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DEEMED TO BE UNIVERSITY

श्रद्धावान् लभते ज्ञानम्

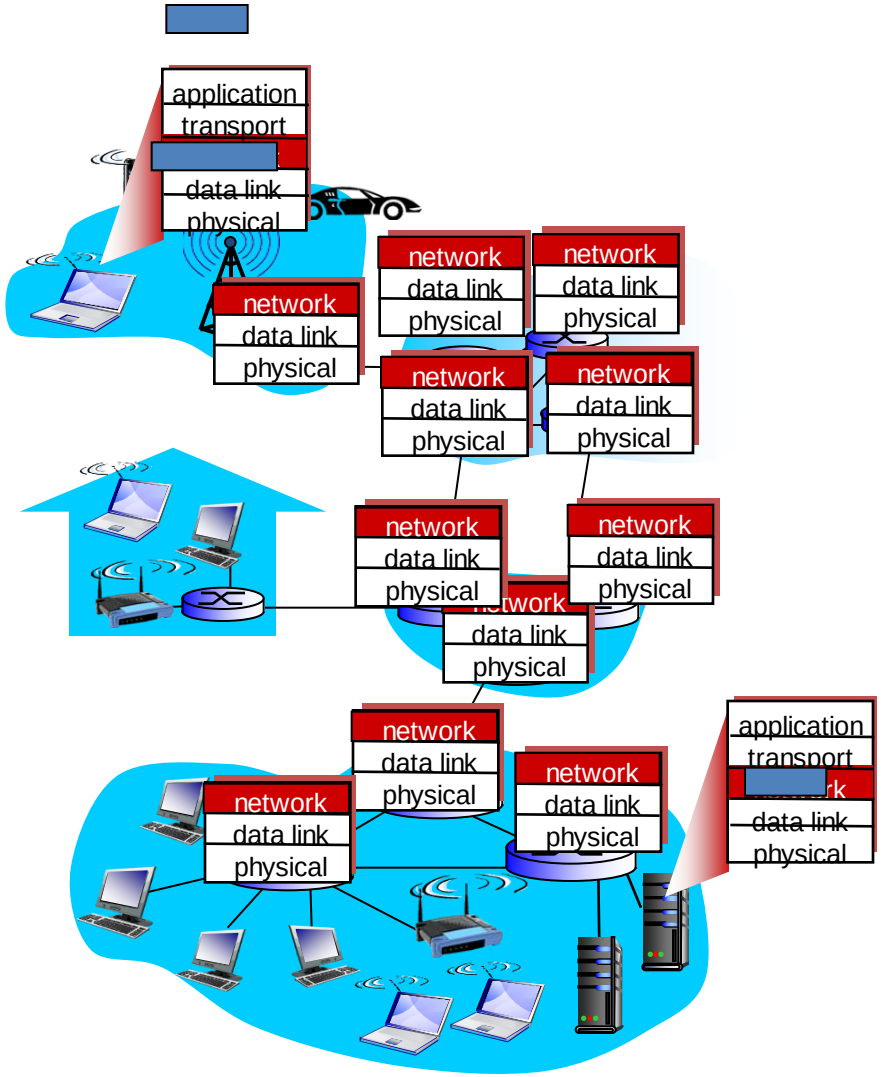
22AIE204
COMPUTER NETWORKS

NETWORK LAYER

- **Network Layer – IP Protocol**

Network layer

- transport segment from sending to receiving host
- on sending side encapsulates segments into datagrams
- on receiving side, delivers segments to transport layer
- network layer protocols in *every* host, router
- router examines header fields in all IP datagrams passing through it



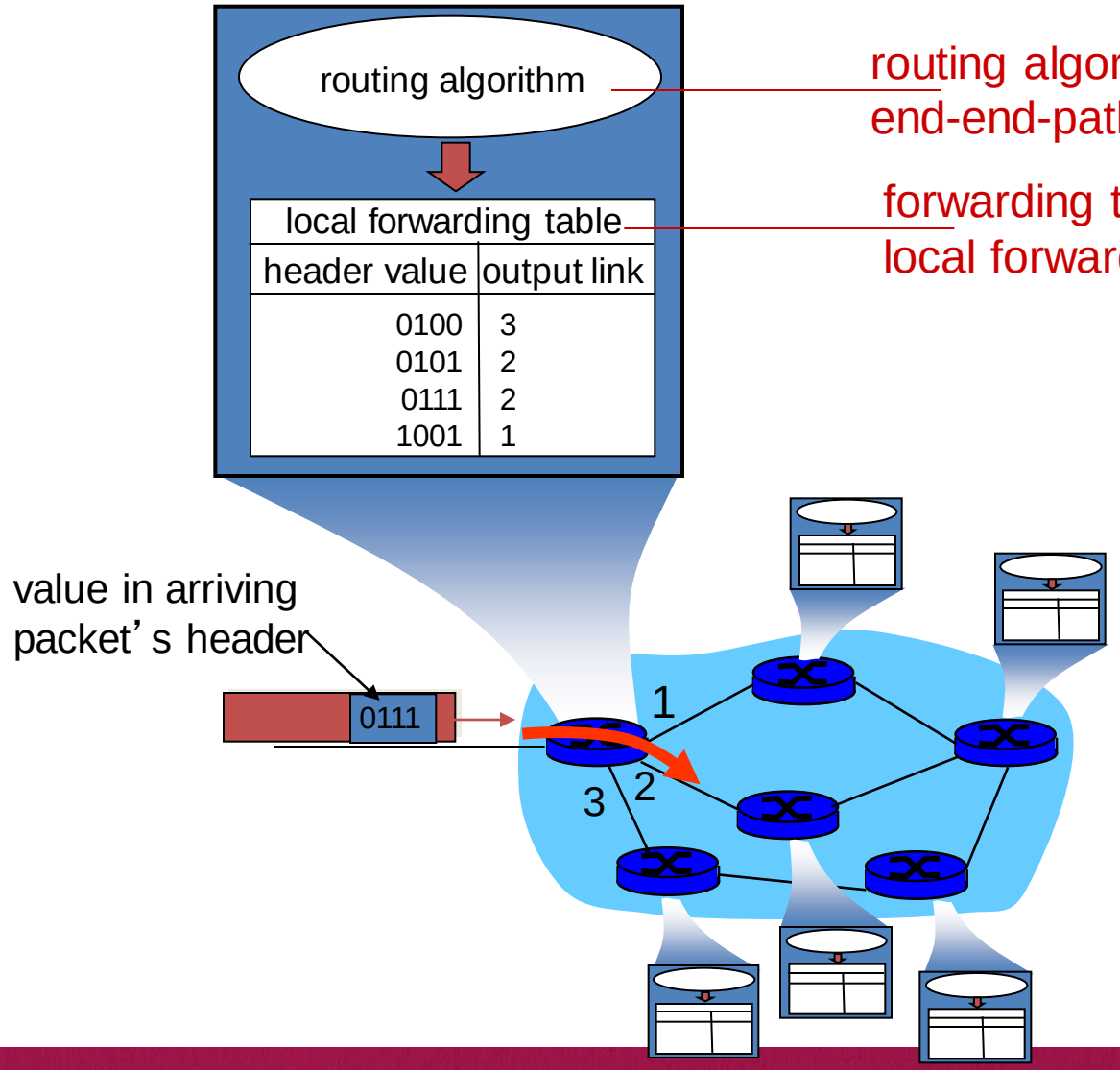
Two key network-layer functions

- *forwarding:* move packets from router's input to appropriate router output
- *routing:* determine route taken by packets from source to dest.
  - routing algorithms

analogy:

