

Computer Network & Network Design

Module 3

Network Layer

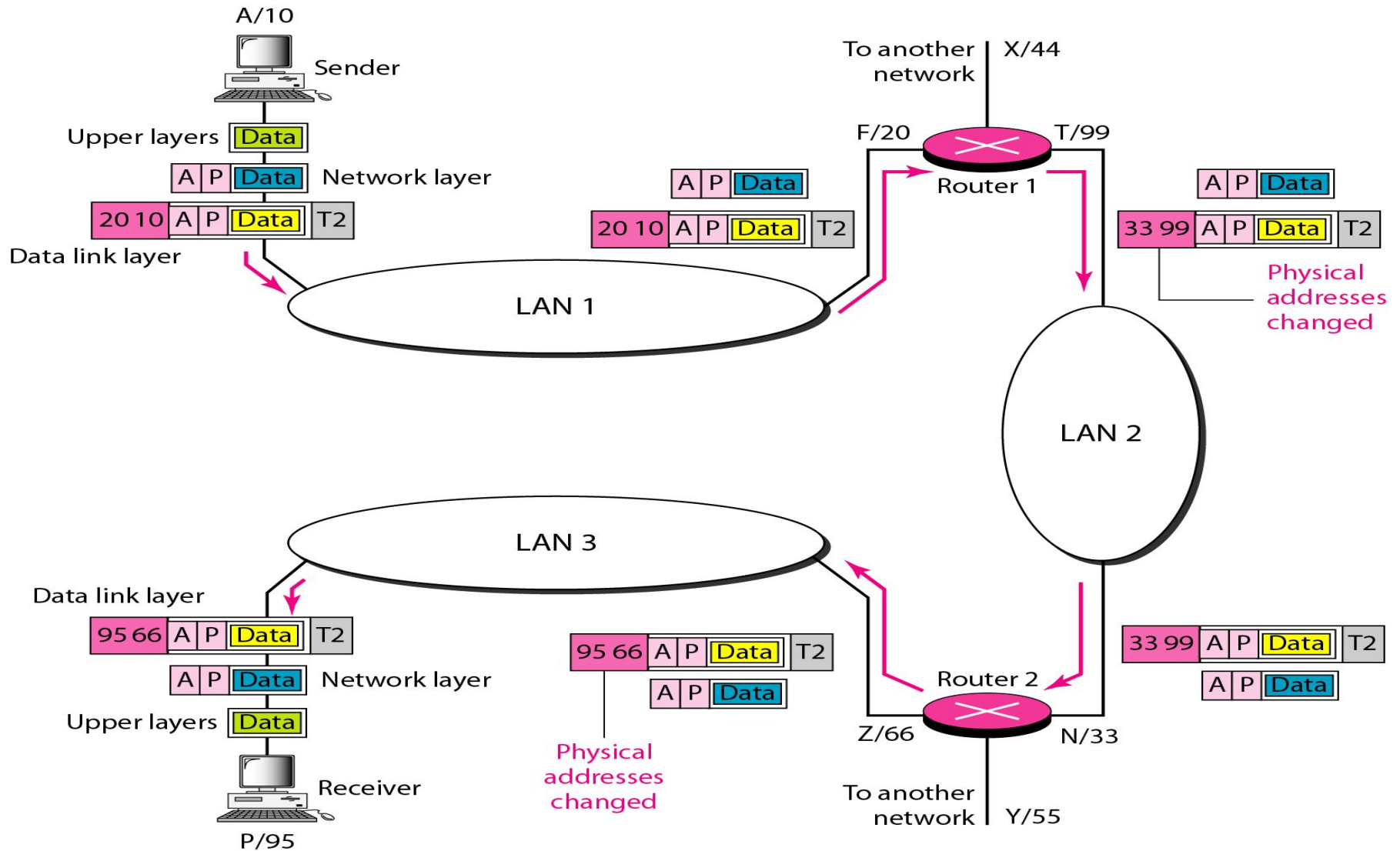
Lecture 16



Network Layer Design Issues

- Responsible for **source to destination** delivery of data
- To reach to destination, data might take **many hops** through the network
- Specific Responsibilities:
 - **Logical Addressing**: every station on the network will have an address, through which it become accessible to every other device on the network.
 - **Routing**: for source to destination delivery of data, the network layer must know the topology of the network (devices and router connections) and should be able to choose appropriate paths through it.

