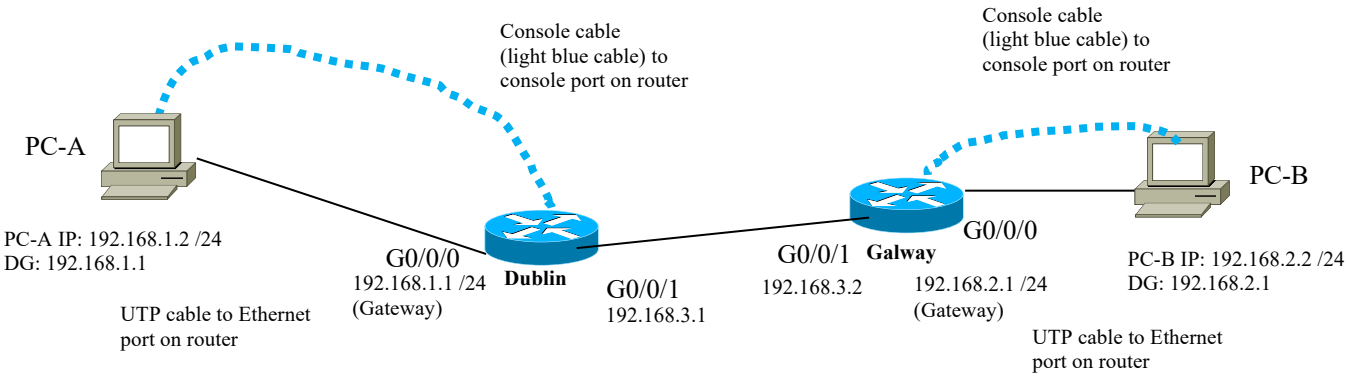
WAN Technologies

WAN Technologies - Two Router Lab

Lab 1 – Building a small Wide Area Network (WAN)

WAN Topology



NOTE: If you need help, please refer to the PDF on Brightspace "Routing Concepts, Static Routing and Dynamic Routing" where lots of different configuration examples are provided.

IMPORTANT NOTE:

Every member of the group needs to participate in this lab to score lab marks. Proceed through the objectives as a group. Showcase your outputs to your lecturer in order to receive the answer code for questions 3 and 4.

Objectives

Part 1: Set Up the Topology and Initialize Devices

Part 2: Configure local LAN Devices and Verify Connectivity

Part 3: Configure static routes across the WAN

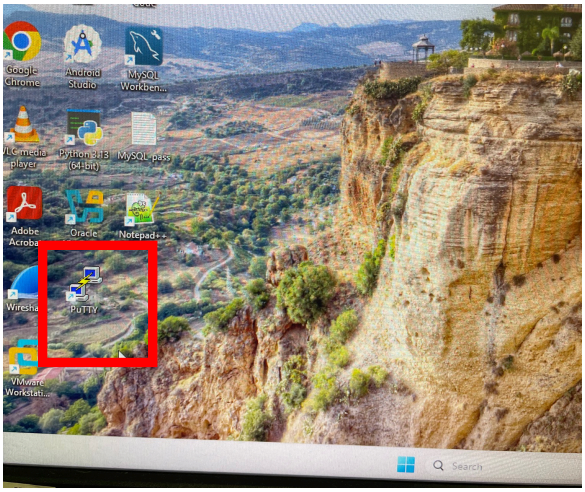
Part 4: Configure a dynamic routing protocol (OSPFv2) across the WAN

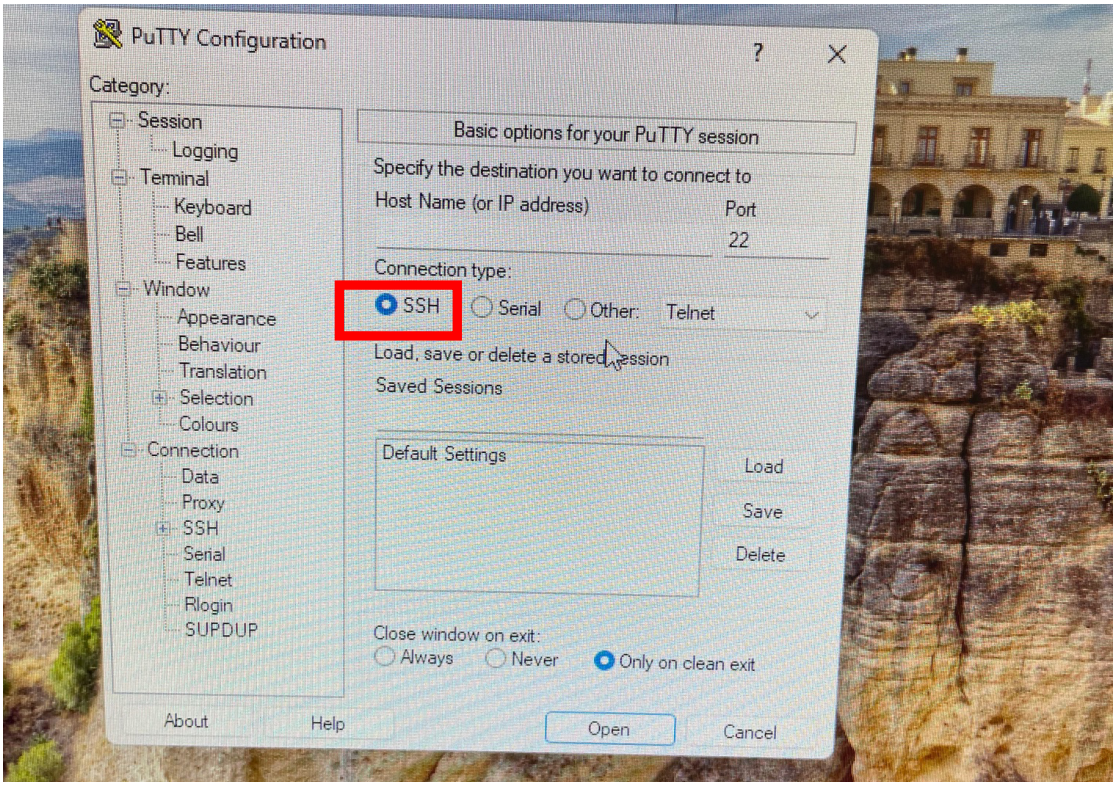
Extension Tasks: Complete tasks to enrich your learning experience

Part 1: Set Up the Topology and Initialize Devices

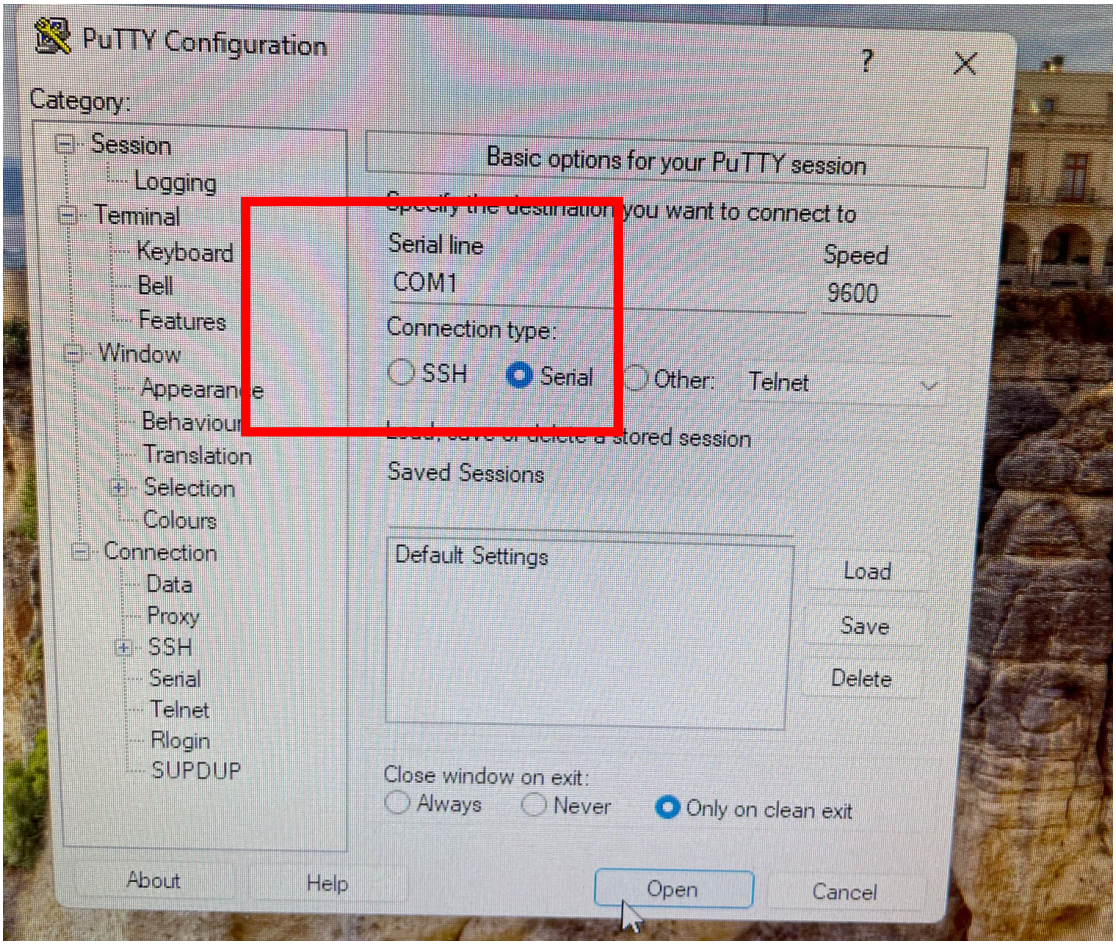
This next section provides an overview of connecting up a PC to a router in the lab. The example used is from E202 but the same concepts apply in any networking lab in TU Dublin (Blanchardstown).

Use **Putty** software to connect to physical equipment (router).