- *routing:* process of planning trip from source to dest
- *forwarding:* process of getting through single interchange

Interplay between routing and forwarding



routing algorithm determines end-end-path through network

forwarding table determines local forwarding at this router

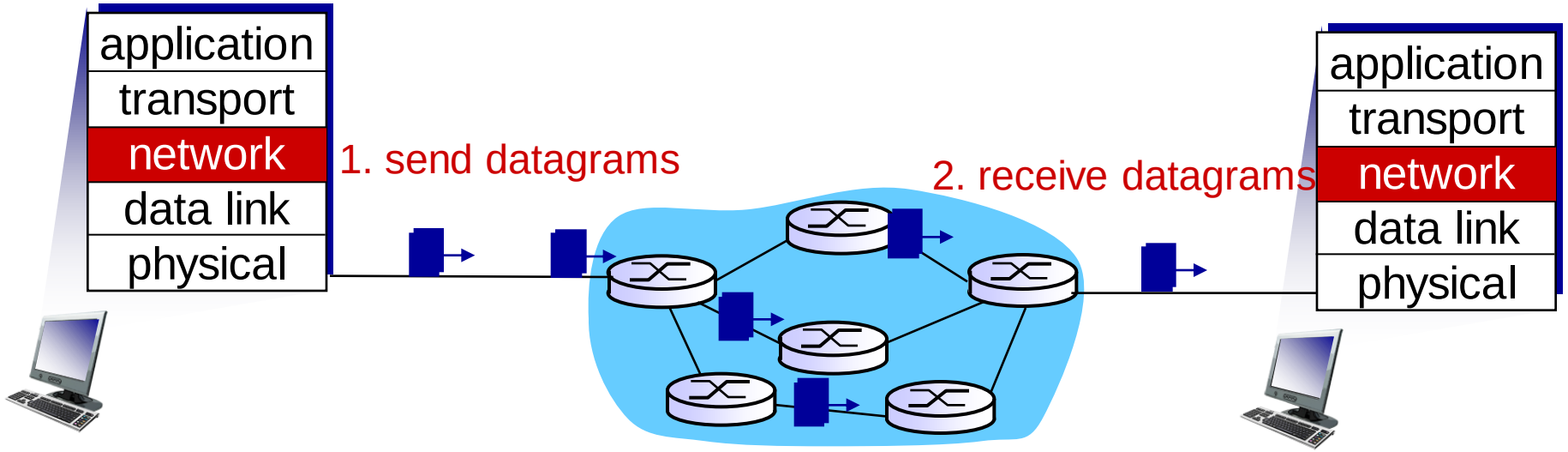
Datagram networks @ Internet

no call setup at network layer

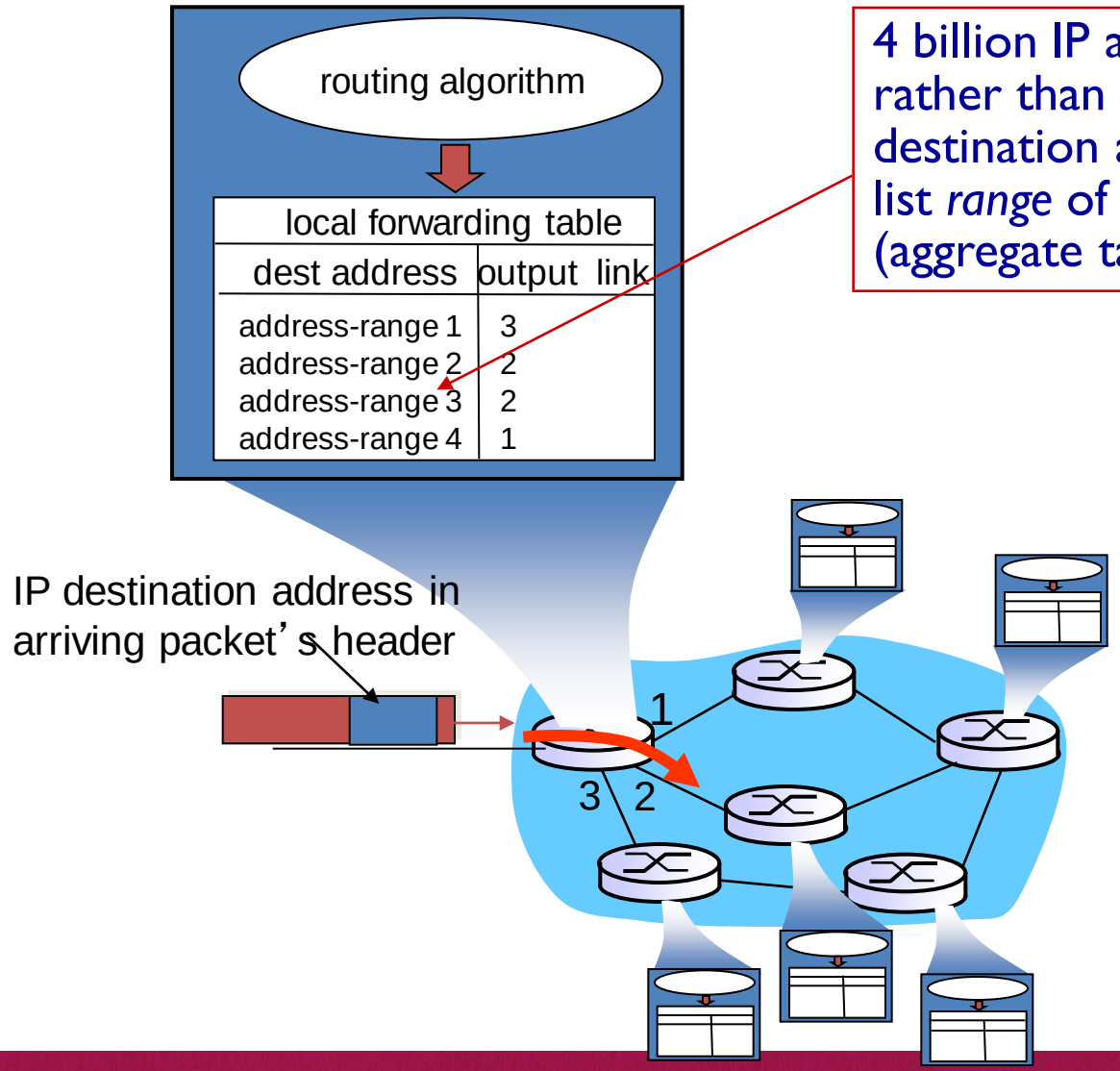
routers: no state about end-to-end connections

no network-level concept of “connection”

packets forwarded using destination host address



Datagram forwarding table



Datagram forwarding table

Destination Address Range	Link Interface
11001000 00010111 00010000 00000000 through 11001000 00010111 00010111 11111111	0
11001000 00010111 00011000 00000000 through 11001000 00010111 00011000 11111111	1
11001000 00010111 00011001 00000000 through 11001000 00010111 00011111 11111111	2
otherwise	3

Q: but what happens if ranges don't divide up so nicely?

Longest prefix matching

longest prefix matching

when looking for forwarding table entry for given destination address, use *longest* address prefix that matches destination address.

Destination Address Range	Link interface
11001000 00010111 00010*** *********	0
11001000 00010111 00011000 *********	1
11001000 00010111 00011*** *********	2
otherwise	3

examples:

DA: 11001000 00010111 00010110 10100001 which interface?

