COMPUTER NETWORKS

SUBNETTING

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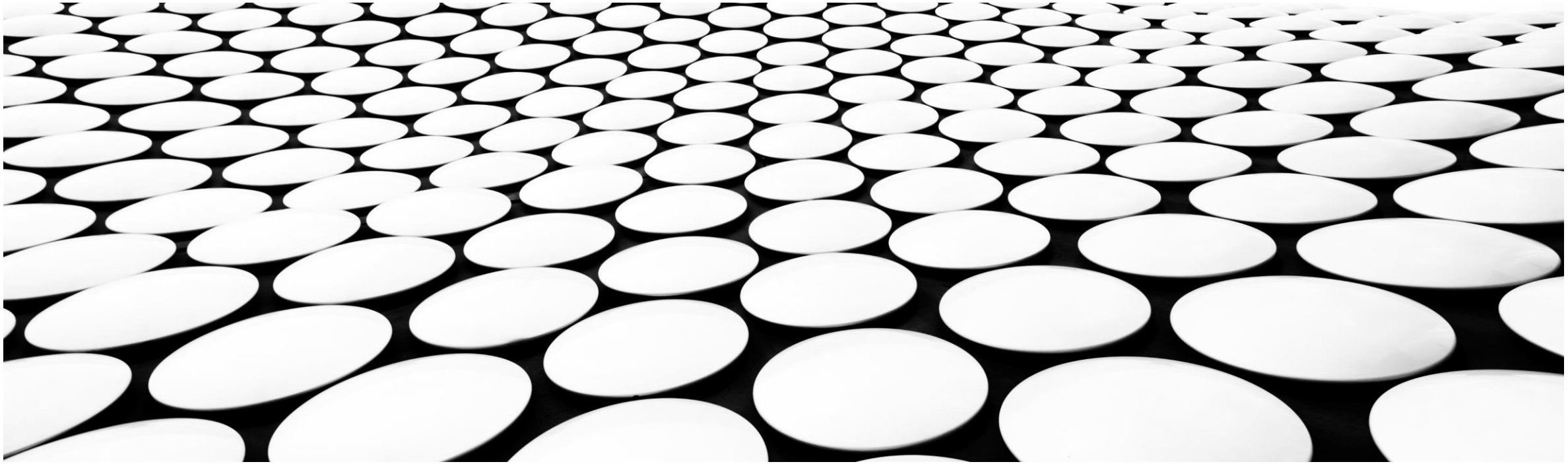


IP ADDRESS (IPV4)

- A unique 32-bit number
- Identifies an interface (on a host, on a router, …)
- Represented in dotted-quad notation (dotted decimal representation) (a.b.c.d)
  - » each quad is 8 bits or 1Byte (0-255 or 0x00-0xFF)
  - » e.g., 194.47.94.71