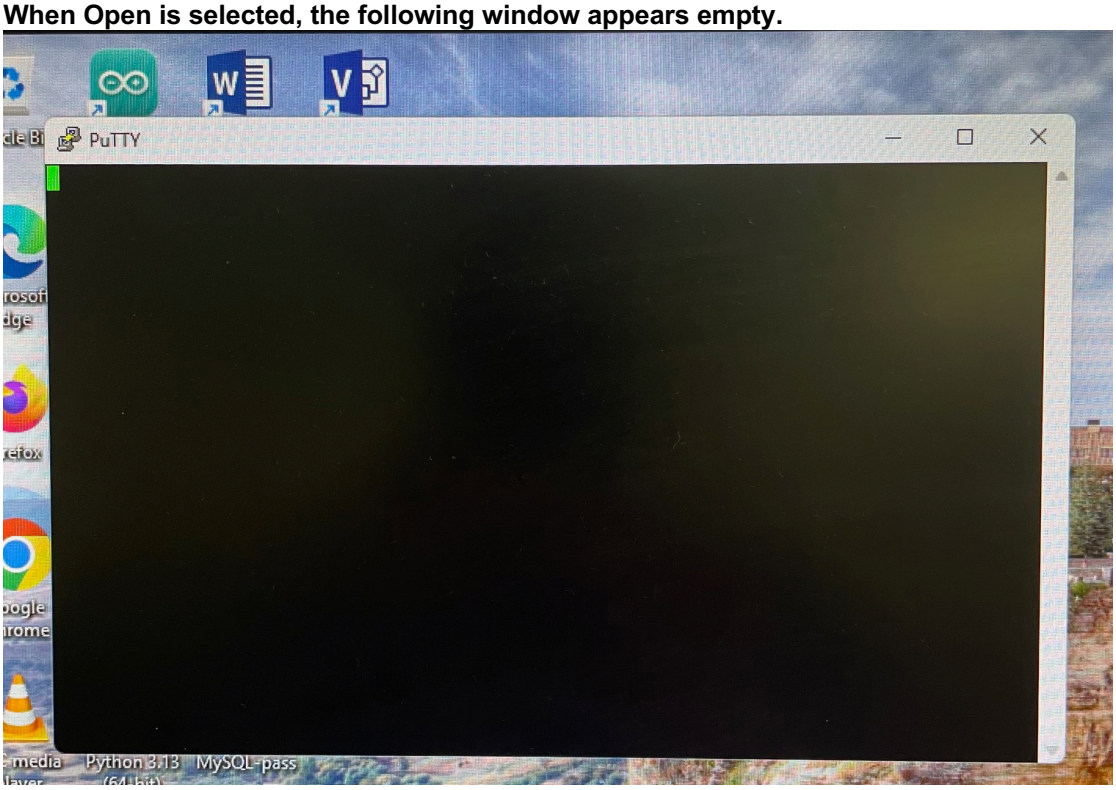




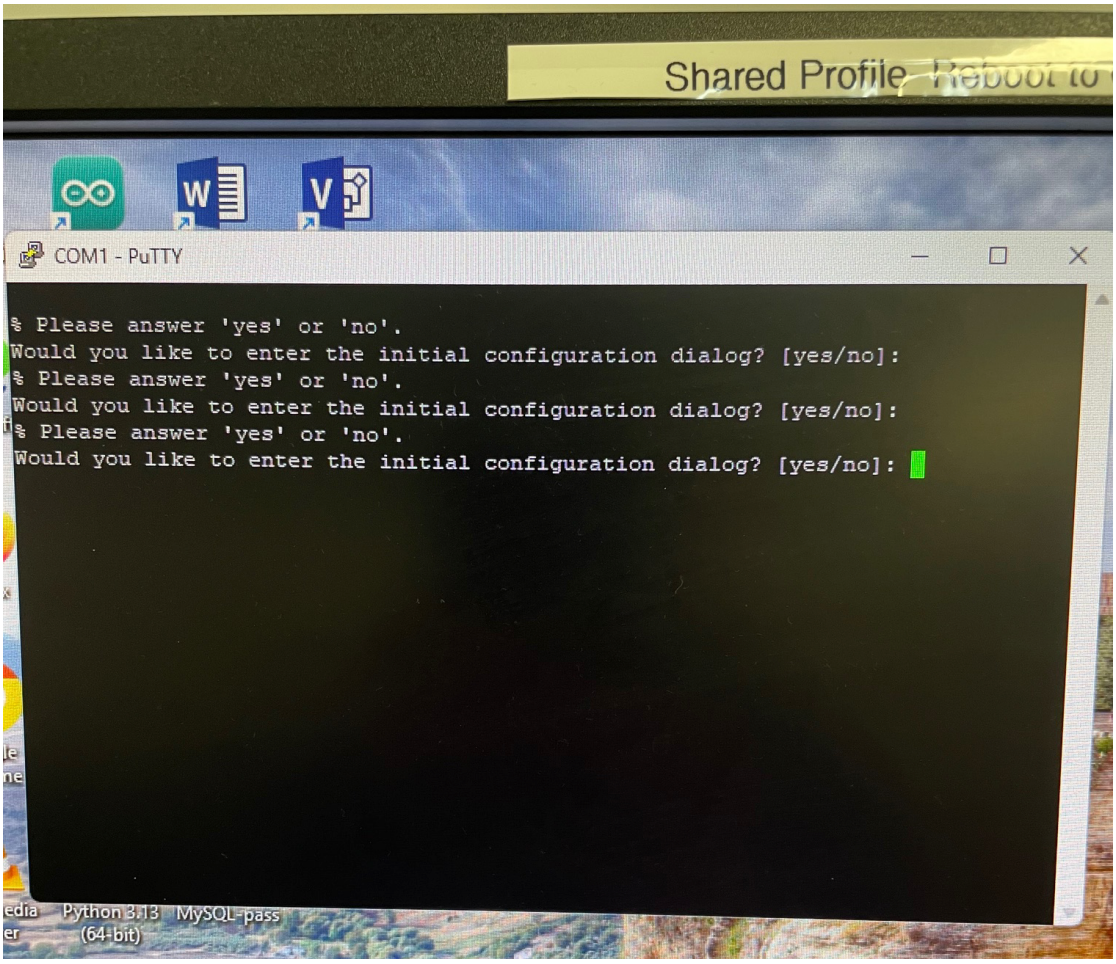
Note: this needs to be changed to Serial.



Note, Serial is now highlighted and we are connecting to COM1.
When Open is selected, the following window appears empty.



NOTE: If you have a console cable attached to your router, press Enter.



You are now ready to begin configuration on your router. Enter no to exit initial configuration dialog.

TROUBLESHOOTING (Software): If you cannot see any prompts from your router on screen, check your cabling (see below).

Also, you may also check Device manager to ensure that console is connected to COM1 port. This may be different for your PC in the lab.

To enter device manager, right click on Windows icon on taskbar and select Device Manager. Check to ensure Com port is available and which port it is. In the below, COM1 is shown but this may be different for your lab PC.

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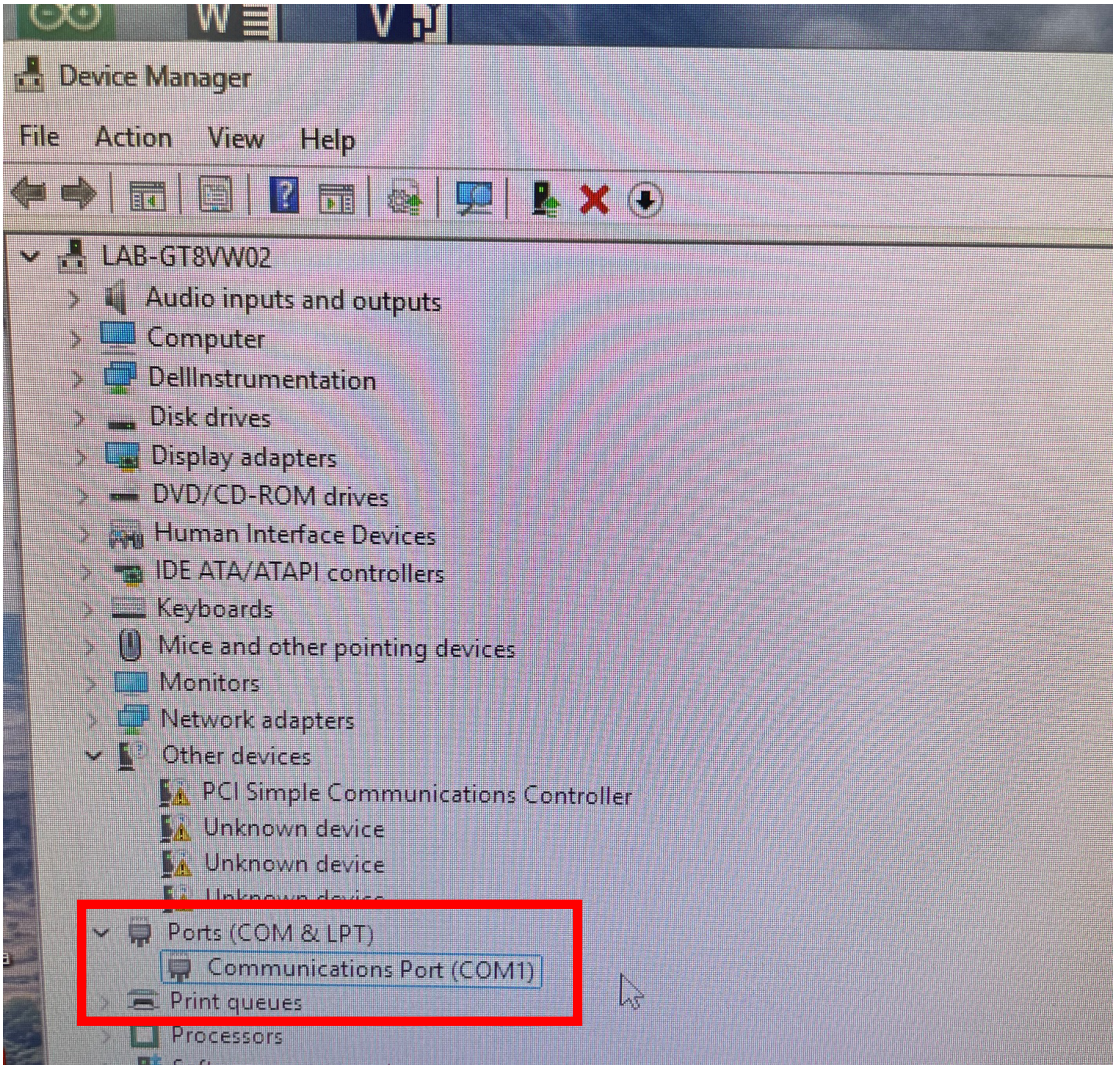
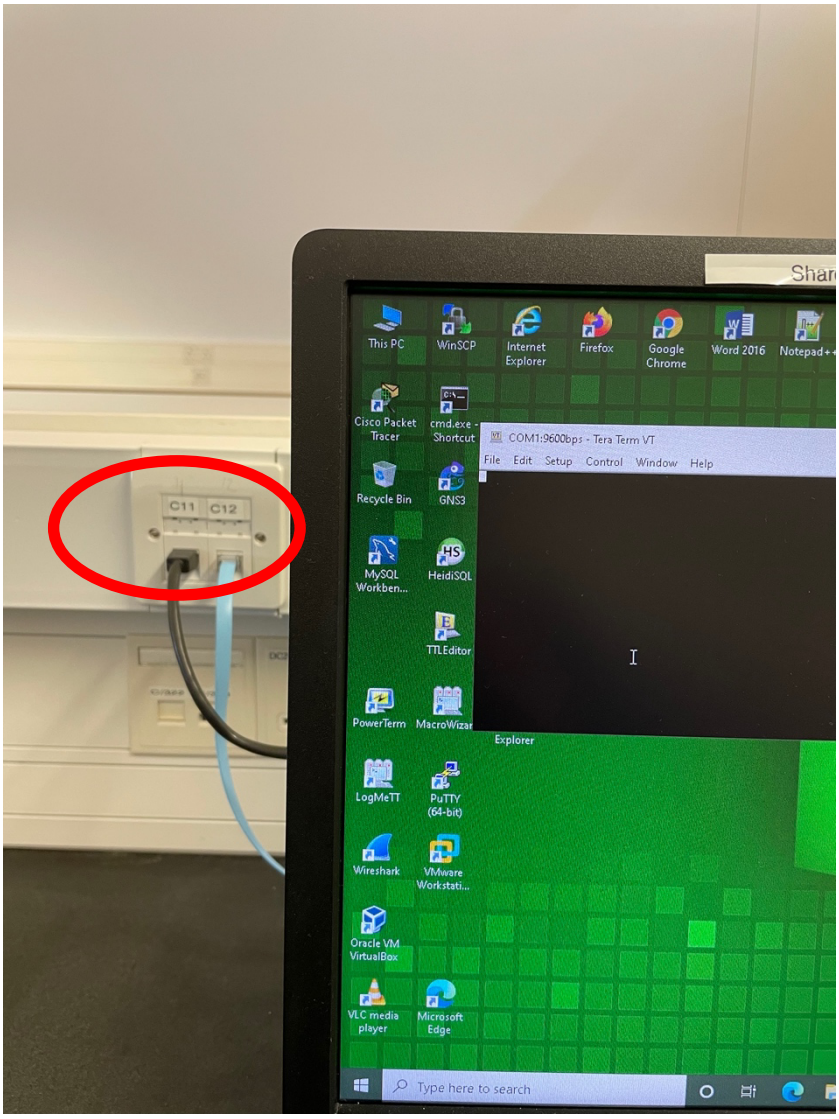


