UNIVERSITY OF DERBY

COLLEGE OF SCIENCE AND ENGINEERING
MATHS AND COMPUTER SCIENCE

Worksheet 1: CISCO Packet Tracer and Python Fundamentals

PART 1: INTRODUCTION TO PACKET TRACER

We would cover:

- A brief introduction to Packet Tracer's protocols, interface and components
- Create and configure a simple topology

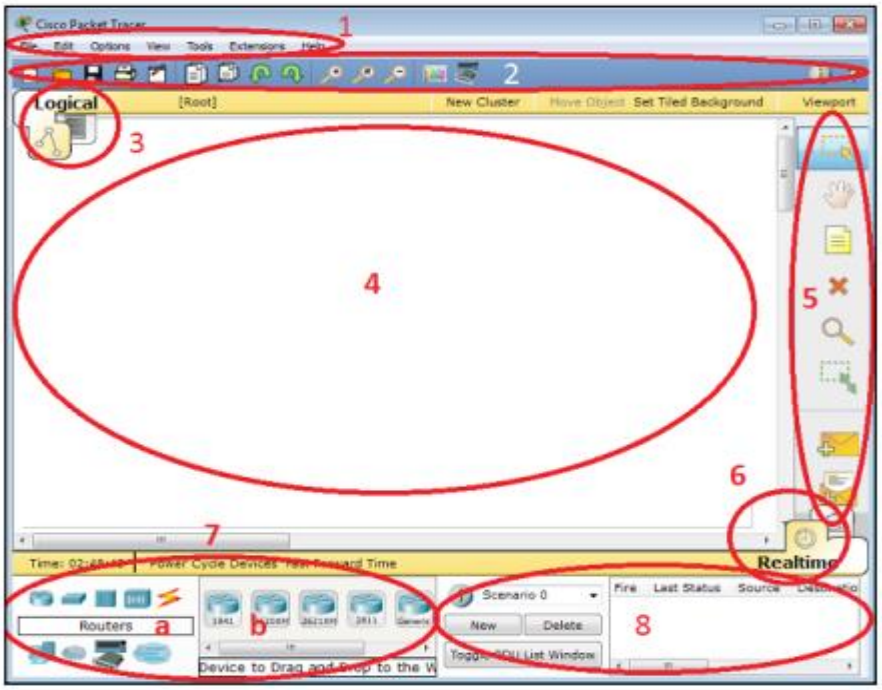
1. BACKGROUND

Protocols supported by Packet Tracer A simulator, as the name suggests, simulates network devices and its environment, so protocols in Packet Tracer are coded to work and behave in the same way as they would on real hardware. The following table shows the protocols supported by Packet Tracer:

Technology	Protocols
LAN	Ethernet (including CSMA/CD*), 802.11 a/b/g/n wireless*, and PPPOE
Switching	VLANs, 802.1q, trunking, VTP, DTP, STP*, RSTP*, multilayer switching*, EtherChannel, LACP, and PAgP
TCP/IP	HTTP, HTTPS, DHCP, DHCPv6, Telnet, SSH, TFTP, DNS, TCP*, UDP, IPv4*, IPv6*, ICMP, ICMPv6, ARP, IPv6 ND, FTP, SMTP, POP3, and VOIP(H.323)
Routing	Static, default, RIPv1, RIPv2, EIGRP, single area OSPF, multiarea OSPF, BGP, inter-VLAN routing, and redistribution
WAN	HDLC, SLARP, PPP*, and Frame Relay*
Security	IPsec, GRE, ISAKMP, NTP, AAA, RADIUS, TACACS, SNMP, SSH, Syslog, CBAC, Zone-Based Policy Firewall, and IPS
QoS	Layer 2 QoS, Layer 3 DiffServ QoS, FIFO Hardware queues, Priority Queuing, Custom Queuing, Weighted Fair Queuing, MQC, and NBAR*
Miscellaneous	ACLs (standard, extended, and named), CDP, NAT (static, dynamic, inside/ outside, and overload), and NATv6

INTERFACE OVERVIEW

The layout of Packet Tracer is divided into several components like a photo editor. Match the numbering in the following screenshot with the explanations given after it



The components of the Packet Tracer interface are as follows:

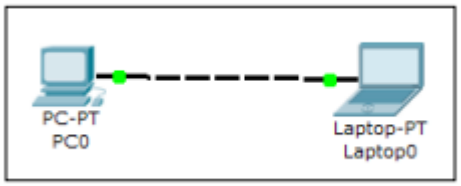
- Area 1: Menu bar – This is a common menu found in all software applications; it is used to open, save, print, change preferences, and so on.
- Area 2: Main toolbar – This bar provides shortcut icons to menu options that are commonly accessed, such as open, save, zoom, undo, and redo, and on the right-hand side is an icon for entering network information for the current network.
- Area 3: Logical/Physical workspace tabs – These tabs allow you to toggle between the Logical and Physical work areas.
- Area 4: Workspace – This is the area where topologies are created, and simulations are displayed.
- Area 5: Common tools bar – This toolbar provides controls for manipulating topologies, such as select, move layout, place note, delete, inspect, resize shape, and add simple/complex PDU.
- Area 6: Realtime/Simulation tabs – These tabs are used to toggle between the real and simulation modes. Buttons are also provided to control the time, and to capture the packets.
- Area 7: Network component box – This component contains all of the network and end devices available with Packet Tracer, and is further divided into two areas:
- ° Area 7a: Device-type selection box – This area contains device categories
- ° Area 7b: Device-specific selection box – When a device category is selected, this selection box displays the different device models within that category

- Area 8: User-created packet box – Users can create highly-customized packets to test their topology from this area, and the results are displayed as a list.
-

2. CREATING A SIMPLE TOPOLOGY

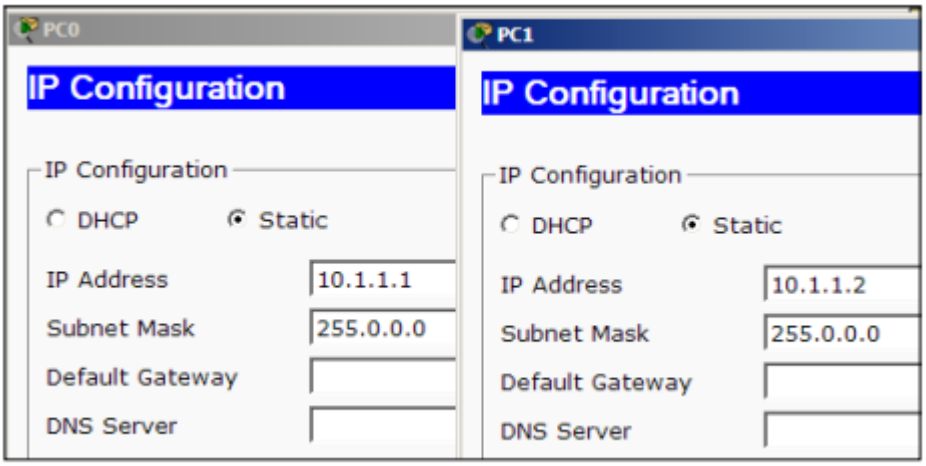
Now that you're familiar with the GUI of Packet Tracer, you can create your first network topology by carrying out the following steps:

1. From the network component box, click on End Devices and drag-and-drop a Generic PC icon and a Generic laptop icon into the Workspace.
2. Click on Connections, then click on Copper Cross-Over, then on PC0, and select FastEthernet. After this, click on Laptop0 and select FastEthernet. The link status LED should show up in green, indicating that the link is up.



3. Click on the PC, go to the Desktop tab, click on IP Configuration, and enter an IP address and subnet mask. In this topology, the default gateway and DNS server information is not needed as there are only two end devices in the network.
4. Close the window, open the laptop, and assign an IP address to it in the same way. Make sure that both IP addresses are in the same subnet (see figure below).

We'll be learning more about end device configuration in a separate section called **Generic IP End Devices**.



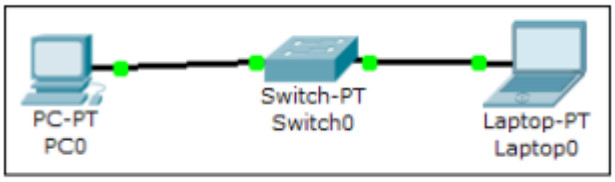
Close the IP Configuration box, open the command prompt, and ping the IP address of the device at the other end to check connectivity

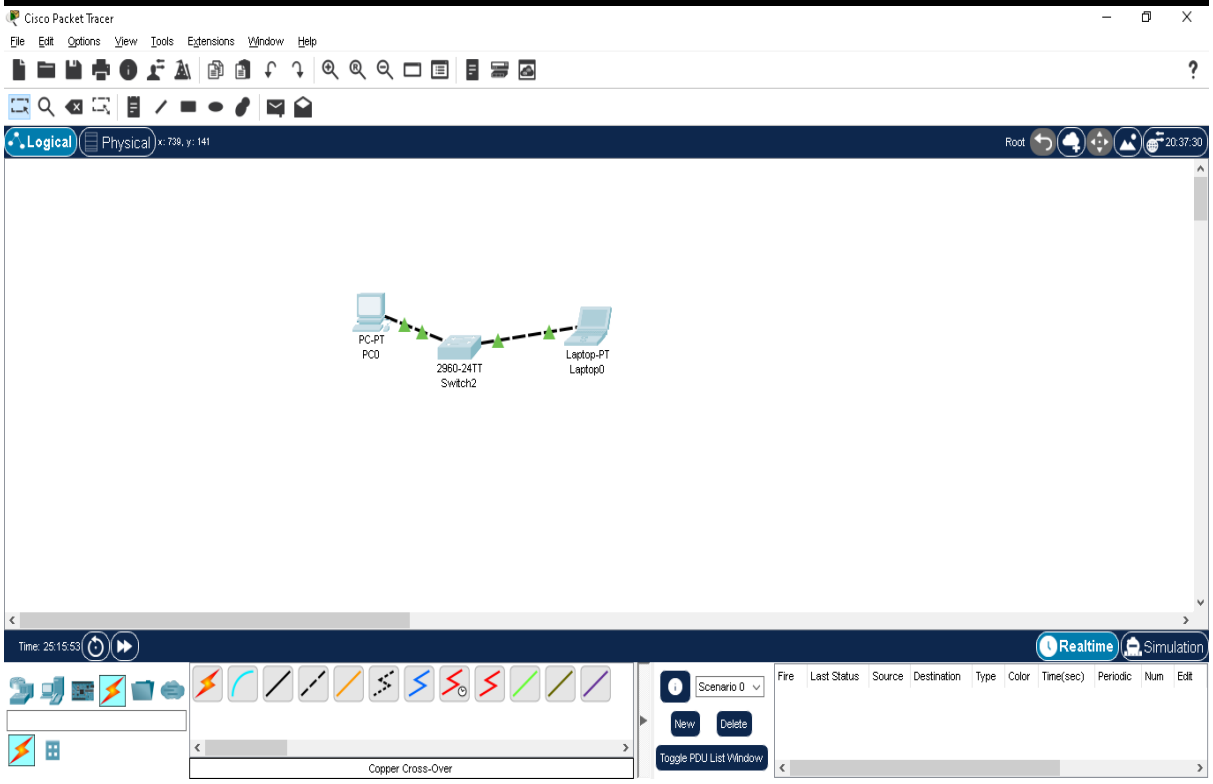
```
PC>ping 10.1.1.1

Pinging 10.1.1.1 with 32 bytes of data:

Reply from 10.1.1.1: bytes=32 time=62ms TTL=128
Reply from 10.1.1.1: bytes=32 time=31ms TTL=128
Reply from 10.1.1.1: bytes=32 time=32ms TTL=128
Reply from 10.1.1.1: bytes=32 time=31ms TTL=128

Ping statistics for 10.1.1.1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 31ms, Maximum = 62ms, Average = 39ms
```

