

# IPv4 Addressing and Organization

**Week 1**



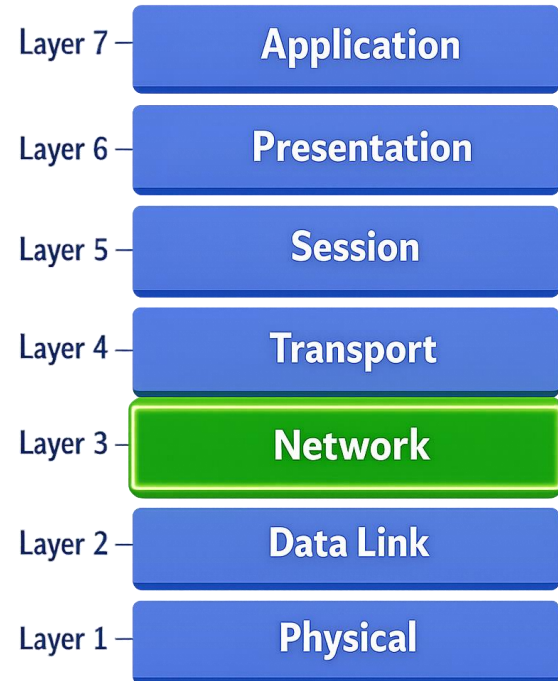
# Content

- **What is an IP address?**
- **IPv4 address structure**
- **IPv6 address structure**
- **IPv4 vs IPv6**
- **Subnetting**
- **Commands**



# What is an IP address?

- **IP address** = uniquely identifies a device on an IP network
- IP is an address assigned to a network interface that allows devices to communicate over a network
- IPv4 and IPv6 operates at the Network Layer (Layer 3) of the OSI model