Logical addressing in Network Layer

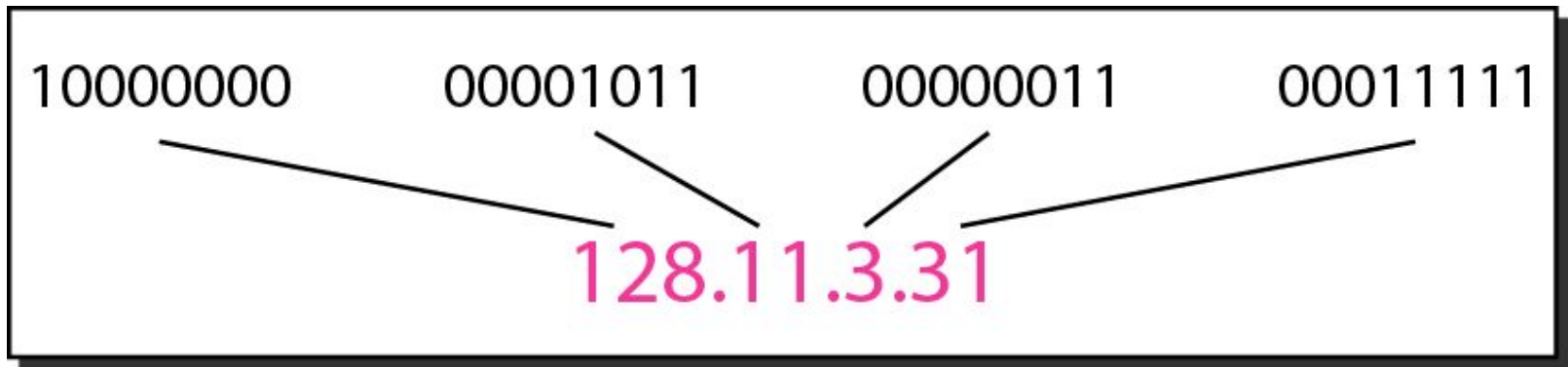


Network Layer: Logical Addressing

- Communication at the network layer is host to host (computer to computer)
- A computer somewhere in the world needs to communicate with another computer somewhere else. In today's world these computers communicate through Internet.
- The packets transmitted by sender may pass through several LANs or WANs before reaching to the destination. Thus we need addressing (Logical Addressing)
- Today, we use the term IP address to mean a logical address in the network layer of the TCP/IP protocol suite.

Internet Addresses

- The Internet addresses are **32 bit** in length (**$\max 2^{32} = 4,294,967,296$ addresses**)
- **Notations:**
 - **Binary Notation:** written as 4 different bytes
 - **Dotted Decimal Notation:** written in decimal form with a decimal point separating the bytes. Number very from 0 to 255