DA: 11001000 00010111 00011000 10101010 which interface?

NETWORK LAYER

- **Host Addressing for Subnets**

IPv4 Addressing Structure

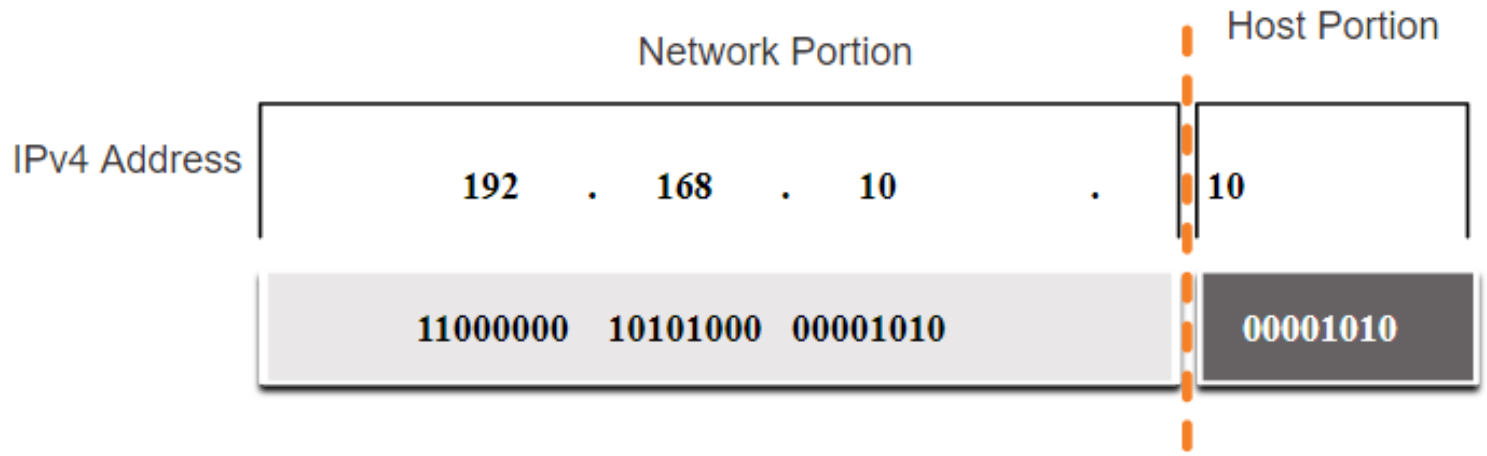
Reference: CCNA ITN Chapter 11.1 IPv4 addressing

Objectives – IPv4 Addressing Structure

- Network and Host portions in IPv4 Address
- Subnet mask to identify network and host portion
- Prefix Length – easier way to specify subnet mask
  - /24 = 255.255.255.0
- Determining the network using Logical AND.

Network and Host Portions

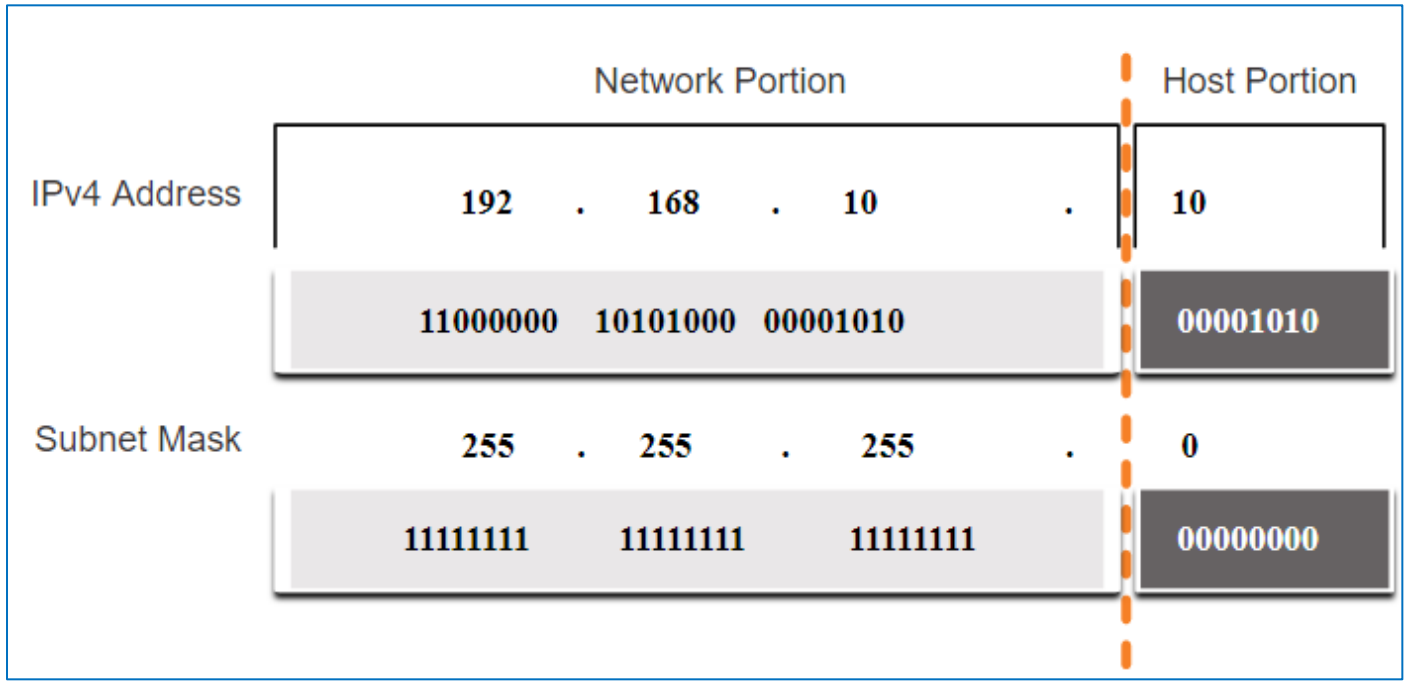
- An IPv4 address is a 32-bit hierarchical address that is made up of a network portion and a host portion.
- When determining the network portion versus the host portion, you must look at the 32-bit stream.
  - Network portion is always in the left and MSB side
  - Host portion is always in the right and LSB side



Reference: CCNA ITN Ch11 IPv4 Addressing

How is network and host portion separated?

- A subnet mask is used to determine the network and host portions.
- The subnet mask is compared to the IPv4 address bit for bit, from left to right for identifying the separator.
- The actual process used to identify the network and host portions is called ANDing.