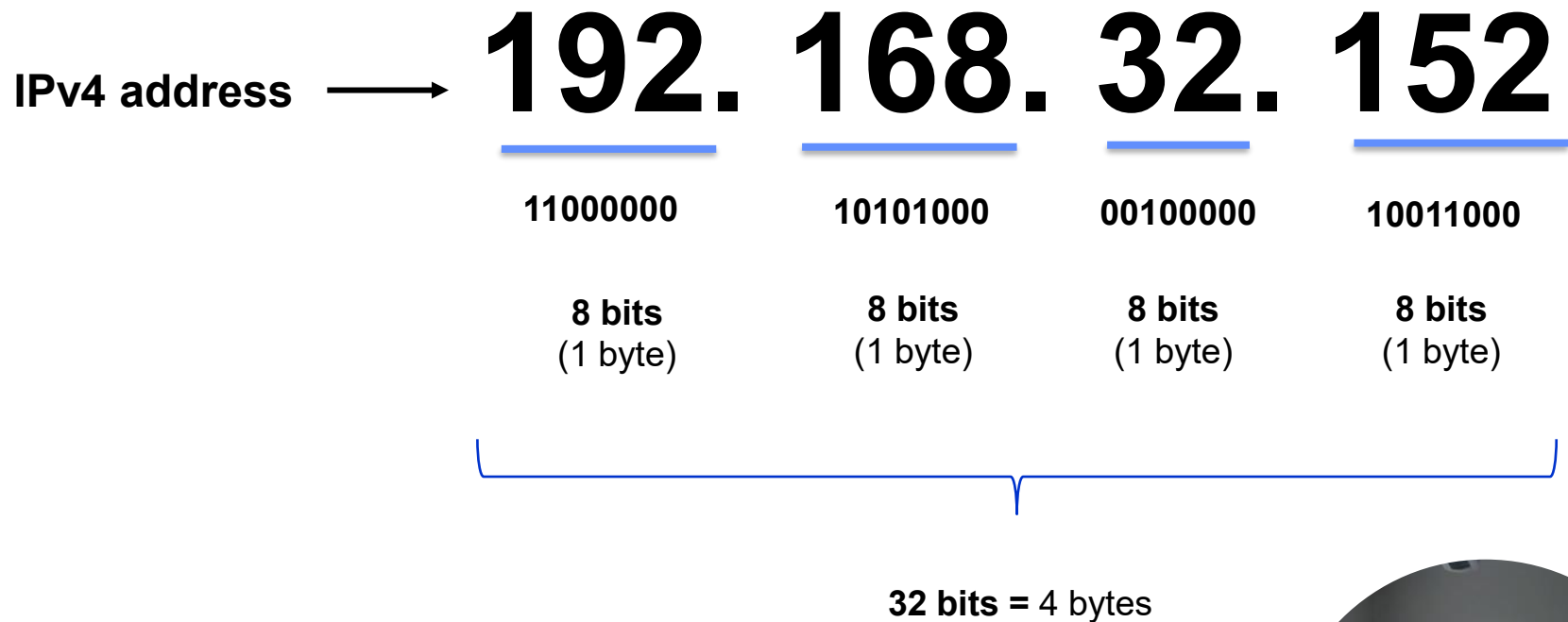


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# IPv4 address structure



# IPv4 address structure

## Classes

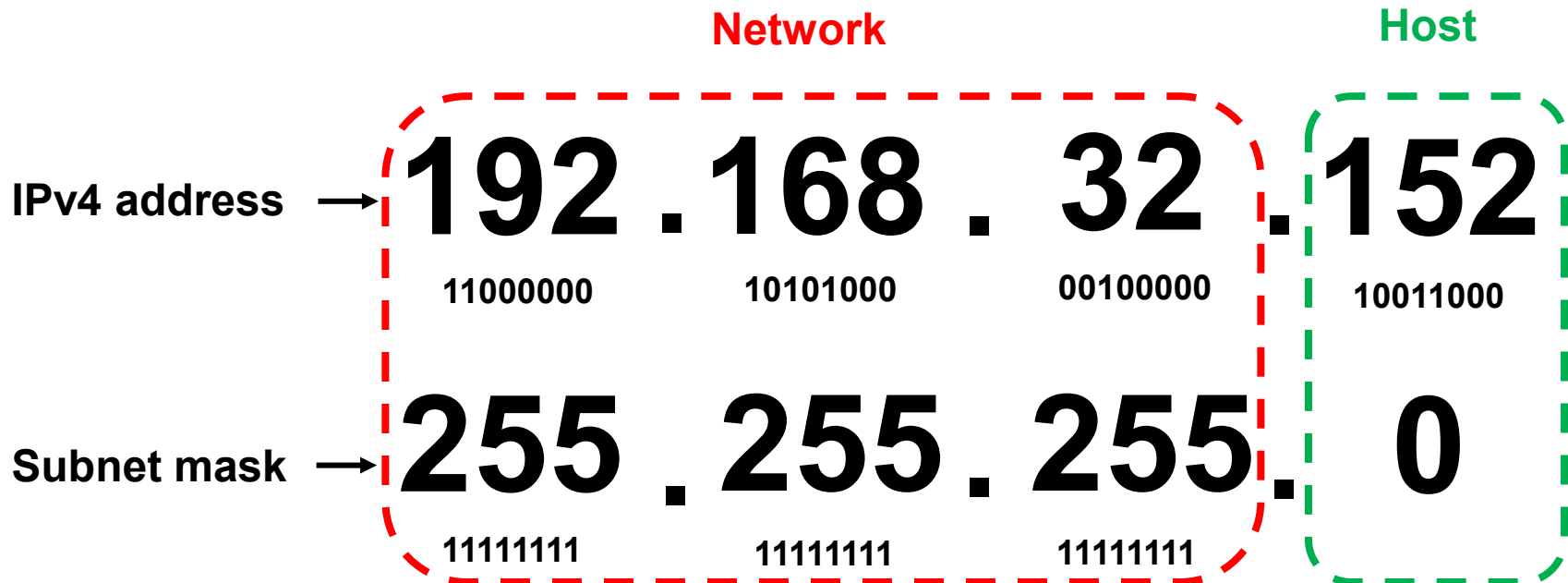
| Class | Subnet mask   | Public Address Range        | Private Address Range       |
|-------|---------------|-----------------------------|-----------------------------|
| A     | 255.0.0.0     | 1.0.0.0 – 126.255.255.255   | 10.0.0.0 – 10.255.255.255   |
| B     | 255.255.0.0   | 128.0.0.0 – 191.255.255.255 | 172.16.0.0 – 172.31.255.255 |
| C     | 255.255.255.0 | 192.0.0.0 – 223.255.255.255 | 192.168.0.0-192.168.255.255 |
| D     |               | 224.0.0.0 – 223.255.255.255 |                             |
| E     |               | 240.0.0.0 – 255.255.255.255 |                             |

Class “E” and “D” does not have a subnet mask or private range because D is reserved for **multicast**, and class E is reserved for **future use/experiments** only.