Pinging Laptop0 from PC0

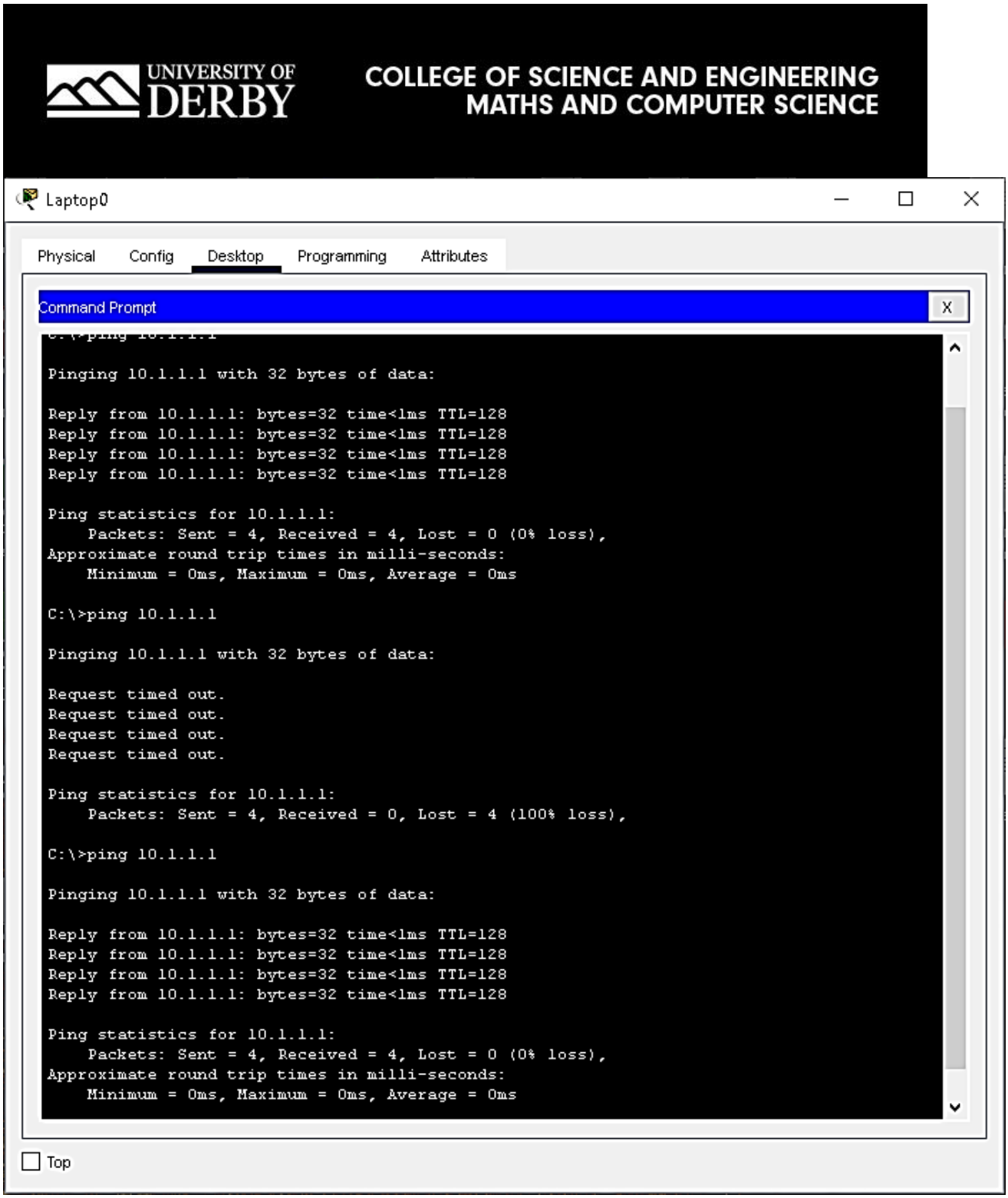
Q. What is a network topology without a single network device in it? Add an Ethernet switch to this topology so that more than two end devices can be connected, by performing the following steps:

1. Click on Switches from the device-type selection box and insert any switch (except Switch-PT-Empty) into the workspace.
2. Remove the link between the PC and the laptop using the delete tool from the common tools bar.
3. Choose the Copper Straight-Through cable and connect the PC and laptop with the switch. At this point, the link indicators on the switch are orange in color because the switchports are undergoing the listening and learning states of the Spanning Tree Protocol (STP) .





4. Once the link turns green, as shown in the previous screenshot, ping again to check the connectivity. The next section, Network Devices, will deal with the configuration of network devices.
5. To save this topology, navigate to File | Save As and choose a location. The topology will be saved with a .pkt extension, with the devices in the same state.


Laptop0
Physical
Config
Desktop
Programming
Attributes
Command Prompt
X
Pinging 10.1.1.1 with 32 bytes of data:
Reply from 10.1.1.1: bytes=32 time<1ms TTL=128
Reply from 10.1.1.1: bytes=32 time<1ms TTL=128
Reply from 10.1.1.1: bytes=32 time<1ms TTL=128
Reply from 10.1.1.1: bytes=32 time<1ms TTL=128
Ping statistics for 10.1.1.1:
Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
Minimum = 0ms, Maximum = 0ms, Average = 0ms
C:\>ping 10.1.1.1
Pinging 10.1.1.1 with 32 bytes of data:
Request timed out.
Request timed out.
Request timed out.
Request timed out.
Ping statistics for 10.1.1.1:
Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),
C:\>ping 10.1.1.1
Pinging 10.1.1.1 with 32 bytes of data:
Reply from 10.1.1.1: bytes=32 time<1ms TTL=128
Reply from 10.1.1.1: bytes=32 time<1ms TTL=128
Reply from 10.1.1.1: bytes=32 time<1ms TTL=128
Reply from 10.1.1.1: bytes=32 time<1ms TTL=128
Ping statistics for 10.1.1.1:
Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
Minimum = 0ms, Maximum = 0ms, Average = 0ms
Top

PART 2: NETWORK DEVICES

This part is mostly a reading exercise, we would discuss:

- Most of the end devices available in Packet Tracer.
- Do check the sample topologies mentioned in this document - Packet Tracer also has instructions on how to use them.
- The goal is to make you familiar with all the devices available in Packet Tracer, their modules, and the utilities available.
- Once you are familiar with the devices, you now go on to learn how to use them.

1. Cisco devices and Packet Tracer devices

Selecting Switches or Routers from the device-type selection box lists both Cisco devices and some devices labelled Generic. These are custom Packet Tracer devices running on Cisco IOS, but the slots that hold the modules are different.

Routers

A router provides connectivity between two logical networks. Every router in Packet

Tracer can be switched on or off by using the provided power button. The power switch is required to make a device simulate its real counterpart. Modules can be added or removed only after powering off the device. If the running configuration is not saved, power cycling a device will make it lose its configuration.

The following routers are available in Packet Tracer:

- Cisco 1841: This is an Integrated Service Router (ISR) having two Fast Ethernet ports, two slots for High Speed WAN Interface Cards (HWICs), and one slot for Advanced Integration Module (AIM)
- Cisco 1941: This is similar to the previous model but runs on Cisco IOS Version 15. It has two ports that operate at Gigabit Ethernet speeds.
- Cisco 2620XM: This is a multiservice router with one Fast Ethernet port, two slots for WAN Interface cards, and one slot for AIM.
- Cisco 2621XM: This is similar to the previous model, except that this router has two Fast Ethernet ports.
- Cisco 2811: This ISR comes with two Fast Ethernet ports, four WIC slots, and a dual slot for AIM.
- Cisco 2901: This router has two Gigabit Ethernet ports, four WIC slots, and two Digital Signal Processor (DSP) slots. This router uses Cisco IOS Version 15.
- Cisco 2911: This router has three Gigabit Ethernet ports and all the other features of the previous router. It runs on IOS Version 15.
- Generic Router-PT: This is a custom router running on Cisco IOS. It contains 10 slots and has separate modules with a naming convention beginning with PT.

Switches

A switch, also called a multiport bridge, connects more than two end devices together. Each switch port is a collision domain. The following switches are available in Packet Tracer:

- Cisco 2950-24: This managed switch comes with 24 Fast Ethernet ports.
- Cisco 2950T-24: This switch is a member of the Catalyst 2590 Intelligent Switch family and has two Gigabit Ethernet ports in addition to the 24 Fast Ethernet ports.
- Cisco 2960-24TT: This is another 24 port switch; the previous switch has Gigabit Interface Converter (GBIC) for Gigabit Ethernet ports, whereas this switch has Small Form-factor Pluggable (SFP) modules for the same. Note that this is a difference only on real switches, it has no impact on Packet Tracer
- Cisco 3560-24PS: This switch is different from the others because it is a layer 3 switch that can be used to perform routing in addition to switching. The PS suffix implies support for Power over Ethernet (PoE), which can be used to power up IP phones without using power adapters.
- Bridge PT: This is a device used to segment a network and it has only two ports (which is why it is a bridge; if it had more, it'd be called a switch).
- Generic Switch PT: This is a Packet-Tracer-designed switch running on Cisco IOS. This is the only customizable switch with 10 slots and several modules. Like the generic router, the switch section also includes a generic switch with 10 slots that can be customized with the required modules. Except for the generic switch, other Cisco model switches cannot be customized and do not have a power switch. This is because that is how real switches of the same models are designed.

