

Networking

UBNetDef, Spring 2022
Week 2

Presenter: Radhika Jois

Learning Goals

- Learn the basics of how network traffic flows
- Interpret a network topology
- Understand OSI network layers 1-3
- Distinguish between network hardware devices
- Configure static networking



Edges and Nodes

- Edges
 - Strands of web between connection points
 - Roadways between cities
 - Neural pathways
 - Associations between members
- Nodes
 - Connection points
 - Cities
 - Neurons
 - Members

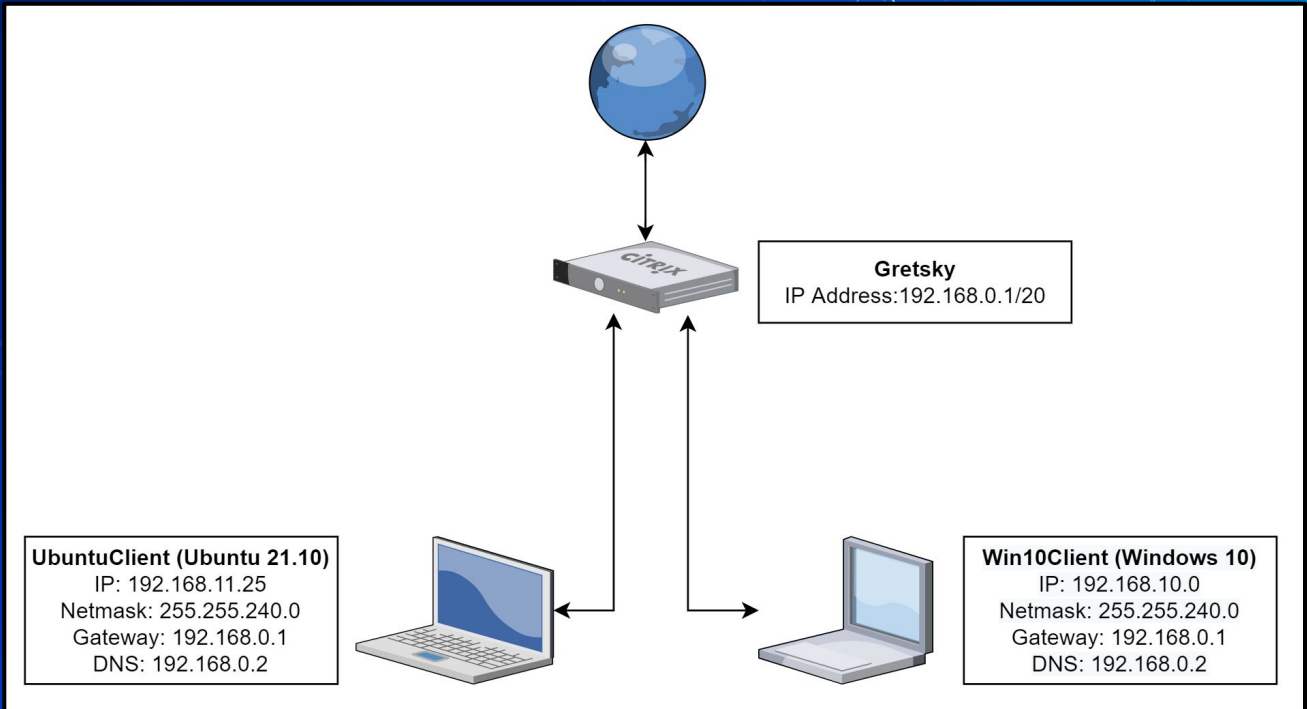
Devices and Connections

- **Devices** are Nodes
 - Your gaming console
 - vCenter servers
 - Home router
- **Connections** are Edges
 - Ethernet wires
 - Wireless signals to eduroam

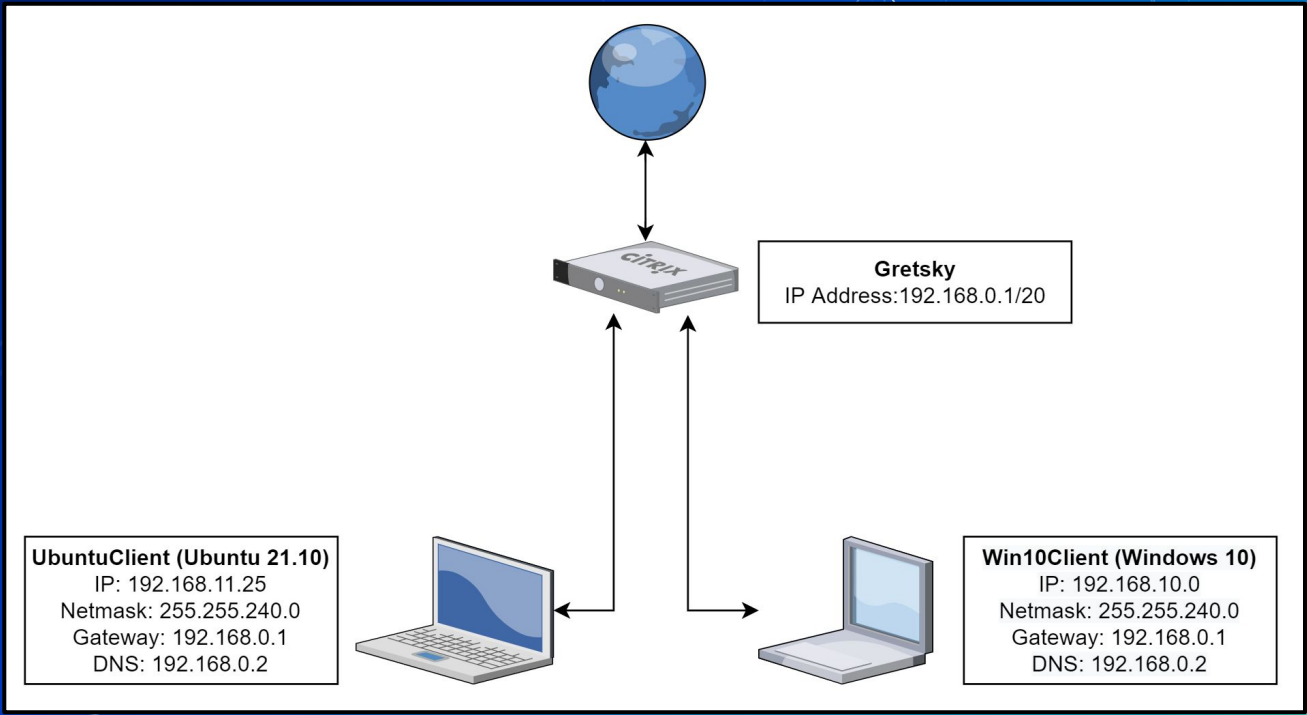
Endpoints vs. Network Devices

- **Endpoints:** process and manipulate data
 - Also referred to as **hosts**
 - Examples: desktop and laptop computers, servers, gaming consoles, mobile devices, IoT devices
- **Network Devices:** distribute connectivity
 - Examples: routers, modems, switches, other gateways

Which are endpoints?



Which are network devices?



Network Devices

- Gateways
 - Receive incoming messages and send outgoing messages
 - Endpoints only recognize the gateway immediately connected to them
- Routers and Layer 3 switches
 - Pass messages between networks

Network Devices

- Layer 2 Switches
 - Distribute messages within an immediate network
- Gateways, routers, and Layer 2 switches are often combined into one piece of hardware

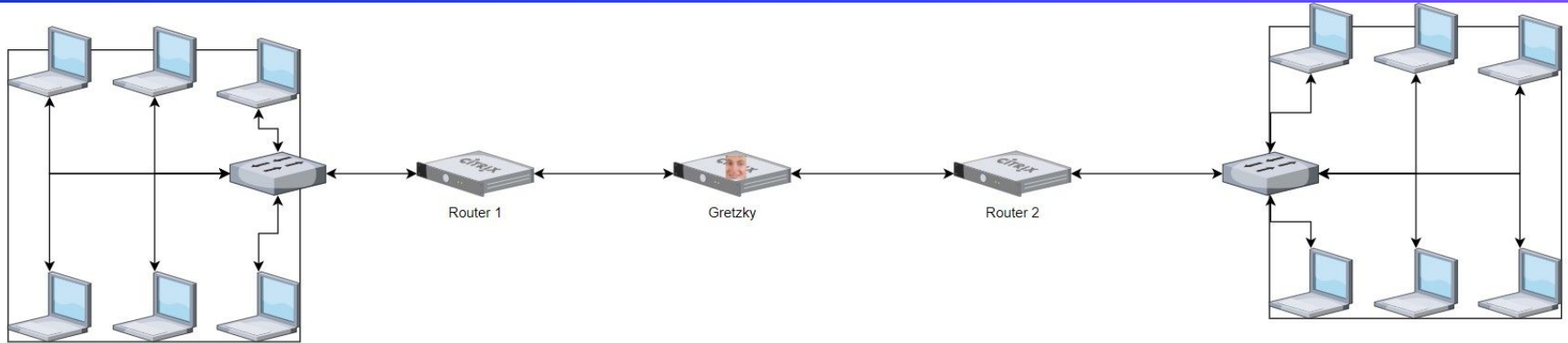
Questions?

