Chit-Chat in Lab (CCL)

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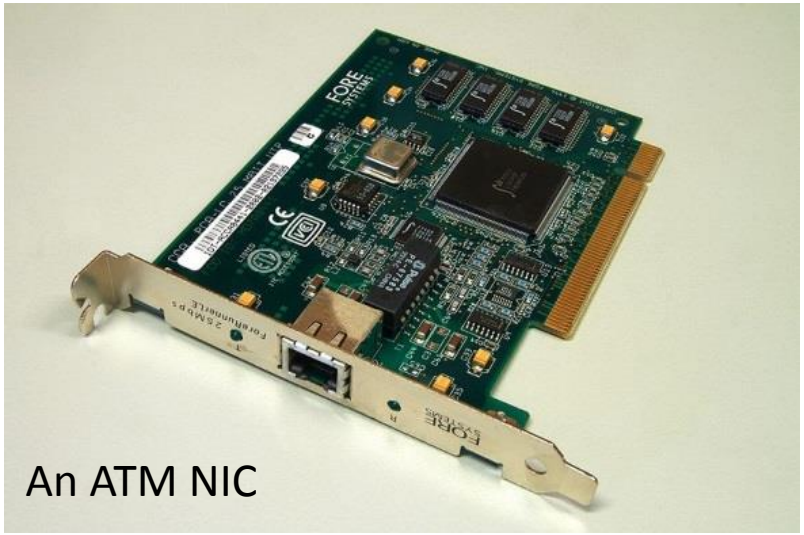
NIC

- NIC: Network Interface Controller
- It connects a device to a computer network
  - A device, e.g., a computer must have an NIC in order to connect to a network
- It is also known as
  - Network Interface Card
  - Network Adapter
  - LAN Adapter
  - Physical Network Interface
- Common manufacturers:
  - Intel, Realtek, Broadcom, Qlogic, Group,



An ATM NIC

NIC Address

- In order to communicate with other devices, each NIC needs two kinds of addresses
  - Physical Address
  - Logical Address
- Physical Address
  - One NIC can have only one Physical address
  - This is a lifetime address
  - MAC Address
- Logical Address
  - One NIC may have multiple logical address at the same time (rare use)
  - This is changeable by *Administrator* or *OS* or *DHCP server*
  - IP Address

MAC Address

- MAC: Medium Access Control
- Each NIC has a **unique** physical address known as MAC address.
- It is 48 bit long written in either of these formats:
  - MM:MM:MM:SS:SS:SS
  - MM-MM-MM-SS-SS-SS

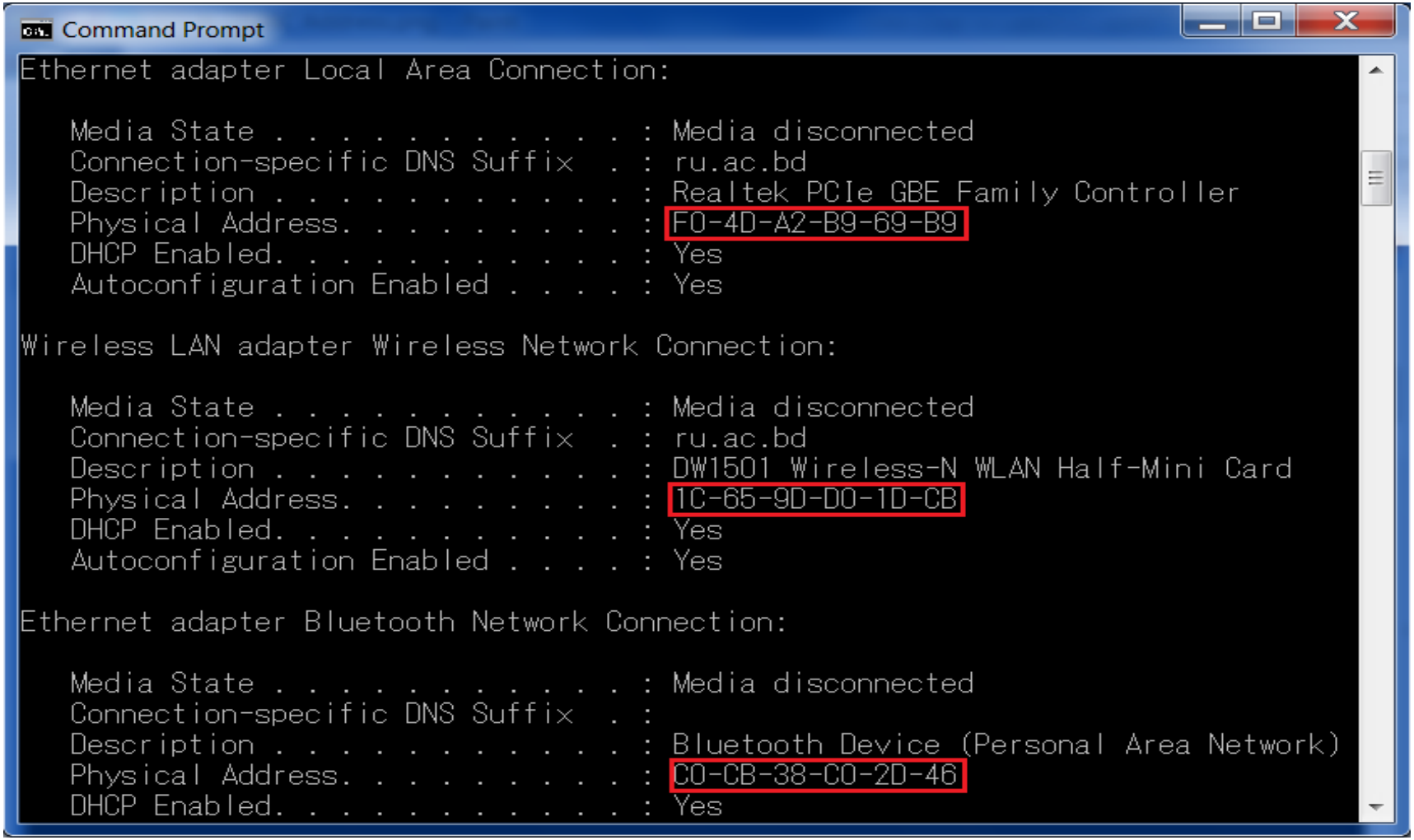
*OUI: Organizationally Unique Identifier

- It is assigned by the manufacturer of NIC
  - Inside a read-only memory
  - firmware

How to Know MAC Address

- In Windows OS
  - Go to the Command prompt
    - Click on Start button, select Run
    - Type ‘cmd’ and press ENTER
  - In the Command prompt, type **ipconfig /all** and press ENTER
- In Linux OS
  - Go to a terminal
  - In the terminal, type **ifconfig** and press ENTER

Example: A Laptop having 3 MAC Addresses



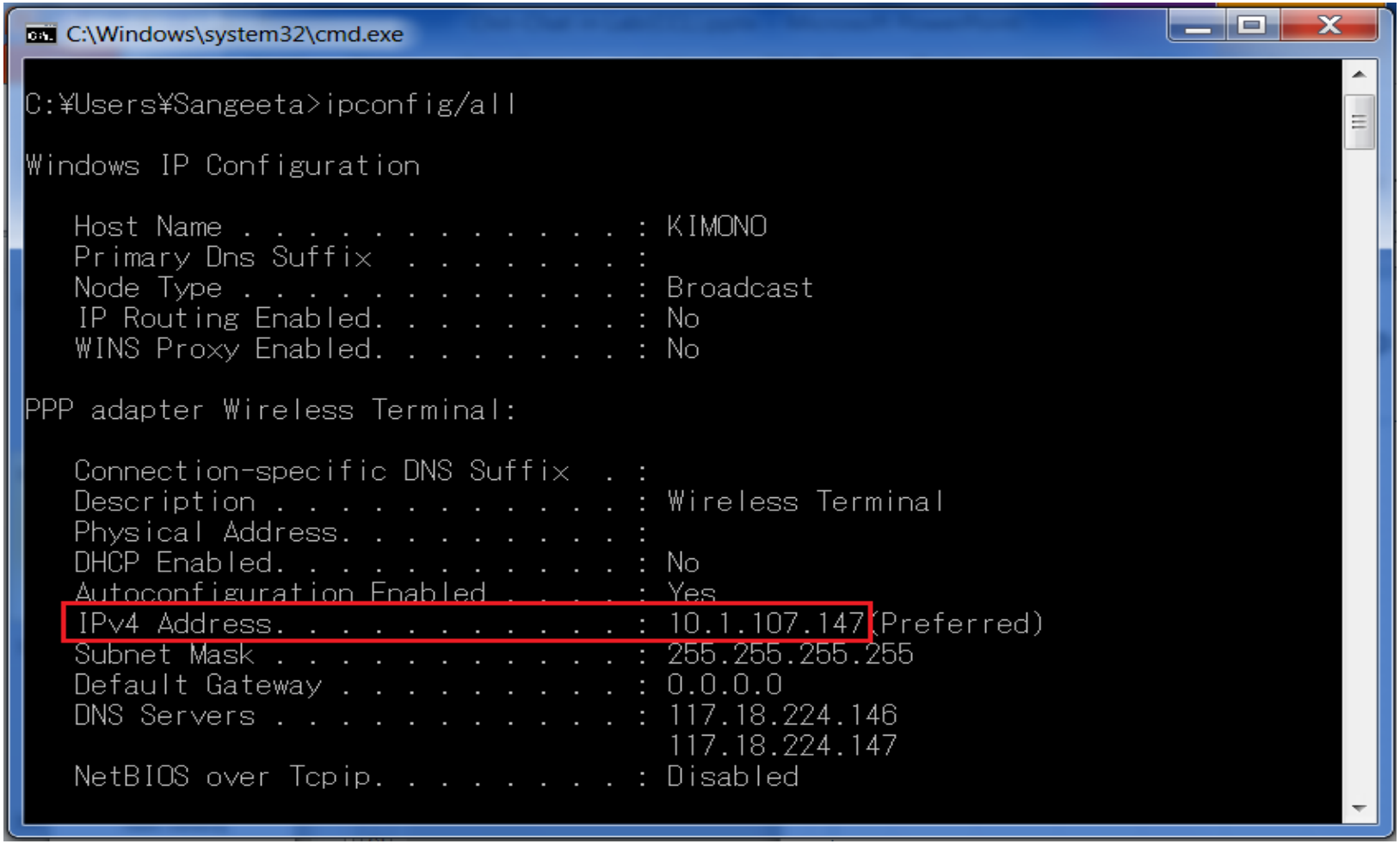
IP Address

- In order to communicate with other machines in the network based on Internet Protocol, each machine must have an IP (Internet Protocol) address.
- An IPv4(IP version 4) or IP (in short) address is 32 bit long.
  - $\mathbf{2^{32}}$ or **4,29,49,67,296** IP addresses.
- An IP address is written by 4 numbers separated by 3 dots.
  - $a.b.c.d$ where $\{0 \leq \{a, b, c, d\} \leq 255\}$
  - Example: 172.16.0.1