When we convert them in binary, we write them in terms of octave

IP ADDRESS AS NETWORK ADD AND HOST ADDRESS

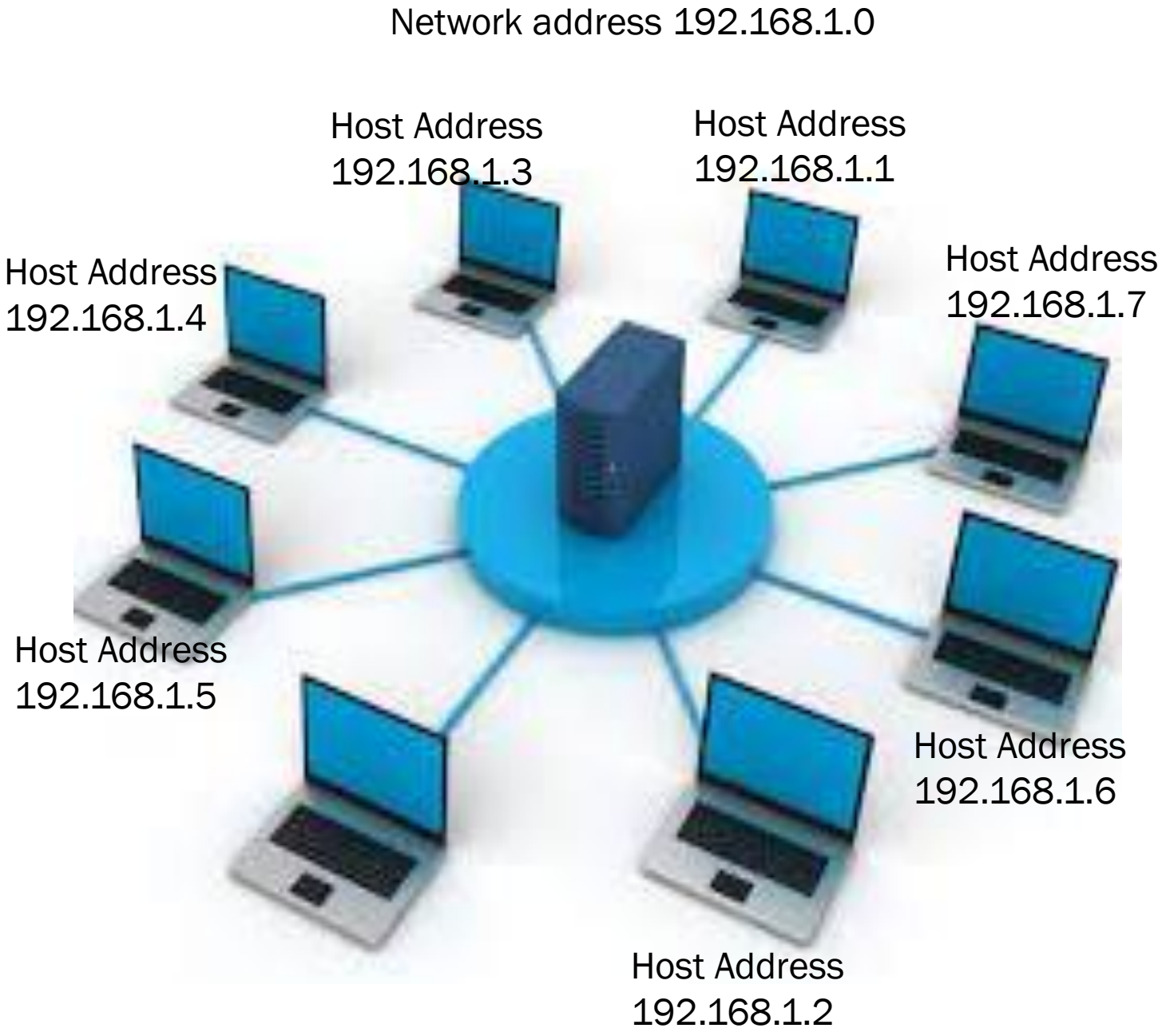
Before subnetting:

In any network (or subnet) one can use most of the IP addresses for host addresses.

Network Address - One address is reserved to that of the network.

Broadcast Address – One address is reserved to address all hosts in that network or subnet.

NET AND HOST ADDRESS



SUBNET MASK

- How do you decide network address part and host address part from the IP address
- Subnet mask: It helps in recognizing the how many bits in the IP address are used for network by masking them

	138.	**101.**	**114.**	**250**
IP Address	10001010	01100101	01110010	11111010
Subnet Mask	11111111	11111111	11111111	11000000
	255.	**255.**	**255.**	**192**

STEP 1: CONVERT TO BINARY

8 bit Octet chart	128	64	32	16	8	4	2	1	
	1	0	0	0	1	0	1	0	138

Network Address	138.	101.	114.	250
	10001010	01100101	01110010	11111010

STEP 1: CONVERT TO BINARY

128	64	32	16	8	4	2	1

	192.	**168.**	**1.**	**0**
IP Address	11000000	10101000	00000001	00000000
Mask	11111111	11111111	11111111	00000000
	255.	**255.**	**255.**	**0**

Step 1:

Translate Host IP Address and Subnet Mask into binary notation

STEP 2: FIND THE SUBNET ADDRESS

	192.	**168.**	**1.**	**0**
IP Address	11000000	10101000	00000001	00000000
Mask	11111111	11111111	11111111	00000000
	255.	**255.**	**255.**	**0**

Network Part	Host part

Step 2:

Determine the Network (or Subnet) where this Host address lives:

1. Draw a line under the mask
2. Perform a bit-wise AND operation on the IP Address and the Subnet Mask

   Note: 1 AND 1 results in a 1, 0 AND anything results in a 0
3. Express the result in Dotted Decimal Notation
4. The result is the Subnet Address of this Subnet or "Wire" which is 192.168.1.0

STEP 2: FIND THE SUBNET ADDRESS

	138.	101.	114.	250
IP Address	10001010	01100101	01110010	11111010
Mask	11111111	11111111	11111111	11000000
Network	10001010	01100101	01110010	11000000
	138	**101**	**114**	**192**

Step 2:

Determine the Network (or Subnet) where this Host address lives:

Quick method:

