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Network Layer & IPv4 (Part II)

รศ.ดร.อนันต์ ผลเพิ่ม

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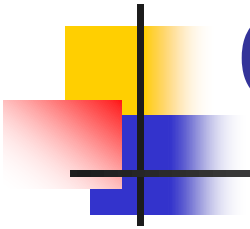
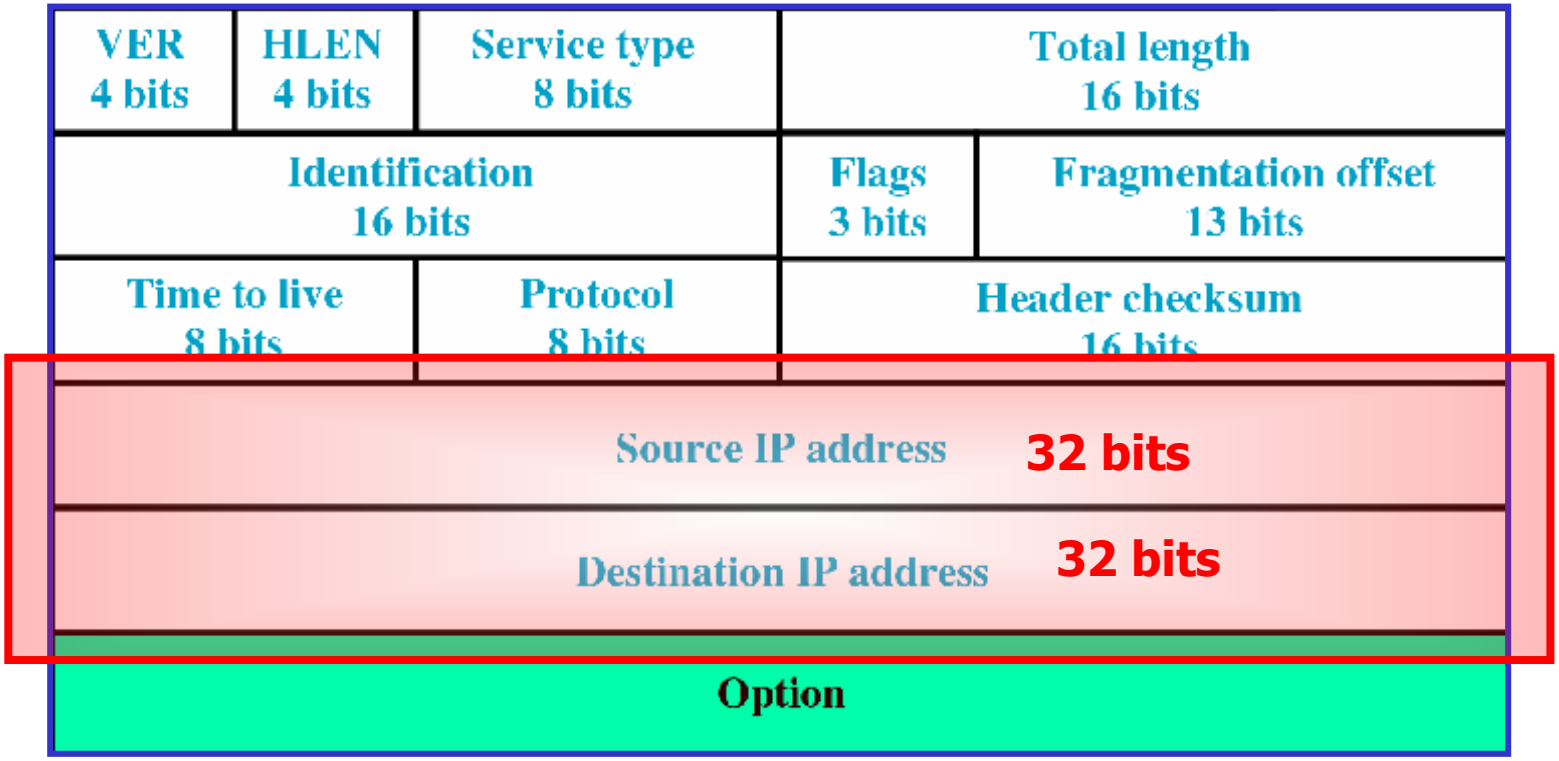
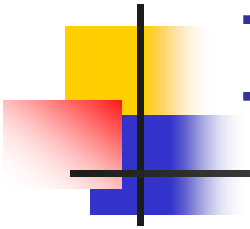


Outline

- Network Layer
- IP Fundamental Operation
- Internet Protocol
- Addressing

IP Address


VER
4 bits
HLEN
4 bits
Service type
8 bits
Total length
16 bits
Identification
16 bits
Flags
3 bits
Fragmentation offset
13 bits
Time to live
8 bits
Protocol
8 bits
Header checksum
16 bits
Source IP address
32 bits
Destination IP address
32 bits
Option



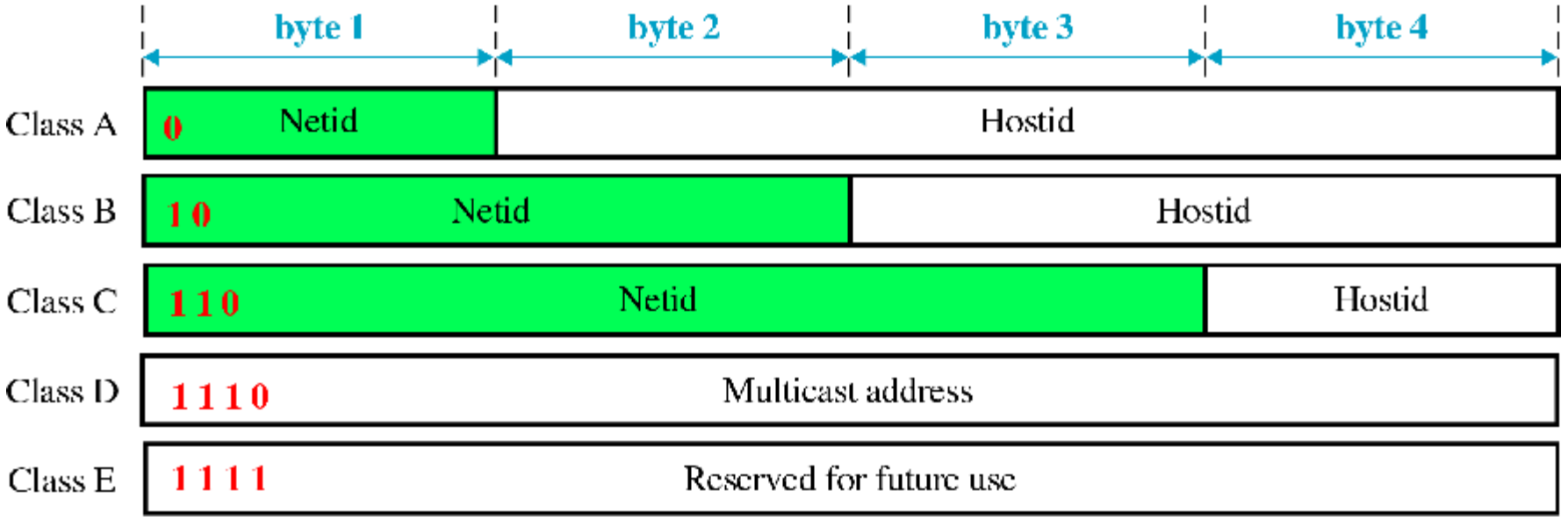
IP Address

- Address space of IPv4 (32 bits)
  - 232 = 4,294,967,296
- Unique and Universal
  - Local & Global Sense
- Assigned by National Registries
- Subset from Internet Corporation for Assigned Names and Number (ICANN)
- Does an IP address represent a machine ?