How to Know IP Address

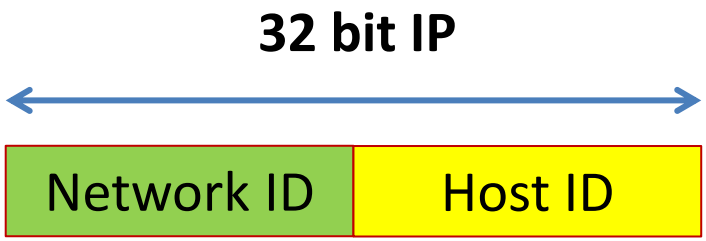
- In Command Prompt of Windows OS
  - Type ipconfig/all and Enter
- In GUI of Windows OS
  - Go to ‘Control Panel’
  - Click on ‘Network and Internet→ View network status and tasks’
  - Click on ‘Connections: ’
  - Click on ‘Details’ Tab
- In Linux
  - Open a terminal
  - Type ‘ip addr show’ to see all IP addresses
  - Type ‘ip addr show eth0’ to see IP information about eth0

Example: IP Address in Command Prompt



Parts of IP Address

- An IP address does not actually refer to a device. It refers to a network interface.
- If a device, e.g., router, is on two networks, it must have two IP addresses.
- An IP address has two parts
  1. Network ID
  2. Host ID



- There are two ways to decide the boundary of each part:
  - Classful Addressing
  - Classless InterDomain Routing (CIDR)

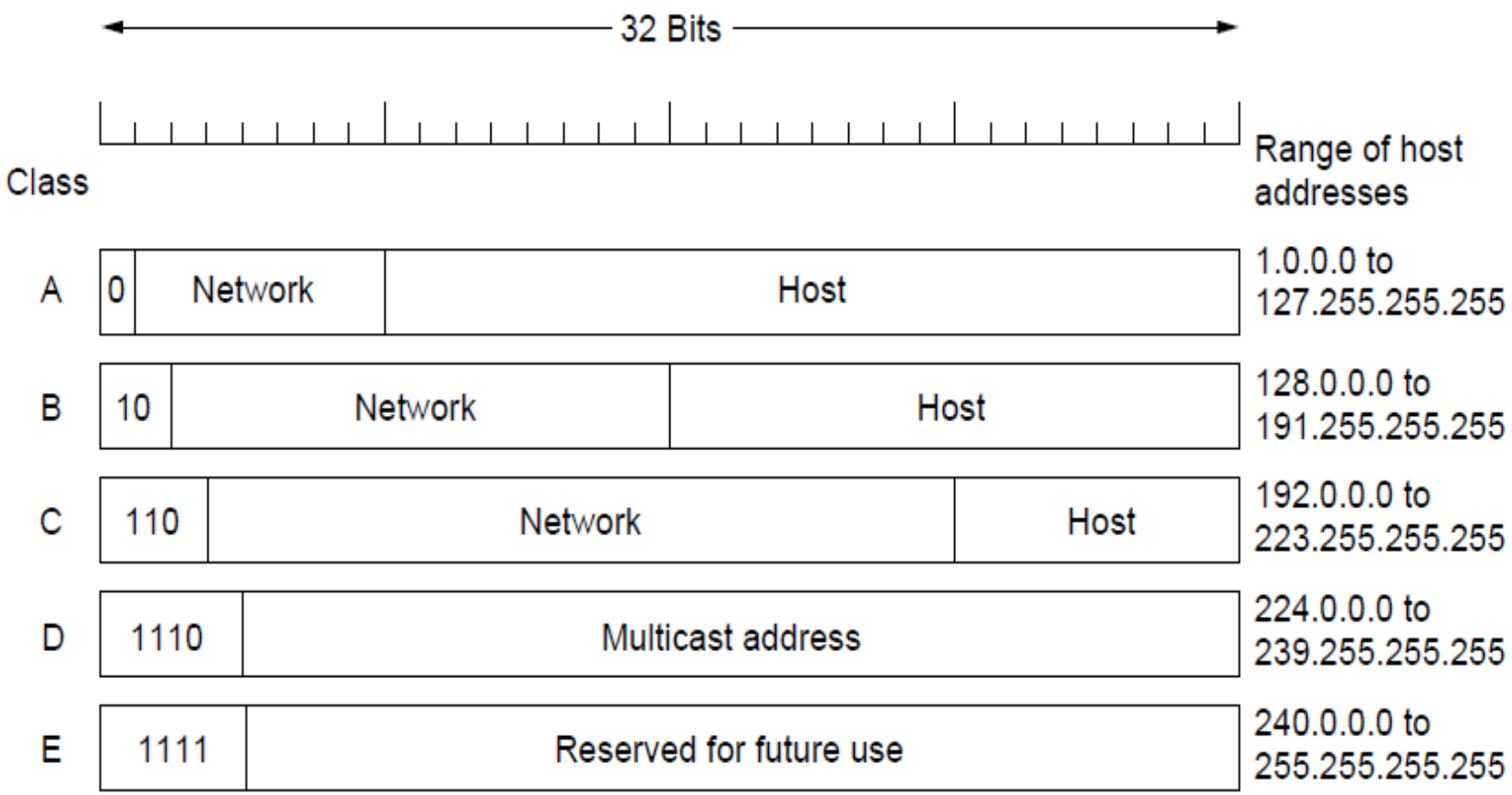
Classful Addressing

- For several decades, IP addresses were divided into 5 classes
  - Class A, B, C, D and E
- **Class A:** 128 networks with 16 million hosts

  Class B: 16,384 networks with up to 64,000 hosts

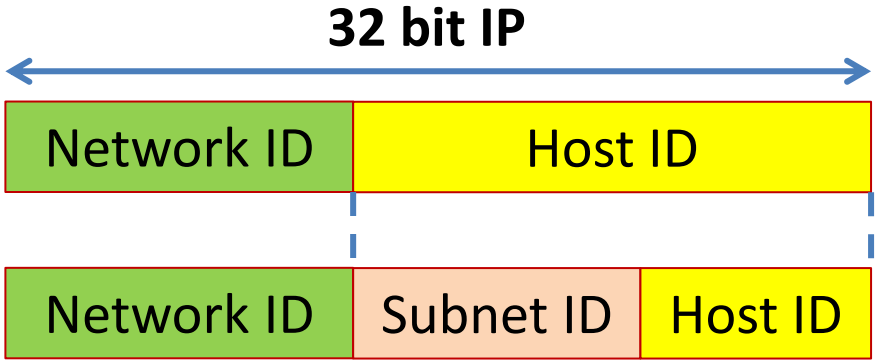
  Class C: 2 million networks with p to 256 hosts
- This concept is no longer used, only found in literature, because
  - The number of networks connected to the Internet is growing every year. Classful addressing cannot support this growth.

IP Address Range in Classful Addressing



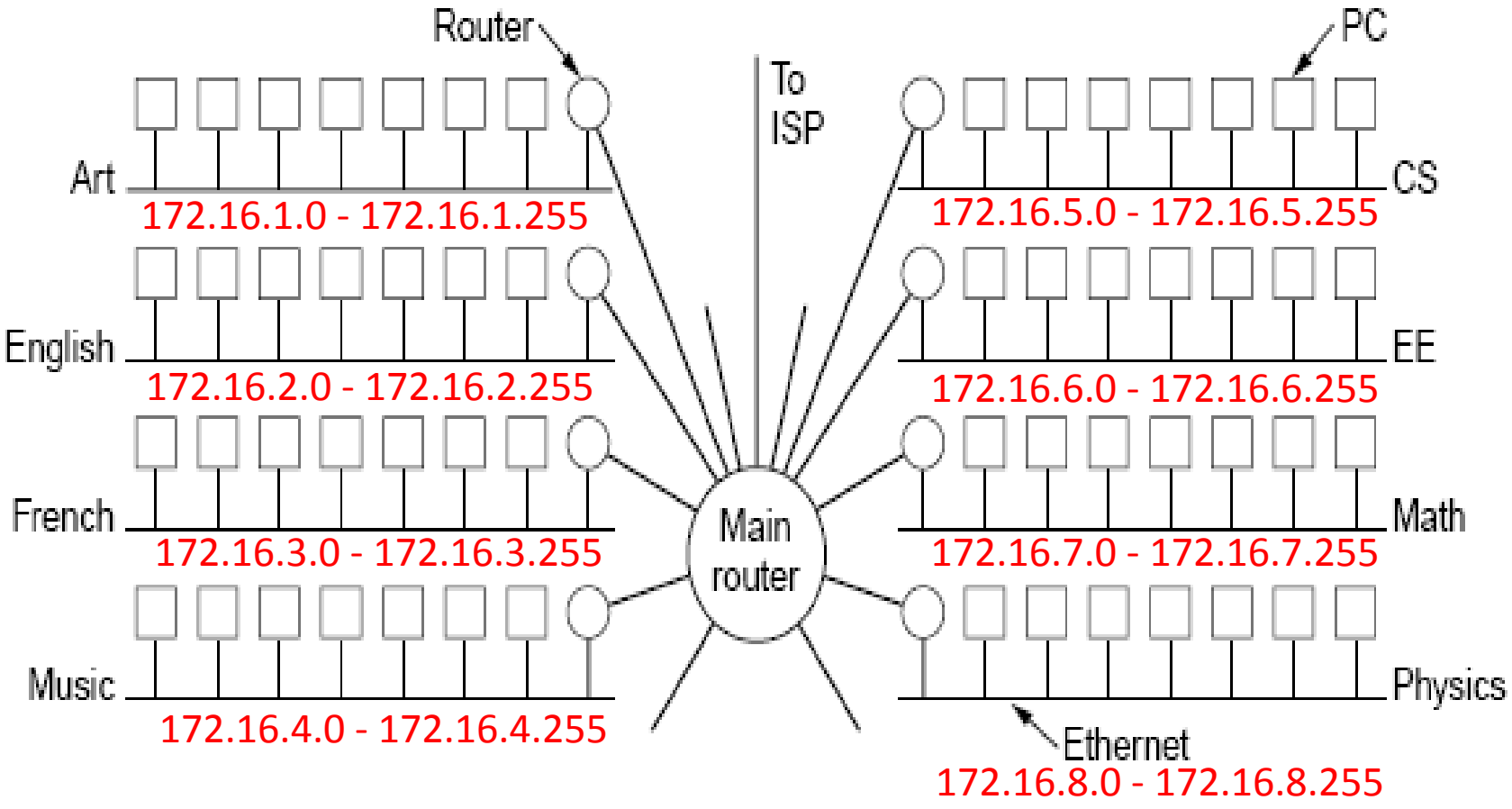
Subnetting

- The practice of dividing a network into two or more networks is called subnetting.
- A subnetwork (in short ‘subnet’) is a subdivision of a network
  - For example, a campus network having a Class B address 172.16.0.0/16 can be divided into multiple subnets so that each department can have separate networks [as shown in next page].

