Computer Communications and Networks
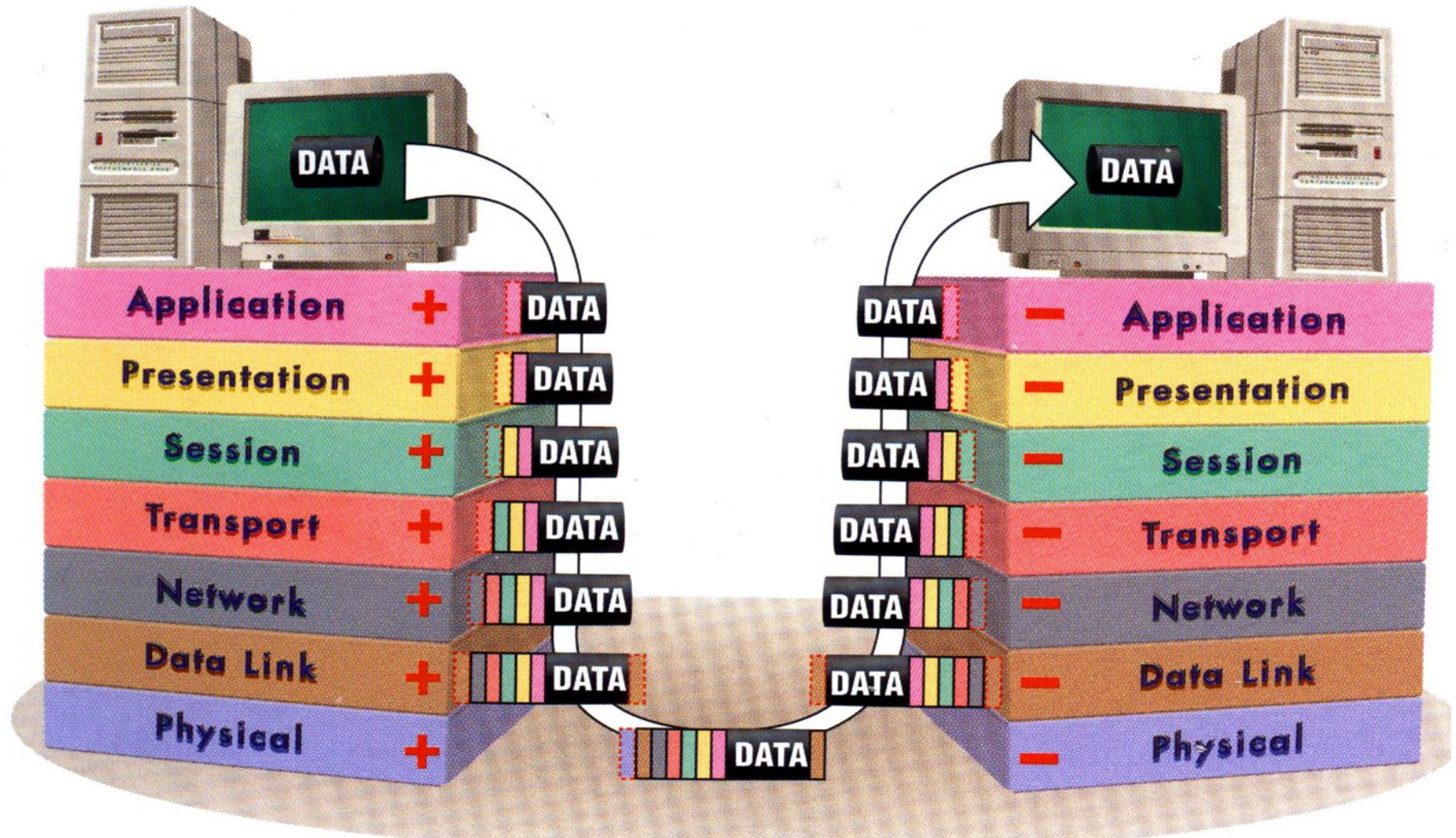
Cisco Packet Tracer: Basic Introduction

Cisco Packet Tracer simulator

- The latest version of Cisco Networking Academy's cutting-edge networking technology teaching and learning software.

- Enables users to create virtual "networks" for exploring, experimenting, and understanding networking concepts and technologies.

- Provides powerful visualisation tools to demonstrate how networks function.

- Empowers users to design, configure, and troubleshoot virtual networks that simulate real-world scenarios.

- Available free of charge to all Networking Academy users, fostering accessible and high-quality learning.

