TNE10005/TNE60002

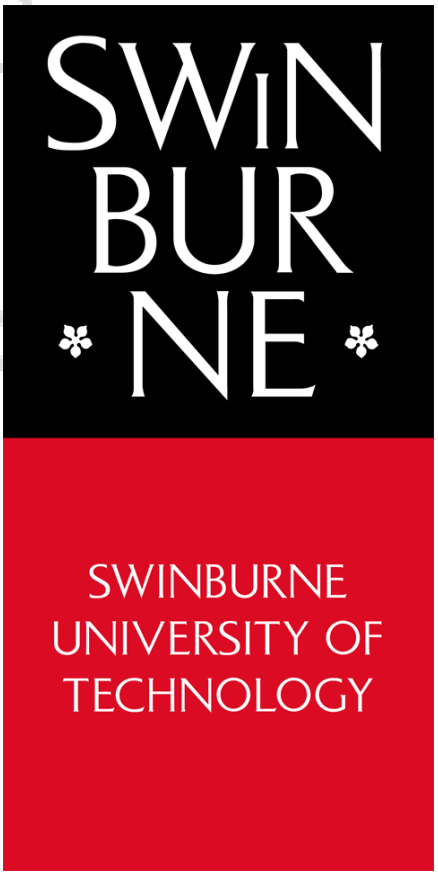
Network Administration

Lab 3

Introduction

to

IPv4 Addressing



Aims:

- Configure IPv4 Addresses
- Observe the purpose of the default gateway
- Observe the purpose of the subnet mask

Note: *For those of you who have studied networking before, this lab will appear deceptively simple. The focus of this lab for experienced students is to explain the observations.*

Preliminary settings

Note: *How to do these preliminary steps have been covered in past labs. If you cannot remember how to do these steps refer to Lab 01 and make sure you record how to do it in your journal for future labs.*

1. Download and launch sWin16RTR, sWin16SVR1, sWin10PC201and sWin16SVR3
2. Check the virtual PC network configuration and ensure that virtual PCs have connected to the correct networks, as given in the topology diagram.
3. Ensure that the virtual PCs sWin16SVR1, sWin10PC201 and sWin16SVR3 have IP addresses configured as outlined in the topology diagram before proceeding. Note:

   On Windows 10 computers, to get to the adapter configuration:

   i Right click on **Start** (at the bottom left of the screen), and select **Network Connections**.

   ii Click on **Change adapter options**

   iii You should be familiar with this window from the first lab. Right-click **Ethernet**, and you can now configure the IPv4 addresses.

   Windows Server 2016 adapter configuration can be accessed using the steps covered in the first lab.

Topology

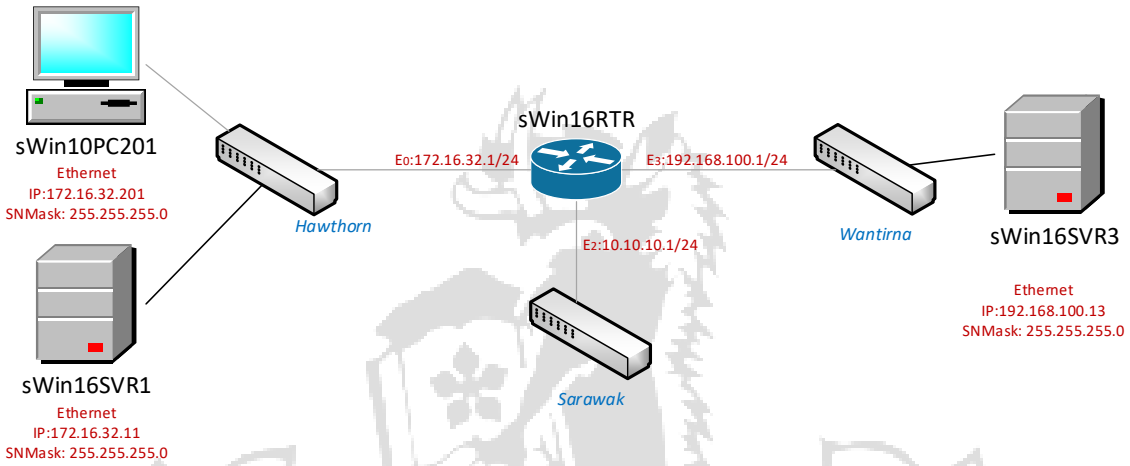


Figure 1 – Network Topology diagram for Lab 3

Gateway Addresses

In order to understand what a gateway address does, lets' do some preliminary tests:

4. On **sWin10PC201** right-click **Start** and select **Powershell**.

5. At the PowerShell prompt, type **`ipconfig`** and press **Enter**.

6. Record the output here:

```
Connection-Specific DNS Suffix: _____________________________
IPv4 Address:                   _____________________________
Subnet Mask:                    _____________________________
Default Gateway:                _____________________________
```

7. We will now use the **ping** command to see which devices we can communicate with, with our current IP configuration.

   Ping stands for **P**acket **In**ternet **G**roper. It uses the ICMP protocol to request a reply packet to be sent back. If we can successfully ping a device it means that our ICMP *Echo-request* packet arrived and the *Echo-reply* has also been returned. Thus confirming that our devices have two way communication.

8. Still on sWin10PC201 we will ping the IP address of sWin16SVR1. At the PowerShell prompt type:

```
Ping 172.16.32.11
```

   Was the ping successful? _____

   If it wasn't get a fellow student to check for errors. If neither of you can find an error in your typing, call your supervisor over to help.

   If the ping was successful you should have received a message similar to this:

```
Reply from 172.16.32.11: bytes=32 time=1ms TTL=128
```

9. We will now ping the IP address of our router. At the PowerShell prompt type:

```
Ping 172.16.32.1
```

   Your ping should have been successful *(if not have a fellow student try and troubleshoot, if neither of you can find the error, call your supervisor over*).

10. Now ping the IP address of our **sWin16SVR3**. At the PowerShell prompt type:

```
Ping 192.168.100.13
```

Was this successful?

_____

11. Pinging sWin16SVR3 should **not** have been successful.

Reviewing the theory covered in the lecture:

> *In order to communicate on any IPv4 network a device needs an **IP address** and a **Subnet mask**.*
>
> *Without an IP address and Subnet mask the device cannot communicate on the network. With **only** an IP address and Subnet mask, the device can communicate with other devices that are:*
>
> *a) Connected to the same network segment, and…*
> *b) Configured with an IP address in the **same subnet.***
>
> *If a device needs to communicate with a device in another network segment and subnet, then the network needs a router. The IP address of the local port of the router (i.e. the port on the device's subnet) must be configured as the **Default gateway.***

Because 192.168.100.203 is in a different subnet we expect the ping to fail when no default gateway address is configured.

Let's see if configuring the default gateway fixes this problem.

12. Review the topology diagram on page 3.

a. Which address do you think should be used as sWin10PC201's gateway address?

_____

b. On **sWin10PC201** go back to the **Ethernet** adaptor properties (Hint: check step 3 on page 2, if you cannot remember how to do this). In the ***Internet Protocol Version 4*** settings type the IP address: **172.16.32.1** as the ***Default gateway***.

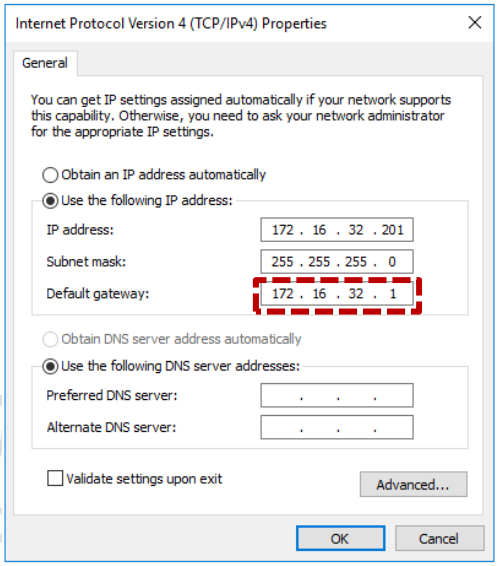


Figure 2 -Configuring the Default gateway address

13. Click **OK**, and close the Ethernet properties dialog box.

14. Back in **Powershell** see if you can ping 192.168.100.13 successfully.

    You should observe output similar to the following:

```
Pinging 192.168.100.13 with 32 bytes of data:
Reply from 192.168.100.13: bytes=32 time<1ms TTL=127
Reply from 192.168.100.13: bytes=32 time<1ms TTL=127
Reply from 192.168.100.13: bytes=32 time<1ms TTL=127
Reply from 192.168.100.13: bytes=32 time<1ms TTL=127
```

    (If not have a fellow student try and troubleshoot, if neither of you can find the error, call your supervisor over).

> *A gateway address is required if you need to communicate with a device in another subnet. The IP address of the local router interface, (i.e. the router interface that is connected to your network) should be configured as your gateway address.*

We have now observed the importance of the Default gateway address.

