

Ambo University
Institute of Technology
Department of Computer
Science
Data Communication &
Computer Networks

Internet Addressing

IP Addressing

- Four types of addresses are used :

1. Physical Addresses

2. Logical (IP) Addresses

3. Port Addresses, and

4. Specific Addresses

IP Addressing

- ❖ **A Hardware address** is used to uniquely identify a host *within a local* network. (by **data link layer** of OSI)
 - Ethernet utilizes the 48-bit **MAC address** as its hardware address.
 - A MAC address is most often represented in **hexadecimal, using one of two** accepted formats:
e.g. 00:43:AB:F2:32:13
0043.ABF2.3213
- ❖ **Logical Addressing**
 - Logical addressing is a function of the **Network layer of the OSI Model** and provides a hierarchical structure.
- ❖ **Specific Address**- are user-friendly addresses
 - E.g. www.aau.edu.et , abertesfaye23@yahoo.com

IP Addressing

- ❖ **Port Number** is a pre-assigned unique numbers so that the computer knows how to respond when it is contacted on a specific port.
- ❖ It is 16-bit address.
 - E.g Web Servers use **port 80**,
 - SMTP (Simple Mail Transfer Protocol) is delivered to **port 25**.

IP addresses-Logical Address

- Internet Protocol moves data between hosts in the form of **datagrams**.
- Each datagram delivered to destination address w/c contains **32 - bit** IP address.

❑ IP address

- is a numeric identifier assigned to each machine on a network.
- Allows a host on one network to communicate with a host on a different network.

IP addresses

- IP address – is a famous layer 3 address
- IPv4 – is the current version of IP .
- IPv6 – is the next version of the Internet Protocol
- Each data packet sent along a network contains **source** and **destination IP addresses**
- A **router** uses the IP address of the destination to forward the packet to the correct destination

IP addresses

- IP addresses are 32 bits wide.



- To work with this 32 bit wide IP addresses ,it needs to be divided into **four** fields
- Each field is 8 bits wide, can be converted to base 10 and separated by dots.
- Each octet has a decimal value from **0** to **255**
- This writing scheme is called **dotted decimal format** and each part is called an **octet** b/c it is made of eight bits.

IP address formats

- **Example**

- Dotted binary format

- ✓ 00001010.00000100.00001111.00001100

- Dotted decimal format

- ✓ 10.4.15.12

- IP addresses have two portions , such as:

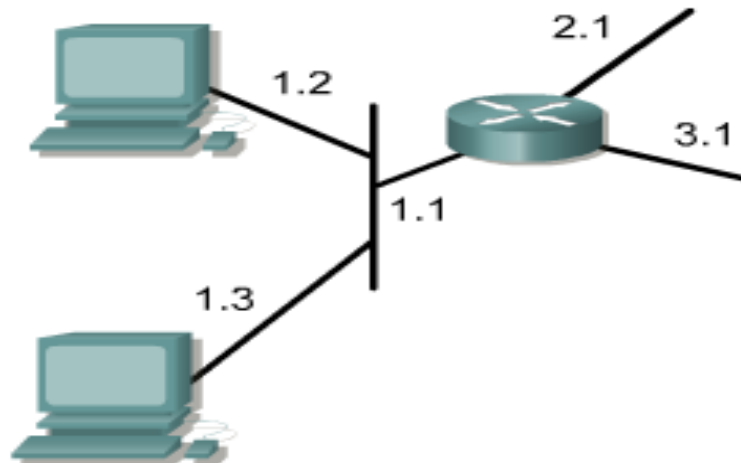
- network portion and

- host portion.