In Class Activity

Packet Polo

Packet Polo

- Level 1: Direct Packet Transfer
- Level 2: Local ARP
- Level 3: Cross Network ARP and Ping



Introduce yourself in the Systems Security Channel

- This counts as your Attendance
- Please state:
 - Name
 - Year
 - Major

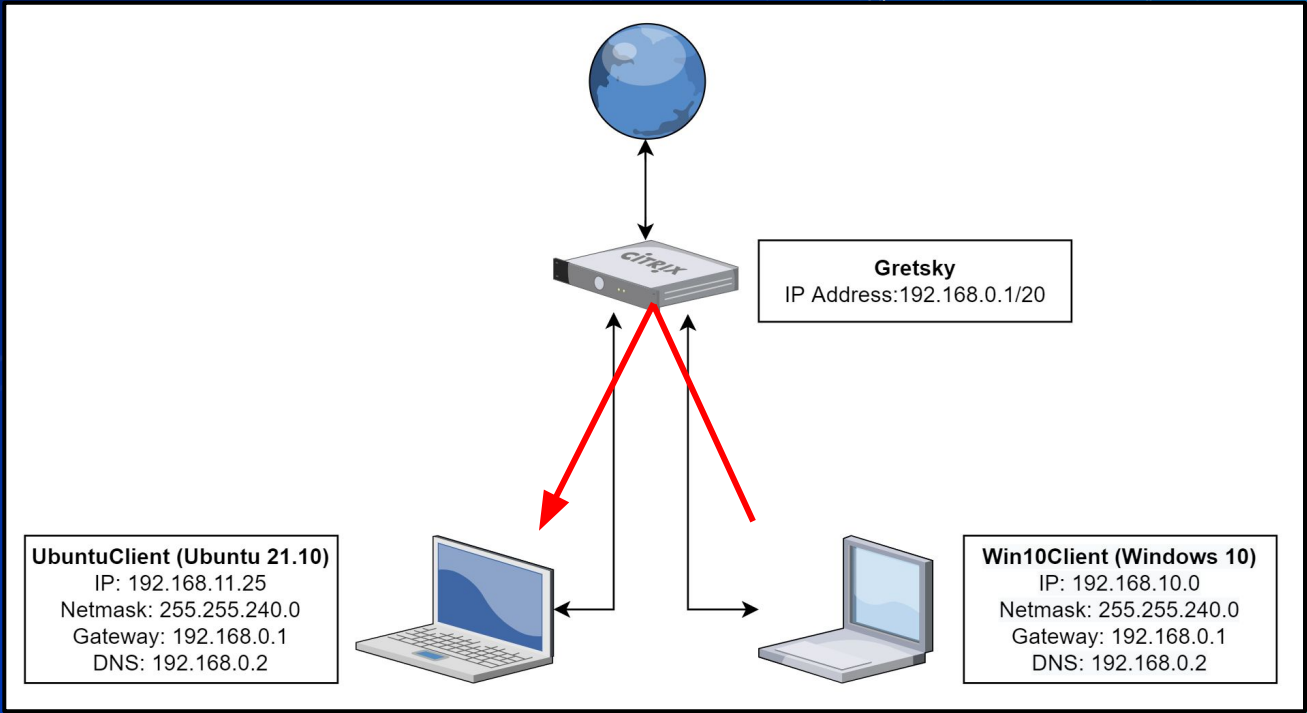
Break slide

Please return in 10 minutes

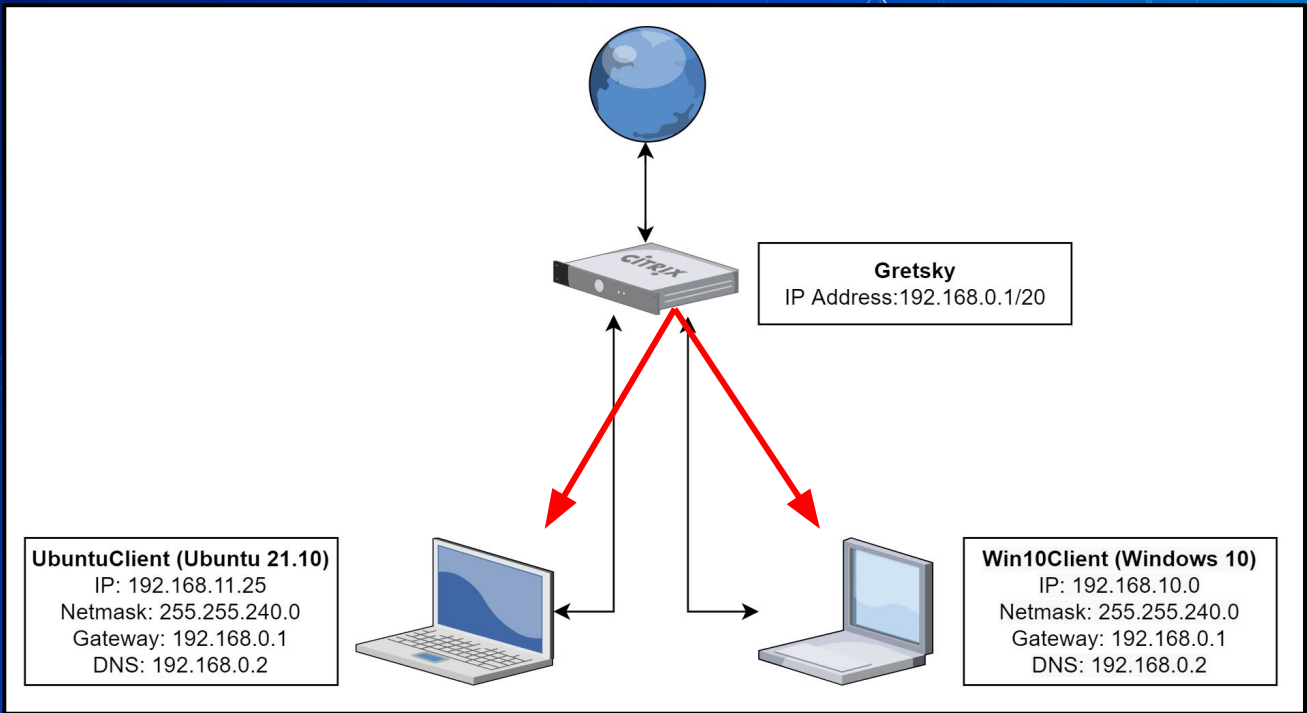
Transmitter vs. Receiver

- **Transmitter (Tx):** Sender of data
- **Receiver (Rx):** Recipient of data
- **Transmission methods**
 - **Unicast:** one transmitter, one receiver
 - **Multicast:** one transmitter, multiple but not all receivers
 - **Broadcast:** one transmitter, all receivers

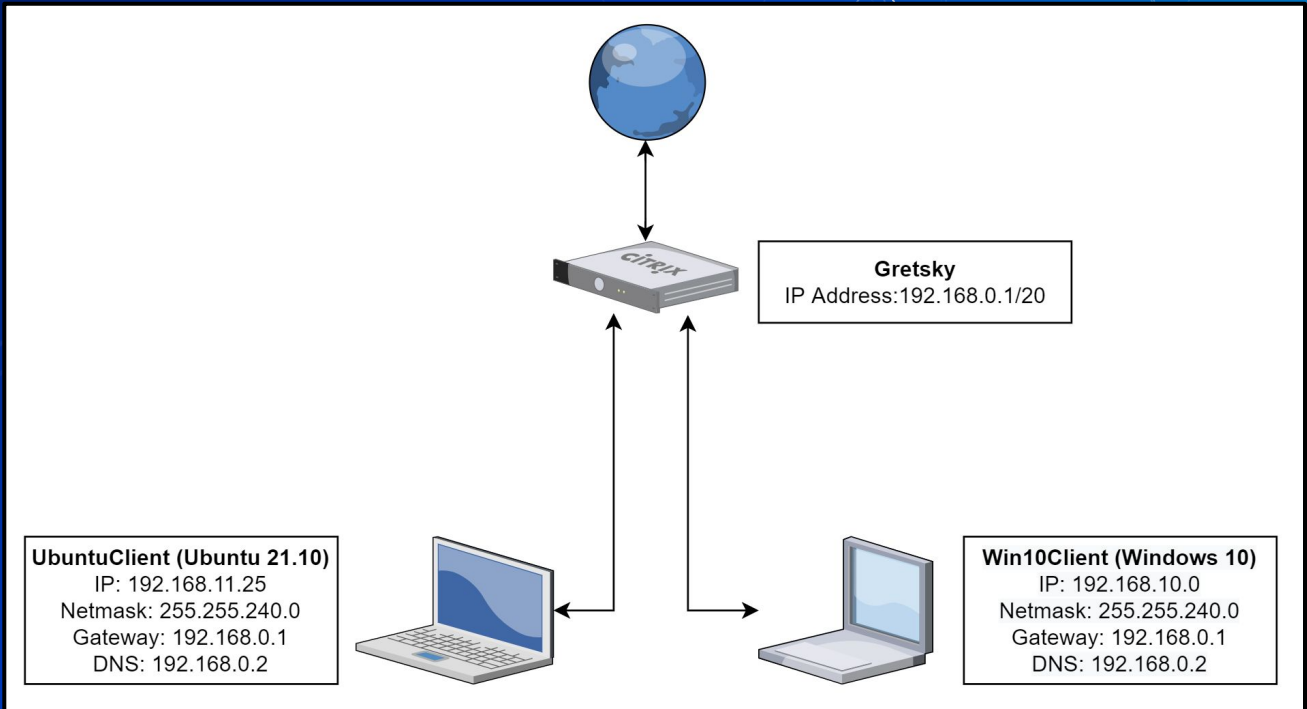
Which broadcast method?