Internet Address

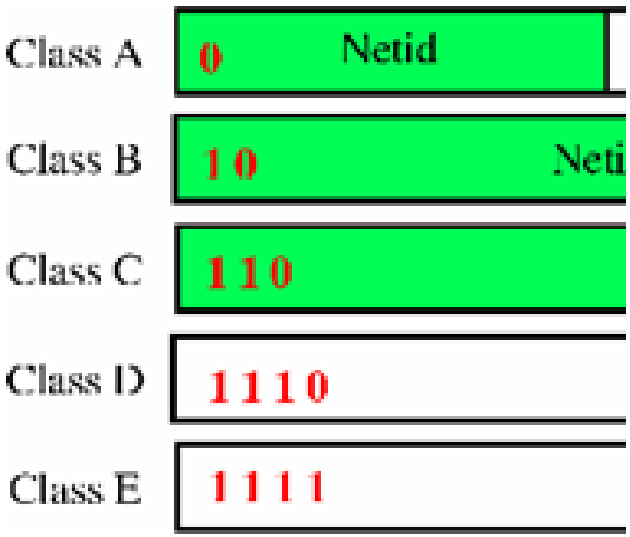
An Internet address is made of four bytes (32 bits) that define a host's connection to a network.

Internet Classes



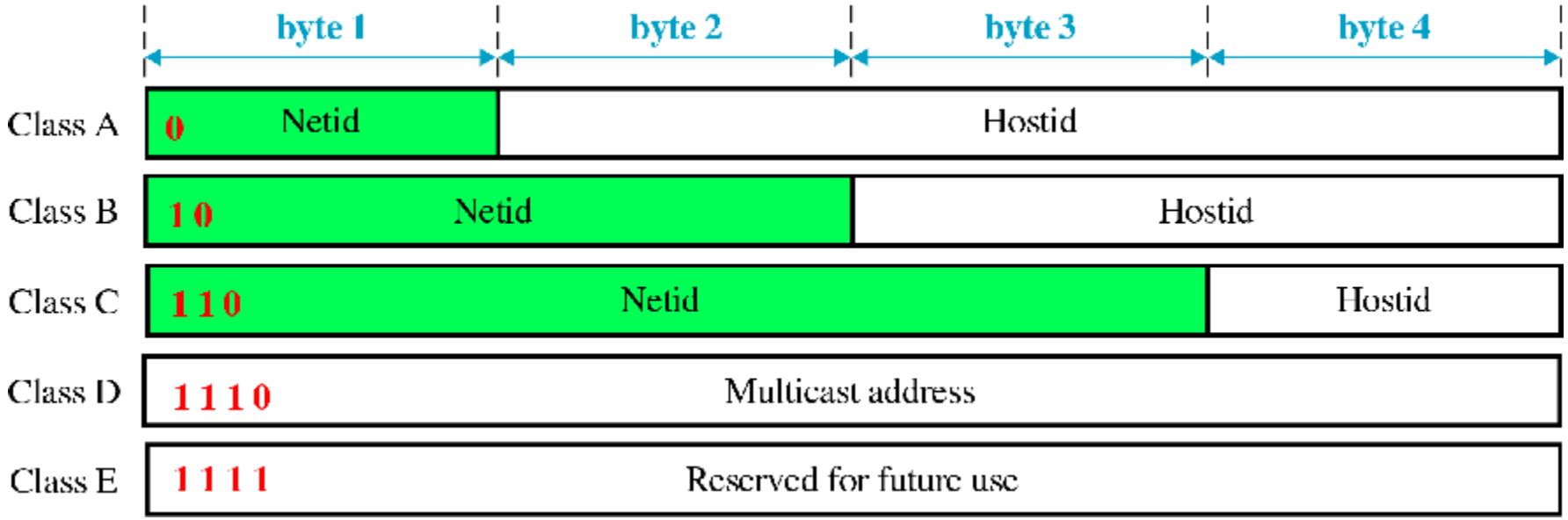
Classfull Addressing

IP Address Class



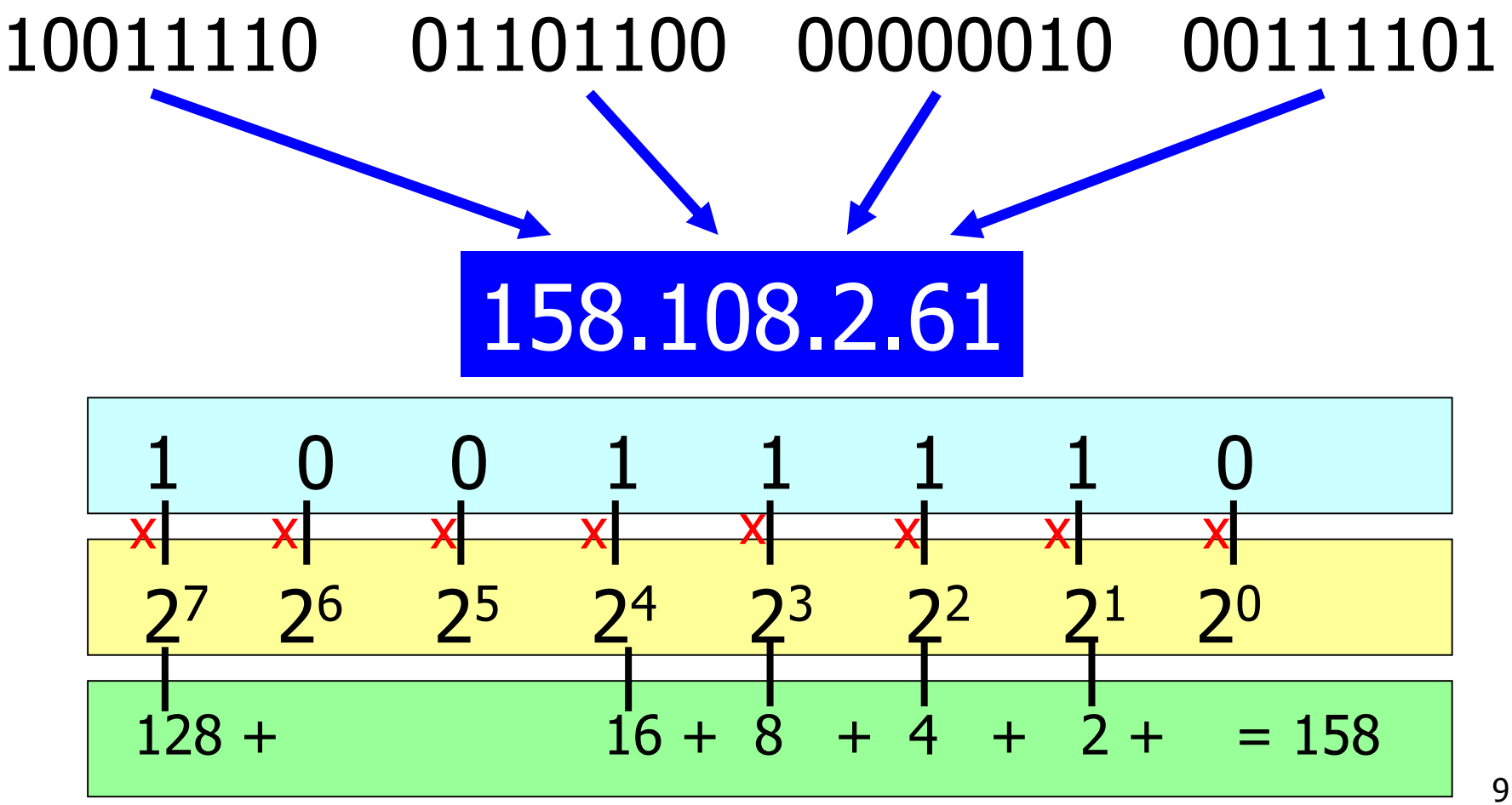
First Four Bits Of Address	Table Index (in decimal)	Class of Address
0000	0	A
0001	1	A
0010	2	A
0011	3	A
0100	4	A
0101	5	A
0110	6	A
0111	7	A
1000	8	B
1001	9	B
1010	10	B
1011	11	B
1100	12	C
1101	13	C
1110	14	D
1111	15	E