Host and Network portions

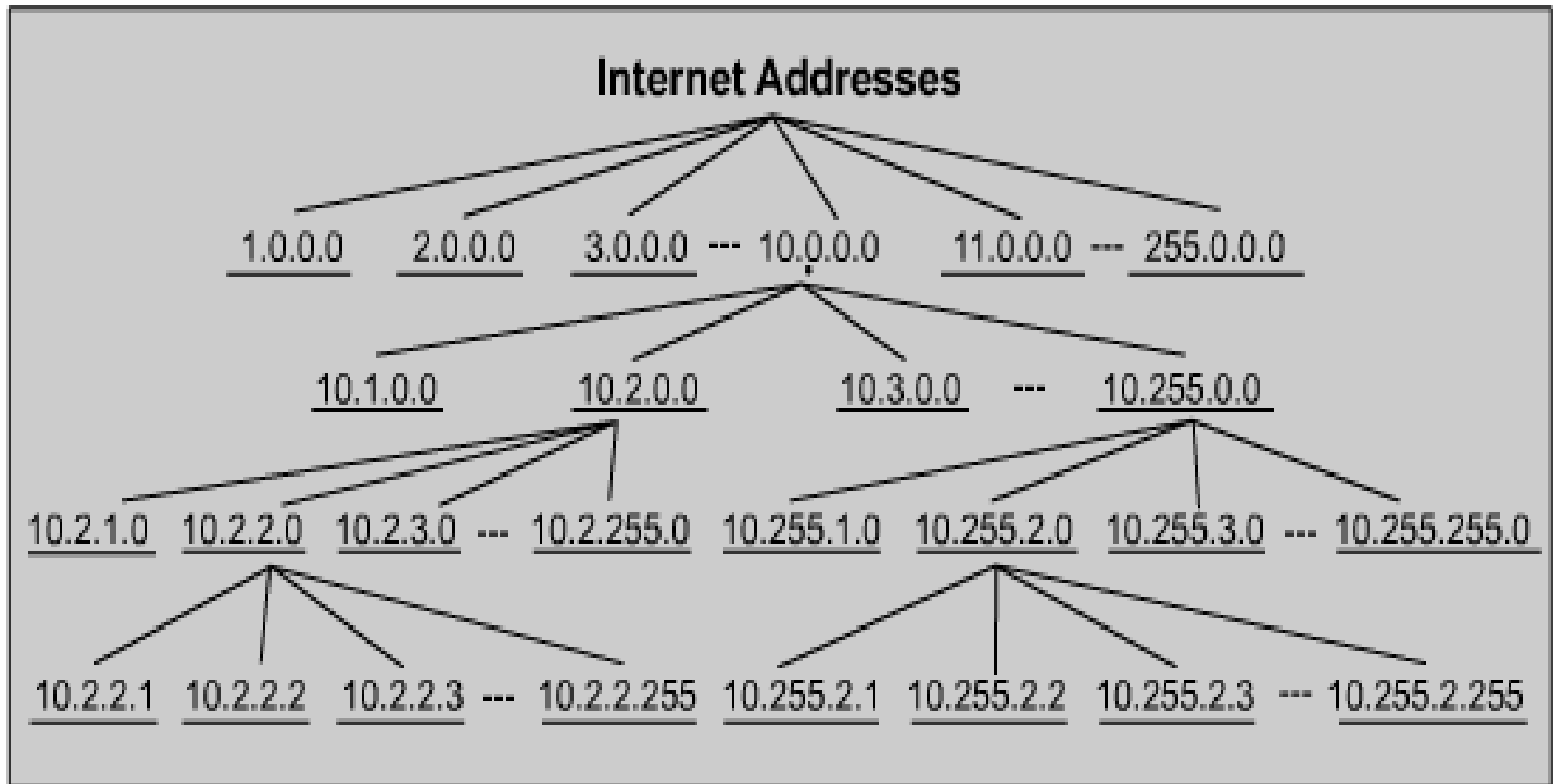
- **The network portion/ addresses**
 - uniquely identifies the network in which the computer is located
 - E.g In the IP address 172.16.30.56, **172.16** is the network address.
- **The host portion/ addresses**
 - identifies the source and destination computer / machine in the network.
 - Also called **node** address. **E.g** In the IP address 172.16.30.56, **30.56** is the host/node address.

