT)** devices
 - TV
 - Speakers
 - Smart Watches
 - Thermometers
 - Lights
 - Refrigerator

Hosts, IP Addresses Networks

- **Hosts** are any device which **sends** or **receive** traffic
 - Clients and Servers



Client



Server

www.site.com

- Client initiate requests, Servers respond

Hosts, IP Addresses Networks

- **Hosts** are any device which **sends or receive** traffic
 - Clients and Servers



www.site.com

- Client initiate requests, Servers respond
 - Relative to specific communication
- Servers are simply computers with software installed which responds to specific requests

Hosts, IP Addresses Networks

- An **IP Address** is the identity of each host



72.45.128.15

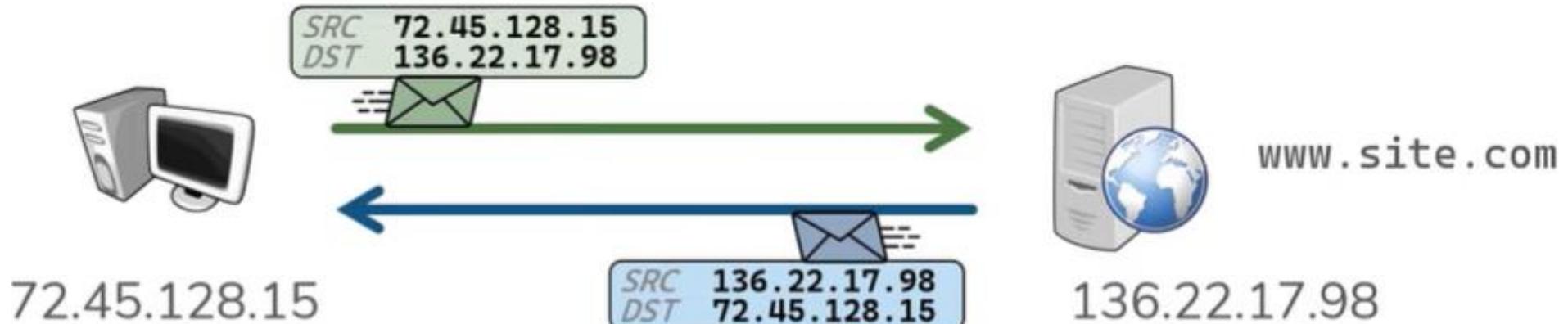


www.site.com

136.22.17.98

Hosts, IP Addresses Networks

- An **IP Address** is the identity of each host



Hosts, IP Addresses Networks

- An **IP Address** is the identity of each host
 - IP addresses are 32 bits
 - Bit = 1 or 0
 - Represented as four Octets
 - Each Octet can be 0-255



136.22.17.98

1 0 0 0 1 0 0 0 0 0 1 0 1 1 0 0 0 1 0 0 0 1 0 1 1 0 0 0 1 0

1000 100 . 0001 011 . 0001 0001 . 0110 0010

136 . 22 . 17 . 98

[0-255] [0-255] [0-255] [0-255]

Hosts, IP Addresses Networks

- An **IP Address** is the identity of each host
 - IP addresses are 32 bits, represented as 4 octets of 0-255
 - Hierarchically assigned

ACME, inc. – **10.x.x.x**

New York

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Hosts, IP Addresses Networks

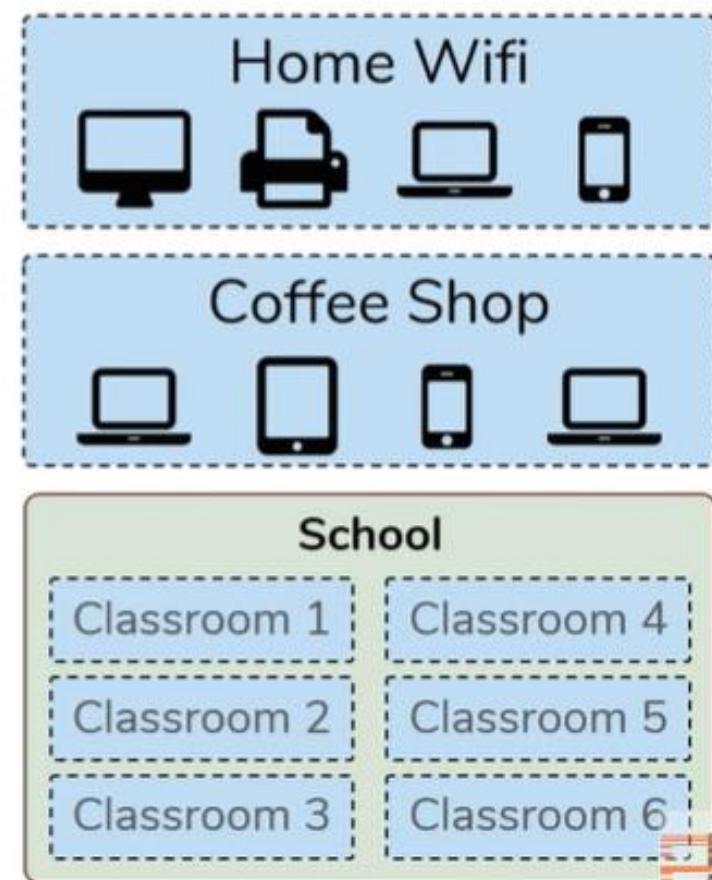
- A **Network** is what transports traffic between Hosts
 - Anytime two hosts are connected, you have a network



- Before Networks:
 - Transferring data between hosts required portable media
 - (disks, thumb drives, etc...)

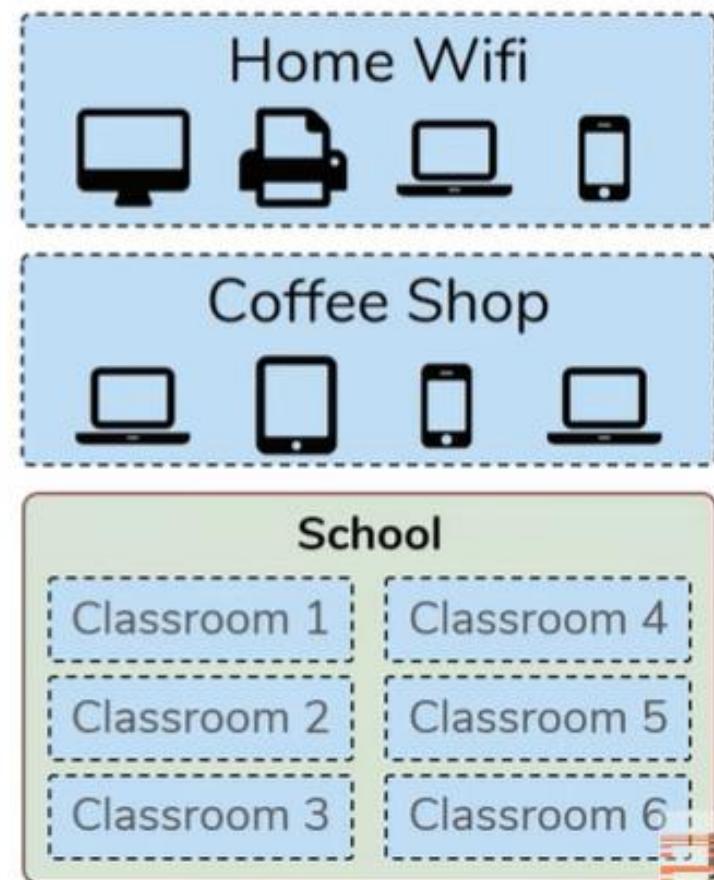
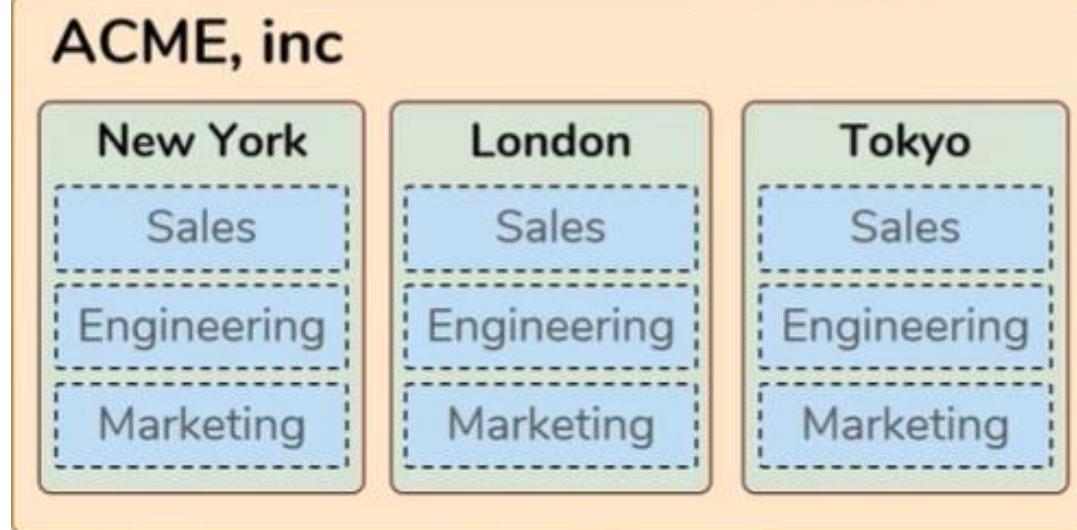
Hosts, IP Addresses Networks

- A **Network** is what transports traffic between Hosts
 - Logical grouping of hosts which require similar connectivity
 - Networks can contain other networks
 - Sometimes called **Sub-Networks** or **Subnets**



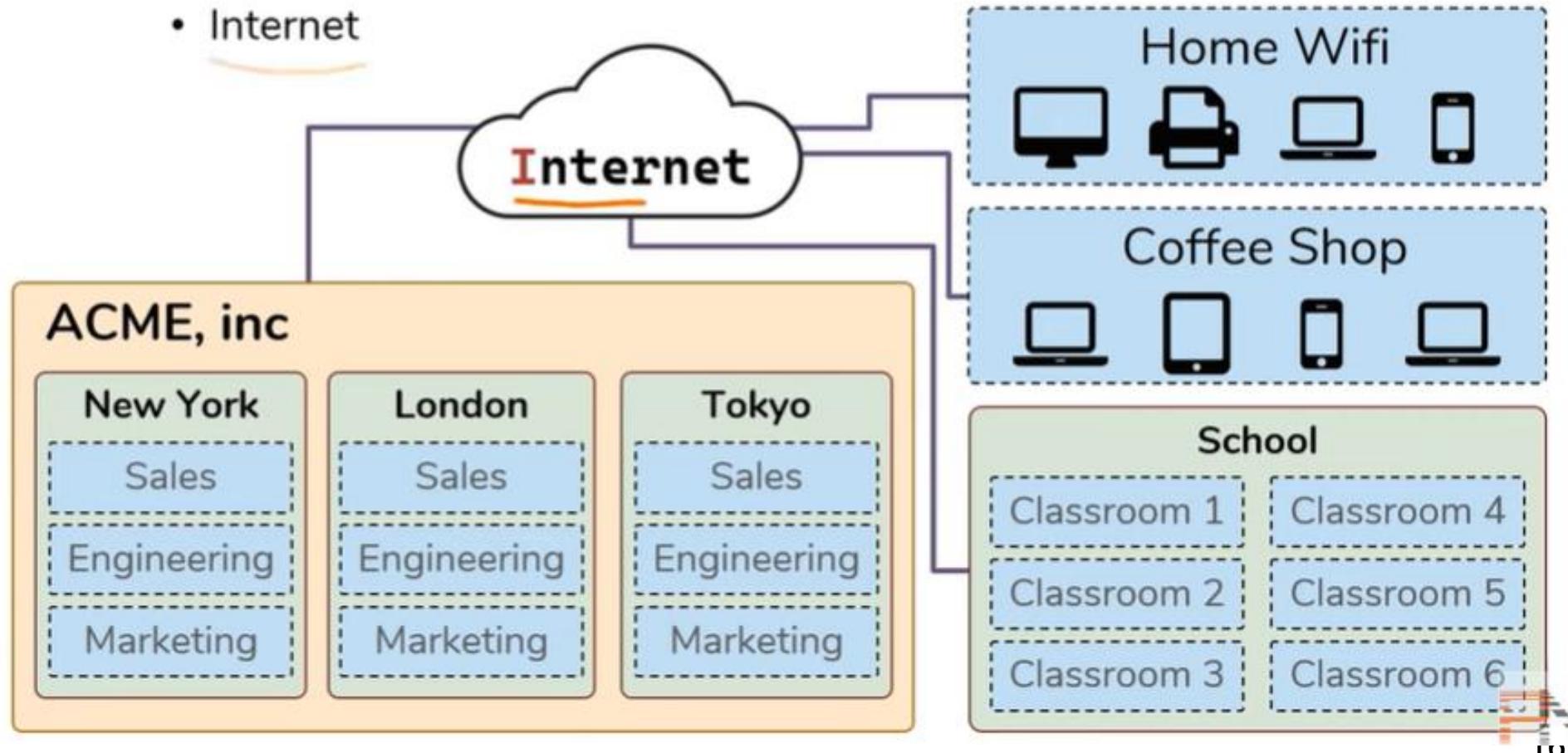
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Hosts, IP Addresses Networks

- A **Network** is what transports traffic between Hosts
 - Logical grouping of hosts which require similar connectivity
 - Networks can contain other networks
 - Sometimes called **Sub-Networks** or **Subnets**
 - Networks connect to other networks
 - Internet



Repeaters

- Data crossing a wire decays as it travels



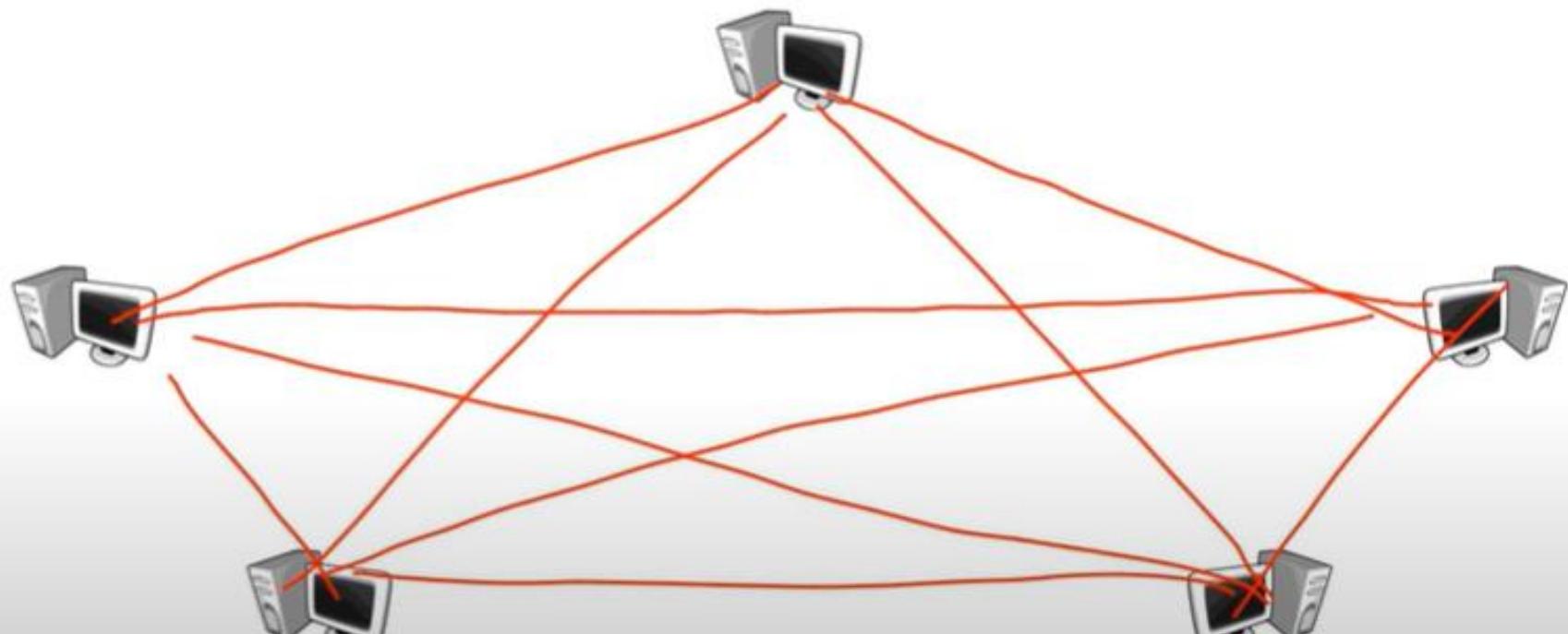
Repeaters

- **Repeaters** regenerate signals
 - Allow communications across greater distances



Hubs

- Connecting hosts directly to each other doesn't scale



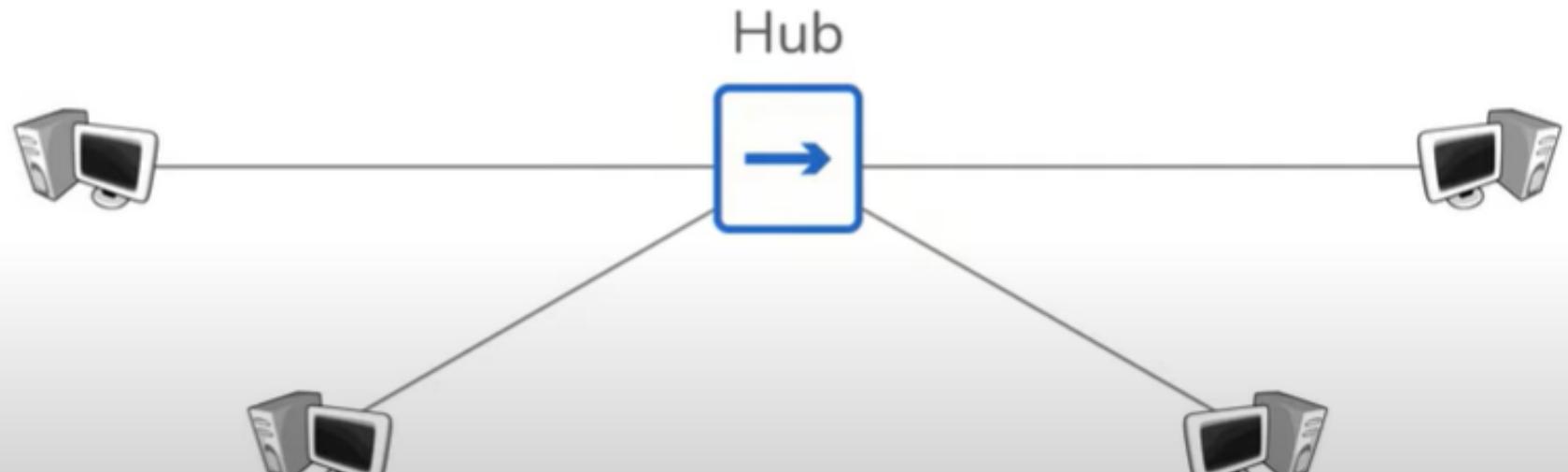
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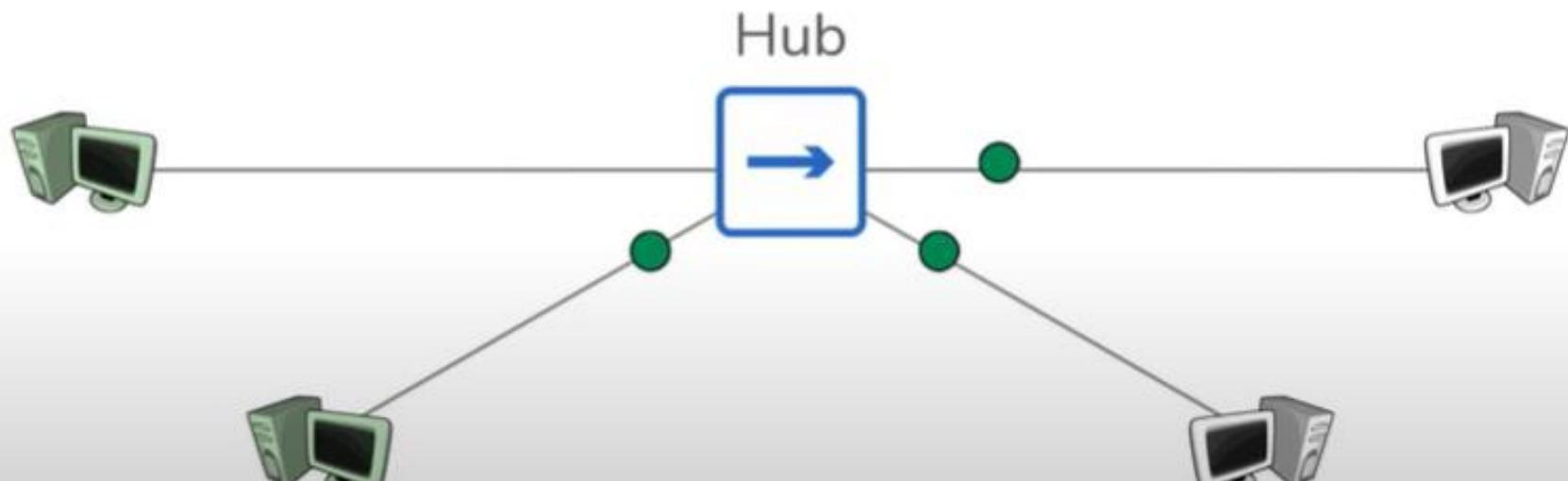
Hubs