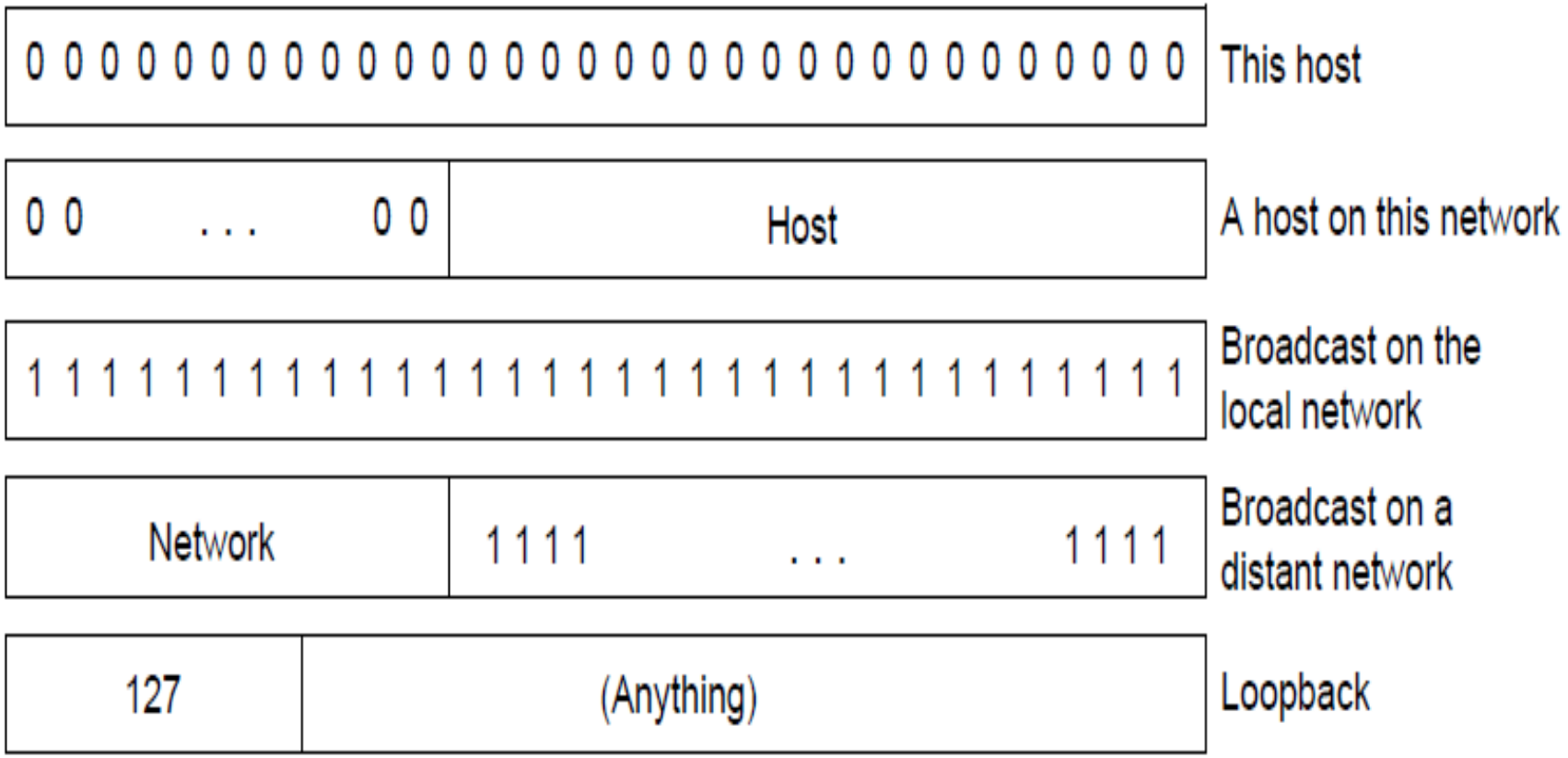


Example of Subnetting

[A Campus Network with Subnets]



Special IP Address



Private Vs Public IP Address

- Uniqueness:
  - Private IP addresses could be duplicate in different home/office/enterprise networks, e.g., LAN, as long as they are not interconnected.
  - Public IP addresses cannot be duplicate. In order to communicate on Internet, each machine must have **a unique global/public/real IP** address.
- Responsible:
  - Network administrator is responsible for deciding private IP addresses for a private network
  - IANA and 5 RIRs(APNIC, AfriNIC, ARIN, LACNIC & RIPE NCC) are responsible for managing real IP addresses.

Range of Private IP Addresses

- Private IP assigned by network administrator:
  - ❖ 10.0.0.0 - 10.255.255.255
  - ❖ 172.16.0.0 - 172.31.255.255
  - ❖ 192.168.0.0 - 192.168.255.255
- Private IP assigned by Operating System
  - 169.254.0.0 -169.254.255.255
  - It is enabled by default in Microsoft Windows OS.
  - It could occur on a network
    - without a DHCP server, or
    - if a DHCP server is temporarily down for maintenance

Authority for Managing IP

- **IANA: Internet Assigned Numbers Authority**
- **IANA** is responsible for the global coordination of
  - the DNS Root,
  - **Internet number**
  - other Internet protocol resources.
- Internet number resources include:
  - **IP addresses**
  - autonomous system (AS) numbers
- **RIR: Regional Internet Registry**
- RIR is an organization that manages the allocation and registration of Internet number resources (e.g., **IP addresses**) within a particular region of the world.

Division of World into RIRs

1. AfriNIC (African Network Information Centre): Africa
2. ARIN (American Registry for Internet Numbers): the United States, Canada, several parts of the Caribbean region, and Antarctica.
3. APNIC (Asia-Pacific Network Information Centre): Asia, Australia, New Zealand, and neighboring countries
4. LACNIC (Latin America and Caribbean Network Information Centre): Latin America and parts of the Caribbean region
5. RIPE NCC(Réseaux IP Européens Network Coordination Centre): Europe, Russia, the Middle East, and Central Asia

[3]

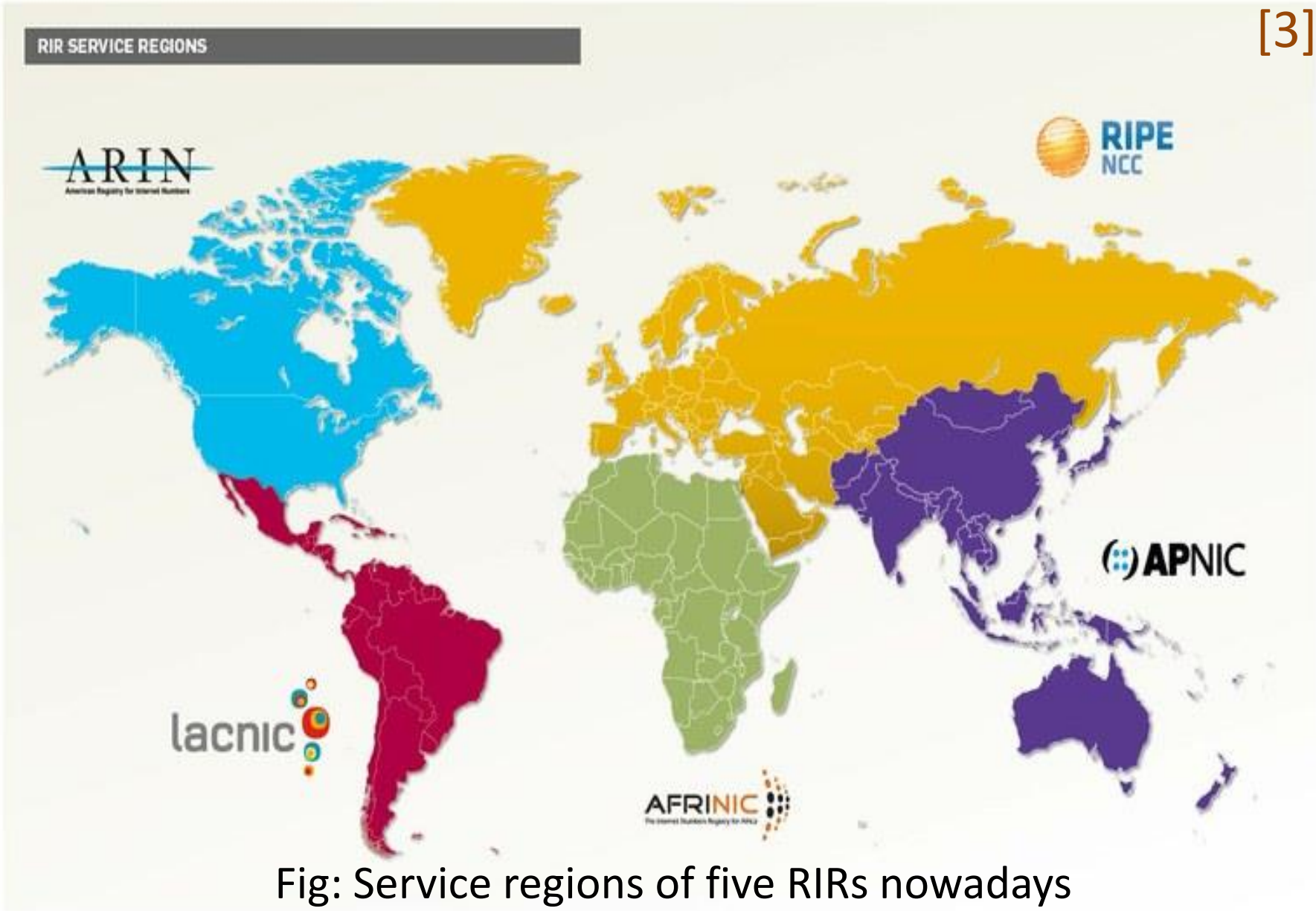


Fig: Service regions of five RIRs nowadays

[2]