Reference: CCNA ITN Ch11 IPv4 Addressing

Prefix Length

- A prefix length is a easy method used to identify a subnet mask address.
- The prefix length is the number of bits set to 1 in the subnet mask.
- It is written in “slash notation” followed by the prefix length

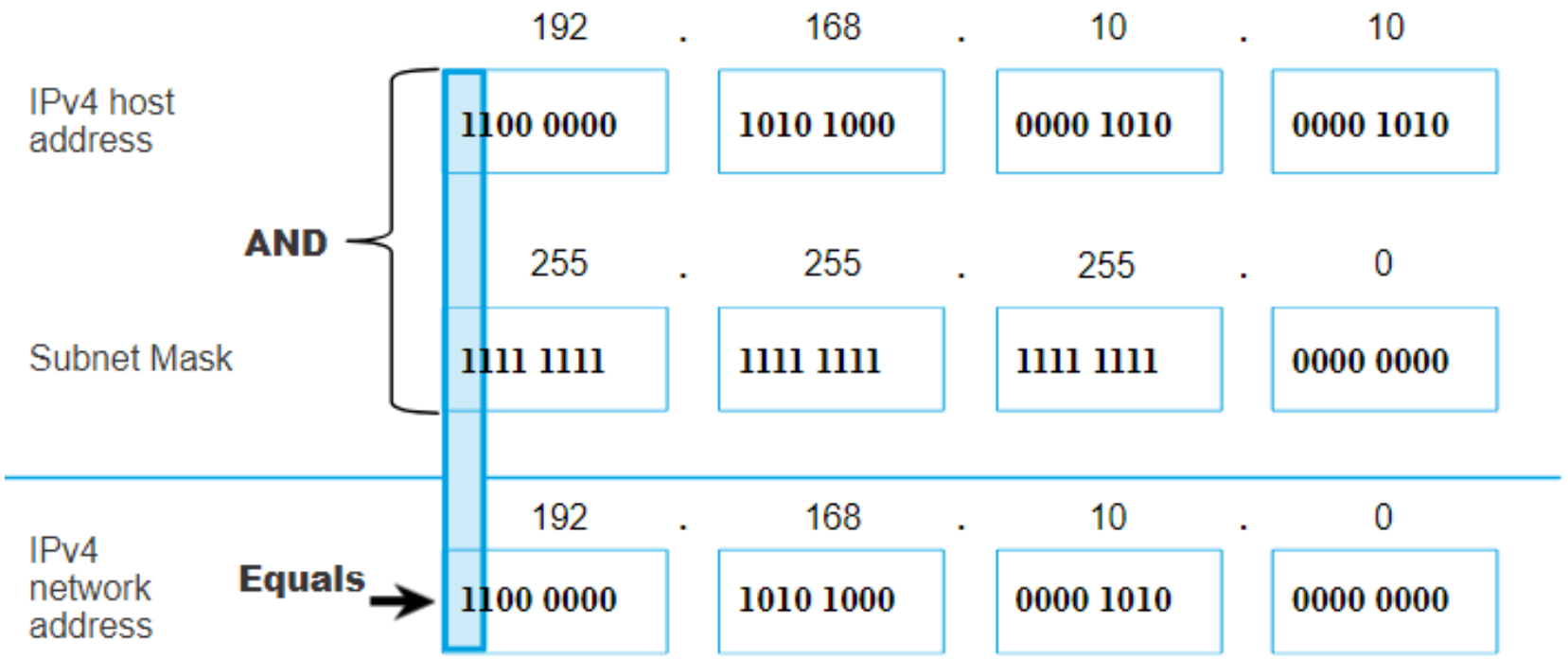
Subnet Mask	32-bit Address	Prefix Length
255.0.0.0	11111111.00000000.00000000.00000000	/8
255.255.0.0	11111111.11111111.00000000.00000000	/16
255.255.255.0	11111111.11111111.11111111.00000000	/24
255.255.255.128	11111111.11111111.11111111.10000000	/25
255.255.255.192	11111111.11111111.11111111.11000000	/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

Reference: CCNA ITN Ch11 IPv4 Addressing

Determining the Network

- To identify the network address, the host IPv4 address is logically ANDed, bit by bit, with the subnet mask to identify the network address.

- Logical AND
- Boolean operation
- 1=True, 0=False
- 1 AND 1 = 1,
- 0 AND 1 = 0,
- 1 AND 0 = 0,
- 0 AND 0 = 0



Reference: CCNA ITN Ch11 IPv4 Addressing

Activity – ANDing to determine the network address

11.1.7

Activity - ANDing to Determine the Network Address

Instructions:

Use the ANDing process to determine the network address (in binary and decimal formats).

Host Address	172	25	248	97
Subnet Mask	255	255	255	224
Host Address in binary	10101100	00011001	11111000	01100001
Subnet Mask in binary	11111111	11111111	11111111	11100000
Network Address in binary				
Network Address in decimal				

Check | New Problem | Show Me | Reset

Summary – IPv4 Addressing Structure

- Network and Host portions in IPv4 Address
  - 192.168.10.1/24
- Subnet mask to identify network and host portion
  - First 24 bits for network and
  - last 8 bits for host portion
- Prefix Length – easier way to specify subnet mask
  - /24 = 255.255.255.0
- Determining the network using Logical AND.
- Next, determining network, host and broadcast address in each network (Cisco LMS)

Network, Host and Broadcast Address

Refer the following video in Cisco Netacad LMS

CCNA ITN 11.1.5 Video - Network, host and broadcast addresses (duration: 6.21 min)

IPv4 Addresses in a Network

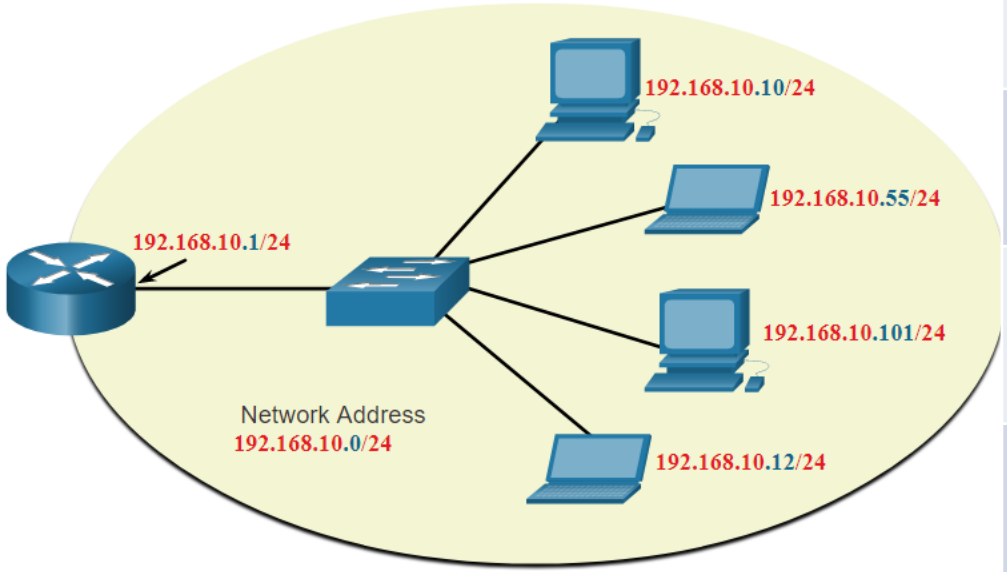
Reference: CCNA ITN 11.1 (Network, host and broadcast address in a network) and 11.2 Unicast, broadcast and multicast Video 5

Objectives – IPv4 Addresses in a Network

- Understand and Analyze any IP address to be a Network, Broadcast or Valid Host address in a network
- Understand and Evaluate the destination IPv4 address as a Unicast, Broadcast and Multicast IP communication

Network, Host and Broadcast Address

- Within each network are three types of IP addresses:
  1. Network address
  2. Host addresses
  3. Broadcast address