Amount of Networks and Hosts



Address Class	Bits In Prefix	Maximum Number of Networks	Bits In Suffix	Maximum Number Of Hosts Per Network
A	7	128	24	16777216
B	14	16384	16	65536
C	21	2097152	8	256

IP address in decimal notation



IP address practice

10011110 01101100 00100000 00010010

00001100 00011001 00000001 00010111

#1

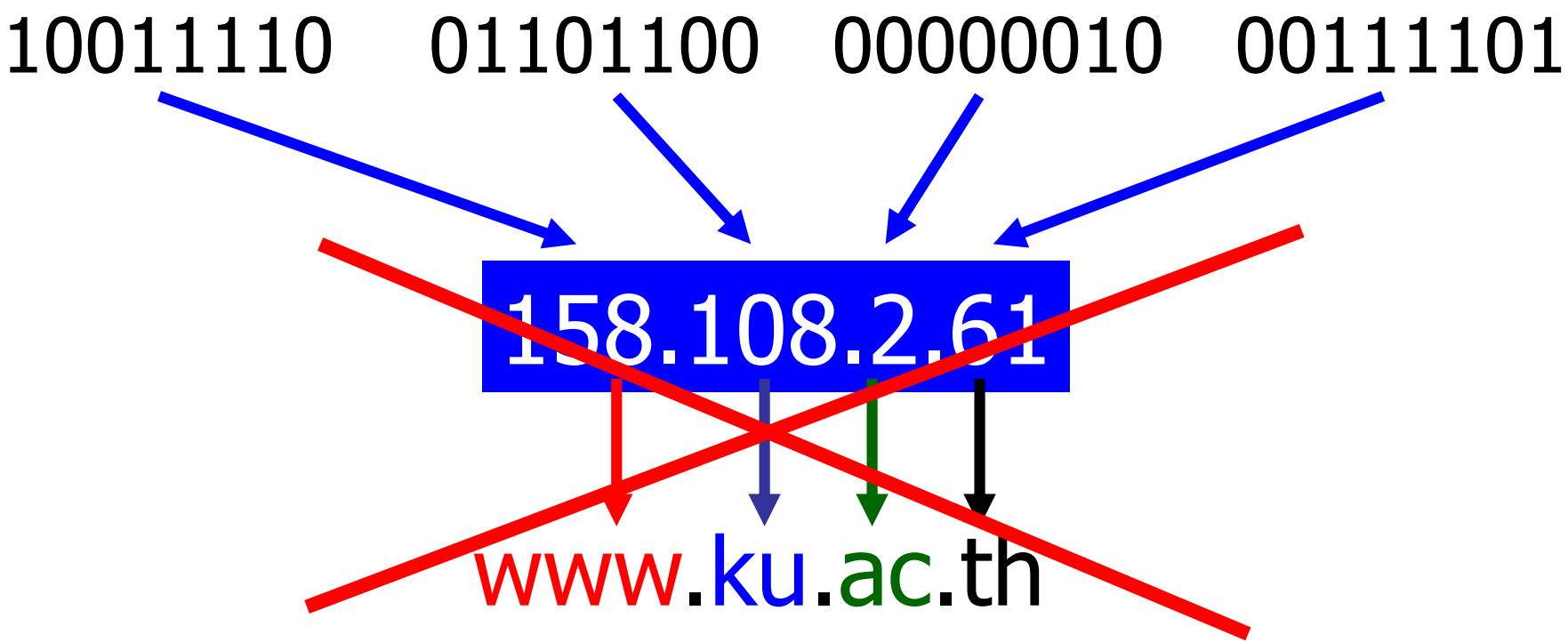
#2

#3

201.125.137.213

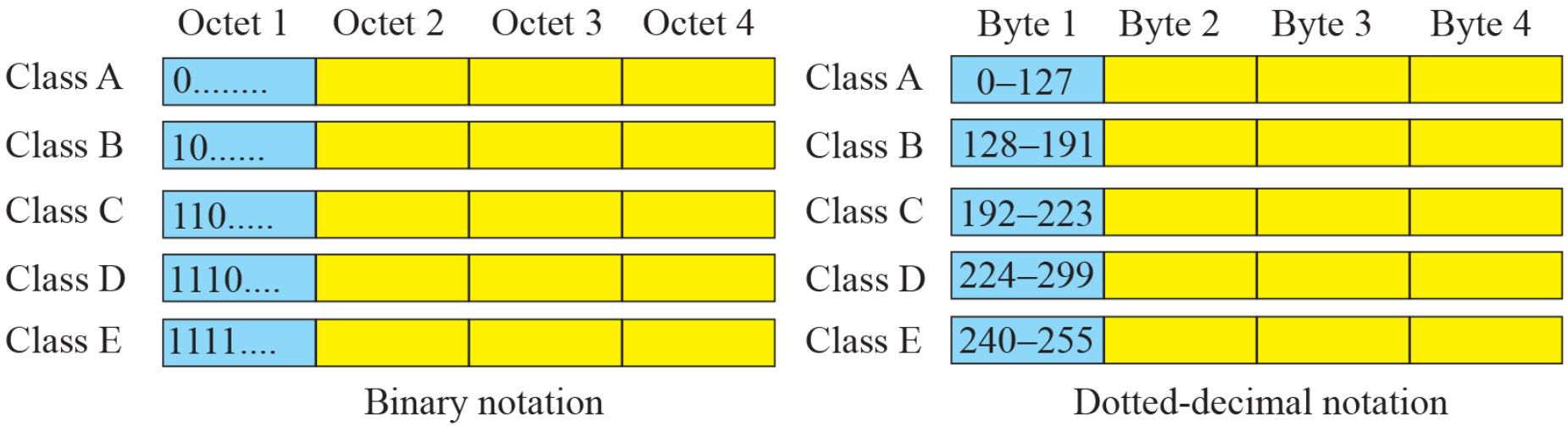
32-bit Binary Number	Equivalent Dotted Decimal
10000001 00110100 00000110 00000000	129.52.6.0
11000000 00000101 00110000 00000011	192.5.48.3
00001010 00000010 00000000 00100101	10.2.0.37
10000000 00001010 00000010 00000011	128.10.2.3
10000000 10000000 11111111 00000000	128.128.255.0