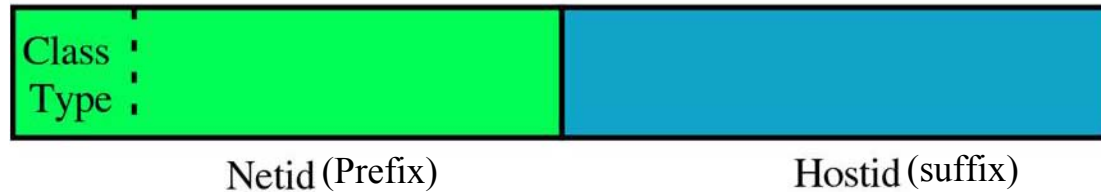


Internet Addresses- examples

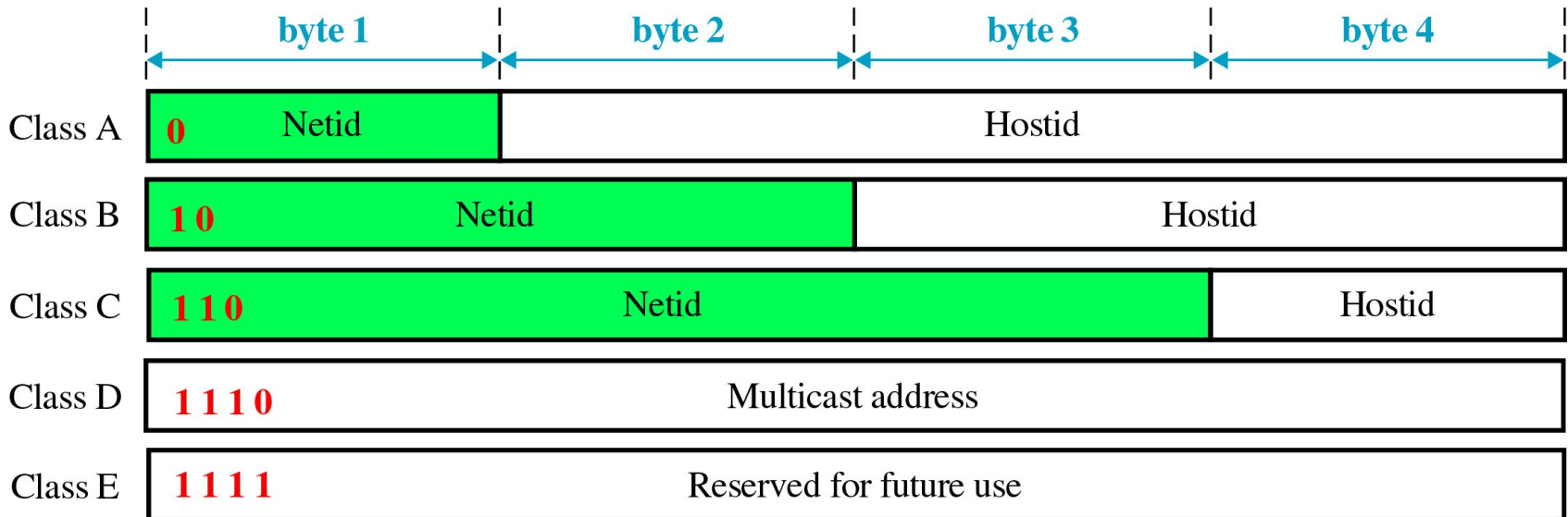
- 111.56.045.78 → Wrong, decimal number should not be preceded by 0
 - 221.34.7.8.20 → Wrong, not more than four decimal fields
 - 75.45.301.14 → Wrong, decimal number should be between 0 and 255
 - 11100010.23.14.67 → Wrong, mixture of two notations is not allowed
-

Internet Addresses- classes

- Each Internet address is defined by two fields: **netid** (includes **class type**) and **hostid**



- These parts vary in length depending upon the class of address



Finding the classes in binary and dotted-decimal notation

	First byte	Second byte	Third byte	Fourth byte
Class A	0			
Class B	10			
Class C	110			
Class D	1110			
Class E	1111			

a. Binary notation

	First byte	Second byte	Third byte	Fourth byte
Class A	0–127			
Class B	128–191			
Class C	192–223			
Class D	224–239			
Class E	240–255			

b. Dotted-decimal notation

Class ranges of Internet Addresses

	From	To
Class A	<div><div>0.0.0.0</div><div>NetidHostid</div></div>	<div><div>127.255.255.255</div><div>NetidHostid</div></div>
Class B	<div><div>128.0.0.0</div><div>NetidHostid</div></div>	<div><div>191.255.255.255</div><div>NetidHostid</div></div>
Class C	<div><div>192.0.0.0</div><div>NetidHostid</div></div>	<div><div>223.255.255.255</div><div>NetidHostid</div></div>
Class D	<div><div>224.0.0.0</div><div>Group address</div></div>	<div><div>239.255.255.255</div><div>Group address</div></div>
Class E	<div><div>240.0.0.0</div><div>Undefined</div></div>	<div><div>255.255.255.255</div><div>Undefined</div></div>

Exercise

- Find the class of each address
 - 4.23.145.90
 - 227.34.78.7
 - 246.7.3.8
 - 129.6.8.4
 - 198.76.9.23
 - **Answers:**
 - **Class A**
 - **Class D**
 - **Class E**
 - **Class B**
 - **Class C**
-

Why Classes ?

