Introduction to Computer Systems

Computer networks

Lecture 10

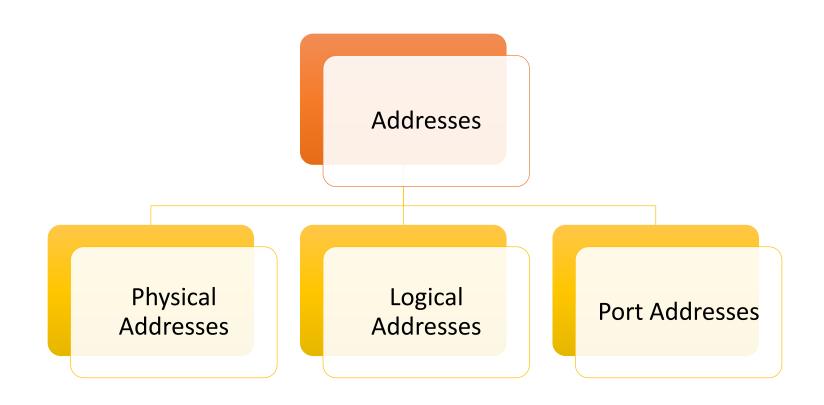# Addressing in a Network

Lecture Outline

Addresses used in a Network

IPv4 Addressing

Classful Addresses
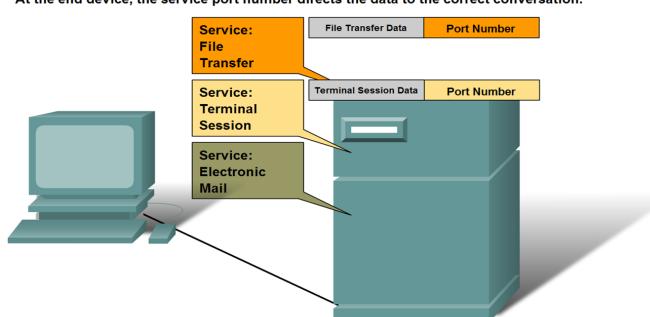
Public vs Private Addresses

Addresses Used in Computer Networks

```
                    ┌──────────────┐
                    │              │
                    │  Addresses   │
                    │              │
                    └──────┬───────┘
          ┌────────────────┼────────────────┐
   ┌──────┴──────┐  ┌──────┴──────┐  ┌───────┴──────┐
   │             │  │             │  │              │
   │  Physical   │  │  Logical    │  │ Port Addresses│
   │  Addresses  │  │  Addresses  │  │              │
   └─────────────┘  └─────────────┘  └──────────────┘
```
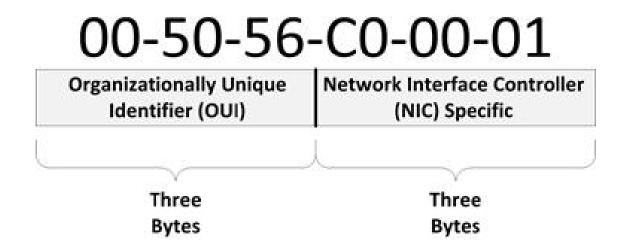
TRANSPORT LAYER ADDRESS: PORT ADDRESS

- Used to identify the **source** and **destination processes** for communication

- Ex: Port address

At the end device, the service port number directs the data to the correct conversation.