If you are having further issues connecting to your router, please ask the lab lecturer for help

TROUBLESHOOTING (Cabling): Checking your physical connections

Understanding connections to the physical lab -
In this lab, each Desktop PC is connected with two cables.

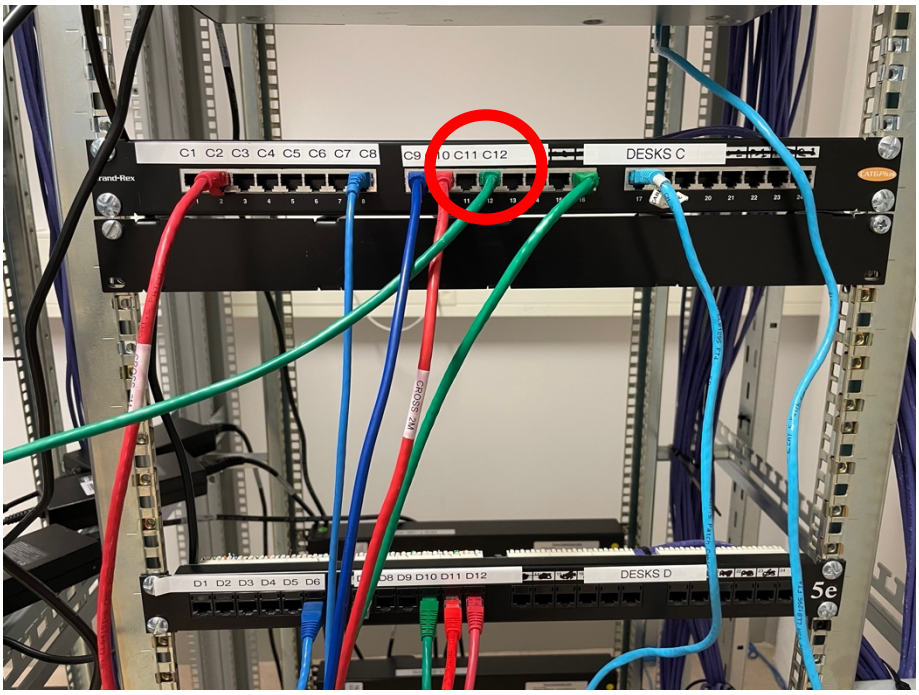


Light blue cable (known as console cable) – in this case, one side of the cable is connected into port **C12** (this is the port it will terminate on the patch panel- it is important to note that in your lab this will likely be different). The other end of this cable connects to the USB to RS232 DB9 Serial Adapter that is connected to the PC.

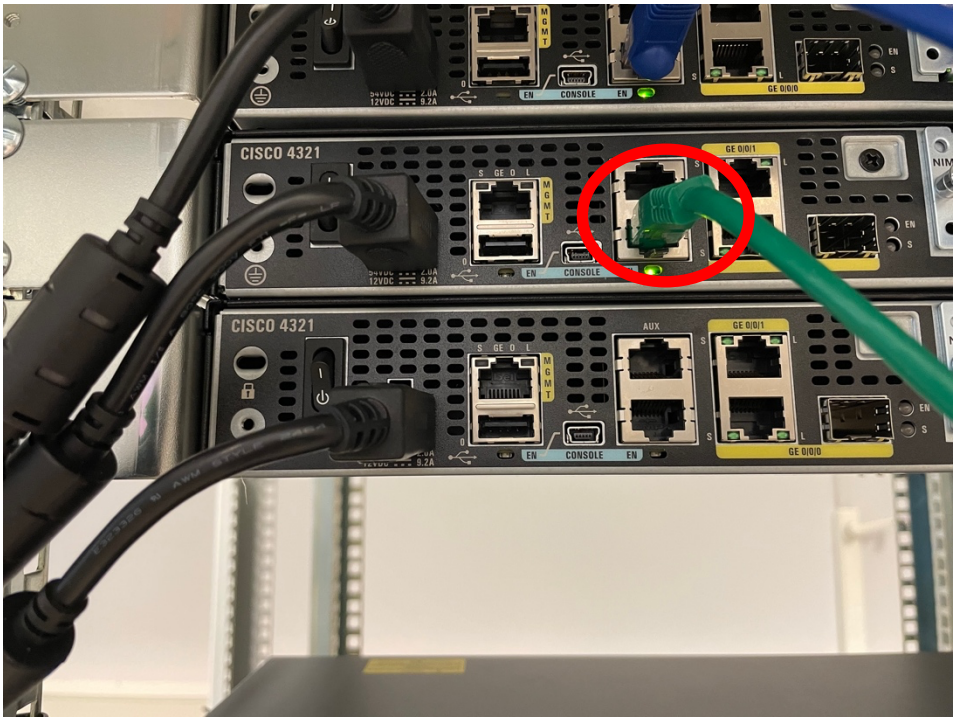
Grey UTP cable – in this case going into port **C11** (this is the port it will terminate on the patch panel) **– the other end of this cable goes into the Ethernet NIC of the PC**.

In the picture below, we wish to connect the Desktop PC to the router (to gain access to the command line interface). We will cable up the console connection ONLY (for now!).

The connection from C12 will be cabled back to a patch panel (in the corner of room). Note another cable (green cable) in this picture below has now been inserted and connected into port C12.
The green cable is an example of a straight through cable. Note: the only cable we don't want to use here is a red crossover cable as this type of cable will NOT work.

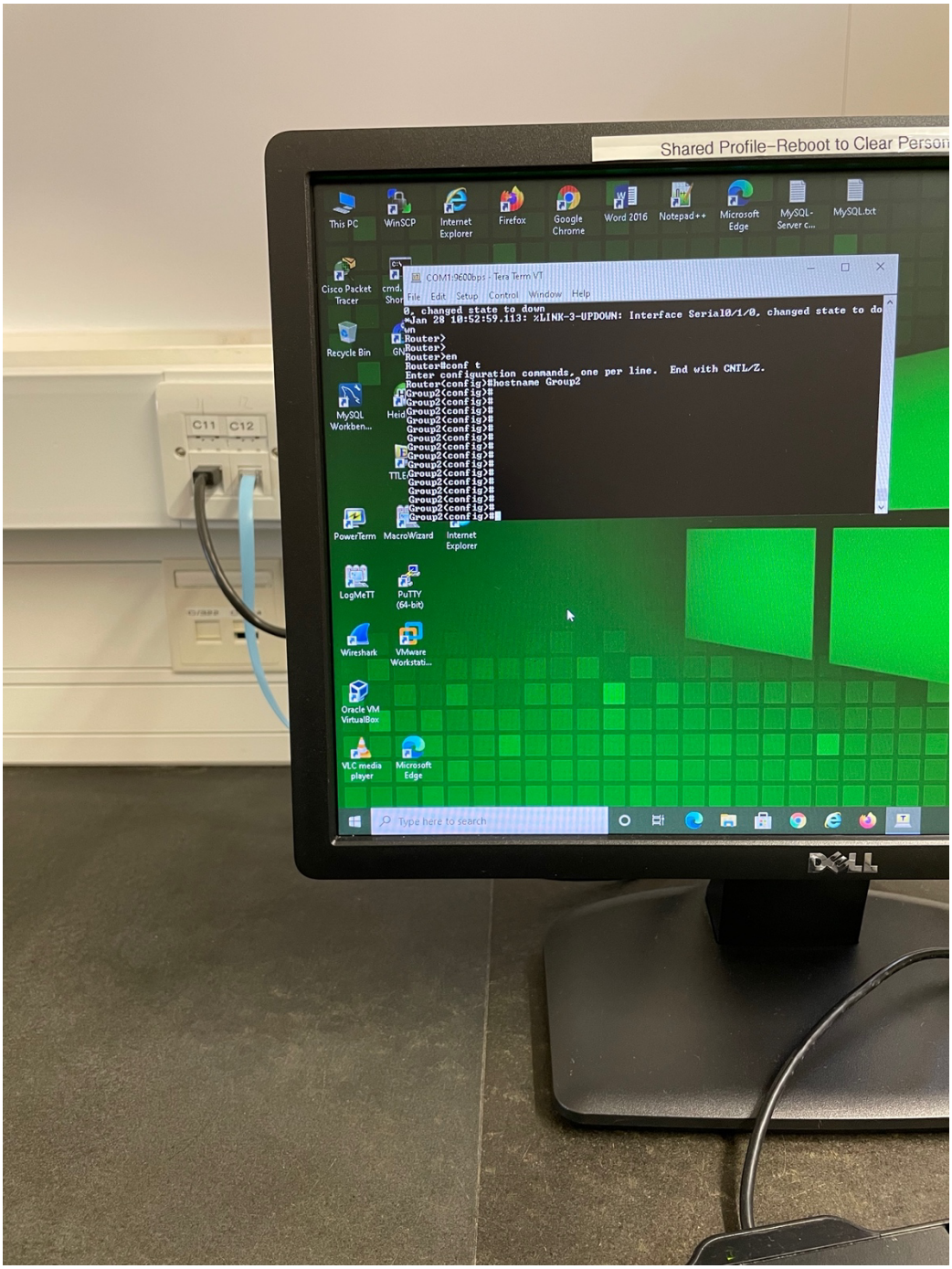


The other end of the green cable is now connecting to the **console port** of the Cisco 4321 router. **Ensure NOT to connect it to the AUX port or any other port! (if we connect to another port we will not get console access!).**



Now return to your PC, press **Enter** on PC's keyboard in Tera Term.