- Different classes are designed to cover needs of different types of organizations.
 - E.g. Class A addresses are numerically lowest and is largest set of host addresses compared to others
 - Can be used in large organizations
 - **Exercise:**
 - How many Host Id's are available in,
 - Class A:
 - Class B:
 - Class C:
 - What is the Network address for Class A?
 - What is the default gateway address for Class A?
 - What is the default broadcast address for Class A?
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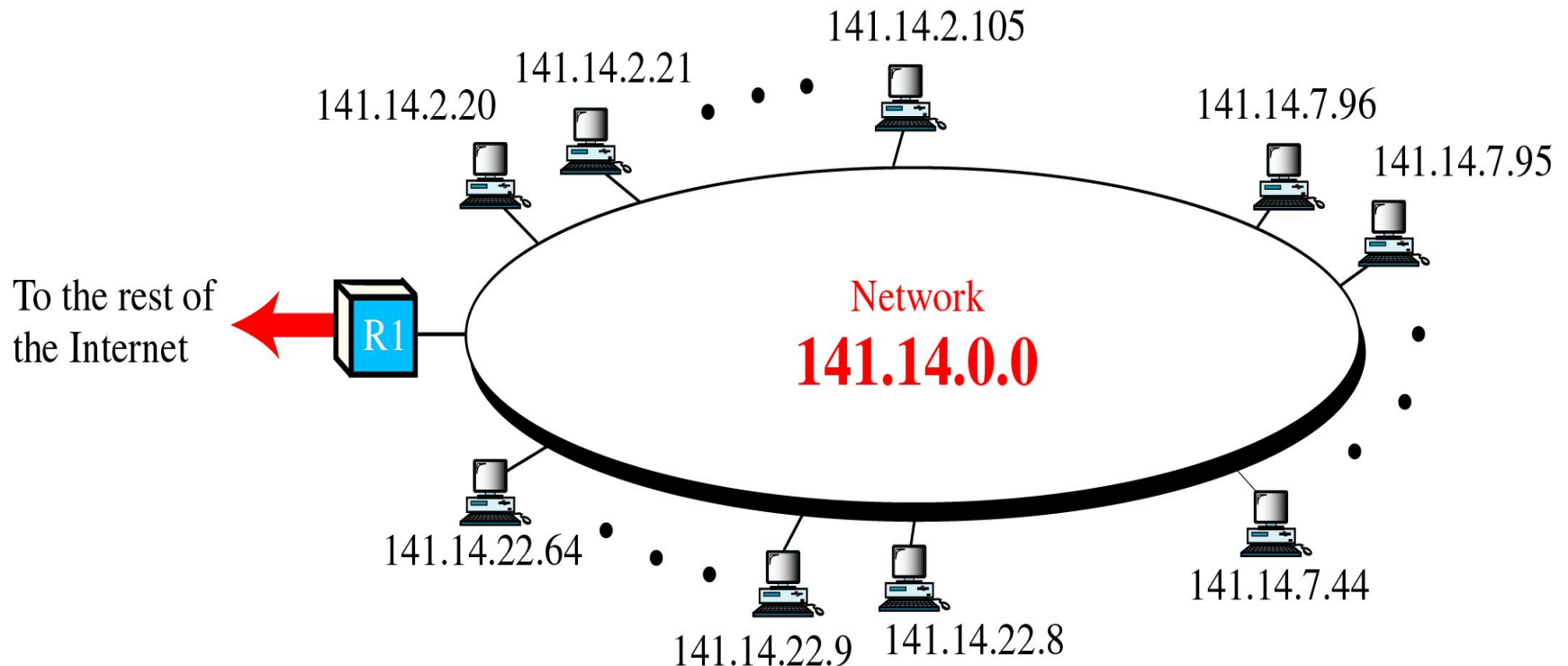
Lecture 17