# IPv4 address structure

## Subnet mask

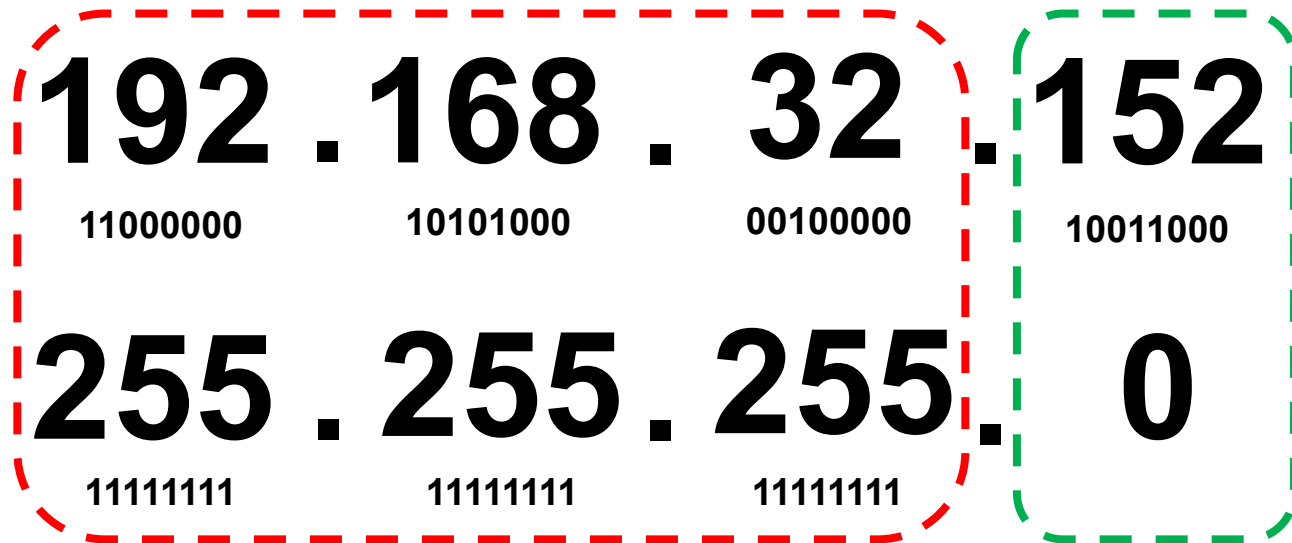


A subnet mask defines which bits belong to the network portion. These bits are set to 1 and will remain the same throughout the network.



# IPv4 address structure

Subnet mask



8 + 8 + 8 set bits:  
/24 mask



# IPv4 address structure

## Prefix length

- **Prefix length** is a method used to identify the subnet mask address
- Prefix length is the number of bits set to 1 in the subnet mask
- Written in "slash notation"

| Subnet Mask     | 32-bit Address                      | Prefix Length |
|-----------------|-------------------------------------|---------------|
| 255.0.0.0       | 11111111.00000000.00000000.00000000 | /8            |
| 255.255.0.0     | 11111111.11111111.00000000.00000000 | /16           |
| 255.255.255.0   | 11111111.11111111.11111111.00000000 | /24           |
| 255.255.255.128 | 11111111.11111111.11111111.10000000 | /25           |
| 255.255.255.192 | 11111111.11111111.11111111.11000000 | /26           |
| 255.255.255.224 | 11111111.11111111.11111111.11100000 | /27           |
| 255.255.255.240 | 11111111.11111111.11111111.11110000 | /28           |
| 255.255.255.248 | 11111111.11111111.11111111.11111000 | /29           |
| 255.255.255.252 | 11111111.11111111.11111111.11111100 | /30           |

192.169.32.152  
255.255.255.0 → 192.169.32.152 /24 → 254 usable hosts



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# IPv6 address structure

IPv6 address → **2001:0db8:0000:0000:0000:0000:0034:0001**

|                |                |                |                |                |                |                |                |
|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| <b>16 bits</b> | <b>16 bits</b> | <b>16 bits</b> | <b>16 bits</b> | <b>16 bits</b> | <b>16 bits</b> | <b>16 bits</b> | <b>16 bits</b> |
| (2 bytes)      | (2 bytes)      | (2 bytes)      | (2 bytes)      | (2 bytes)      | (2 bytes)      | (2 bytes)      | (2 bytes)      |