You should now see the Cisco command line interface (CLI) and can now start configuring the device allocated to your group.



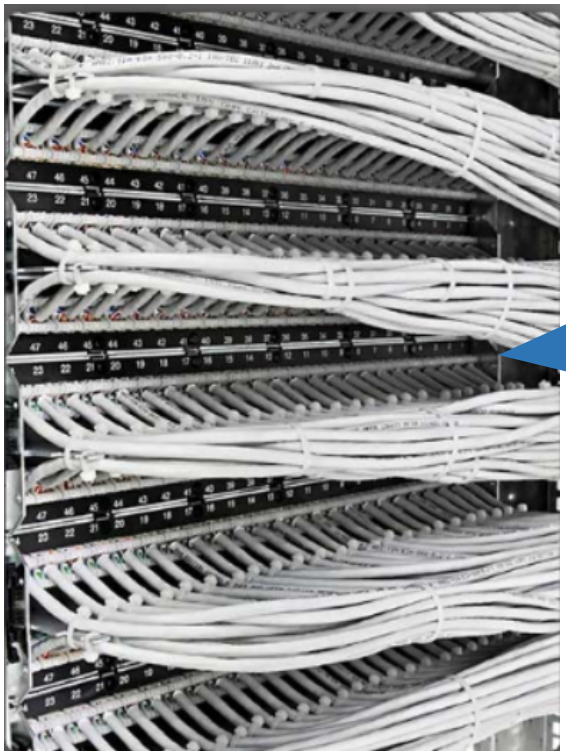
Question: Where will the grey cable go that runs to C11?
Class discussion.

Note the solution is on the next page!

You will now run a new straight through cable from C11(on the patch panel) to the ***Gigabit Ethernet port e.g G0/0/0 of your assigned Router.***

Your assigned router should now have ***TWO*** *UTP cables connected – one connecting to the console port and another connected to the Gigabit Ethernet port.*

Note re: the function of the patch panel



Patch Panel - A centralized place where network cables attach to the back.

Patch cables are used to make a connection to another patch panel which connects to a different wiring closet, or to a device such as a switch mounted nearby.

Background / Scenario

In this lab, you will work in a team. Two members of the team will work together setting up the Dublin office (Pod 1) and two others will work together in another team setting up the Galway office (Pod 2) networking equipment.

Once both teams have setup their local LAN's in Part 3 you will work across pods to setup WAN connectivity.

First, you will cable the equipment as shown in the topology diagram below.

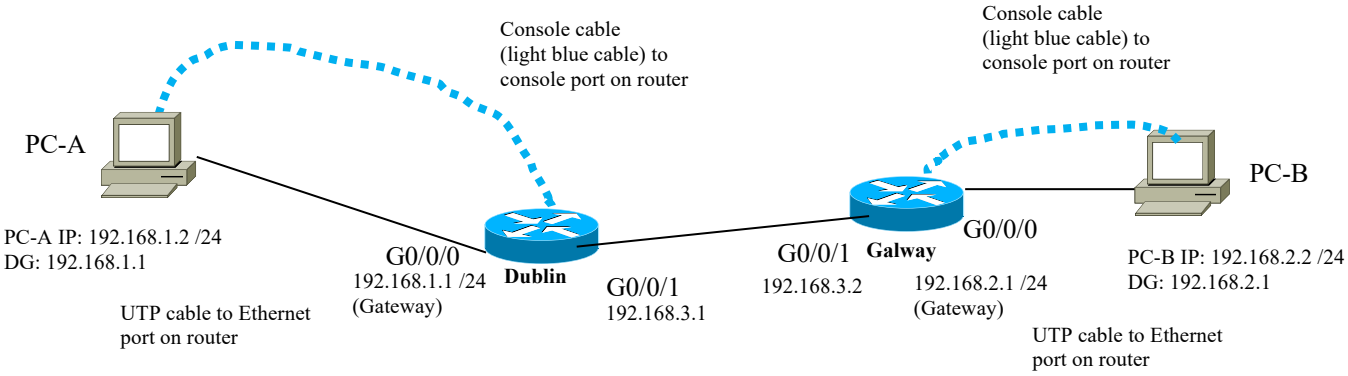
IMPORTANT: These instructions are GENERAL guidelines, it is important to note depending on the lab the equipment may differ (which may mean ports/commands may change. For example: below in the configuration it shows both G0/0/0 and G0/0/1 – none, one or both of these device names may differ depending on the lab and particular device). For example, the Gigabit port may be g0/0.

use the command
'show ip int brief'
to see your exact interfaces and take note of these.

Part 2: Configure local LAN Devices and Verify Connectivity

We will configure devices to match the topology diagram. After the configurations have been saved, you will verify your configurations by testing for local LAN connectivity and then later test WAN network connectivity.

WAN Topology



In this exercise, you will work in teams. It's important to listen to instructions and to keep in mind health and safety best practices outlined by your instructor at all times.

Your instructor will allocate you to a group and designate your team with a router.

2.1 ENSURE ROUTER CONSOLE CONNECTIVITY (CABLE ROUTER CONNECTION) – please note you will have completed this in PART 1 above.

Step 1 (both Pods):

- Connect PC-A to router called Dublin using a straight through cable – use the pictures above to help you with this part. **(Dublin Team)** Note: don't use a red cable as this is a cross-over (connecting to the console port.)
- Connect PC-B to router called Galway using a straight through cable **(Galway Team)** Note: don't use a red cable as this is a cross-over (connecting to the console port.)

Step 2 (both Pods):
When you have booted your router, ***if the previous student has left their configuration on the router, you should erase it.***

To clear the configuration, issue the **erase start-config** command as outlined below. Confirm your intentions when prompted, and answer "no" if you are asked to save changes. The result should look something like this:

```
Router> enable

Router# erase startup-config
```

```
Erasing the nvram filesystem will remove all files! Continue?
[confirm]
[OK]
Erase of nvram: complete
```

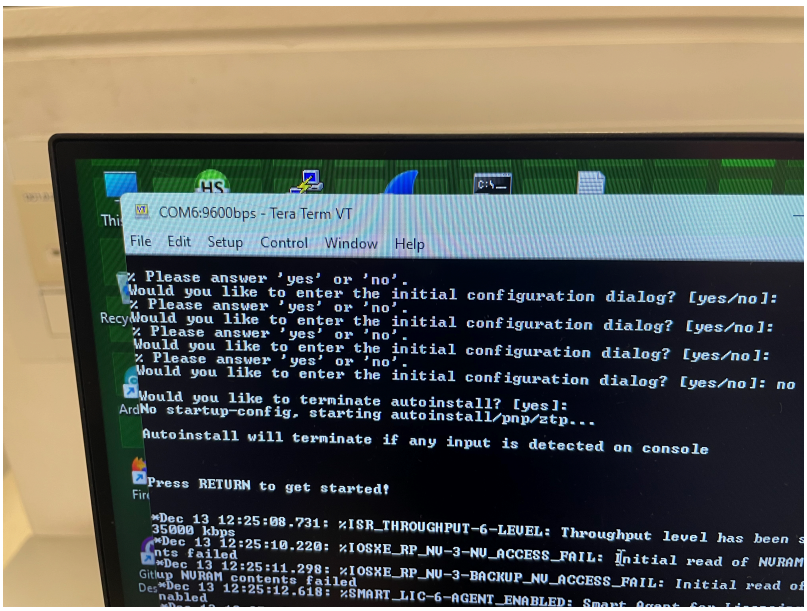
When the prompt returns, issue the **reload** command. Confirm your intentions when prompted.

```
Router# reload
```

If you get the following:
System config has been modified. Save? **No**
Proceed with reload [Press enter]

The router will take a few minutes to reboot.

Once the router boots, it should show the following prompt:



Would you like to enter the initial configuration dialog? **NO**

Would you like to terminate autoinstall?[yes] **Press Enter**

You should now have the following prompt:

```
Router>
```

The sequence of commands presented here are for the router called **Dublin ONLY. If you are are configuring the Galway router, then consult the diagram above for the relevant IP addresses**. *If you are configuring the Galway router, then the network address is **192.168.2.0** and you can assign the individual host numbers of .1 and .2 to the router interface and PC respectively. If you are configuring Galway please work together with the Dublin pod to help with the configuration commands.*

Type in the following commands to setup the router:

```
Router> enable
Router# show ip int brief
```

Review the interfaces and the current status of each.

```
Router# configure terminal
Router(config)# hostname Dublin
```

Configure the enable secret password to be "class".

```
Dublin(config)#enable secret class
```

Now, setup a console and telnet passwords - ***Please ensure you use these passwords provided above (rather than creating your own).***

Configure the password to be "cisco" when someone tries to log in from the console port.

```
Dublin(conf)# line con 0
Dublin(config-line)# password cisco
Dublin(config-line)# login
```

Configure the password to be "cisco" when someone tries to telnet into the router.

```
Dublin# configure terminal
Dublin(conf)# line vty 0 15
Dublin(conf-line) password cisco
Dublin(conf-line) login
Dublin(conf-line) transport input telnet
Dublin(conf-line) end
```

The following sequence of commands will allow you to configure and test the Gigabit 0/0/0 port on the router. Later you will perform testing – this will require that you use both **ping** and **telnet**.

Setting the IPv4 address on the Gigabit 0/0/0 *

**This interface will depend on the equipment you are using and the port that you plugged the cable into!*

Step 3: Configure the port with PC CONNECTION TO THE ROUTER

Now you are ready to cable up the Desktop Ethernet Connection to the Router's Gigabit Ethernet port. Note the port where the Desktop PC is connected to (in the example below it is C11.)

```
Dublin(config)# interface G0/0/0
Dublin(config-if)# ip address 192.168.1.1 255.255.255.0
Dublin(config-if)# no shutdown
```

No shutdown. Router Interfaces are shut down by default. Remember to explicitly issue the **no shutdown** command in interface configuration mode when you are ready to bring up the interface.
Check ip addresses and physical connections:

```
Dublin# ping 192.168.1.1
```
success !!!!!

If you got a successful response, you have applied the ip address correctly.

If ping doesn't work enter Dublin**#show ip interface brief** to see the status of attached interfaces. Ensure you have connected the correct cable from the patch panel to the router.

2.2 CONFIGURE IPv4 ADDRESSES on the DESKTOP PC

Please see section bottom of the document for help with this section - ADD A STATIC IPV4 ADDRESS (ON WINDOWS 10)

Step 1 (Dublin Pod): - on the DESKTOP PC

- **Set the IP address and mask of the PC-A**
  For example: **IP: 192.168.1.2**
  SM: 255.255.255.0
  DG: 192.168.1.1
- Check that the IP address of the PC-A is configured properly:
  Open a CMD window and type **ipconfig**.