  Visit [Cisco Networking Academy](#) page for more information

Protocol Stack - Open Systems Interconnection (OSI) model

COS5025-B: Computer Communications and Networks

Protocol and Addressing TCP/IP model

Application
SMTP, HTTP/HTTPS, FTP, SSH

Transport
UDP, TCP

Internet
IPv4/IPv6, ICMP, ARP

Network Access

The TCP/IP Model

Application

Transport

Internet

Network Access

The OSI Model

Application

Presentation

Session

Transport

Network

Data Link

Physical

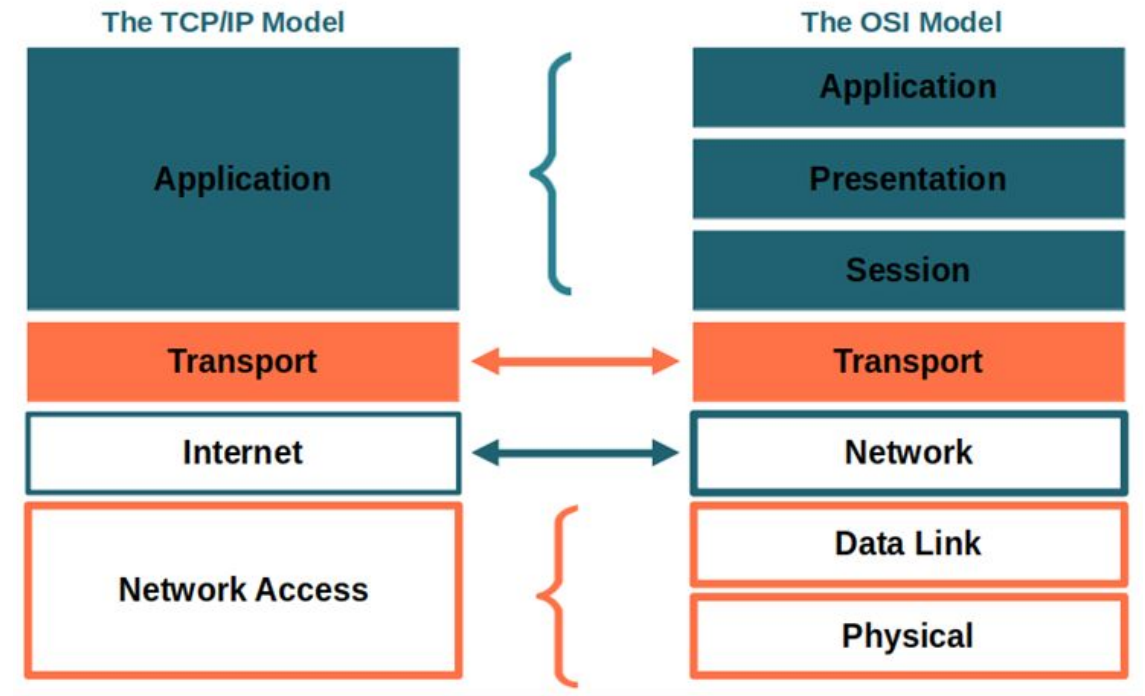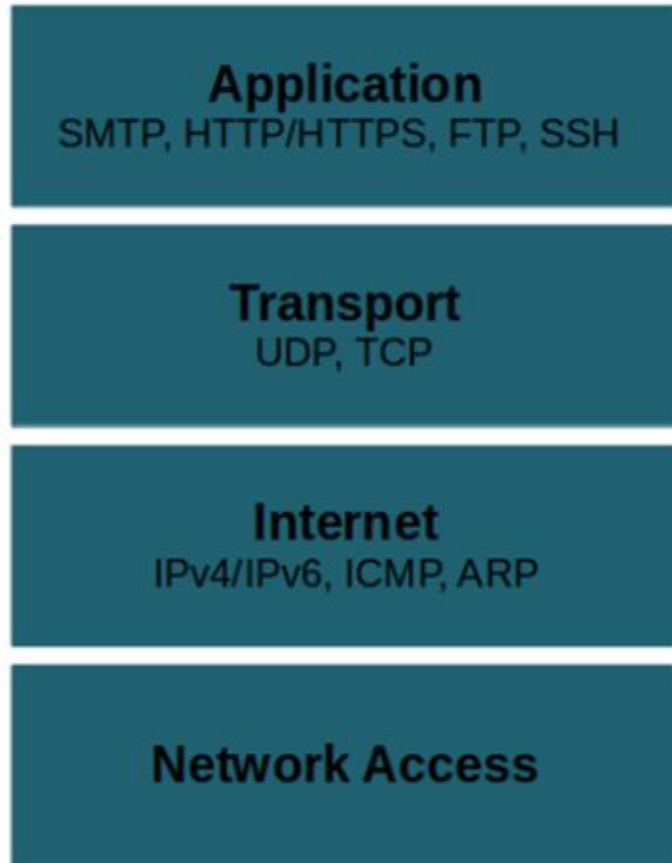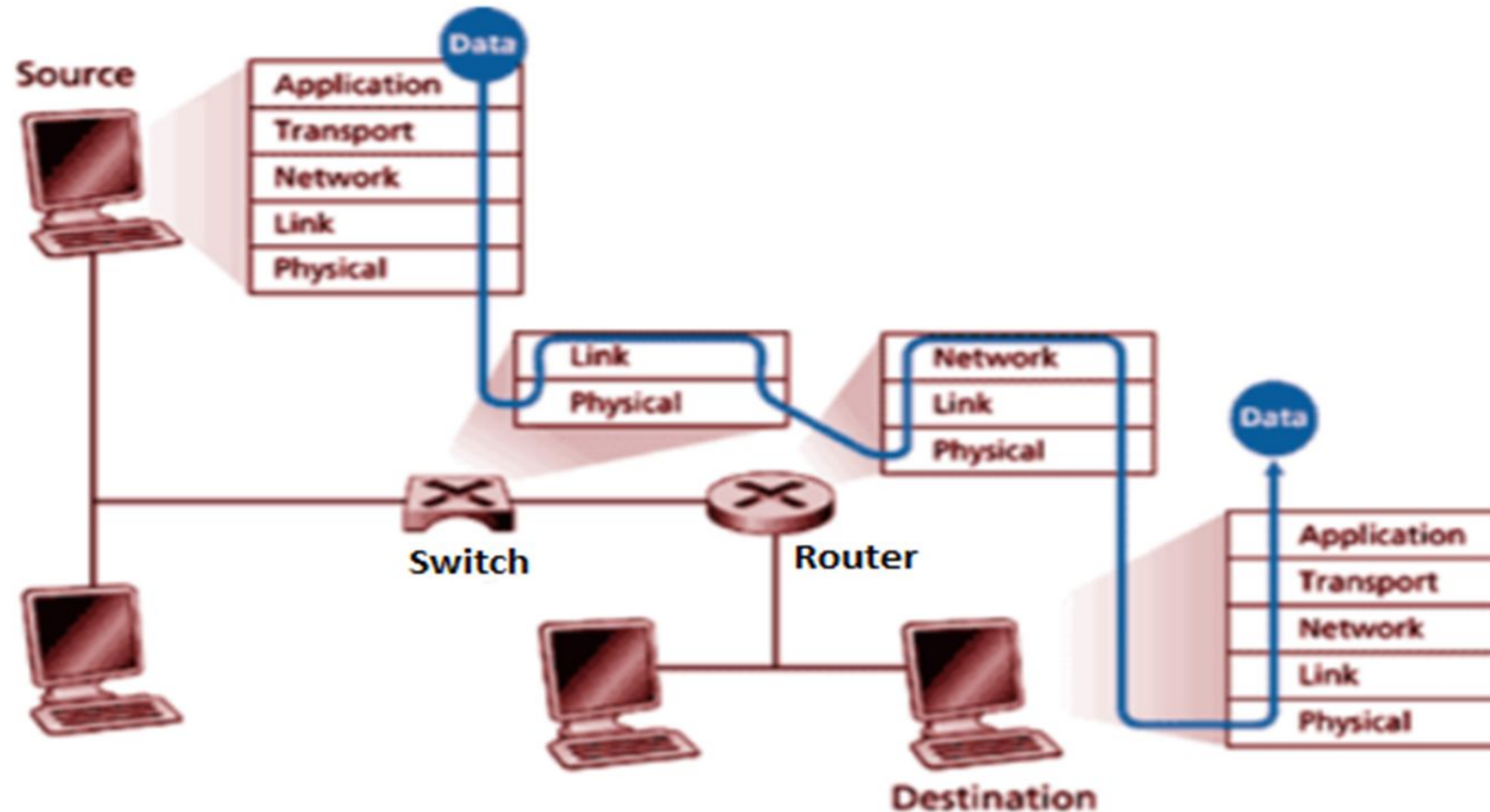Image source: https://cheapsslsecurity.com/

Protocol and Addressing

- Internet has a large collections of protocols organised in a layering model.

  - **Application:** enables the user, whether human or software, to access the network.

  - **Transport:** responsible for source-to-destination (end-to-end) data transfer.

  - **Network:** responsible for routing packets from source-to-destination across multiple networks.

  - **Data link:** responsible for data transfer between neighbouring network elements.

  - **Physical:** coordinates the functions required to transmit a bit stream over a physical medium.

Overall view of Network

Switches create a network. Routers connect networks.

Key Facts about Switches and Routers

- Switches primarily operate at the **Data Link Layer (Layer 2)** of the OSI model.
- They use **MAC addresses** (Media Access Control addresses) to forward data frames to the correct destination within the same local network (LAN).
- Switches **do not examine or utilise IP addresses** (Layer 3 information) for making forwarding decisions.
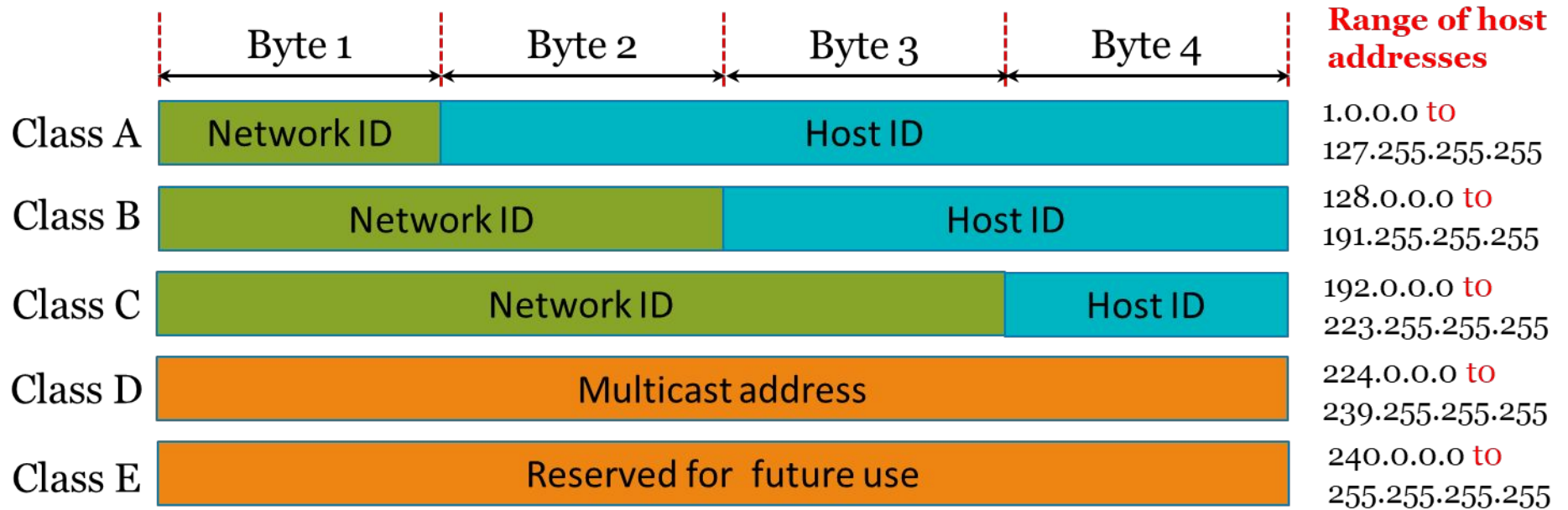
- Routers operate at the **Network Layer (Layer 3)** of the OSI model.
- They use **IP addresses** to route packets between different networks.

Exceptions:
- Layer 3 Switches:
  - A Layer 3 switch combines the functionality of a switch and a router.
  - It can use IP addresses for routing traffic between VLANs or subnets.
- A switch may have an IP address assigned for **management purposes**, such as configuring the switch via a web interface or remote access using SSH.