**128 bits = 16 bytes**



# IPv4 vs IPv6

| Feature             | IPv4                         | IPv6                              |
|---------------------|------------------------------|-----------------------------------|
| Address size        | 32 bits                      | 128 bits                          |
| Groups              | 4 groups of 8 bits (1 byte)  | 8 groups of 16 bits (2 bytes)     |
| Format              | Decimal (192.168.1.1)        | Hexadecimal (2001:0db8::1)        |
| Number of addresses | $2^{32} \approx 4.3$ billion | $2^{128} \approx 340$ undecillion |
| Address exhaustion  | Yes 🙄                        | No 😍                              |



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# Subnetting

**192.169.32.152 /24**

**254 usable hosts**

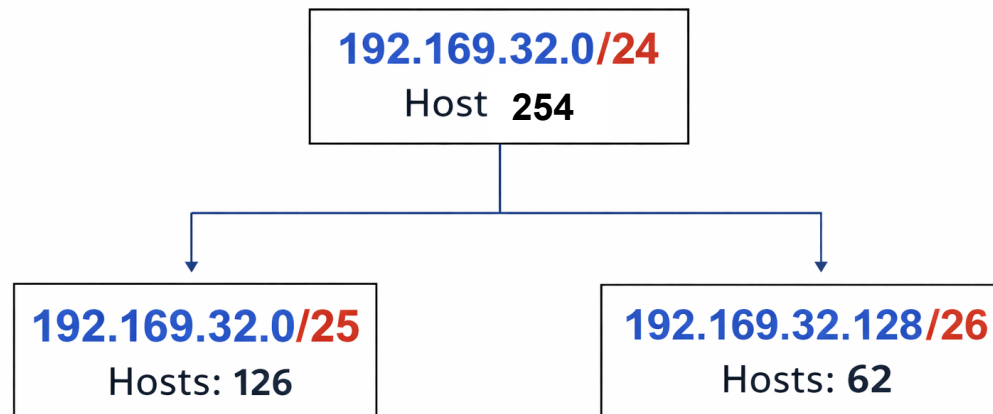
- IPv4-address is always 32 bits, so this leaves 8 host bits left.
- Usable hosts =  $2^{host\ bits}$