Host and network portions



Network	Host
1	1 2 3
2	1
3	1

- IP addresses are hierarchical



IP address classes

➤ IP addresses

- Are classified into **three main** address **classes** to define *large*, *medium* and *small* networks.
 - **Class A** IP addresses are used for **larger** networks.
 - **Class B** for **medium** networks.
 - **Class C** for **small** networks.
- Other **classes** - w/c are used for **multicasting** and **research purposes** are **D** and **E** .
- This grouping of addresses is referred to as **class full addressing**.

IP address classes – Ranges

IP Address Class	High Order Bits	First Octet Address Range	Number of Bits in the Network Address
Class A	0	0 – 127*	8
Class B	10	128 – 191	16
Class C	110	192 – 223	24
Class D	1110	224 – 239	0
Class E	1111	240 – 255	0

IP address classes - network and host portions

Class A	Network	Host		
Octet	1	2	3	4

Class B	Network		Host	
Octet	1	2	3	4

Class C	Network			Host
Octet	1	2	3	4

Class D	Host			
Octet	1	2	3	4

Class A addresses

- **Class A IP address**
 - Use only **the first octet** to indicate the **network address**, the remaining three octets provide **host addresses**.
 - If the first bit of the first octet of IP address is 0, it is the address of a class A network.
- The **lowest number** that can be represented is 00000000, decimal 0.
- The **highest number** that can be represented is 01111111, decimal 127.
- The numbers 0 and 127 are reserved and cannot be used as **network addresses**.
- Any address that starts with a value between **1** and **126** in the first octet is a **Class A address**.
- Example: **98.56.82.30**

Class B addresses

- Class B IP address
 - Designed to support moderately large sized networks.
 - i.e. more than 65 thousand host addresses are available.
 - Use the **first two octets** to indicate the **network address**, the remaining **two octets** provide for **host addresses**.
- If the first bits of the first octet of an IP address is always 1 and the second bit of the first octet of an IP address is always 0, it is a **class B network address**.

- This first **2 bits** are used to identify class; the next 14 bits identify the network, and the last 16 bits identify the host.
- The lowest number that can be represented is **10000000**, decimal **128**.
- The highest number that can be represented is **10111111**, decimal **191**.
- Any address that starts with a value between 128 and 191 in the first octet is a Class B address.
- Example: **167.3.27.30**

Class C addresses

- **Class C addresses**

- Designed to support **moderately** large sized networks.
- i.e. A maximum of **254 host addresses** are available.
- Use the first three octets to indicate the network address, the remaining octet provides host addresses.
- If the first 3 bits of the address are 1 1 0, it is a *class C network address*.

- In a class C address, the first 3 bits are class identifiers; the next 21 bits are the network address, and the last 8 bits identify the host.
- The lowest number that can be represented is **11000000**, decimal **192**.
- The highest number that can be represented is **11011111**, decimal **223**.
- Any address that starts with a value 192- to -225 in the first octet is a Class C address
- Example: **192.168.0.1**

Class D addresses

- **Class D addresses**
 - Designed to support **multicasting**.
 - Hence there is no need to allocate octets to separate network and host addresses.
 - If the first 4 bits of the address are 1 1 1 0, it is a multicast address.
 - The lowest number that can be represented is 11100000, decimal 224.

Class D addresses

- The highest number that can be represented is 11101111, decimal 239.
- Any address that starts with a value between 224 and 239 in the first octet is a Class D address.
- Example: **231.100.250.101**

Class E addresses

- Class E addresses are reserved for **research purposes**.
- If the first 4 bits of the address are 1 1 1 1, it is a multicast address.
- The lowest number that can be represented is 11110000, decimal 240.
- The highest number that can be represented is 11111111, decimal 255.
- Any address that starts with a value between 240 and 255 in the first octet is a Class E address.