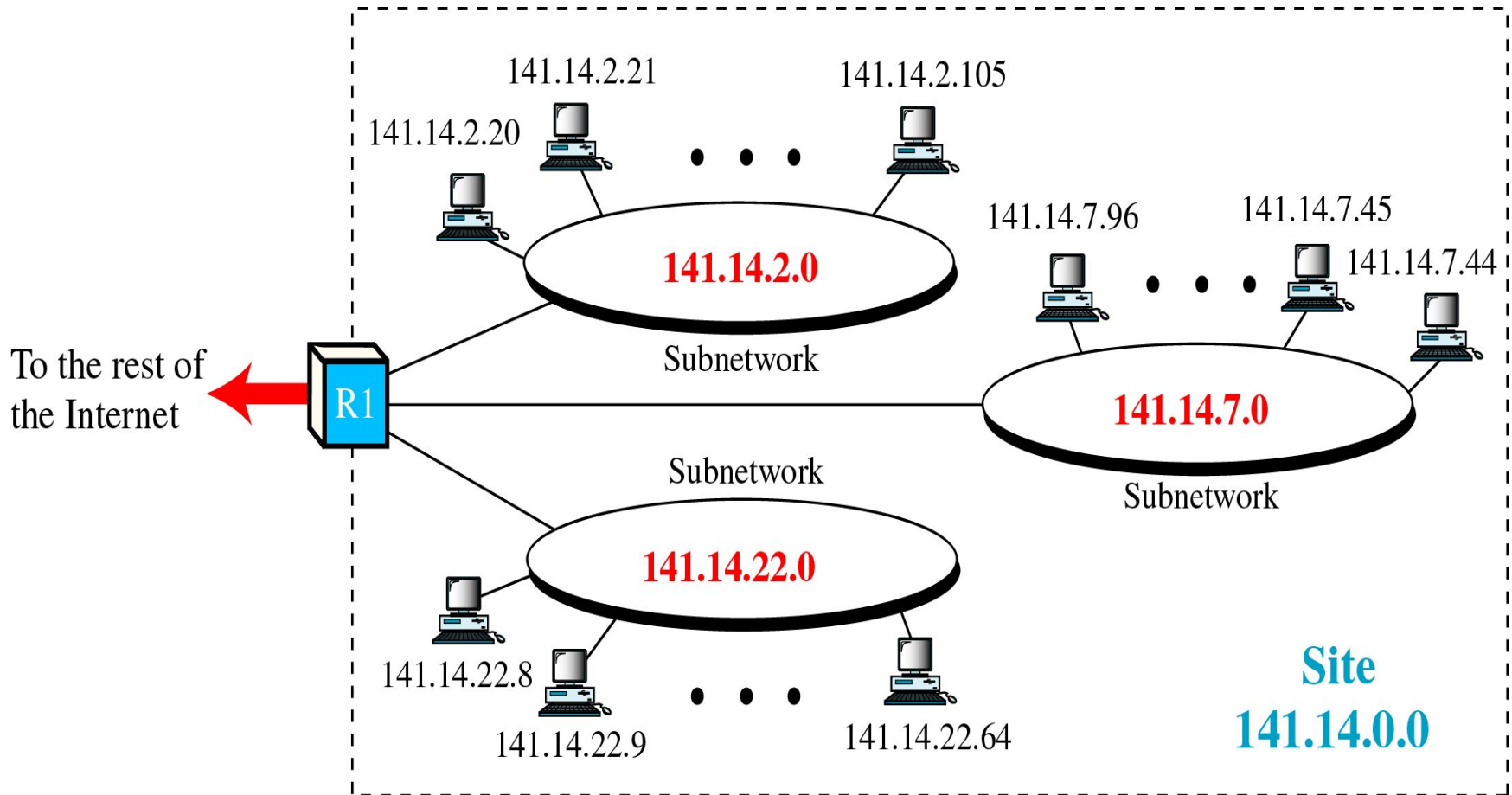
Concept of Subnetting

- An IP address contains two ID's
 - Network ID
 - Host ID
 - It follows the hierarchy of network followed by host.
 - To reach to a host on the Internet, we must first reach the network using **netid**. Then we must reach to the host using **hostid**.
 - This design of addresses is called “Two Levels of Hierarchy”
 - **has limitation** – The number of hierarchy levels are not enough
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A Network with Two Levels of Hierarchy



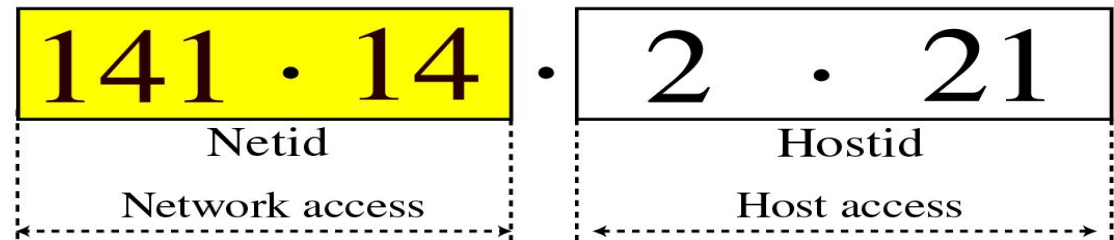
A Network with Three Levels of Hierarchy