1. Find the last (right-most) 1 bit in the subnet mask.
2. Copy all of the bits in the IP address to the Network Address
3. Add 0's for the rest of the bits in the Network Address

STEP 2: FIND THE SUBNET ADDRESS

	172.	16.	1.	0
IP Address	10101100	00010000	00000001	00000000
Mask	11111111	11111111	00000000	00000000
Network	255	255	0	0
	10101100	00010000	01110010	11000000
	172	**16**	**1**	**0**

Network part

Host part

Step 2:

Determine the Network (or Subnet) where this Host address lives:

Quick method:

1. Find the last (right-most) 1 bit in the subnet mask.
2. Copy all of the bits in the IP address to the Network Address
3. Add 0's for the rest of the bits in the Network Address

STEP 2: FIND THE SUBNET ADDRESS

- 255.0.0.0
- 255.255.0.0
- 255.255.255.0
- It is easy to find the network add and host address with default subnet mask
- Now lets examine the case of
- 255. 255. 224.0

COMPLEX SUBNET MASK

Subnet Mask	11111111	11111111	11100000	00000000
	255.	**255.**	**224.**	**0**

COMPLEX SUBNET MASK

IP	**172** 10101100	**16** 00010000	**1** 00000001	**0** 00000000
Subnet Mask	11111111	11111111	11100000	00000000

172 10101100	**16** 00010000	**1** 00000001	**0** 00000000

Network add

Host add

WHY DO A NETWORK HAS NETWORK AND HOST ADDRESS?

- Why do not a network assign unique IP addresses to all devices in the network
- This is for breaking down a large netwok into smaller subnetworks which is called subnetting

SUBNETTING

- It is performed by varying the default subnet mask by borrowing some of the bits from the host part

SUBNETTING

Subnet Mask	11111111	11111111	11111111	00000000
	255	255	255	0

1 Network with 254 hosts

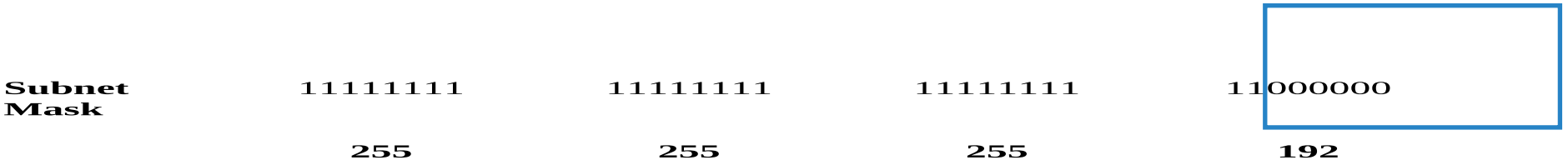
Lets borrow one bit from host part, 1 bit can represent two subnetwork