Which broadcast method?



How about a multicast?



Local vs. Remote

- Let A designate a device.
- **Local:** The relationship A has with itself.
 - A operates locally when printing to PDF or managing its clipboard.
- Let B designate a device distinct from A on the same network.
- **Remote:** A is remote from B . B is remote from A
 - A operates remotely when printing to a network printer or using Google Docs

Endpoint Types

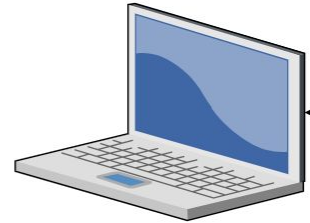
- **Clients:** primarily request remote services
 - Examples: mobile device, workstation, laptop, computer
 - Behavior: browse the web, receive updates, provide credentials
- **Servers:** primarily provide remote services
 - Examples: web servers, intrusion detection systems, active directory
 - Behavior: store and provide web pages, distribute updates, verify credentials

Understand the topology

- **IP Address:** Identifies a machine on a network
- **Subnet Mask:** Defines the range of available addresses on a network
- **Gateway:** A network device that provides direct network connectivity
- **DNS:** translates URL entries into IP Addresses

UbuntuClient (Ubuntu 21.10)

IP: 192.168.11.25
Netmask: 255.255.240.0
Gateway: 192.168.0.1
DNS: 192.168.0.2

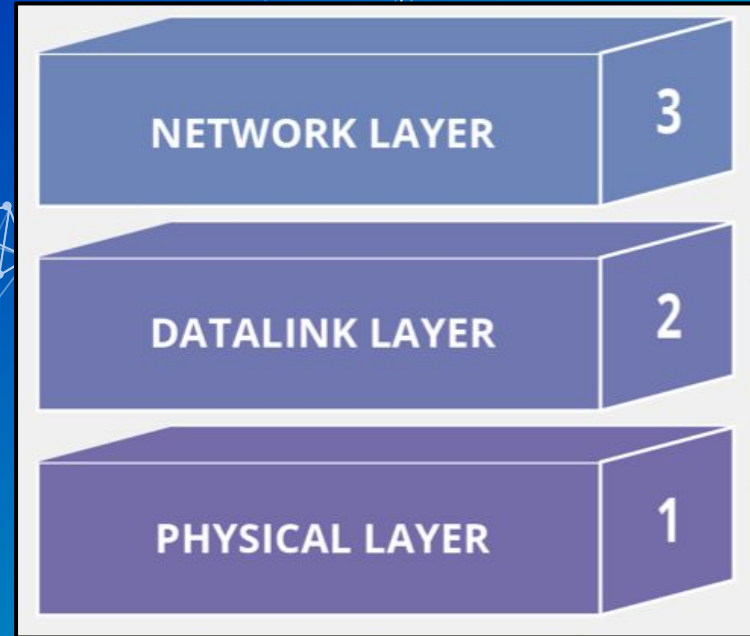


Break slide

Please return in 5 minutes

Computer Layering Models

- New technologies get layered over old technologies
 - Computer architecture
 - Operating systems
 - Networking



OSI Layer 1: Physical Layer

- Layer 1: Physical Layer
 - Physical connections
 - Mediums
 - Signals

OSI Layer 2: Datalink Layer

- Layer 2: Datalink Layer
 - Receives bits and delivers them to a processor
 - Physical receivers are identified by MAC Addresses
 - I.e., physical addresses
 - Only within the immediate network

OSI Layer 3: Network Layer

- Layer 3: Network Layer
 - Interconnects networks

OSI Layer 3: Network Layer

- Layer 3: Network Layer
 - Interconnects networks
 - IP Addresses
 - Public and private
 - Requires a network connection to exist
 - There is an exception
 - 2 different versions of IP addresses
 - IPv4 will be the focus of this class

IPv4 Addresses

- Written in decimal-octal form
- Separated by octets in range 0-255
 - [octet 1].[octet 2].[octet 3]. [octet 4]
 - Octet 1 - leftmost
 - Octet 4 - rightmost
- For every IP address:
 - Some characters represent a network.
 - Some characters represent the individual device.

IPv4 Addresses

- Composite Network devices have more than one IP Address
 - External IP Address
 - A network device's address assigned by the external network device.
 - Sometimes called the upstream gateway.
 - Internal IP Address
 - A network device's address that identifies itself on the local network

Subnet Masks

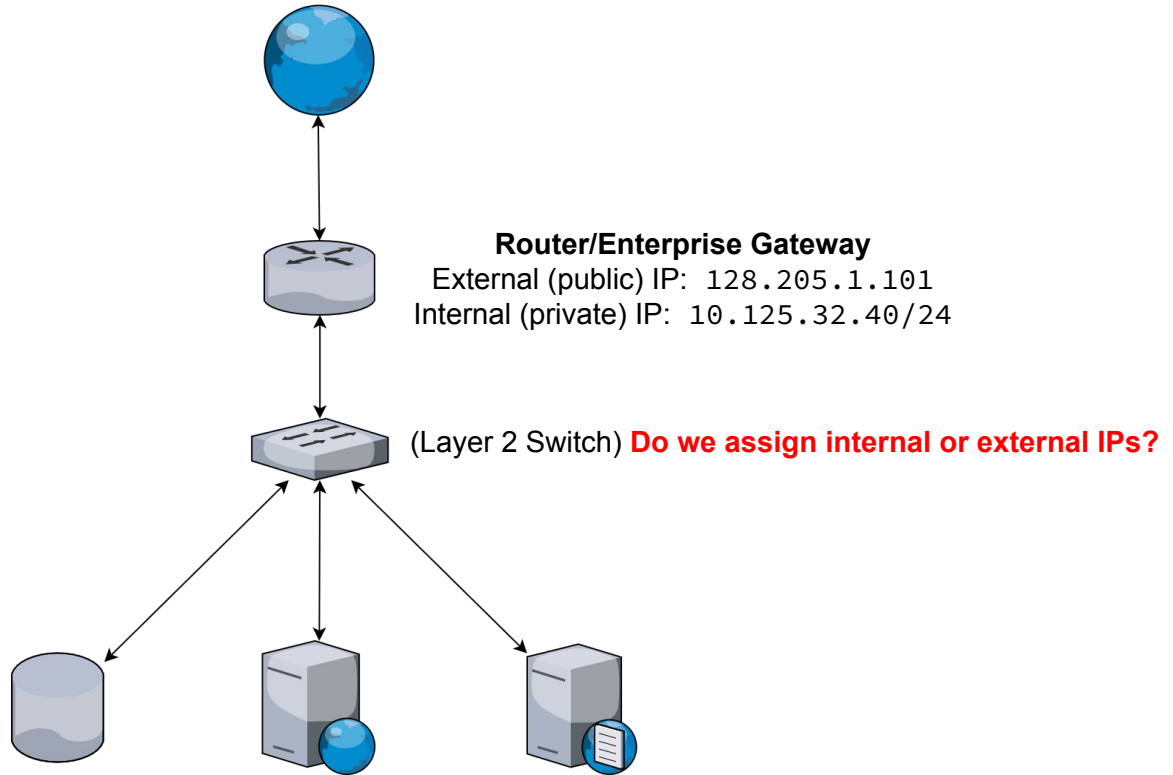
- Indicate the IP address range for endpoints
 - Decide which IP address characters identify the network versus the individual devices
- Written in decimal-octal form or CIDR notation
 - CIDR suffix example: /24
 - Generally range between /8 and /30

Questions?