Other devices

Packet Tracer has more than just Cisco routers and switches, which we'll see in

this section. These devices do not have any configuration options and work out

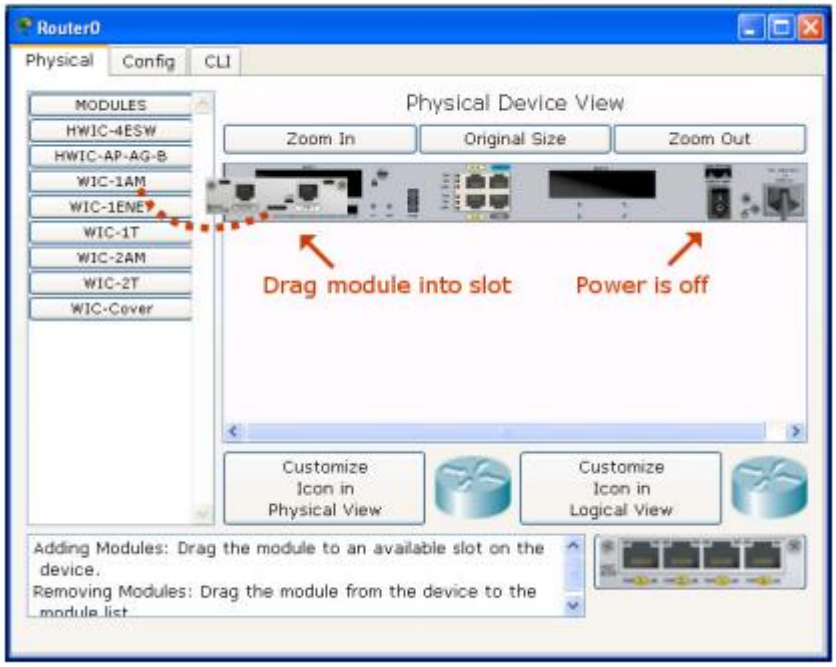
of the box.

- Hub PT: This network hub was the oldest way to connect multiple end devices together. It still exists in Packet Tracer so that you can simulate and learn about network storms and broadcasts. This Packet Tracer device has 10 slots.
- Repeater PT: This device is used to boost the signal on a wire when the distance between two points is high. We'll be using it in Chapter 5, Navigating and Modifying the Physical Workspace; this device has two slots.
- Coaxial Splitter PT: This is used to split a single coaxial connector into two. It has three coaxial ports and cannot be customized in any way.

2. CUSTOMIZING DEVICES WITH MODULES

A device module is a piece of hardware containing several device interfaces. For example, a HWIC-4ESW module contains four Ethernet (10 MBps) ports. Similar to a real router/switch, the device has to be powered off in order to add or remove modules.

The power switch is on the right-hand side of each device, with a green LED indicating that the power is on. Click on this switch to turn it off. To add a module, drag one from the modules list and drop it onto an empty slot. If a module doesn't fit into that slot, it automatically returns to the module list.



To remove a module, power off the device and drag it from the slot back to the module list.

Naming convention

Each router has more than a dozen modules but the interface they offer can be

identified by their names. So, we have grouped them based on their similarities.

a. Copper Ethernet Interface: This is the normal LAN interface, which takes in an RJ-45 connector crimped to a copper cable. Based on speeds, these interfaces are named Ethernet (10 MBps), FastEthernet (100 MBps), and GigabitEthernet (1000 MBps). Modules having Ethernet interfaces can be identified with a number followed by E, FE, CE, CFE, or CGE. Modules with SW provide switching features when used on routers.

° HWIC-4ESW (four Ethernet switching ports)

° WIC-1ENET (single Ethernet port)

° NM-1E (single Ethernet port)

° NM-1FE-TX (single Fast Ethernet port)

° NM-4E (four Ethernet ports)

° NM-ESW-161 (16 Ethernet switching ports)

° PT-ROUTER-NM-1CE, PT-ROUTER-NM-1CFE, PT-ROUTER, NM-1CGE (Packet Tracer custom modules)

b. Fiber Ethernet Interface: This is like the previous interface, except that it uses a fibre cable. These modules are identified based on the letter F.

° NM-1FE-FX (single Fast Ethernet fiber media)

° PT-ROUTER-NM-1FFE, PT-ROUTER-NM-1FGE (Packet Tracer custom modules)

c. Serial Interface: Modules with serial interfaces have the letter T or the string A/S. The difference is that the ones with T are synchronous while the A/S modules are asynchronous. This difference affects only production environments, but in a simulator it makes no difference.

° WIC-1T, WIC-2T (a single or dual synchronous serial port)

° NM-4A/S, NM-8A/S (four or eight asynchronous/synchronous serial ports)

° PT-ROUTER-NM-1S, PT-ROUTER-NM-1SS

d. Modem Interface: Modules with this interface have RJ11 ports for analog telephone cables. They are identified by having the letters AM present after a number as shown in the following list:

° WIC-1AM (dual RJ11 ports for phone and modem)

° WIC-2AM, WIC-8AM (two or eight RJ11 ports)

° PT-ROUTER-NM-1AM

e. WICs within NMs: Some Network Modules (NM) don't take up all the space of a slot, so they provide WIC slots within them to accommodate smaller cards. Such modules can be recognized by the letter W at the end of their names.

° NM-1E2W, NM-1FE2W (a single Ethernet / Fast Ethernet port and two WIC slots)

° NM-2E2W, NM-2FE2W (two Ethernet / Fast Ethernet ports and two WIC slots)

° NM-2W (no interfaces, only two WIC slots)

f. Slot Covers: Packet Tracer also provides covers for empty slots. While it makes no difference in a simulator, it can give a cleaner look when using the physical view (more information on this in Chapter 5, Navigating and Modifying the Physical Workspace).

° NM-Cover: Covers a network module slot

° WIC-Cover: Covers a WIC slot

g. HWIC-8A: This module is new to Packet Tracer 6. It provides eight asynchronous EIA-232 connections to console ports. A router can be used as an access server if this module is plugged in.

3. CREATING A CUSTOM DEVICE

If you require a router with a particular set of modules, it could be a daunting task to

drag-and-drop modules each time before creating a topology. So Packet Tracer offers

a feature to save a device that you've customized as a custom-made device. Carry out

the following steps to create a custom device:

1. Drag-and-drop a network device into the work area. For this example, we'll use a Generic switch: Switch-PT-Empty.
2. Click on the switch to open its configuration dialog box and turn the device off.
3. Add your most-used modules to this switch.
4. Navigate to Tools | Custom Devices Dialog, or press Ctrl + E.
5. Click on the Select button, and then click on the switch that was just customized.
6. Provide a name and description, and then click on Add and Save. This custom device is saved with a .ptd extension in %USERPROFILE%\Cisco Packet Tracer 6.0.1\templates\; to make this custom device available to all users, copy it to %PT5HOME%\templates\.

Emulating WAN

To bring in more real-life scenarios, Packet Tracer has devices that emulate a WAN.

Clicking on the WAN emulation cloud icon from the device-type selection box

lists the following devices:

- Cloud-PT: This device looks like a cloud in the toolbar, but under the configuration window it looks more like a router with several slots.

The following modules are available for the cloud device:

° NM-1AM: This module provides an RJ11 connector for connecting modems using telephone cables. The interface name of this module is ModemN, with N being the port number.

° NM-1CE, NM-1CFE, NM-1CGE: These three modules provide an Ethernet, Fast Ethernet, or Gigabit Ethernet interface respectively, through which the devices connected to the modem and cable interfaces can be accessed. Except for speed, all three modules

perform the same function.

° NM-1FFE, NM-1FGE: These two modules provide Fast Ethernet or Gigabit Ethernet for connecting fiber media. Functionality-wise, they perform the same function as the previous modules.

° NM-1CX: This module has a coaxial connector for connecting a cable modem.

° NM-1S: A serial port is available on this interface for configuring frame relay. The Config tab for this interface provides options for creating frame relay mappings.

- DSL-Modem-PT: This is a modem with an Ethernet interface and an RJ11 interface. The Ethernet interface can be switched between Ethernet, FastEthernet, and GigibitEthernet. This device doesn't have any configuration options.
- Cable-Modem-PT: This modem is similar to the previous one, except that it supports a coaxial port.

Accessing the CLI

The Command-line Interface of a device in Packet Tracer can be accessed

in two ways:

- The CLI tab
- Console port

Although it is possible to access a device through SSH or Telnet, these are Cisco methods and are not exclusive to Packet Tracer.

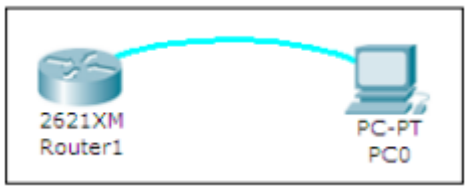
The CLI tab

This is the simplest way of accessing the Command-line Interface of a device; click on a network device, navigate to the CLI tab, and you'll see the booting process.