IP address in decimal notation

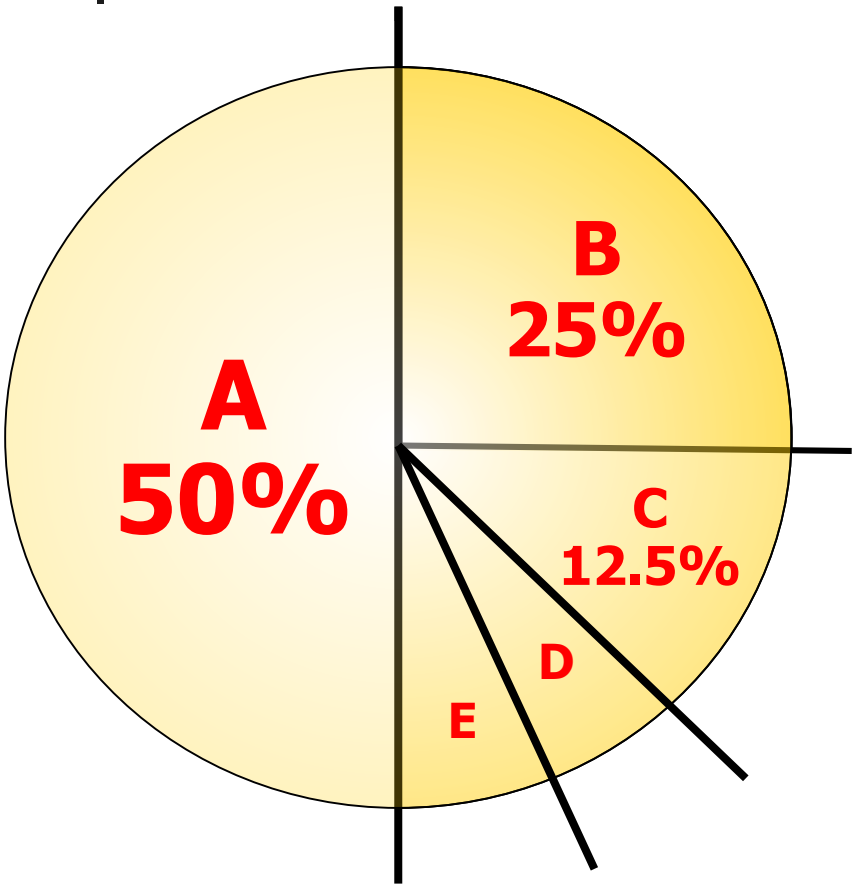


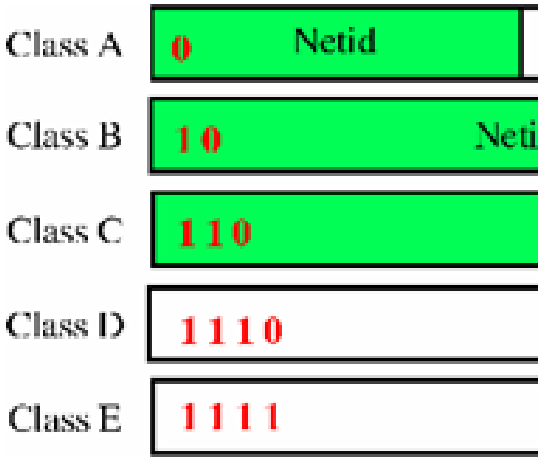
How about **iwing.cpe.ku.ac.th** ?

Class Ranges



IP Address Class





Class A: 2^{31} = 2,147,483,648 addresses, 50%

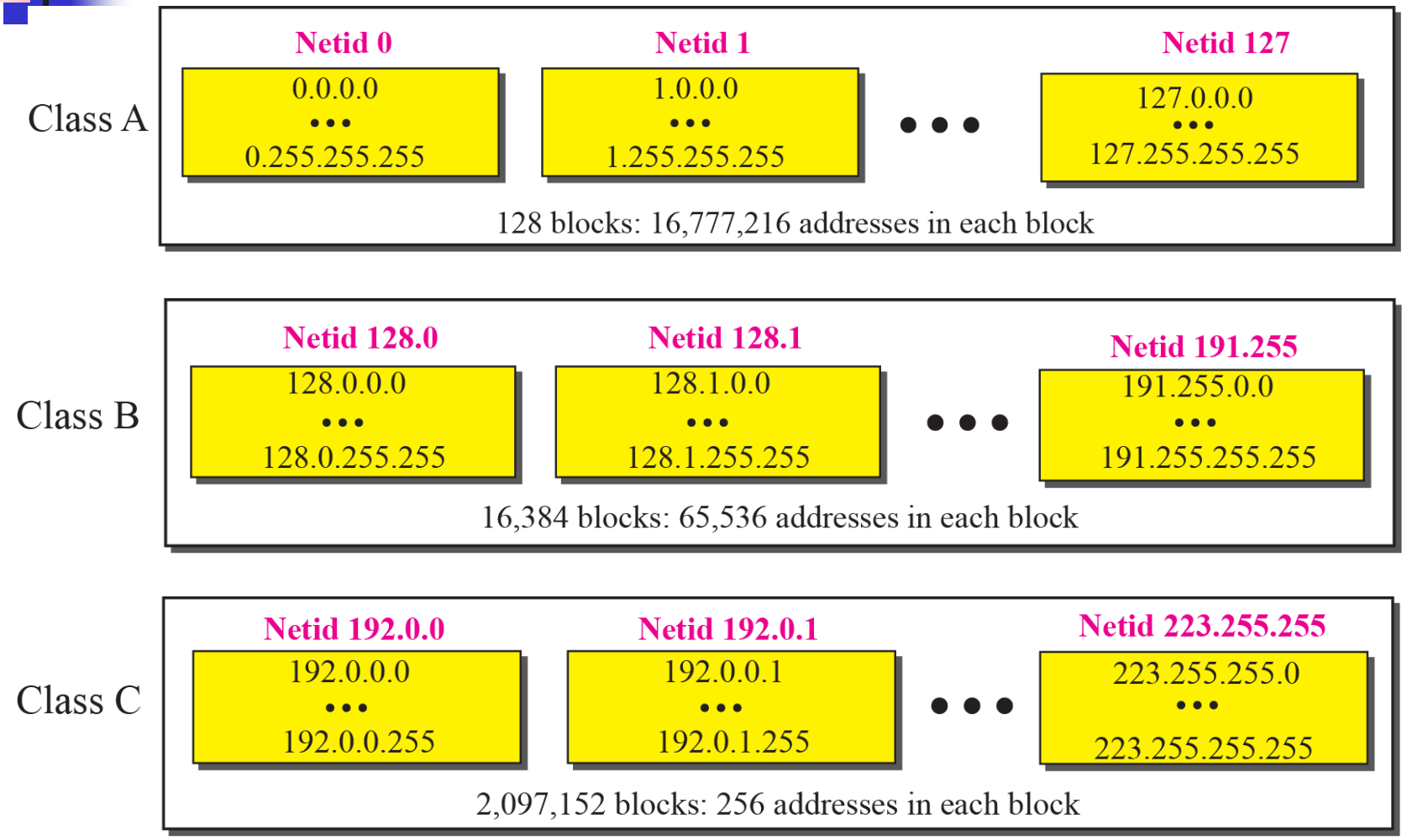
Class B: 2^{30} = 1,073,741,824 addresses, 25%

Class C: 2^{29} = 536,870,912 addresses, 12.5%

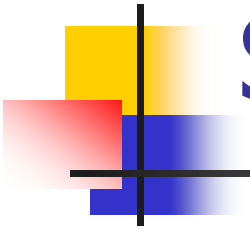
Class D: 2^{28} = 268,435,456 addresses, 6.25%