- **Hubs** are simply multi-port **Repeaters**



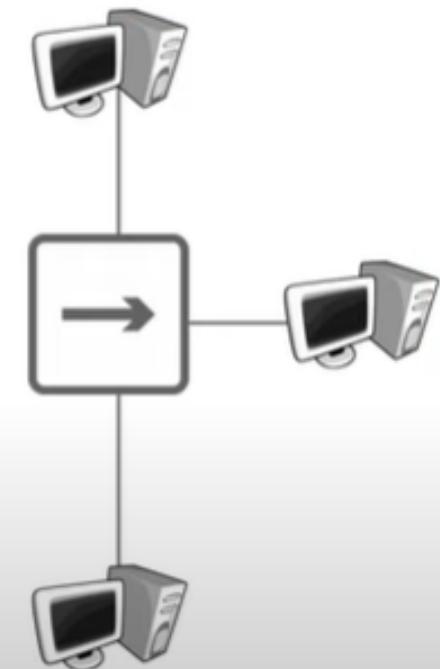
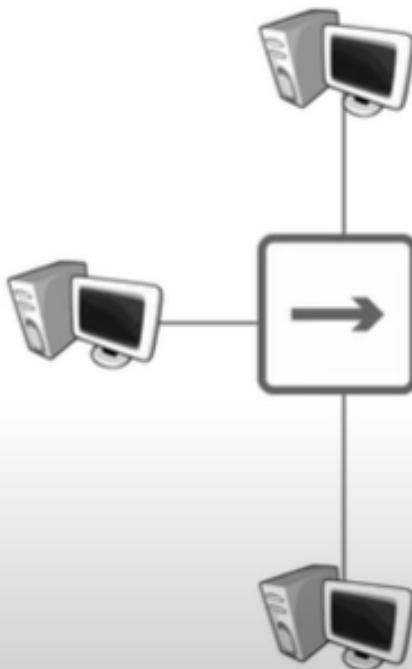
Hubs

- **Hubs** are simply multi-port **Repeaters**
 - Facilitates scaling communication between additional hosts
 - Everyone receives everyone else's data



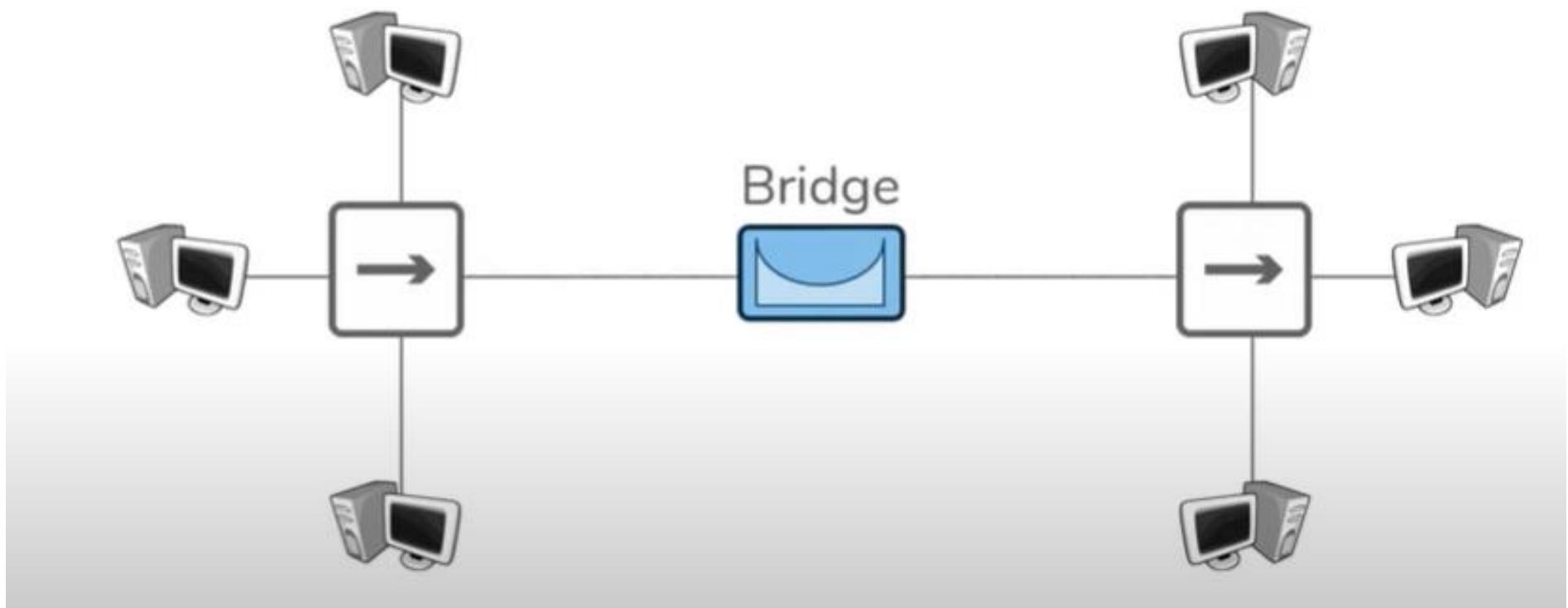
Bridges

- **Bridges** sit between Hub-connected hosts



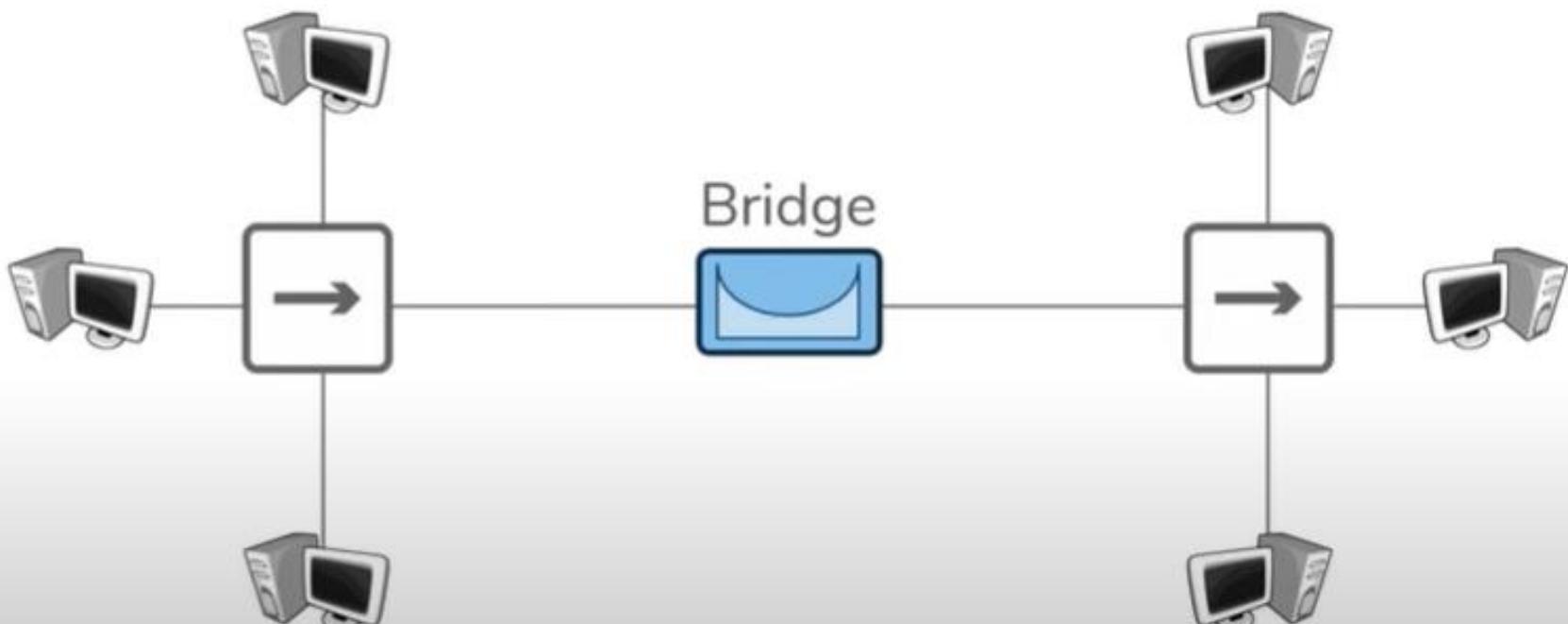
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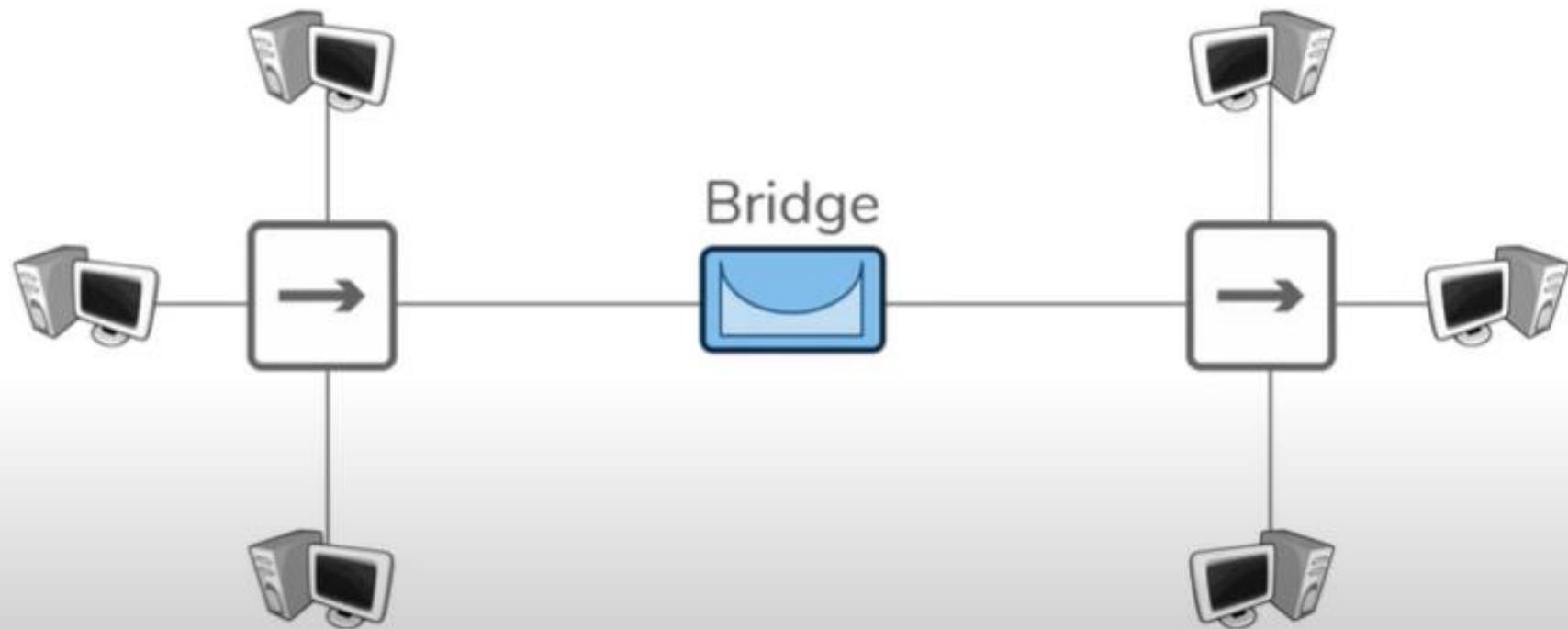
Bridges

- **Bridges** sit between Hub-connected hosts
 - Bridges only have two ports



Bridges

- **Bridges** sit between Hub-connected hosts
 - Bridges only have two ports
 - Bridges learn which hosts are on each side



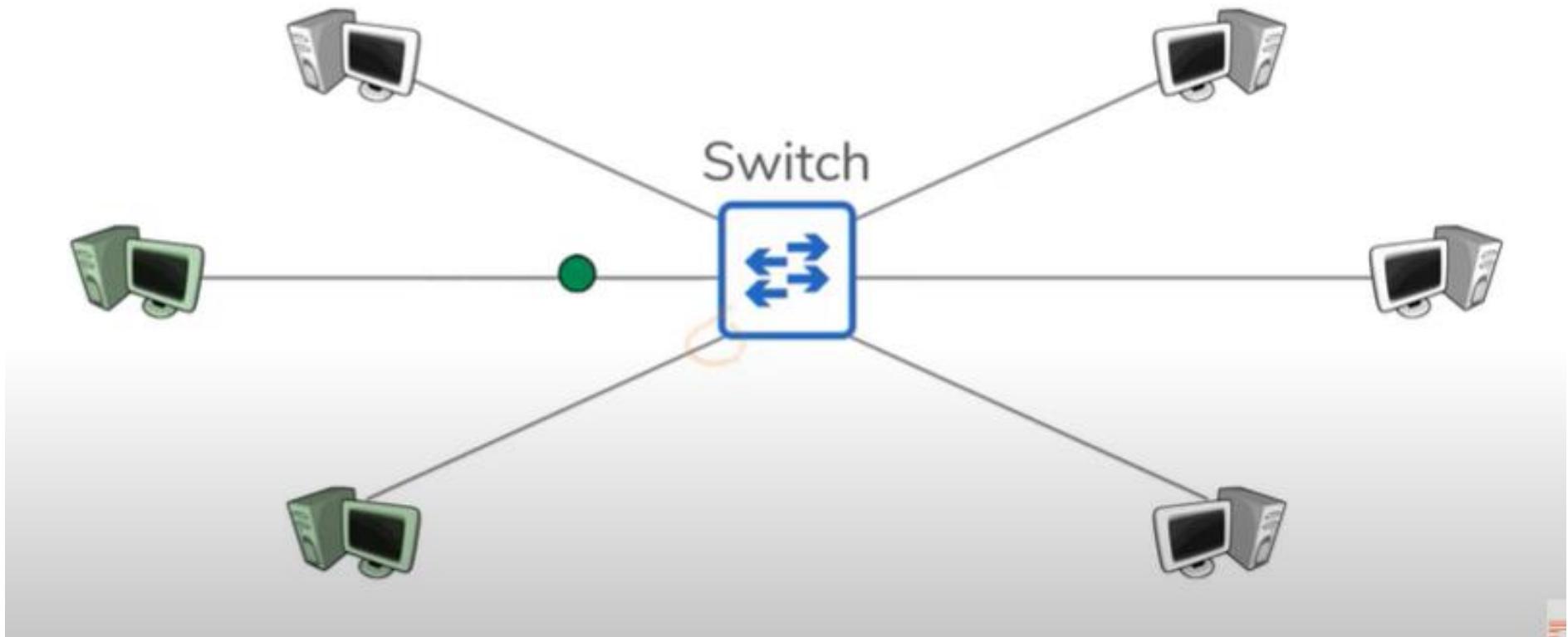
Switches

- Switches are a combination of Hubs and Bridges



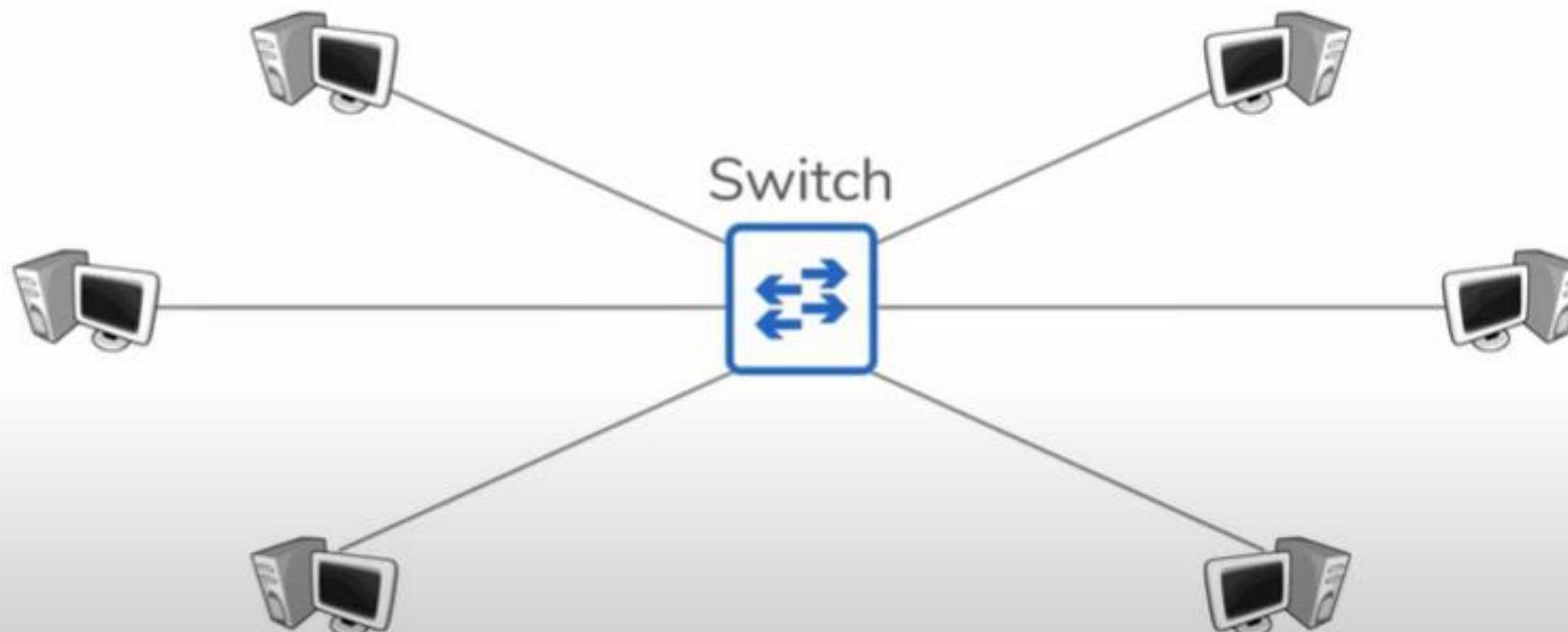
Switches

- Switches are a combination of Hubs and Bridges
 - Multiple Ports
 - Learns which hosts are on each port