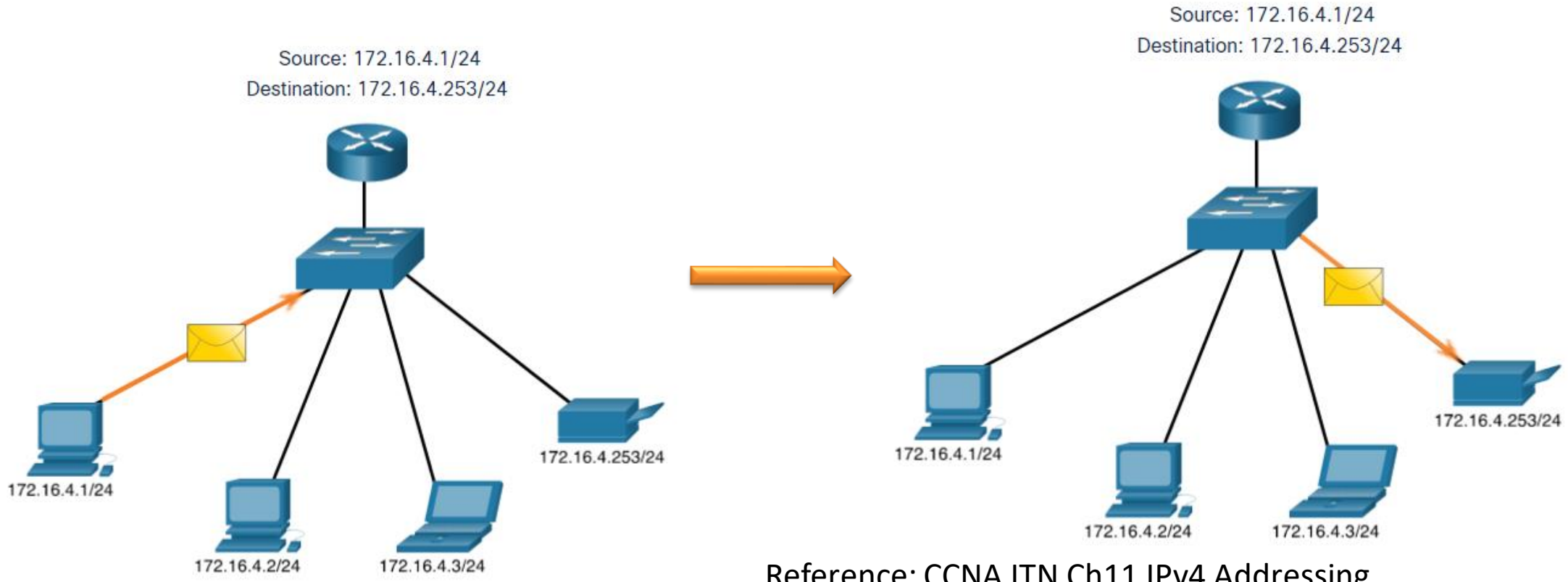


Reference: CCNA ITN Ch11 IPv4 Addressing

	Network Portion			Host Portion	Host Bits
Subnet mask **255.255.255.**0 or **/24**	255 11111111	255 11111111	255 11111111	0 00000000	
Network address **192.168.10.**0 or **/24**	192 11000000	168 10100000	10 00001010	0 00000000	All 0s
First address **192.168.10.**1 or **/24**	192 11000000	168 10100000	10 00001010	1 00000001	All 0s and a 1
Last address **192.168.10.**254 or **/24**	192 11000000	168 10100000	10 00001010	254 11111110	All 1s and a 0
Broadcast address **192.168.10.**255 or **/24**	192 11000000	168 10100000	10 00001010	255 11111111	All 1s

Unicast IPv4 Address

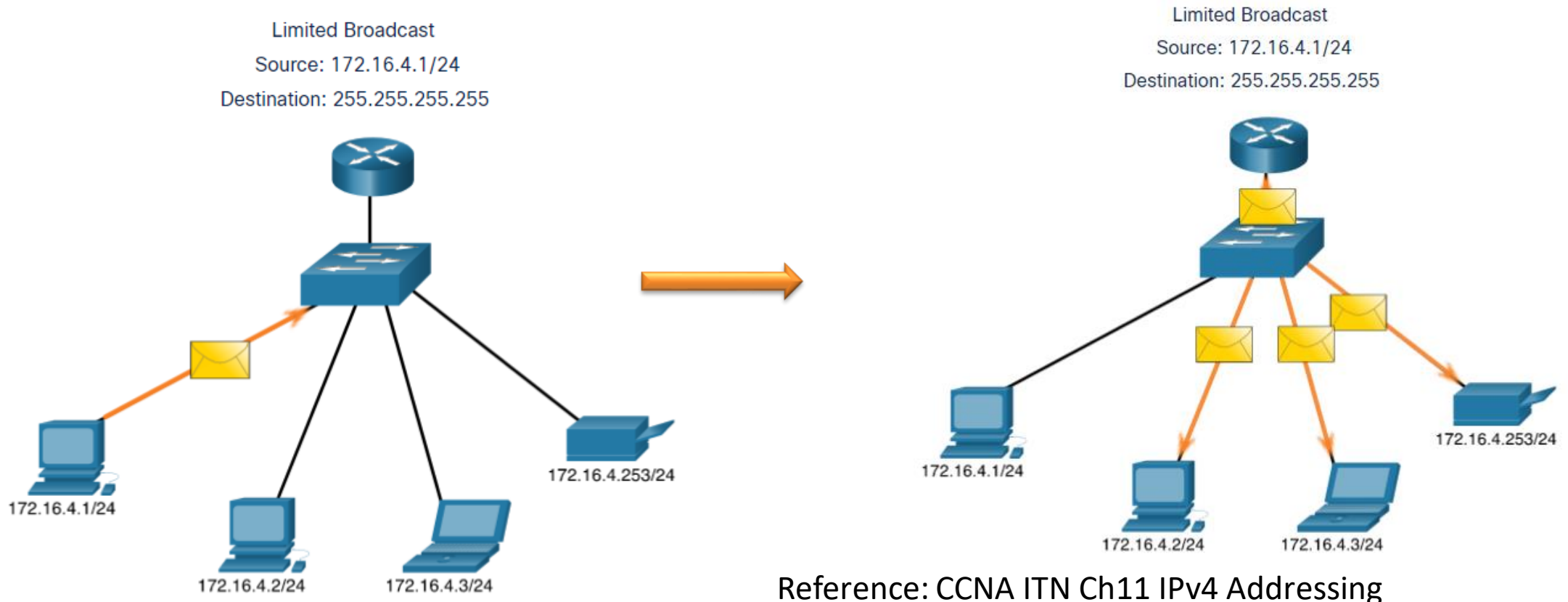
- Unicast transmission is sending a packet to one destination IP address.
- For example, the PC at 172.16.4.1 sends a unicast packet to the printer at 172.16.4.253.