Class E: 2^{28} = 268,435,456 addresses, 6.25%

IP Address Blocks



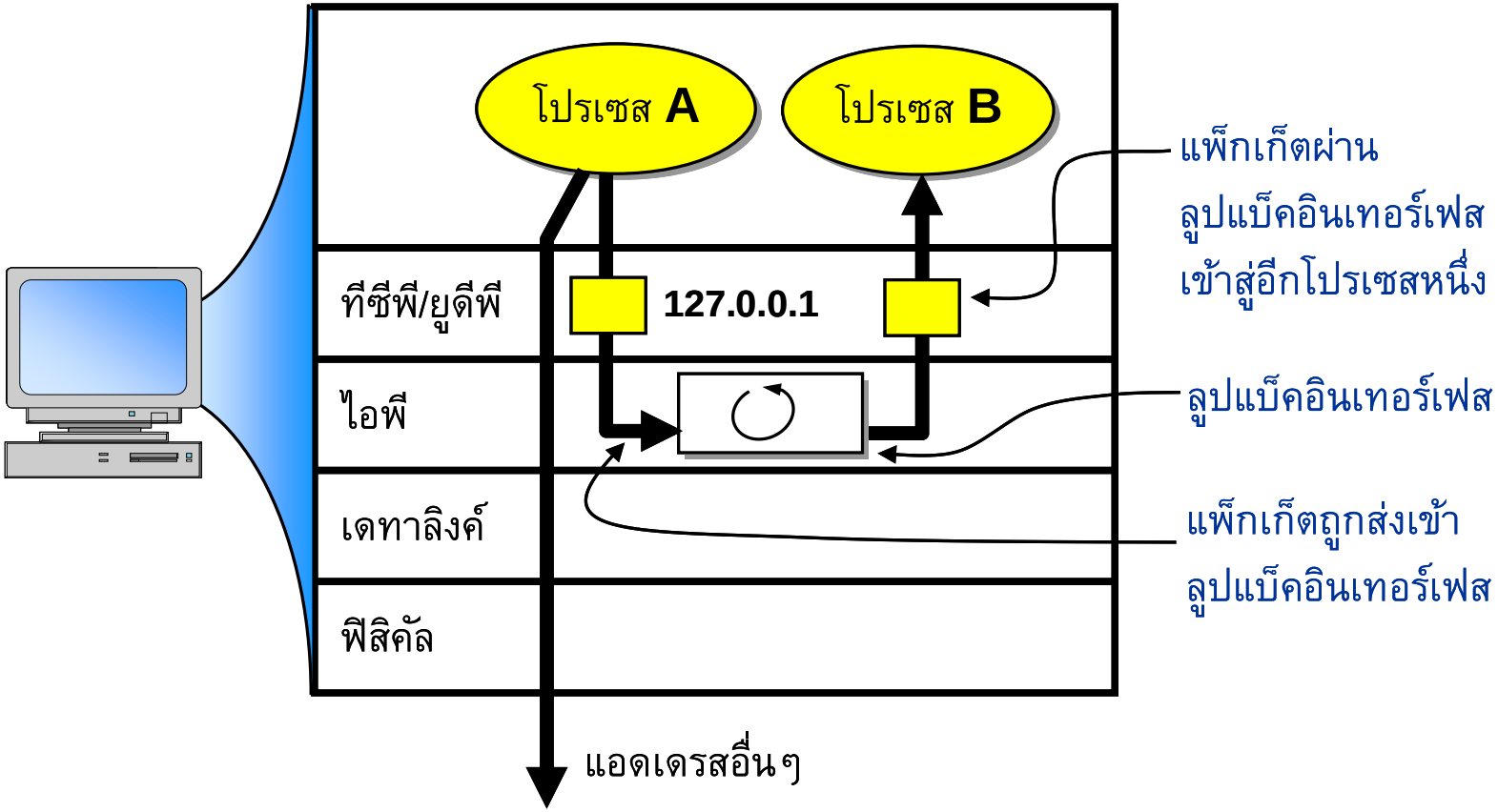
Special IP Addresses



- This computer Address (all 0; e.g. 0.0.0.0)
- Loopback Address
- Broadcast Address
- Private IP Address
- Network Address

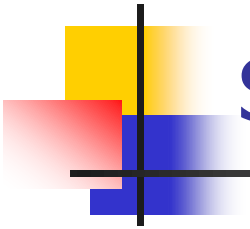
Special IP Address: **Loopback** Address

127.0.0.0/8 ➔ 127.0.0.1



Special IP Address: **Broadcast** Address

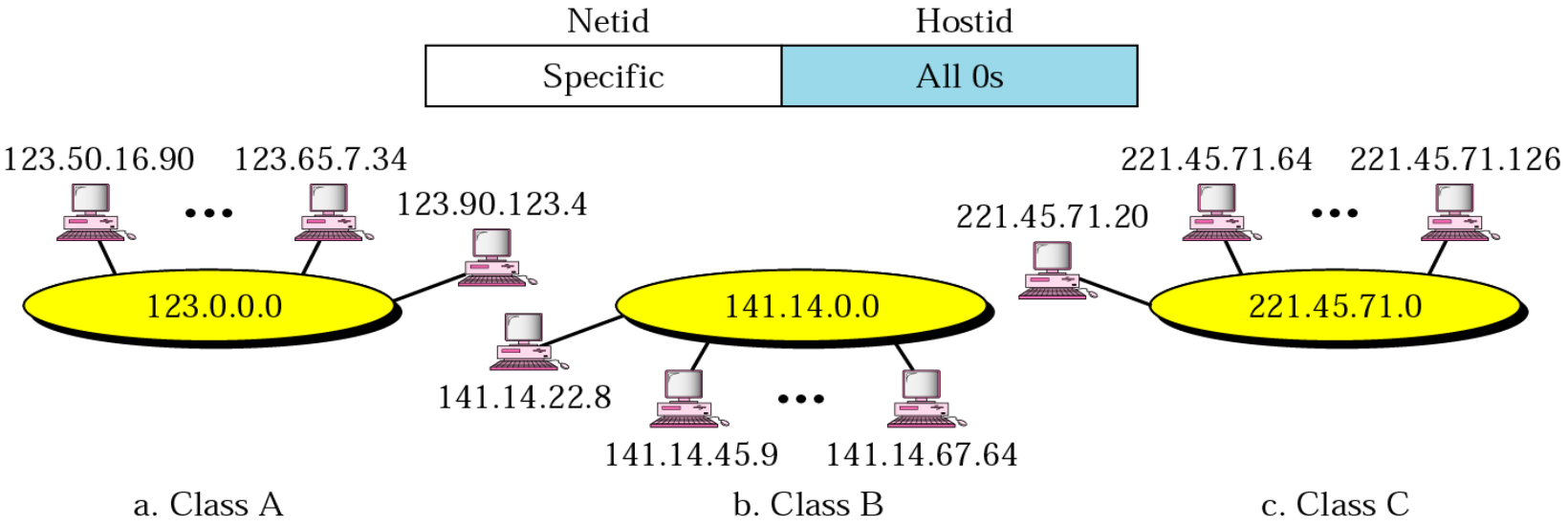
- Ending with 255
- Use for sending to all nodes in class range
- Directed Broadcast Address
  - all hosts = 1
  - Class A broadcast: 10.255.255.255
  - Class B broadcast: 158.108.255.255
  - Class C broadcast: 202.100.15.255
- Limited Broadcast Address
  - all 1; e.g. 255.255.255.255