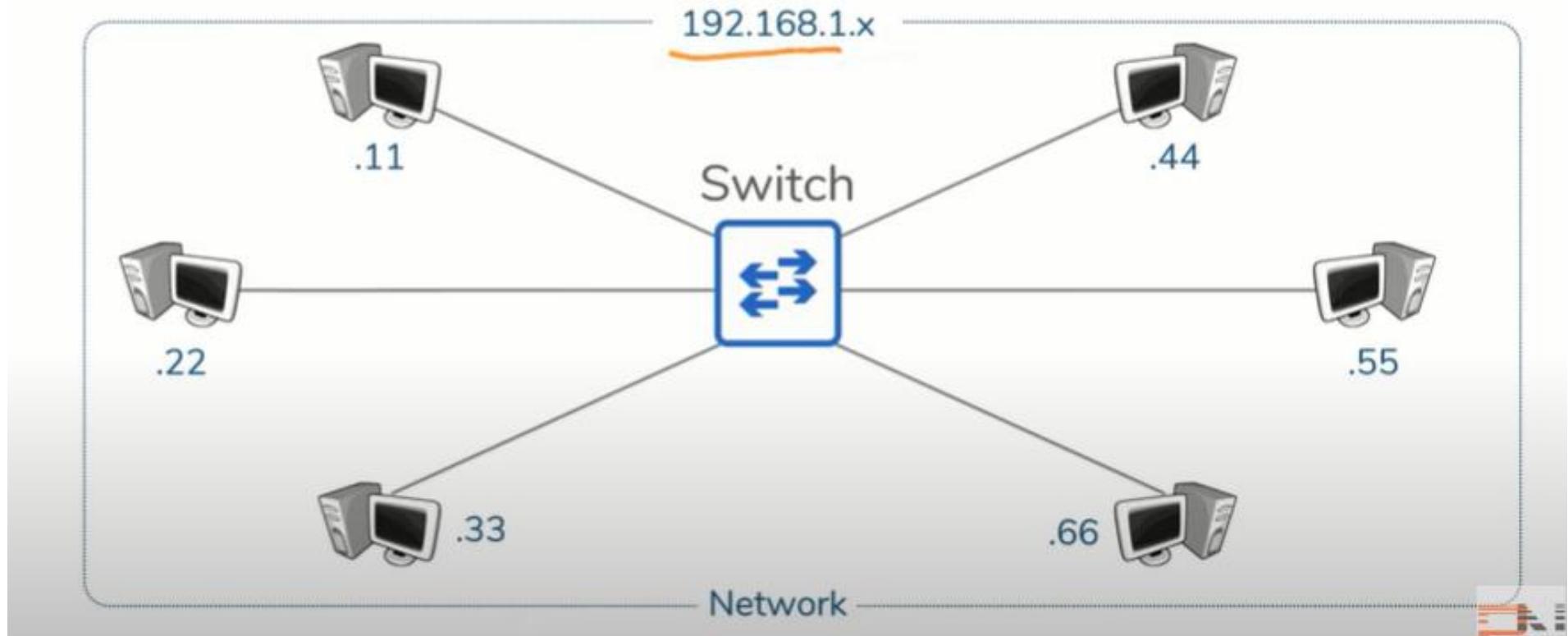
Switches

- **Switches** facilitate communication **within** a network
 - **Network:** Grouping of hosts which require similar connectivity



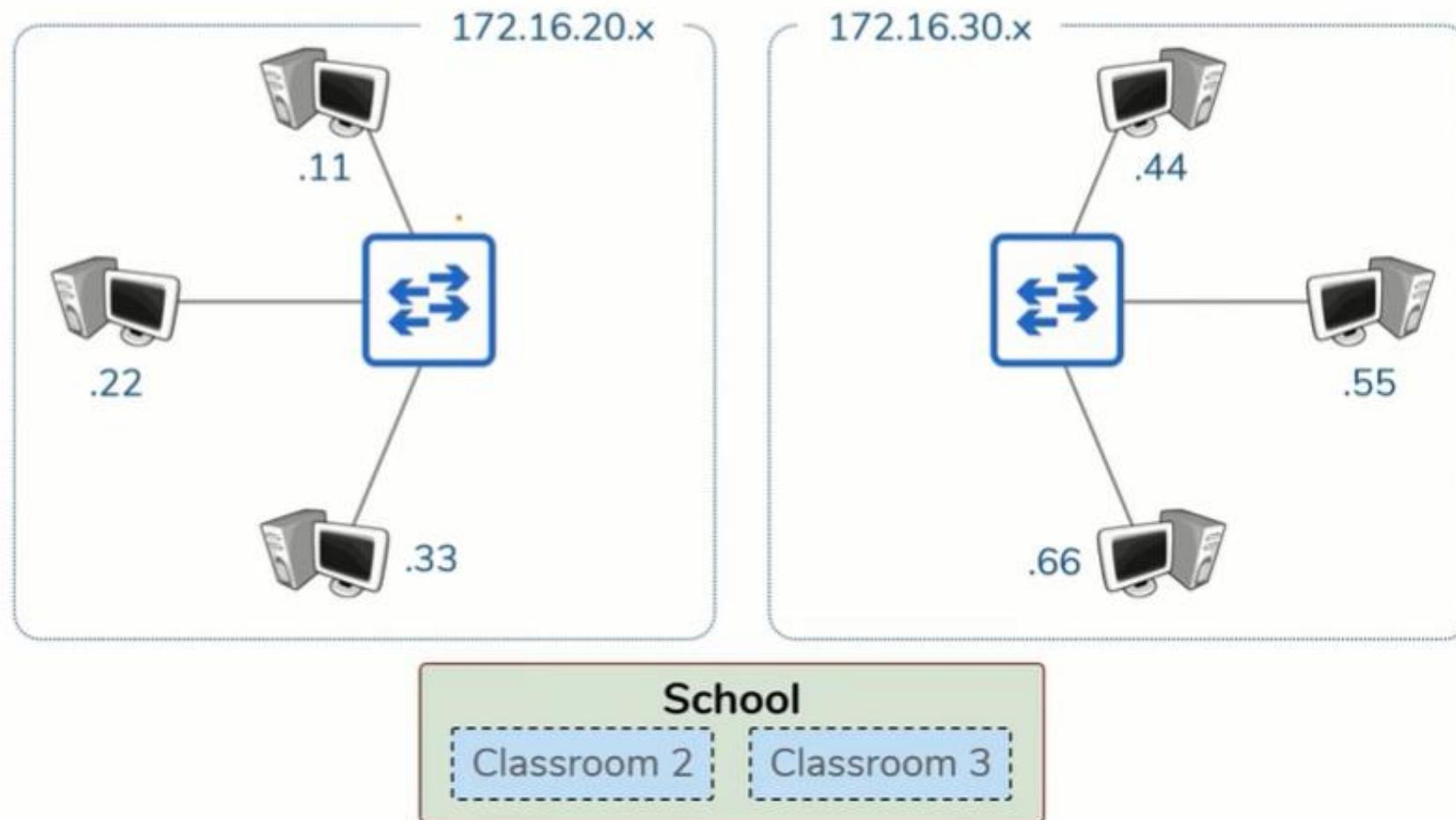
Switches

- **Switches** facilitate communication **within** a network
 - **Network:** Grouping of hosts which require similar connectivity
 - Hosts on a Network share the same IP address space



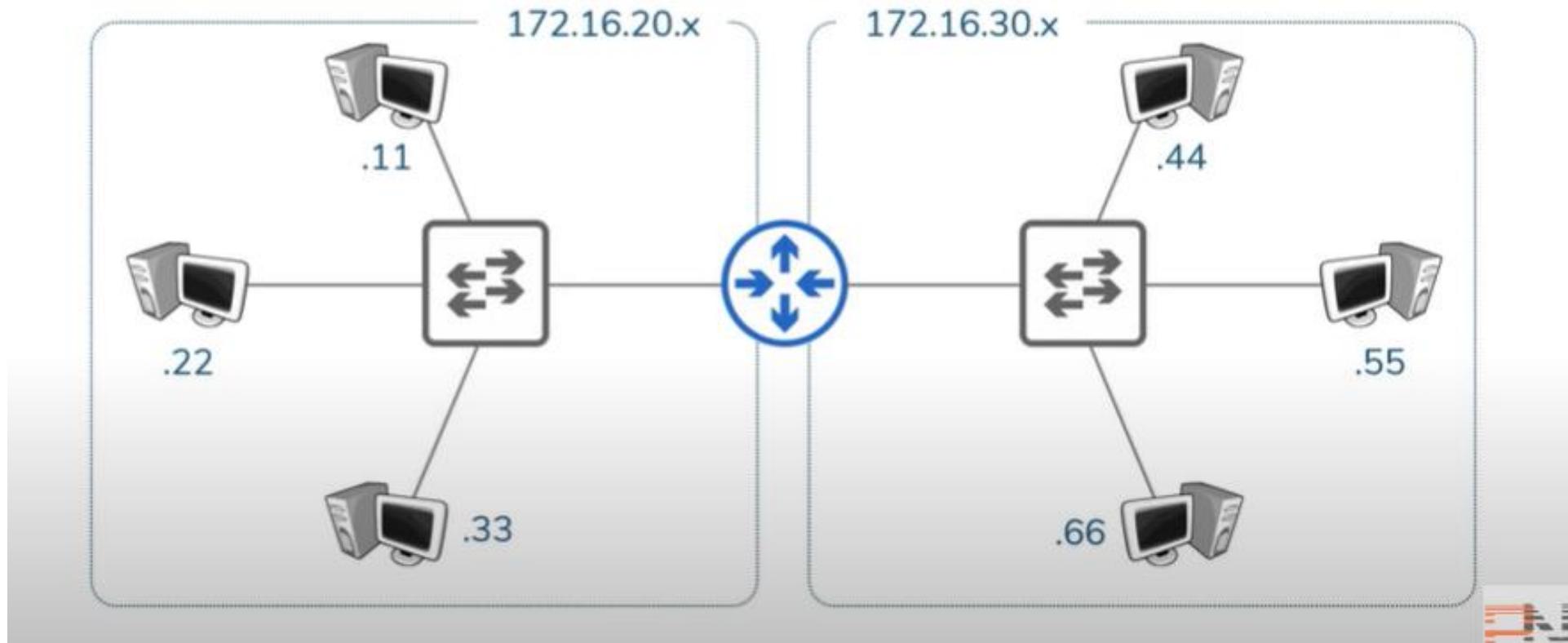
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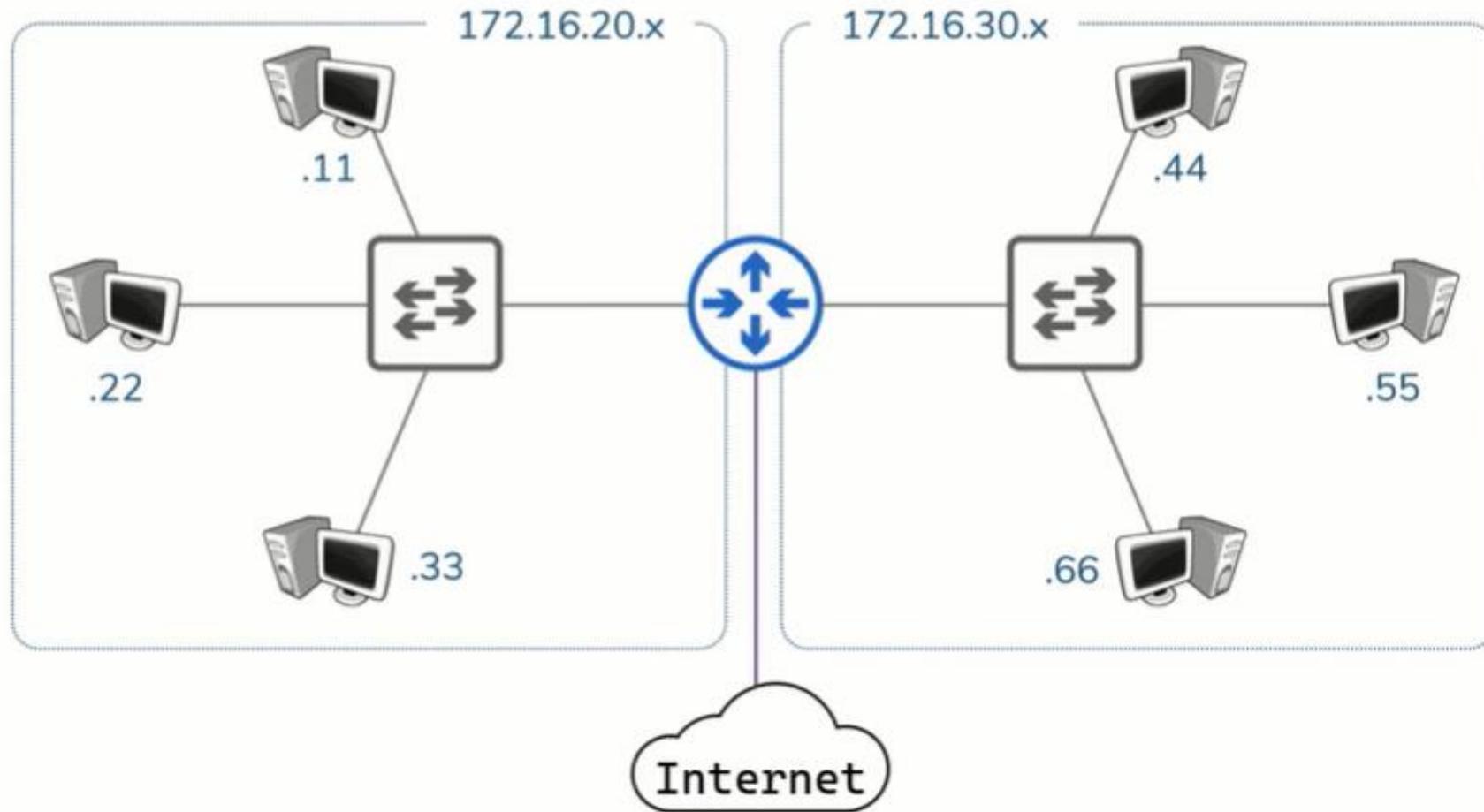
Routers

- **Switches** facilitate communication **within** a network
 - **Network:** Grouping of hosts which require similar connectivity
- **Routers** facilitate communication **between** networks



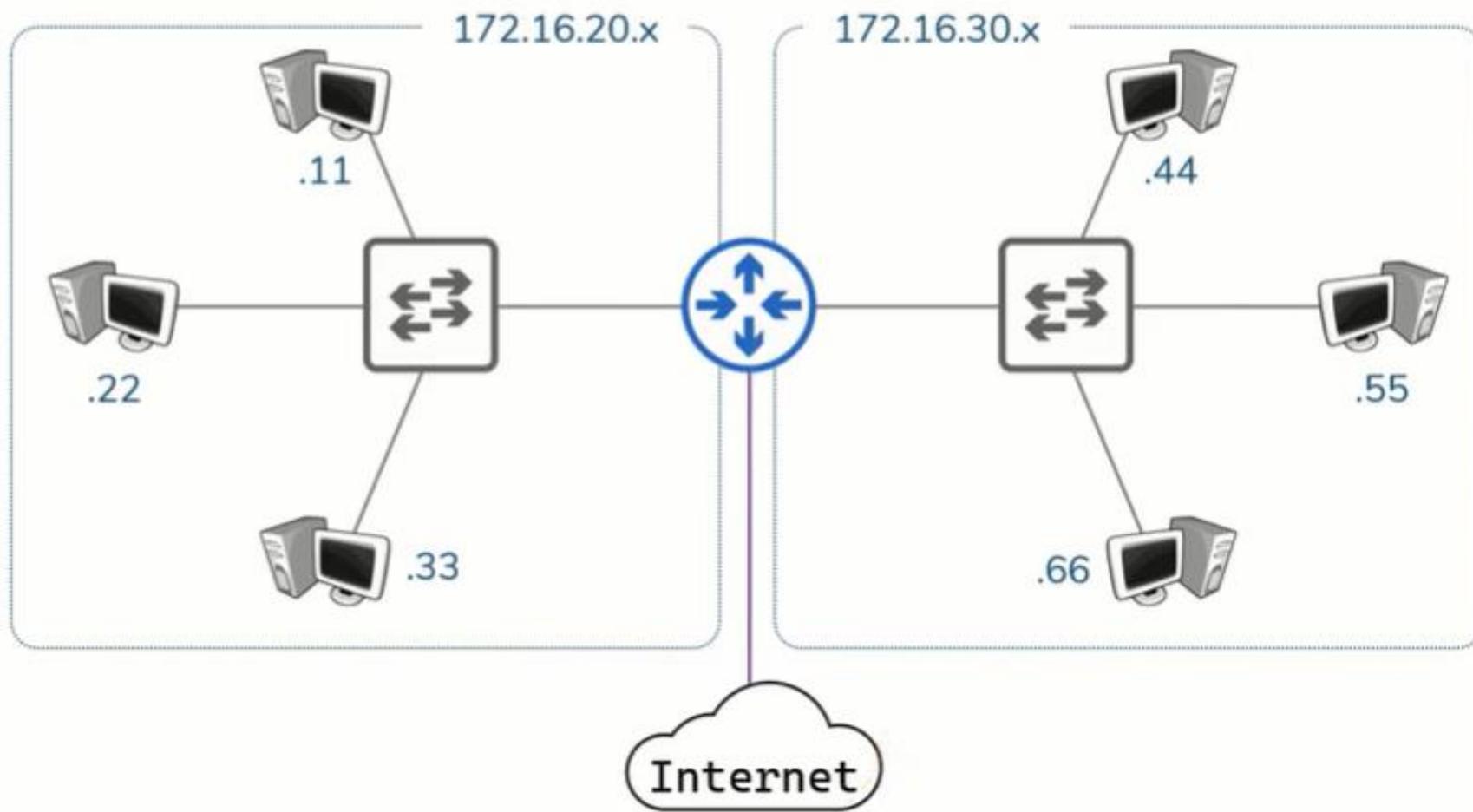
Routers

- **Routers** facilitate communication **between** networks
 - **Network:** Grouping of hosts which require similar connectivity
 - Provides a traffic control point (security, filtering, redirecting)



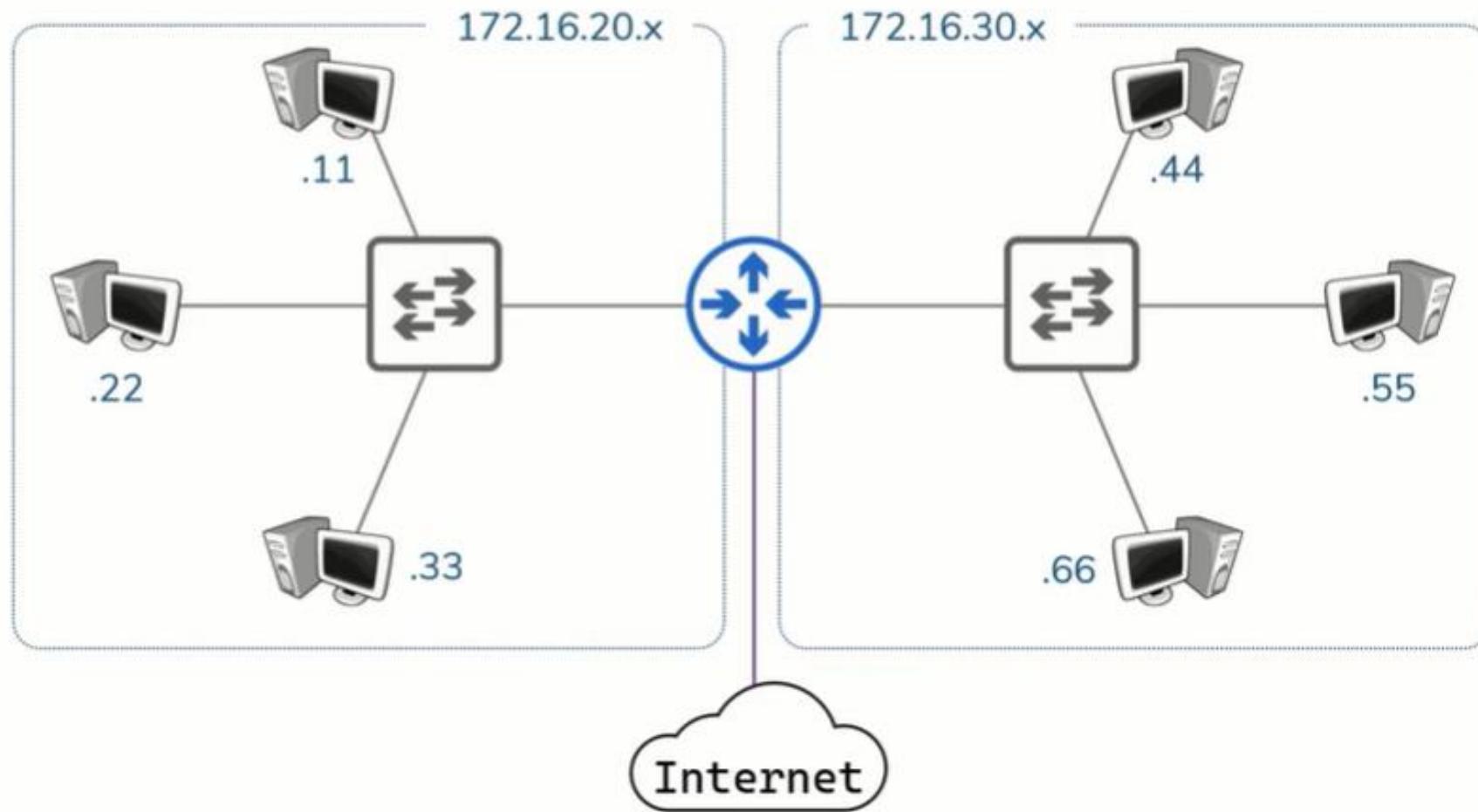
Routers

- **Routers** facilitate communication **between** networks
 - Routers learn which networks they are attached to