Class for IP Addresses

128	64	32	16	8	4	2	1

8 bits

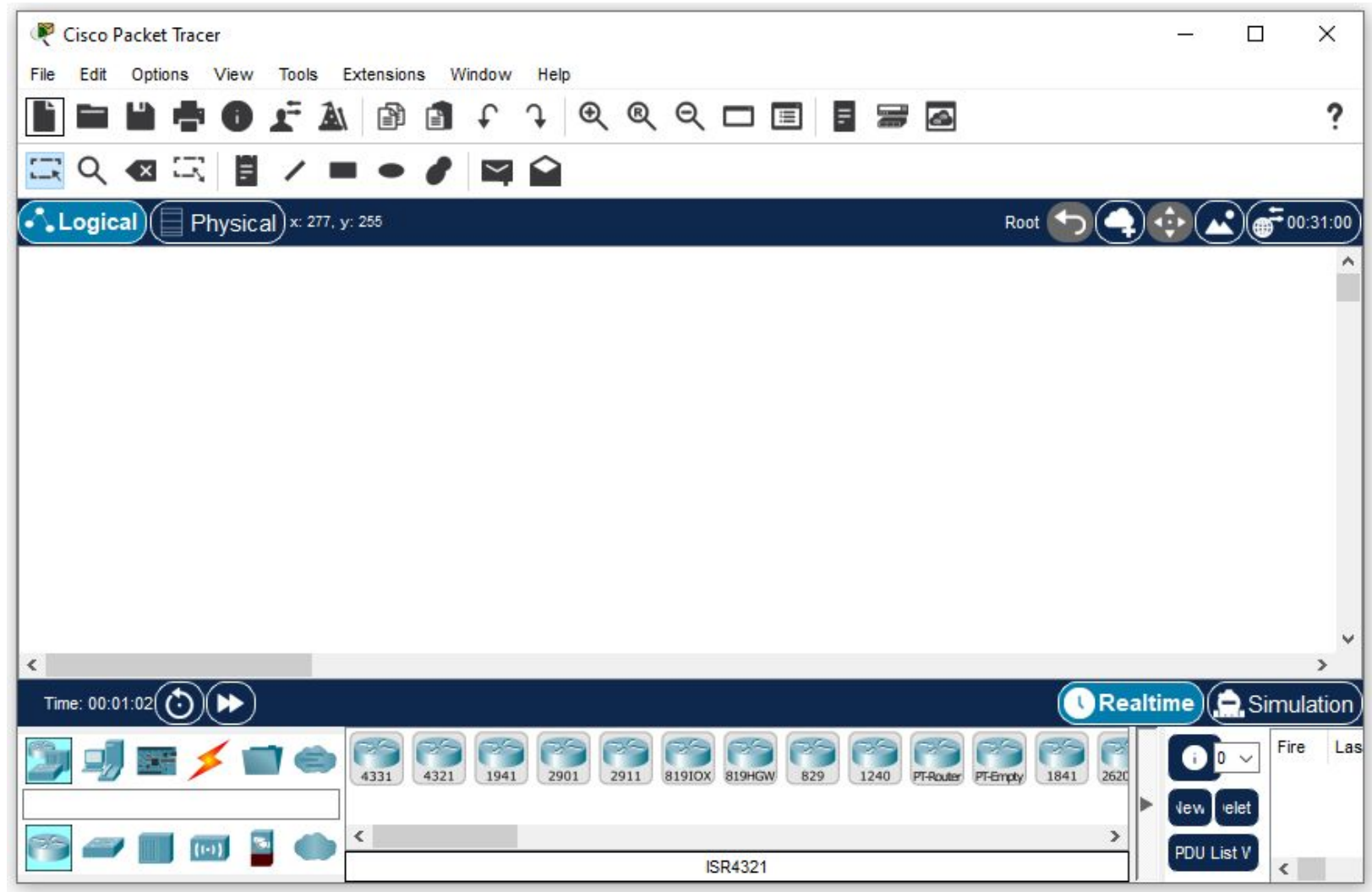|	Byte 1	Byte 2	Byte 3	Byte 4	**Range of host addresses**
Class A	Network ID	Host ID			1.0.0.0 to 127.255.255.255
Class B	Network ID		Host ID		128.0.0.0 to 191.255.255.255
Class C	Network ID			Host ID	192.0.0.0 to 223.255.255.255
Class D	Multicast address				224.0.0.0 to 239.255.255.255
Class E	Reserved for future use				240.0.0.0 to 255.255.255.255

*Use the command **ipconfig /all** to find the IP address for your PC, the subnet, and gateway IP addresses? Tell us which class is your PC IP address. Then Convert it to Binary*
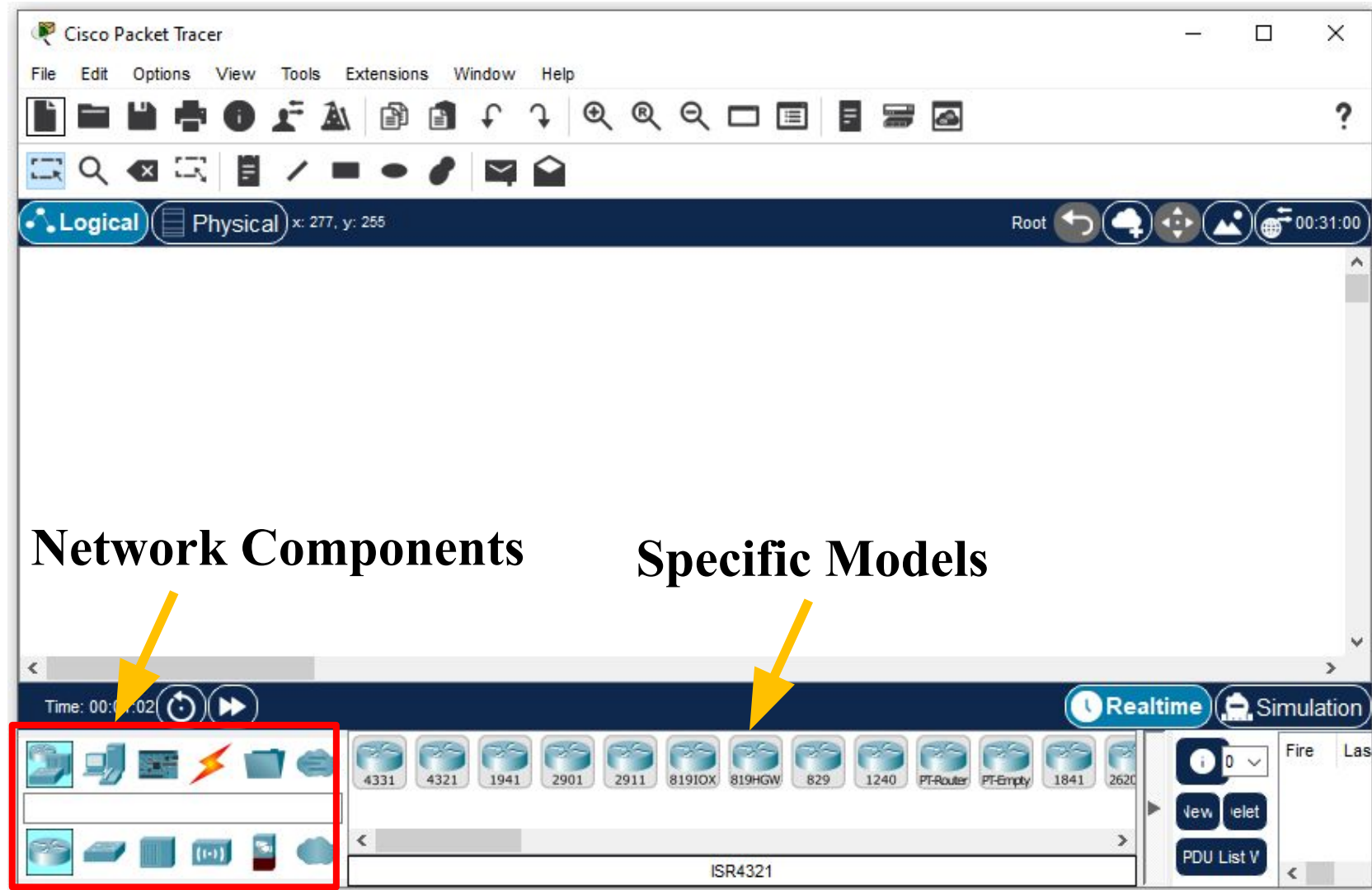
Network Simulation Program

Cisco Packet Tracer

Packet Tracer Interface

Upon running the tool, you should see an interface similar to the one shown here.