Service: File Transfer | File Transfer Data | Port Number

Service: Terminal Session | Terminal Session Data | Port Number

Service: Electronic Mail

What is the layer of IOS-OSI Ref. model the PORT addresses are introduced?
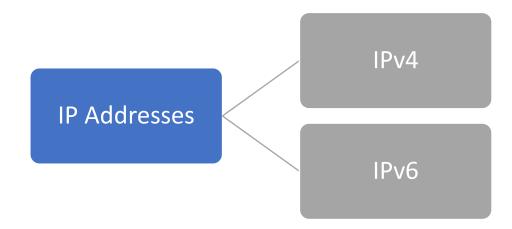
PHYSICAL ADDRESS
DATA LINK LAYER ADDRESS: MAC ADDRESS

00-50-56-C0-00-01

Organizationally Unique Identifier (OUI)	Network Interface Controller (NIC) Specific
Three Bytes	Three Bytes

What is the layer of IOS-OSI Ref. model the MAC addresses are introduced?
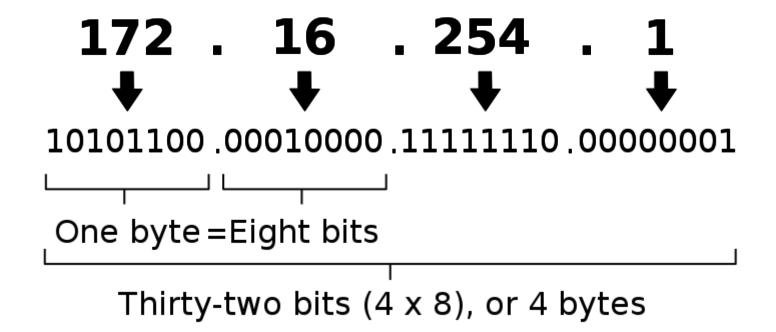
LOGICAL ADDRESS
NETWORK LAYER ADDRESS: IP ADDRESS

- There are **two major versions** of IP addresses

- IP version 4 (**IPv4**) address is **32** bits long (i.e. **4 bytes**)
- IP version 6 (**IPv6**) address is **128** bits long (i.e. **16 bytes**)

What is the layer of IOS-OSI Ref. model the IP addresses are introduced?

IP version 4 (IPv4)

172 . 16 . 254 . 1

10101100 .00010000 .11111110 .00000001

One byte = Eight bits

Thirty-two bits (4 x 8), or 4 bytes

Activity

➢ Change the following IP addresses from binary notation to dotted decimal notation.

10000001 00001011 00001011 11101111

➢ Change the following IP addresses from dotted decimal notation to binary notation.
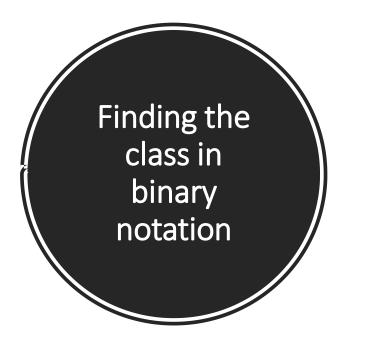
111.56.45.78

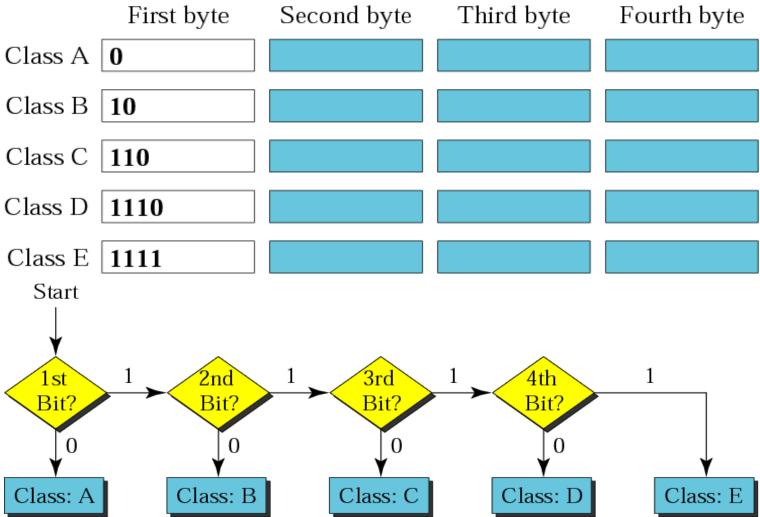➢ Find the error, if any, in the following IP address:

111.56.045.78

Classful Addressing

- When IP addressing was first introduced, all **IPv4 addresses** were divided into **5 classes**.