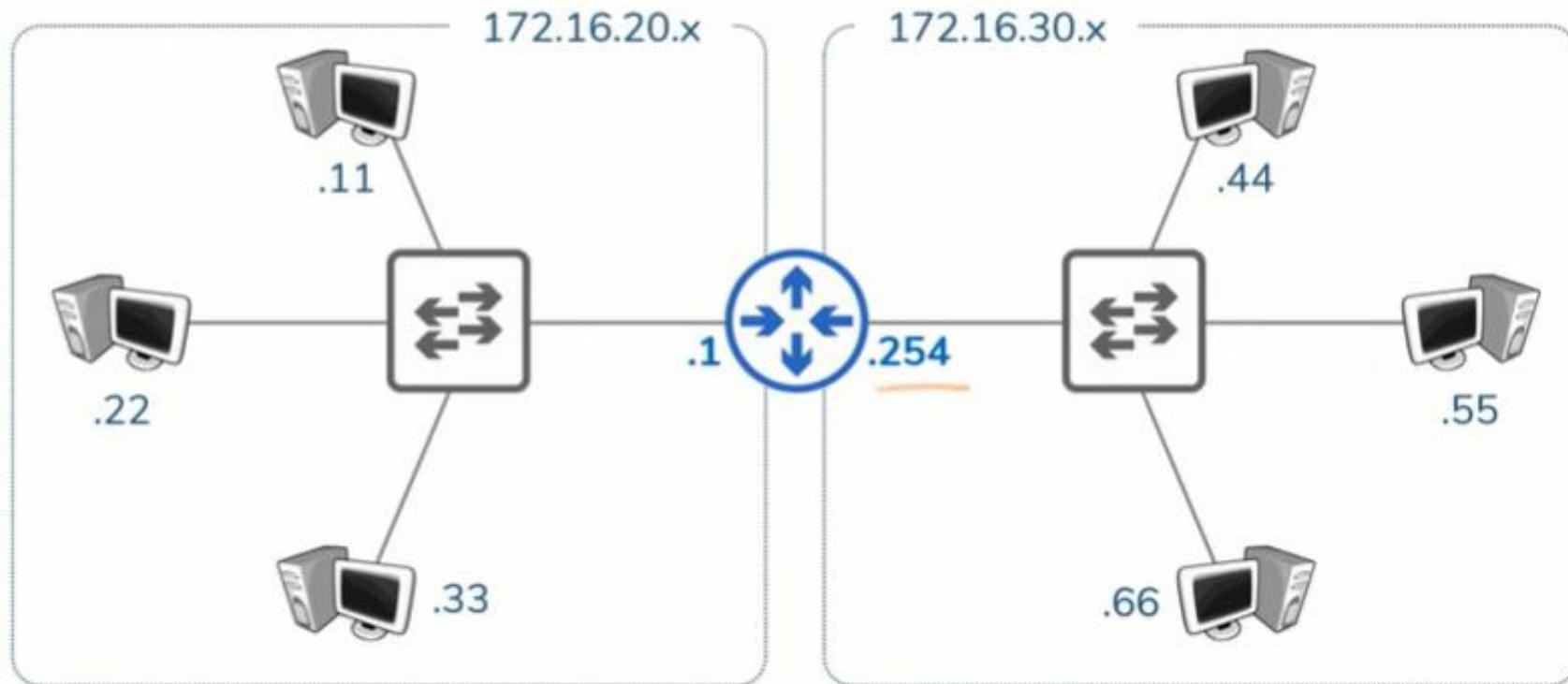
Routers

- **Routers** facilitate communication **between** networks
 - Routers learn which networks they are attached to
 - Known as **Routes** – Stored in a **Routing Table**
 - **Routing Table** – all networks a Router knows about



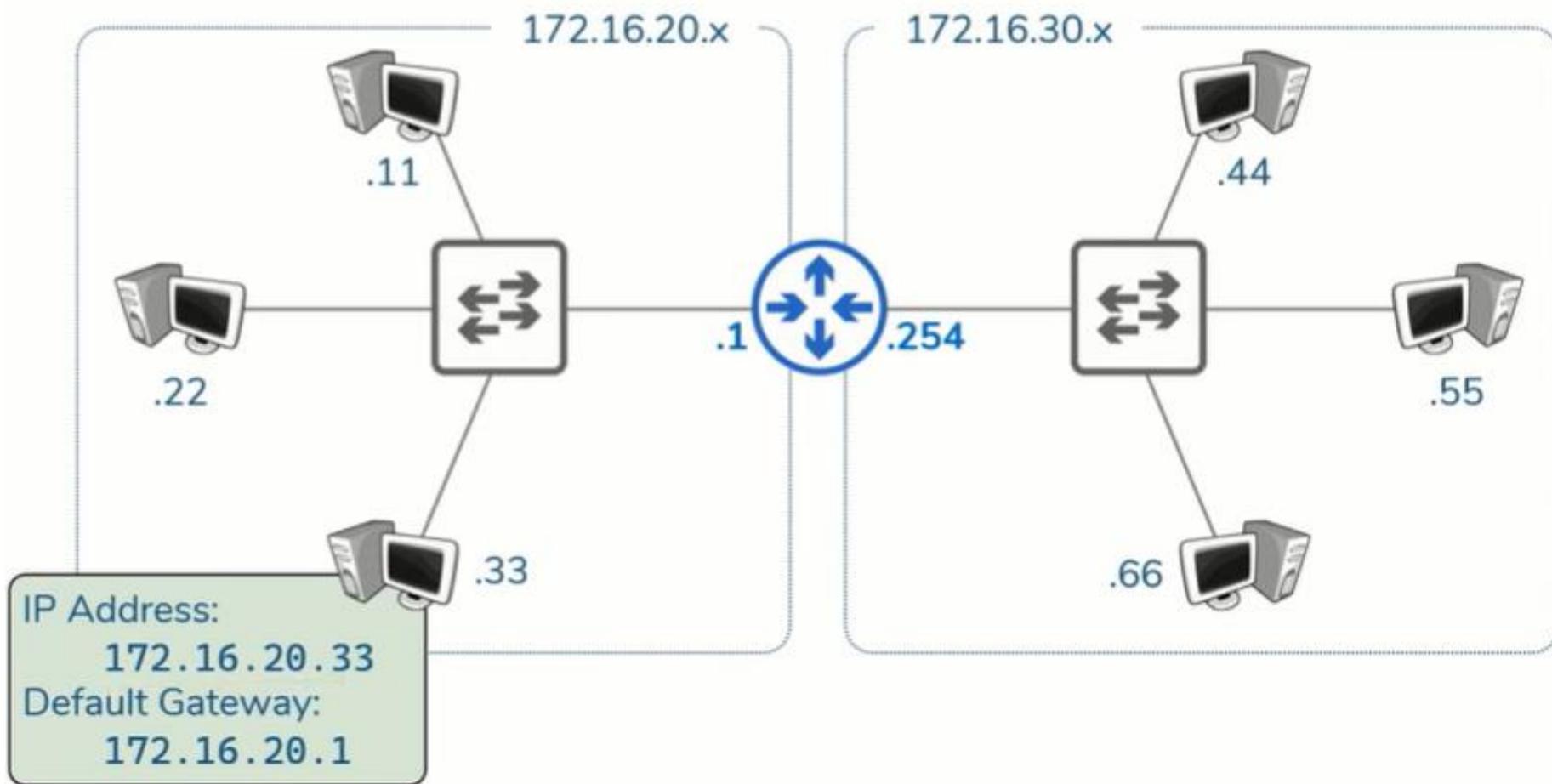
Routers

- **Routers** facilitate communication **between** networks
 - Have IP addresses in the Networks they are attached to



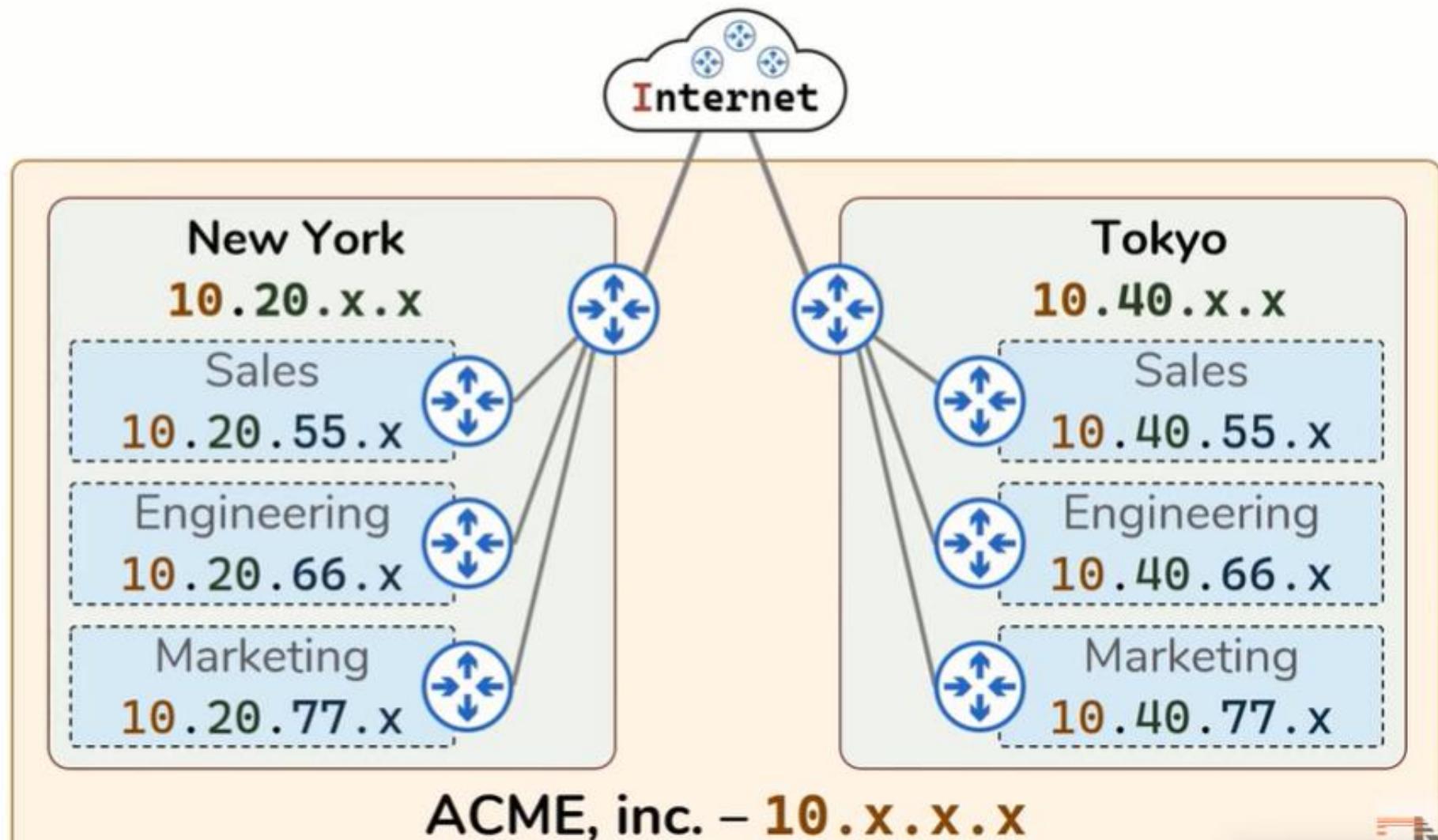
Routers

- **Routers** facilitate communication **between** networks
 - Have IP addresses in the Networks they are attached to
 - **Gateway** – each host's way out of their local Network



Routers

- **Routers** facilitate communication **between** networks
 - Create the Hierarchy in Networks and the entire Internet



Summary

- **Routers** facilitate communication **between** networks
- **Switches** facilitate communication **within** a network
- **Routing** is the process of **moving data between networks**
 - A Router is a device whose primary purpose is Routing
- **Switching** is the process of **moving data within networks**
 - A Switch is a device who's primary purpose is Switching
- There are many other Network Devices:
 - Access Points
 - Firewalls
 - Load Balancers
 - Virtual Switches
 - Layer 3 Switches
 - IDS / IPS
 - Proxies
 - Virtual Routers
- All of them perform Routing and/or Switching



Summary

- **Hosts** are any device which **sends** or **receive** traffic
 - Clients and Servers
- An **IP Address** is the **identity of each host**
- A **Network** is what **transports traffic between Hosts**
 - Logical grouping of hosts which require similar connectivity
 - Subnetworks, Subnets
- **Repeaters** **regenerate** signals
- **Hubs** are simply multi-port **Repeaters**
- **Bridges** sit between Hub-connected hosts
- **Switches** facilitate communication **within** a network
 - Switching
- **Routers** facilitate communication **between** networks
 - Gateways, Routes, Routing Table, Routing

OSI Model

OSI Model

- Purpose of Networking:
 - Allow two hosts to share data with one another



OSI Model

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- Purpose of Networking:
 - Allow two hosts to share data with one another
- Hosts must follow a set of rules
 - Example: English language has rules
Spanish language has rules



OSI Model

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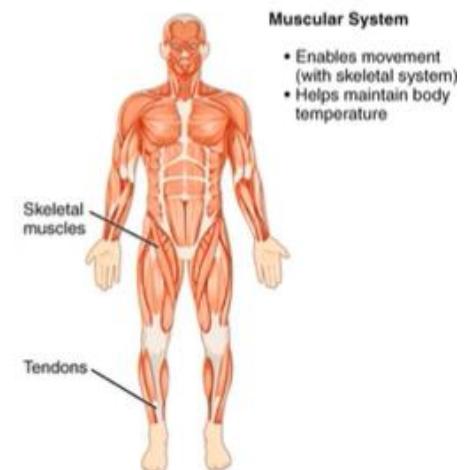
- Purpose of Networking:
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 - Example: English language has rules
Spanish language has rules
- The rules for Networking are divided into seven layers:
 - OSI Model



OSI Model

OSI Model

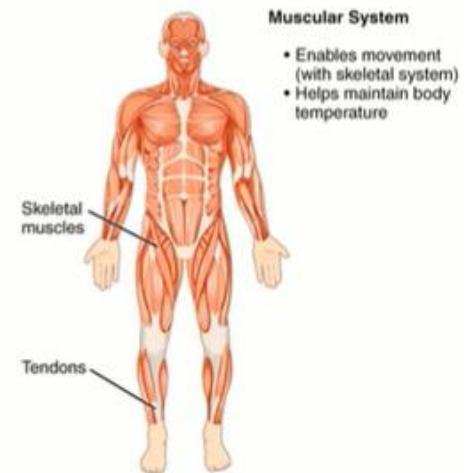
- Purpose of Networking:
 - Allow two hosts to share data with one another
- Human Body is made up various systems:
 - Skeletal, Respiratory, Nervous, Cardiovascular, Muscular, etc...
 - If all these systems are functioning, the human lives
- OSI model divides rules of networking into 7 layers
 - Each layer serves a specific function
 - If all layers are functioning, hosts can share data



OSI Model

OSI Model

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- OSI model divides rules of networking into 7 layers
 - Each layer serves a specific function
 - If all layers are functioning, hosts can share data
- Instead, understand the purpose of each layer, and how it contributes to the goal of Networking



OSI Model

OSI Model

- **Layer 1 – Physical**

- Computer data exists in the form of Bits (1's and 0's)
- Something has to transport those bits between hosts

7	Application
6	Presentation
5	Session
4	Transport
3	Network
2	Data Link
1	Physical



OSI Model

OSI Model

- **Layer 1 – Physical – Transporting Bits**

- Computer data exists in the form of Bits (1's and 0's)
- Something has to transport those bits between hosts
- L1 Technologies: Cables

(Ethernet)

Twisted Pair



Coaxial



Fiber



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Wi-Fi



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 - L1 Technologies: Cables, Wifi, Repeaters, Hubs

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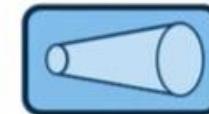
Fiber



Wi-Fi



Repeaters



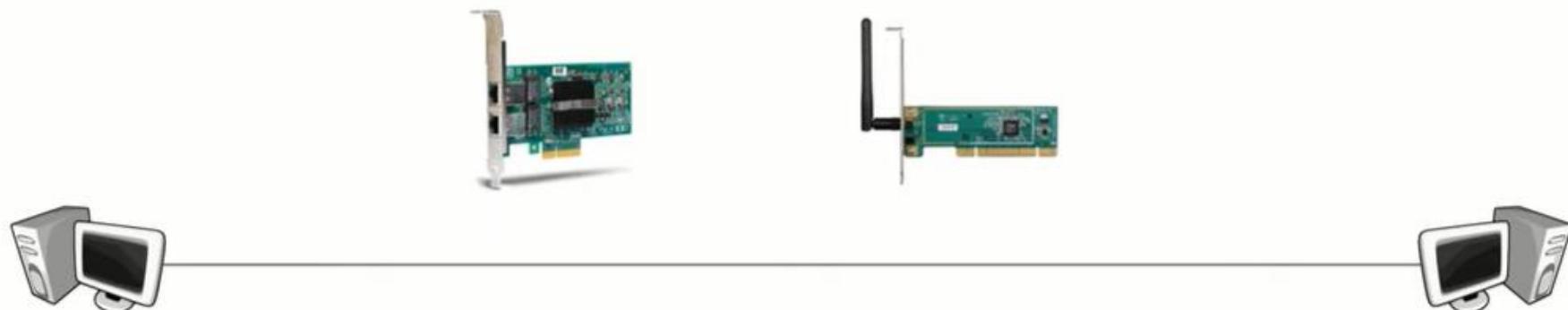
OSI Model

OSI Model

- **Layer 2 – Data Link**

- Interacts with the Wire (i.e., Physical layer)
 - NIC – Network Interface Cards / Wi-Fi Access Cards