Subnet Mask

We will now explore the function of the subnet mask.

*A networked device uses the **subnet mask** to determine which MAC address needs to be entered into the Data-link layer's **Destination Address**. There are only two options, the MAC address of the destination device or the MAC address of the Default gateway.*

*If the network portion of the destination device's address **matches** the network portion of the source device's address then the MAC address of the **destination device** will be entered.*

*If the network portion of the destination device's address **does not match** the network portion of the source device's address then the MAC address of the **default gateway** will be entered.*

Figure 3 illustrates how the destination MAC address is selected and used.

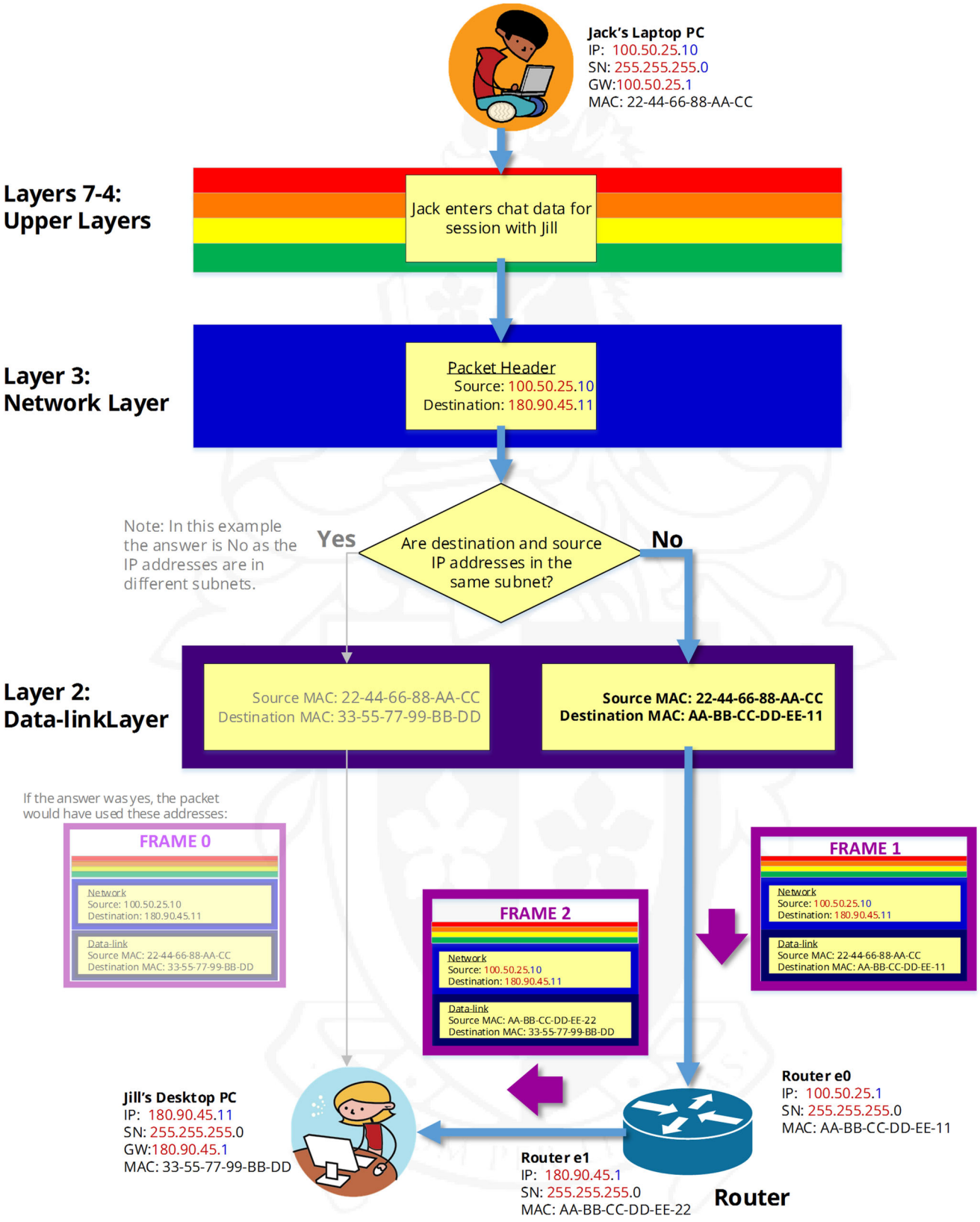


Figure 3 - How Subnet masks determine destination MAC addresses

15. Question: Look at the source and destination addresses of Frame 1 and Frame 2.

    a. Which addresses change? _____

    b. Which addresses stay the same? _____

    c. Try to explain why some change and others don't:

    _____

ANDing

16. Subnet masks work by:

    a. ANDing the binary Source IP address with the local subnet mask.
    (Remember when both bits are 1 the result is 1, if either bit is 0 the result is 0)

    b. ANDing the binary Destination IP address with the local subnet mask.

    c. Comparing the resultant network addresses to see if they are identical.

        i If identical they use the destination's MAC address as the layer 2 destination address.

        ii If different they use the default gateway's MAC address as the layer 2 destination address. (Note: In this situation, if no gateway address is configured the packet will be dropped)

17. ***Example***

    a. PCa has the IP4 configuration of:

        IP: 10.10.10.100

        SN: 255.255.255.0

        GW: 10.10.10.1

    PCa wants to communicate with PCb.

    PCb has the IP address of IP: 10.10.10.102

i To calculate its own **network address** PCa uses its IP address and Subnet mask.
It performs an AND operation:

PCa IP	00001010	.	00001010	.	00001010	.	01100100
PCa SN	11111111	.	11111111	.	11111111	.	00000000
PCa Network Address	00001010	.	00001010	.	00001010	.	00000000

ii To calculate PCb's **network address** PCa uses its own subnet mask and ANDs it with PCb's IP address

PCb IP	00001010	.	00001010	.	00001010	.	01100110
PCa SN	11111111	.	11111111	.	11111111	.	00000000
PCb Network Address	00001010	.	00001010	.	00001010	.	00000000

iii If we convert both PCa's and PCb's network addresses back to decimal we get:

PCa	10	.	10	.	10	.	0
PCb	10	.	10	.	10	.	0

We can see that both network addresses are identical. So at the Data-link layer PCb's MAC address will be inserted as the destination address.

18. Question: Do PCc and PCd have the same network address?

PCc IP:192.168.100.103

PCc SN: 255.255.255.0

PCd IP: 192.168.111.104

We will now look at this from a practical perspective.

19. On **sWin10PC201** ping **172.16.32.1** (the local router interface).

    Make sure the ping is successful.

20. On **sWin10PC201** change the subnet mask to **255.255.255.192**, and **delete** the Default gateway address (the Default gateway should be " . . . ").
    (Hint: check step 3 on page 2, if you have forgotten where to configure this)

    a. Make sure that you click **OK** on the **Ethernet Properties** dialogue box.

    b. Now try to **ping 172.16.32.1**

       Were you successful? _____

21. On **sWin16Svr1** make the same IP configuration changes. Change the subnet mask to **255.255.255.192**, and **delete** the Default gateway address.

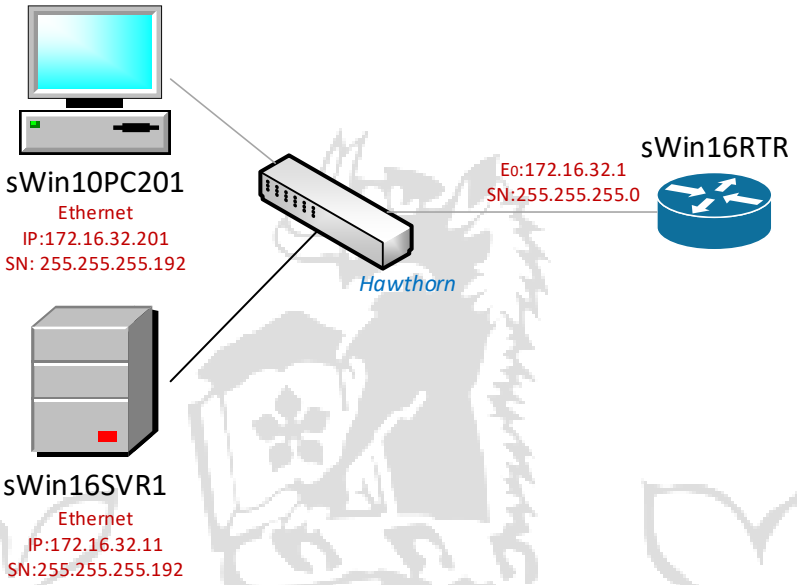
    a. Now try to **ping 172.16.32.1**

       Were you successful? _____

    b. Now try to **ping sWin10PC201**

       Were you successful? _____

22. Review the addressing of our current network segment.



a. Why could **sWin16SVR1** successfully ping **sWin16RTR(E_0)** but not **sWin10PC201**?

b. **sWin16SVR1** and **sWin16RTR(E_0)** could successfully ping, but they have different subnet masks. Explain how this could be? *(**Note:** If you are new to networking, do not stress if you cannot answer this question… you will be able to by the end of the semester).*

Extension – Investigating ARP

Note: This is an optional component of the lab. Only students who have finished early should consider doing the practical exercises in this extension.

