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Course	:	ECC 3702 COMPUTER NETWORKS
Credit Hours	:	4 (3+1)
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Laboratory	:	INTELLIGENT SYSTEMS LAB
Duration	:	3 HOURS
Experiment Date	:	21ST OCTOBER 2022
Submission Date	:	29TH OCTOBER 2022

LAB 1 [REPORT]

NETWORK CABLING AND LAN CONNECTION

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1.0 Introduction

A local area network or commonly known as LAN, is a collection of devices that are connected together at a particular location such as an office or a home. They vary in size from a small home network having only a few devices to a large network comprising of thousands of users and devices such as in a university or office. The network consists of cables, access points , switches, routers and other components that allow devices or end systems to connect to internal servers, web servers and other LANs [15].

Ethernet cables are the most popular method of physically connecting devices such as computers in a LAN. Having devices hardwired to one another ensures a faster and more reliable internet connection. Typically, Ethernet cables are used for 'stationary' devices such as computers and WiFi is used for mobile devices like smartphones [14].

There are different available structures of ethernet cables. The most prevalent is the Twisted Pair cable which has become the industry standard. The cable consists of wire pairs that are twisted together which reduces noise interference in the cable. The Twisted Pair cable standard is robust and high-performing being inferior to only fibre-optic cables in terms of performance [14].

The Twisted pair cables are available in two forms; the Unshielded Twisted Pair (UTP) cable and the Shielded Twisted (STP) cable. The UTP cables are much cheaper compared to the STP cables as they do not have foil or braided shielding around them, unlike the STP cables. Their drawback is that the quality of the signal decreases due to electrical noise. The STP cables have shielding made from copper or a conductive polymer which improves the quality of the internet connection by reducing the electrical noise [14].

In this laboratory experiment, the UTP cable were spliced into the two commonly utilised configurations; straight-through and crossover. Proper cable splicing techniques were carried out and testing was done to ensure functionality of the cables.

2.0 Objectives

- Familiarisation with network cabling techniques and testing methods
- Configuration of simple Local Area Network (LAN) connection

3.0 List of Equipment

No.	Equipment	Quantity
1	Cable connector (RJ45)	4
2	UTP network cable (2m)	2
3	Crimping tool	1
4	Cable stripper	1
5	Network cable tester	1

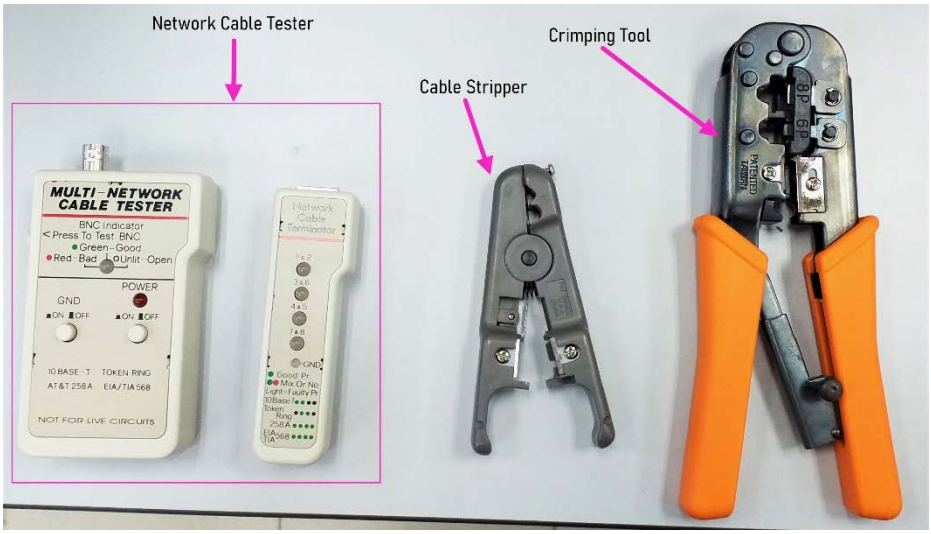

Figure 1. Tools used for cable splicing and testing

4.0 Procedures

The cables were setup using two types of cabling standards; straight-through and crossover techniques. The following steps were carried out to splice the cables according to the above-mentioned standards. The steps taken were the same for both cables except for the arrangement of the inner-cables as in step 3.