In Class Activity

IP Assignment Walkthrough

Example 1



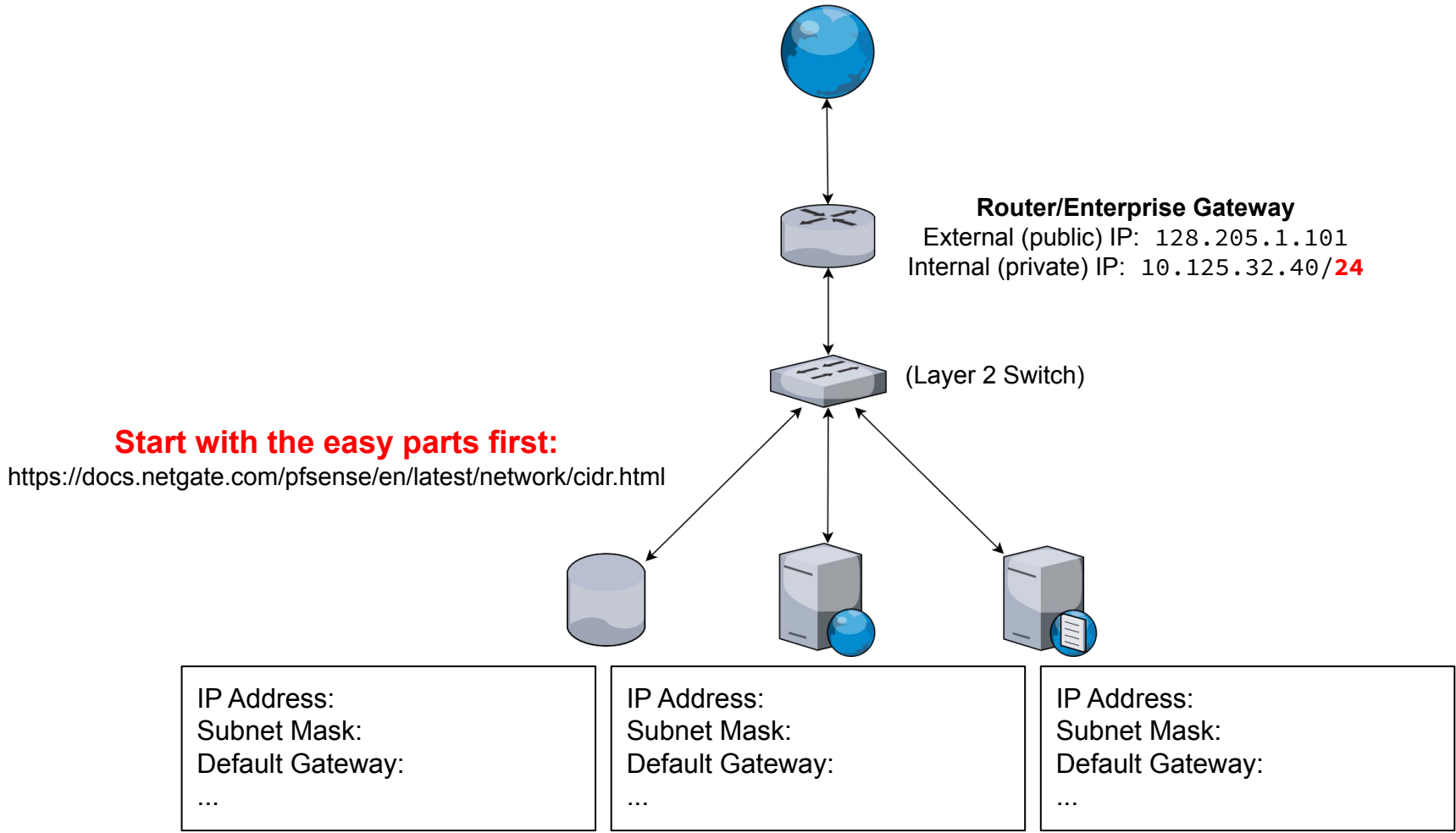
Router/Enterprise Gateway
External (public) IP: 128.205.1.101
Internal (private) IP: 10.125.32.40/24

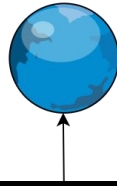
(Layer 2 Switch) **Do we assign internal or external IPs?**

IP Address:
Subnet Mask:
Default Gateway:
...

IP Address:
Subnet Mask:
Default Gateway:
...

IP Address:
Subnet Mask:
Default Gateway:
...





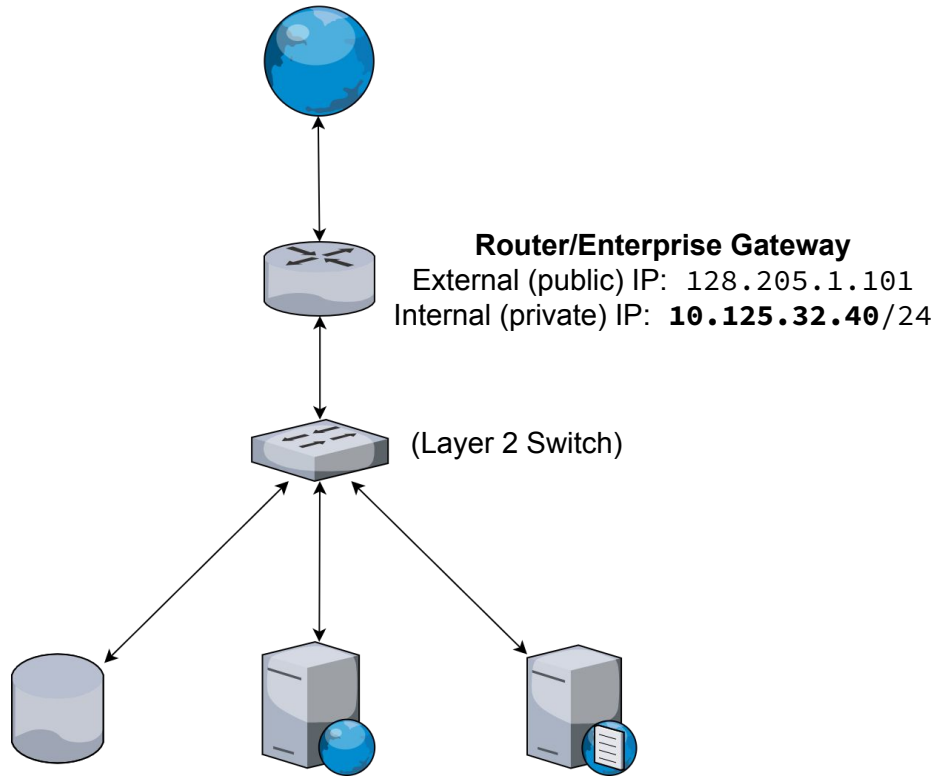
Subnet Mask	CIDR Prefix	Total IP Addresses	Usable IP Addresses	Number of /24 ne
255.255.255.128	/25	128	126	1 half
255.255.255.0	/24	256	254	1
255.255.254.0	/23	512	510	2
255.255.252.0	/22	1024	1022	4
255.255.248.0	/21	2048	2046	8



IP Address:
Subnet Mask: 255.255.255.0
Default Gateway:
...

IP Address:
Subnet Mask: 255.255.255.0
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...

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Subnet Mask: 255.255.255.0
Default Gateway:
...

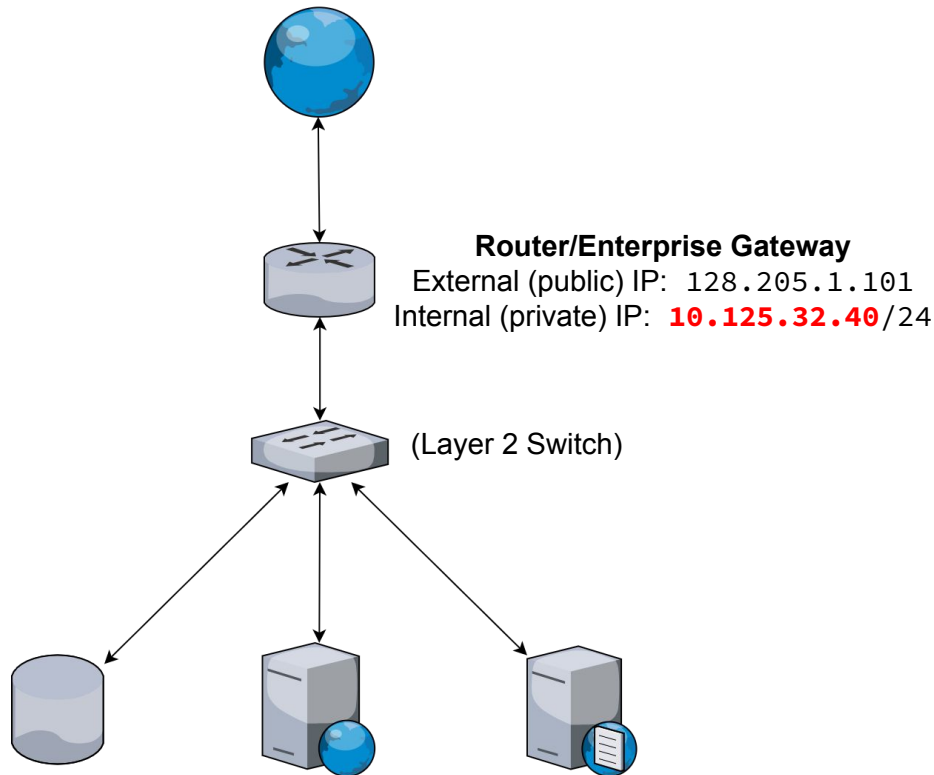


IP Address:
Subnet Mask: 255.255.255.0
Default Gateway:
...

IP Address:
Subnet Mask: 255.255.255.0
Default Gateway:
...

IP Address:
Subnet Mask: 255.255.255.0
Default Gateway:
...

Next easy part:
Default Gateway = Internal IP



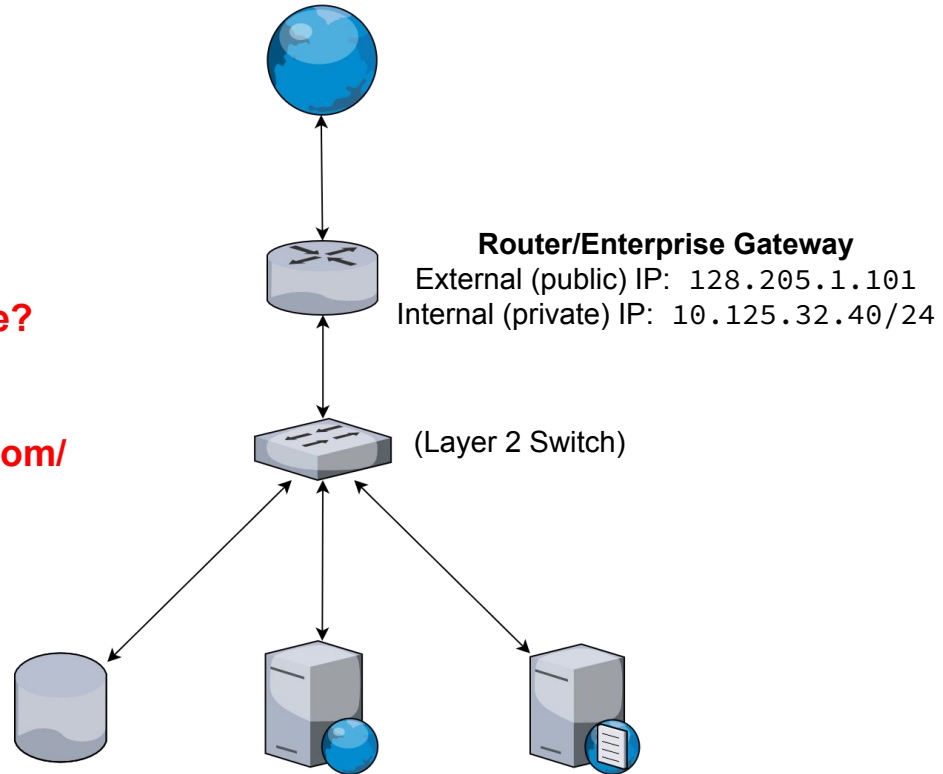
IP Address:
Subnet Mask: 255.255.255.0
Default Gateway: 10.125.32.40
...