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Packet Tracer Interface

Network Components
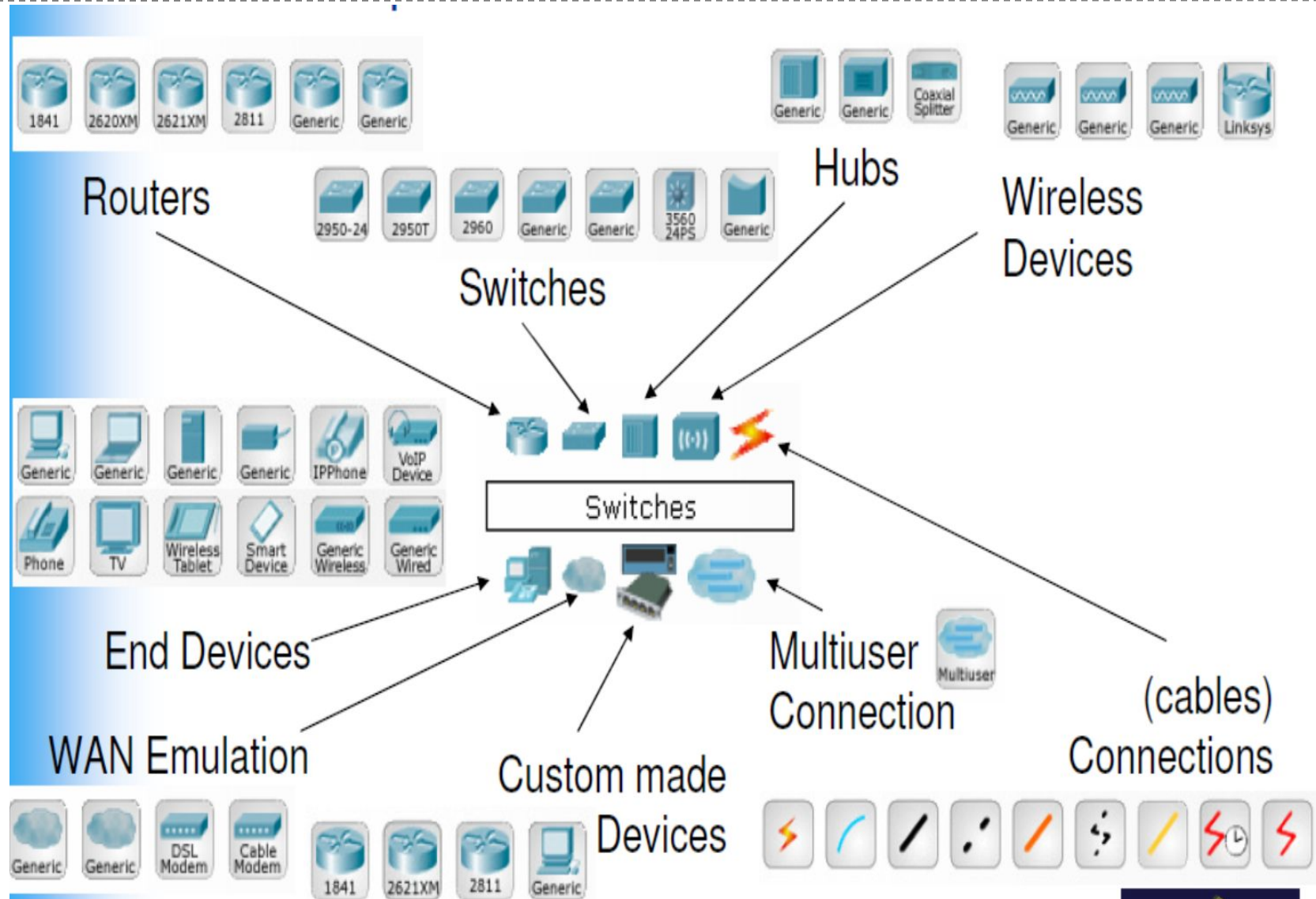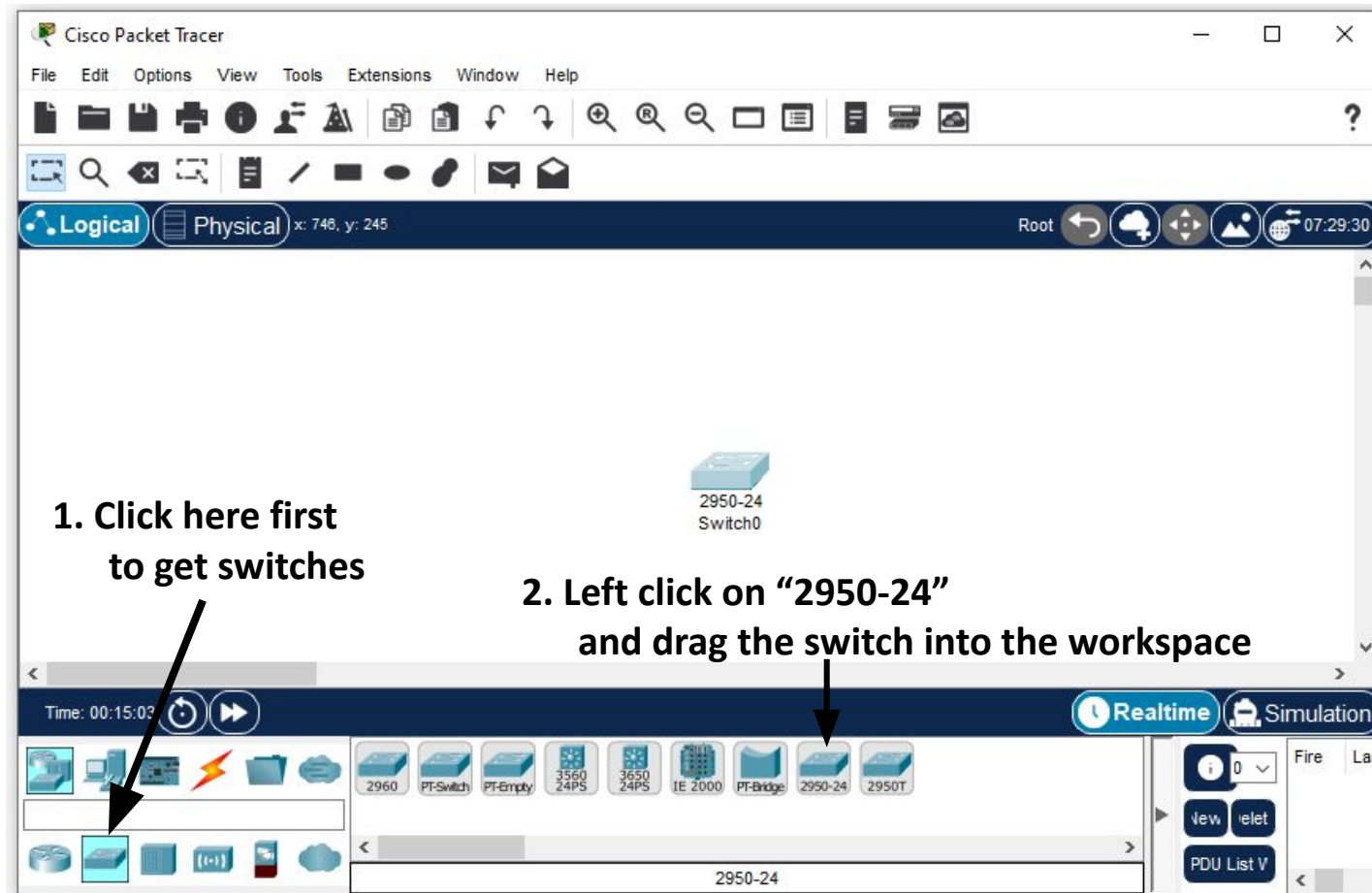
Specific Models

COS5025-B: Computer Communications and Networks
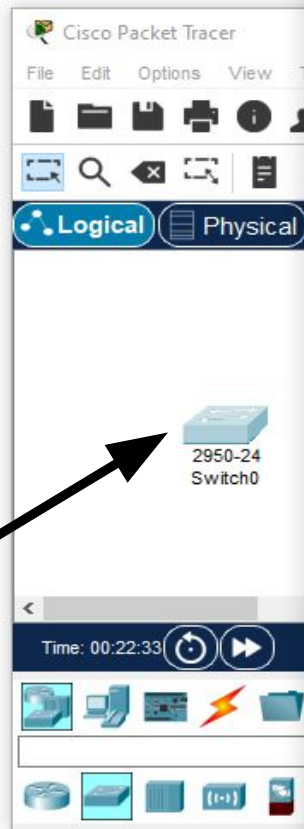
Network Components

Today, most business networks rely on switches to connect computers, printers, and servers within a building or campus. Acting as a central controller, a switch facilitates efficient communication between networked devices.