1) The cable stripper was used to remove around an inch of the outer covering of the ends of the UTP cables. It was ensured that gentle pressure was applied when using the cable stripper to prevent damage to the inner cables as shown in Figure 2 below.

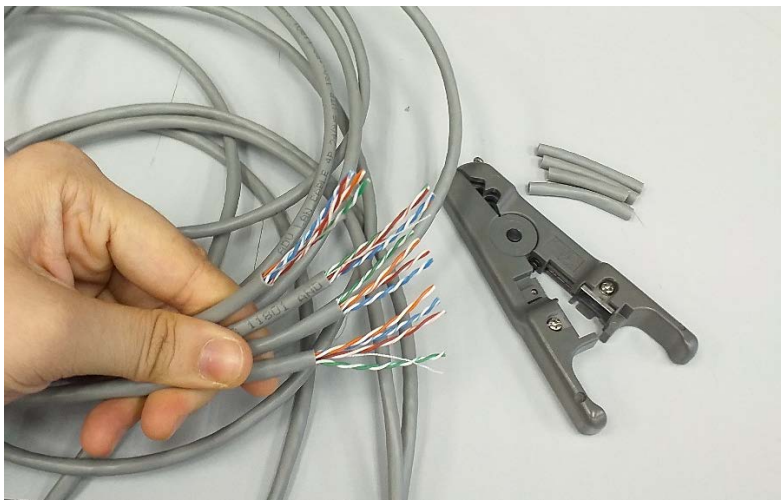

Figure 2. UTP cables with the end outer-coverings removed.

2) The inner cables were unraveled as seen in Figure 3 below. They were then straightened and to prepare for arrangement.

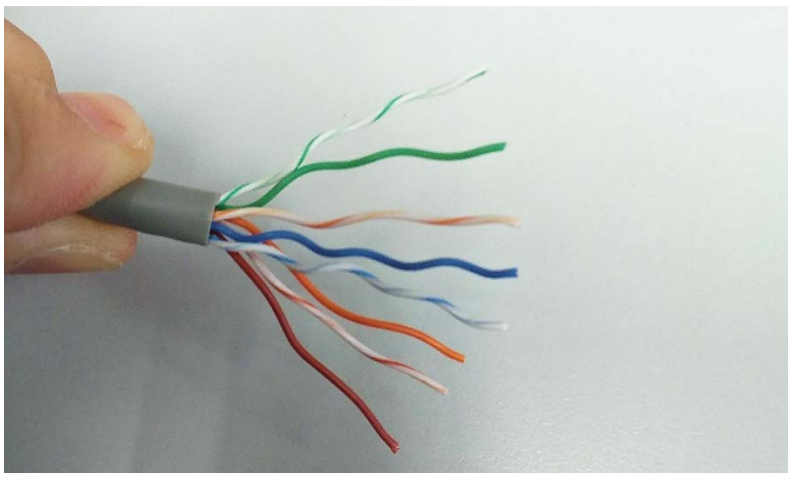

Figure 3. Unraveled inner cables

3) For the straight-through configuration the ends of the cable was arranged according to Figure 4 below. Both ends of the cable were arranged in the same way which implies that the inner cables are ‘straight-through’ the cable.