Fig: Service regions of three RIRs in 2002-2005

[2]

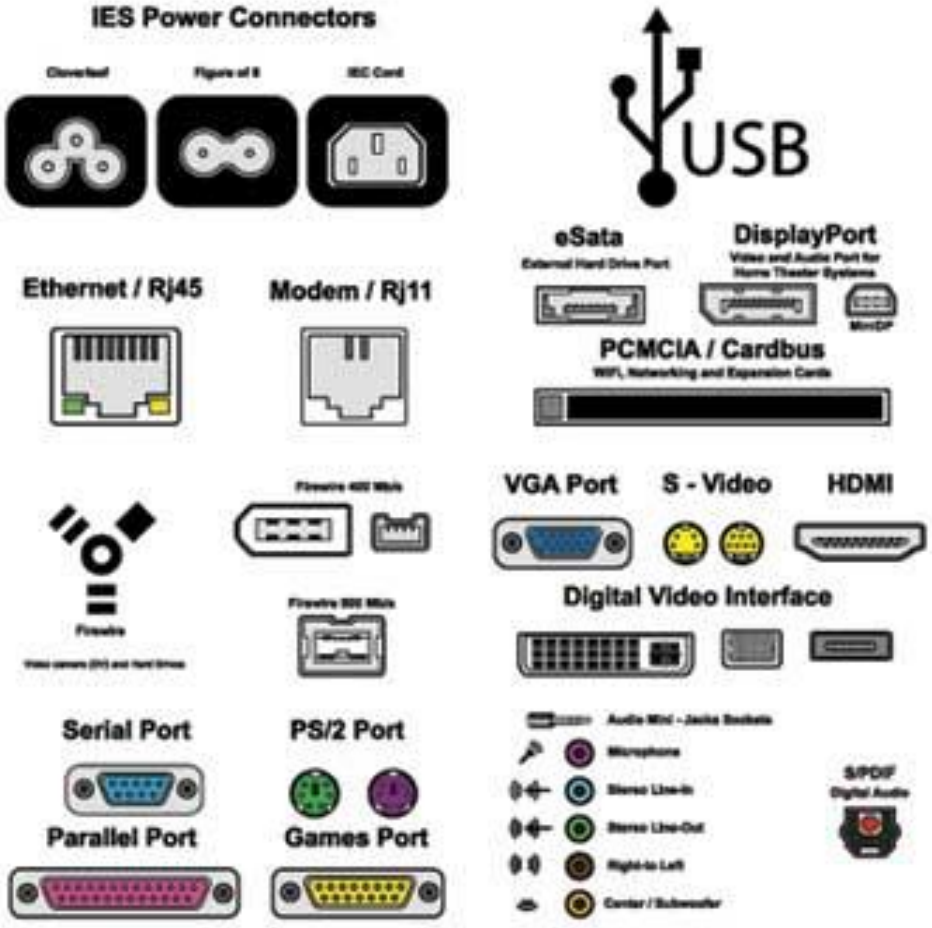
Fig: Service regions of three RIRs in 2002

APNIC

- Founded: 13 January, 1993
- Focus:
  - **allocating IPv4** and IPv6 address space, and Autonomous System Numbers,
  - maintaining the public Whois Database for the Asia Pacific region,
  - representing the interests of the Asia Pacific Internet community on the global stage.
- Location: Brisbane, Queensland, Australia
- Website: www.apnic.net
- Members: 4,737 from 56 economies
  - **Bangladesh has 207 members** here [checked on 20.3.2015]

Port

- In computer networking ‘port’ refers to connectio points.
- There are two kinds of ports
    1. Physical port
    2. Logical port
- Physical Port:
    - ❖ an interface on a device in which user can insert a connector for that device

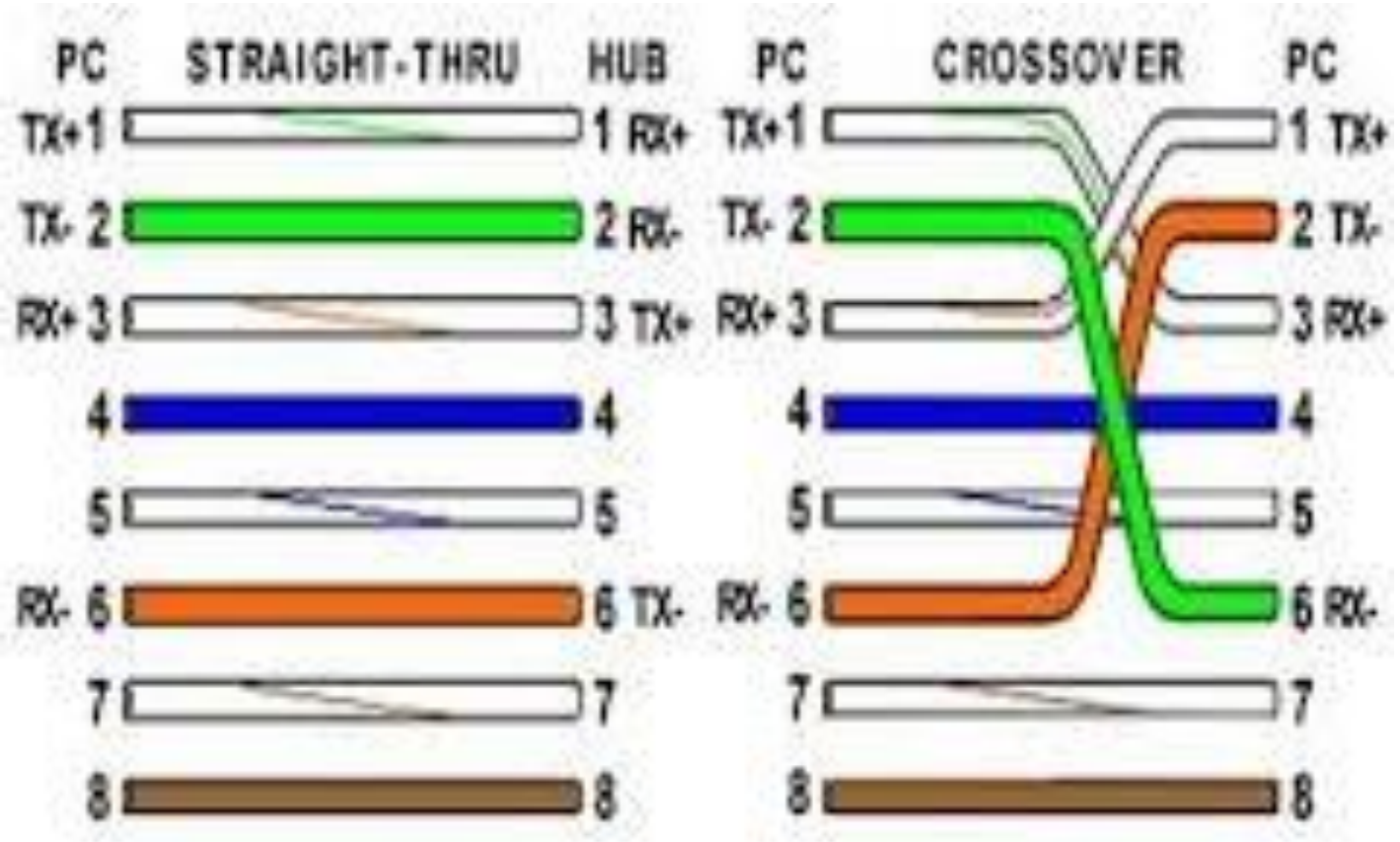


Different kind of Physical Ports

Logical Port

- A port is an end-point of a logical connection and the way where a client program specifies a particular server program on a computer in a network.
- It is always associated with an IP address of a host and the protocol type of the communication.
- A logical port number is 16-bit long.
  - There are 0-65535 logical port numbers.
  - 0-1024 numbers are used for well-known services.
  - Well-known port numbers are assigned by IANA.
- Some well-known ports
  - 20 → FTP data 21 → FTP control
  - 53 → DNS service 80 → HTTP
  - 546 → DHCP Client 547 → DHCP Server

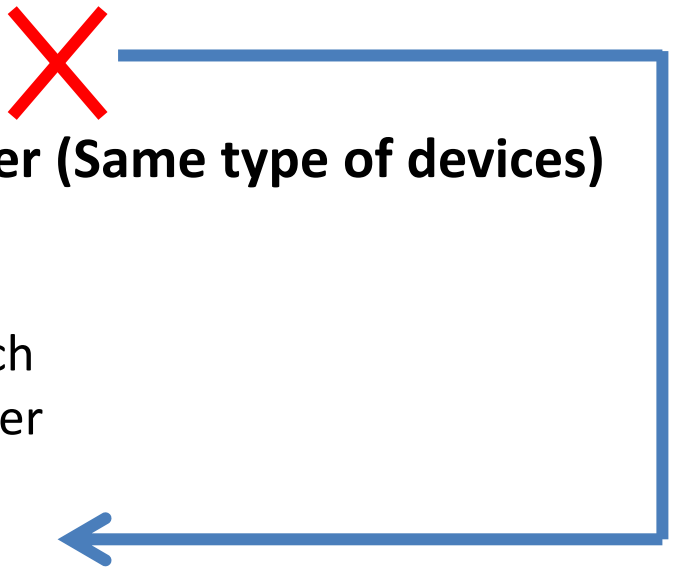
Connection: Straight-Through vs. Cross-Over