IP Address:
Subnet Mask: 255.255.255.0
Default Gateway: 10.125.32.40
...

IP Address:
Subnet Mask: 255.255.255.0
Default Gateway: 10.125.32.40
...

What address space is available?

Consult:
<https://www.subnet-calculator.com/>



IP Address:
Subnet Mask: 255.255.255.0
Default Gateway: 10.125.32.40
...

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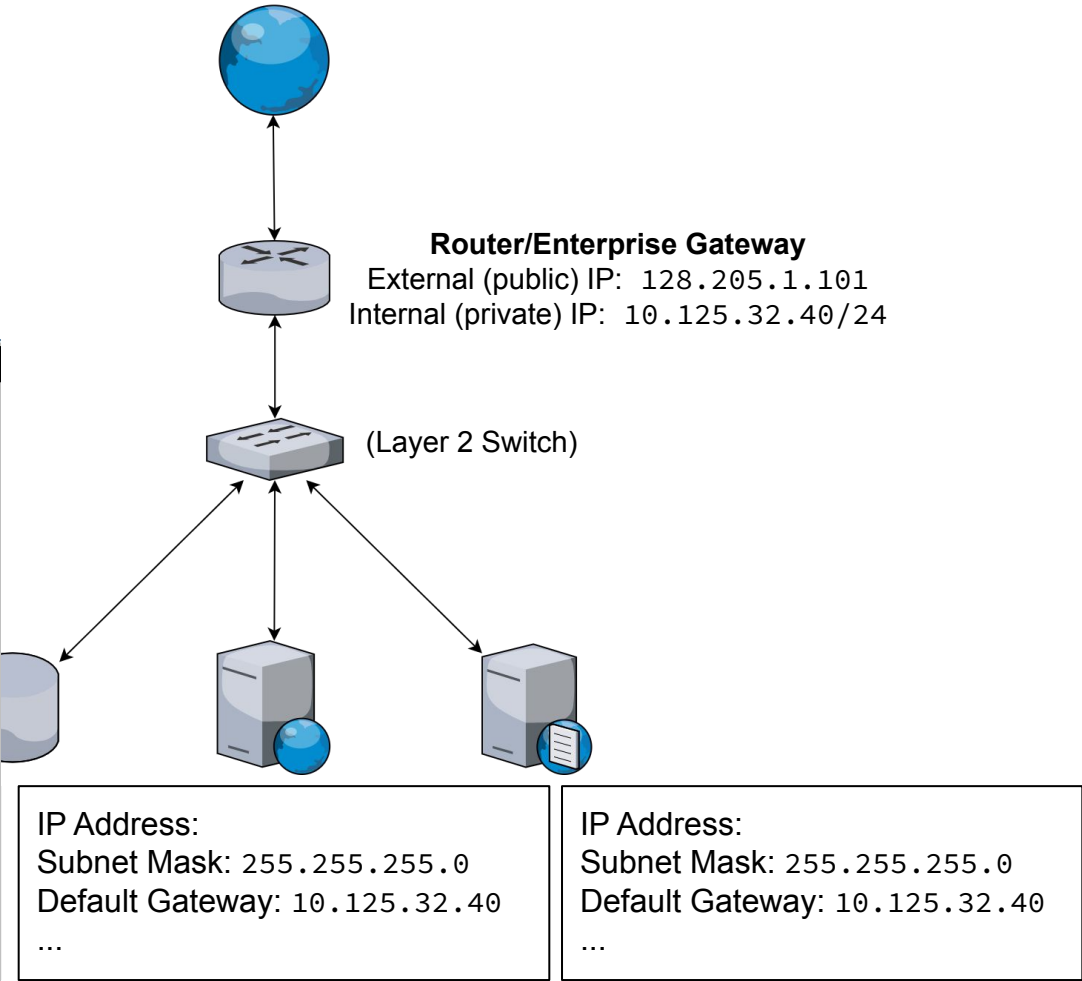
IP Address:
Subnet Mask: 255.255.255.0
Default Gateway: 10.125.32.40
...

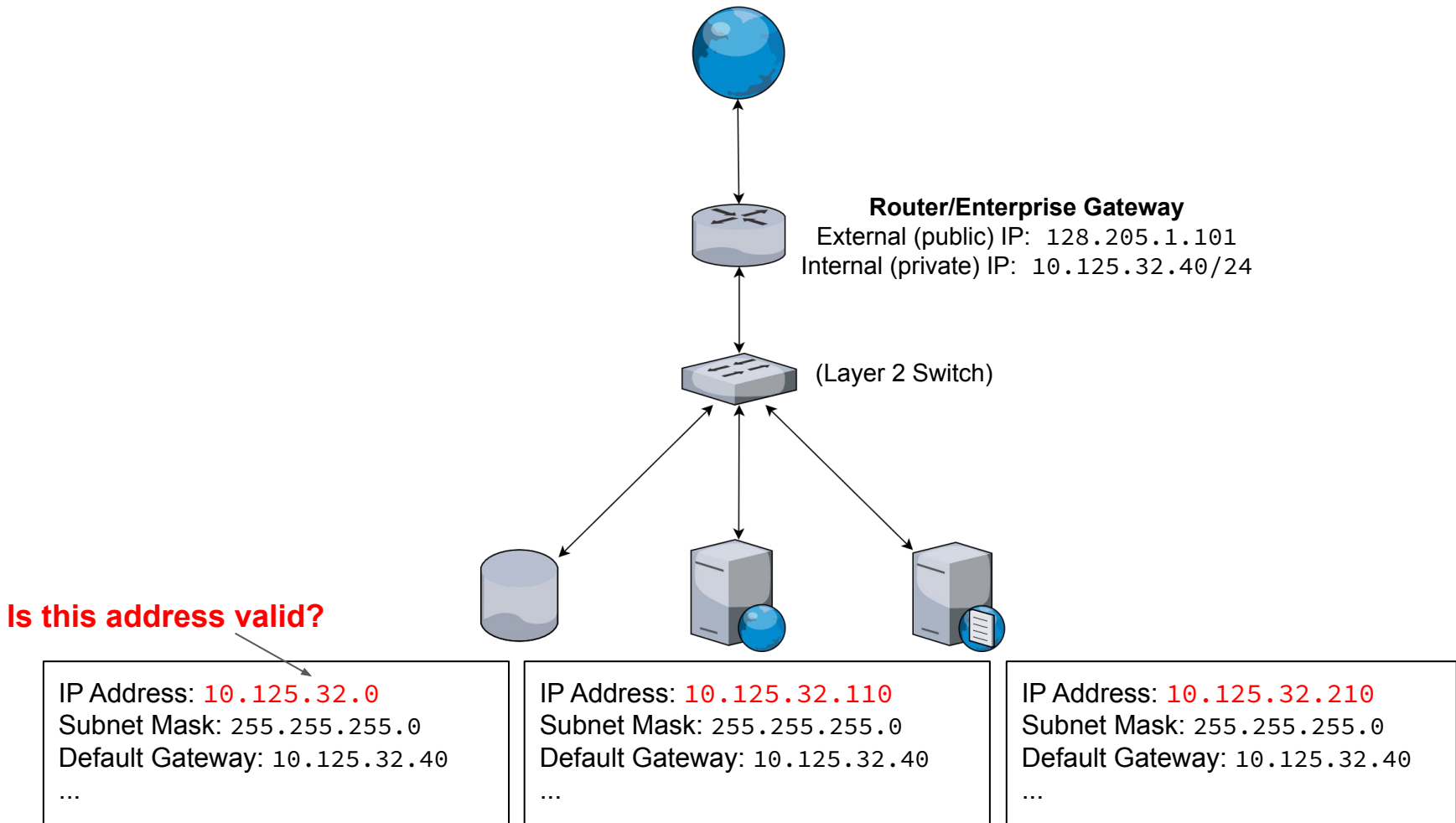
What address space is available?