- **In the CMD, ping the default gateway: ping 192.168.1.1** (this should be successful) – if not, ensure to check the help available in the Appendix (bottom of document) on how to add a static IPv4 address to the appropriate network adapter.

Note in Step 2, the following addresses are for the Galway Team.

Step 2 (Galway Pod ONLY): - on the desktop PC

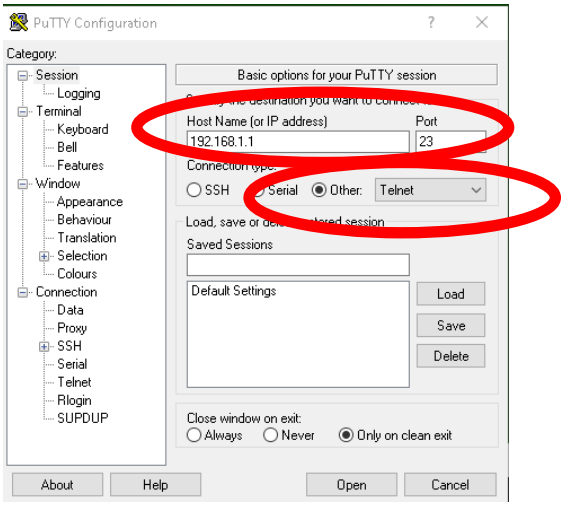
- **Set the IP address and mask of the PC-B**
  For example: **IP: 192.168.2.2**
  SM: 255.255.255.0
  DG: 192.168.2.1
- Check that the IP address of the PC-B is configured properly:
  Open a CMD window and type **ipconfig.**

- **Try to ping the default gateway of the Galway router**

- **ping 192.168.2.1**
- **Note: this should be successful** – if not, ensure to check the help available in the Appendix (bottom of document) on how to add a static IPv4 address to the appropriate network adapter.

Once you can ping the default gateway (you have successfully verified that you can communicate from your PC to the router – your default gateway) , continue onto the next step.

For Dublin Pod: Now you will telnet from the PC to your local default gateway. On the Desktop PC, open a new **Putty** window. Type in the address of the default gateway (e.g. diagram shows connecting to Dublin router). Ensure to select **Other** radio button and **telnet**. Ensure that the port is 23. This is the well known port for telnet traffic.



This should then prompt you to login with the password you set above - **cisco**

If you get the above message with a message prompting for password - Well done! You have now successfully connected via telnet from the PC to the local router (Dublin). This telnet connection travels over the Ethernet connection.

For Galway Pod:

For Galway Pod: Telnet from the PC to your local default gateway. On the Desktop PC, open a new **Putty** window. Type in the address of the default gateway (this will be **192.168.2.1**)

Like how Dublin connected above you should ensure to select **Other** radio button and **telnet** and select port 23.

This should connect you to the Galway router via Telnet.
This should then prompt you to login with the password you set above - **cisco**

Well done! You have now successfully connected via telnet from the PC to the local router (Galway).

Please go to Brightspace:

Open Lab 1 - Building a small WAN using Cisco Hardware QUESTIONS

Answer questions 1-2 and keep the quiz open as you move on to Part 3.

Part 3: Configure static routes across the WAN

A router uses a routing table to determine where to send packets. The routing table contains a set of routes that describe which gateway or interface the router uses to reach a specified network. Initially, the routing table contains only directly connected networks. To communicate with distant networks, routes must be specified and added to the routing table.
In this lab, you will manually configure a static route to a specified distant network based on a exit interface or next-hop IP address.

Connect the Dublin to Galway offices using another Ethernet cable. This can be a red crossover cable (both teams should agree the port it should connect to on both routers – note this is indicated as G0/0/1 on the diagram).

ADD A CROSS OVER CABLE BETWEEN ROUTERS DUBLIN AND GALWAY

In this part, we want to configure communication between the two routers, Dublin and Galway. This will be our "WAN" connection.

This will allow the two LAN networks to "see" and have connectivity with each other.

There are two ways of configuring routing between the routers, **static routing and dynamic routing**. First, we will look at the static method and in **Part 4**, we will configure dynamic routing.

On router Dublin, configure an IP address of **192.168.3.1**, on the appropriate port G0/0/1 (as shown in topology above). *Router Galway will use an IP address of **192.168.3.2** for it's G0/0/1 port.*

As before, it's IMPORTANT TO REMEMBER: These instructions are general guidelines, depending on the lab the equipment may differ (which may mean ports/commands may change. For example: below in the configuration it shows G0/0/1–these port names may differ depending on the lab and particular device).

```
Dublin# configure terminal
Dublin(config)# interface g0/0/1
Dublin(config-if)# ip address 192.168.3.1 255.255.255.0
Dublin(config-if)# no shutdown
Dublin(config-if)# end
```

To test that the interface is working, type in the following command:

```
Dublin# show ip int brief
```

If both line and protocol are up, then try pinging the end points of the serial line.

```
Dublin# ping 192.168.3.2
```
- success !!!!! *

(IMPORTANT: *in order for this to succeed the Galway team would also needed to have configured their g0/0/1 interface for the ping to succeed above)

```
Dublin# show ip route
```

From the Dublin router, it does not know of the LAN connected to the Galway router (192.168.2.0/24 network).
Note: at this point you will not see any 'S' learned routes in the output. These mean static routing entries.

From the Dublin office, you cannot reach via ping the Galway Pods LAN PC because router Dublin does not know about the Galway network i.e. 192.168.2.0

From the Galway router, you cannot reach via ping Dublin's network 192.168.1.0

We need to setup a routing entry on both routers so they know where to route packets.

On Dublin, type in the following command:

```
Dublin(config)#ip route 192.168.2.0 255.255.255.0 g0/0/1
Or
Dublin(config)# ip route 192.168.2.0 255.255.255.0 192.168.3.2
```

In the first command above, g0/0/1 signifies the exit interface on the Dublin router to send packets to the 192.168.2.0/24 network.

In the 2nd command above, we use the next hop router of Galway (192.168.3.2) to send packets to the 192.168.2.0/24 network.

Either of these commands sets up a static route between Dublin and Galway and packets for network 192.168.2.0 will be forwarded through the Dublin router.

On the Dublin PC, ping the Galway based PC.

Were you successful?

This will likely be **unsuccessful** as there needs to be a route configured back! **You will need to check-in with the Galway pod to see how they are getting on with their static routing configuration.**

Configure the static route for Galway, to reach Dublin. **Communicate in your pods to work out the static route you will need to enter on the Galway router.**

Without this route, Dublin and Galway LANs cannot successfully communicate!

NOTE: If you are unsure how to configure the static routes, please refer to the PDF on Brightspace "Routing Concepts, Static Routing and Dynamic Routing" where a different configuration example is provided.

Once this is complete,
you should be able to see a static route in the routing table on both routers.

```
Dublin# show ip route
```

You should see an '**S**' learned route in the routing table – this indicates a **static route.**

IMPORTANT: After you have configured the static route, you will also need to ensure that the Windows Firewall is turned off on both PC's in order for the ping to be successful from end to end (see appendix at bottom of document for help to do this). Windows Defender will be blocking ICMP traffic by default (so the pings will fail).

Try pinging from Dublin PC to Galway PC – once static routes are configured on both routers and you have turned off both firewalls on Dublin & Galway PC's **the pings should succeed!**

Showcase your outputs to your Lecturer to score lab marks. Your lecturer will provide you with a code for Question 3. Be sure to enter this code into Brightspace exactly as provided.

Dynamic Routing – Part 4

Static routes require the router's administrator to manually change the commands every time routes are changed. Another way of setting up routing is to use a routing protocol like Open Shortest Path First (OSPF) to dynamically exchange routing information.

OSPF is a link-state routing protocol for IP networks. OSPFv2 is defined for IPv4 networks, and OSPFv3 is defined for IPv6 networks. OSPF detects changes in the topology, such as link failures, and converges on a new loop-free routing structure very quickly. It computes each route using Dijkstra's algorithm, a shortest path first algorithm.

In this section, you will configure the network topology with OSPFv2 routing.

> **NOTE: If you are unsure how to configure the dynamic routes, please refer to the PDF on Brightspace "Routing Concepts, Static Routing and Dynamic Routing" where a different configuration example is provided.**
>
> **In addition, available on Brightspace (in section Lecture 1 – Network Security Concepts, OSPF Review) is lecture notes from LAN Switching and Wireless).**

REMOVE any static addresses on both routers.

Depending how you completed Part 3, you now need to remove the static routes.

```
Dublin(config)#no ip route 192.168.2.0  255.255.255.0  g0/0/1
```

Do a similar command on the Galway router, as shown below:

```
Galway(config)#no ip route 192.168.1.0  255.255.255.0  g0/0/1
```

Now, when you issue the 'show ip route' command, you should NOT see any 'S' routes.

The Dublin PC and Galway PC's will once again not have connectivity – pinging will NOT work as the routers again no longer can see the remote LANs.

Task: Try pinging from Dublin to Dublin PC and vice versa, again this should not be successful now as there is no route to the destination network.

Now configure OSPFv2 routes on both Dublin and Galway routers. Please note you will configure a single area OSPF configuration (backbone area 0).

The two factors that are foundational to OSPF configuration are **enabling OSPF** and **configuring OSPF areas**.

After identifying the OSPF process, you need to identify the interfaces on which you want to activate OSPF communications as well as the area in which each resides. This will also configure the networks you're going to advertise to others. Wildcards are used in the OSPF configuration. You will configure OSPFv2 routing on all routers in the network and then verify that routing tables are updated correctly.

Step 1: Configure OSPFv2 on Dublin.

Here's an example of a basic OSPF configuration:

Note: this is not the completed configuration!

```
Dublin#config t
Dublin(config)#router ospf 1
Dublin(config-router)# network 192.168.1.0 0.0 0.255 area 0
```

In this network, you can configure a single area OSPF design (this is indicated by using area 0 – backbone area).

IMPORTANT TO NOTE – **we are not yet complete** with our OSPF configuration on the Dublin router.

Challenge: In your pods, complete the other command required on the Dublin router.

As a tip: Note we ONLY advertise the networks that are directly connected to each router. There are TWO networks connected to the Dublin router. So, you will need TWO network statements on the Dublin router.

Configure a router ID e.g. Dublin router-id 1.1.1.1

Step 2: Configure OSPFv2 on Galway.

You will also need to configure OSPF and configure TWO network statements on the Galway router. Work across your pods to configure connectivity.

Configure a router ID e.g. Galway router-id 2.2.2.2

Test your connections as before. Look at your routing table and see what networks your router knows about.

What are the responses to the following commands?