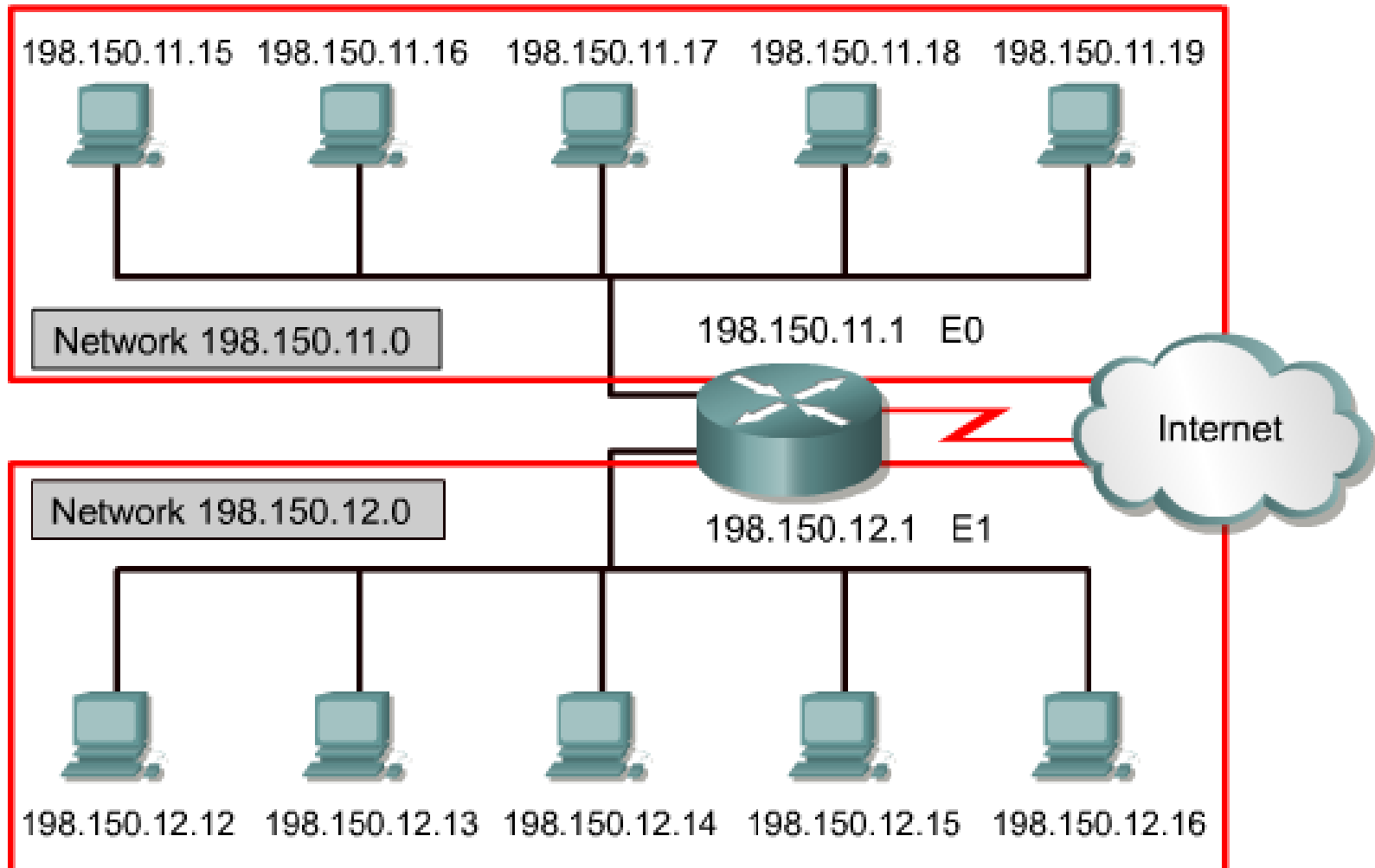
Reserved IP addresses

- Certain IP addresses are reserved and cannot be used as an address to a host.
- Some of them are:
 - **Network addresses** – w/c used to identify the network.
 - **Broadcast addresses** – w/c used to broadcast messages.
- Network addresses
 - Used to identify the network itself.
 - E.g a class C network which starts with **200.150.56.0**

Network addresses

- The address 200.150.56.0 is called the **network address**.
- An addresses can be assigned for hosts from **200.150.56.1** to **200.150.56.254**
- The only time when the host portion of the address matters is when data is on the local area network.
- In general, **network addresses** have all **zeros** for the **host portion**.