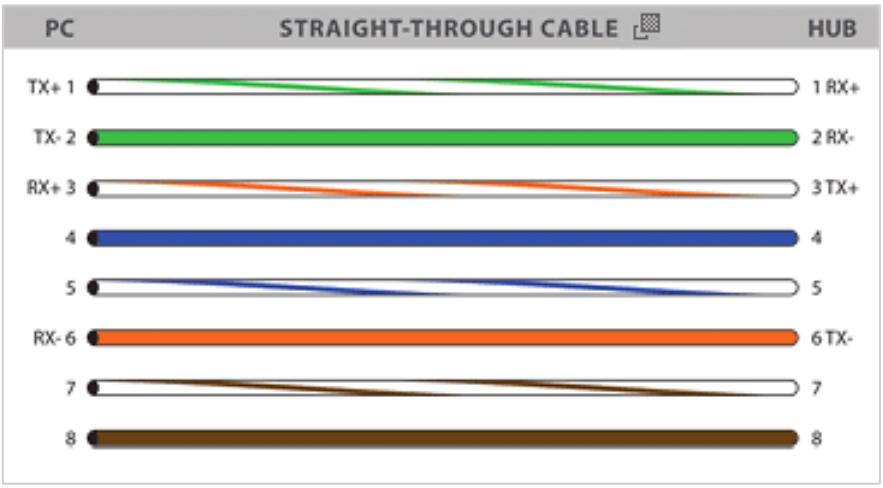

Figure 4. Straight-through cable standard

For the crossover configuration the ends of the cable was arranged according to Figure 5 below. One end of the cable is to be arranged as shown under ‘PC’ and the other end is to be arranged as shown under ‘HUB’. The inner cables were ‘crossed’ in this arrangement and had different ends.

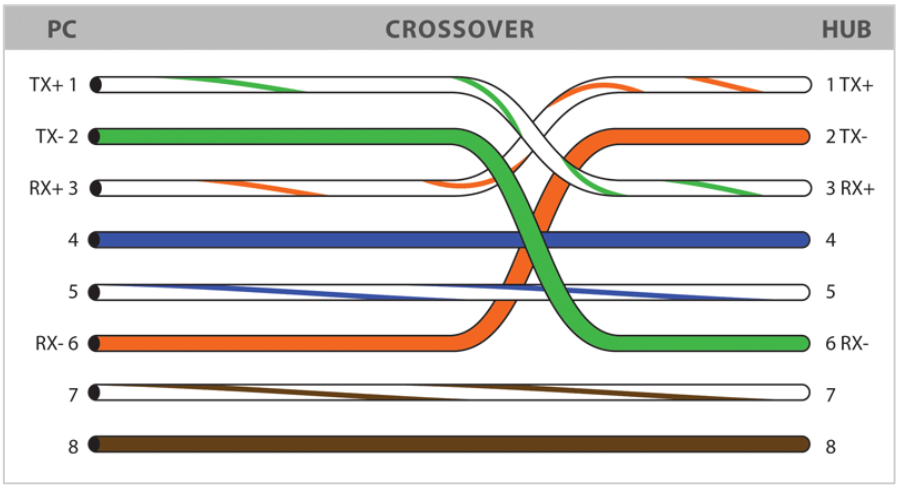

Figure 5. Crossover cable standard

4) After arranging the inner-cables according to the standards, they were trimmed evenly to a size suitable for the RJ45 cable connector and then lined up closely together as shown in Figure 6 below.

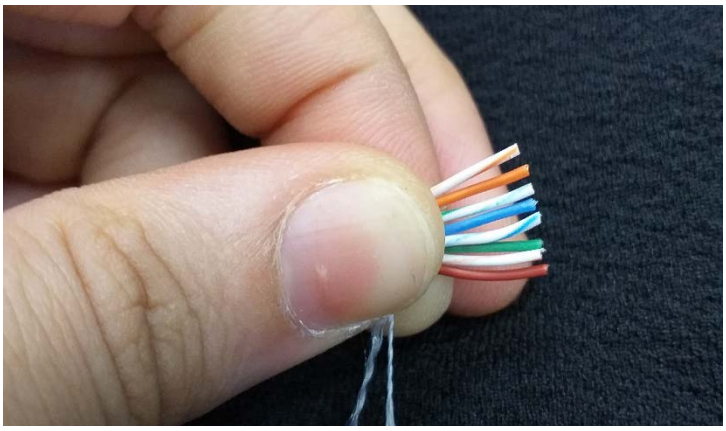

Figure 6: Inner cables trimmed and lined up closely.