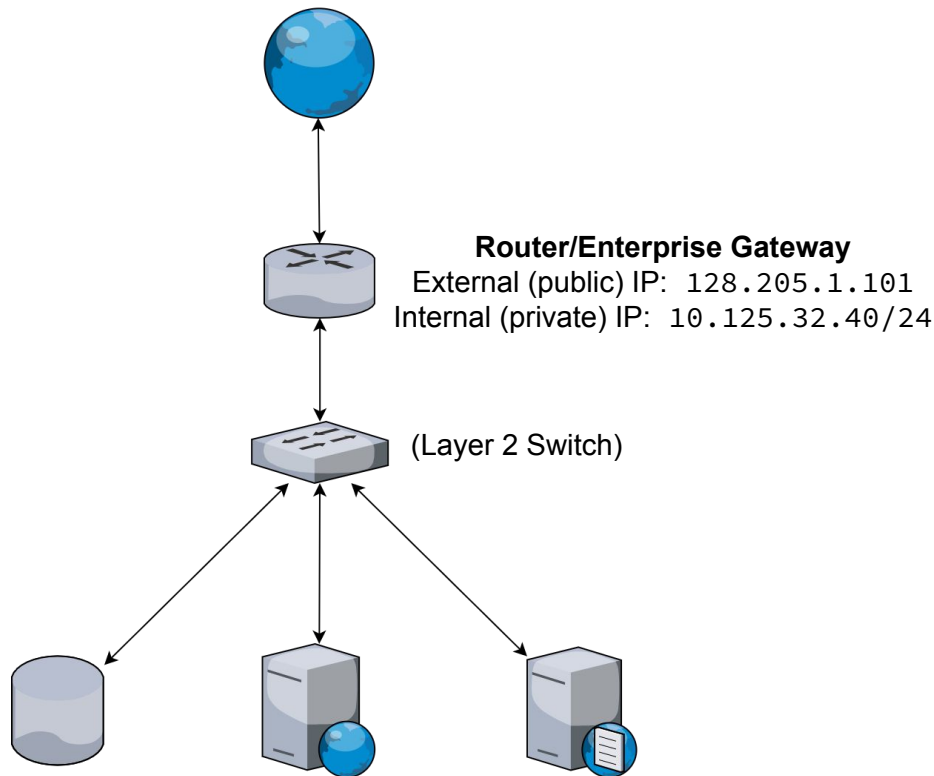
- Subnet ID and Broadcast Address are unusable

Subnet Calculator

Network Class	First Octet Range
A <input checked="" type="radio"/> B <input type="radio"/> C <input type="radio"/>	1 - 126
IP Address	Hex IP Address
10.125.32.40	0A.7D.20.28
Subnet Mask	Wildcard Mask
255.255.255.0	0.0.0.255
Subnet Bits	Mask Bits
16	24
Maximum Subnets	Hosts per Subnet
65536	254
Host Address Range	
10.125.32.1 - 10.125.32.254	
Subnet ID	Broadcast Address
10.125.32.0	10.125.32.255
Subnet Bitmap	
0nnnnnnn.ssssssss.ssssssss.hhhhhhhh	







IP Address: 10.125.32.14
Subnet Mask: 255.255.255.0
Default Gateway: 10.125.32.40
...

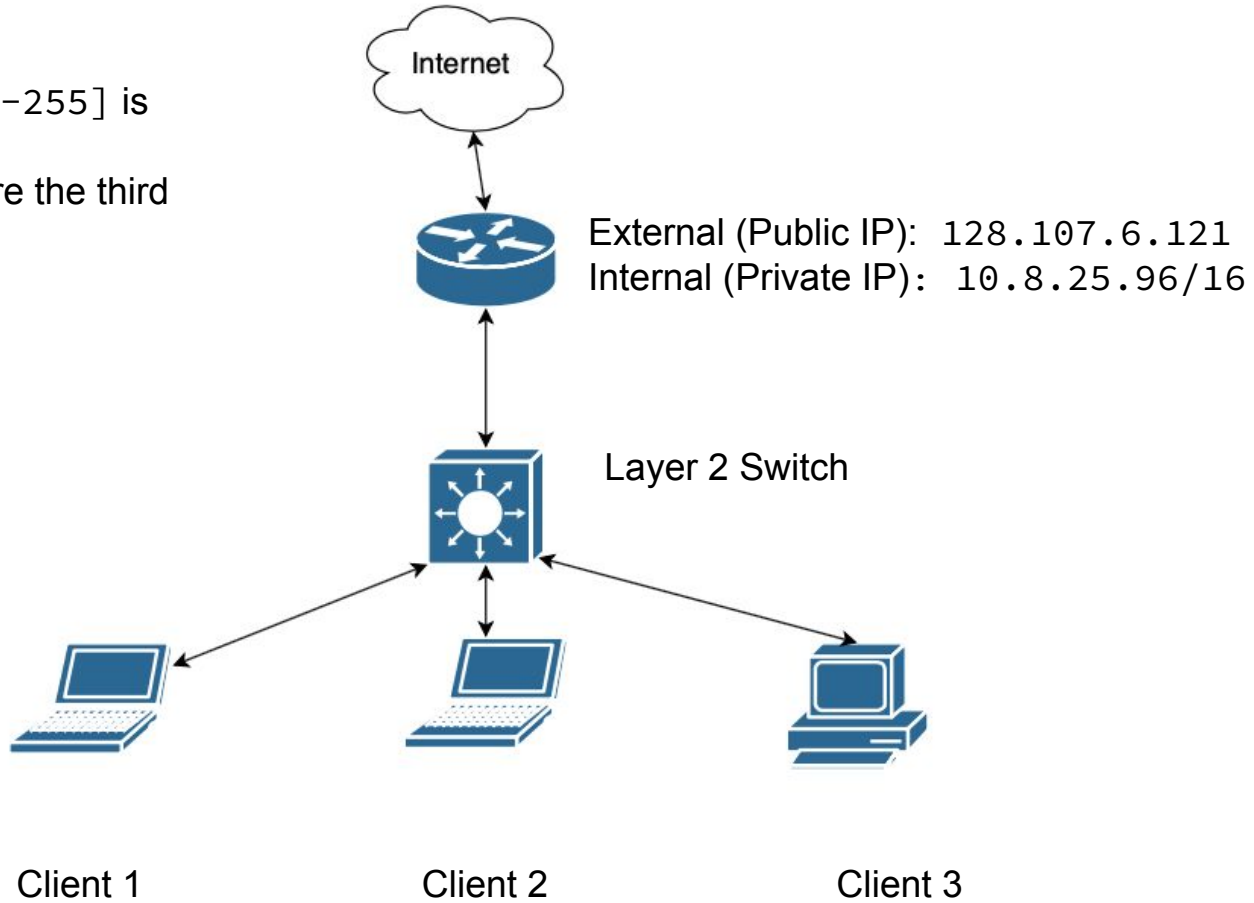
IP Address: 10.125.32.110
Subnet Mask: 255.255.255.0
Default Gateway: 10.125.32.40
...

IP Address: 10.125.32.210
Subnet Mask: 255.255.255.0
Default Gateway: 10.125.32.40
...

Example 2

Rules:

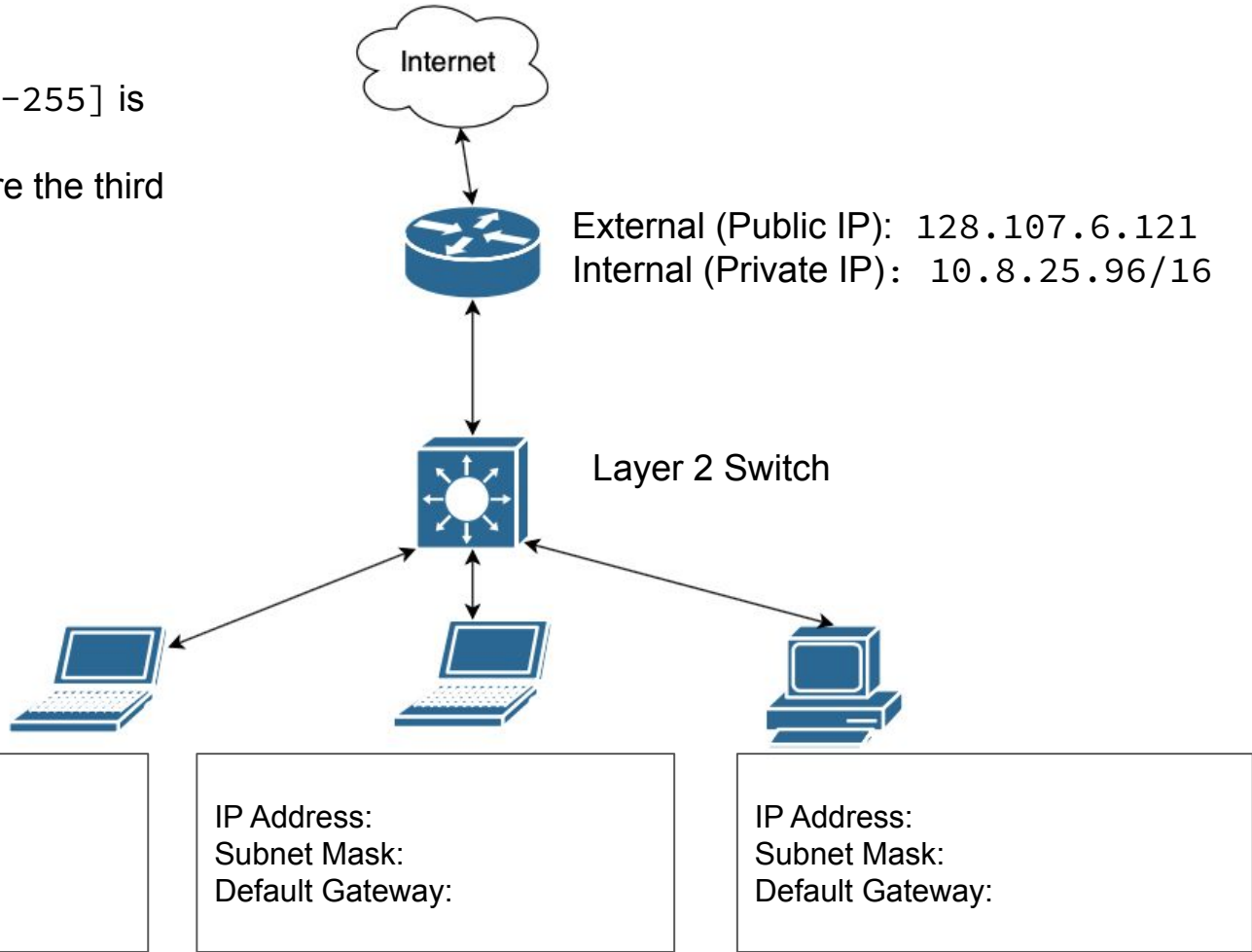
- IP address range 10.8.[1-24].[0-255] is forbidden
- No clients can share the third octet



Rules:

- IP address range 10.8.[1-24].[0-255] is forbidden
- No clients can share the third octet

Once again, let's start easy. What are the subnet masks for our 3 clients?