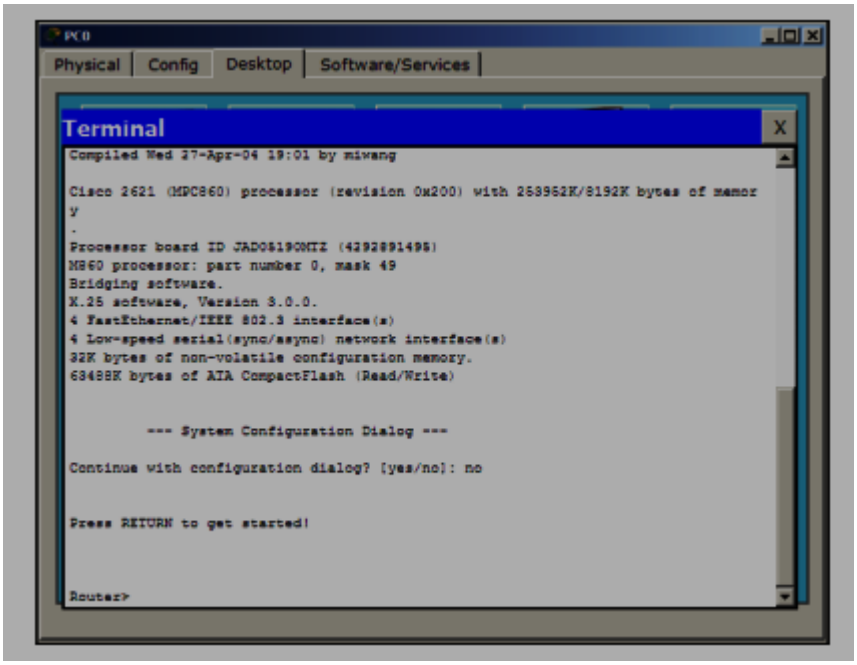
The Console port

There is no difference between what is seen and controlled in this method and the previous one, but the Console Port can be used to make the topology look similar to the real world. Follow the steps to configure the console port:

1. Add a PC or a laptop to the workspace.
2. Choose connections, and then click on the console cable.
3. Connect the console cable of the network device to the RS-232 port of the PC/laptop.



Open the PC/laptop, navigate to the Desktop tab, open Terminal, and then with the default settings, click on OK to view the console. The following screenshot displays a router's console through its terminal:

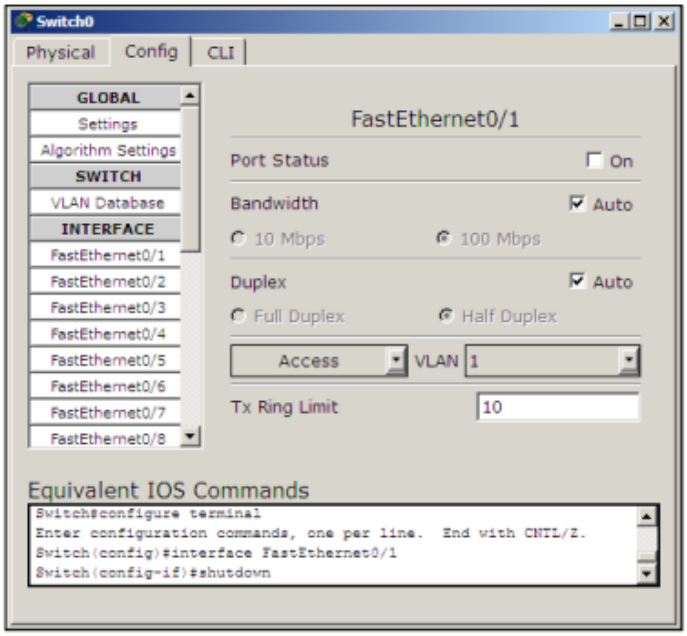


In step 2, if you use the Automatically Choose Connection Type option, the Ethernet ports of both devices will be connected.

Configuring network devices

In this section, you'll learn how to configure Cisco routers and switches without using a single command! Yes, it is possible; Packet Tracer provides a Config tab that contains GUI options for the most common configurations. What's more, as you tinker with the GUI, its equivalent Cisco IOS command is also displayed.

Look at the following screenshot:



From the Config tab of the switch, we will set the Interface option to FastEthernet0/1and uncheck the On checkbox for Port Status. So the Equivalent IOS Commands section displays the following command to achieve this process:

Switch>enable

Switch#configure terminal

Switch(config)#interface FastEthernet0/1

Switch(config-if)#shutdown

Using the Config tab, the following can be configured:

- Global settings
- Routing (on a router and a layer 3 switch)
- VLAN database (on a switch)
- Interface settings

Let's see what options are offered under each of these sections.

Global settings

The first part of Global settings allows you to change the Display name and Hostname of the device. The display name can also be changed by clicking on the name below the device icon. The configuration file for the device can also be saved, erased, or exported for later use. The Algorithm Settings section contains settings meant for advanced users who want to minutely tweak their device to see how it responds to certain situations.

These settings can also be globally set for all network devices by navigating to Options | Algorithm Settings, or by using the shortcut Ctrl + Shift + M.

Routing

This section has options for configuring Static and dynamic routing (RIP). To configure static routing, enter the network address, netmask, and its next hop address, and then click on Add. Here is some sample network information:

- Network: 192.168.30.0
- Mask: 255.255.255.0
- Next Hop: 10.0.0.6

To configure Routing Information Protocol (RIP), it is enough to add only the network IP. Please note that the GUI uses RIP Version 1, so classless routing is not supported.

Configuring Routing with the CLI

Apart from routers, routing can also be configured on the 3560-24PS switch, as it is a layer 3 switch.

The VLAN Database

This section will teach you how to create and remove VLANs. VLANs and trunking are discussed in Chapter 10, Configuring VLANs and Trunks. Only the VLAN database can be modified from these options; adding interfaces to these VLANs is what we'll see in the next section.

Interface settings

This section slightly differs from the switch and the router. Switches have options for modifying the speed and duplex setting and for assigning a port to VLAN. On routers, the VLAN section is replaced by the IP address configuration. While changing the speed and duplex settings, if you are setting it to anything other than auto, make sure that the settings are the same on both ends. For example, if you set it to 100 MBps on one end and 10 MBps on the other, the link won't come up.

4. GENERIC IP END DEVICES

If network devices are the core, end devices are the ones that use this core. Packet Tracer offers a wide range of end devices, starting from PCs and laptops, to tablets, PDAs, and even a TV! In this chapter, we'll learn about each end device, the modules available for it, and its configuration options. You'll be surprised to find that these end devices support a wide array of modules; such as network devices, and also have a lot of utilities under the Desktop tab that match the ones you have on your real computer!

Desktops and laptops

Desktops and laptops form the highest level of configurable and usable client devices in Packet Tracer. There is no difference between them when it comes to usability; only the naming conventions of the modules are different. The following modules are available for desktops and laptops. Like routers (as seen in the earlier), these devices too have to be switched off before adding/removing modules.

- Linksys-WMP300N: This provides a wireless interface for configuring WLAN on a WiFi network.
- PC-HOST-NM-1AM: This provides an RJ11 interface that can be used as a dial-up modem.
- PC-HOST-NM-1CE, PC-HOST-NM-1CFE, PC-HOST-NM-1CGE: These three modules provide an Ethernet, FastEthernet, and GigabitEthernet connection, respectively.PC-HOST-NM-1FFE, PC-HOST-NM-1FGE: This is the fibre Ethernet version of the previous module.
- PC-HOST-NM-1W, PC-HOST-NM-1W-A: Both of these modules provide a wireless interface for WLAN. The first one has a frequency of 2.4 GHz and the second 5GHz for 802.11a networks.
- PC-HEADPHONE, PC-MICROPHONE, PC-CAMERA, PC-USB-HARDDRIVE: These modules serve the purpose of representing each of their respective devices. They do not have any functionality associated with them.

On laptops, the same modules are available with a different name. Instead of HOST, LAPTOP is used. So, a PC-HOST-NM-1AM module is named PC-LAPTOP-NM-1AM.

Servers

Servers are an entirely different breed when compared to other end devices. They have various functionalities and have space for two network interfaces. The modules available for servers are the same as PC modules, except that the servers do not have the PC-HOST-NM-1AM module. Looking under the Config tab of a server, you can see that the following services are available. Let us look at what each of these offers.

HTTP

The HTTP service offers a web server that runs both HTTP and HTTPS protocols. A textbox below the HTTP section provides options to create and edit static HTML pages. These are displayed when this server is accessed through the web browser utility of other end devices. This service is on by default.

DHCP

The DHCP service can be used to assign IP addresses to routers. This section has options to create and edit DHCP pools of IP addresses. It has a default pool called serverPool, which cannot be removed or edited. This service is off by default.

TFTP

The TFTP service can be immensely useful when learning about backing up and restoring Cisco IOS images and configuration files. This section lists several IOS images from routers and switches available in Packet Tracer. If any file is copied from a network device to the TFTP server, that too will be displayed. A sample is available at Cisco Packet Tracer 6.0.1\saves\Server\TFTP\TFTP.pkt. This service is on by default.

DNS

The DNS service is for resolving domain names to IP addresses. The DNS service offers the following record types: A, CNAME, SOA, and NS. Though this interface looks simple and complete, multilevel DNS setups can be configured. A sample is available at Cisco Packet Tracer 6.0.1\saves\Server\DNS\Multilevel_DNS.pkt. A DNS cache button allows you to view cached DNS requests and has a feature that clears this cache. This service is off by default.

SYSLOG

This protocol provides a centralized logging service. Setting the Syslog server's IP to point to the configured server's IP from a network device fills the table in the Configtab with all of the logging messages generated by the device. This service is on by default.

AAA

AAA stands for Authentication, Authorization, and Accounting. This service is used for centrally managing the credentials of all network devices. It supports the RADIUS and TACACS authentication protocols. The options in this section allow you to create users and configure the network credentials to be used. Several samples are available at Cisco Packet Tracer 6.0.1\saves\Server\AAA\. This service is off by default.

NTP

Network Time Protocol ensures that the clocks of all devices are synchronized properly. This section has a calendar to set the date and time. Optionally, NTP authentication can also be configured. Once the server has a proper time set, all of the network devices can be configured to synchronize their clocks from this server. This service is on by default.

EMAIL

This section incorporates SMTP service and POP3 service. A domain name can be set and users created so that users can communicate by using the EMAILoption under the Config tab of a PC or laptop. Only one domain is allowed per server, and either SMTP or POP3 can be switched on or off as desired.

FTP

FTP has more features as compared to TFTP. Users can be created and permissions can be granted to each one of them. This section also lists files that have been uploaded. There is no GUI client for accessing the FTP server. But the command line under the Desktop tab provides the FTP command-line client. A sample is available at Cisco Packet Tracer 6.0.1\saves\Server\FTP\FTP.pkt.

Firewall/IPv6 Firewall

Because the server has two network interfaces now, the firewall feature has been introduced in PT Version 6. This section allows you to configure inbound rules that match source/destination IP addresses and local/remote port numbers. Based on the match, the connection can either be allowed or denied.

Other end devices

Apart from PCs, laptops, and servers, Packet Tracer has a lot of end devices; some of these have no functionality while some provide interesting features.