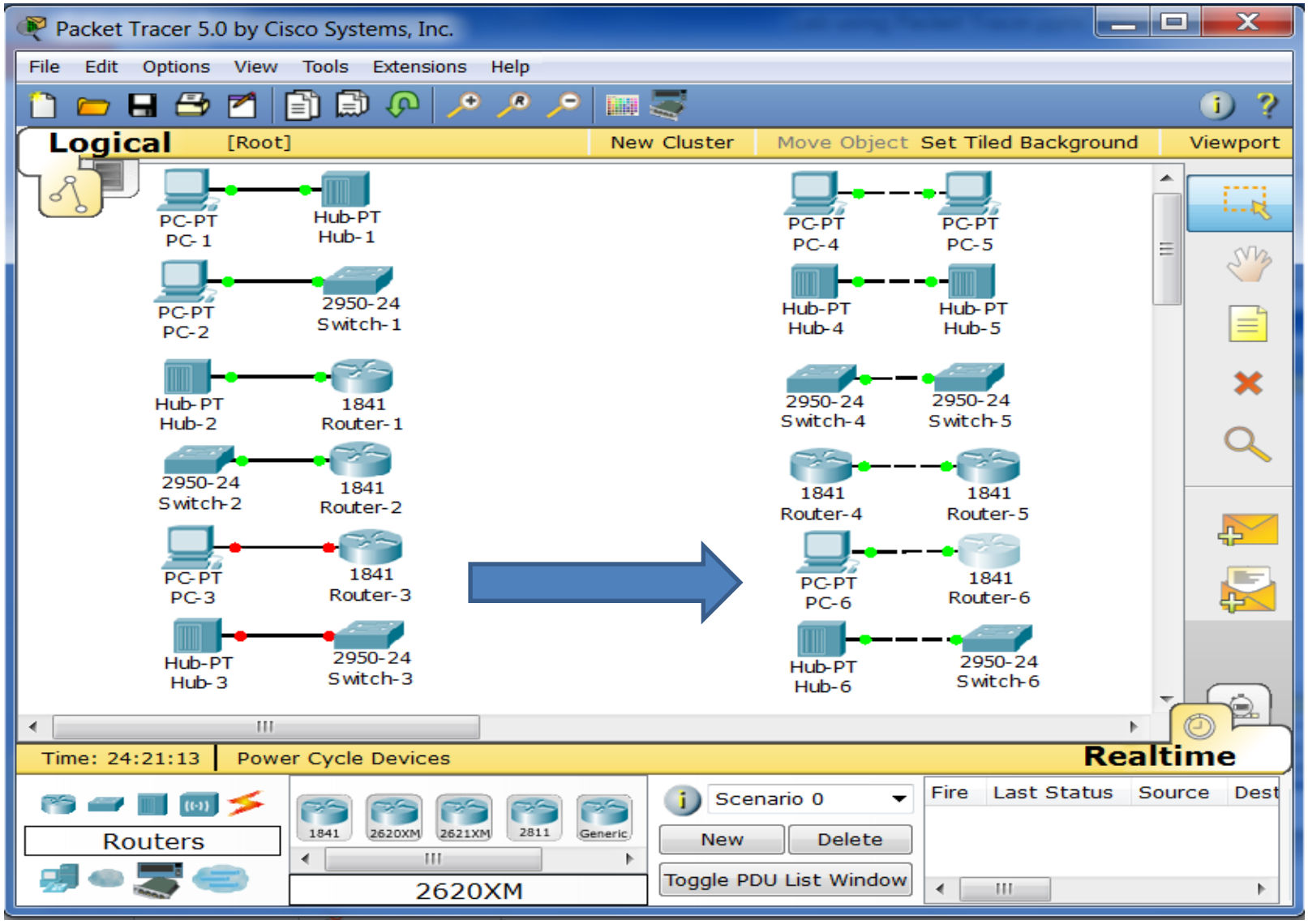
*** In Cross-over connection, only (1&3) and (2&6) are crossed

End-points: Straight-Through vs. Cross-Over

- **Straight-Through (Different type of devices)**
  - PC-to-Hub
  - PC-to-Switch
  - Switch-to-Router
  - Hub-to-Router
  - **PC-to-Router**
  - **Hub-to-Switch**
- **Copper Cross-Over (Same type of devices)**
  - PC-to-PC
  - Hub-to-Hub
  - Switch-to-Switch
  - Router-to-Router
  - **PC-to-Router**
  - **Hub-to-Switch**



Coper Straight-Through Vs. Cross-Over



DHCP

- DHCP : Dynamic Host Configuration Protocol
- It is a protocol used to **automatically/dynamically provide network configuration information** to devices connected to an IP network.
- DHCP usually provides:
  - **IP Address**
  - Subnet mask
  - Gateway address
  - Name server address

Advantages of DHCP(1)

- **Reduced time to configure and deploy:** When the number of hosts is large in a network, DHCP is faster than human engineer especially than inexperienced/ non-technical administrator to allocate unique IP addresses.

- **Reliable IP address configuration:** DHCP minimizes configuration errors caused by manual IP address configuration, such as typographical errors, or address conflicts caused by the assignment of an IP address to more than one computer at the same time.

Advantages of DHCP(2)

- **Reduced network administration:** DHCP includes features to efficiently handle the IP address changes for clients that must be updated frequently, such as those for portable computers that move to different locations on a wireless network. This feature reduces operational overhead of network administrator.

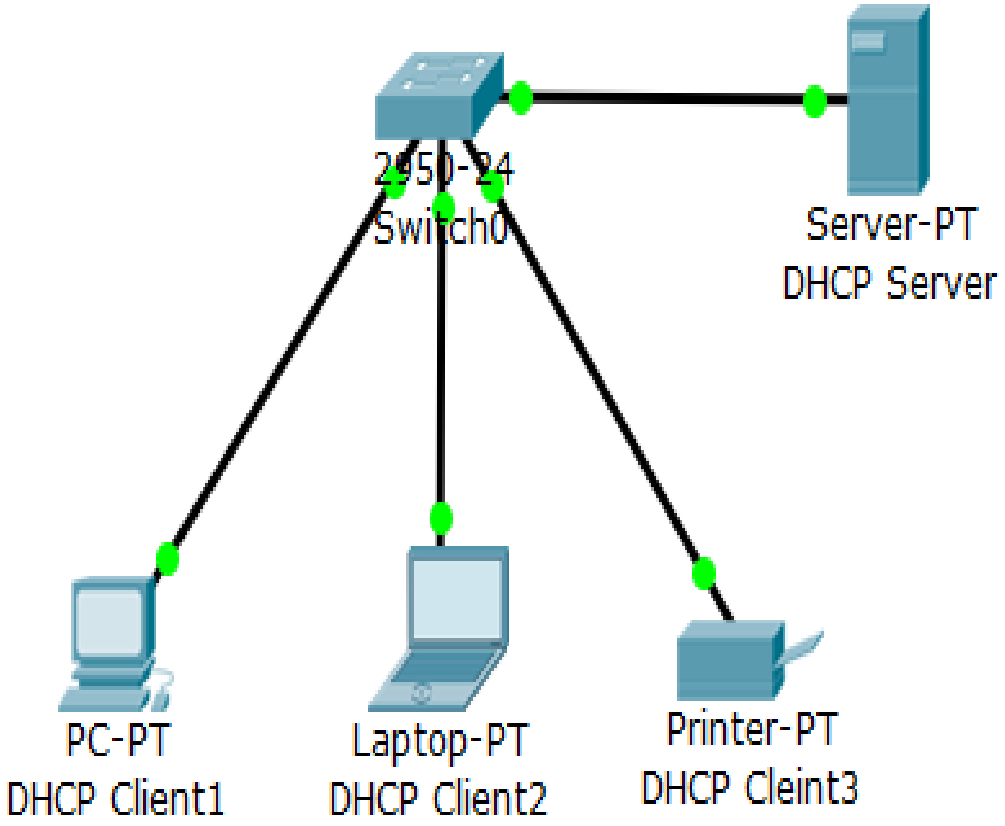
- **Centralized management:** The DHCP Server maintains configurations for several networks. Therefore, an administrator only needs to update a single, central server when configuration parameters change.

Advantages of DHCP(3)

- **Reduced costs:**
  - Using automatic IP address assignment at each remote site substantially reduces Internet access costs. Static IP addresses are considerably more expensive to purchase than are automatically allocated IP addresses.
  - Because DHCP is easy to configure, it minimizes costs associated with device configuration tasks and eases deployment by nontechnical users.

DHCP Server-Client Model

- DHCP is based on a server-client model.
  - **DHCP Server**: maintains TCP/IP configuration information and provide address configuration to DHCP-enabled clients in the form of a lease offer.
  - **DHCP Client**: obtains an IP address from a DHCP Server dynamically using the DHCP protocol.



DHCP Address Pool

- Address pool is a set of IP addresses decided by a Network engineer for allocating to DHCP clients by the DHCP server.
- The nature of IP addresses received by DHCP clients will depend on the nature of IP addresses in the pool.
  - For example, if 192.167.23.0 255.255.255.0 is assigned to a pool, DHCP clients will dynamically get **254 real IP** addresses in the range 192.167.23.1-192.167.23.254.
  - On the other hand, if 192.168.23.0 255.255.255.0 is assigned to a pool, DHCP clients will dynamically get **254 private IP** addresses in the range 192.168.23.1-192.168.23.254.

Allocation of IP Addresses

1. Based on availability and usage policies set on the DHCP server, it chooses an appropriate address (if any) from its pool to give to the client.
2. The DHCP Server pings chosen address a certain times before assigning that address to the requesting client.
3. If the ping is unanswered, the DHCP Server assumes (with a high probability) that
   - the address is not in use and
   - reserves the address to the requesting client.