**! 2 reserved addresses per subnet,  
network address and broadcast address**

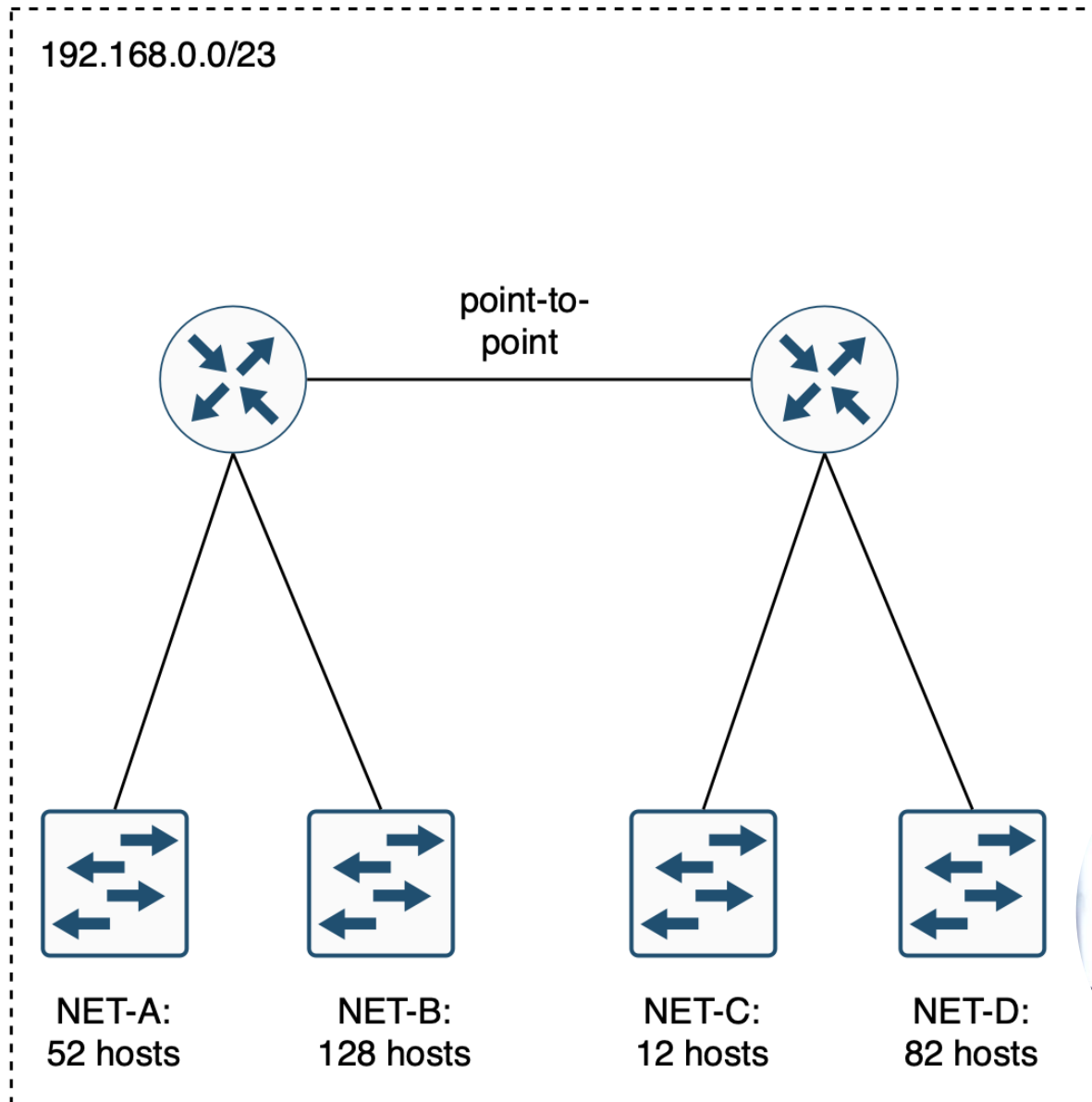


# Subnetting for network segmentation

- Creating subnets allows for
  - Better use of Ips
  - Easier organization
  - Better security
  - Reducing broadcast traffic