5) The lined-up inner-cables were slowly inserted into the cable connector ensuring that the cables touched the ends of the cable connector. It was also ensured that the flat-side of the cable connector was facing upwards. After insertion, the cable crimper was used to crimp the connector to the cable. It was ensured that the crimper was properly clamped onto the cable connector to ensure proper fixation of the cable. Figure 7 below shows the crimping process.

Figure 7: Cable being crimped

6) The completed cables were then tested using the network cable tester. Both ends of a cable were plugged into both components of the tester and the light indicators were observed to check for any errors. This was done for both cable configurations.

5.0 Results and Observations

The two cable configurations were completed. Figure 8 and Figure 9 below show the completed cable heads. The inner-cables were arranged correctly according to the given configurations in Figure 4 and Figure 5 above. It was ensured the inner cables were properly lined up with the pins of the cable connectors to allow proper functionality.

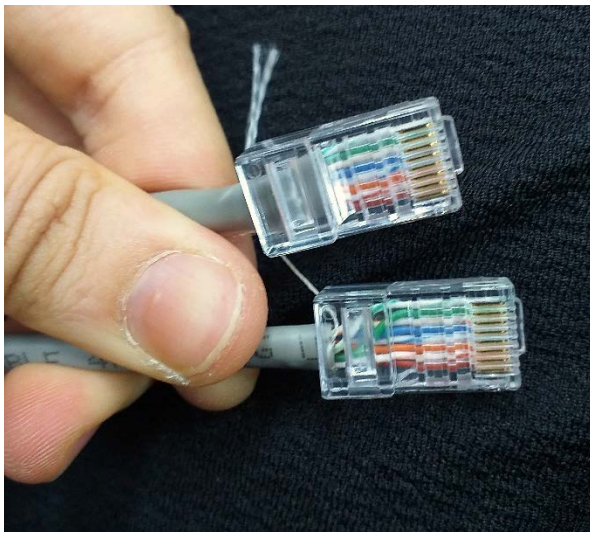

Figure 8. Completed straight-through cabling standard

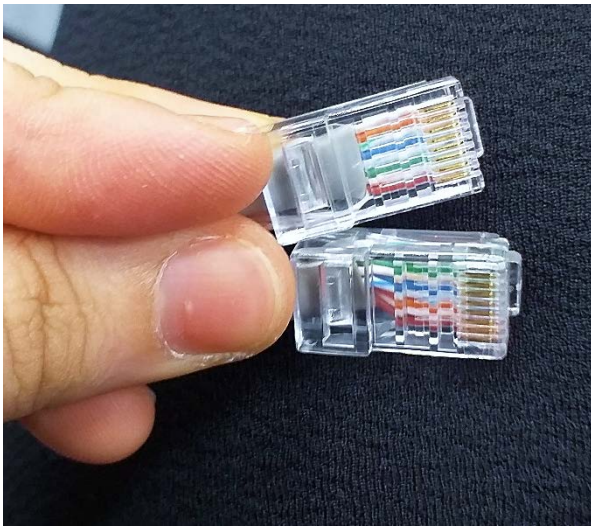

Figure 9. Completed crossover cabling standard

Figure 10 below shows the output of LEDs on the tester for the straight-through configuration. The LEDs lit up in the following sequence; 1&2, 3&6, 4&5 and 7&8. This pattern of the LEDs being illuminated with a green light from top to bottom repeatedly proves that the straight-through configuration was carried out successfully. Any red light would have indicated an error

Figure 10. (a) Straight-through configuration cable testing process showing LED output 1&2

Figure 10. (b) Straight-through configuration cable testing process showing LED output 3&6