- Printer-PT: This is a network printer with modules similar to a PC except for the PC-HOST-NM-1AM module. The only option available in this device is the IP address configuration option.
- 7960: This is a Cisco IP phone with two Ethernet ports, one for connecting to a switch and another for connecting to a PC. The only module available is IP_PHONE_POWER_ADAPTER. If PoE (Power over Ethernet) is not available, this module has to be used to power the device on.
- Home-VoIP-PT: This device has no modules and the only configuration available is for the server address. This should be the IP address of the router on which Communications Manager Express (CME) has been configured. It has an Ethernet port and an RJ11 port for an analog phone.
- Analog-Phone-PT: This is a phone with an RJ11 connector, which, when connected to a Home-VoIP-PT device, can be used to make calls between Cisco IP phones.
- TV-PT: This television has a coaxial port and a single configuration option

to turn it on or off. The screen can be viewed only in the Physical view of Packet Tracer. When this device is connected to Cloud-PT, it can be used to display a slideshow of images.

- TabletPC-PT: This has desktop options similar to a PC but doesn't have any modules. It has a wireless interface for connecting it to a WLAN.
- PDA-PT: This device is similar to the tablet we saw previously.
- WirelessEndDevice-PT: This is a device with a wireless interface. It has an editable GUI that uses HTML code. The GUI tab has Traffic Generator similar to the one available on PCs and laptops.
- WiredEndDevice-PT: This is similar to the previous device but has a wired interface.

Configuring end devices

End devices have a Desktop tab, which provides a lot of utilities for testing and debugging the network. We will learn about each utility in this section. The following utilities are available for PCs, laptops, PDAs, and tablet PCs.

IP Configuration

We have already used the IP Configuration utility in Part 1, Getting Started with Packet Tracer, when we created a simple topology. This option is used to choose between a dynamic and static IP address. Entering a static IP address fills the Subnet Mask field; according to the class of the IP address, this field can also be edited if required. If DHCP is configured on Server-PT, choosing DHCP here obtains an IP address dynamically. Starting with Packet Tracer Version 6, this utility also has a section for configuring IPv6 addresses.

Dial-up

A modem dialer, this utility can be used if the PC-HOST-NM-1AM module is plugged in. This utility is available only on PC-PT and Laptop-PT devices as other end devices do not have the NM-1AM module. A cloud-PT device with phone numbers is required to be connected to this PC on one end and a router on the other end with a modem interface. A username/password combination is also required in the router; after this is done, entering them in this utility creates a connection.

Terminal

We used this utility in Chapter 2, Network Devices, for accessing the CLI through the console port. In most cases, the settings in this utility can be left to their defaults; but if you change the baud rate of the network device, it has to be changed here so that they match. This module is not available on the Server-PT device as it doesn't have an RS-232 interface.

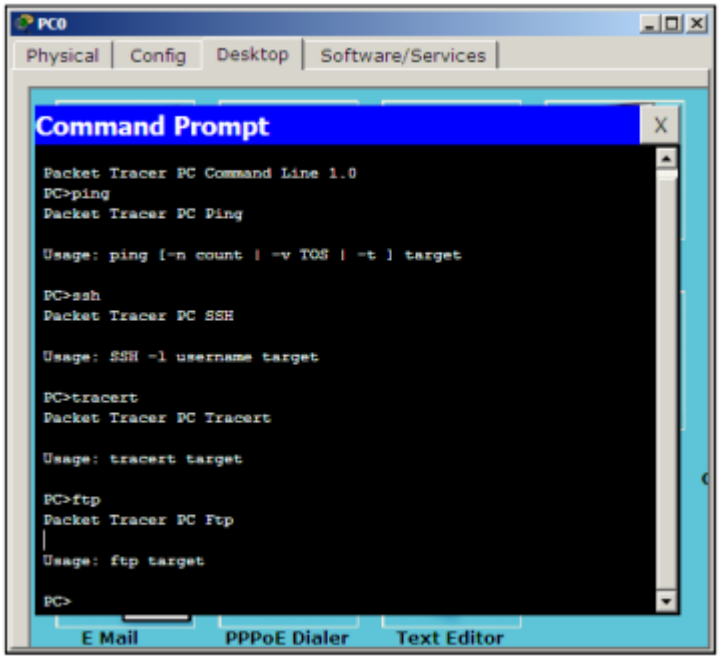
Command Prompt

This utility simulates the command line offered in Windows Operating Systems. Only a limited set of commands are available but they are enough to test the network. The following are the commands available:

? arp delete dir ftp help ipconfig ipv6config netstat nslookup ping

snmpget snmpgetbulk snmpset ssh telnet tracert

Each command's supported parameters can be found by entering a command without any options as shown in the following screenshot:



Displaying arguments for each command

Web Browser

Web Browser is a utility with minimal options, which can be used if you have a Server-PT device configured with HTTP. This can also be used if there is a Linksys-WRT300N device to access its web interface. This utility has only back, forward, go, and stop buttons and does not store any cache or history.

PC Wireless

This utility is designed for the Linksys-WMP300N module. It displays signal strength information and also has options for choosing a wireless network and modifying profiles to connect to wireless routers that are not broadcasting their SSID. These settings can also be saved, imported, or exported. This utility is available only on PC-PT and Laptop-PT devices, as other end devices do not have the Linksys module.

VPN

The VPN utility is used to create a VPN connection for secure communication. A router must be configured as a VPN server for this to work. A sample topology is available at Cisco Packet Tracer 6.0.1\saves\PC\VPN\Vpn_Easy.pkt.

Traffic Generator

This utility is similar in functionality to the Add Simple PDU and Add Complex PDU tools in the common tools bar. It is used to create customized packets and send them at periodic intervals. This is immensely useful for simulating a real environment.

MIB Browser

The MIB (Management Information Base) Browser utility sends out SNMP requests. This allows you to retrieve router and switch data or make changes to the devices. A get request is sent to fetch a value, whereas a set request is sent to modify a value. A router has to be configured with an RO (Read Only) community string and RW(Read Write) community string. This utility is not available on the Server-PT device. A sample topology is available at Cisco Packet Tracer 6.0.1\saves\PC\MIB_Browser\SNMP_Router.pkt.

Cisco IP Communicator

Cisco IP Communicator is a Cisco software that can be used to turn a computer into an IP phone. This utility is available in Packet Tracer to make and answer calls using a PC or laptop. Clicking on it opens a phone GUI that can be used to dial numbers; the default TFTP server can also be changed by navigating to the Preferences… option, as shown in the next screenshot. This utility is not available on the Server-PT device.

Cisco IP Communicator on the PC

E Mail

This is an e-mail client utility that can be used to send and receive e-mails. The first time it is opened, it has to be configured with the Incoming mail server (POP3), Outgoing mail server (SMTP), and credentials. A Server-PT device has to exist in the topology with its EMAIL section configured. This utility is not available on the Server-PT device. A sample topology is available at Cisco Packet Tracer 6.0.1\saves\Server\Mail\mail_2Server_2PC.pkt.

PPPoE Dialer

This utility is required to establish a connection using a DSL-Modem-PT device. On one end, the modem device connects this PC over Ethernet and on the other end, it has a cloud connected by a

phone wire. A router has to be configured as a PPPoE server with a username and password. A sample topology is available at Cisco Packet Tracer 6.0.1\saves\Router\PPPOE\client.server.modem.pppoe.pkt.

Text Editor

The Text Editor utility is similar to the Notepad available in Windows. It can be used to create, edit, and save text files that can be listed using the dir command in the command-prompt utility. Created text file can also be used to test FTP by uploading it from the command line.

PART 3: CREATING TOPOLOGIES AND CLUSTERS

we would learn:

- the nuances of creating a network topology in Packet Tracer, the types of connections available, and link statuses.
- how to test connectivity by using simple and complex PDUs. The test feature will help you a lot as you build complex topologies.
- The simulation mode of Packet Tracer—go ahead and explore this mode using hubs and look at the difference between hubs and switches.
- Finally, creating and managing clusters.

1. CREATING A NETWORK TOPOLOGY

So far, we have learned a lot about the devices available in Packet Tracer. we will start putting these devices to use. We'll learn what it takes to create a network topology, its connections, and link indications. Then we'll test the connectivity between the topologies and a PDU (Protocol Data Unit), both simple and complex. Once we are done with that, you'll no doubt be curious to see how data moves from one node to another. That will be taken care of by the simulation mode of Packet Tracer. Finally, we'll clean up our workspace a bit by using the clustering feature.

Connecting devices

Choosing the Connections icon from the device-type selection box lists several cables in the device-specific selection box. Packet Tracer provides the following cables that can be used to connect devices:

- Console: This is a console cable that is used to view the network device's console from a PC/laptop. One end of the cable connects to the console port of a network device while the other one connects to the RS-232 port on a PC/laptop.
- Copper straight-through: This is a standard Ethernet cable that is used to connect two devices that operate in different layers of the OSI model (such as hub to router and switch to PC). It can be used with Ethernet, Fast Ethernet and Gigabit Ethernet port types.
- Copper cross-over: This Ethernet cable connects devices operating in the same OSI layer (such as hub to hub, PC to PC, PC to router, and PC to printer). This cable can also be used with Ethernet, Fast Ethernet and Gigabit Ethernet port types.

- Fiber: This cable connects Fast Ethernet and Gigabit Ethernet ports of a fiber port.
- Phone: This RJ11 cable connects the analog phone to a VoIP phone or a PC's modem to a cloud. It also connects the modem interface of routers.
- Coaxial: The coaxial cable connects the cloud with a cable modem and a TV with the cloud.
- Serial DCE and DTE: Serial cables connect routers together and connect routers to the cloud. The DCE (Data Circuit-terminating Equipment) end has a clock symbol on it. Clocking must be enabled on this end using the clock rate <300-4000000> command

to bring the line protocol up. If Serial DTE (Data Terminal Equipment) is chosen, the first device connected with this cable will be the DTE end and next device will be the DCE end. For the Serial DCE cable, this is just the opposite.

- Octal: This cable was introduced in PT Version 6. It has a high-density connector on one end and eight RJ45 plugs on the other.
- Automatically choose connection type: If you are confused about the cable to use, choosing this option automatically connects two devices with the best cable. We say best cable because if you have two routers with serial and Fast Ethernet interfaces on both of them and want to connect both of their Fast Ethernet interfaces, choosing this option will connect only their serial interfaces together. Similarly, console ports cannot be connected using this option.