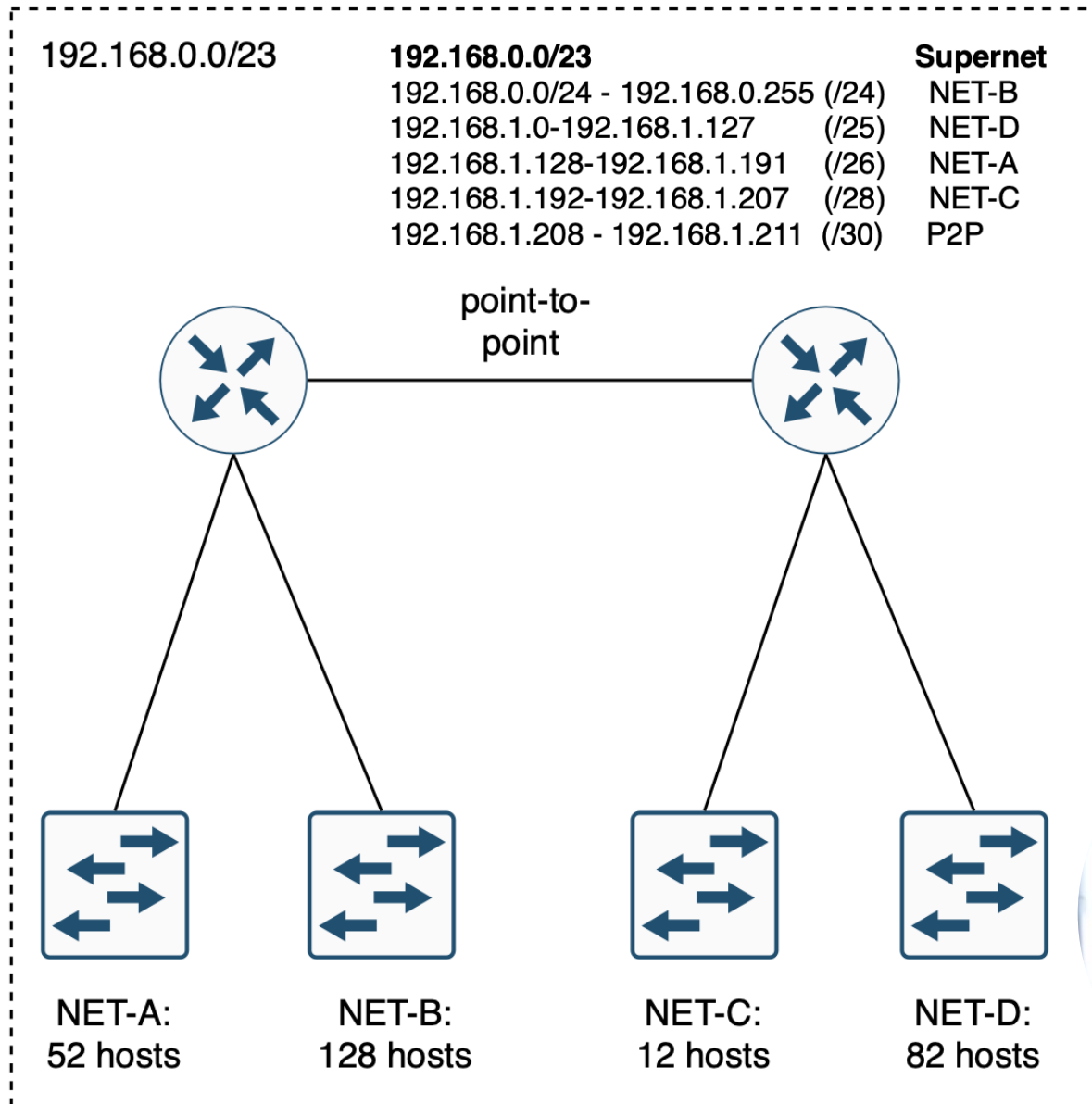


# Subnetting exercise





# Subnetting exercise



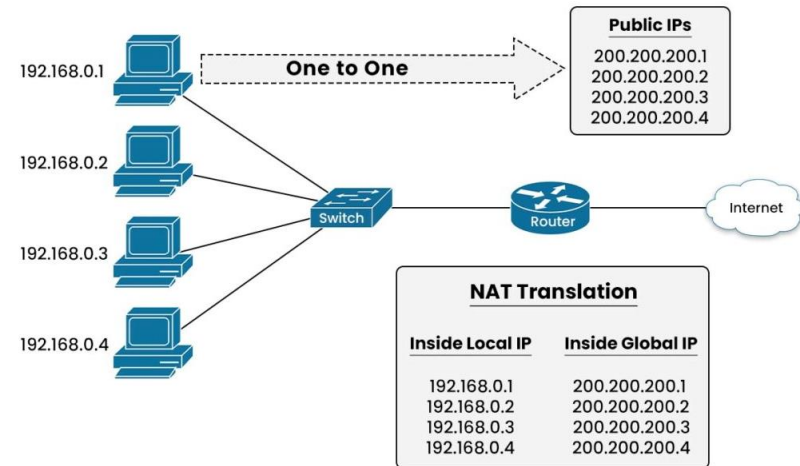
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# Network address translation (NAT)

- *What is it?*
  - **NAT** = translate many private IP addresses to one public IP address (and back)
  - Sits at the border between the private network and the internet
- *Why does it exist?*
  - IPv4 exhaustion
  - NAT allows many private IPv4 addresses to share one public IP address
- *How does it work?*
  - Maintains a **NAT translation table** mapping the private IP to the public IP



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# IP addressing commands

Console - Router1

```
Router>enable ! enter privileged mode
Router#configure terminal ! enter configuration mode
Router(config)#interface fastEthernet 0/0 ! select the interface
Router(config-if)#ip address 192.168.1.1 255.255.255.0 ! assign IP and subnet mask
Router(config-if)#no shutdown ! enable the interface
Router(config-if)#exit ! go back one level
Router(config)#exit ! exit configuration mode
Router#show ip interface brief ! overview of interfaces and IPs
Router#show interfaces ! detailed interface info
Router#ping 192.168.1.2 ! test connectivity

Router#_
```

!Reminder: Some commands work only within specific modes (i.e. config, config-if). Keep track of where you're entering commands.