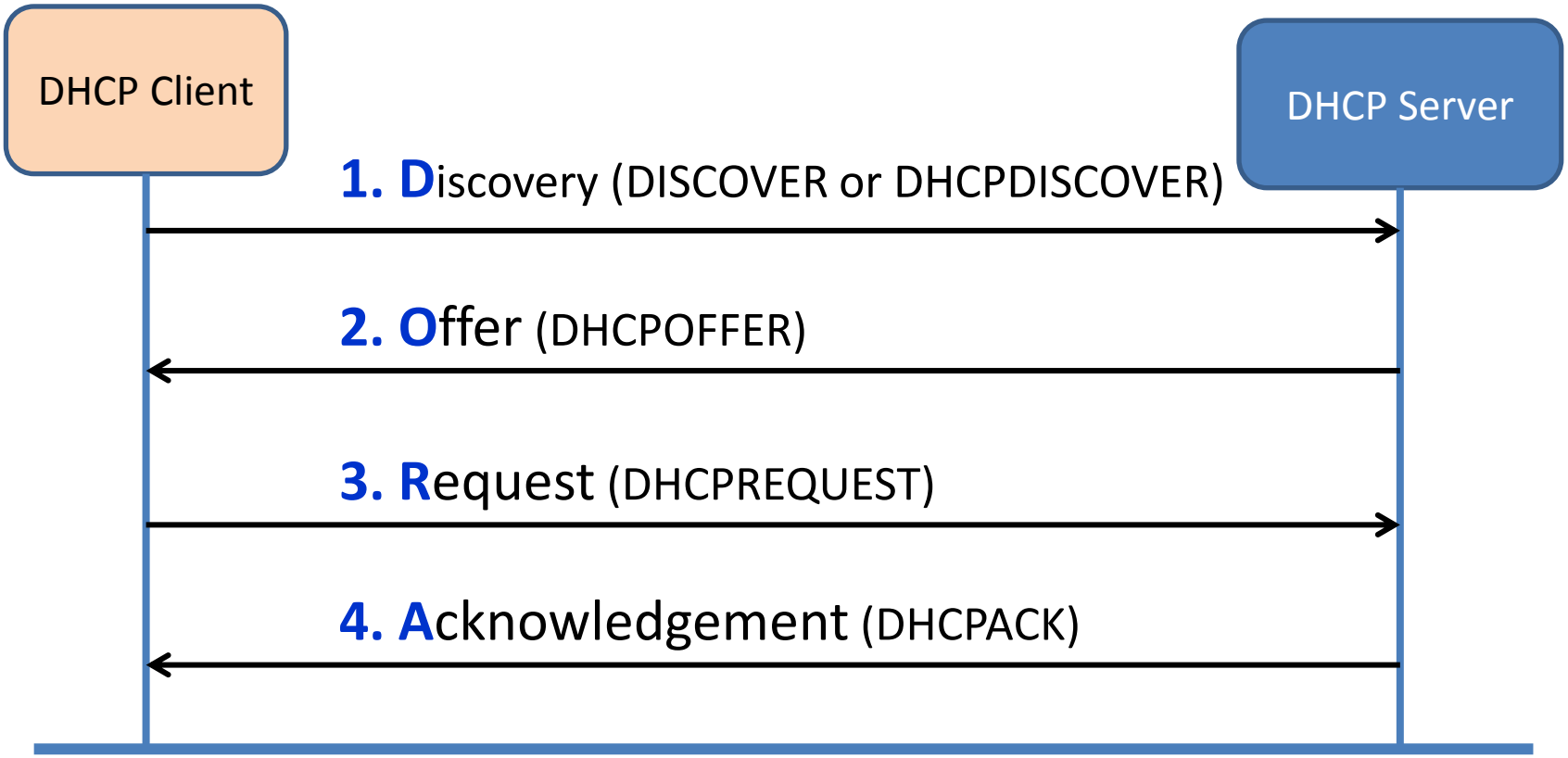
Steps for Getting an IP Address

When a machine connected in the network is turned on with a DHCP client:

1. The **client sends a broadcast request** (called a DISCOVER or DHCPDISCOVER), looking for a DHCP server to answer.
2. The **DHCP server** temporarily reserves an IP address for the client and **sends back to the client an OFFER (or DHCPOFFER) packet**, with that address information.
3. The **client sends a REQUEST (or DHCPREQUEST) packet**, letting the server know that it intends to use the address.
4. The **server sends an ACK (or DHCPACK) packet**, confirming that the client has a been given a lease on the address for a server-specified period of time.

DORA

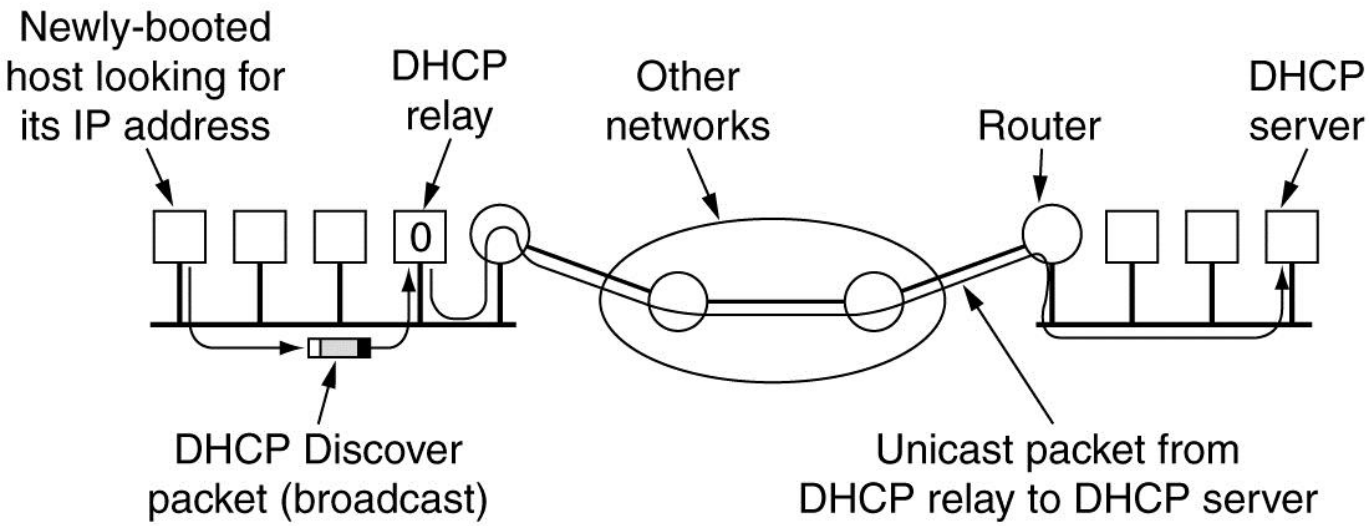
- DHCP's steps are abbreviated as DORA



DHCP Relay Agent

- Along with the DHCP server and DHCP clients, there is a **DHCP relay agent** in DHCP.
- A DHCP relay agent relays DHCP packets between clients and servers, when they are not on the same physical subnet/ network.
- Because DHCP is a broadcast-based protocol, by default its packets do not pass through routers. A DHCP relay agent receives any DHCP broadcasts on the subnet and forwards them to the specified IP address on a different subnet.
- Relay agent forwarding is distinct from the normal forwarding of an IP router, where IP datagrams are switched between networks somewhat transparently.

Operation of DHCP Relay Agent



- When a relay agent receives DHCP messages, it sets the gateway address (giaddr field of the DHCP packet) and if configured, adds the relay agent information option (option82) in the packet and forwards it to the DHCP server.
- The reply from the server is forwarded back to the client after removing option 82.

Limited Access

- After the network adapter has been assigned an IP address, the computer can use TCP/IP to communicate with any other computer that is:
  - connected to the same LAN and that is also configured for APIPA or
  - has the IP address manually set to the 169.254.x.y (where x.y is the client's unique identifier) address range with a subnet mask of 255.255.0.0.
- The computer cannot communicate with
  - computers on other subnets, or
  - computers that do not use APIPA, i.e., that got IP addresses from DHCP servers

  [[Computer with an APIPA address has **'Limited Access** ']]

DHCP Configuration using Packet Tracer 6.1

Recommended PDF :

Chapter : Configuring DHCP

Cisco IOS IP Configuration Guide Release 12.2

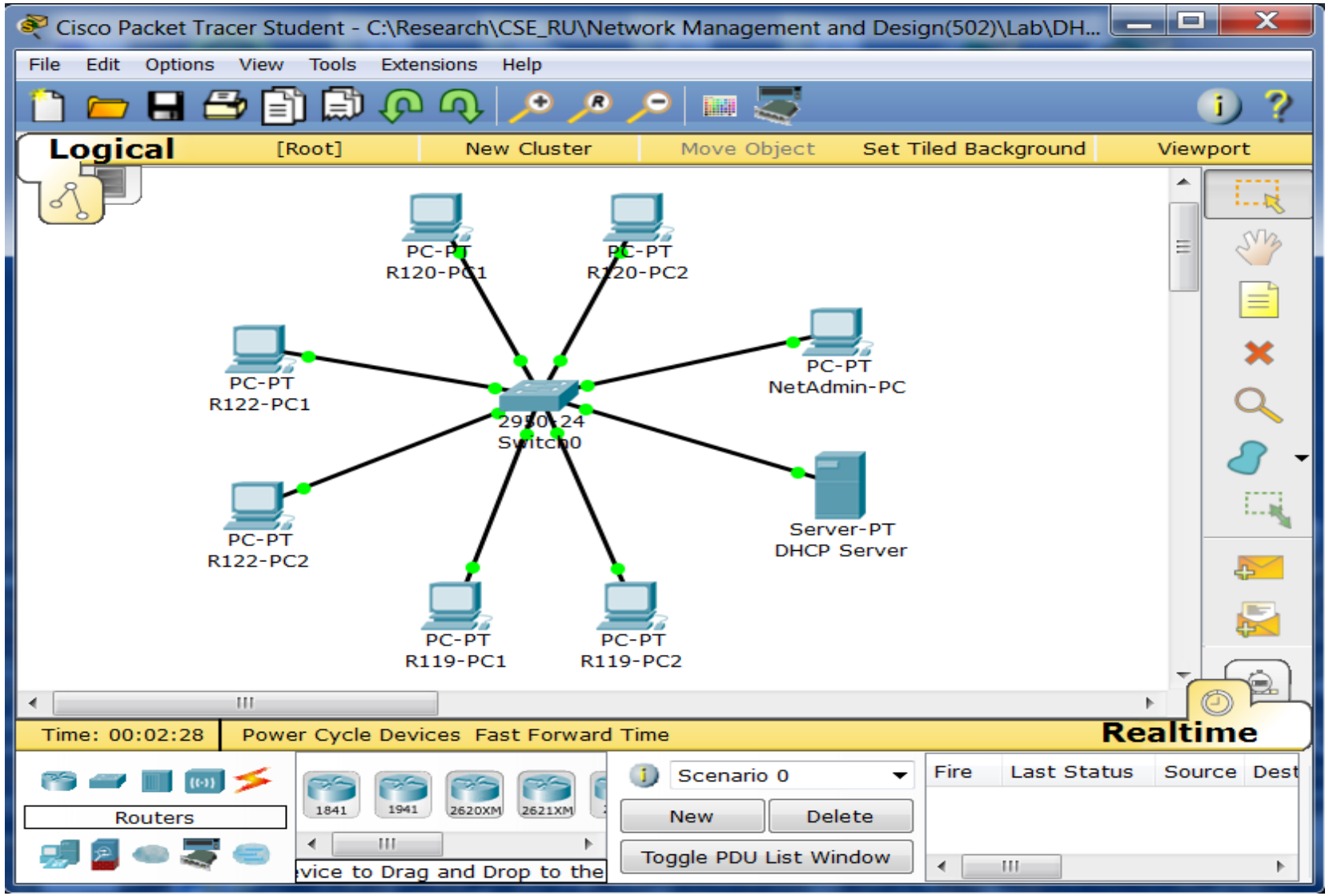
Problem-1

- Configure a DHCP server for a simple LAN of 8 machines covering four rooms of our CSE department
  - Rooms: admin, R122, R120 and R119
  - At most 30 machines can be attached to this LAN
  - Start IP address: 172.16.0.0
  - DHCP Server's IP address: 172.16.0.1
  - Other machines will get IP addresses from DHCP server when they will be booted. Say if PC-1 of R122 is booted earlier than PC-1 of R119, then R122-PC1 will get lower IP address.