1. Click here first to get switches

2. Left click on "2950-24" and drag the switch into the workspace
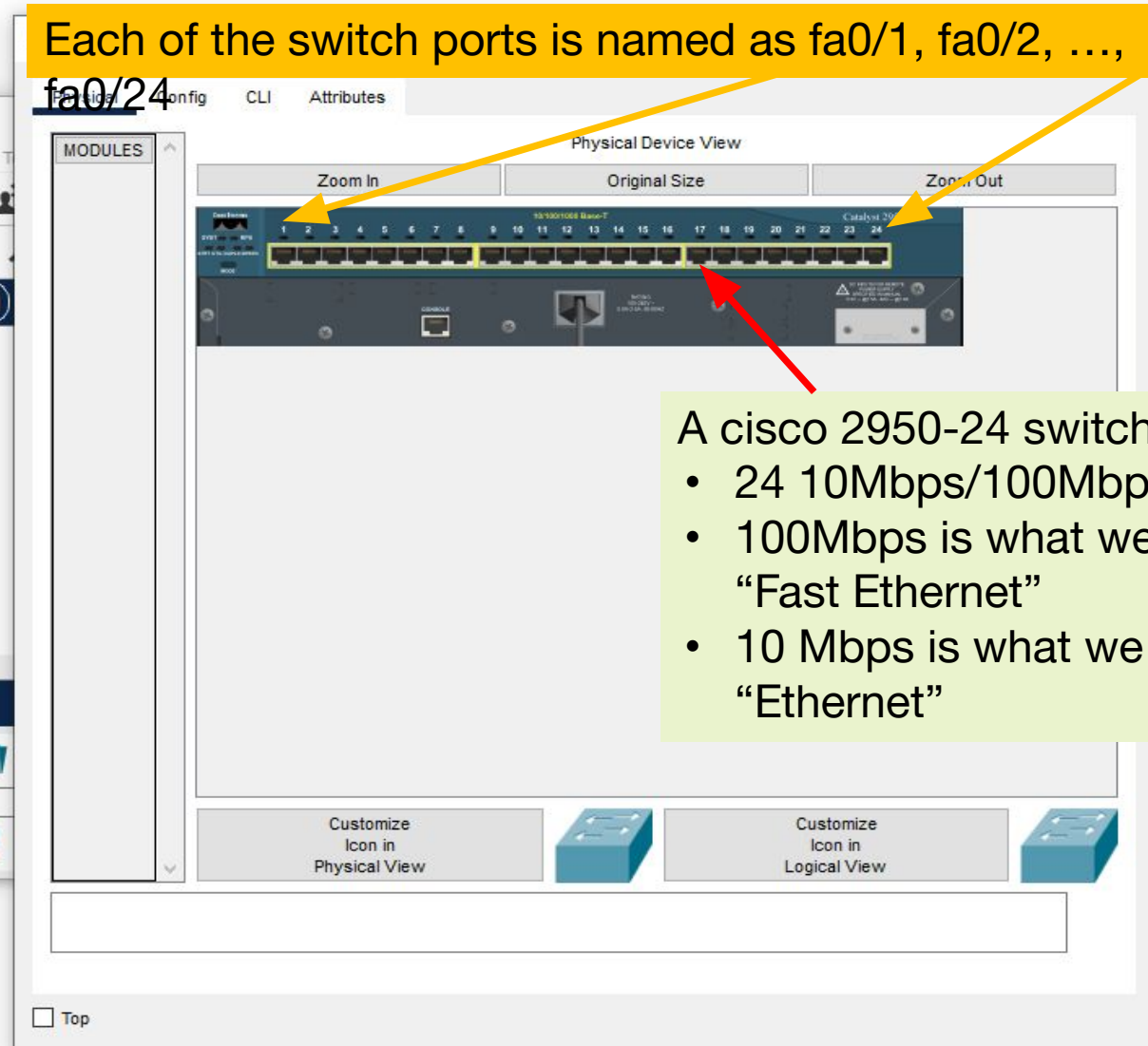
Switch

Each of the switch ports is named as fa0/1, fa0/2, ..., fa0/24

Double click on the Switch

A cisco 2950-24 switch has
- 24 10Mbps/100Mbps ports
- 100Mbps is what we call "Fast Ethernet"
- 10 Mbps is what we call "Ethernet"

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Hover your mouse over the switch. What have you noticed?

Each port/interface has a unique MAC address!

```
Cisco Packet Tracer                                    —   □   ×
File  Edit  Options  View  Tools  Extensions  Window  Help

Logical    Physical   x: 132, y: 106              Root          20:20:30

2950-   Device Name: Switch0
Switch  Device Model: 2950-24
        Hostname: Switch

        Port              Link   VLAN   IP Address    MAC Address
        FastEthernet0/1   Down   1      --            0001.C7EE.0A01
        FastEthernet0/2   Down   1      --            0001.C7EE.0A02
        FastEthernet0/3   Down   1      --            0001.C7EE.0A03
        FastEthernet0/4   Down   1      --            0001.C7EE.0A04
        FastEthernet0/5   Down   1      --            0001.C7EE.0A05
        FastEthernet0/6   Down   1      --            0001.C7EE.0A06
        FastEthernet0/7   Down   1      --            0001.C7EE.0A07
        FastEthernet0/8   Down   1      --            0001.C7EE.0A08
        FastEthernet0/9   Down   1      --            0001.C7EE.0A09
        FastEthernet0/10  Down   1      --            0001.C7EE.0A0A
        FastEthernet0/11  Down   1      --            0001.C7EE.0A0B
        FastEthernet0/12  Down   1      --            0001.C7EE.0A0C
        FastEthernet0/13  Down   1      --            0001.C7EE.0A0D
        FastEthernet0/14  Down   1      --            0001.C7EE.0A0E
        FastEthernet0/15  Down   1      --            0001.C7EE.0A0F
        FastEthernet0/16  Down   1      --            0001.C7EE.0A10
        FastEthernet0/17  Down   1      --            0001.C7EE.0A11
        FastEthernet0/18  Down   1      --            0001.C7EE.0A12
        FastEthernet0/19  Down   1      --            0001.C7EE.0A13
        FastEthernet0/20  Down   1      --            0001.C7EE.0A14
        FastEthernet0/21  Down   1      --            0001.C7EE.0A15
        FastEthernet0/22  Down   1      --            0001.C7EE.0A16
        FastEthernet0/23  Down   1      --            0001.C7EE.0A17
        FastEthernet0/24  Down   1      --            0001.C7EE.0A18
        Vlan1             Down   1      <not set>     000A.F397.34C5

        Physical Location: Intercity > Home City > Corporate Office > Main Wiring Closet > Rack > Switch0
```
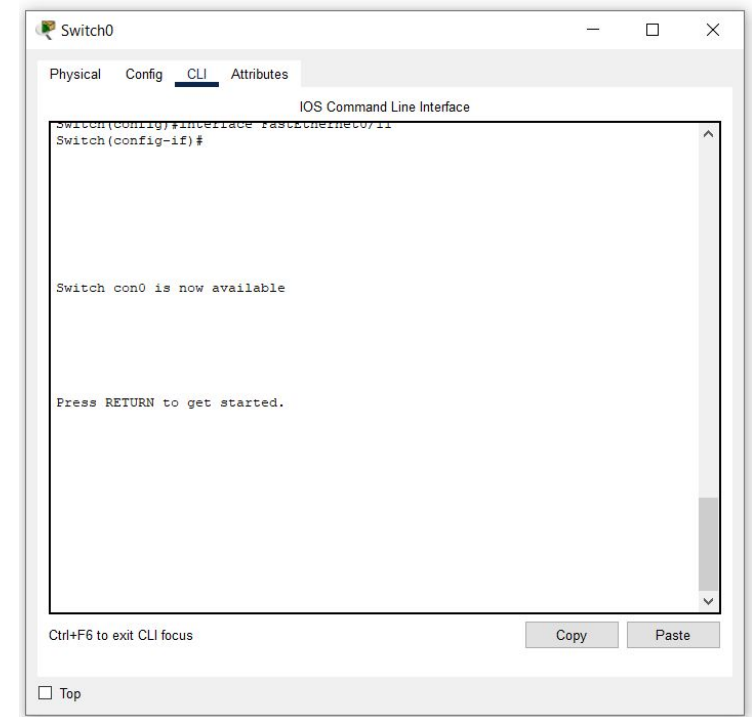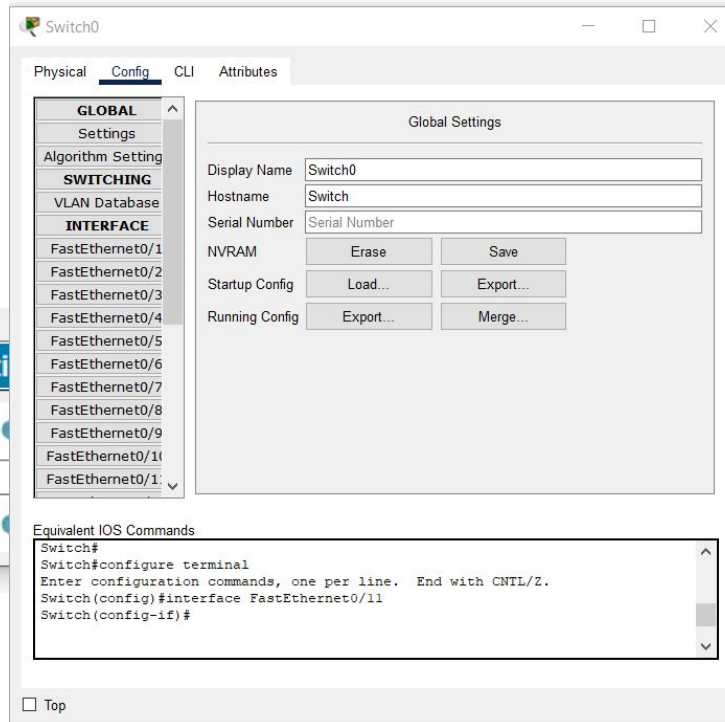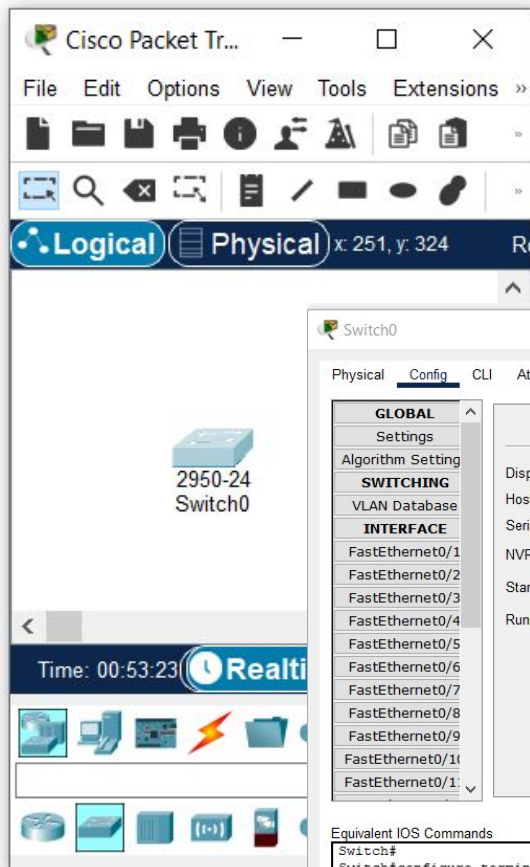
Time: 00:40:50

By clicking on **Config** and **CLI** tabs, you will access two different user interfaces.