Class	Usage
Class A	General purpose
Class B	General purpose
Class C	General purpose
Class D	Multicasting
Class E	Reserved for future use

Finding the class in binary notation

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

Start

1st Bit? —1→ 2nd Bit? —1→ 3rd Bit? —1→ 4th Bit? —1→
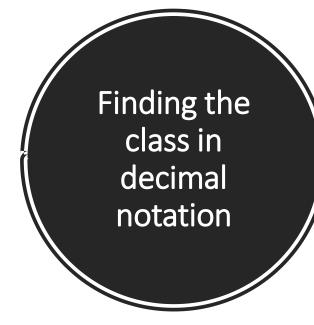
0 ↓ Class: A   0 ↓ Class: B   0 ↓ Class: C   0 ↓ Class: D   ↓ Class: E

Activity

Find the class of each address:

➢ 00000001 00001011 00001011 11101111

➢ 11000001 10000011 00011011 11111111

➢ 11011111 10110000 00011111 01011101

➢ 11110111 11110011 10000111 11011101

➢ 10101111 11000000 11110000 00011101

Finding the class in decimal notation

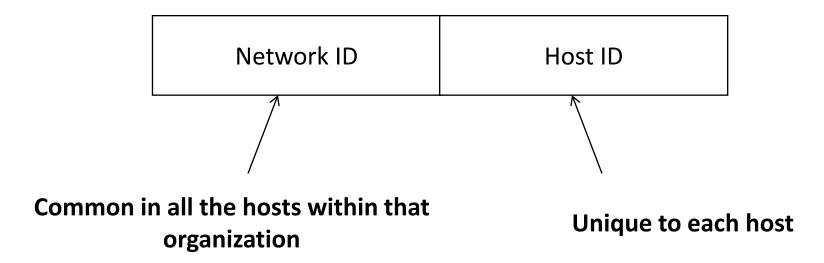|	First byte	Second byte	Third byte	Fourth byte
Class A	0 to 127			
Class B	128 to 191			
Class C	192 to 223			
Class D	224 to 239			
Class E	240 to 255			

Activity

Find the class of each address:

- ✓ 227.12.14.87
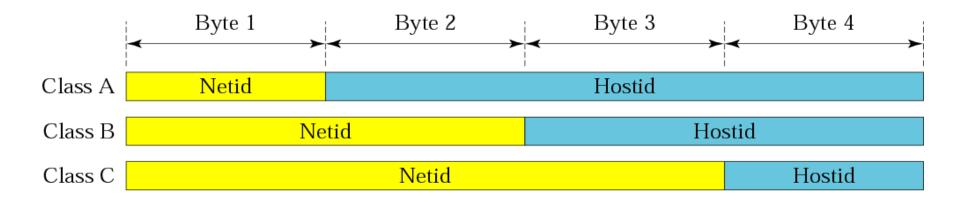- ✓ 193.14.56.22
- ✓ 14.23.120.8
- ✓ 252.5.15.111
- ✓ 134.11.78.56

Network ID (Net ID) and Host ID

- When an organization reserves a set of IP addresses from their ISP (Internet Service Provider) to use for the hosts used within that organization,

Each IP address consist of two parts

Network ID	Host ID

Common in all the hosts within that organization

Unique to each host
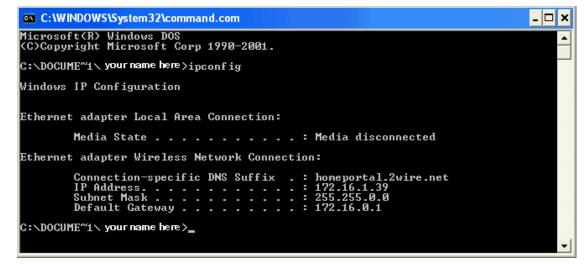
Net ID and Host ID cont.