- **show ip route**
- **show ip protocols**
- **show ip ospf**
- **show ip ospf neighbor**

When you have configured OSPF statements: You should see **'O'** learned routes in the routing table. **These are OSPF learned routes.**

Step 3: Testing

Perform a ping

See if you can ping from PC-A to PC-B – if OSPF has been setup correctly, **these pings should be successful.**

So, from PC-A (Dublin PC), open command prompt and ping 192.168.2.2 PC-B (Galway PC). You should receive 100% ping success. If not, troubleshoot!

Also, from PC-B (Galway PC)in the command prompt, ping PC-A the Dublin PC.

Note: You should receive 100% ping success.

Perform a traceroute

Traceroute is a network diagnostic tool used to track the path packets take to reach a destination. Perform a traceroute on the Dublin Windows PC:

So, from PC-A (Dublin PC), open command prompt and enter the command:

tracert 192.168.2.2

This will perform a traceroute to PC-B (Galway PC).

The traceroute command sends packets to the destination and lists each hop (intermediate router) it passes through.
It displays the following information for each hop:
The hop number.
Response time (in milliseconds) for three ICMP Echo Requests.
The IP address or hostname of the device at that hop.

Analyze the Results:

You should be able to see the Path: The route taken to the destination.

Once this is complete, call over your lecturer to demonstrate your work.

Showcase your outputs to your Lecturer to score lab marks.

Your lecturer will provide you with an answer code for Question 4. Ensure to insert this into Brightspace.

Extension Tasks:

- **Complete tasks to enrich your learning experience**
- **The following will deepen our understanding and enhance your knowledge and critical thinking of OSPF**

- **Both teams add a loopback interface on Dublin and Galway routers. E.g. 10.10.10.10 on Dublin and 20.20.20.20 on Galway**
- **Advertise these loopbacks into the OSPF process.**
- **On Dublin router, ping the loopback address of the Galway router. These loopback addresses should also display in the routing tables.**
- **Configure OSPF so that routing updates are not sent into networks where they are not required (tip passive interfaces)**
- **On Galway, configure a default static route that uses interface Loopback 1 as the exit interface. Then, propagate the default route into OSPF (tip: default-information originate).**

Showcase your outputs to your Lecturer

Well done on completing the lab!

IMPORTANT: Before leaving the lab ensure to erase your configuration.

```
Router# erase startup-config
```

```
Erasing the nvram filesystem will remove all files! Continue?
[confirm]
[OK]
Erase of nvram: complete
```

When the prompt returns, issue the **reload** command. Confirm your intentions when prompted.

```
Router# reload
```

If you get the following:
System config has been modified. Save? **No**
Proceed with reload [Press enter]

Once the router boots, it may show the following prompt:

```
Would you like to enter the initial configuration dialog?  NO
```

You should now have the following prompt,

```
Router>
```

Appendix

TEMPORARILY TURNING OFF WINDOWS 10 HOST FIREWALL

To access the host Firewall on Windows 10. Click on the Windows Start button and then select **Windows Security**.

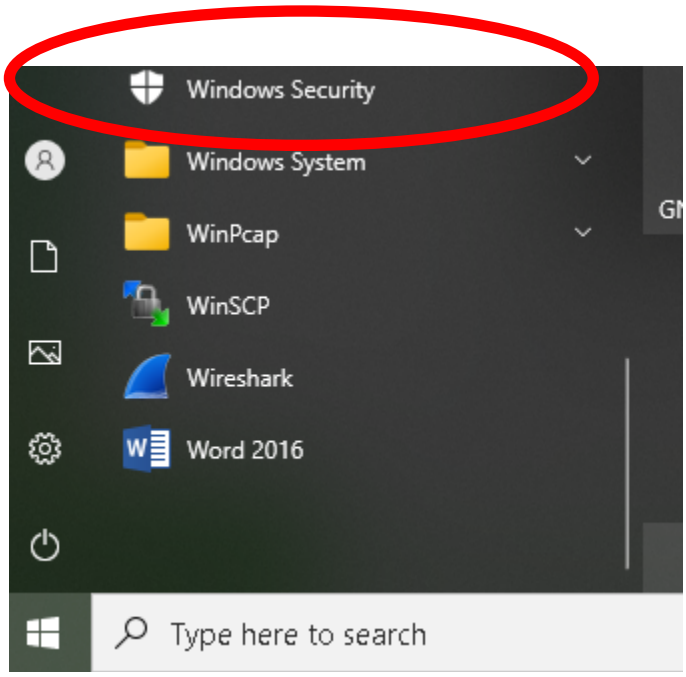


Figure 1

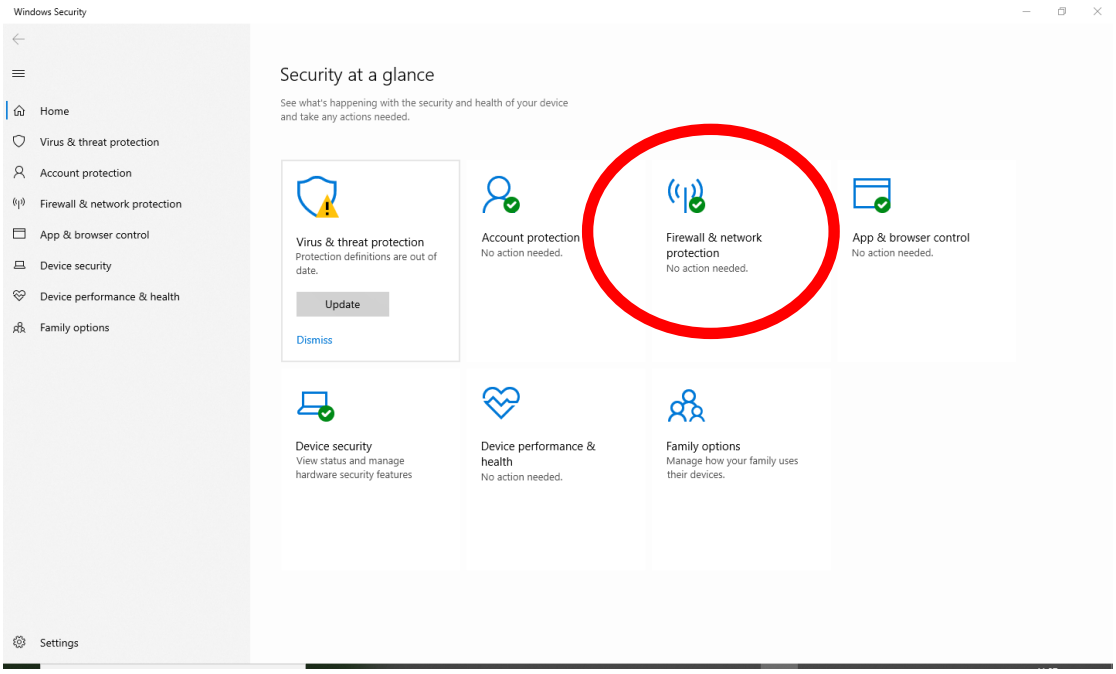


Figure 2 – Click on Firewall & network protection

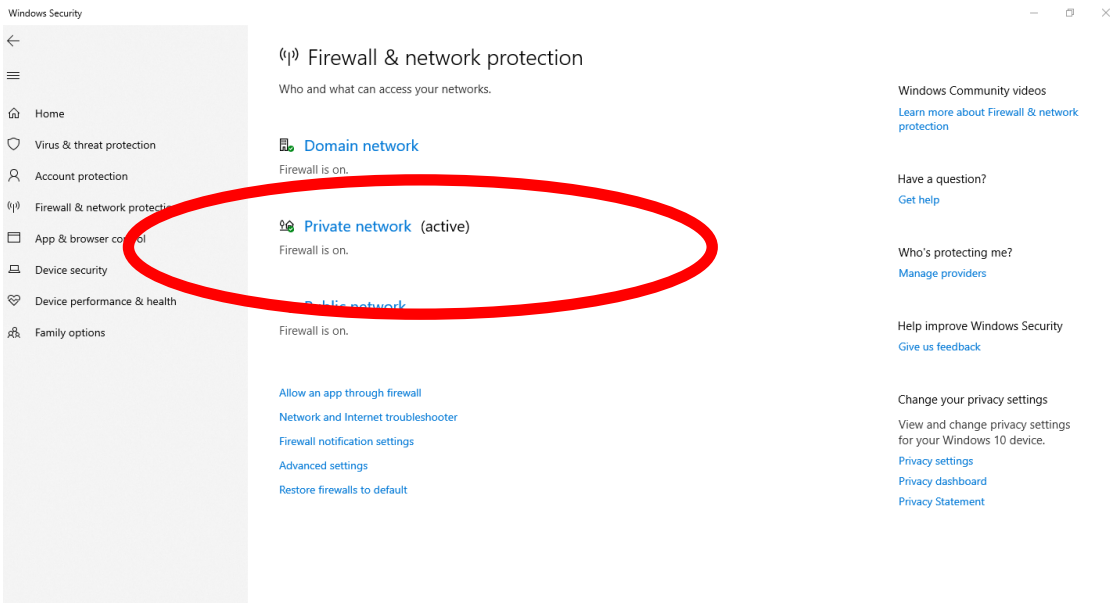


Figure 3 – Click on Private network (the active connection)

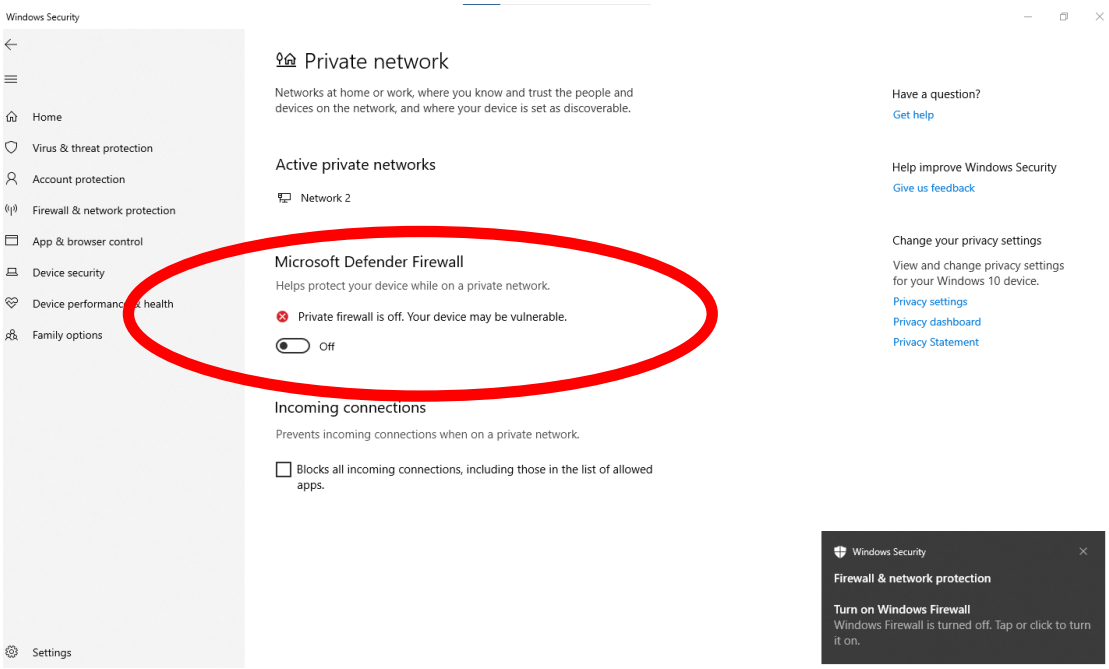


Figure 4 – Temporarily disable Firewall

ADD A STATIC IPV4 ADDRESS (ON WINDOWS 10)

Firstly ensure that you have connected your cable from the patch panel to your assigned Router.