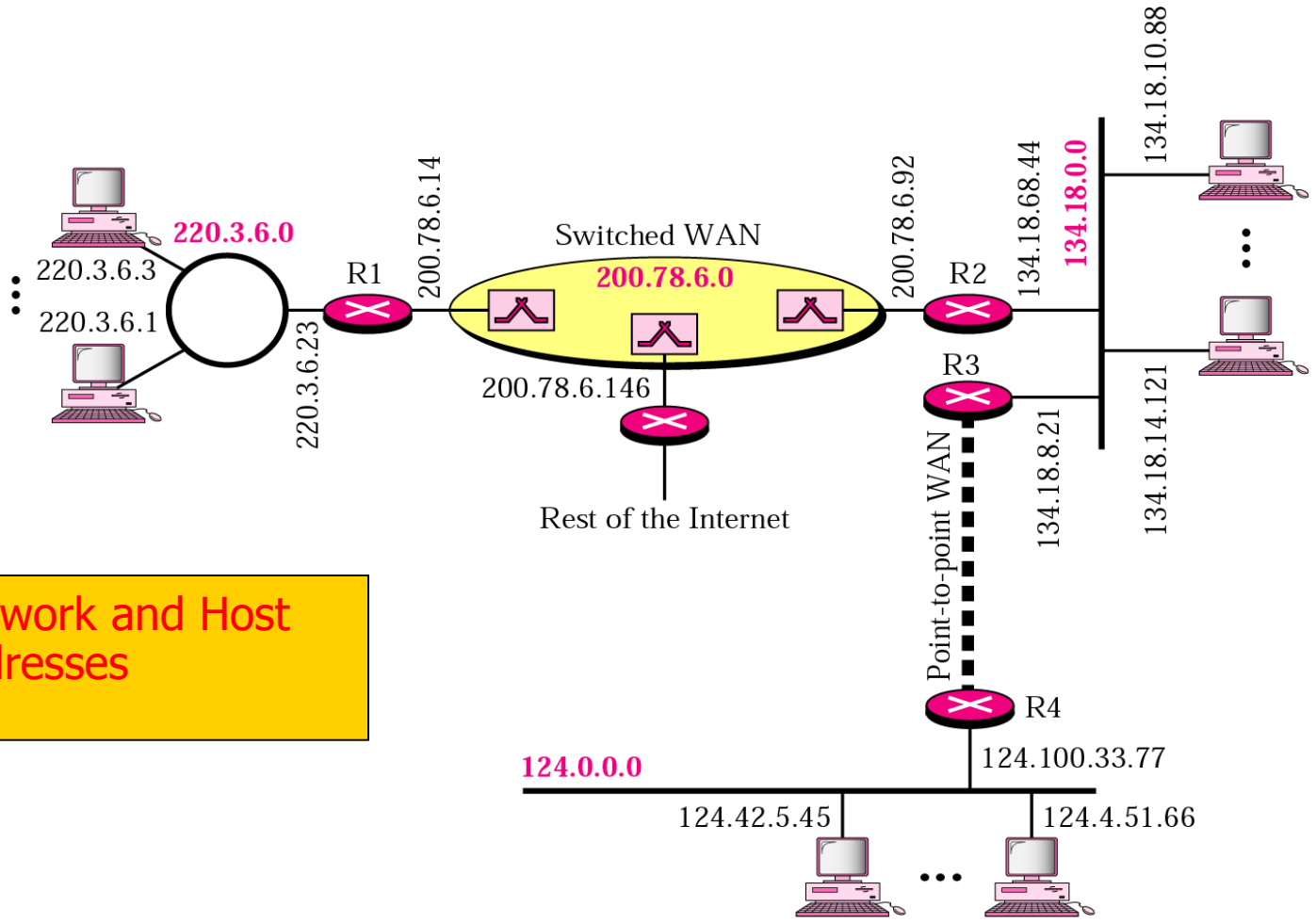
Special IP Address: **Private IP** Address

- Class A (1 group)
  - 10.0.0.0 – 10.255.255.255
- Class B (16 groups)
  - 172.16.0.0 – 172.31.255.255
- Class C (256 groups)
  - 192.168.0.0 – 192.168.255.255