Class	1st Octet Decimal Range	1st Octet High Order Bits	Network/Host ID (N=Network, H=Host)	Default Subnet Mask	Number of Networks	Hosts per Network (Usable Addresses)
A	1 – 126*	0	N.H.H.H	255.0.0.0	126 ($2^7 - 2$)	16,777,214 ($2^{24} - 2$)
B	128 – 191	10	N.N.H.H	255.255.0.0	16,382 ($2^{14} - 2$)	65,534 ($2^{16} - 2$)
C	192 – 223	110	N.N.N.H	255.255.255.0	2,097,150 ($2^{21} - 2$)	254 ($2^8 - 2$)
D	224 – 239	1110		Reserved for Multicasting		
E	240 – 254	1111		Experimental; used for research		

Note: Class A addresses 127.0.0.0 to 127.255.255.255 cannot be used and is reserved for loopback and diagnostic functions.

Masking Concept

- **Each LAN is** owned by a particular organization, the **net ID/Network Address** is what **differentiates** one LAN from another in Internet terms

- Finding the net ID is extremely important because net ID is used by routers to route the packets from one LAN to another LAN over the Internet

```
C:\WINDOWS\System32\command.com                           _ □ ×

Microsoft(R) Windows DOS
(C)Copyright Microsoft Corp 1990-2001.

C:\DOCUME~1\ your name here>ipconfig

Windows IP Configuration


Ethernet adapter Local Area Connection:

        Media State . . . . . . . . . . : Media disconnected

Ethernet adapter Wireless Network Connection:

        Connection-specific DNS Suffix  . : homeportal.2wire.net
        IP Address. . . . . . . . . . . . : 172.16.1.39
        Subnet Mask . . . . . . . . . . . : 255.255.0.0
        Default Gateway . . . . . . . . . : 172.16.0.1

C:\DOCUME~1\ your name here>_
```

NET1 ID/Address
172.16.0.0

NET2 ID/Address
192.168.8.0

```
Connection-specific DNS Suffix  . :
Description . . . . . . . . . . . : ''
Physical Address. . . . . . . . . : 98-5F-D3-
DHCP Enabled. . . . . . . . . . . : Yes
Autoconfiguration Enabled . . . . : Yes
Link-local IPv6 Address . . . . . : fe80::803f:d5c1:30d4:6018%21(Preferred)
IPv4 Address. . . . . . . . . . . : 192.168.8.101(Preferred)
Subnet Mask . . . . . . . . . . . : 255.255.255.0
Lease Obtained. . . . . . . . . . : Thursday, May 9, 2019 10:27:25 AM
Lease Expires . . . . . . . . . . : Friday, May 10, 2019 10:27:25 AM
Default Gateway . . . . . . . . . : fe80::a257:e3ff:fe0a:73c2%21

DHCP Server . . . . . . . . . . . :
DHCPv6 IAID . . . . . . . . . . . : 345530323
DHCPv6 Client DUID. . . . . . . . : 00-01-00-01-23-E2-A7-10-9C-EB-E8-0A-E3-F5
DNS Servers . . . . . . . . . . . : fe80::a257:e3ff:fe0a:73c2%21

NetBIOS over Tcpip. . . . . . . . : Enabled
```
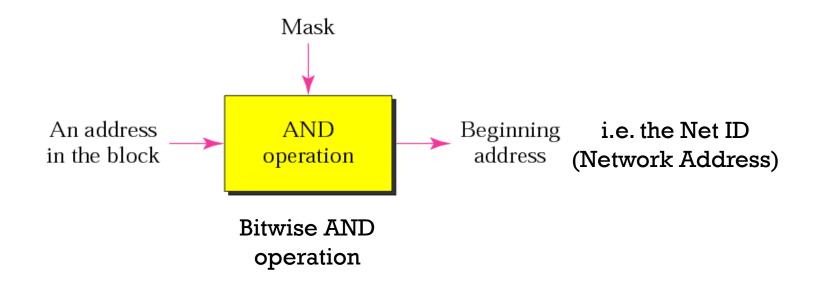
Masking Concept Cont.