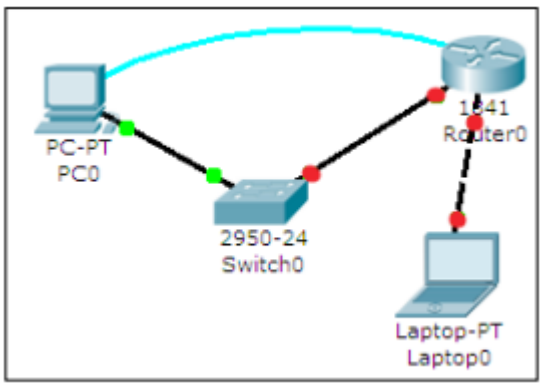
Link status

After connecting devices together, you'll find a light at each end of the cable; this indicates the state of the connection, as follows:

- Bright green: This indicates that the physical link is up, but it doesn't indicate the status of the line protocol.
- Blinking green: This indicates link activity.
- Red: This indicates that the physical link is down. This can be caused by incorrect cables or by a port being administratively shut down.
- Amber: This appears only on switches and indicates that the port is running the STP (Spanning Tree Protocol) algorithm to detect layer 2 loops.

Let us demonstrate how to connect devices in a topology containing a PC, laptop,

switch, and a router. We will be using the following topology for this demo:

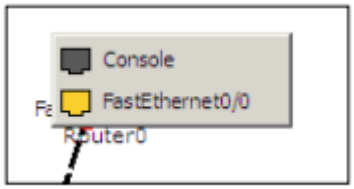


After adding the devices shown in the previous topology, click on a connection type

from the device-type selection box and choose a connection. Click on a device and a

context menu will list all the interfaces available for the device. Select the interface

and repeat the same steps on the other device to create a link between the two.



If a router is connected to any device, the link status will be red because routers have their ports in "shutdown" status by default. If a device is connected to a switch, the link is initially amber in colour, indicating that it is going through the states of STP.

Testing connectivity with PDUs

Once a topology has been created, connectivity can be tested between devices by using either simple or complex PDUs. Although it is possible to do the same by pinging devices from their command-line interface, using the PDU option is quicker for large topologies.

Simple PDU

The Add Simple PDU option uses only ICMP (Internet Control Message Protocol). We will create a topology with a PC and a server to demonstrate how this option works:

1. Add a PC and a server to the workspace and connect them using a copper crossover cable.
2. Assign IP addresses to both in the same subnet. Example, PC1: 192.168.0.1/255.255.255.0 and PC2: 192.168.0.2/255.255.255.0.
3. From the common tools bar, click on the closed envelope icon or use the shortcut key P.

4. The pointer will change to an envelope symbol. Click on the PC first and then on the server. Now look at the User Created Packet box. You'll see the status as Successful and will also see the source, the destination, and the type of packet that was sent.

Fire	Last Status	Source	Destination	Type	Color	Time (sec)	Periodic	Num	Edit
	Successful	PC0	Server0	ICMP		0.000	N	0	(edit)

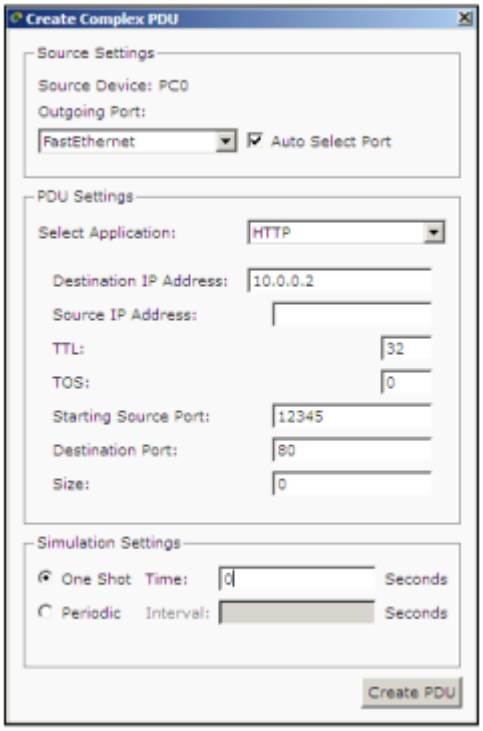
That was very simple, wasn't it? Now let's see what complex PDUs have to offer.

Complex PDU

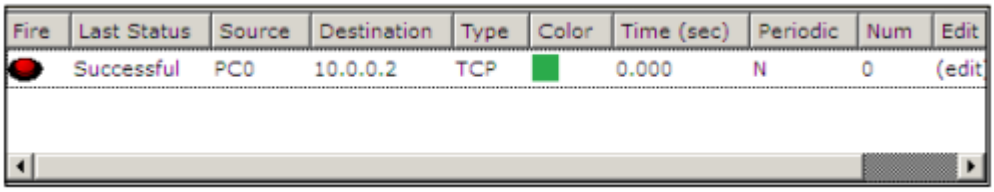
We will demonstrate complex PDUs with the same PC-Server topology:

1. Click on the open envelope icon or press C; this is the Add Complex PDU option.

2. Click on the PC and the Create Complex PDU dialog box opens. Select the application and fill the Destination IP address (IP of the server), Starting Source Port, and Time fields, and then click on the Create PDU button.



3. Now click on the server and then look at the user-created packet box. An entry indicates a successful TCP three-way handshake as shown in the following screenshot:



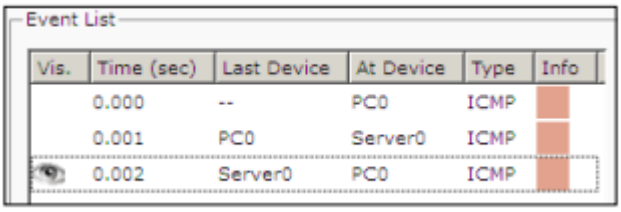
See the red button under the Fire column? Double clicking on it will send the same packet again.

Using the simulation mode

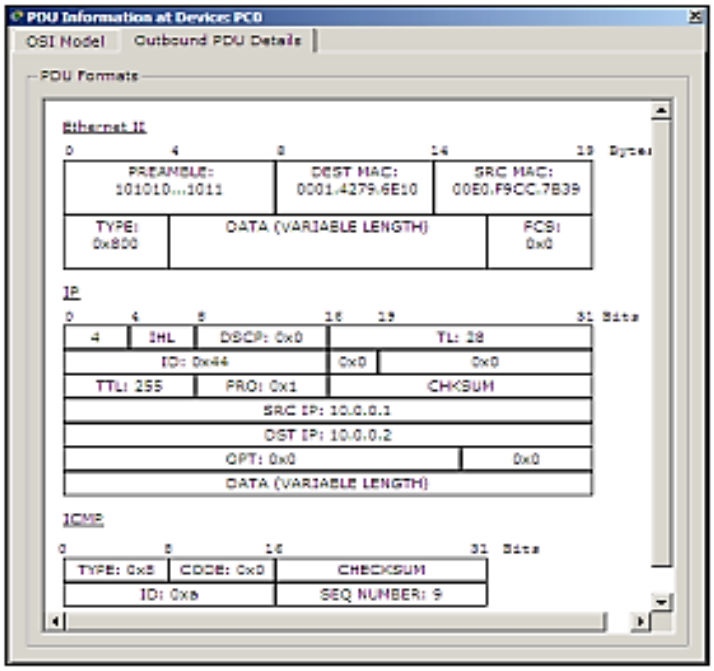
All of this was done while we were working in real-time mode, so the only indication of traffic was the link status blinking green. But, using simulation mode, you can see packets flowing from one node to another and can also click on a packet to see detailed information categorized by OSI layers.

- Use the realtime/simulation tab to switch to the simulation mode.

Click on the Auto Capture / Play button to begin packet capture. Try a Simple PDU, as described in the previous section, and the event list will be populated with three entries, indicating the creation of an ICMP packet, ICMP echo sent, and ICMP reply received:



If you click on a packet (the envelope icon), you'll be presented with the packet information categorized according to OSI layers. The Outbound PDU Details tab lists each layer's information in a packet format:



The simulation mode has a Play Controls section that works similar to the controls

of a media player and is as follows:

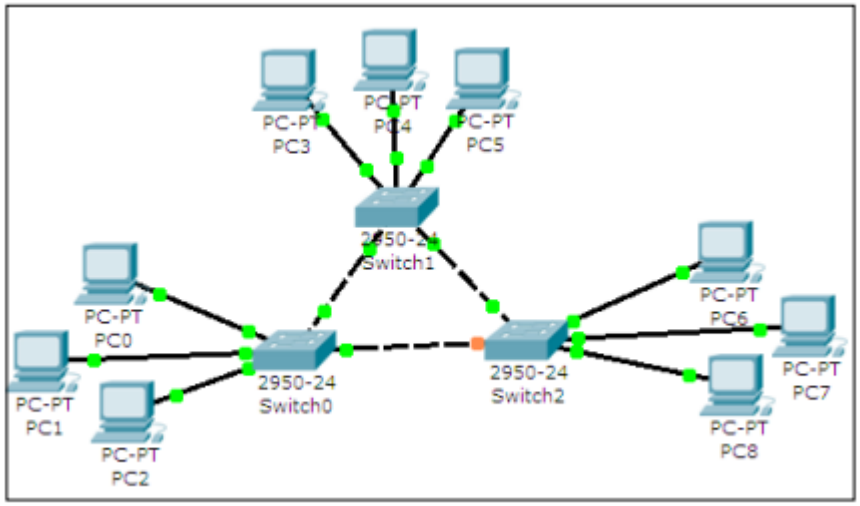
- Back: This button moves the process one step back each time it is clicked on.
- Auto Capture / Play: Pressing this button results in all of the network traffic (chosen under event filters) being continuously captured until this button is pressed again.
- Capture/Forward: This is the manual mode of the previous button. This has to be pressed each time to move the packet from one place to another.

Clustering a topology

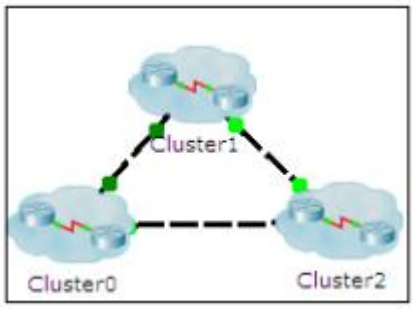
When large topologies are created, it becomes difficult to understand them after a while. Clustering comes to the rescue by combining several devices that you choose into a single cloud icon. Then, double-clicking on the cluster expands and displays the devices normally.