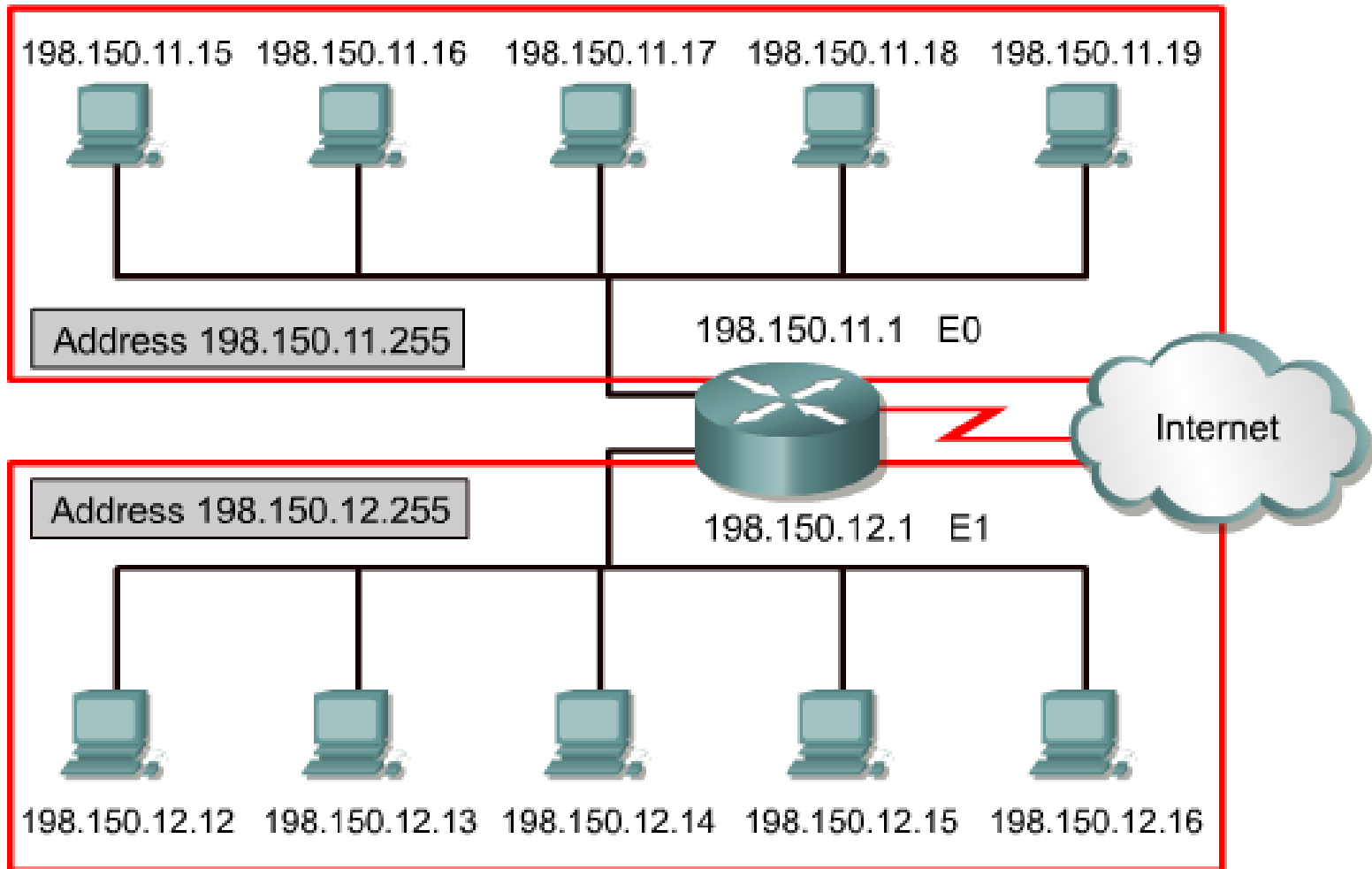
Network addresses (cont...)