* The Config interface allows you to configure devices manually using graphical user interface.
* The CLI interface enables you to perform the configuration using commands.

Command Line Interface (CLI)

- Most connectivity devices can be configured using either a **graphical user interface** or a **command line** interface.
- A CLI can give the network administrator more detailed **control** and **flexibility** than a graphical user interface.
- For security reasons, the Cisco IOS separates access to management functions into **two command modes**:
  - **User EXEC mode**
    - provides limited functionality, but is still useful for basic operations
  - **Privileged EXEC mode**
    - allows the operator to execute configuration commands. <u>We will mostly use this mode.</u>

Mode	Description	Default device prompt
User EXEC mode	- Allows only a limited number of basic monitoring commands. - Often known as "view only".	**Switch>** **Router>**
Privileged EXEC mode	- Provides access to all commands and features. - The operator has access to all monitoring, configuration and management commands.	**Switch#** **Router#**

CLI Commands

Switch0 — IOS Command Line Interface

```
Press RETURN to get started.

Switch>?
Exec commands:
  connect     Open a terminal connection
  disable     Turn off privileged commands
  disconnect  Disconnect an existing network connection
  enable      Turn on privileged commands
  exit        Exit from the EXEC
  logout      Exit from the EXEC
  ping        Send echo messages
  resume      Resume an active network connection
  show        Show running system information
  telnet      Open a telnet connection
  terminal    Set terminal line parameters
  traceroute  Trace route to destination
Switch>
```
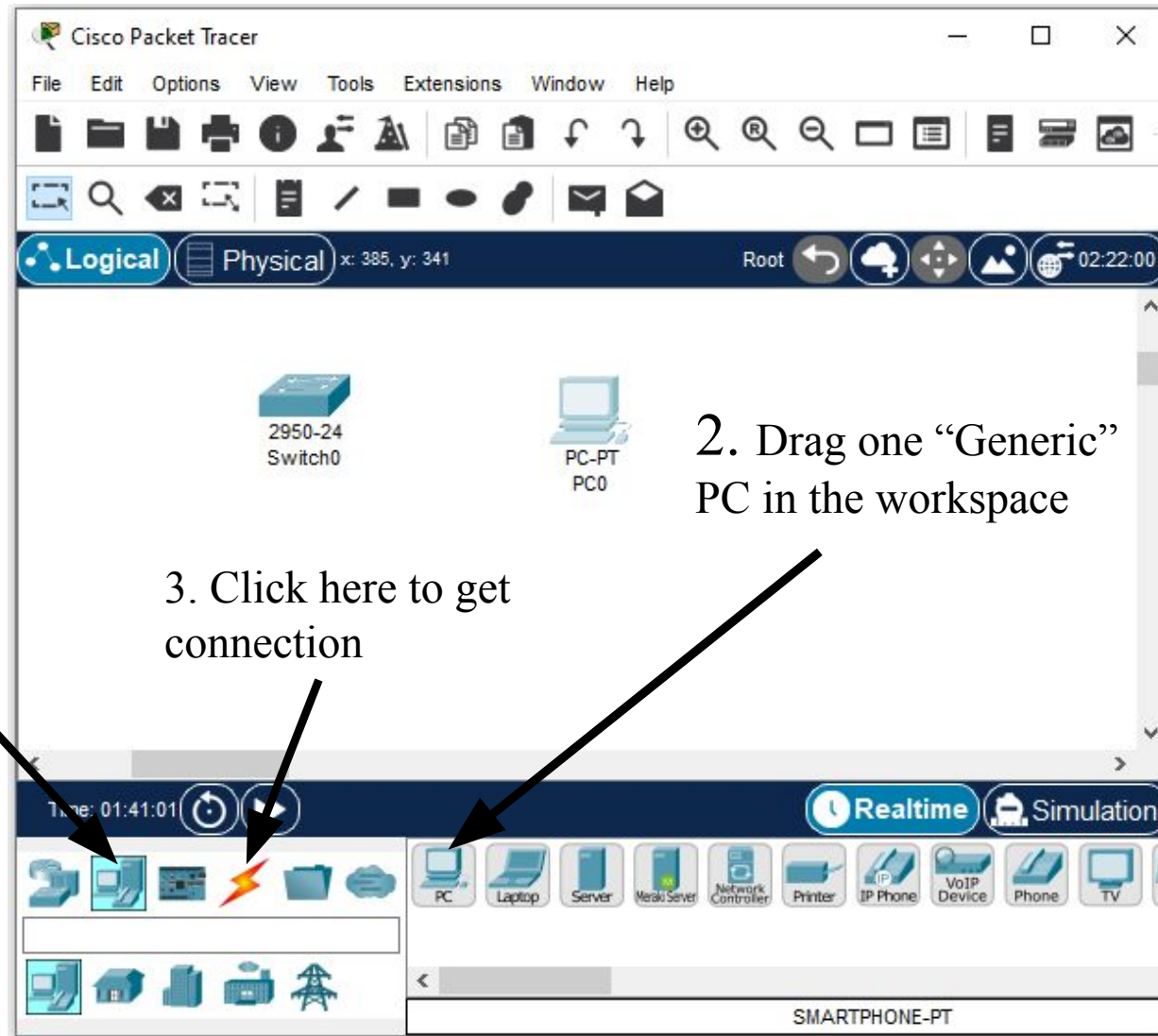
To see all the available commands in any mode type **?**

Switch1 — IOS Command Line Interface

```
Model number: WS-C2950-24
System serial number: FHK0610Z0WC

Cisco Internetwork Operating System Software
IOS (tm) C2950 Software (C2950-I6Q4L2-M), Version 12.1(22)EA4, RELEASE
SOFTWARE (fc1)
Copyright (c) 1986-2005 by cisco Systems, Inc.
Compiled Wed 18-May-05 22:31 by jharirba

Press RETURN to get started!


Switch>?
Exec commands:
  connect     Open a terminal connection
  disable     Turn off privileged commands
  disconnect  Disconnect an existing network connection
  enable      Turn on privileged commands
  exit        Exit from the EXEC
  logout      Exit from the EXEC
  ping        Send echo messages
  resume      Resume an active network connection
  show        Show running system information
  telnet      Open a telnet connection
  terminal    Set terminal line parameters
  traceroute  Trace route to destination
Switch>enable
Switch#disable
Switch>
```

To switch between User EXEC and Privileged EXEC mode, type the command **enable** to enter Privileged EXEC mode, or **disable** to return to User EXEC mode.