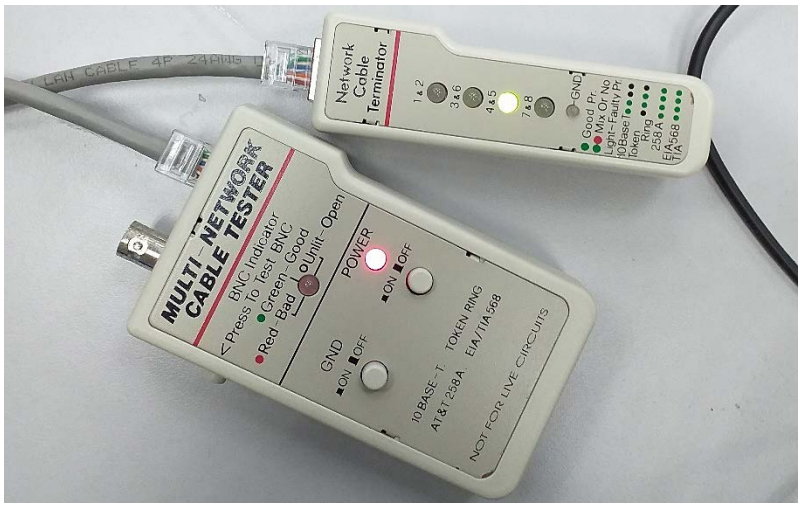

Figure 10. (c) Straight-through configuration cable testing process showing LED output 4&5

Figure 10. (d) Straight-through configuration cable testing process showing LED output 7&8

Figure 11 below shows the output of LEDs on the tester for the crossover configuration. The LEDs lit up in the following sequence; 3&6, 1&2, 4&5 and 7&8. Unlike the straight-through configuration, the pattern of the LED illumination shows ‘jumps’. This proves that the crossover configuration was carried out successfully. Any red light would have been an indication of error.

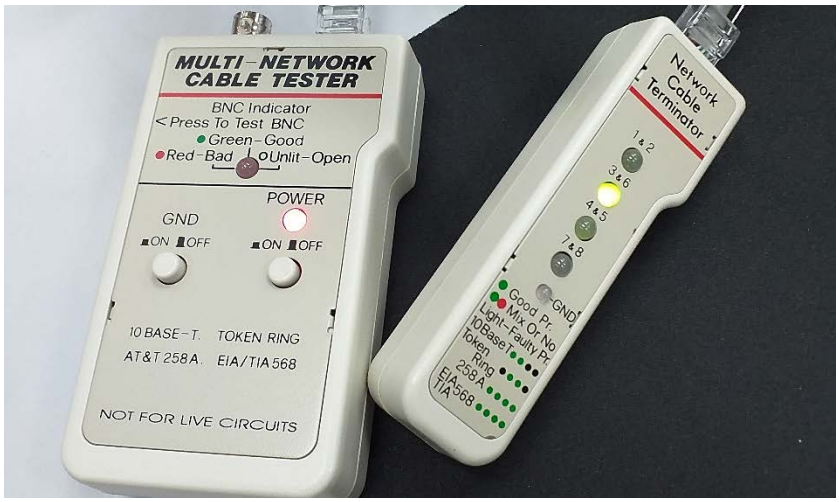

Figure 11. (a) Crossover configuration cable testing process showing LED output 3&6

Figure 11. (b) Crossover configuration cable testing process showing LED output 1&2