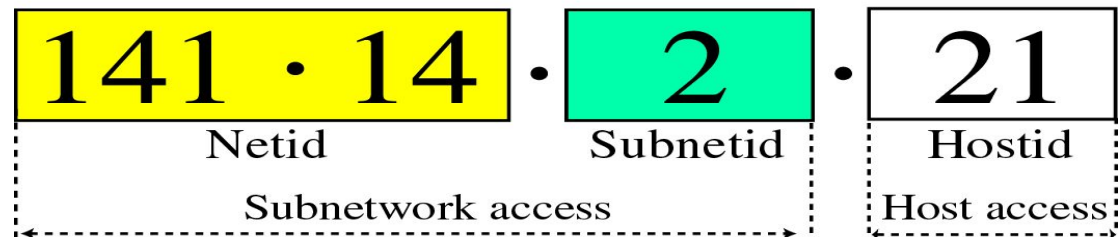
Three Levels of Hierarchy in an IP Address

- Adding subnetworks creates an **intermediate level** of hierarchy in the IP addressing system.
- Thus, the three levels are

- **Netid**
- **Subnetid**
- **Hostid**



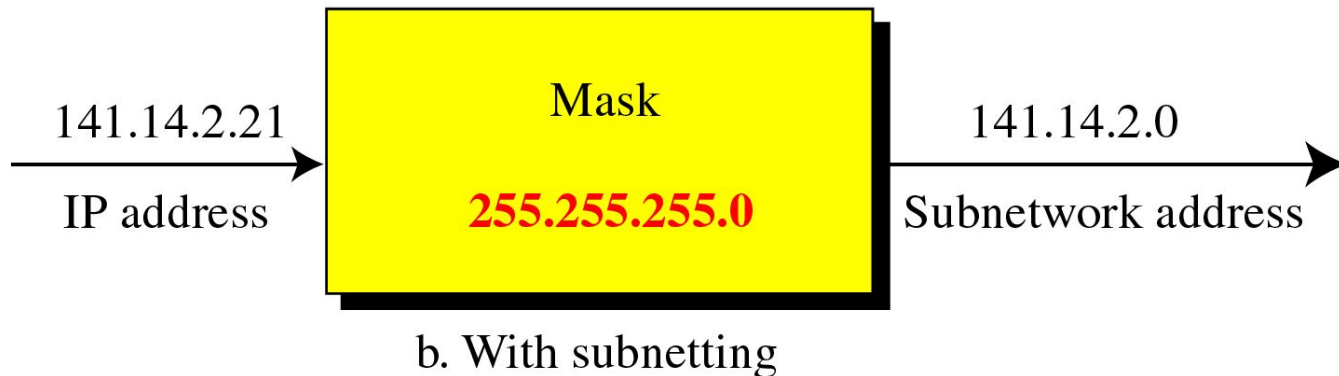
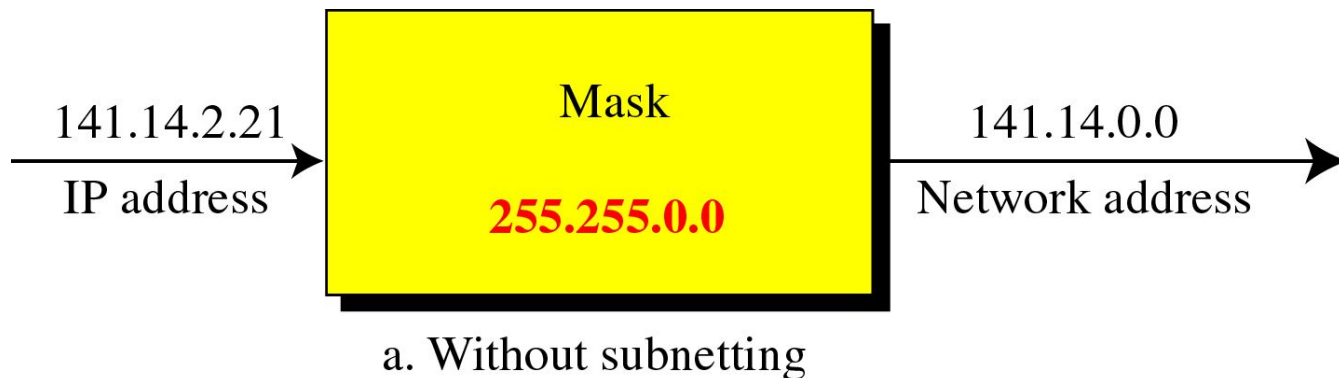
a. Without subnetting



b. With subnetting

Masking

- **Masking** is the process that **extracts** the **network address** from an IP address. Use **AND** operation.