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```
Switch>?
Exec commands :
    connect       Open a terminal connection
    disable       Turn off privileged commands
    disconnect    Disconnect an existing network connection
    enable        Turn on privileged commands
    exit          Exit from the EXEC
    logout        Exit from the EXEC
    ping          Send echo messages
    resume        Resume an active network connection
    show          Show running system information
    ssh           Open a secure shell client connection
    telnet        Open a telnet connection
    terminal      Set terminal line parameters
    traceroute    Trace route to destination
Switch>en
```

User EXEC mode

```
Switch#?
Exec commands :
    clear         Reset functions
    clock         Manage the sysrem clock
    configure     Enter configuration mode
    connect       Open a terminal connection
    copy          Copy from one file to another
    debug         Debugging functions (see also "undebug")
    delete        Delete a file
    dir           List files on a filesytem
    disable       Turn off privileged commands
    disconnect    Disconnect an existing network connection
    enable        Turn on privileged commands
    erase         Erase a filesystem
    exit          Exit from the EXET
    logout        Exit from the EXET
    more          Display the contents of a file
    no            Disable debugging informations
    ping          Send echo messages
    reload        Halt and perform a cold restart
    resume        Resume an active network connection
    setup         Run the SETUP command facility
    show          Show running system information
    ssh           Open a secure shell client connection
    telnet        Open a telnet connection
    terminal      Set terminal line parameters
    traceroute    Trace route to destination
    undebug       Disable debugging functions (see also "debug")
    write         Write running configuration to memory, network, or terminal
Switch#
```

Privileged EXEC mode

Image source: https://openclassrooms.com/

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1. Click here first to get "End Devices"

2. Drag one "Generic" PC in the workspace

3. Click here to get connection

Configure Connection

- In networks, we use different types of cables to connect various end-devices and networking devices
- The commonly used cables in Packet Tracer:
  - Rollover (console) cable
  - Ethernet copper straight through
  - Ethernet copper cross-over
  - Fibre optics
  - Telephone cables
  - Coaxial
  - Serial cables

Configure Connection

- A console (rollover) cable is a specialised cable with a serial communication connector on one end and an RJ-45 connector on the other.
- Rollover connects the serial communication port of a PC to the console port of a router.
- Rollover cable is only used for router configuration, not data transfer in the network.

Console (Rollover) cable

Configure Connection

Straight-through cables are represented by solid line in Packet Tracer

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Configure Connection

Crossover cables are represented by dashed line in Packet Tracer

Easy-to-remember rule for choosing between crossover and straight-through cables:

- **Straight-through cable:** Used for different devices (e.g., PC to Switch, Router to Switch, or PC to Router).
  - **Think:** Different devices (use straight-through).

- **Crossover cable:** Used for similar devices (e.g., PC to PC, Switch to Switch, Router to Router).
  - **Think:** Same devices (use crossover).

- However, modern devices can work with either crossover or straight-through cables without any issues.
- So, while it's possible to connect different devices using a crossover cable (for example, PC to router), straight-through cables are still the preferred choice for different devices.

1. Click here to select Console cable

2. Click on PC and select RS232 option

RS-232 stands for Recommended Standard and is a protocol for serial data transmission, where data is sent one bit at a time over a single communication line.

Configure Switch Connection

1. Click on Switch and select "Console"

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1. Change to "**Privileged EXEC**"

2. Change to "**Configure EXEC**"

3. Change the name of the switch

4. Enter the configuration mode for the console line 0

5. Set a password for the console line 0

6. Enable password checking on the console line

Switch0

Physical   Config   CLI   Attributes

IOS Command Line Interface

```
Switch>enable
Switch#configure terminal
Enter configuration commands, one per line.  End with
CNTL/Z.
Switch(config)#hostname SW0
SW0(config)#exit
SW0#
%SYS-5-CONFIG_I: Configured from console by console

SW0#configure terminal
Enter configuration commands, one per line.  End with
CNTL/Z.
SW0(config)#line console 0
SW0(config-line)#password ccn1234
SW0(config-line)#login
SW0(config-line)#exit
SW0(config)#banner motd "This is a secure system,
Authorised Access Only!"
SW0(config)#exit
SW0#
%SYS-5-CONFIG_I: Configured from console by console
```

Ctrl+F6 to exit CLI focus   Copy   Paste

☐ Top

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1. Exit from Users EXEC mode
2. See the message
3. Asking for password

Switch0 — □ ×

Physical Config **CLI** Attributes

IOS Command Line Interface

```
Press RETURN to get started!

This is a secure system, Authorised Access Only!

User Access Verification

Password: |
```

Ctrl+F6 to exit CLI focus   Copy   Paste

☐ Top

1. Create a new file
2. Drag a 2950-24 switch and two generic PCs to the workspace as shown in this figure.

3. Click here to get connection

4. Click on this to automatically choose connection type

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- Click on PC0 and then Switch0 to form a connection.
- Do the same to connect a cable for PC1 and Switch0.
- Wait for the little Orange bubbles to turn green Triangles.

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Green Triangle (ready for communication)

Creating Simple Network

Are we ready to send a message from one PC to another?

Not quite ready yet?

We need to configure the PCs.

Configuring PCs

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1. Double click on PC0 to call out the PC0 window

2. Click on Desktop Tab

3. Click on IP configuration

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4. Close this window

3. Close this window

1. Enter IP address **192.168.1.1**

2. Press tab key, it will automatically fill the subnet mask to **255.255.255.0**

Repeat the same procedure for PC1 to assign an IP address 192.168.1.2 to PC1

From PC1's window click on Command Prompt

Ping PC0 192.168.1.1

Ping command is successful

Simple Network: Troubleshooting

Download the file named '**Network01-Lab1.pkt**' from Canvas and open it using Packet Tracer.

- Try pinging one PC from another or sending a message between two PCs. What do you observe?

- Can all the PCs communicate with each other successfully? If not, can you identify the possible reasons for the communication failure?

- If you have identified the reason(s), address the issues to ensure all PCs can successfully communicate with each other.

Router

A router is a network device that routes the data packets from source to the destination using the shortest network path available. Routers are of different types and there are many vendor options available on the market.
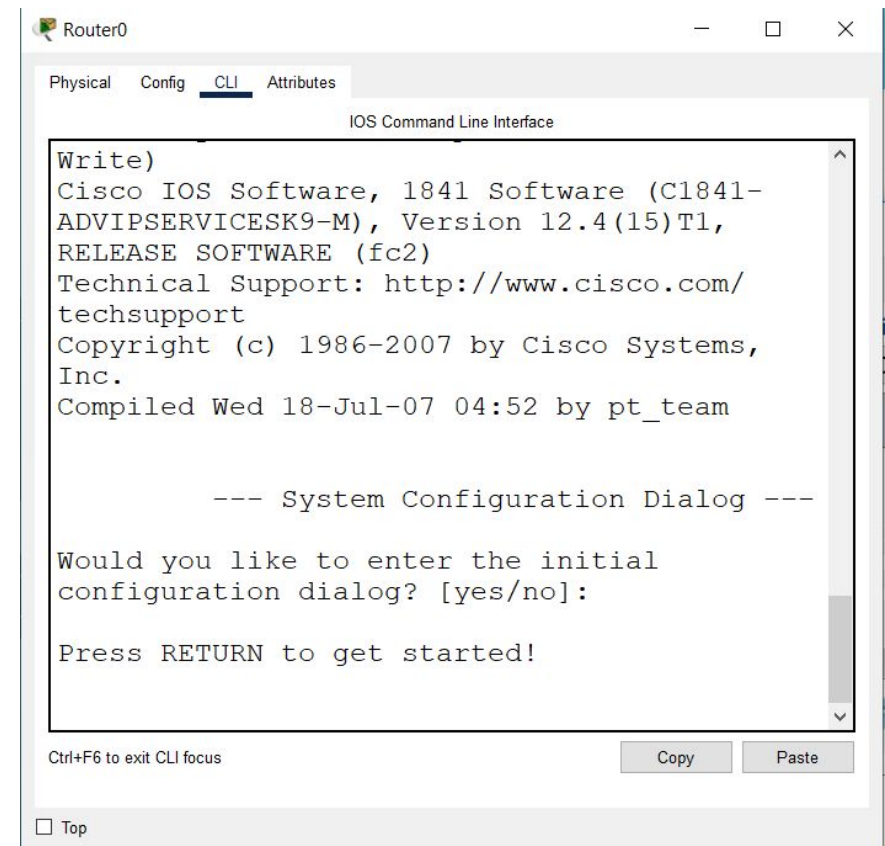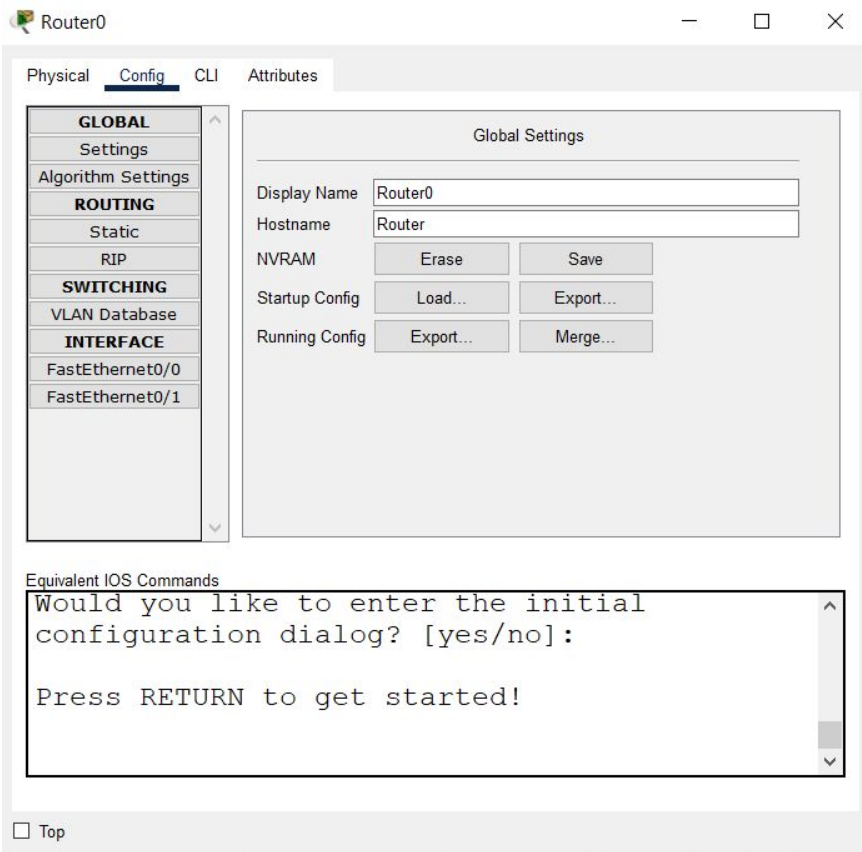
Drag a 1841 router into the workspace.

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Cisco 1841 router

Console port

Rear View

Slot for module
(will discuss later)

Fast
Ethernet
ports
(fa0/0 and fa0/1)

Aux port

Slot for module
(will discuss later)
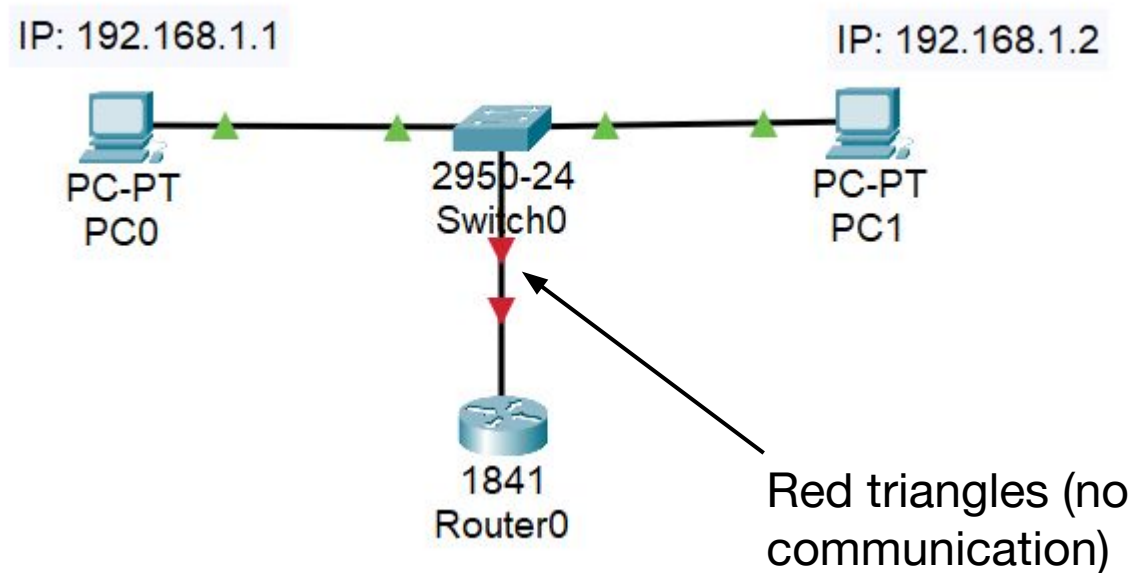
On/off switch

Front View

Similar to the switch explore the Config and CLI tabs by clicking on the router.

- Using the CLI, identify the commands available in both **User EXEC mode** and **Privileged EXEC** mode.

Connecting Router to Switch

- Form a network like this one.

- Assign the IP addresses to the PCs as mentioned.

IP: 192.168.1.1

IP: 192.168.1.2

PC-PT
PC0

2950-24
Switch0

PC-PT
PC1

1841
Router0

Red triangles (no communication)

Click on CLI tab to go into router configuration

Type 'no' and press enter to continue

Configuring IP in Router

Set port fa0/0 to have IP= 192.168.1.200

1. Type 'enable' or 'en' to enter into Privileged EXEC mode

2. Type 'configure terminal' or 'conf t'

3. Type 'interface fa0/0' or 'int fa0/0'

4. Type 'ip address 192.168.1.200 255.255.255.0'

5. Type 'no shutdown'

This task can also be done using GUI using the config tab.

Router0 — □ ✕

Physical   Config   CLI   Attributes

IOS Command Line Interface