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OSI Model

OSI Model

- Layer 2 – Data Link – Hop to Hop
 - Interacts with the Wire (i.e., Physical layer)
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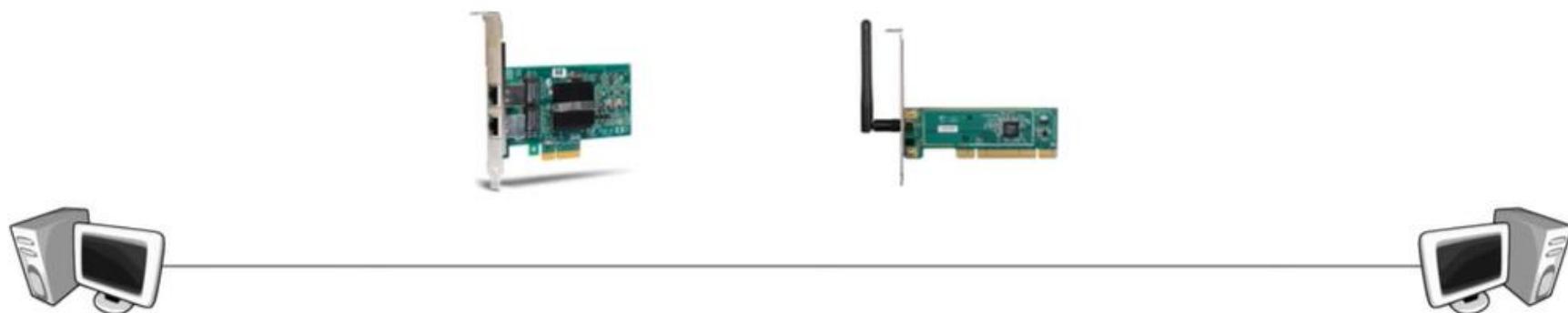


OSI Model

OSI Model

- **Layer 2 – Data Link – Hop to Hop**

- Interacts with the Wire (i.e., Physical layer)
 - NIC – Network Interface Cards / Wi-Fi Access Cards
- Addressing Scheme – MAC addresses
 - 48 bits, represented as 12 hex digits
 - 94-65-9C-3B-8A-E5 / 94:65:9C:3B:8A:E5 / 9465.9C3B.8AE5



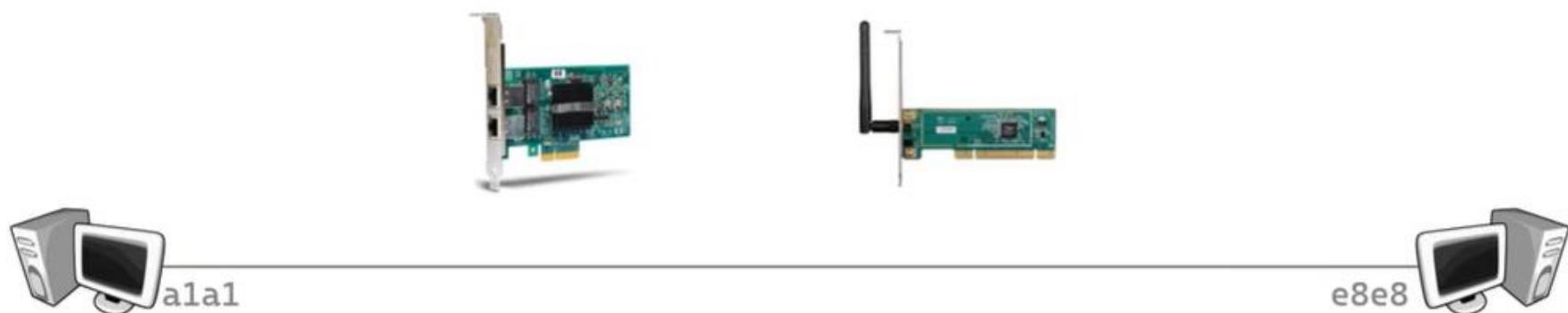
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 - Every NIC has a unique MAC address

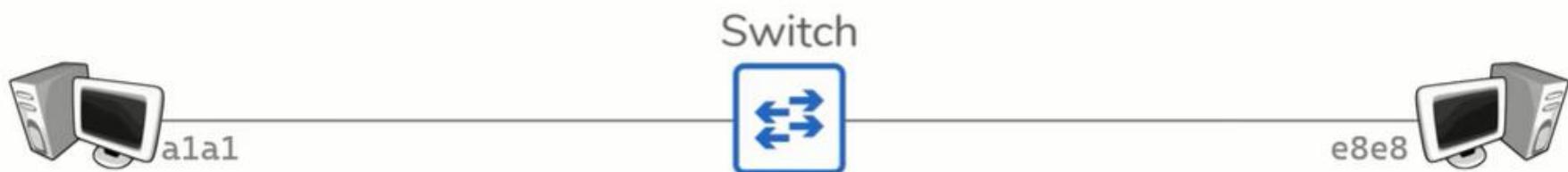
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OSI Model

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 - L2 Technologies: NICs, Switches

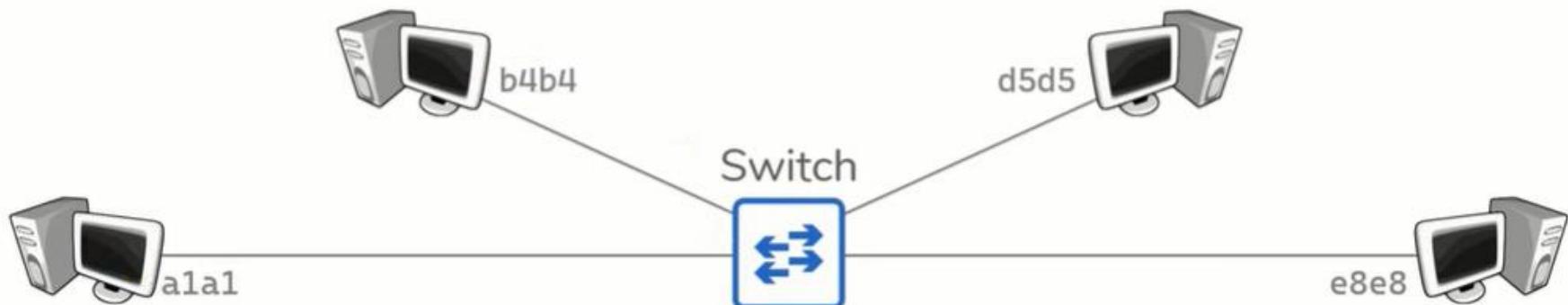


OSI Model

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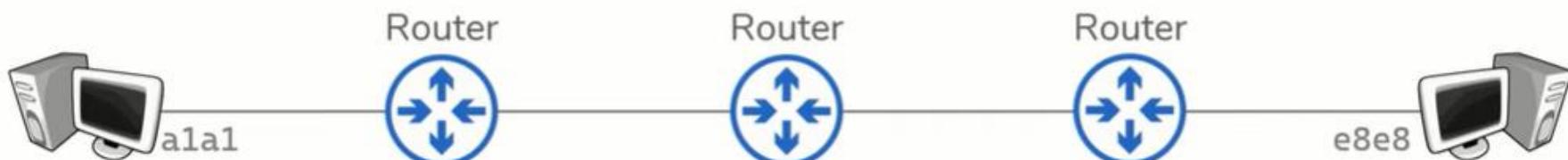
OSI Model

OSI Model

- **Layer 2 – Data Link – Hop to Hop**

- Interacts with the Wire (i.e., Physical layer)
- Addressing Scheme – MAC addresses
- L2 Technologies: NICs, Switches
- Often communication between hosts require multiple hops

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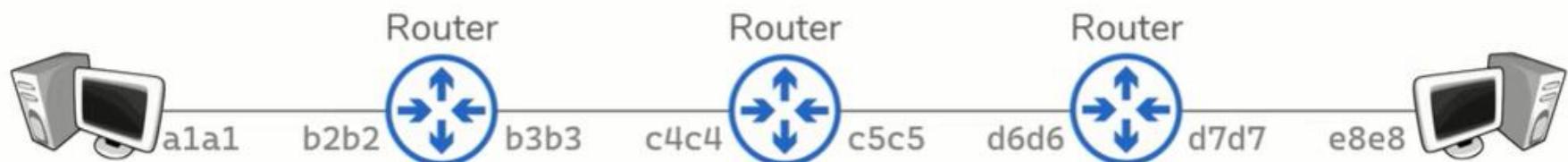


OSI Model

OSI Model

- Layer 3 – Network

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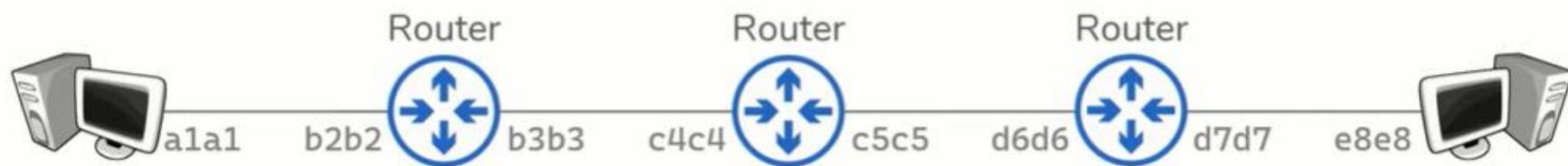


OSI Model

OSI Model

- Layer 3 – Network – End to End

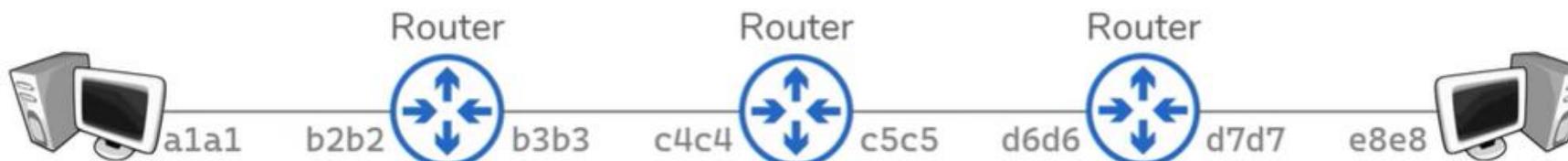
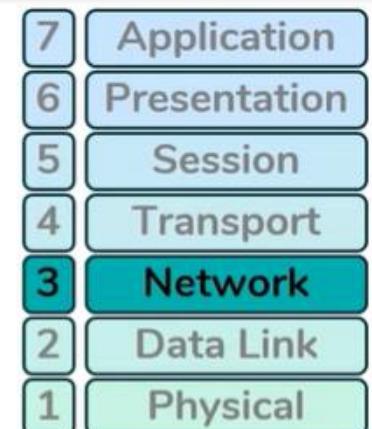
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OSI Model

OSI Model

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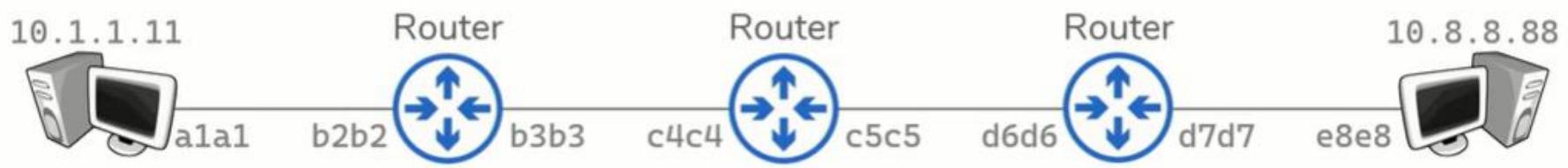
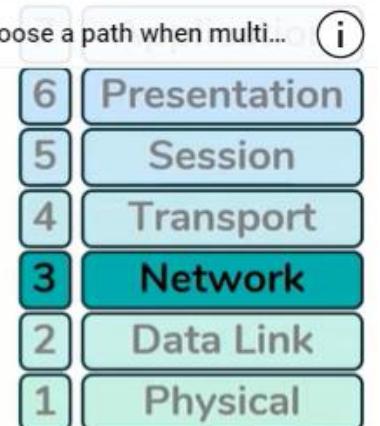


OSI Model

OSI Model

- Layer 3 – Network – End to End
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 - 32 bits, represented as 4 octets, each 0-255
 - L3 Technologies: Routers

Route Precedence -- How does a Router choose a path when multi... [\(i\)](#)

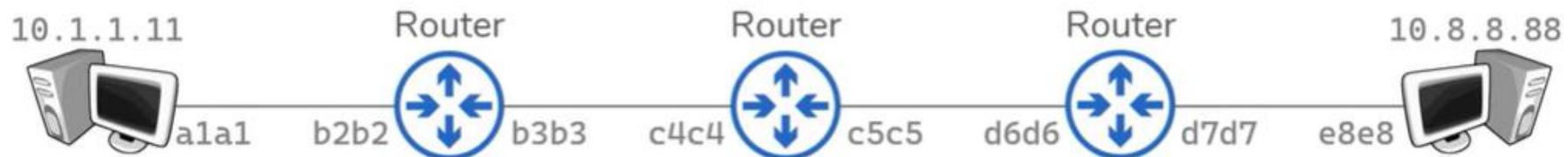


OSI Model

OSI Model

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 - L3 Technologies: Routers, Hosts, (anything with an IP)

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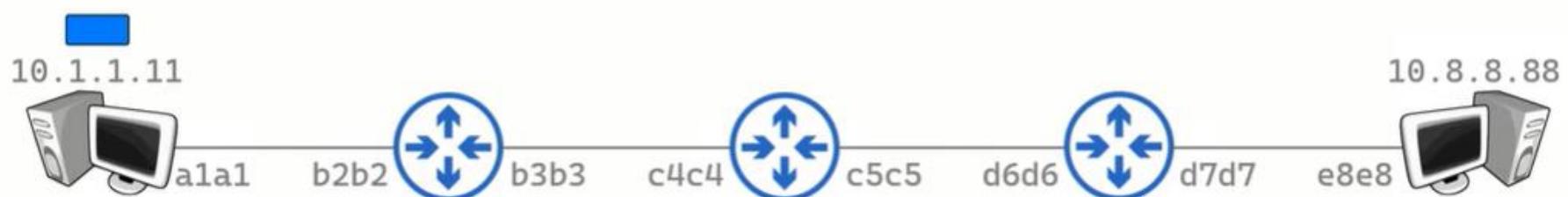
OSI Model

OSI Model

- Layer 3 – IP Addresses – End to End delivery
 - Layer 2 – MAC Addresses – Hop to Hop delivery



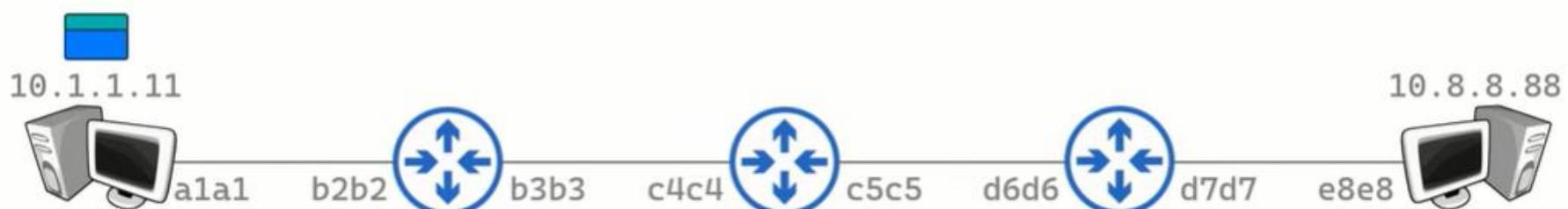
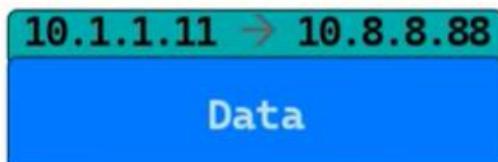
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OSI Model

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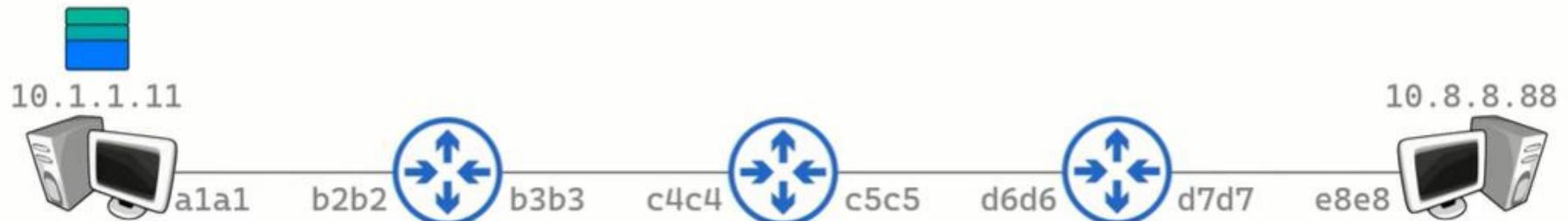
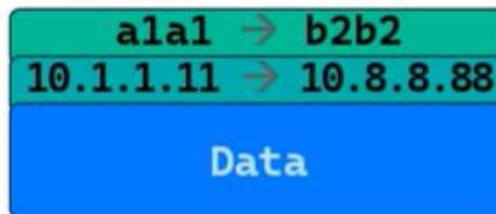
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OSI Model

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- Layer 3 – IP Addresses – End to End delivery
- Layer 2 – MAC Addresses – Hop to Hop delivery

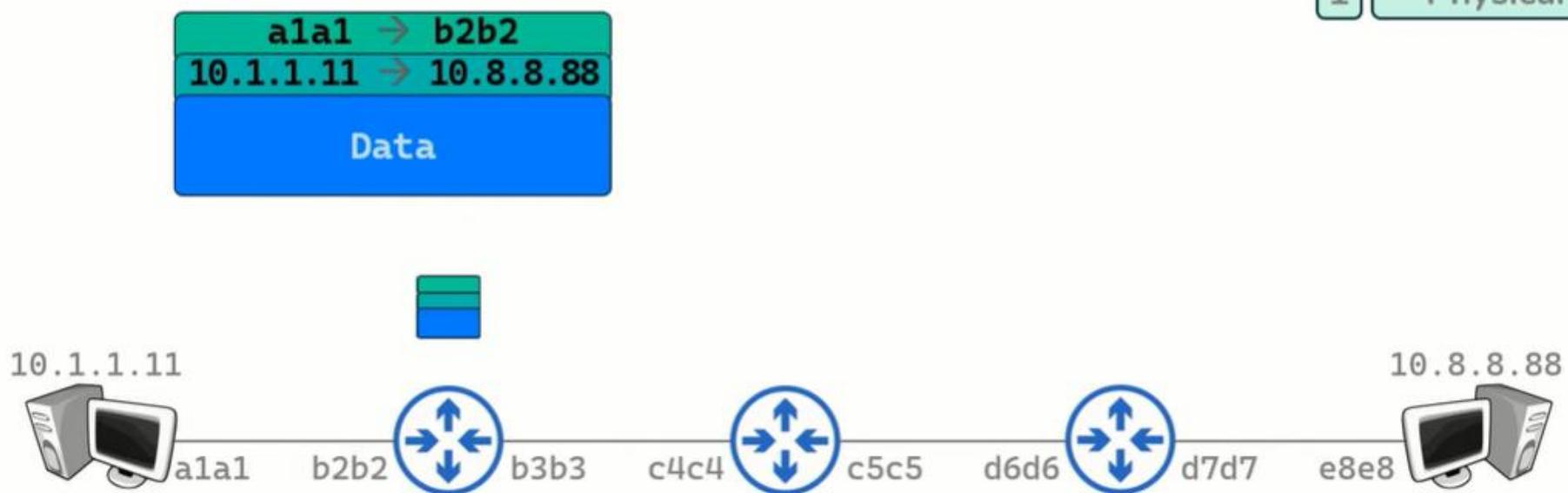


OSI Model

OSI Model

- Layer 3 – IP Addresses – End to End delivery
- Layer 2 – MAC Addresses – Hop to Hop delivery