Let us see how to create a cluster:

1. We'll be using the following topology containing three switches and nine PCs. While this is not at all cluttered, it will give you an idea when to use this feature.



2. Click on the whitespace next to PC3; drag your mouse to select PC3, PC4, PC5, and Switch1; and click on the New Cluster button on the top-right corner. Repeat these steps selecting the other two sets of three PCs and a switch.
3. You'll get a clustered view as follows:

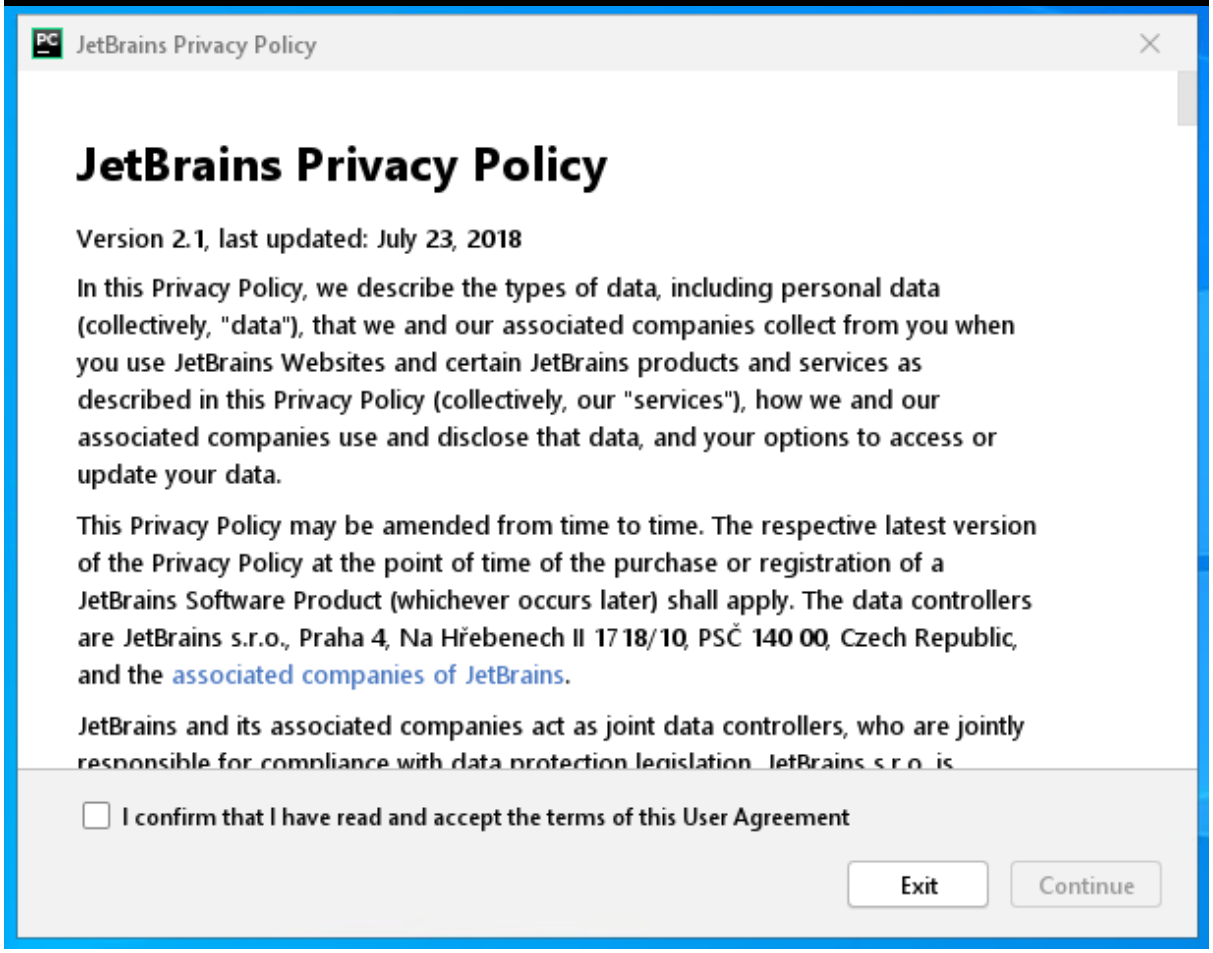


4. Double-clicking on a cluster expands it and displays only the devices within it. To go back, click on the Back button on the top-left corner.

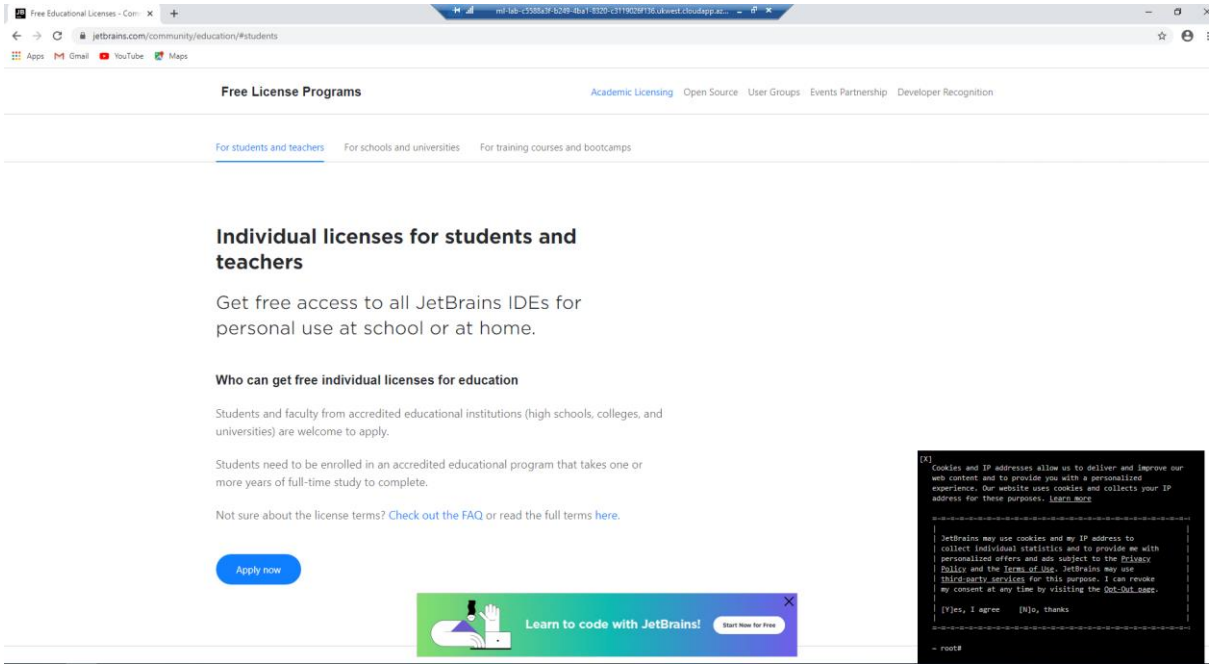
Clusters can also be created inside clusters. A cluster is a feature of the logical workspace and hence does not affect how devices are displayed in the physical workspace.

PART 3: INTRODUCTION TO PYCHARM – PYTHON NETWORK PROGRAMMING

1. When running PyCharm for the first time you will see the JetBrains privacy policy, accept and set the defaults for the environment. Python 3.8.5 should be installed.