Reference: CCNA ITN Ch11 IPv4 Addressing

Broadcast IPv4 Address

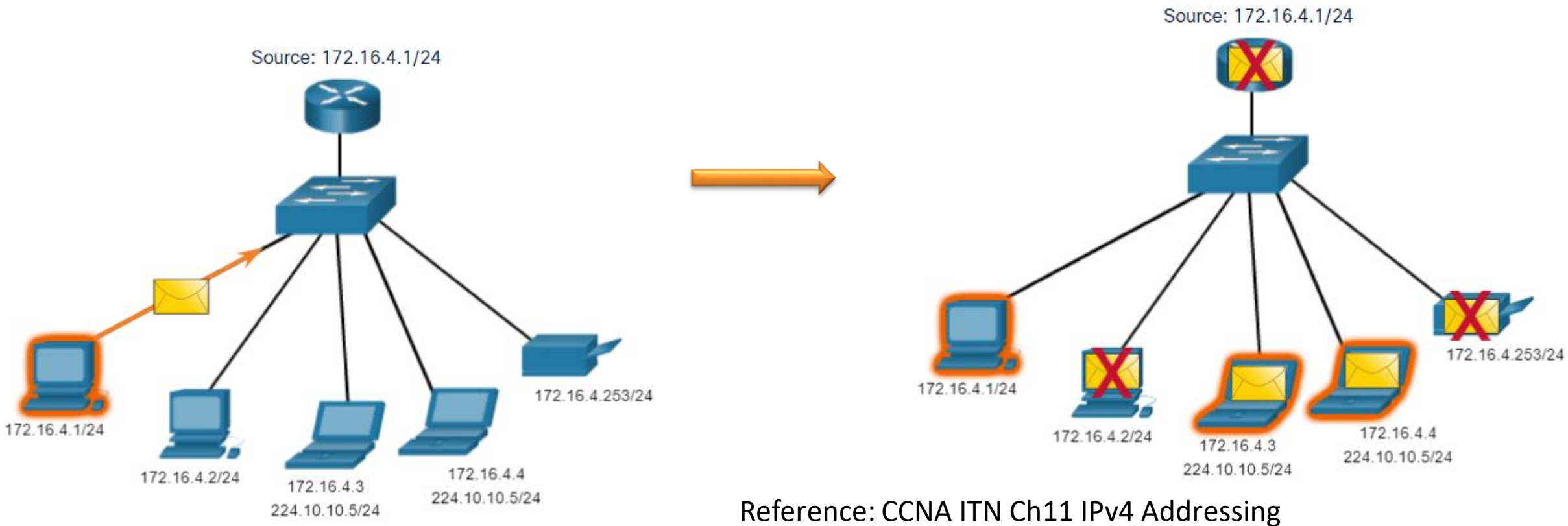
- Broadcast transmission is sending a packet to all other destination IP addresses.
- For example, the PC at 172.16.4.1 sends a broadcast packet to all IPv4 hosts.



Reference: CCNA ITN Ch11 IPv4 Addressing

Multicast IPv4 Address

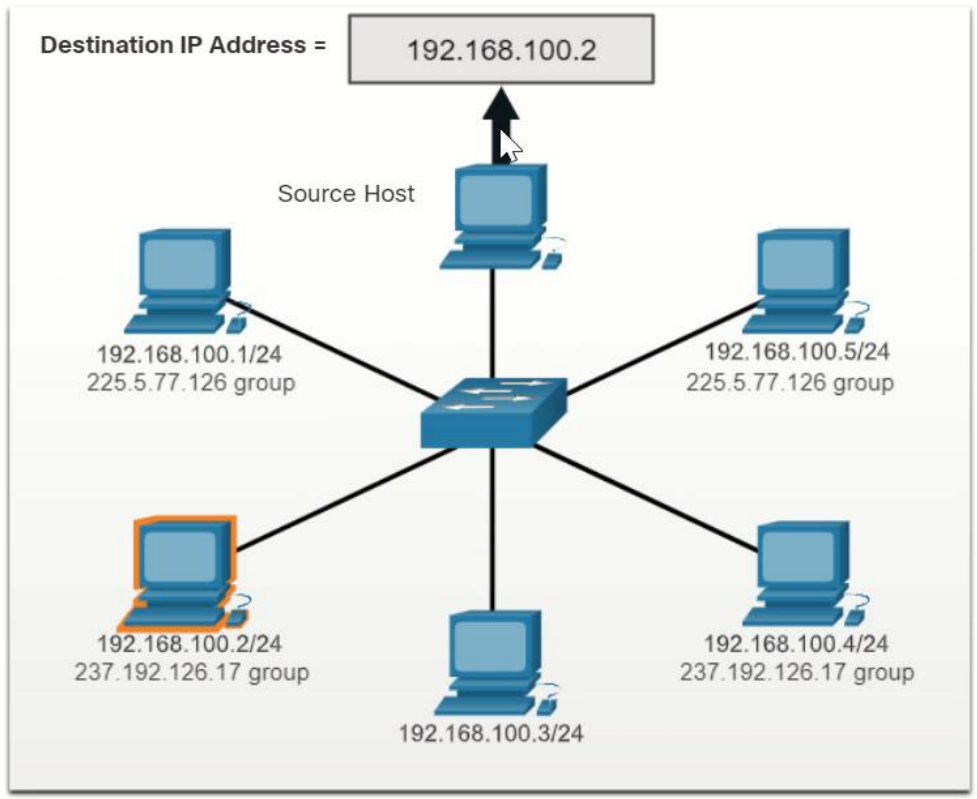
- Multicast transmission is sending a packet to a multicast address group.
- For example, the PC at 172.16.4.1 sends a multicast packet to the multicast group address 224.10.10.5.



Reference: CCNA ITN Ch11 IPv4 Addressing

Activity Check

Click Start to see a destination IP address. Next, click the host or hosts which will receive a packet based on the address type (unicast, broadcast, or multicast). Click **Check** to verify your answer. Click **New Problem** again to get a new problem.



New Problem | Check

Summary – IPv4 Addresses in a network

- Analyzed host address, broadcast and network address in a network
- Examined Unicast, Broadcast and Multicast IPv4 addresses in a activity also
- Next, we shall discuss IPv4 address types including public or private IP address

Types of IPv4 Addresses

Reference: CCNA ITN Module 11.3
Types of IPv4 addresses

Objectives – Types of IPv4 Addresses

- Understand and Analyze Public and Private IPv4 Addresses
- Routing to the Internet
- Special use IPv4 Addresses
- Understand and Evaluate class A, B, C in Legacy Classful Addressing
- Assignment of IP Addresses