Special IP Address: **Network** Address

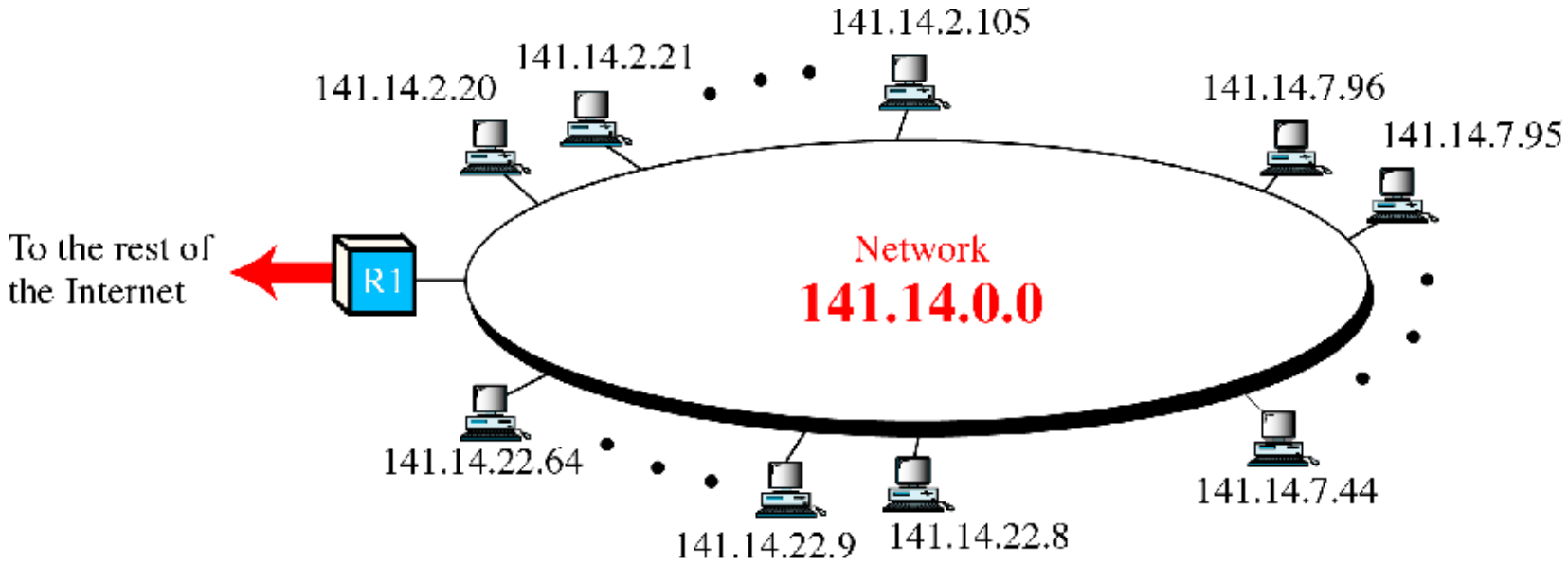


Sample internet

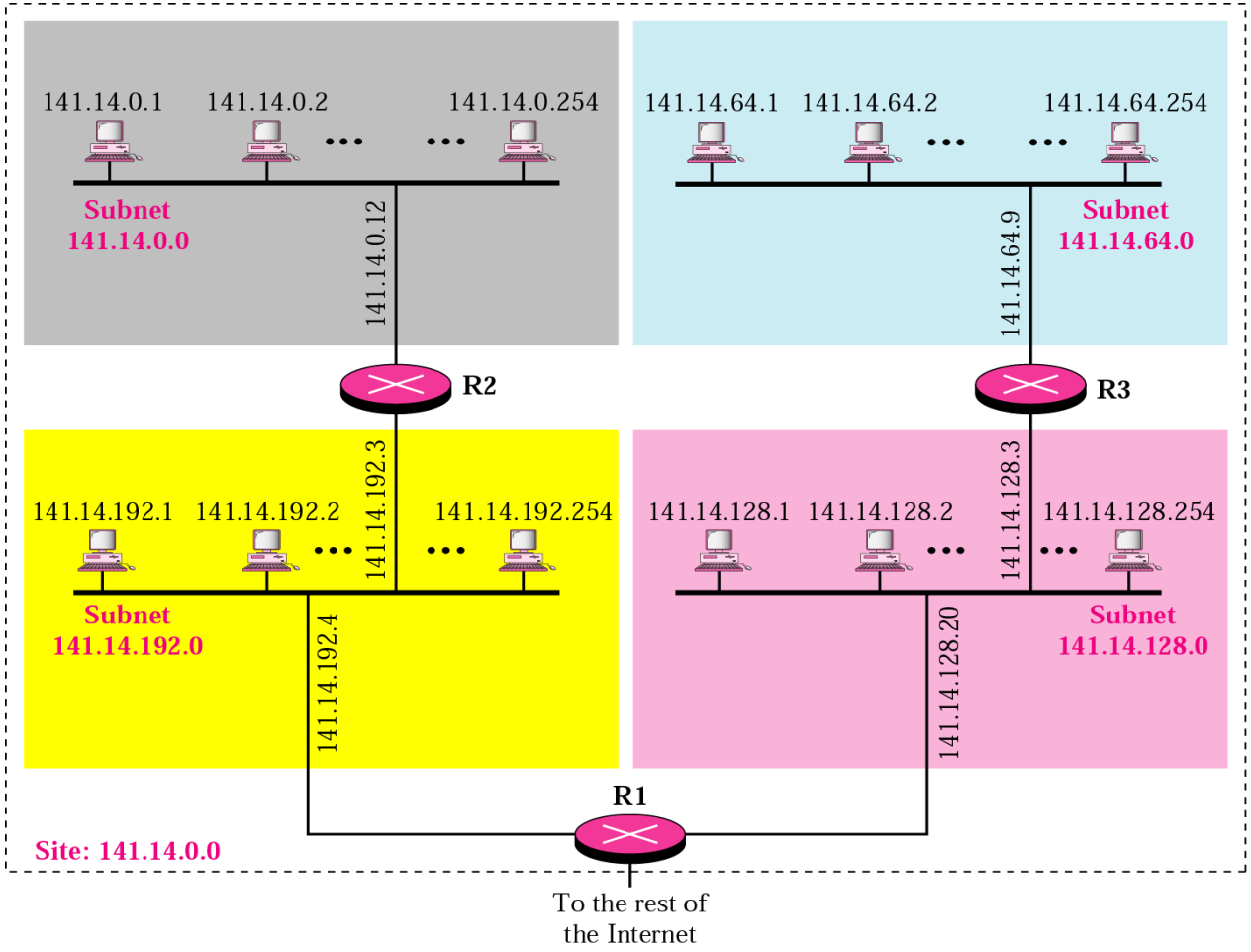


Network and Host addresses

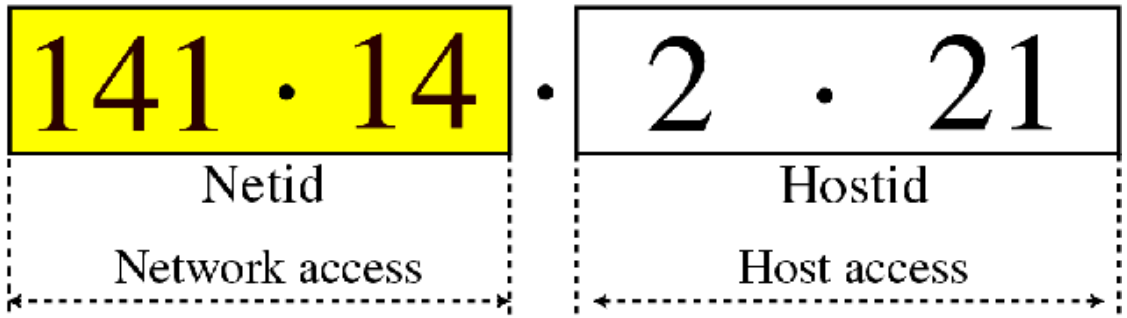
A Network with Two Levels of Hierarchy



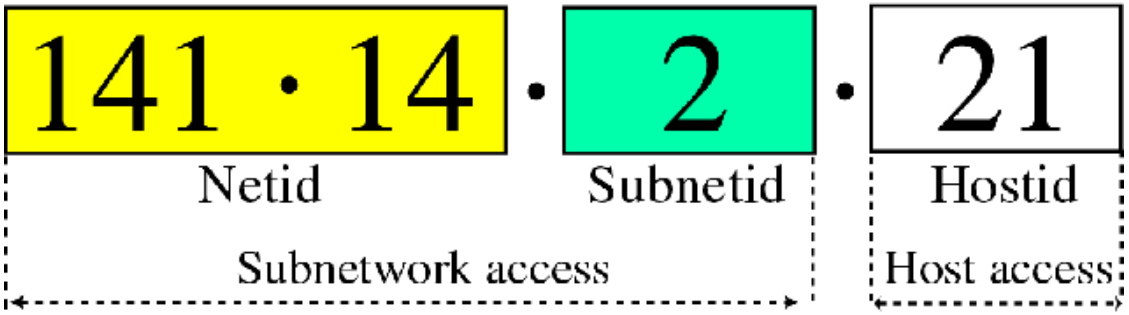
A Network with Three Levels of Hierarchy