Default Masks

Class	Mask in binary	Mask in dotted decimal	Mask in slash (/) notation
A	**11111111** 00000000 00000000 00000000	**255**.0.0.0	/8
B	**11111111 11111111** 00000000 00000000	**255.255**.0.0	/16
C	**11111111 11111111 11111111** 00000000	**255.255.255**.0	/24

Masking Concept Cont.

- Although we humans can easily interpret the net ID of a given classful IP address, how does a router calculate the net ID?

- For this we use the concept of masking

Bitwise AND operation

Activity

- Find the subnet mask for following addresses

  ✓ 35.56.7.91 ➔ 255.0.0.0

  ✓ 68.87.34.68

  ✓ 140.30.1.21

  ✓ 210.50.60.1

  ✓ 188.1.1.1
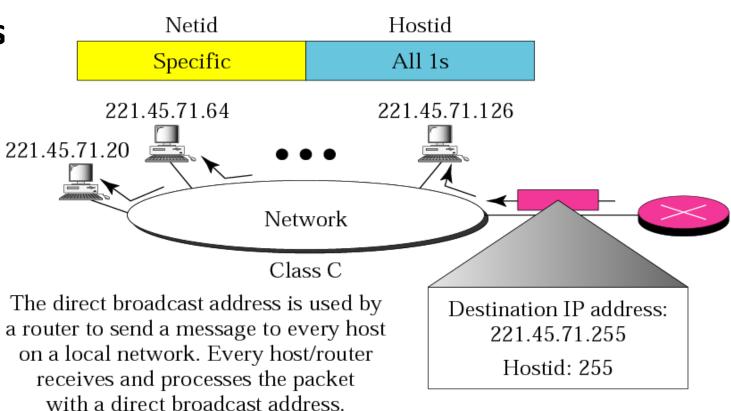
✓ Then Find the Network address for above addresses

Address: 35.56.7.91   00100011.00111000.00000111.01011011
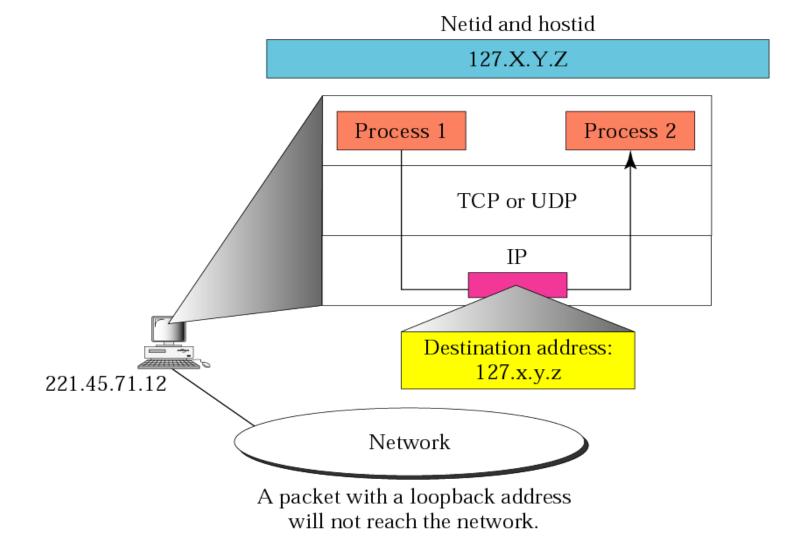Netmask: 255.0.0.0 = 8   11111111.00000000.00000000.00000000
=> Network: 35.0.0.0/8   00100011.00000000.00000000.00000000 (Class A)