The Address Resolution Protocol is how the Network Layer and the Data-link layer are able to link IPv4 addresses with MAC addresses.

It achieves this by keeping a table of IP and MAC addresses. Every time a device tries to communicate with another device it uses the IP address (and subnet mask) that has come from the Network Layer and tries to locate the appropriate MAC address in the ARP table. If there is no match, ARP will then send out a broadcast to try and locate the device with that IP address. If that device replies to the broadcast, the reply will have the MAC address in the source field of the frame, which can then be inserted as a new entry in the ARP table.

In this exercise we will observe how an ARP table is constructed, and how addresses within the same subnet and addresses in another subnet are treated differently.

23. Configure the IP address settings of sWin10PC201 and sWin16SVR1 as given in Figure 4.

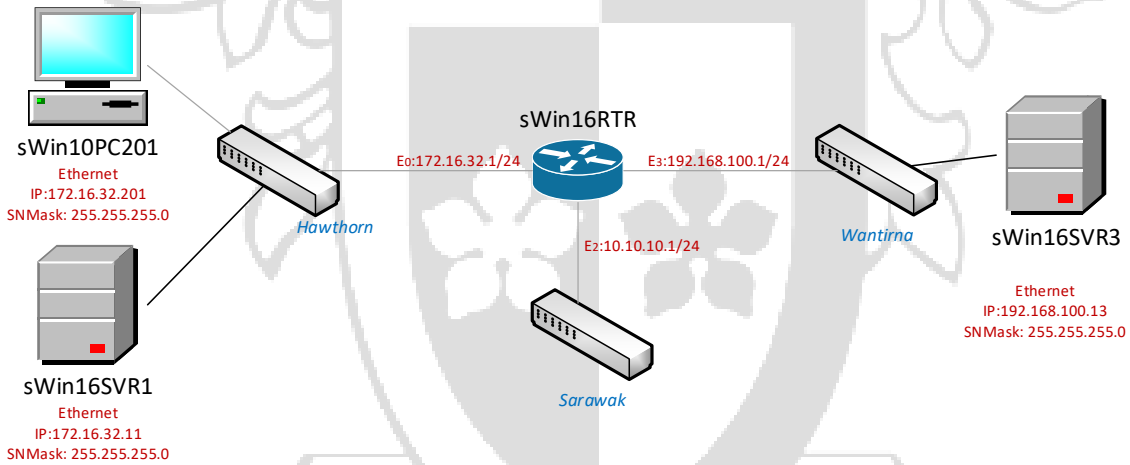


Figure 4 - Extension Network Topology

24. Start up the virtual machines sWin16DC1 and sWin16SVR2

25. On sWin10PC201, load up **Windows PowerShell (Admin)**, and type:

```
arp –d
```

26. Now display the ARP table by typing:

```
arp - a
```

Ideally (if you were fast enough) there will be no entries in your ARP table, however you may observe one or two 224.0.0.x addresses (.22 is used by IGMP, and .252 is used by LLMNR – both are beyond the scope of this course). If you were slow the Default gateway may have an entry appear.

27. Now ping sWin16SVR1, and display your ARP table (i.e. arp –a). You should now see an entry for it.

28. Now ping sWin16DC1 (172.16.32.10) and display your ARP table. There should now be an entry for this.

29. If your default gateway is not appearing in your ARP table ping it (172.16.32.1) and make sure that there is an entry in the ARP table.

    a. What happened every time you pinged a new address?

    _____

    b. How many entries do you now have in your ARP table? _____

30. Now ping sWin16SVR3 and check your ARP table. Are there any new entries? ____

31. Now ping sWin16SVR2 (10.10.10.12) and check your ARP table. Are there new entries now? _____

32. Explain your observations:

    _____

    _____

    _____

    _____

    _____

33. Get your supervisor to check your explanation.

Pack Up

1. Shut down and revert all virtual machines used in this lab.
2. Log off the Host server **ATC626-XY**
3. Push your chair in as you leave.

End of Lab