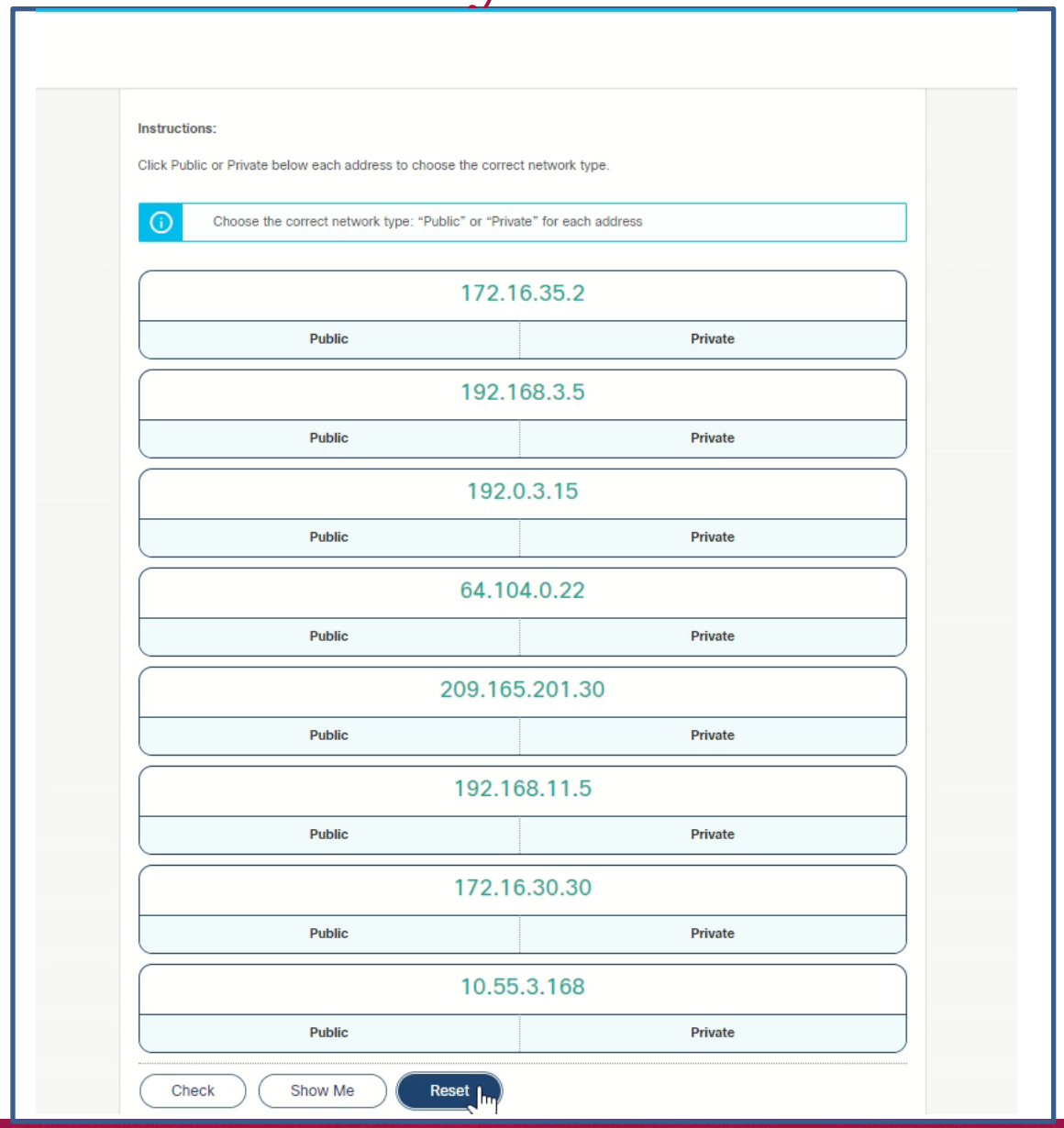
Public and Private IPv4 Addresses

- As defined by IETF in RFC, Public IPv4 addresses are globally routed between internet service provider (ISP) routers.
- Private addresses are common blocks of addresses used by most organizations to assign IPv4 addresses to internal hosts.
- Private IPv4 addresses are not unique and can be used internally within any network.
- However, private addresses are not globally routable.

Network Address and Prefix	RFC 1918 Private Address Range
10.0.0.0/8	10.0.0.0 - 10.255.255.255
172.16.0.0/12	172.16.0.0 - 172.31.255.255
192.168.0.0/16	192.168.0.0 - 192.168.255.255

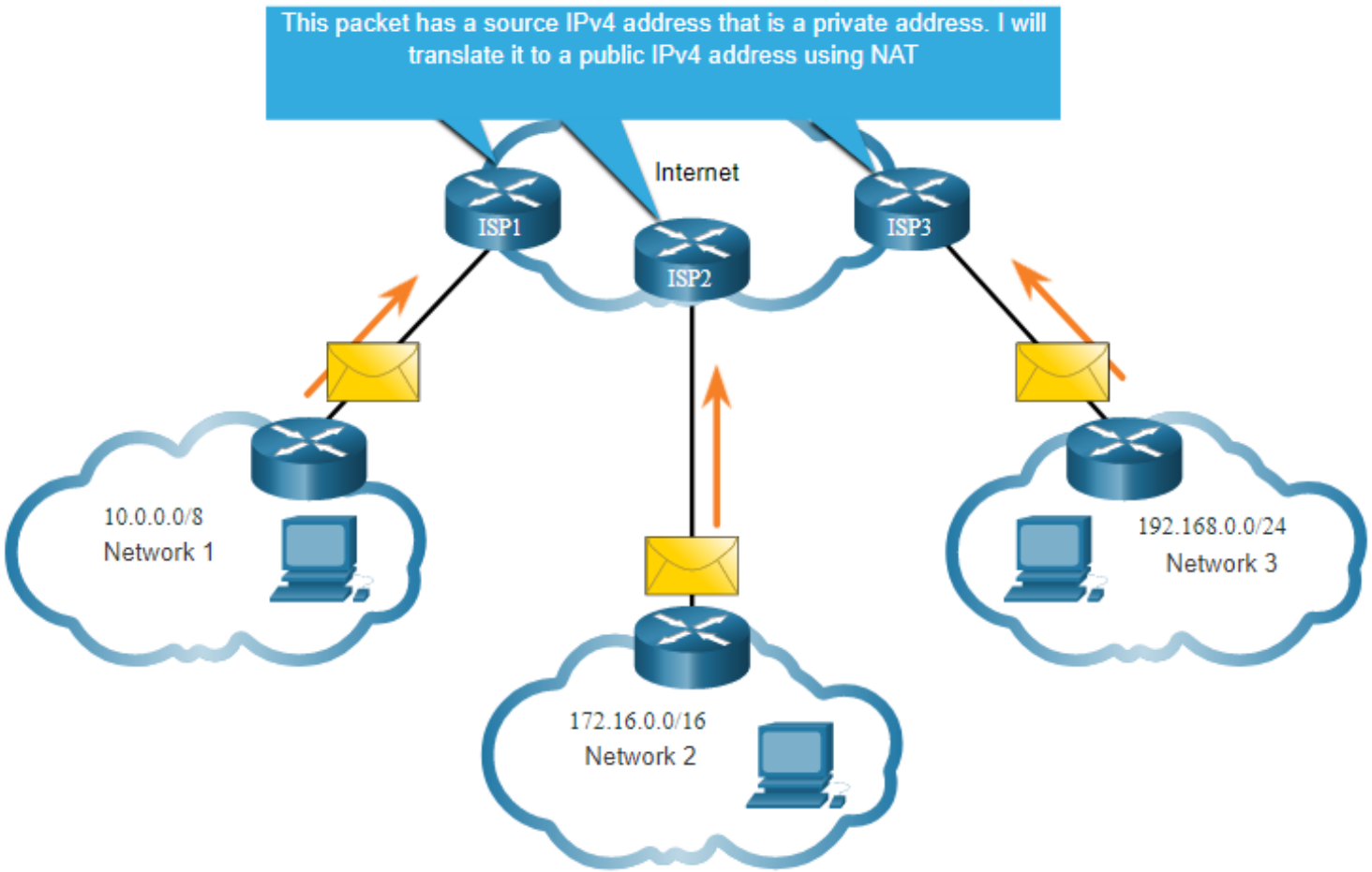
Reference: CCNA ITN Ch11 IPv4 Addressing

Activity check



Routing to the Internet

- Network Address Translation (NAT) translates private IPv4 addresses to public IPv4 addresses.
- NAT is typically enabled on the edge router connecting to the internet.
- It translates the internal private address to a public global IP address.