Special IPv4 Addresses

Special Address	Netid	Hostid	Source or Destination
Network address	Specific	All 0s	None
Direct broadcast address	Specific	All 1s	Destination
Limited broadcast address	All 1s	All 1s	Destination
This host on this network	All 0s	All 0s	Source
Specific host on this network	All 0s	Specific	Destination
Loopback address	127	Any	Destination

Direct Broadcast Address (Broadcast Address)

Netid | Hostid
Specific | All 1s

221.45.71.64   221.45.71.126

221.45.71.20

Network

Class C

The direct broadcast address is used by a router to send a message to every host on a local network. Every host/router receives and processes the packet with a direct broadcast address.

Destination IP address:
221.45.71.255

Hostid: 255

Loopback Address

Netid and hostid
127.X.Y.Z

Process 1   Process 2

TCP or UDP

IP

Destination address:
127.x.y.z

221.45.71.12

Network

A packet with a loopback address
will not reach the network.

- The most widely used loopback address is 127.0.0.1

Activity

- For following addresses, find the
  - Network address
  - Subnet mask
  - Broadcast address
  - 1st usable host IP address
  - Last usable host IP address

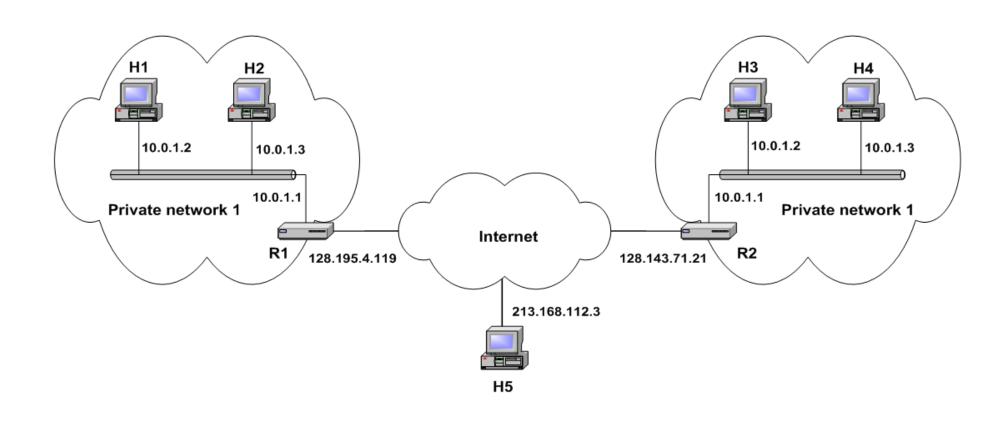 ✓ 23.56.7.91
  ✓ 72.87.34.10
  ✓ 130.10.1.21
  ✓ 200.50.60.1
  ✓ 198.1.1.1

Public Addresses vs Private Addresses

IPv4 Private Address Ranges

- Following ranges are reserved to be used in Local Area Networks for private addresses.

- Remember: You cannot use these ranges for machines/interfaces that are directly connected to Internet.

Class	Netids	Blocks
A	10.0.0	1
B	172.16 to 172.31	16
C	192.168.0 to 192.168.255	256

Problems with Classful Addressing

Class A and B are **too large** for typical organizations and many IP addresses will not be used and wasted.

Class C is **not enough** for most organizations resulting the reservation of at least a Class B address range for the organization.

The end result is that, the available IP addresses are depleting at an alarming rate and soon there will be no more IP addresses.

Solutions

✓ **Short Term**:
  - Subnetting
  - Classless Addressing

✓ **Long Term**: IPv6

Address Allocation

Who has the authority to provide you an IP address?

Internet Service Provider (e.g. Sri Lanka Telecom).

Who has the authority to reserve IP addresses to each ISP?

A global authority called the Internet Corporation for Assigned Names and Addresses (ICANN).

THANK YOU!

ANY QUESTIONS?