Subnet Mask	11111111	11111111	11111111	10000000
	255	255	255	128

2 Networks with 126 hosts

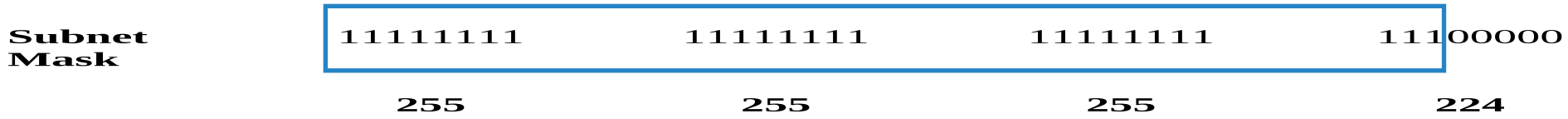
SUBNETTING

Lets borrow two bits from host part, 2 bit can represent four subnetwork



4 Networks with 62 hosts

Lets borrow 3 bits from host part, 3 bit can represent 8 subnetwork



8 Networks with 30 hosts

SUBNETTING

Lets borrow 4 bits from host part, 4 bit can represent 16 subnetwork

Subnet Mask	11111111	11111111	11111111	11110000
	255	**255**	**255**	**240**

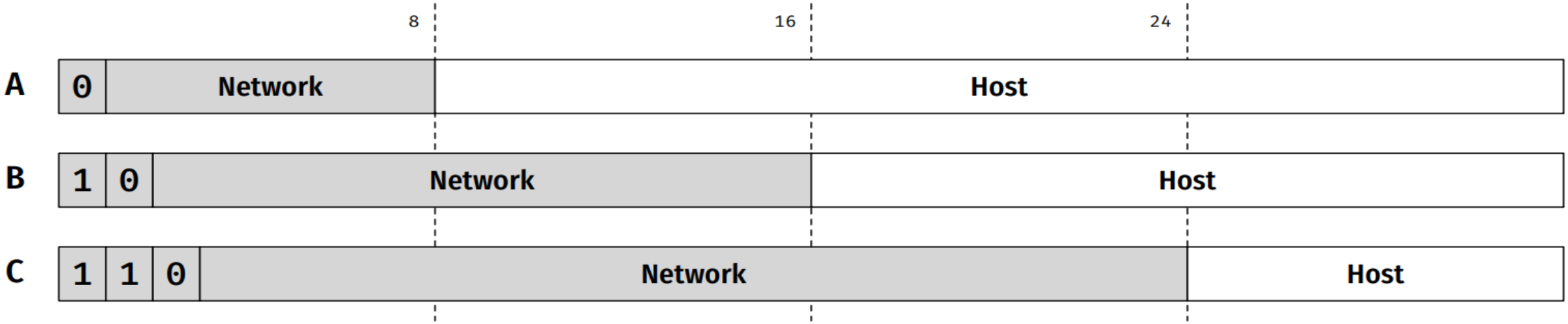
16 Networks with 14 hosts

Lets borrow 5 bits from host part, 5 bit can represent 32 subnetwork

Subnet Mask	11111111	11111111	11111111	11111000
	255	**255**	**255**	**252**

32 Networks with 6 hosts

CLASS-BASED ADDRESSING TO RESOLVE THE SCALABILITY ISSUE

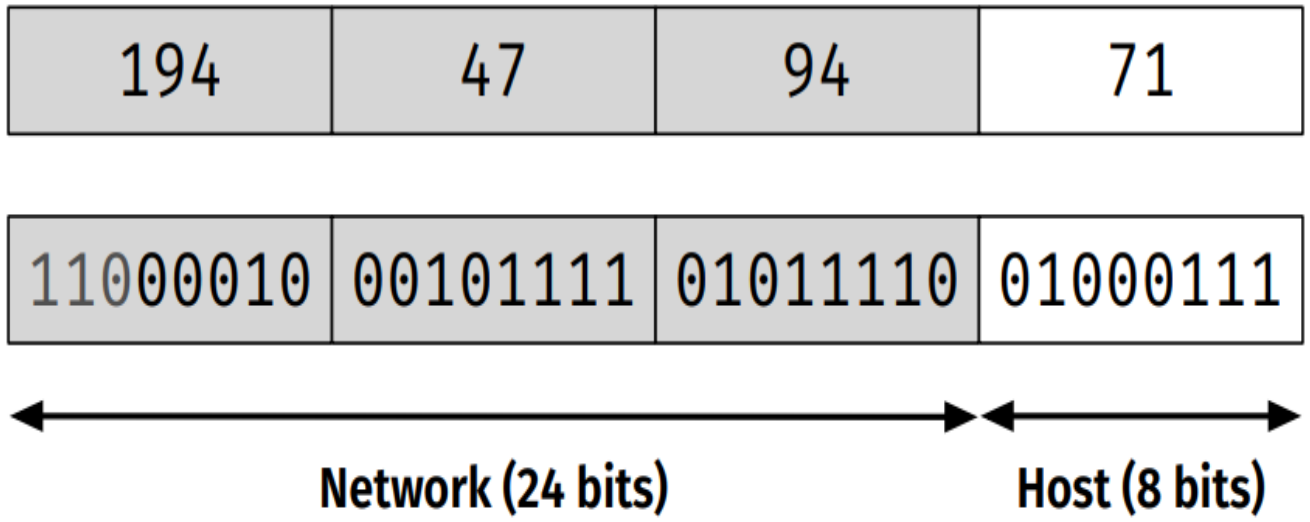


Class-based Addressing (RFC791) Address Formats:

High Order Bits	Format	Class
0	7 bits of net, 24 bits of host	a
10	14 bits of net, 16 bits of host	b
110	21 bits of net, 8 bits of host	c
111	escape to extended addressing mode	