On desktop PC, right click on Windows Start button and select **Network Connections**

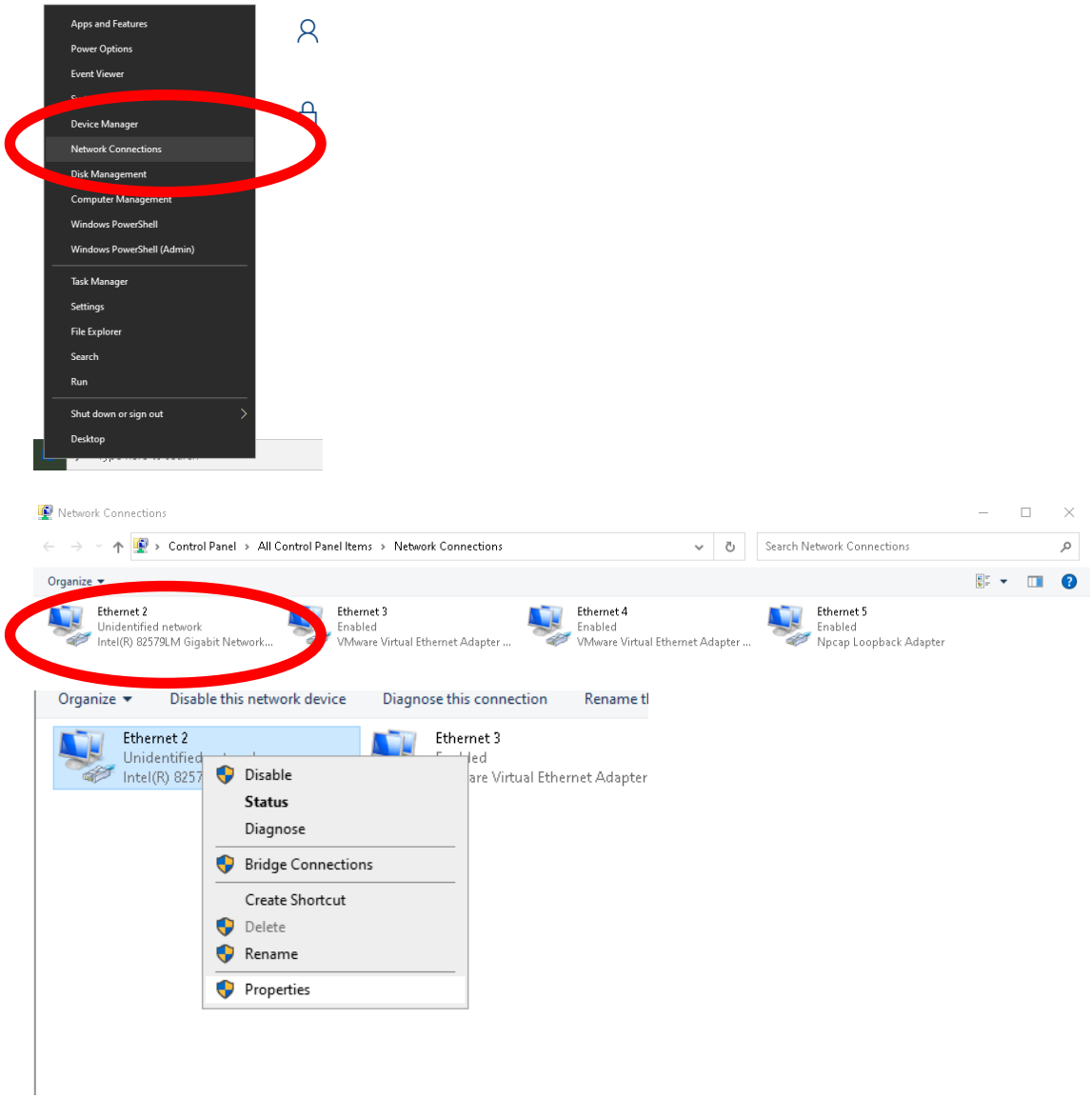


Figure 5 – Add a static IPv4 address on ethernet port

Notice Ethernet 2 has an Unidentified network (note this may be different Ethernet adapter on your Desktop PC) – very important to configure IPv4 address on connected adapter!

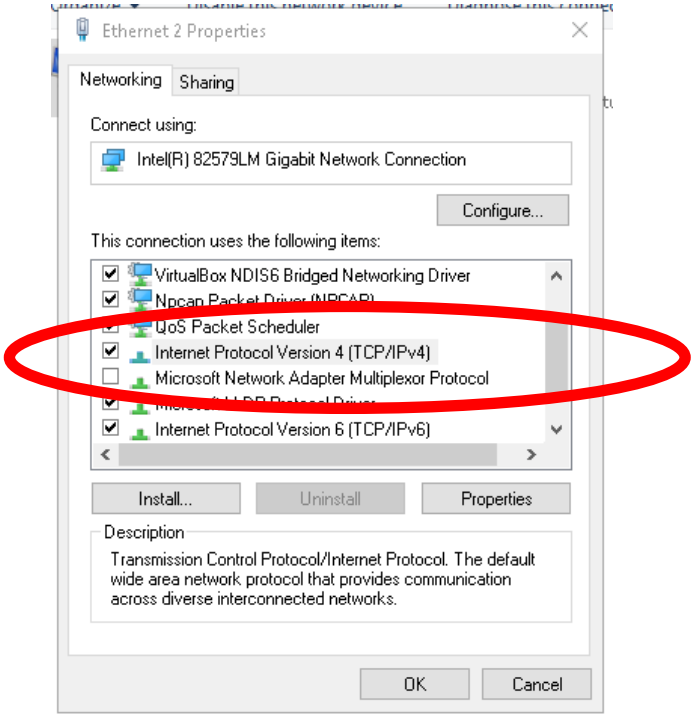


Figure 7 – Right click on the unidentified adapter (above) and select Properties on Internet Protocol Version 4 (TCP/IPv4) settings

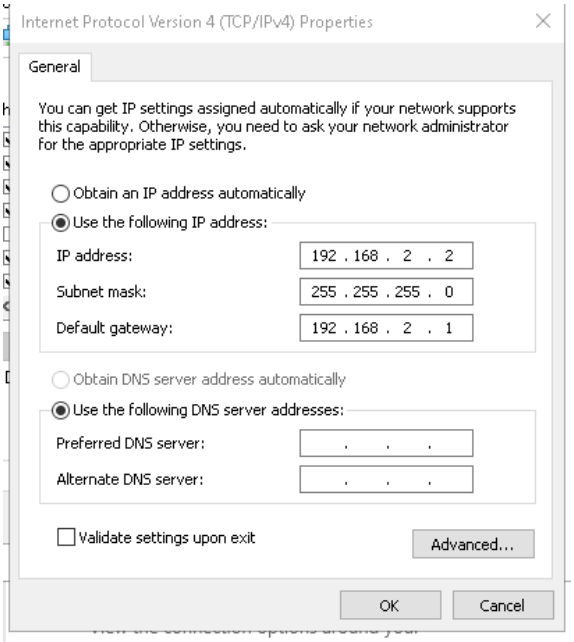


Figure 8 – Add the relevant IPv4 address and Default gateway address. This address will depend if you are configuring Dublin or Galway based PC.

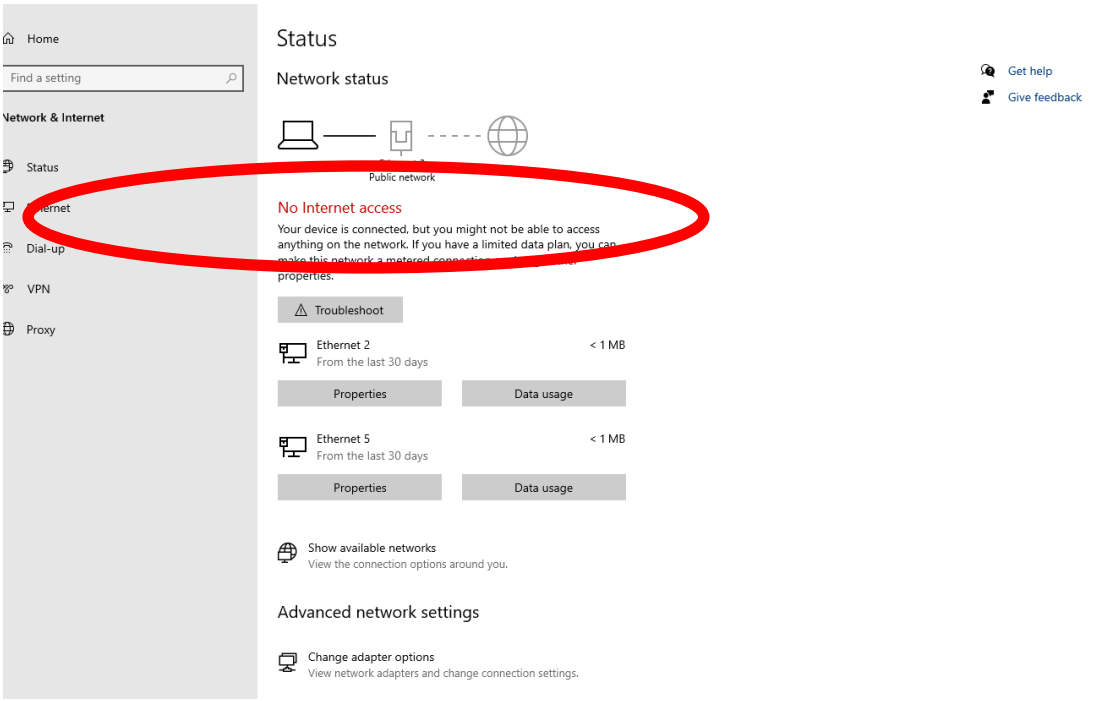


Figure 9 – Note – don't worry if it shows you have No Internet access – this is normal for this lab!