Broadcast Addresses

- Is the address that used by applications and hosts to send information to all hosts / nodes on a network.
- Used for broadcasting packets to all the devices on a network.
- Hosts use broadcast addresses to send data to all hosts on a network.
- Assume a class C network with a network address **200.150.56.0**
- The broadcast address for this network is **200.150.56.255**
- In general, broadcast addresses have all **ones** for the **host portion**.

Broadcast addresses (cont...)



Loopback IP

- The class A address which starts with **127** is used as a **loopback** address.
- **Hosts** use this address to **send packets to themselves**.
- It can also be used for testing (eg. use it to test if **NIC** is working properly or **the driver** has been correctly installed).
- Hence addresses which start with 127 are not assigned to hosts under normal conditions.
- Usually the address **127.0.0.1** is used as a loopback IP.

IP address Allocation

- IP addresses must be uniquely assigned to hosts.
- Originally, an organization known as the [Internet Network Information Center \(InterNIC\)](#) took over the responsibility of making sure that IP addresses are unique.
- InterNIC is no longer exists and has been succeeded by the [Internet Assigned Numbers Authority \(IANA\)](#).
- IANA manages the remaining supply of IP addresses to ensure that duplication of publicly used addresses does not occur.
- Duplication would cause instability in the Internet and compromise its ability to deliver packets to networks.

Public and Private address

- The internet grows rapidly => we are running out of IP addresses.
- One solution is to have public and private IP addresses.
- Since public networks require public IP addresses we give hosts in that network a public IP address which is obtained from IANA.
- This address is called a **public address**.