HIERARCHICAL ADDRESSING: IP PREFIXES

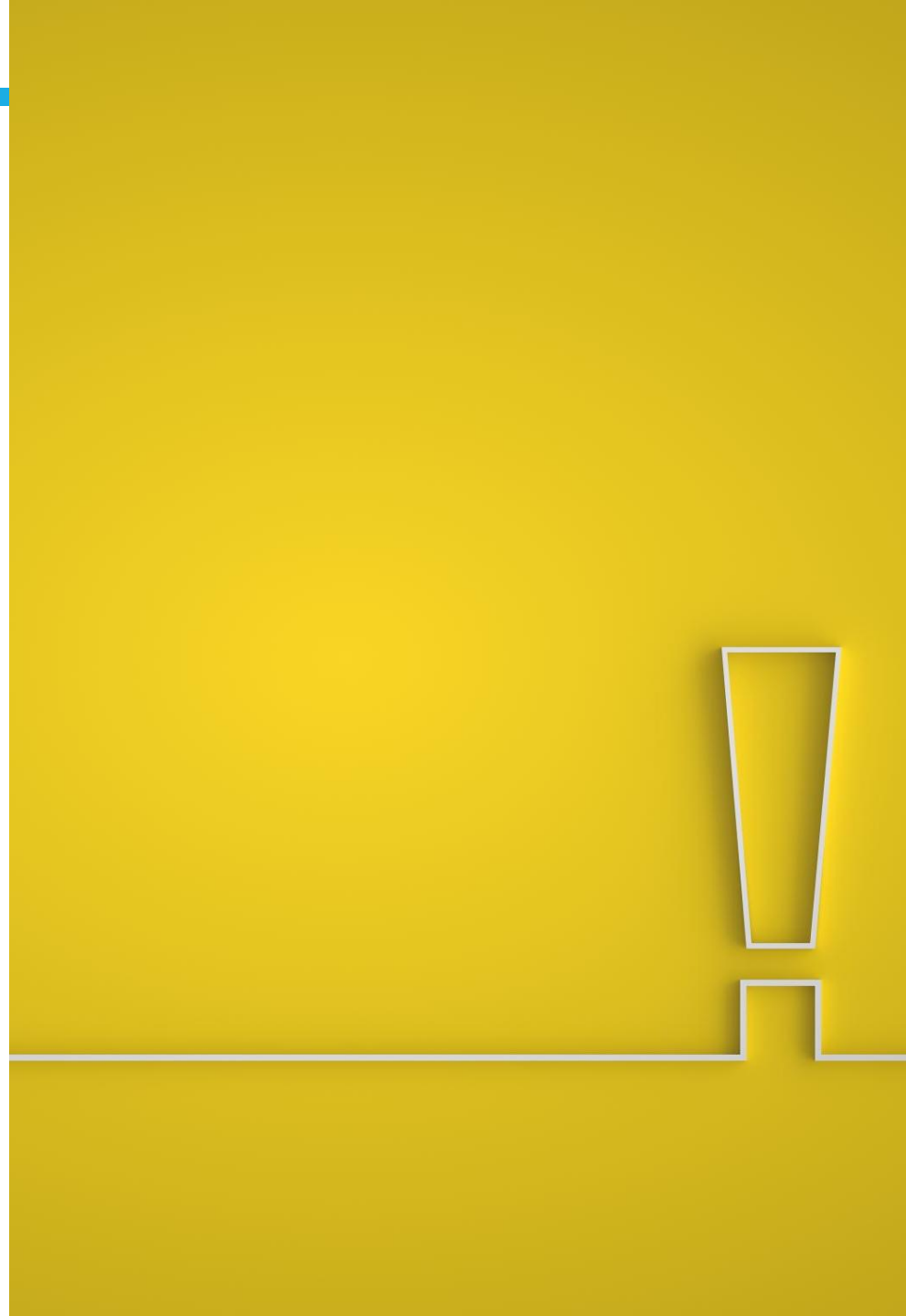
IP addresses can be divided into two parts: network (left) and host (right)



194.47.94.0/24 is a 24-bit prefix (class C) which covers 28 addresses (e.g., up to 255 hosts)

IP ADDRESS PROBLEM (1991)

- Class A, B and C all ranges from 24 to 8 bits address, which is not sufficient for the bigger network



CLASSLESS INTERDOMAIN ROUTING (CIDR), OR CIDR ADDRESS ASSIGNMENT STRATEGY OR SLASH NOTION

- Slash notation is the shortest way to write the subnet mask.
- With forward slash it shows number of 1's in the subnet mask
- 192.168.1.0/24 , i.e subnet mask has 24 1's (11111111 . 11111111. 11111111. 00000000)
- 192.168.1.0/25 , i.e subnet mask has 25 1's (11111111 . 11111111. 11111111. 10000000)
- 192.168.1.0/1 , i.e subnet mask has 25 1's (11111111 . 00000000. 00000000. 00000000)

In this way an organization can create multiple subnets within the allocated IP address space.