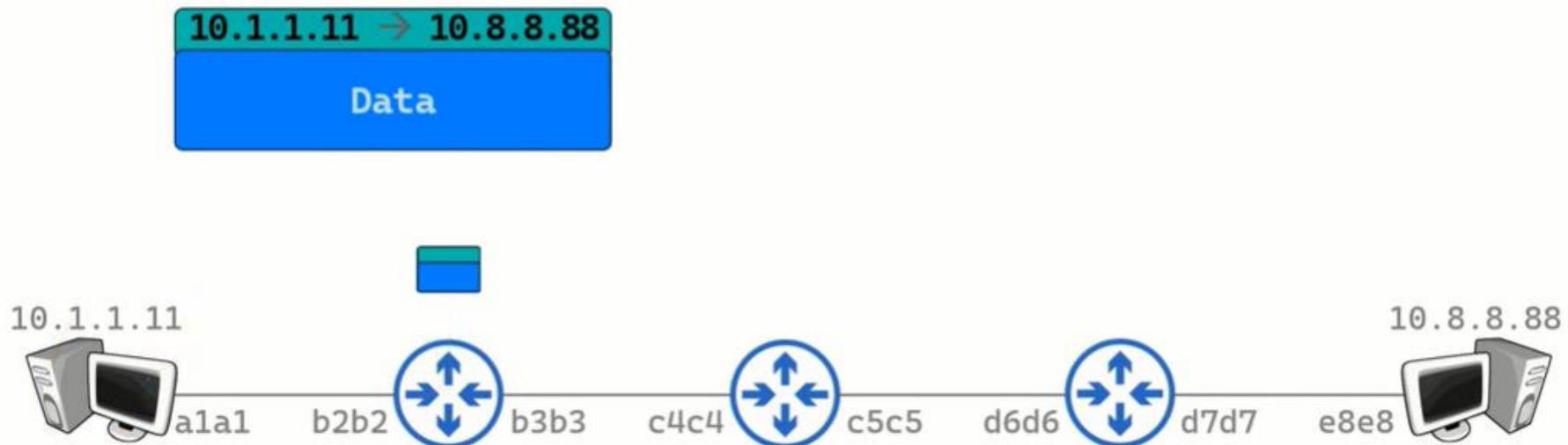
7	Application
6	Presentation
5	Session
4	Transport
3	Network
2	Data Link
1	Physical



OSI Model

OSI Model

- Layer 3 – IP Addresses – **End to End delivery**
- Layer 2 – MAC Addresses – **Hop to Hop delivery**

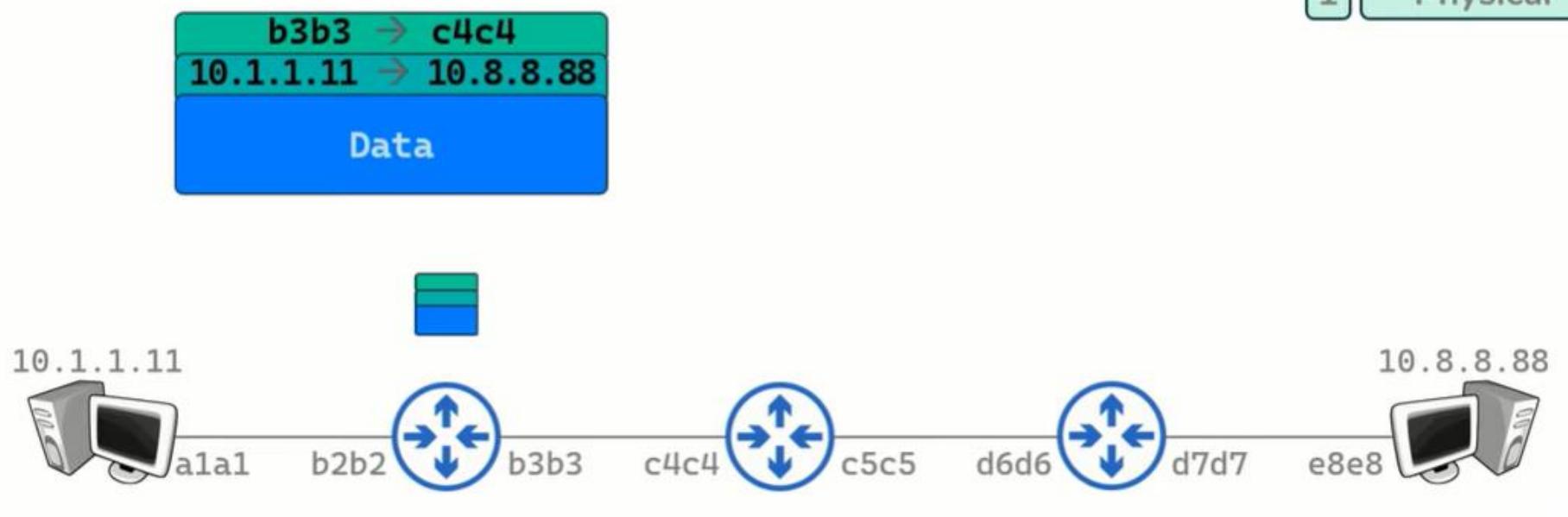


OSI Model

OSI Model

- Layer 3 – IP Addresses – End to End delivery
- Layer 2 – MAC Addresses – Hop to Hop delivery

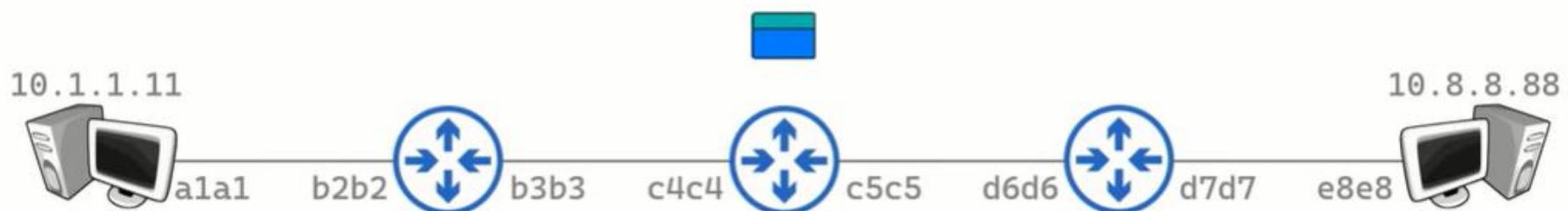
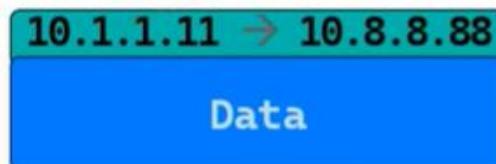
7	Application
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5	Session
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OSI Model

OSI Model

- Layer 3 – IP Addresses – End to End delivery
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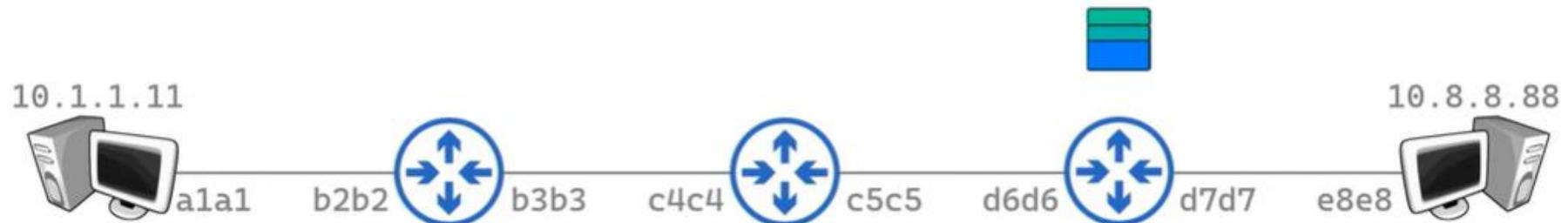


OSI Model

OSI Model

- Layer 3 – IP Addresses – End to End delivery
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7	Application
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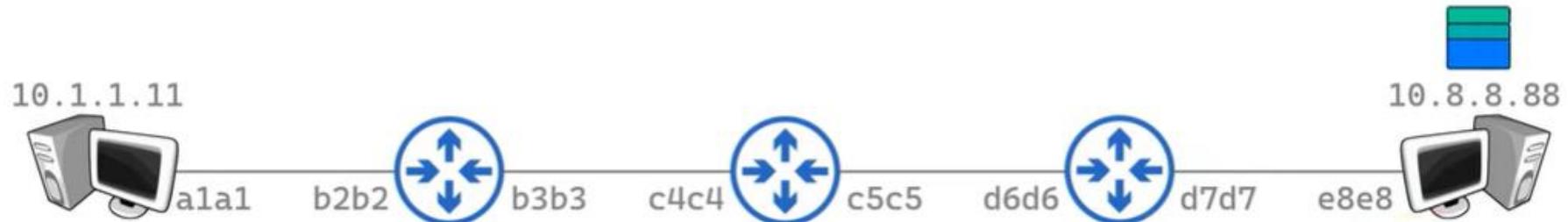
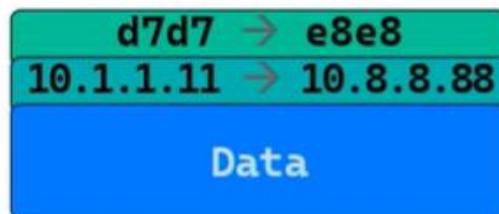


OSI Model

OSI Model

- Layer 3 – IP Addresses – End to End delivery
- Layer 2 – MAC Addresses – Hop to Hop delivery

7	Application
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5	Session
4	Transport
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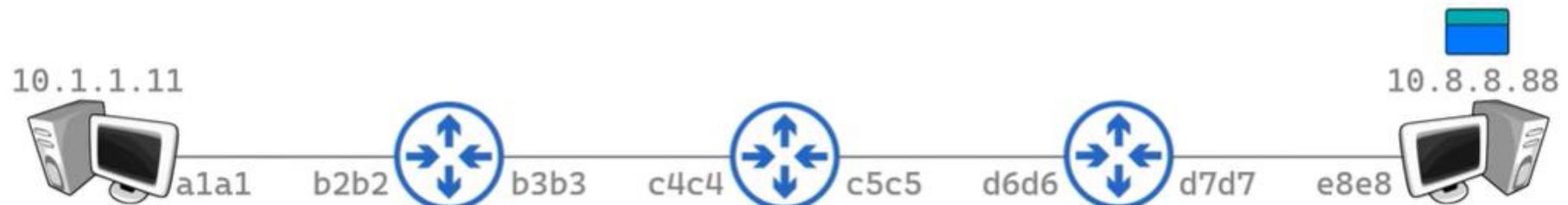
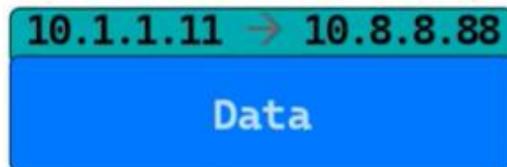


OSI Model

OSI Model

- Layer 3 – IP Addresses – End to End delivery
- Layer 2 – MAC Addresses – Hop to Hop delivery

7	Application
6	Presentation
5	Session
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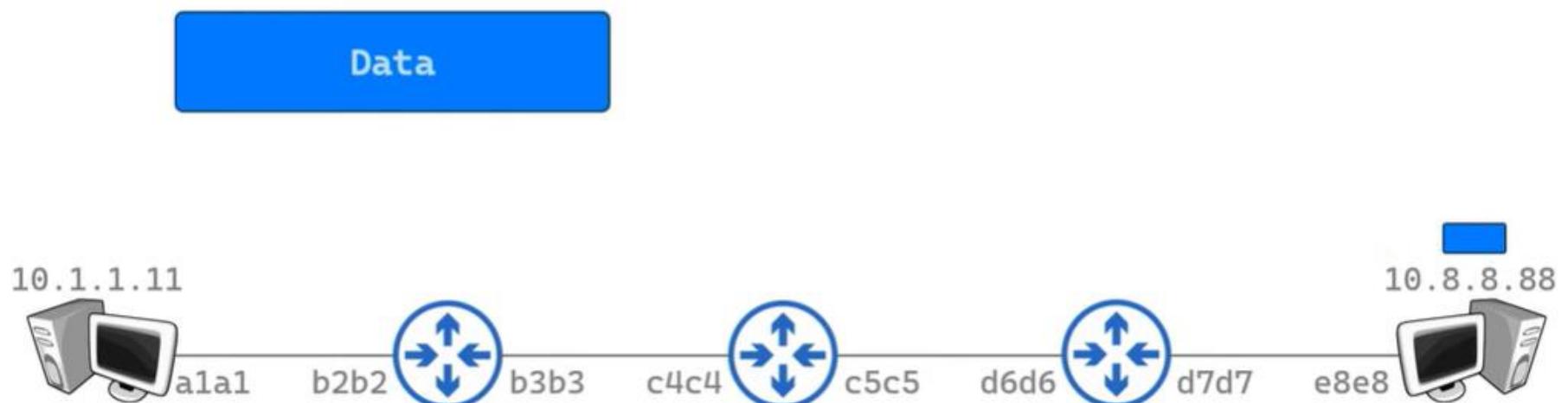


OSI Model

OSI Model

- Layer 3 – IP Addresses – End to End delivery
- Layer 2 – MAC Addresses – Hop to Hop delivery

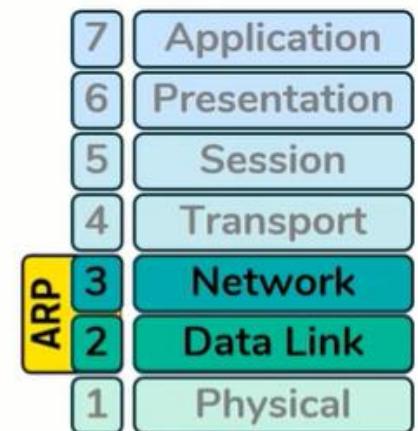
7	Application
6	Presentation
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4	Transport
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2	Data Link
1	Physical



OSI Model

OSI Model

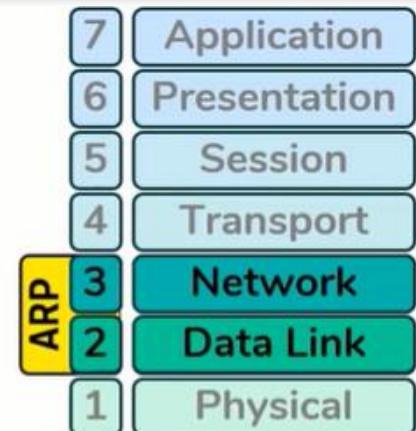
- Layer 3 – IP Addresses
- Layer 2 – MAC Addresses
- ARP – Address Resolution Protocol



OSI Model

OSI Model

- Layer 3 – IP Addresses
- Layer 2 – MAC Addresses
- ARP – Address Resolution Protocol
 - Links a L3 address to a L2 address

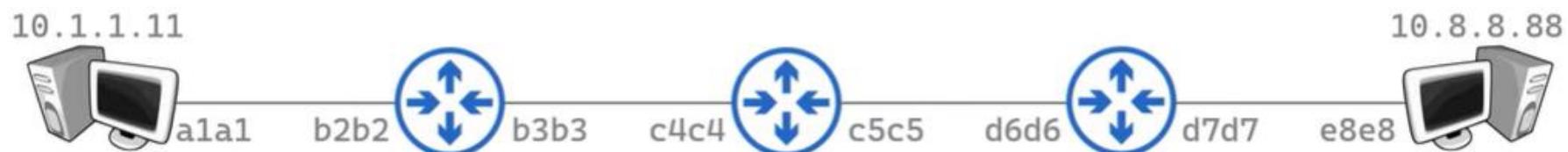


Summary

OSI Model

- Part 1:
 - Layer 1 – **Physical Layer** – Transporting Bits
 - Wires, Cables, Wi-Fi, Repeaters, Hubs
 - Layer 2 – **Data Link Layer** – Hop to Hop
 - MAC Addresses, Switches
 - Layer 3 – **Network Layer** – End to End
 - IP Addresses, Routers, any device with an IP address
 - How Layer 2 + Layer 3 work together to move data across the Internet

7	Application
6	Presentation
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1	Physical



OSI Model

OSI Model

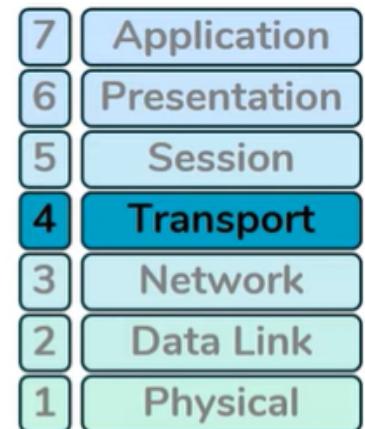
- Layer 4 – Transport



OSI Model

OSI Model

- Layer 4 – Transport – Service to Service



OSI Model

OSI Model

- Layer 4 – Transport – Service to Service

7	Application
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5	Session
4	Transport
3	Network
2	Data Link
1	Physical

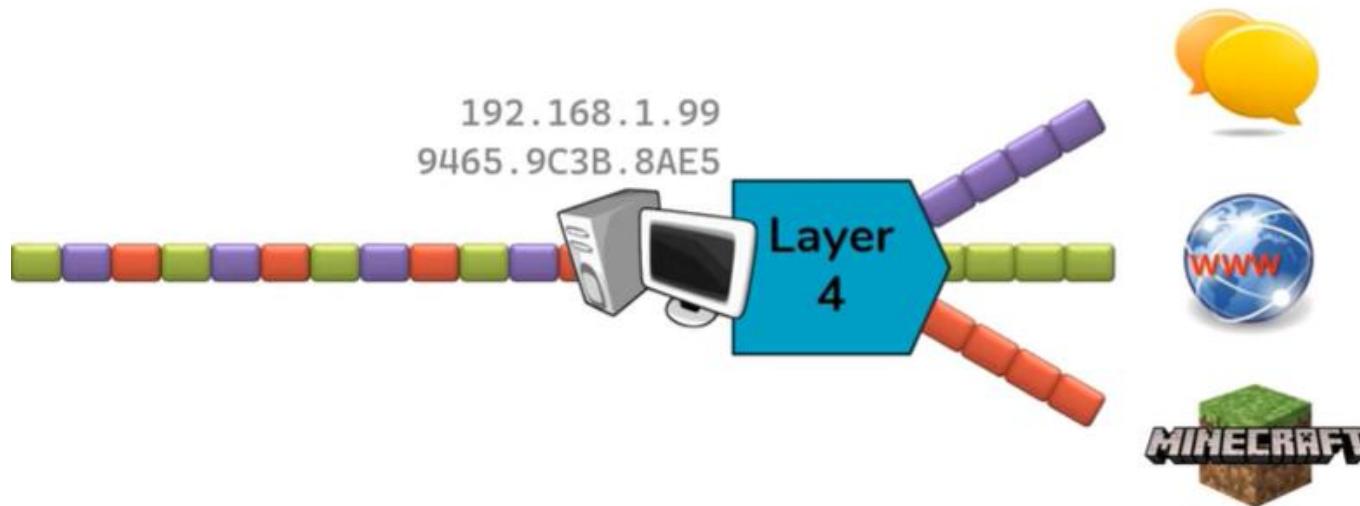


OSI Model

OSI Model

- Layer 4 – Transport – Service to Service
 - Distinguish data streams
 - Addressing Scheme – Ports