```
Translating "diable"...domain server (255.255.255.255)
% Unknown command or computer name, or unable to find
computer address

Router#clear
% Incomplete command.
Router#disable
Router>enable
Router#conf t
Enter configuration commands, one per line.  End with
CNTL/Z.
Router(config)#interface fa0/0
Router(config-if)#ip address 192.168.1.200 255.255.255.0
Router(config-if)#no shutdown

Router(config-if)#
%LINK-5-CHANGED: Interface FastEthernet0/0, changed state
to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface
FastEthernet0/0, changed state to up
```
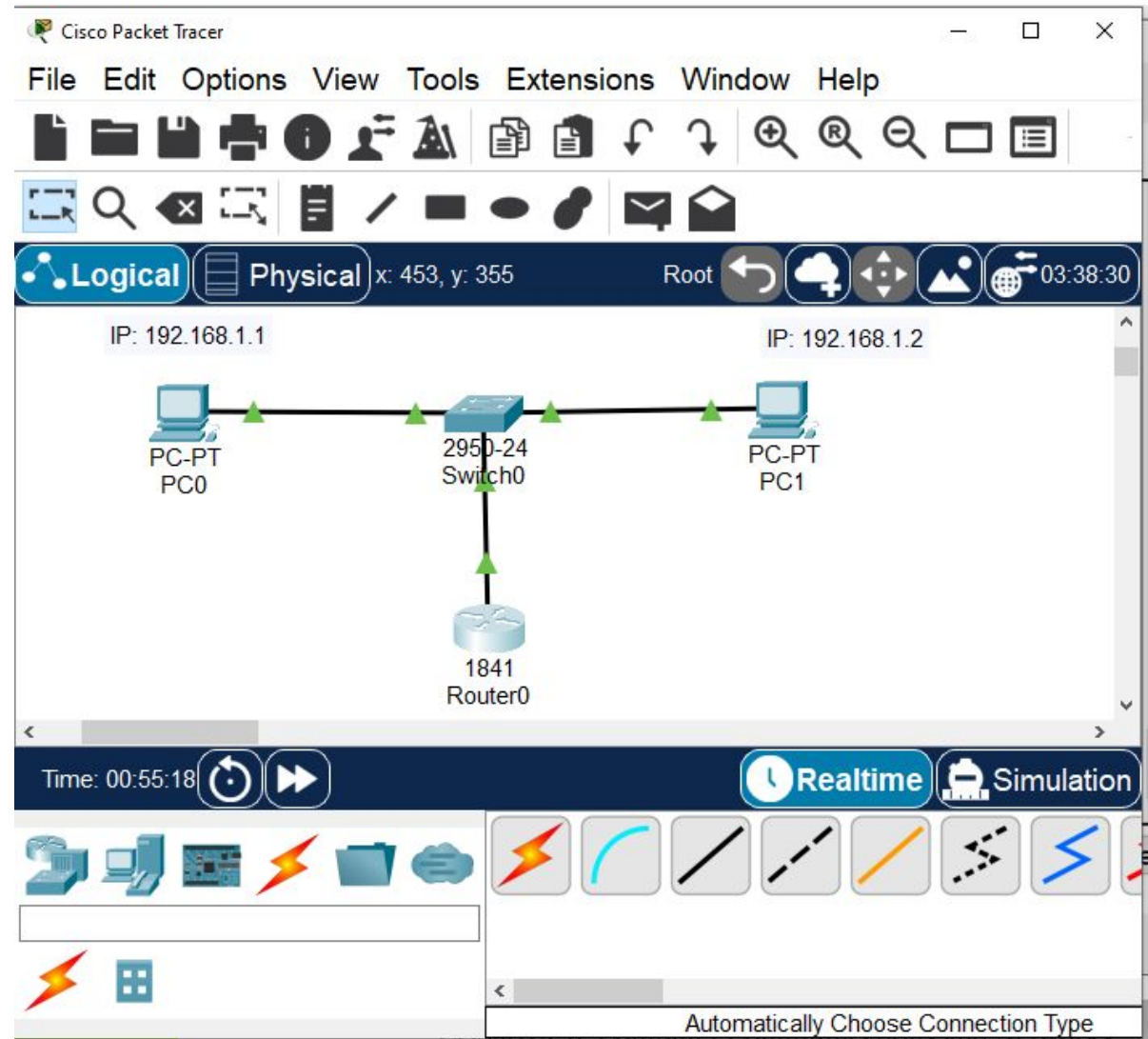
Ctrl+F6 to exit CLI focus   Copy   Paste

☐ Top

Router IP = Gateway of LAN

The interface fa0/0 has IP address set to **192.168.1.200.**

The IP address will be the default gateway for all host in the LAN

The green triangles means the connection is established.

Exercise

Establish the network topology (as shown below) and ensure that PC0 and PC1 can communicate with each other.