Reference: CCNA ITN Ch11 IPv4 Addressing

Special Use IPv4 Addresses

Loopback addresses

- 127.0.0.0 /8 (127.0.0.1 to 127.255.255.254)
- Usually identified as only 127.0.0.1
- Used to test if TCP/IP is operational.

```
C:\Users\NetAcad> ping 127.0.0.1
Pinging 127.0.0.1 with 32 bytes of data:
Reply from 127.0.0.1: bytes=32 time<1ms TTL=128
Reply from 127.0.0.1: bytes=32 time<1ms TTL=128
```

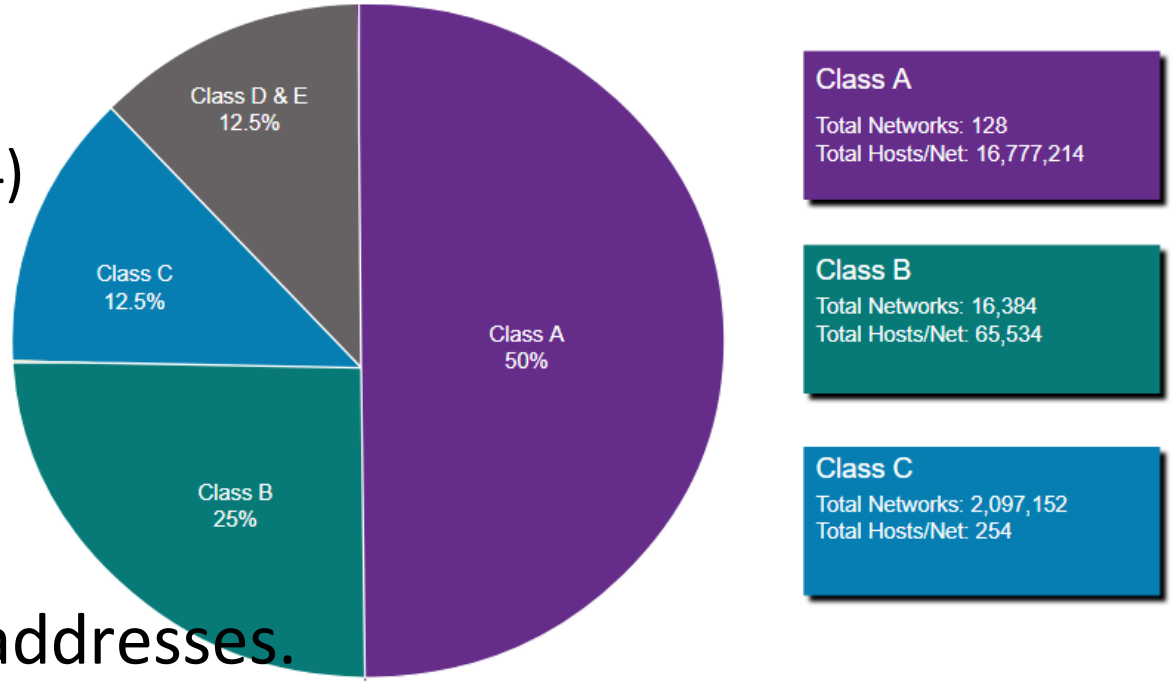
Link-Local addresses

- 169.254.0.0 /16 (169.254.0.1 to 169.254.255.254)
- Commonly known as the Automatic Private IP Addressing (APIPA) addresses or self-assigned addresses.
- Used by Windows DHCP clients to self-configure when no DHCP servers are available.

Reference: CCNA ITN Ch11 IPv4 Addressing

Legacy Classful Addressing

- RFC 790 (1981) allocated IPv4 addresses in classes
  - Class A (0.0.0.0/8 to 127.0.0.0/8)
  - Class B (128.0.0.0 /16 – 191.255.0.0 /16)
  - Class C (192.0.0.0 /24 – 223.255.255.0 /24)
  - Class D (224.0.0.0 to 239.0.0.0)
  - Class E (240.0.0.0 – 255.0.0.0)

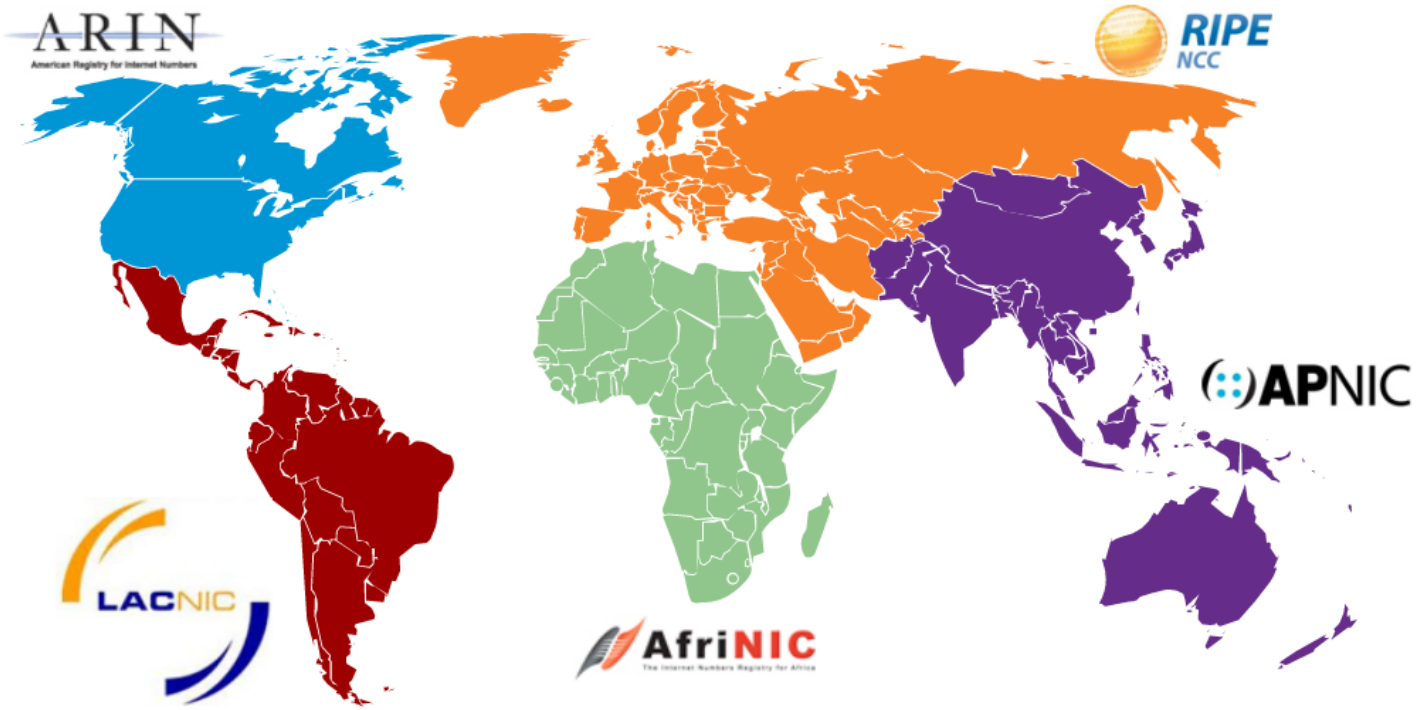


- Classful addressing wasted many IPv4 addresses.
- Classful address allocation was replaced with classless addressing which ignores the rules of classes (A, B, C).

Reference: CCNA ITN Ch11 IPv4 Addressing

Assignment of IP addresses

- The Internet Assigned Numbers Authority (IANA) manages and allocates blocks of IPv4 and IPv6 addresses to five Regional Internet Registries (RIRs).
- RIRs are responsible for allocating IP addresses to ISPs who provide IPv4 address blocks to smaller ISPs and organizations.



Reference: CCNA ITN Ch11 IPv4 Addressing

Summary – Type of IPv4 Addresses

- Classification of Public and Private IPv4 Addresses
- Routing using Network Address Translation (NAT)
- Special IPv4 Addresses
  - Loop back 127.0.0.1
  - Link Local 169.254.0.0/16
- Classful Vs Classless Addressing
- Assignment of IP Addresses by Regional Internet Registries (RIRs)

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