Addresses with and without Subnetting

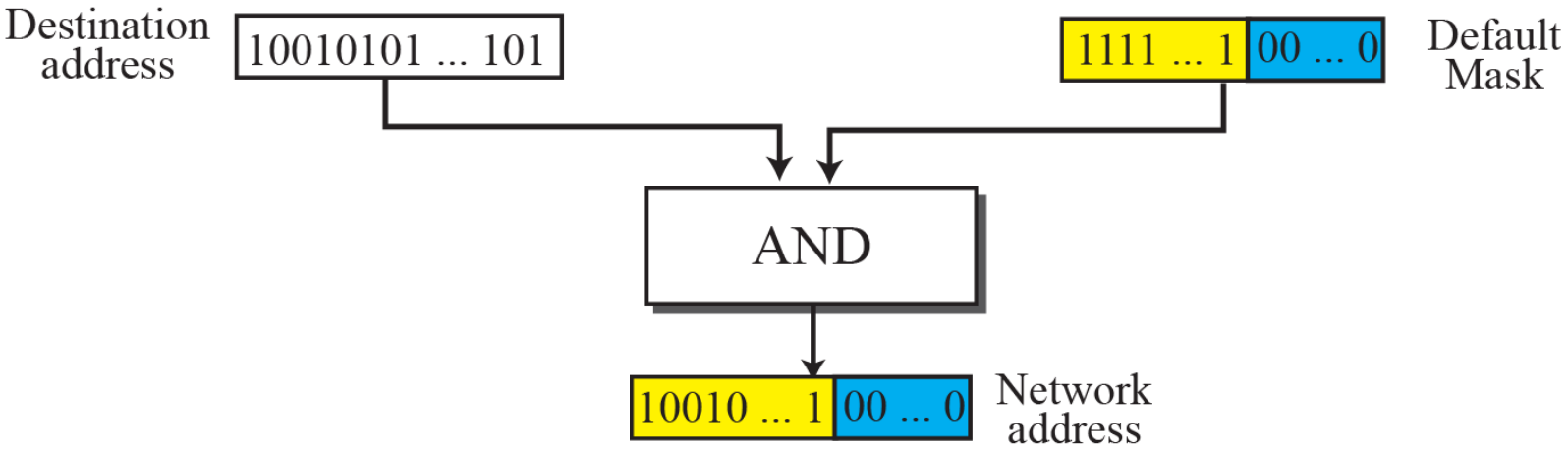


a. Without subnetting

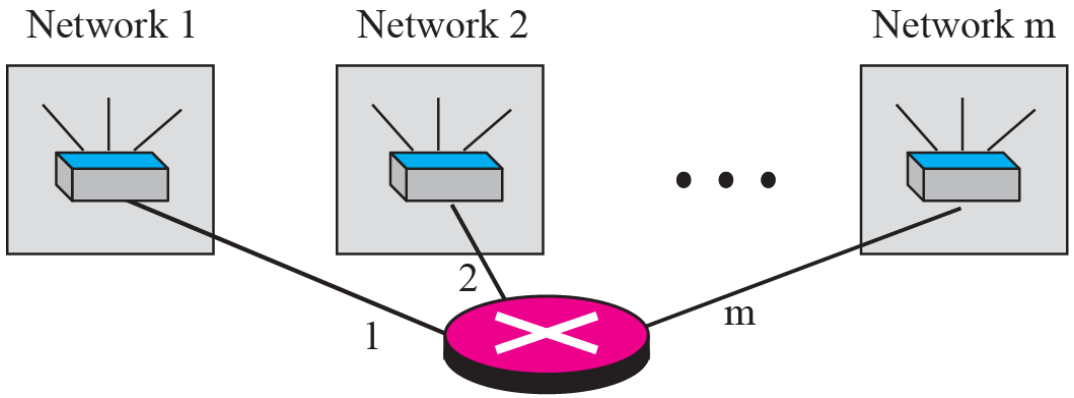


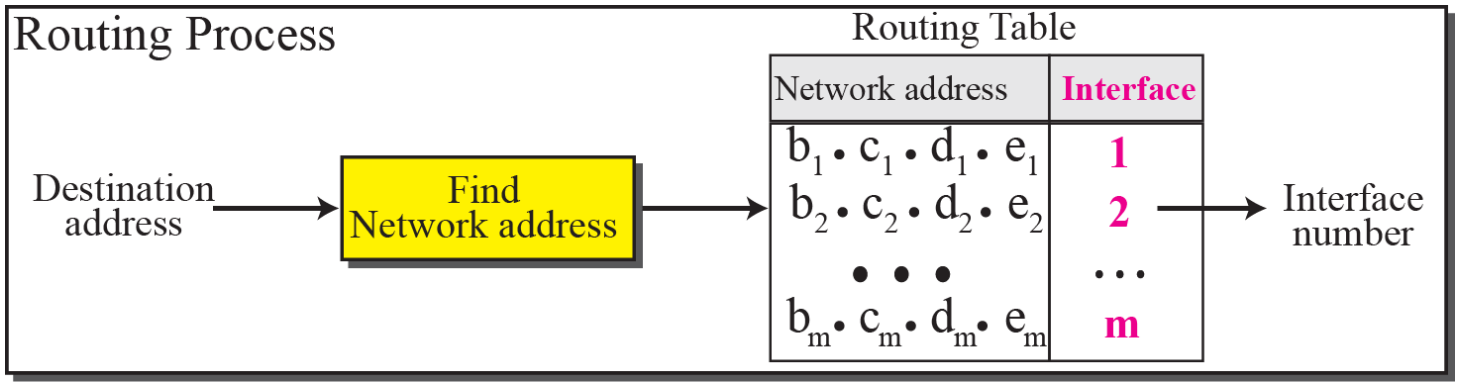
b. With subnetting

Finding a Network Address



Network Address





Masking (without subnet)

IP Address:	141	.	14	.	2	.	21
Binary IP Address:	1000 1101	.	0000 1110	.	0000 0010	.	0001 0101

&

Mask:	255	.	255	.	0	.	0
Binary Mask:	1111 1111	.	1111 1111	.	0000 0000	.	0000 0000

Network Address:	141	.	14	.	0	.	0
Binary IP Address:	1000 1101	.	0000 1110	.	0000 0000	.	0000 0000

Masking (with subnet)

IP Address:	141	.	14	.	2	.	21
Binary IP Address:	1000 1101	.	0000 1110	.	0000 0010	.	0001 0101

&

Mask:	255	.	255	.	**255**	.	0
Binary Mask:	1111 1111	.	1111 1111	.	1111 1111	.	0000 0000

Network Address:	141	.	14	.	**2**	.	0
Binary IP Address:	1000 1101	.	0000 1110	.	0000 0010	.	0000 0000

Default Mask

Class	*In Binary*	*In Dotted-Decimal*	*Using Slash*
A	11111111 00000000 00000000 00000000	255.0.0.0	/8
B	11111111 11111111 00000000 00000000	255.255.0.0	/16
C	11111111 111111111 11111111 00000000	255.255.255.0	/24

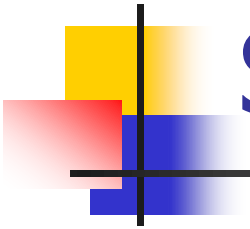
Example

A router receives a packet with the destination address 201.24.67.32. Show how the router finds the network address of the packet.

Solution

Class C ➔ default mask = 255.255.255.0

Destination address	→	201	.	24	.	67	.	32
Default mask	→	255	.	255	.	255	.	0
Network address	→	201	.	24	.	67	.	0



Subnet Design

- Given a network 194.30.12.0 with 16 hosts in each subnetwork
- Find the following:
  - The number of subnetworks
  - Sub-network ID / Broadcast Address
  - Sub-netmask
  - First/Last address that can be used for each subnet

Subnet Design

Class C IP address

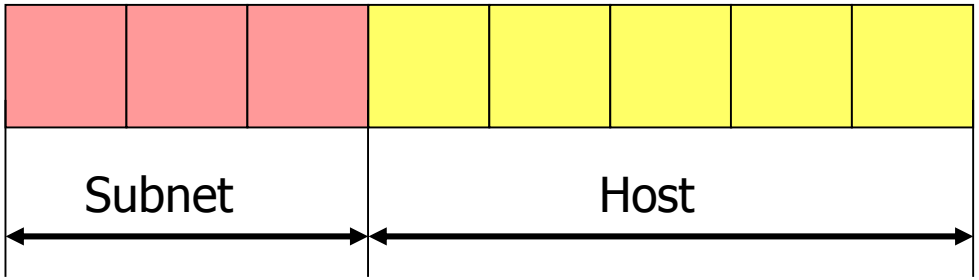
192.30.12.0

Last Byte(Host ID)

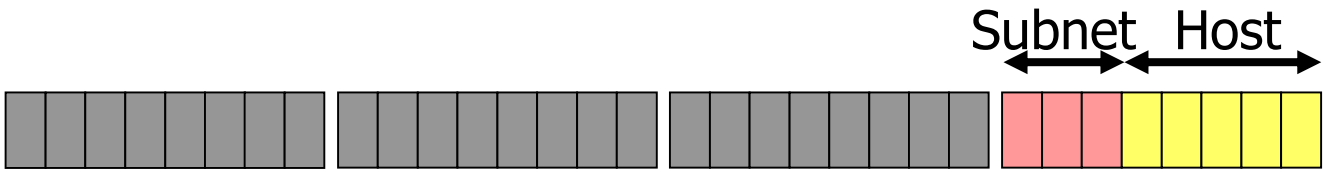
16 Hosts ➔ 2^4 =16 is not enough (subnetID and broadcast)

➔ 2^5 = 32 ➔ total of 30 hosts

➔ 5 bits for Host and 3 bits for subnet



Subnet Design



Subnet Mask	255	255	255	**1 1 1 0 0 0 0 0**
	255	255	255	224
Subnet ID	194	30	12	00000000 = 0
	194	30	12	00100000 = 32
	194	30	12	01000000 = 64
	194	30	12	01100000 = 96
	194	30	12	10000000 = 128
	194	30	12	10100000 = 160
	194	30	12	11000000 = 192
	194	30	12	11100000 = 224

Subnet Design

Subnet	Subnet ID	1st Add	Last Add	Broadcast
0	192.30.12.0	192.30.12.1	192.30.12.30	192.30.12.31
1	192.30.12.32	192.30.12.33	192.30.12.62	192.30.12.63
2	192.30.12.64	192.30.12.65	192.30.12.94	192.30.12.95
3	192.30.12.96	192.30.12.97	192.30.12.126	192.30.12.127
4	192.30.12.128	192.30.12.129	192.30.12.158	192.30.12.159
5	192.30.12.160	192.30.12.161	192.30.12.190	192.30.12.191
6	192.30.12.192	192.30.12.193	192.30.12.222	192.30.12.223
7	192.30.12.224	192.30.12.225	192.30.12.254	192.30.12.255