7	Application
6	Presentation
5	Session
4	Transport
3	Network
2	Data Link
1	Physical



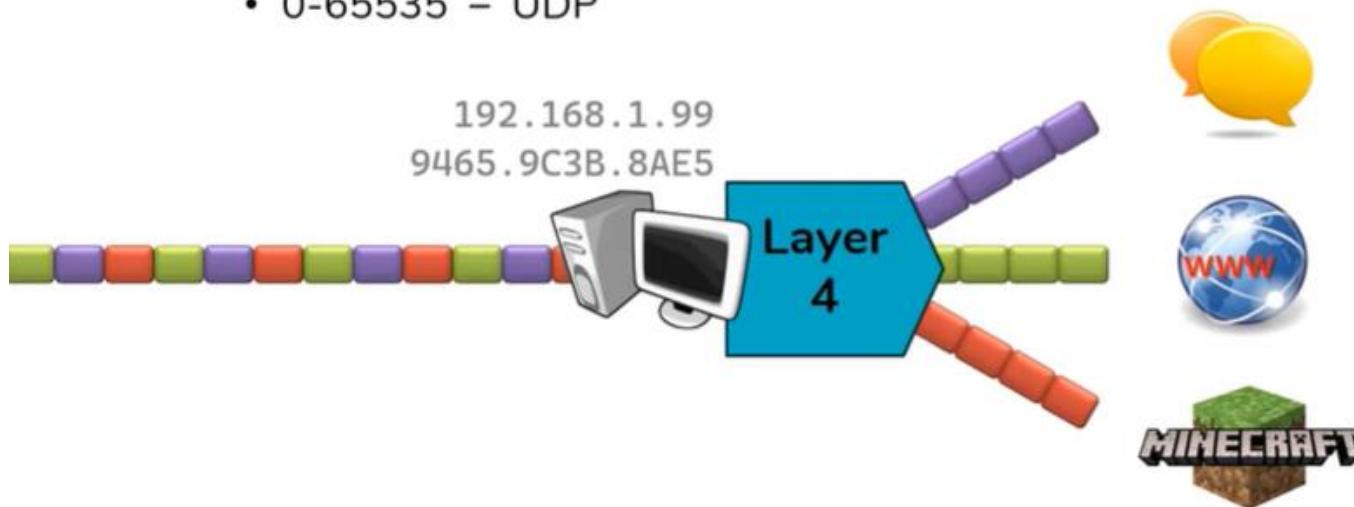
OSI Model

OSI Model

- Layer 4 – Transport – Service to Service

- Distinguish data streams
- Addressing Scheme – Ports
 - 0-65535 – TCP
 - 0-65535 – UDP

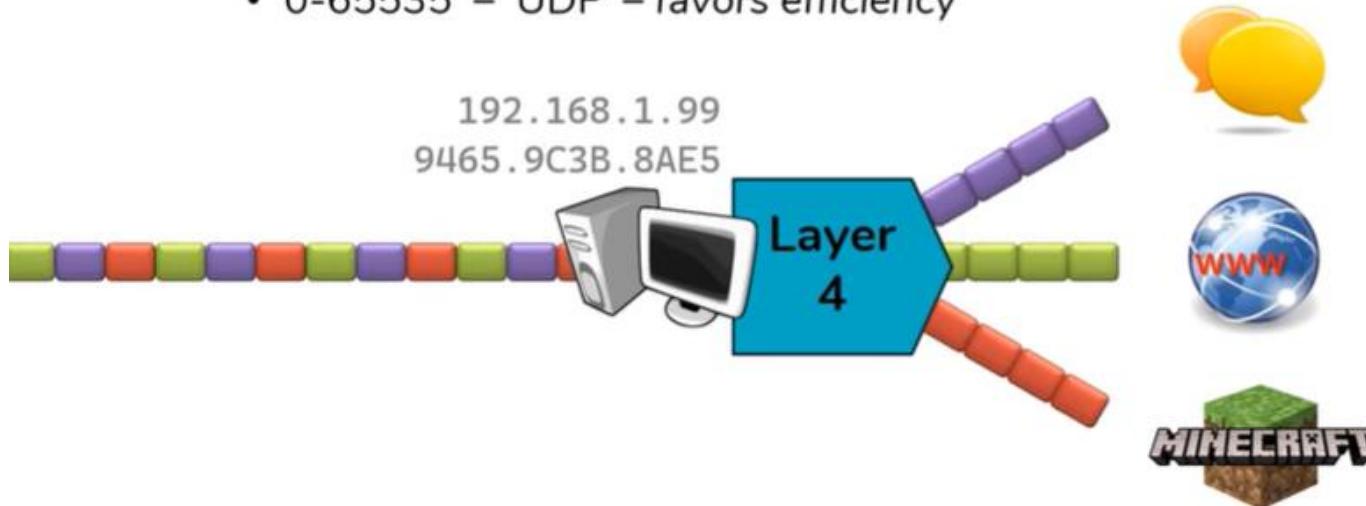
7	Application
6	Presentation
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4	Transport
3	Network
2	Data Link
1	Physical



OSI Model

OSI Model

- Layer 4 – Transport – Service to Service
 - Distinguish data streams
 - Addressing Scheme – Ports
 - 0-65535 – TCP – favors reliability
 - 0-65535 – UDP – favors efficiency



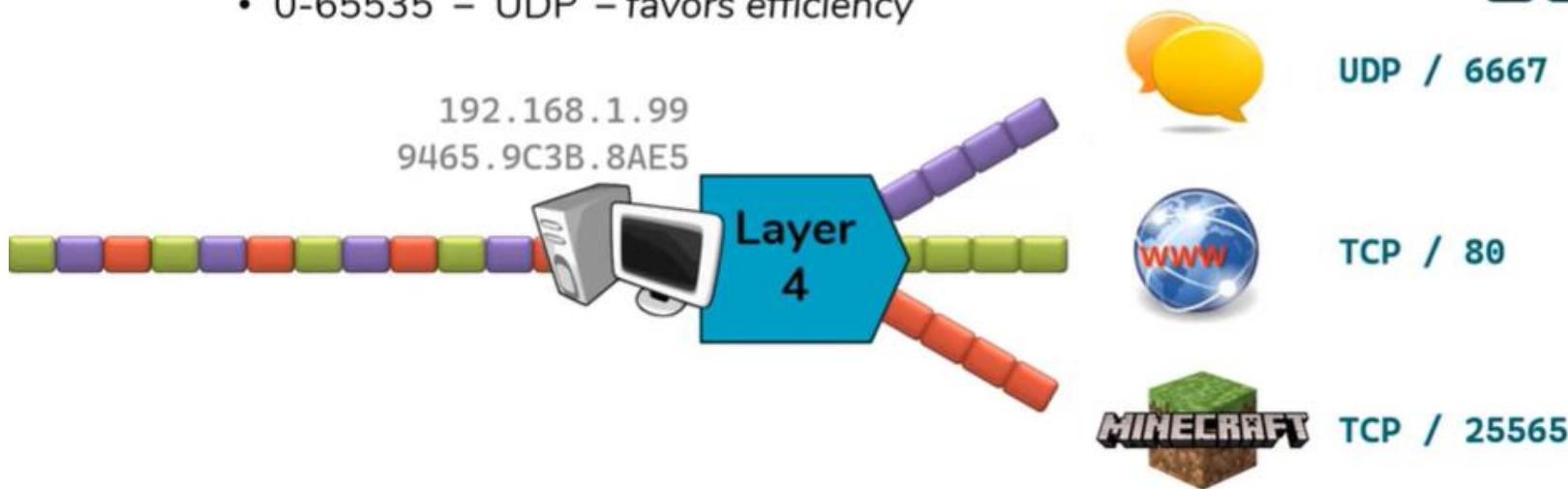
7	Application
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OSI Model

OSI Model

- **Layer 4 – Transport – Service to Service**

- Distinguish data streams
- Addressing Scheme – Ports
 - 0-65535 – TCP – favors reliability
 - 0-65535 – UDP – favors efficiency

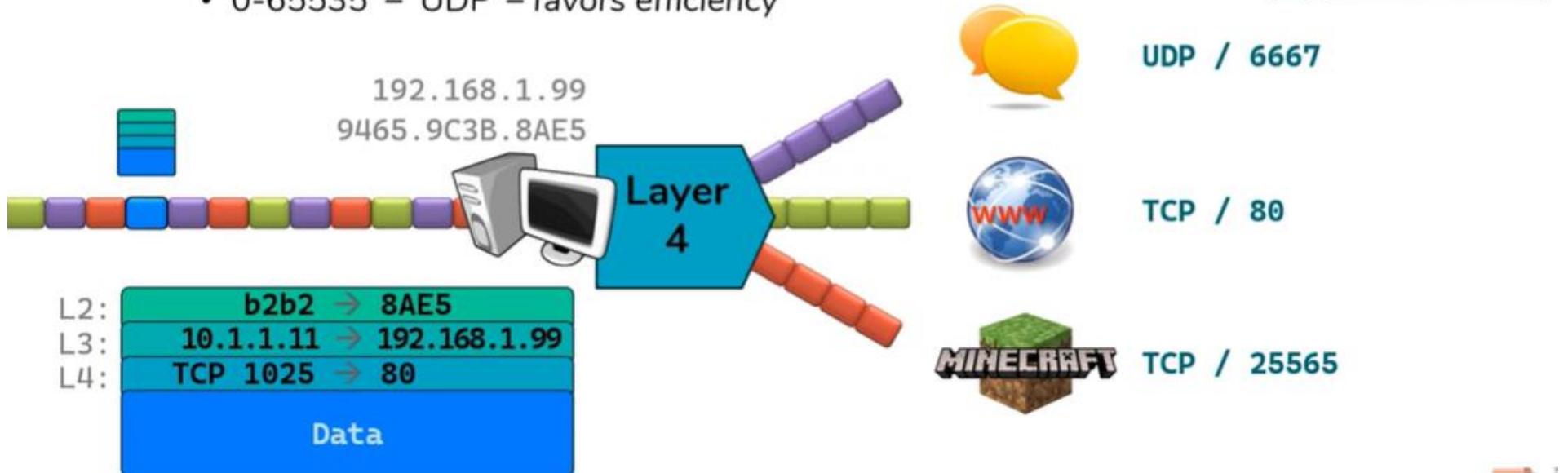


OSI Model

OSI Model

- Layer 4 – Transport – Service to Service

- Distinguish data streams
- Addressing Scheme – Ports
 - 0-65535 – TCP – favors reliability
 - 0-65535 – UDP – favors efficiency



OSI Model

OSI Model

- **Layer 4 – Transport – Service to Service**

- Distinguish data streams
- Addressing Scheme – Ports – 0-65535, TCP or UDP



1.1.1.1



2.2.2.2
www.bank.com



3.3.3.3
www.site.com



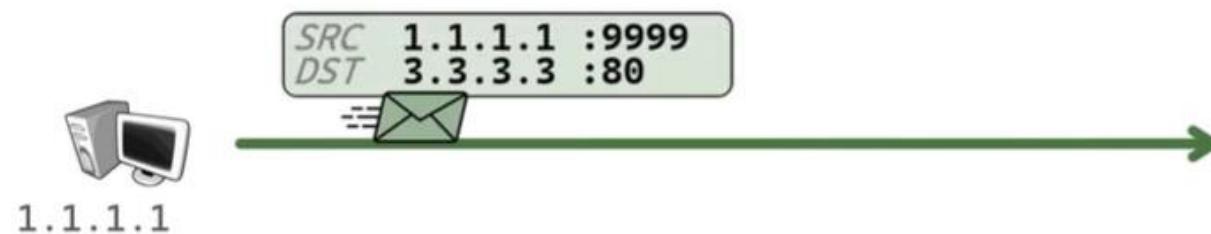
4.4.4.4
Chat Server

OSI Model

OSI Model

- **Layer 4 – Transport – Service to Service**

- Distinguish data streams
- Addressing Scheme – Ports – 0-65535, TCP or UDP
- Servers listen for requests to pre-defined Ports
- Clients select random Port for each connection



7	Application
6	Presentation
5	Session
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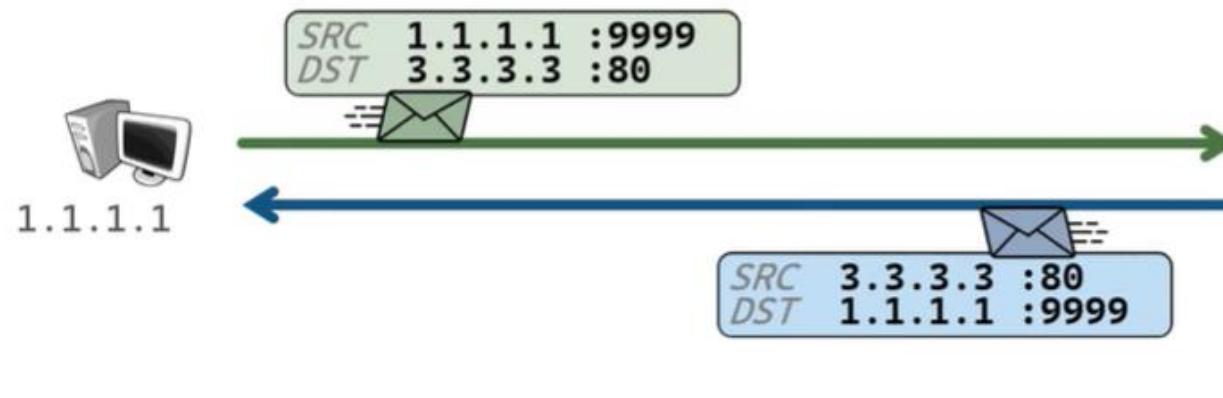


OSI Model

OSI Model

- **Layer 4 – Transport – Service to Service**

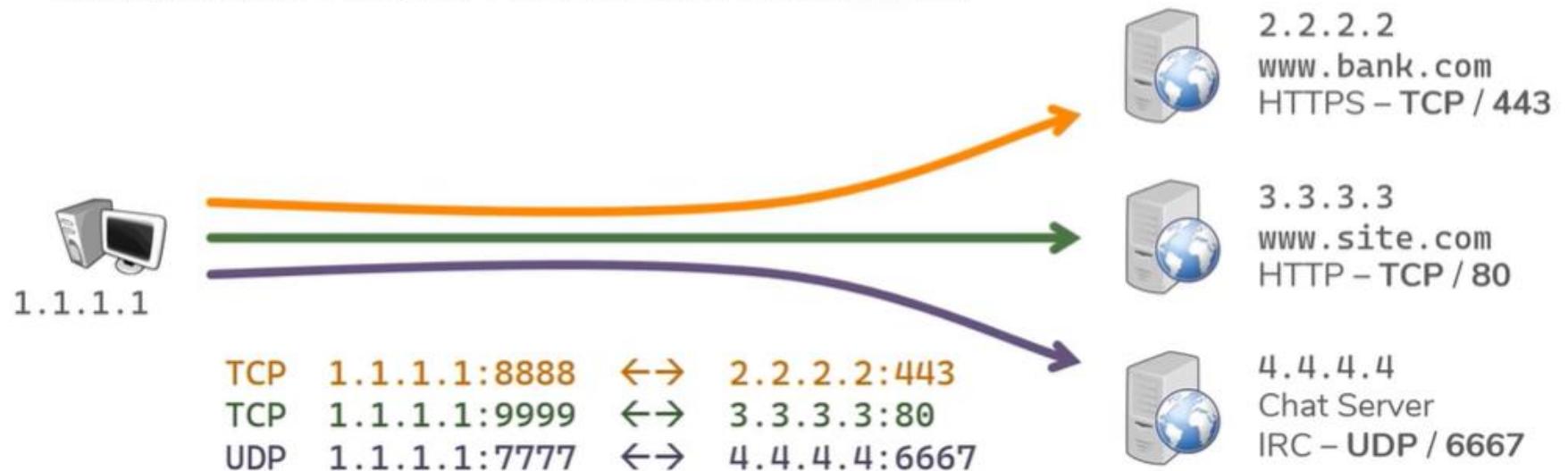
- Distinguish data streams
- Addressing Scheme – Ports – 0-65535, TCP or UDP
- Servers listen for requests to pre-defined Ports
- Clients select random Port for each connection
 - Response traffic will arrive on this port



OSI Model

OSI Model

- Layer 4 – Transport – Service to Service
 - Distinguish data streams
 - Addressing Scheme – Ports – 0-65535, TCP or UDP
 - Servers listen for requests to pre-defined Ports
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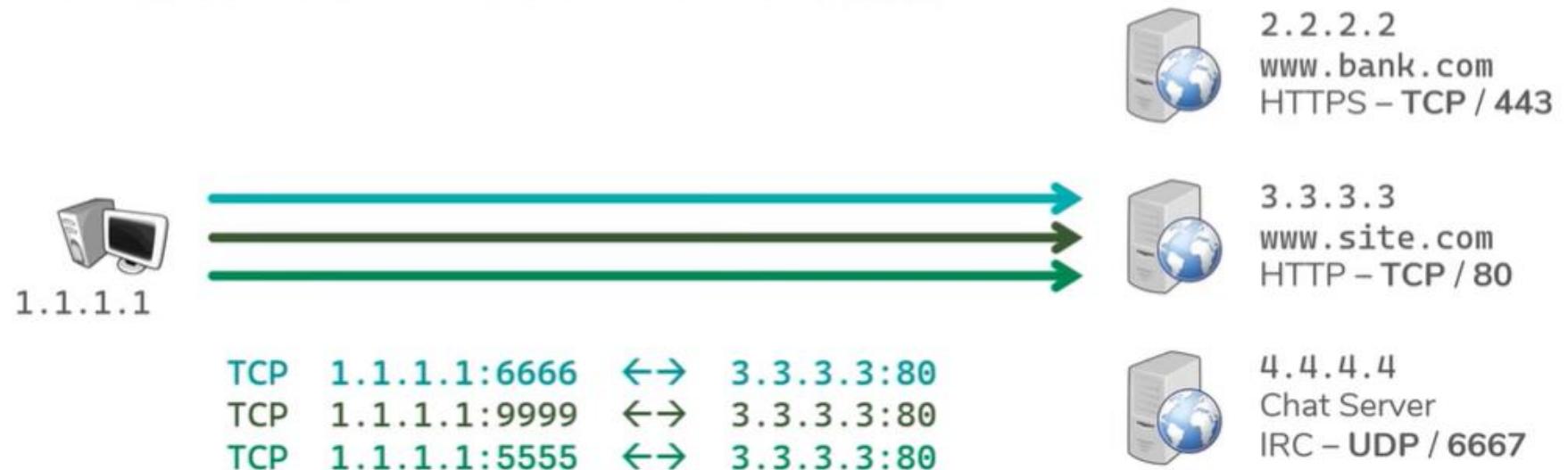


OSI Model

OSI Model

- Layer 4 – Transport – Service to Service

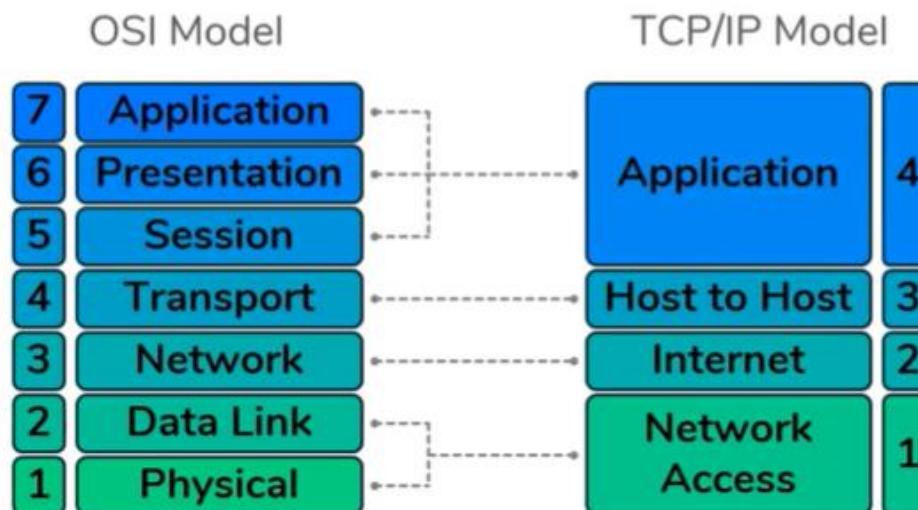
- Distinguish data streams
- Addressing Scheme – Ports – 0-65535, TCP or UDP
- Servers listen for requests to pre-defined Ports
- Clients select random Port for each connection