Solution: CSE Network-1

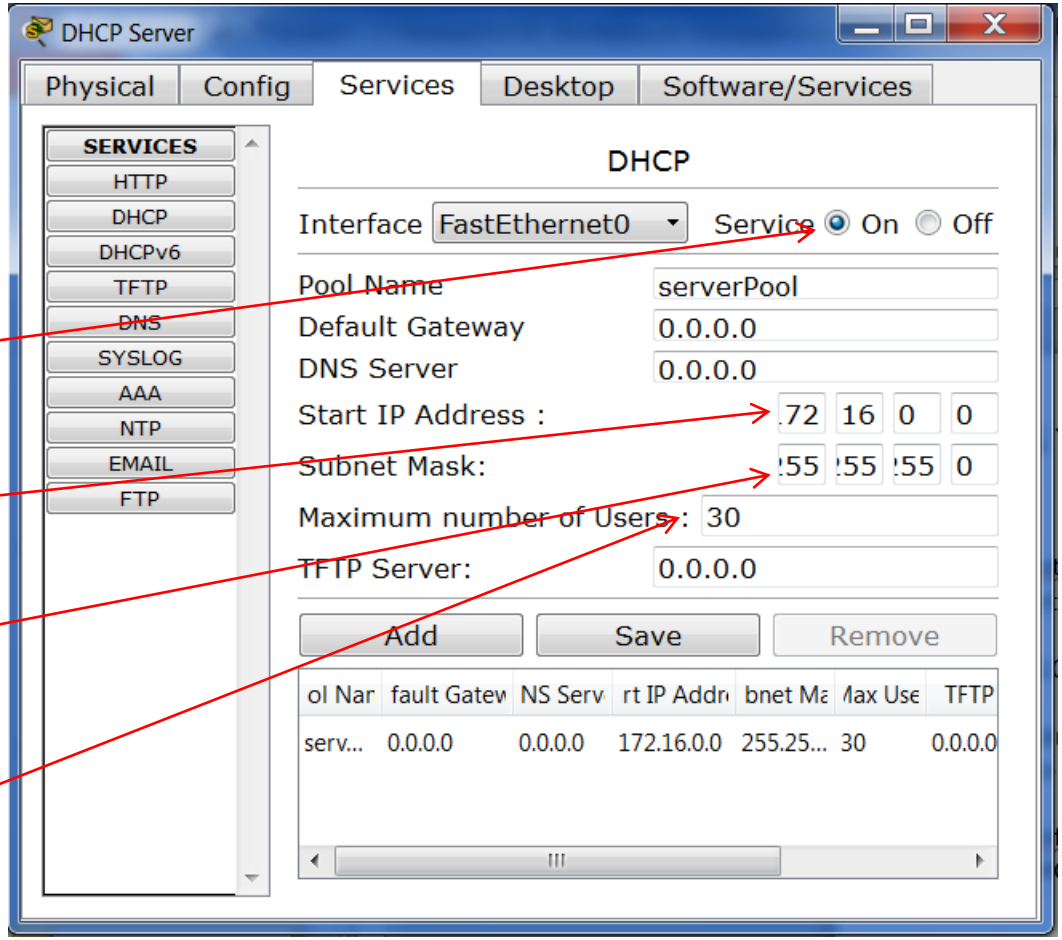
1. Take one Server and one PC for Admin's room(say, admin).
2. For other three rooms (say R122,R120 and R119), take 2 PCs.
3. Connect all machines to a Switch using **Copper Straight-Through** connector.
4. Wait for a while so that all connections will have green boxes indicating that all machines are connected to Switch.
5. Change name of all machines, eg., R122-PC1, R119-PC1 or NetAdmin-PC, etc. [Figure in next slide]
6. Assign an static IP, say 172.16.0.1, to DHCP server.
7. Rest of the 7 machines will get IP addresses dynamically from the server after DHCP server configuration completed.

DHCP Server Configured in a Server Machine



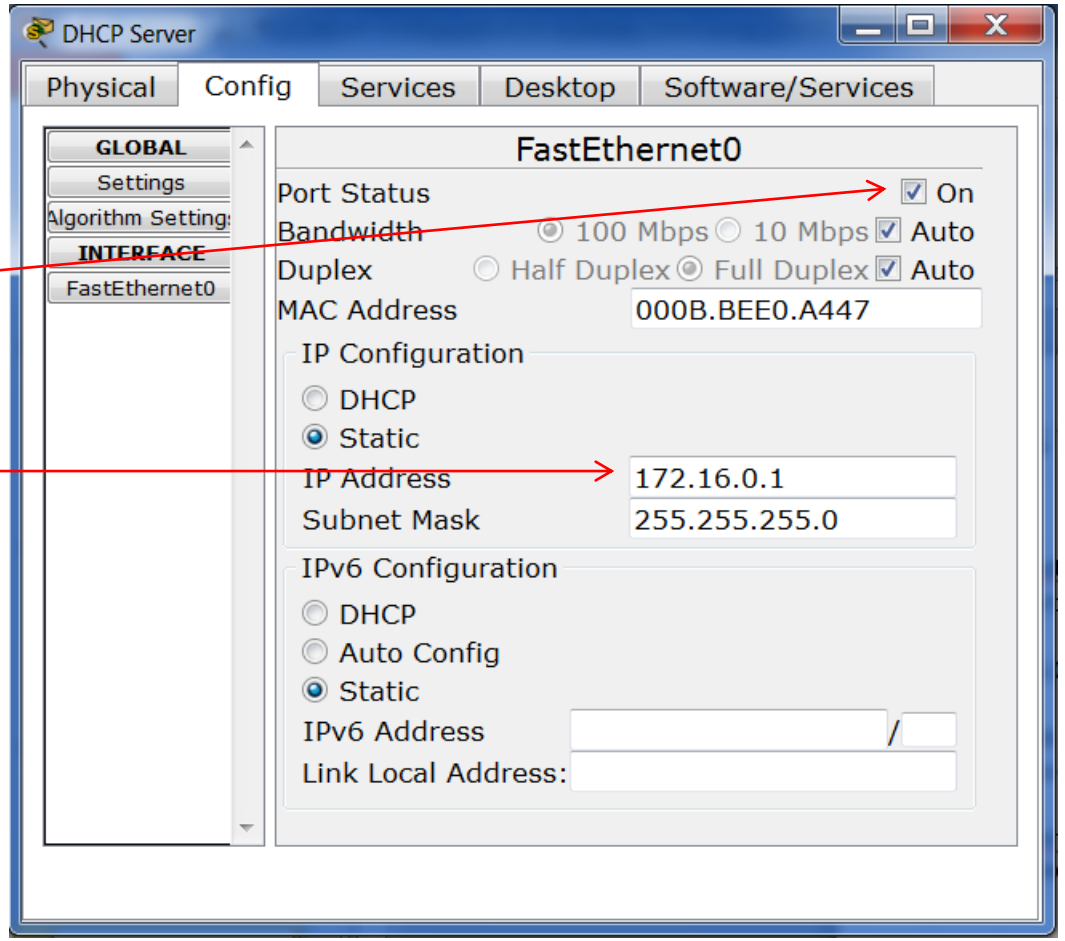
Steps for DHCP Configuration(1)

1. Double click on DHCP server.
2. Open '**Services**' window
3. Click on DHCP
4. Click on Service (On) radio button
5. Put 172.16.0.0 into **'Start IP Address'.**
6. Set Subnet Mask 255.255.255.0
7. Put 30 into **'Maximum number of Users'** box.
8. Click on 'Save' button



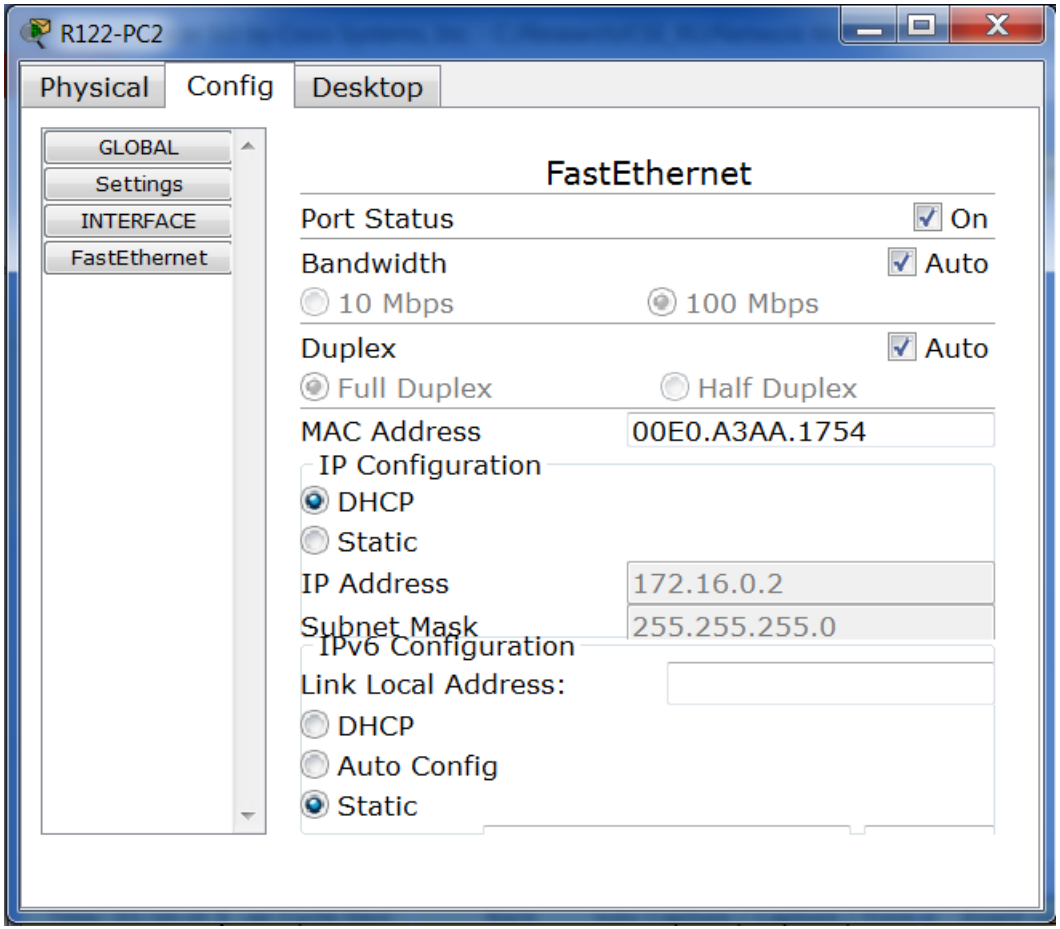
Steps for DHCP Configuration(2)