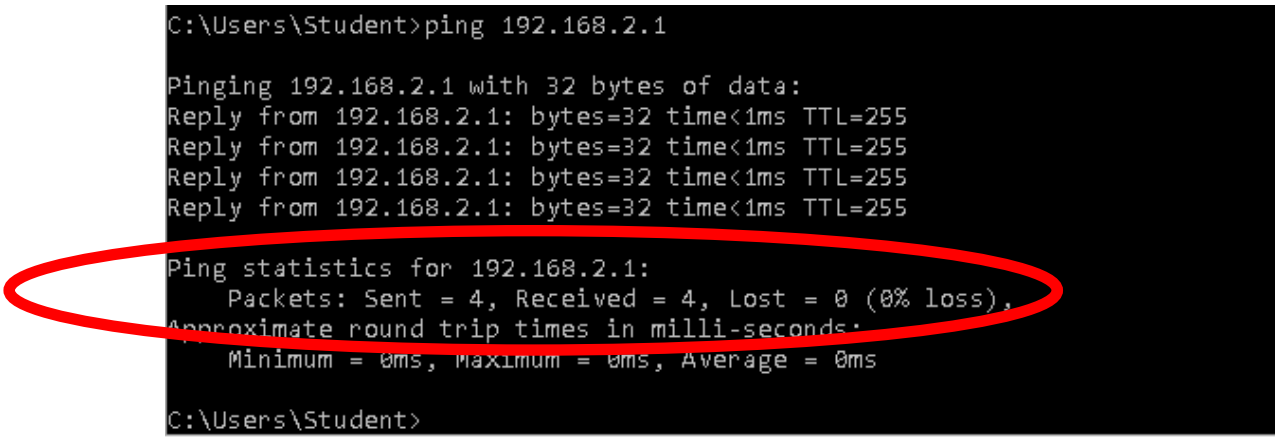


Figure 10 – After you have configured your Router, you should be able to ping from PC to default gateway address. In this case Galway's PC can ping Galway's default gateway.

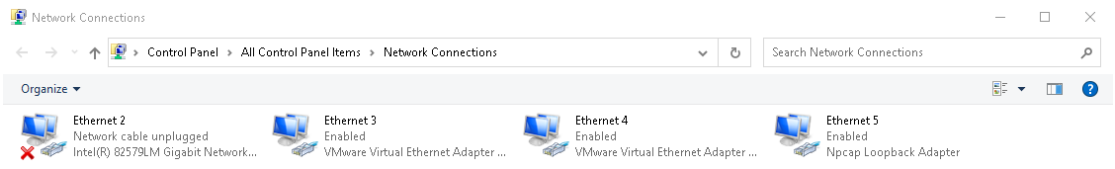


Figure 11– Troubleshooting tip: If you cannot ping - If you are unsure which adapter is the correct one – disconnect the cable from the patch cable to the router. This will indicate a cable has been unplugged. You should be able

SAMPLE CONFIGURATION FOR GALWAY

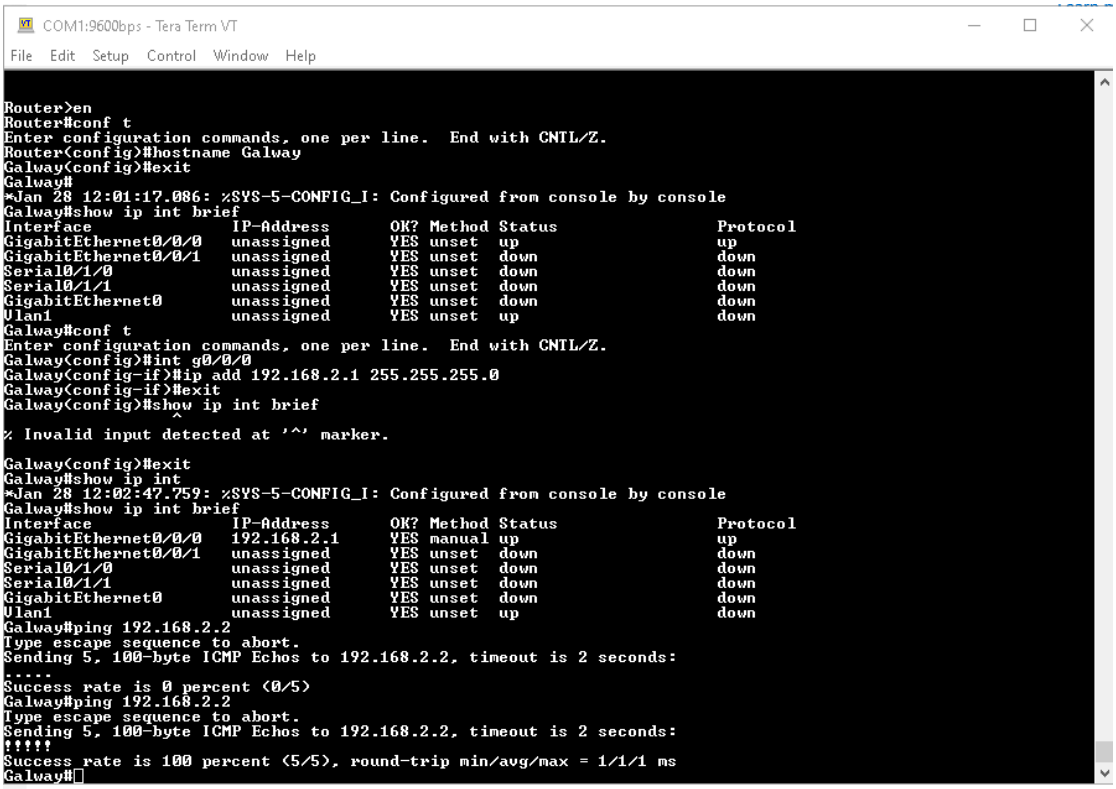


Figure 12– Sample Galway configuration

The above example has NOT configured the enable, console and telnet passwords – refer to the Dublin configuration above to ensure you configure this!

Note in the above, I didn't use the no shutdown command under g0/0/0 as the interface was already up. On your router, ensure to use the no shutdown (to bring up the interface if not already up!)

Good idea to always check the IP address is configured on the correct adapter and configuration addresses are correct.

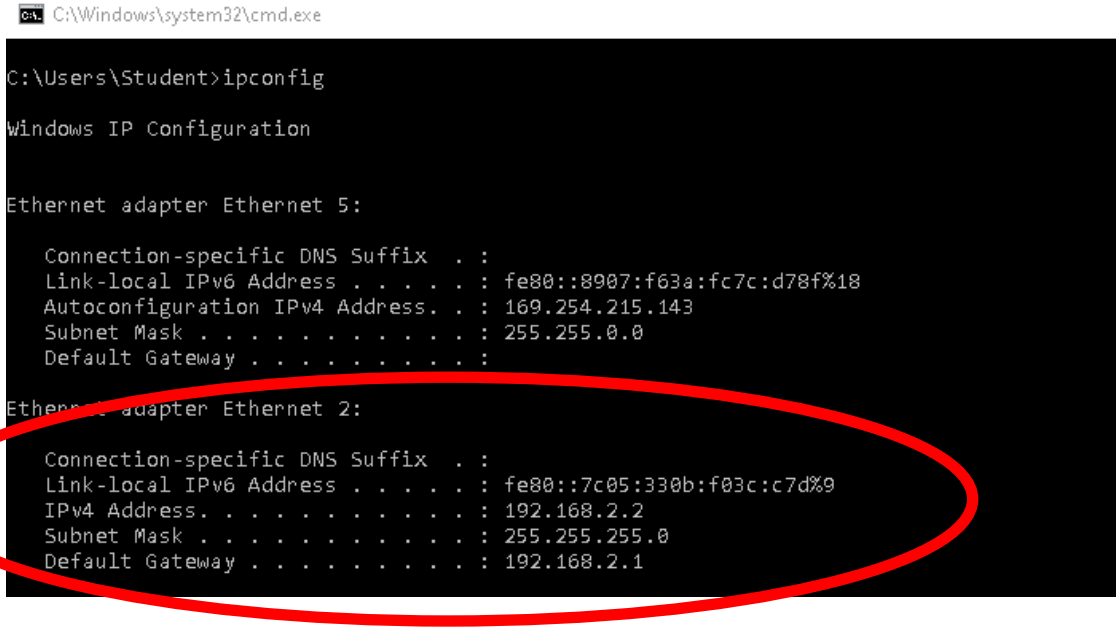


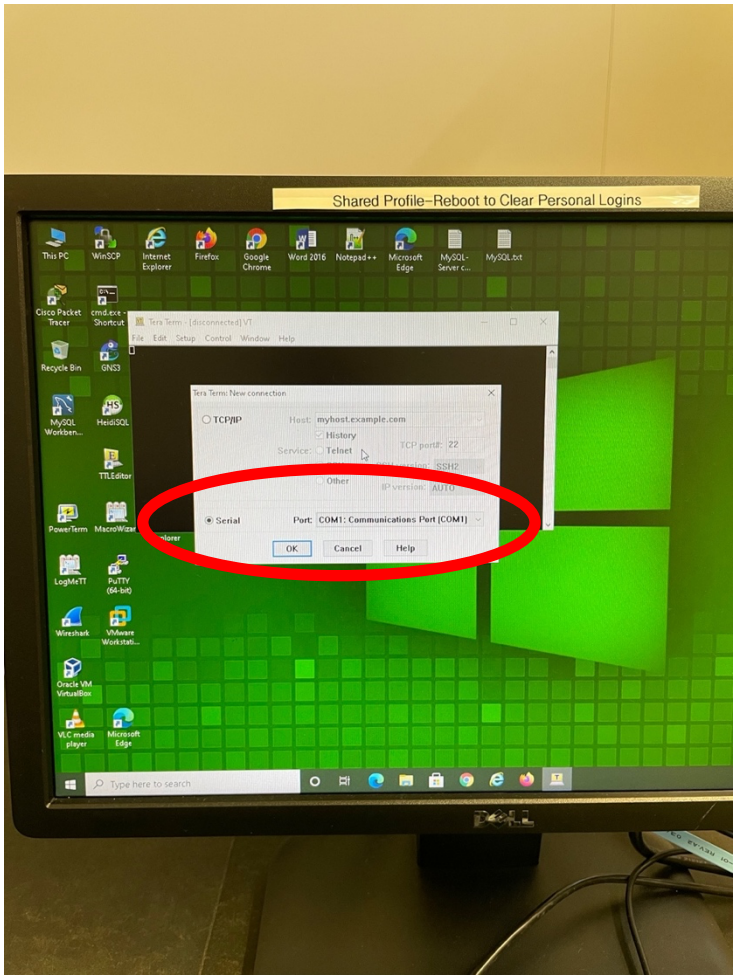
Figure 13– ipconfig

Connecting to Router using Tera Term

Another option to connect to hardware e.g routers

is Tera Term.

Opening Tera Term (Terminal emulator) on a desktop PC
Select Serial connection.



In many labs you will need to select the correct serial connector port. If you are not sure which Serial port to choose – please ask your lecturer.

Notice that the cursor is blank initially. If you press ENTER on the keyboard nothing happens.