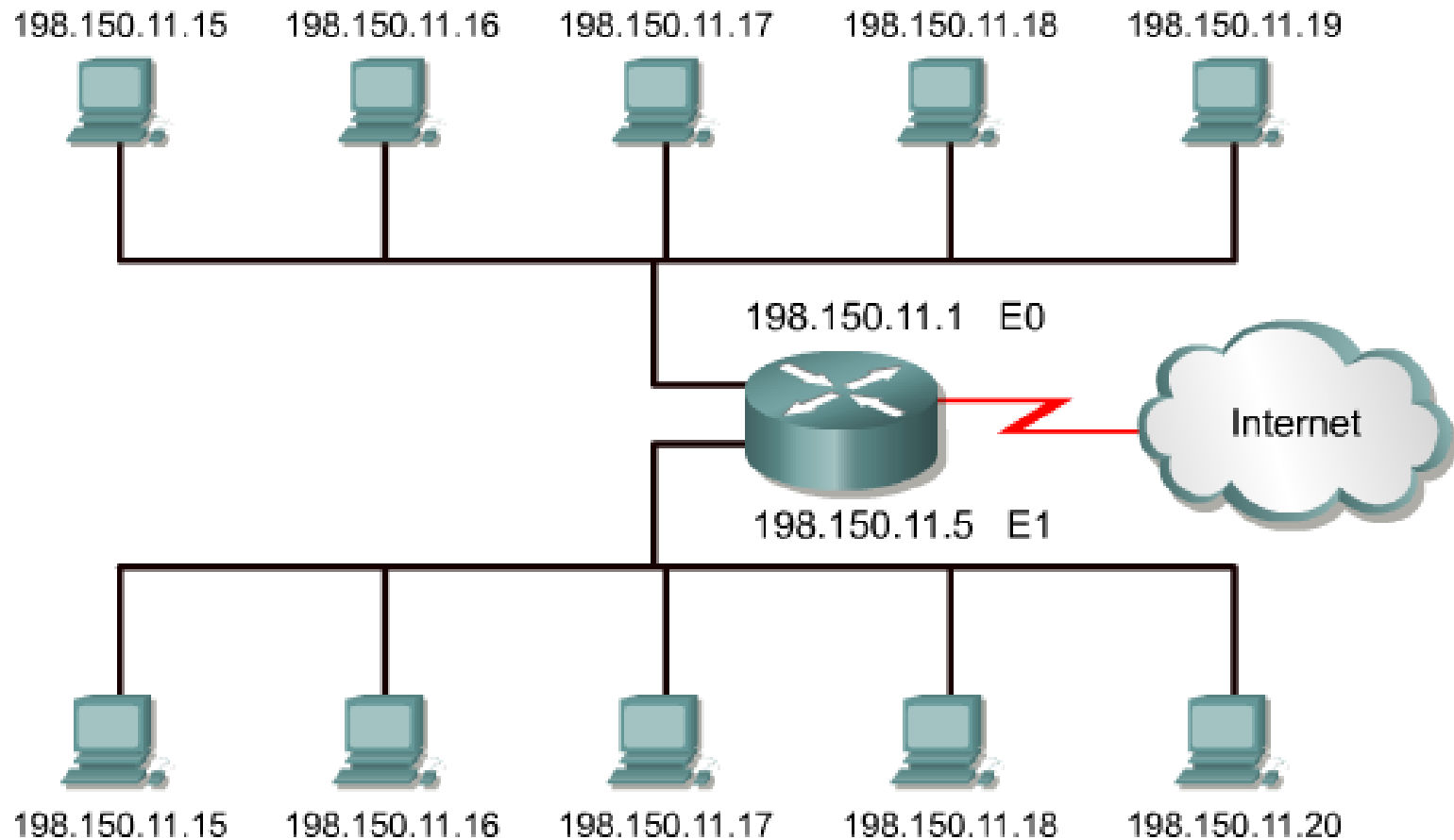
Public and private address

- But private networks (like networks in the laboratories of Ambo University) do not require public IP addresses.
- We can assign a host in a private network any address we like.
- We only make sure that each host in the private network has a unique IP address.
- This address is called a **private address**.

Private IP addresses - the problem

- A problem occurs if a private network is connected to the internet.
- Now suppose a private network is connected to the internet.
- Host X with an IP address of 198.150.11.16 wants to communicate with host Y with an address 198.150.11.16.
- Is host Y on the same private network as host X or is it a host somewhere in the internet?
- The router on the next slide will not be able to forward the data packets correctly.

Which host?



Private IP addresses -solution

- To resolve this confusion, three blocks of IP addresses have been reserved for use in private networks (specified by [RFC 1918](#)).
- These three blocks consist of a range of Class A, Class B and Class C addresses.
- These addresses are recommended for private addresses.

Private IP addresses -solution (contd.)

- Addresses that fall within these ranges are not routed on the Internet backbone.
- Internet routers immediately discard private addresses.
- If addressing a nonpublic intranet, **a test lab**, or a **home network**, these private addresses can be used instead of globally unique, public addresses.

Class		1918 internal address range
A		10.0.0.0 to 10.255.255.255
B		172.16.0.0 to 172.31.255.255
C		192.168.0.0 to 192.168.255.255

Subnetting

- Suppose we have a class A address.
- **How to assign these addresses to hosts.**
(over 16 million)?
- **Sub netting** is a process which divides a network into smaller, more manageable parts.
- Smaller parts of the network are called **subnets**.

IP address assignment

- Every host should obtain an IP address in order to exchange data OR function on the internet.
- There are two ways of assigning IP addresses to hosts.
 - **Static assignment**
 - **Dynamic assignment**

Static IP address assignment

- **Static** assignment works best on small, in frequently changing networks.
- IP addresses are manually assigned for each computer, printer, or server on the intranet.
- Servers should be assigned a static IP address so workstations and other devices will always know how to access needed services.

Dynamic IP address assignment

- Two types of dynamic IP address assignments:
 - **RARP**
 - **DHCP**
- RARP
- Stands for Reverse Address Resolution Protocol.
- Every host knows its own MAC address.
- i.e. RARP server keeps a list of MAC addresses and corresponding IP addresses.
- When a host boots up, it broadcasts a RARP request and the RARP server responds, telling the host's IP address.