8. Click on Config-> FastEthernet
9. Ensure ‘Port Status’ is checked.
10. Put 172.16.0.1 into **‘IP Address’.**
11. Click on Subnet Mask (it will be automatically changed)
12. Close ‘Config’ window of DHCP Server.



Steps for IP Address Allocation

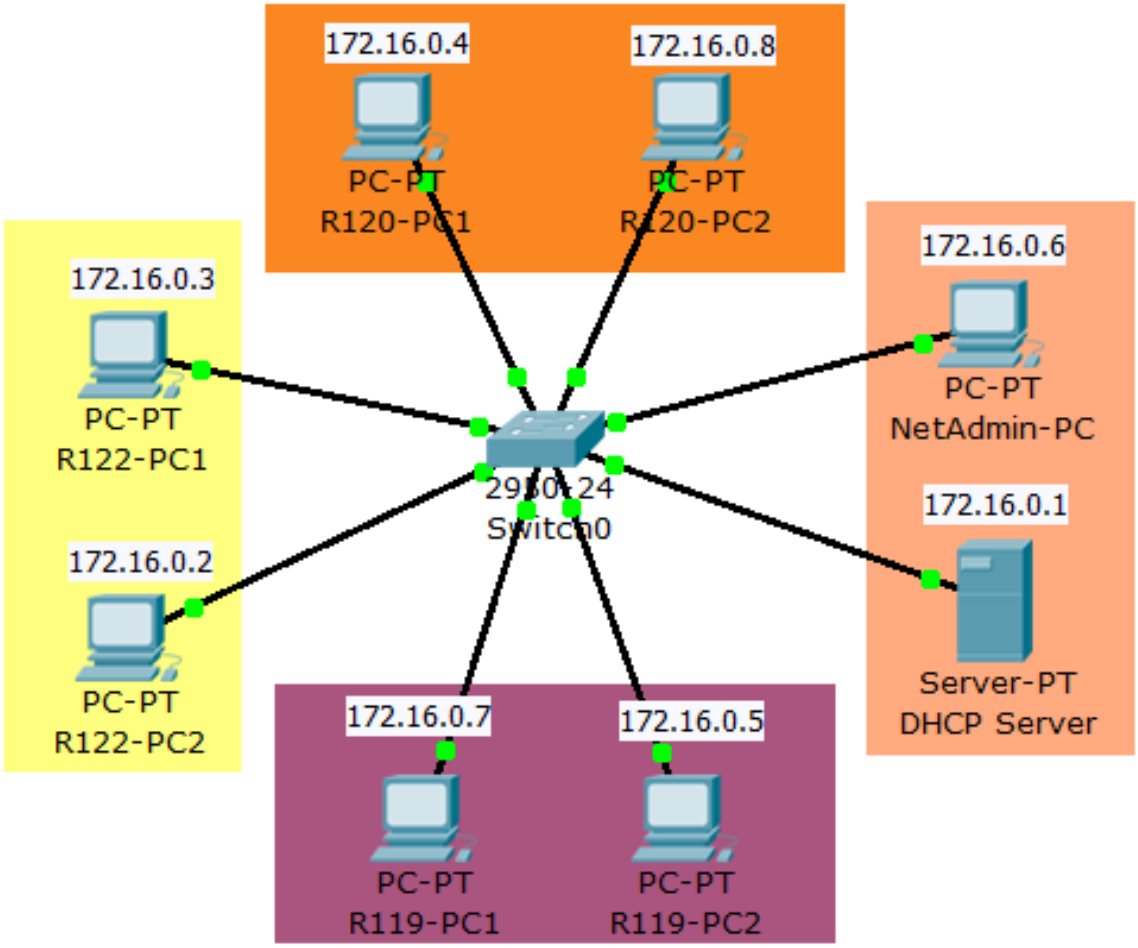
1. Open ‘Config’ window of a client, e.g., PC.
2. Click on FastEthernet.
3. Ensure ‘Port Status’ is checked.
4. Click on **‘DHCP’** radio button
5. Wait for a while
6. Close ‘Config’ window of PC.



Final Look of CSE Network-1

* PCs of R122 got sequential IP addresses while PCs of other rooms got discontinuous addresses.

* Allocation of IP addresses was dependent on the clients' booting sequence.



Problem-2

- Configure a DHCP server for CSE simple LAN
  - R122, R120, R119 and admin rooms could have at most 254 machines
  - Range of IP address:

    admin: 172.16.0.1-172.16.0.254

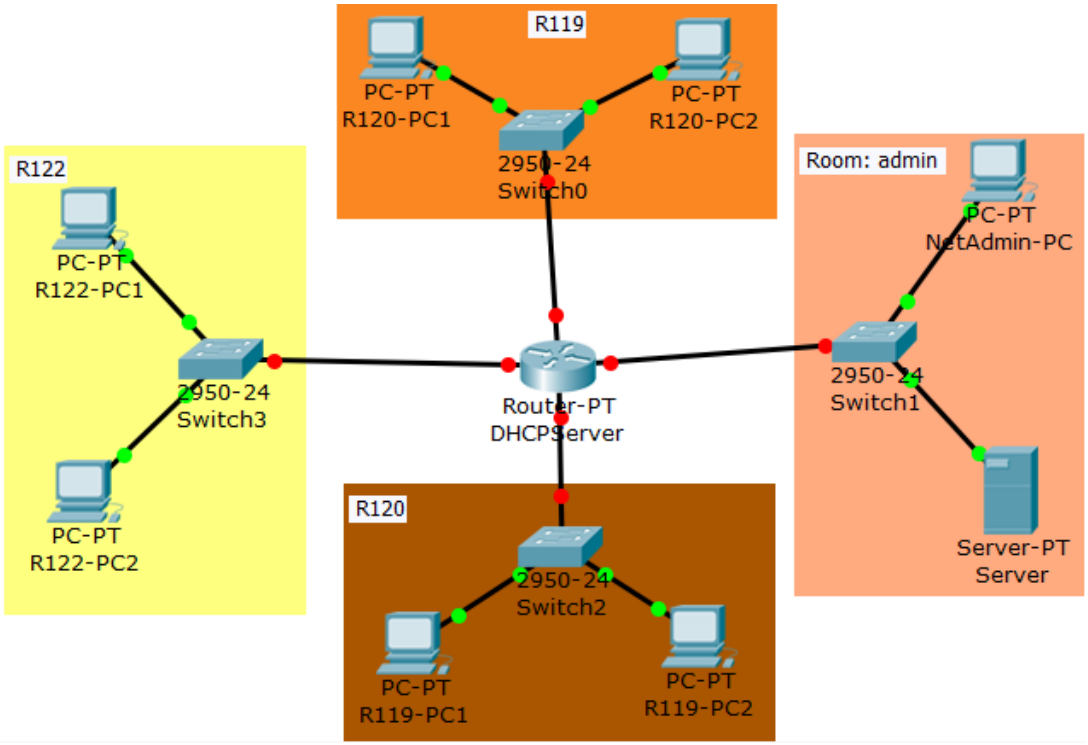
    R119 : 172.16.10.1-172.16.10.254

    R120 : 172.16.20.1-172.16.20.254

    R122 : 172.16.30.1-172.16.30.254
  - Machines will get IP addresses from DHCP server when they will be booted. Say if PC-1 of R122 is booted earlier than PC-2, R122-PC1 will get lower IP address.

Solution

- We need to make four subnets for four rooms.
- We need a router to connect four subnets.
- We can configure a DHCP server either in the router or in the server machine in the admin room



Few Commands for Configuring a DHCP Server in a Router(1)

Task	Command
See command list	Router>? Router#?
Turn on privileged commands	Router> **enable**
Enter configuration mode	Router# **configure terminal**
Select an interface to configure	Router(config**)# Interface FastEthernet**[number,e.g.,0/1]
Allocate IP address	Router(config-if)# **ip address** IP-*address mask*
Turn on port	Router(config-if)# **no shutdown**
Inform relay agent about DHCP server	Router(config-if)# **ip helper-address** IP-*address*
Exit from interface configuration mode	Router(config-if)# **exit**

Few Commands for Configuring a DHCP Server in a Router(2)

Task	Command
See command list	Router(config)#? Router(dhcp-config)#?
Configure a DHCP Address Pool	Router(config)# **ip dhcp pool** *name*
Configure the subnet and mask of the DHCP Address Pool	Router(dhcp-config)# **network** *network-number mask*
Set gateway	Router(dhcp-config)# **default-router** *IP-address*
Set DNS server	Router(dhcp-config)# **dns-server** *IP-address*
Exclude IP addresses	Router(config)# **ip dhcp excluded-address** *low-address* [*high-address*]
Exit from network configuration mode	Router(dhcp-config)# **exit**

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16. http://www.cisco.com/en/US/docs/ios/12_4t/ip_addr/configuration/guide/htdhcpre.html

Confession

- These slides are only for students in order to give them very basic concepts about the giant, “Networking”, not for experts.
- Since I am not a network expert, these slides could have wrong/inconsistent information…I am sorry for that.
- Students are requested to check references and Books, or to talk to Network engineers.