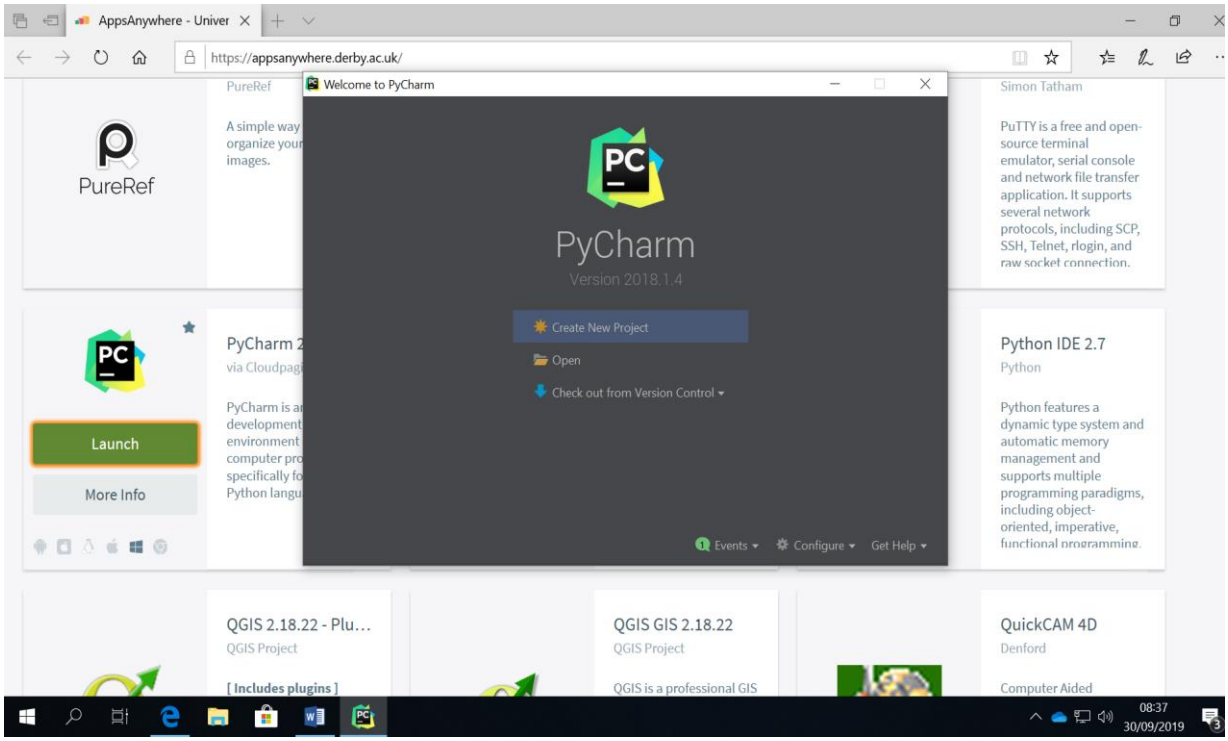


2. If you don't have a JetBrains account – create one, the software they make is great and it's free for you!

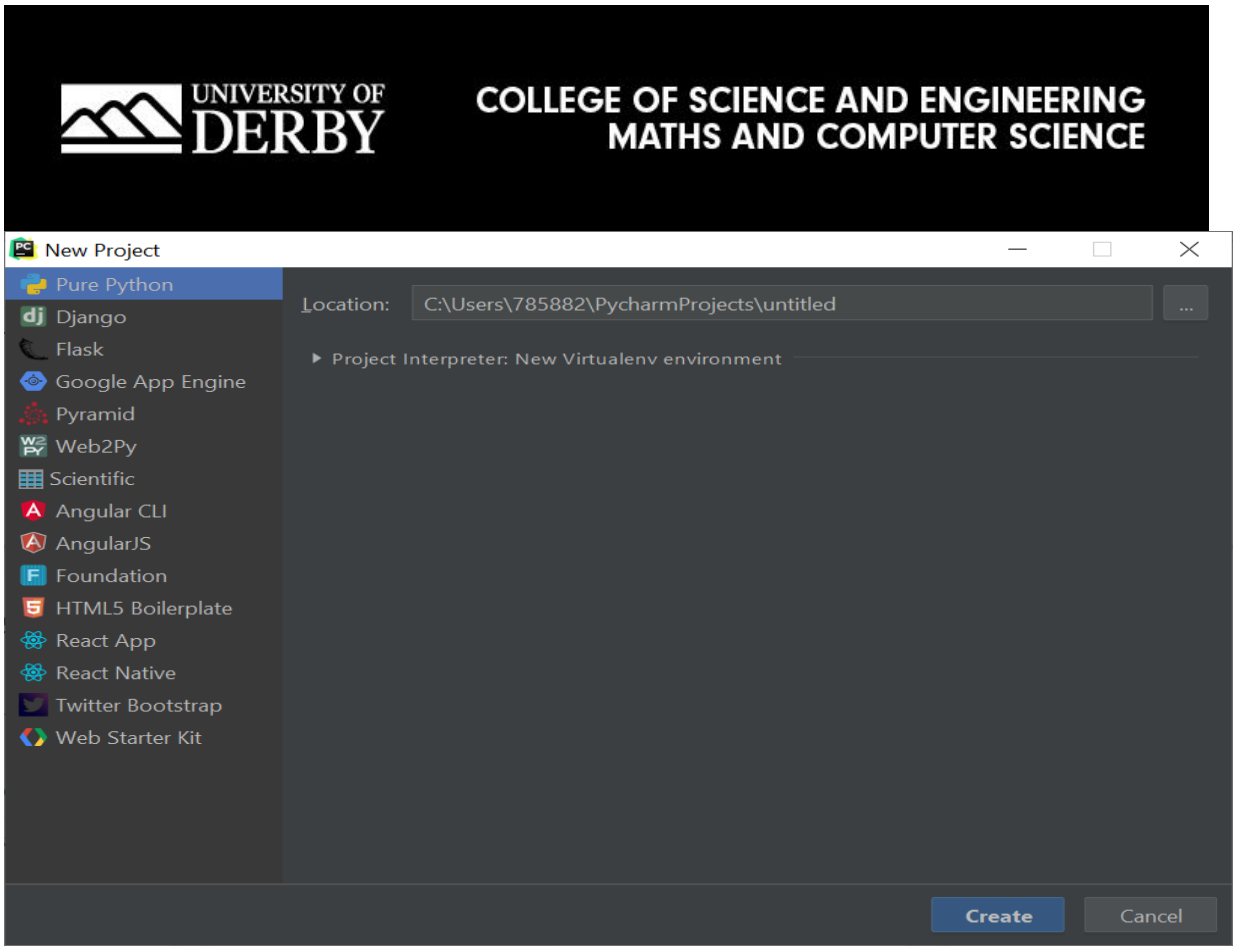


You should work through the tutorials at https://www.w3schools.com/python/ or https://docs.python.org/3/tutorial/ to learn the syntax and structure of the language, then undertake the tasks below. A series of screenshots is provided below to show you the rough process of starting a new project and testing that Python is installed correctly.

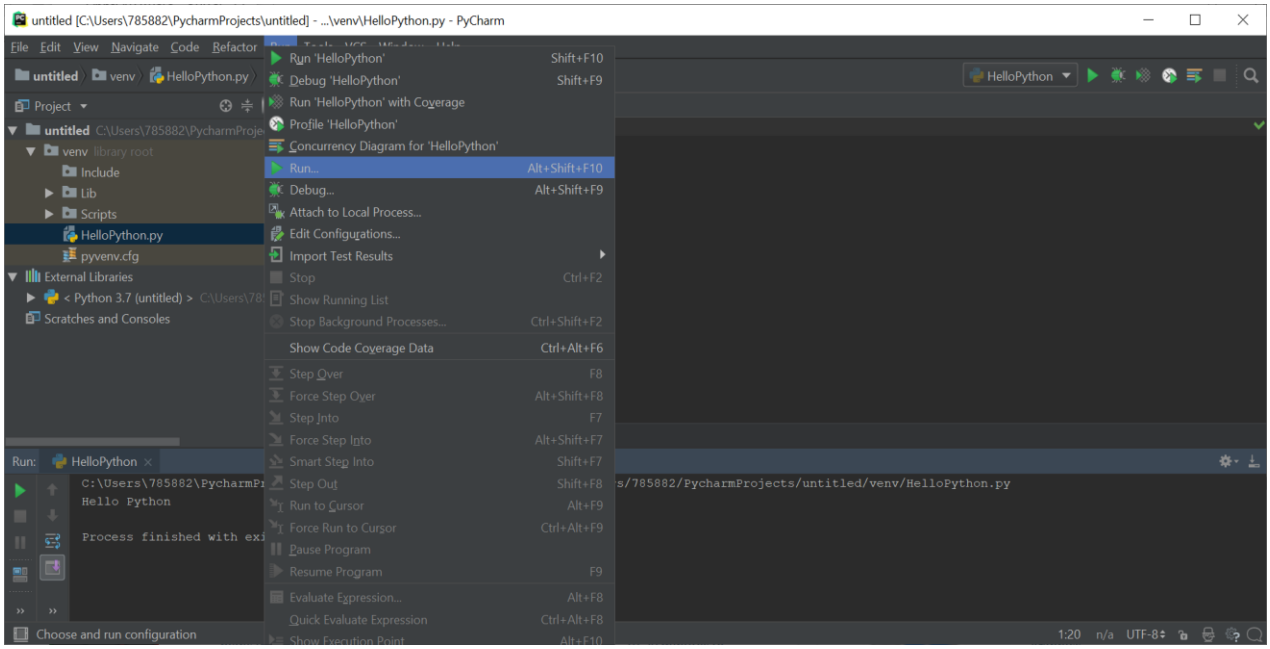
3. Start a new python project



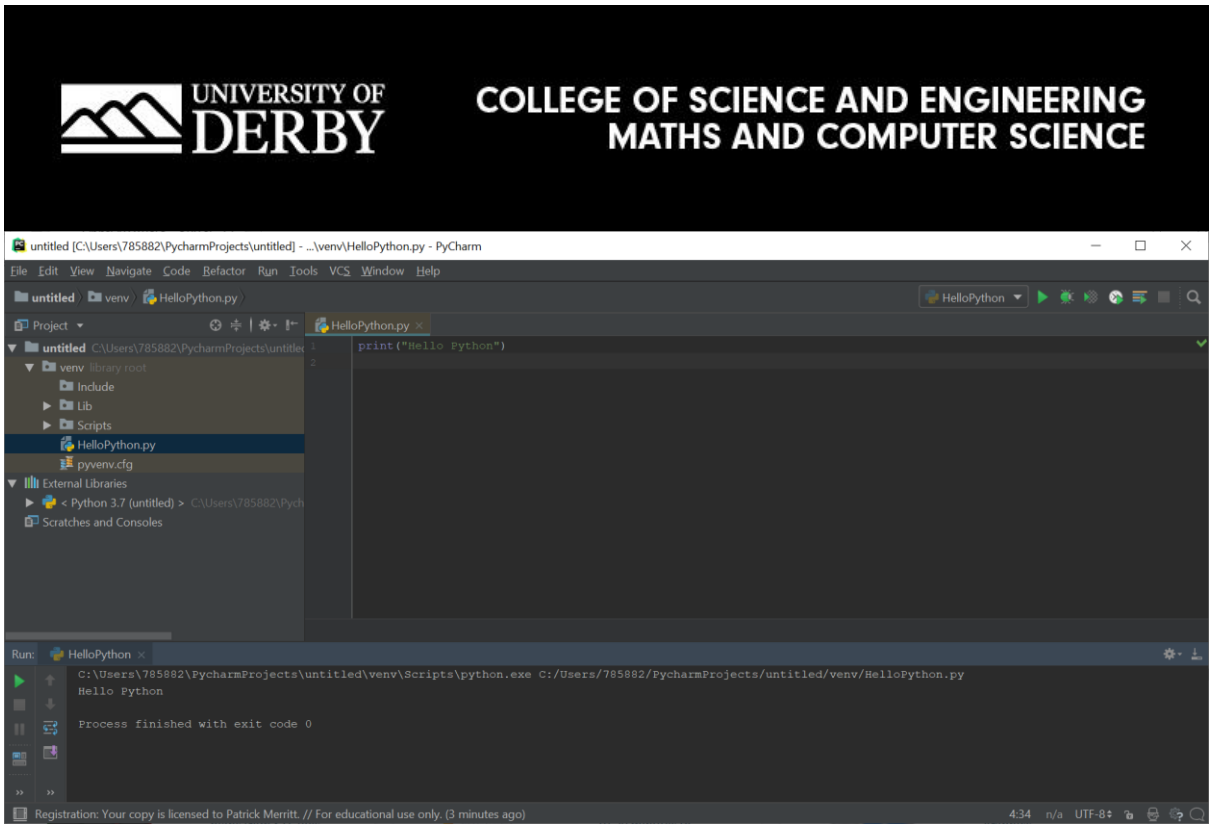
4. Select Pure Python



5. Run the auto-generated code to verify that your instance of Python is correctly setup



6. Check the output is correct



7. Start building some basic programs, sample code is available online
    1. Implement a version of “Hello World”
    2. Demonstrate the use of iteration and selection by implementing “99 moderately annoyed grizzly bears on the wall”, allow the solution to alter the number, singular, and plural terms in the strings.
    3. Demonstrate the use of methods and classes by implementing a simple number guessing game
    4. Demonstrate the use of lists and dictionaries by implementing a game of hangman