DHCP

- Stands for Dynamic Host Configuration Protocol.
- A range of IP addresses which can be assigned to hosts are defined on a DHCP server.
- As hosts come online (when they boot up or when they are connected to the network), they contact the DHCP server and request for addresses.
- The DHCP server chooses an address and **leases** it to that host.
- An IP address can be leased to a host for **a week, a month, three months**, etc.

DHCP (contd.)

- When the lease time interval expires, the host requests for an IP address again.
- Beside requesting for an address, hosts can also tell the DHCP server that they no longer need the address they are using.
- This is also called **releasing an IP address**.
- After an address is released, it can be leased to another host.

Name Resolution - the problem

- In TCP/IP communications
 - a datagram on a local-area network must contain both a destination MAC address and a destination IP address.
 - These addresses must be correct and match the destination MAC and IP addresses of the host device.
 - If it does not match, the datagram will be discarded by the destination host.
 - There needs to be a way to automatically map IP to MAC addresses.
 - It would be too time consuming for the user to create the maps manually.

Solution - ARP

- The TCP/IP suite has a protocol, called Address Resolution Protocol (ARP), which can automatically obtain MAC addresses for local transmission.
- Hosts find MAC addresses by:
 - Broadcasting an ARP request, for which the destination host replies
- Once a host finds out the MAC address of a host, it adds it on its own **ARP table**.
- ARP tables contain a list of MAC addresses and IP addresses.
- To make the work more efficient, hosts consult their ARP table before sending out an ARP request.

IPv4 - drawbacks

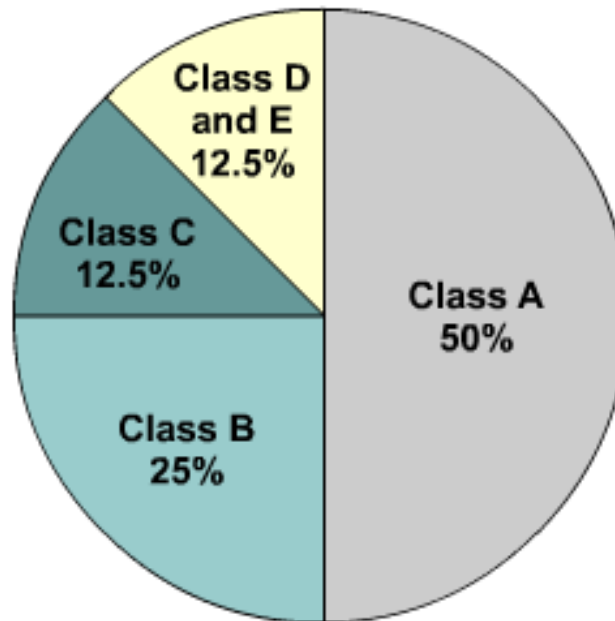
- Class A and B addresses make up 75 percent of the IPv4 address space, however fewer than 17,000 organizations can be assigned a Class A or B network number.
- Class C network addresses are far more numerous than Class A and Class B addresses, although they account for only 12.5 percent of the possible IP addresses
- Unfortunately, Class C addresses are limited to 254 usable hosts.

IPv4 - drawbacks

- This does not meet the needs of larger organizations that cannot acquire a Class A or B address.
- Even if there were more Class A, B, and C addresses, too many network addresses would cause Internet routers to come to a stop under the burden of the enormous size of the information they will need to store and process.

IPv4 – Drawbacks

With Class A and B addresses virtually exhausted, class C addresses are (only 12.5 percent) left to be assigned to new networks.



IPv6

- Among the efforts made to solve this problem (private and public IP addresses being one), a more **scalable version of IP**, called IPv6 has been developed.
- IPv6 uses **128 bits** rather than **32 bits**.
- IPv6 is slowly being implemented in selected networks.
- Eventually IPv6 is expected to replace IPv4.

Thank you!!!