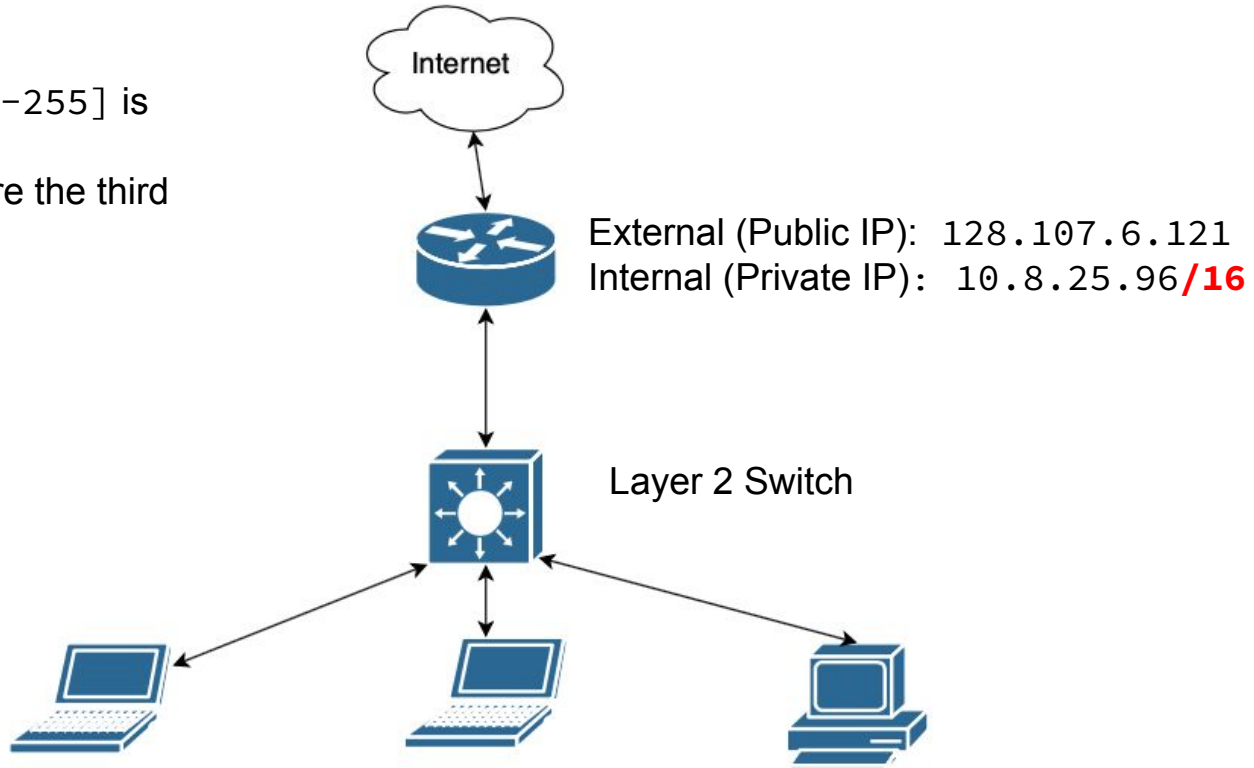
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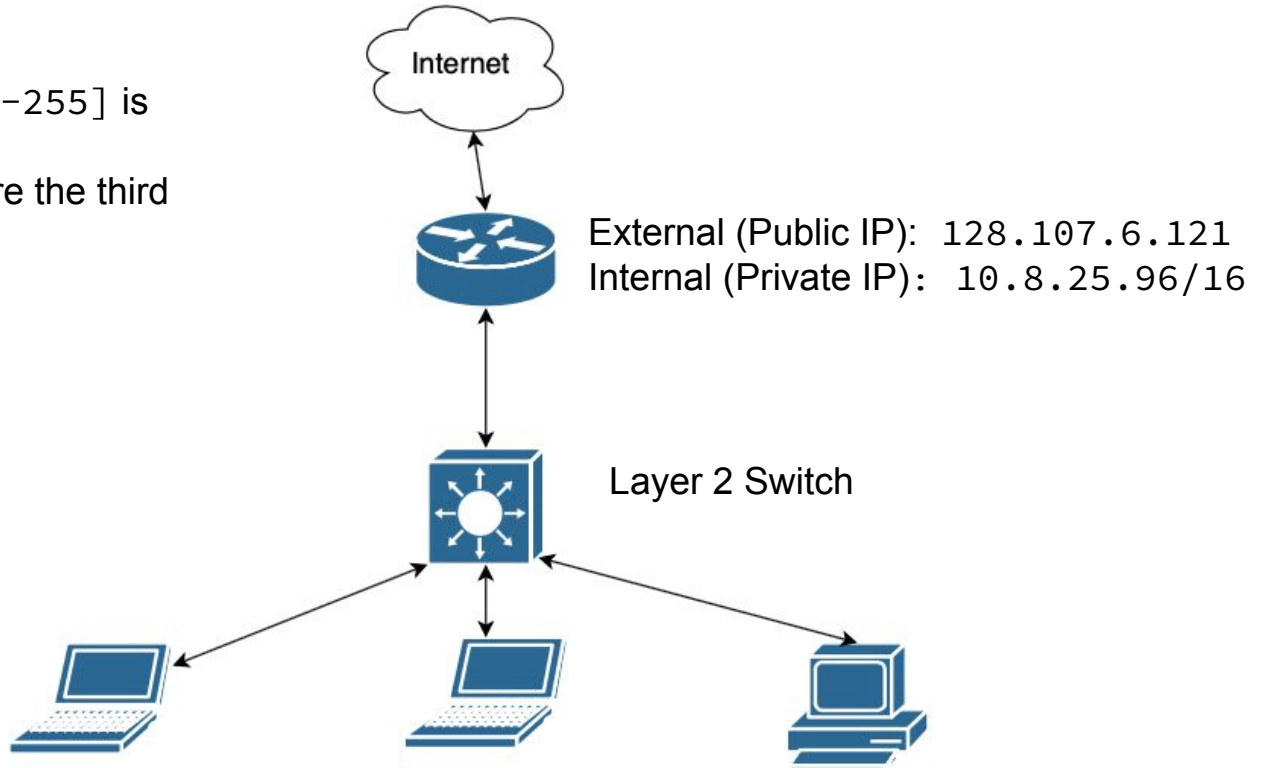


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Subnet Mask	CIDR Prefix	Total IP Addresses	Usable IP Addresses	Number of /24 netw
255.255.0.0	/16	65,536	65,534	256

Rules:

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Once again, let's start easy. What are the subnet masks for our 3 clients?