OSI Model

OSI Model

- Layer 5, 6, 7 – Session, Presentation, Application
 - Distinction between these layers is somewhat vague
 - Other Networking Models combine these into one layer
 - L1-L4 are most important to understand how data flows



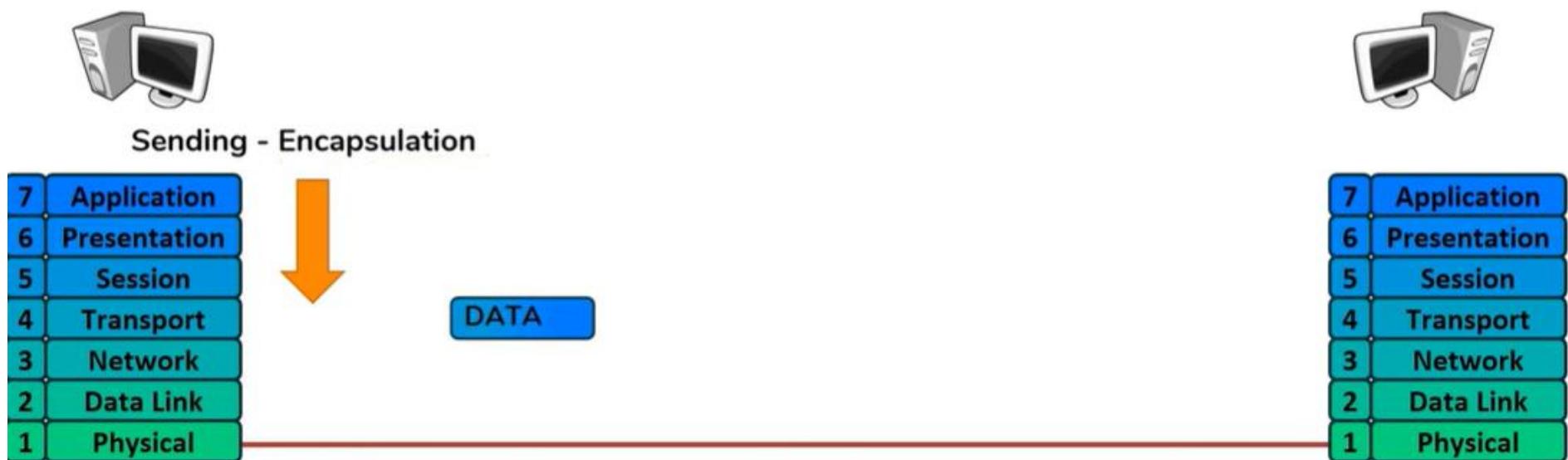
OSI Model

OSI Model



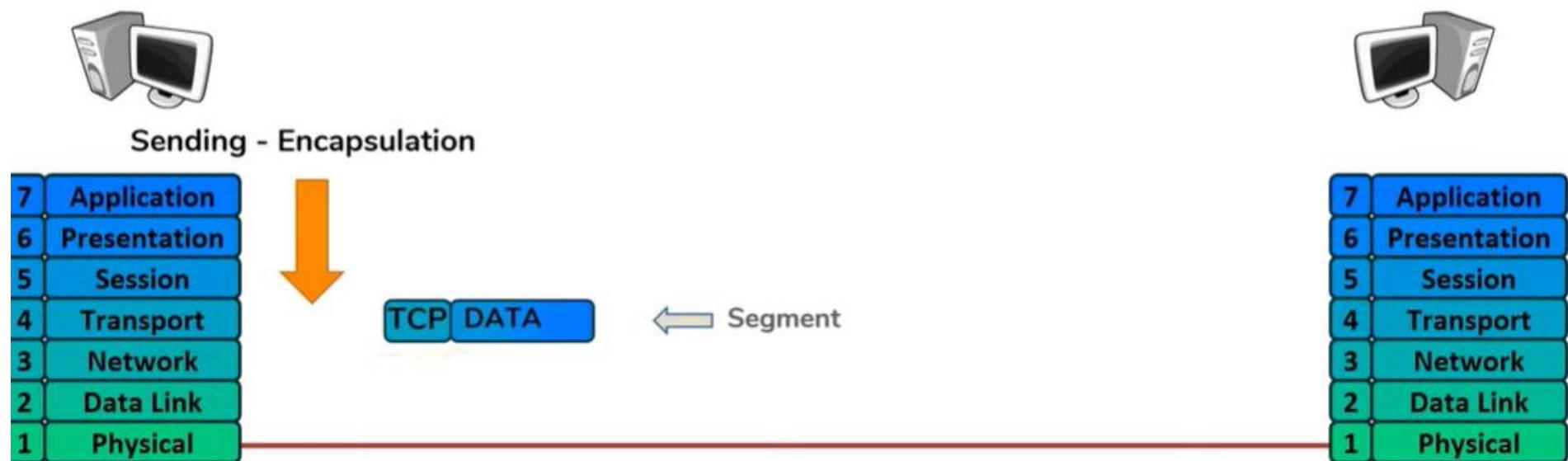
OSI Model

OSI Model



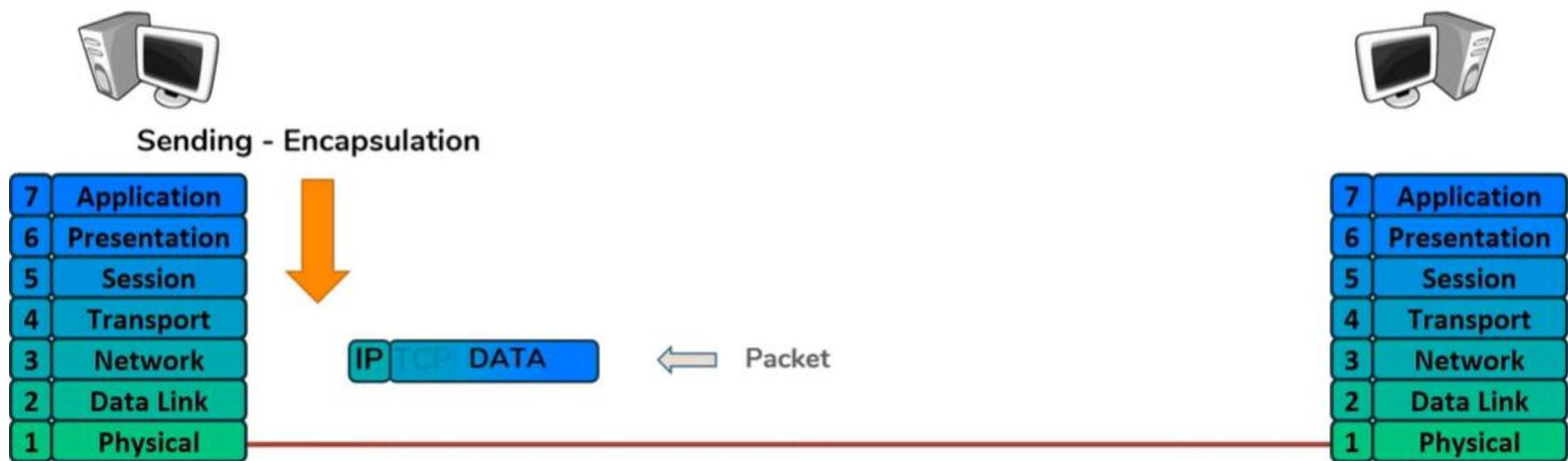
OSI Model

OSI Model



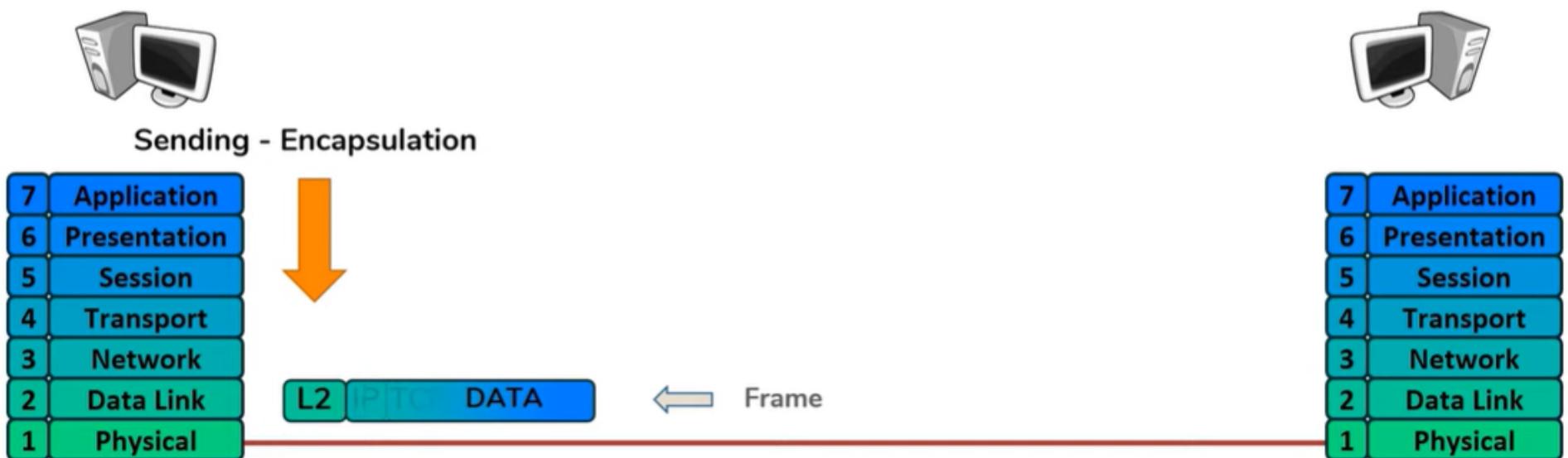
OSI Model

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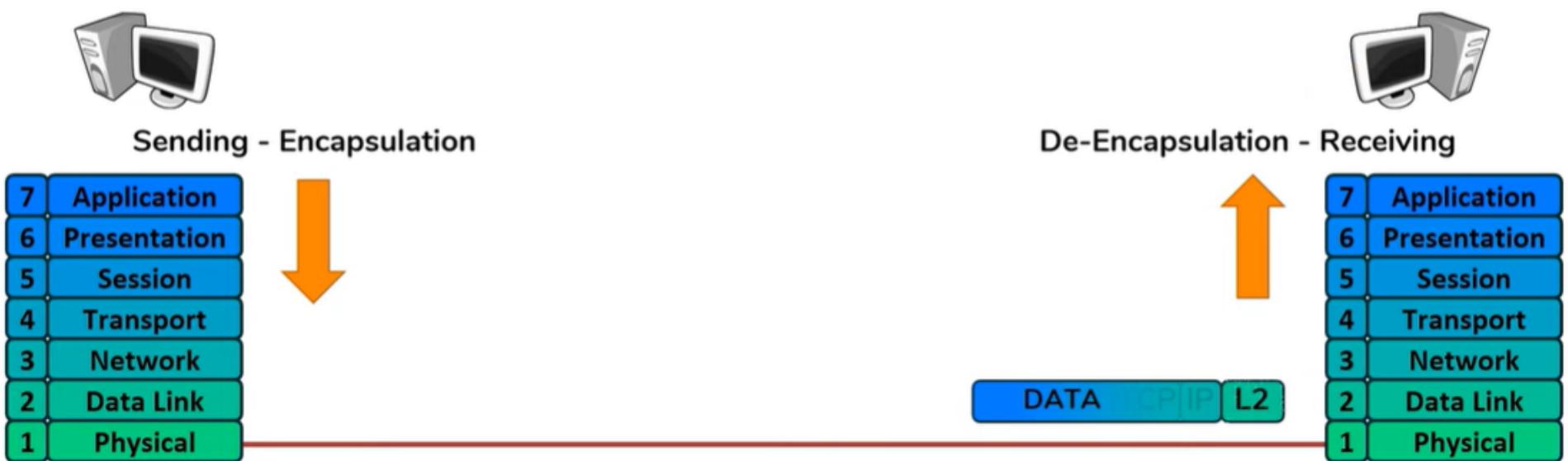
OSI Model

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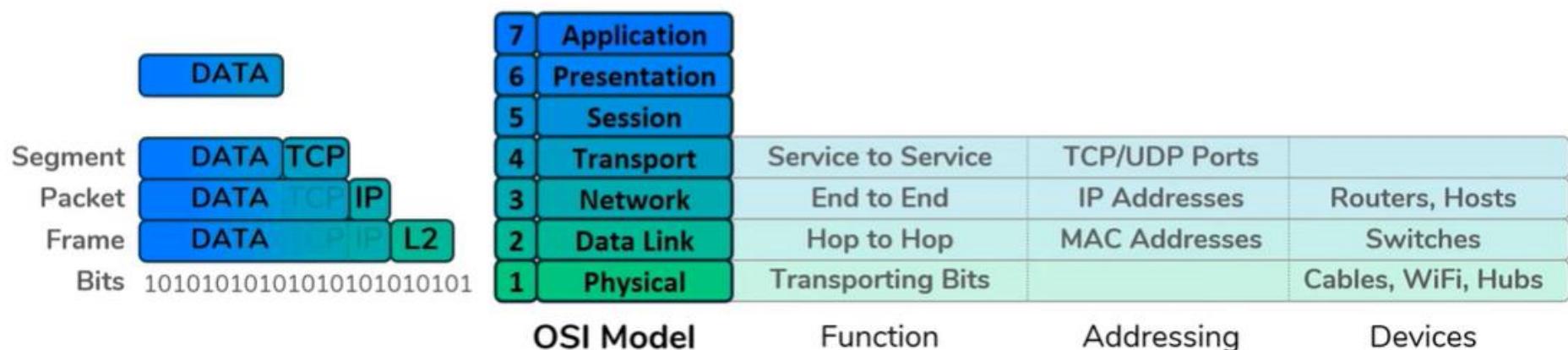
OSI Model



OSI Model

OSI Model

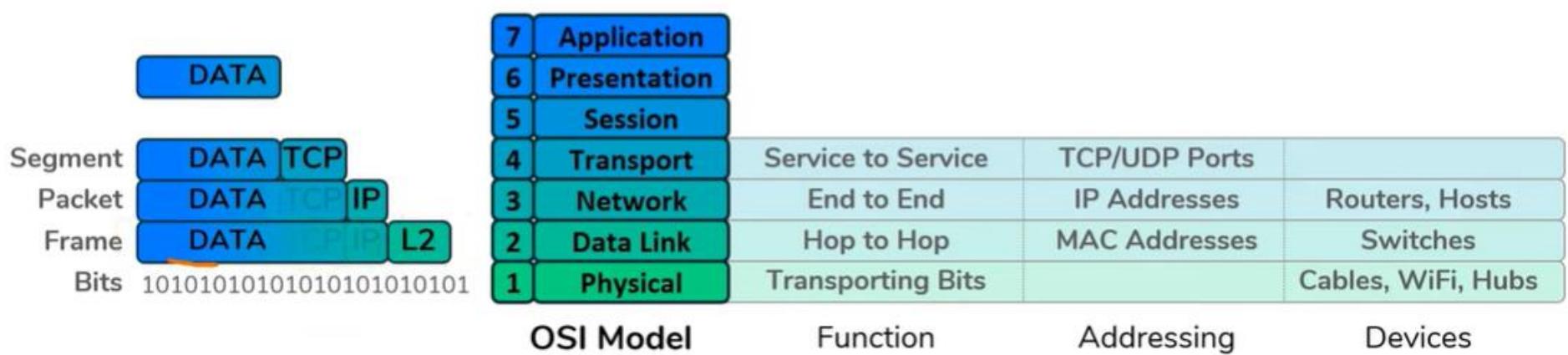
- Network Devices operate at specific layers



OSI Model

OSI Model

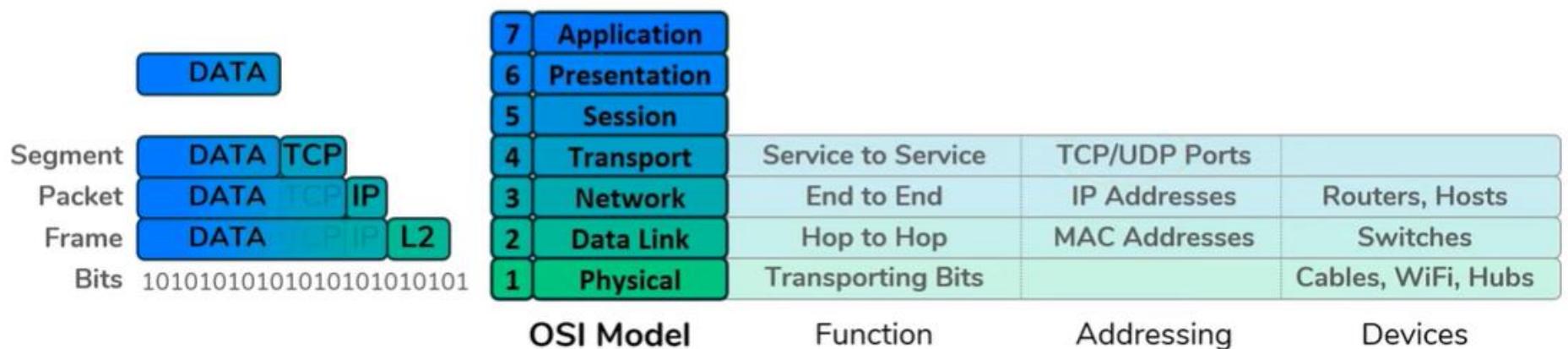
- Network Devices operate at specific layers
 - L2 devices only look into the datagram up to L2 header (Switches)
 - L3 devices only look into the datagram up to L3 header (Routers)



OSI Model

OSI Model

- Network Devices operate at specific layers
- Network Protocols operate at specific layers

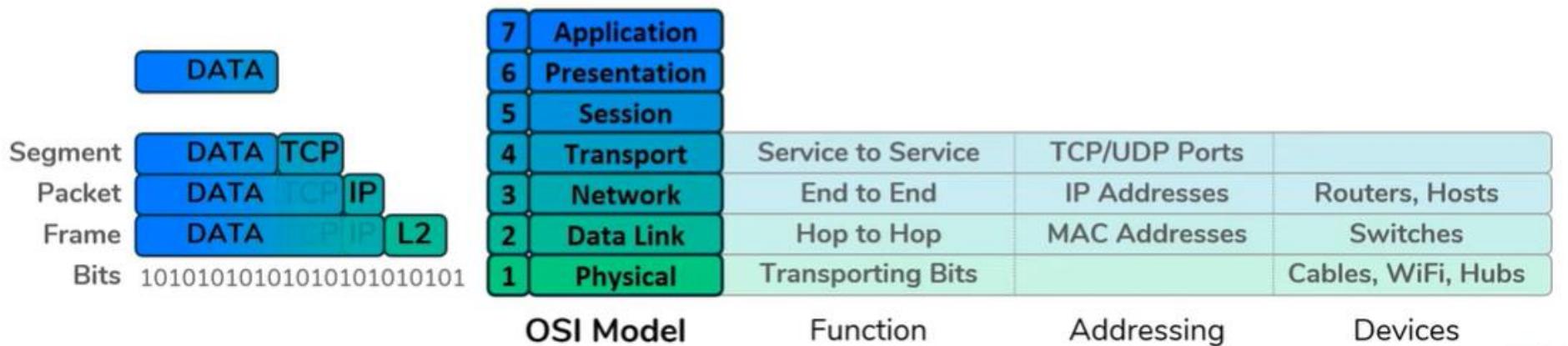


OSI Model

OSI Model

What Are Access Lists? -- Access Control Lists (ACLs) -- Part 1 of 8 i

- Network Devices operate at specific layers
- Network Protocols operate at specific layers
- **Neither of these are strict rules** – exceptions exist



OSI Model

OSI Model

- Network Devices operate at specific layers
- Network Protocols operate at specific layers
- Neither of these are strict rules – exceptions exist
- OSI Model is simply a model – not rigid rules everything adheres to
 - Conceptualization of what is required for data to flow through the Internet