Masking- without subnetting examples

Class	Mask	Address (Example)	Network Address
A	255.0.0.0	15.32.56.7	15.0.0.0
B	255.255.0.0	135.67.13.9	135.67.0.0
C	255.255.255.0	201.34.12.72	201.34.12.0
D	N/A	N/A	N/A
E	N/A	N/A	N/A

Masking- more examples

- For address 132.7.21.84 find the class and network address.

Ans:

Type of Network: Class B (ranges from 128.0.0.0 to 191.255.255.255)

Mask : 255.255.0.0

- A router receives the packet with destination address 190.240.34.95. if subnet mask is 19 (first 19 bits are 1's and rest are 0's) find subnet address.

Ans: **Given IP : 190.240.34.95**

Binary form : 10111110 11110000 00100010 01011111

Subnet Mask : 11111111 11111111 11100000 00000000

Subnet Addr : 10111110 11110000 00100000 00000000

Decimal notation: 190.240.32.0

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Masking- with & without subnetting

Class	Mask without subnetting	Mask with subnetting
A	255.0.0.0	255.255.0.0
B	255.255.0.0	255.255.255.0
C	255.255.255.0	?

Masking- subnetting examples

Class	Subnet Mask	Address (Example)	Subnetwork Address
A	255.255.0.0	15.32.56.7	15.32.0.0
B	255.255.255.0	135.67.13.9	135.67.13.0
C	255.255.255.192	201.34.12.72	201.34.12.64
D	N/A	N/A	N/A
E	N/A	N/A	N/A

Subnetting in Class C



Bits allocated for subnet from hostid	Hostid byte in Mask	Mask for extracting subnet addr	No. of subnets	No. of Hosts
1	1000 0000	255.255.255.128	$2^1=2$	$2^7=128$
2	1100 0000	255.255.255.192	$2^2=4$	$2^6=64$
3	1110 0000	255.255.255.224	$2^3=8$	$2^5=32$
4	1111 0000	255.255.255.240	$2^4=16$	$2^4=16$
5	1110 0000	255.255.255.224	$2^5=32$	$2^3=8$
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More exercises

1. Which of the following is a class A host address?

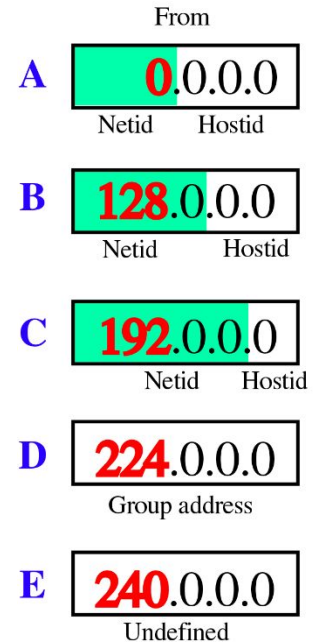
1. 128.4.5.6
2. 117.4.5.1
3. 117.0.0.0
4. 117.8.0.0

2. Which of the following is a class B host address?

1. 230.0.0.0
2. 130.4.5.6
3. 230.0.0.0
4. 30.4.5.6

3. Which of the following is a class C host address?

1. 230.0.0.0
2. 130.4.5.6
3. 200.1.2.3
4. 30.4.5.6



More exercises

- Find the netid and the hostid for each address
 - 4.23.145.90
 - 227.34.78.7
 - 246.7.3.8
 - 129.6.8.4
 - 198.76.9.23
 - Answers
 - Class A, netid:4.0.0.0, hostid bytes:23.145.90
 - Class D, no hostid, no netid
 - Class E, no hostid, no netid
 - Class B, netid: 129.6.0.0, hostid bytes: 8.4
 - Class C, netid: 198.76.9.0, hostid byte: 23
-

More exercises

1. Find the subnetwork address for the following:
 1. IP addr: 125.34.12.56, mask: 255.255.0.0
 2. IP addr: 120.14.22.16, mask: 255.255.128.0
 3. IP addr: 141.181.14.16, mask: 255.255.224.0

Ans:

4. **125.34.0.0**
 5. **120.14.0.0**
 6. **141.181.0.0**
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