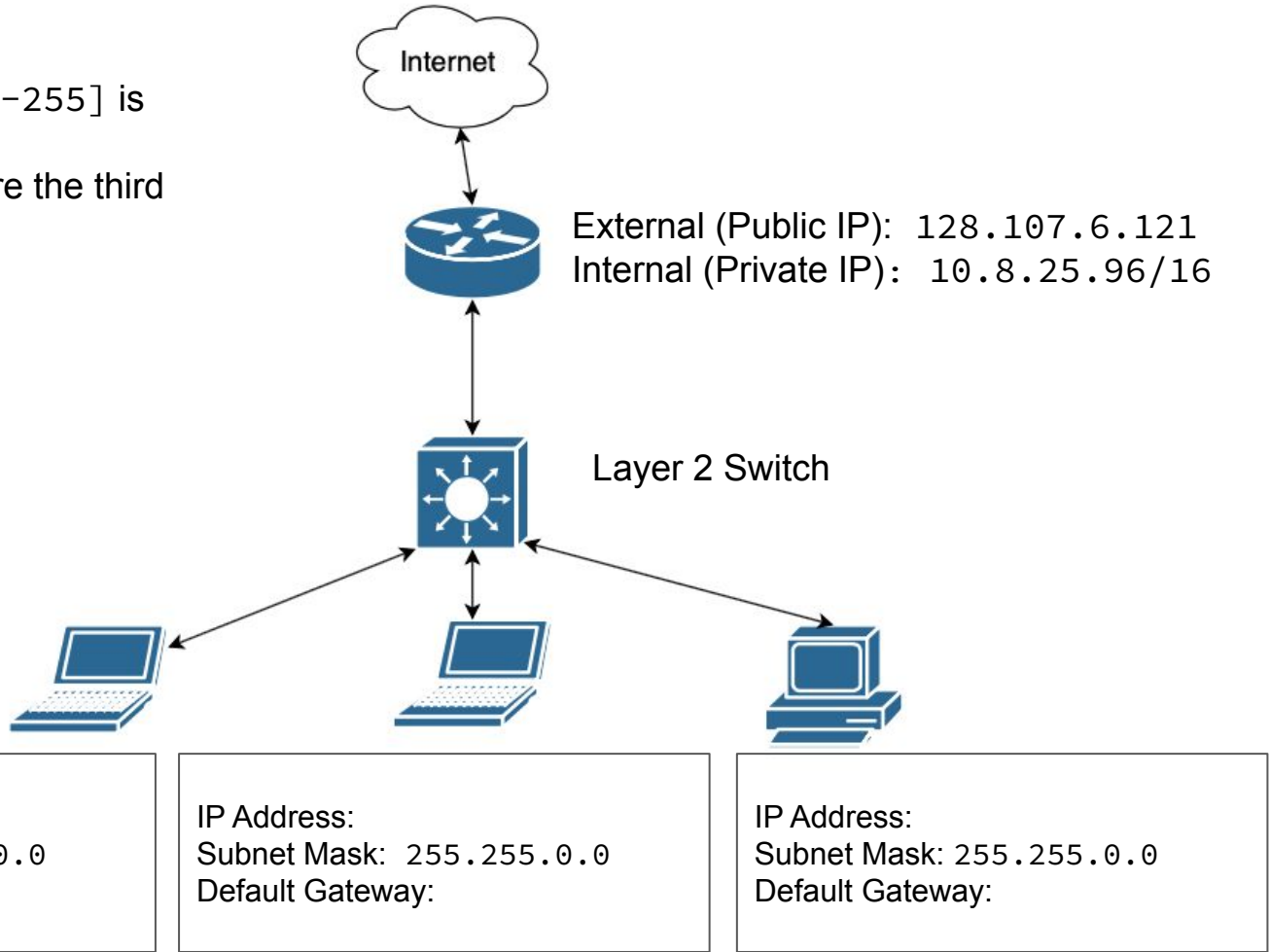
IP Address:
Subnet Mask: 255.255.0.0
Default Gateway:

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Subnet Mask: 255.255.0.0
Default Gateway:

Rules:

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What is our default gateway?

Rules:

- IP address range 10.8.[1-24].[0-255] is forbidden
- No clients can share the third octet

What is our default gateway?



External (Public IP): 128.107.6.121
Internal (Private IP): 10.8.25.96/16



Layer 2 Switch



IP Address:
Subnet Mask: 255.255.0.0
Default Gateway: 10.8.25.96

IP Address:
Subnet Mask: 255.255.0.0
Default Gateway: 10.8.25.96

IP Address:
Subnet Mask: 255.255.0.0
Default Gateway: 10.8.25.96

Rules:

- IP address range 10.8.[1-24].[0-255] is forbidden
- No clients can share the third octet

What is our IP Address?



External (Public IP): 128.107.6.121
Internal (Private IP): 10.8.25.96/16



Layer 2 Switch



IP Address:
Subnet Mask: 255.255.0.0
Default Gateway: 10.8.25.96

IP Address:
Subnet Mask: 255.255.0.0
Default Gateway: 10.8.25.96

Subnet Calculator	
Network Class <input checked="" type="radio"/> A <input type="radio"/> B <input type="radio"/> C	First Octet Range 1 - 126
IP Address 10.8.25.96	Hex IP Address 0A.08.19.60
Subnet Mask 255.255.0.0	Wildcard Mask 0.0.255.255
Subnet Bits 8	Mask Bits 16
Maximum Subnets 256	Hosts per Subnet 65534
Host Address Range 10.8.0.1 - 10.8.255.254	
Subnet ID 10.8.0.0	Broadcast Address 10.8.255.255
Subnet Bitmap 0nnnnnnn.ssssssss.hhhhhhhh.hhhhhhhh	

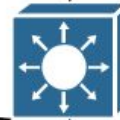
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Is this a valid IP address?



External (Public IP): 128.107.6.121
Internal (Private IP): 10.8.25.96/16



Layer 2 Switch



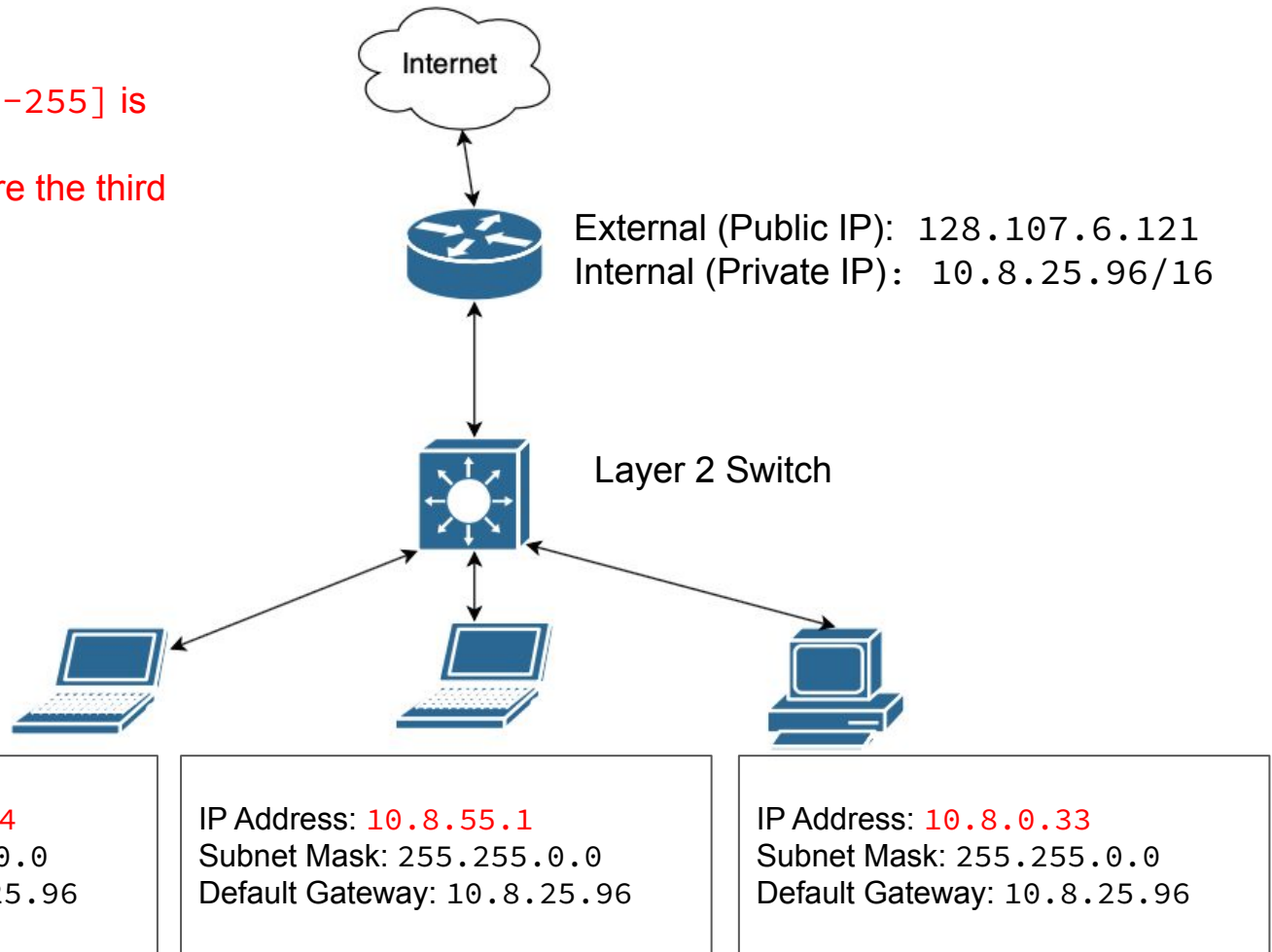
IP Address: 10.8.0.254
Subnet Mask: 255.255.0.0
Default Gateway: 10.8.25.96

IP Address: 10.8.55.1
Subnet Mask: 255.255.0.0
Default Gateway: 10.8.25.96

IP Address: 10.8.0.33
Subnet Mask: 255.255.0.0
Default Gateway: 10.8.25.96

Rules:

- IP address range 10.8.[1-24].[0-255] is forbidden
- No clients can share the third octet



Why does layering matter?

- Each device will have 2 types of addresses
 - MAC addresses
 - IP addresses
- You will need to properly identify them and their use cases

Why does layering matter?

- There are 2 different types of network devices
 - Layer 2 devices
 - E.g., switches
 - Operate exclusively with MAC addresses
 - Layer 3 devices
 - E.g., switches, routers, gateways, modems
 - Provides connectivity using IP addresses only

Summary and Wrap-up

Today's achievements:

- We met each other
- We learned how **network devices** work with network traffic
- We understood the components of a network topology
- We described the OSI networking layers 1-3
- We communicated why **layering** matters

Parting questions

Now is the time!

Class dismissed

See you next week!