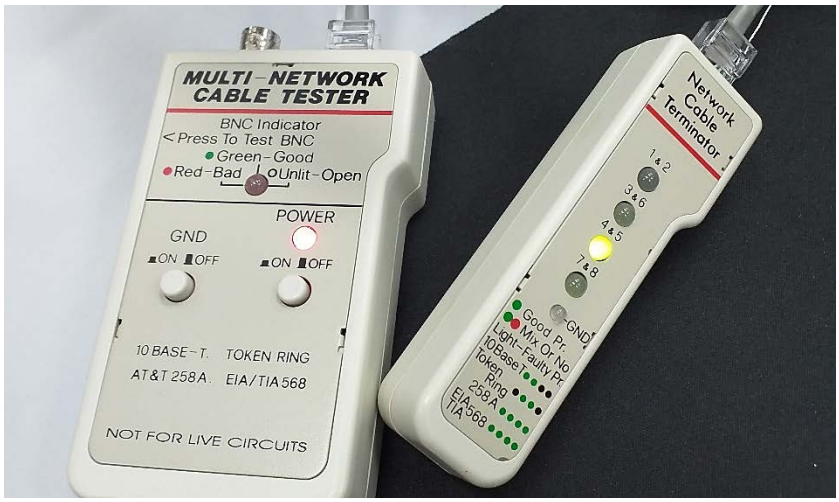

Figure 11. (c) Crossover configuration cable testing process showing LED output 4&5

Figure 11. (d) Crossover configuration cable testing process showing LED output 7&8

6.0 Discussion

a) What does UTP stand for?

UTP stands for Unshielded Twisted Pair. It is a commonly used type of copper cabling used in telephone and LANs (local area network).

b) Discuss the cabling standard being used in the laboratory for straight-through and crossover cabling technique. Discuss other available standards.

The cable used in the laboratory experiment was a CAT-5E UTP which followed the standard of generic LAN known as the TIA/EIA-568-A standard. The two cabling methods used were; straight-through and crossover cabling techniques.

The straight-through cabling is most commonly used for connecting a host to a client. The cable used in the laboratory was of CAT-5E which is used to connect network client devices to the router switch (host device) when following the straight-through configuration [10]. The configuration of the straight-through cabling is shown in Figure 4 above.

The crossover cabling is most commonly used for connecting two host devices directly for example; connecting two computers together or a from one switch to another. In recent devices, there is auto-sensing technology that detects the cable and device and crosses wire pairs when necessary [10]. The difference between the crossover and straight-through configuration can be seen in Figure 5 and compared with Figure 4.

There is another method of Ethernet cabling known as the roll-over configuration. Alternatively, it is called the ‘yost cable’ or the ‘console’ cable. Unlike the prior methods, this is a ‘null-modem’ cable [9] as is not used to carry data. It is used to connect the console port of a device to make to make programming changes in the device. This type of cable is typically flat in appearance and a light colour to distinguish from the above two types. From Figure 12 below, it is seen that the inner-cables are completely ‘rolled-over’ or reversed in order from one end to the other.

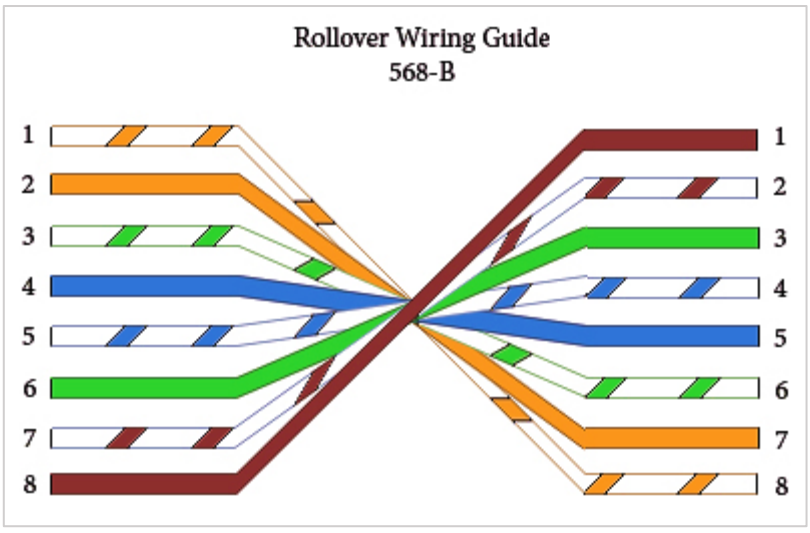

Figure 12. Roll-over cable standard (568-B) [10]

c) What are 100BaseT, 1000BaseT and 100BaseFX? Give type of cable used for each specification.

The first version of Ethernet was known as 10Base-T and transmitted at a rate of 10Mbps [7] over Category 3 unshielded twisted wire pairs (UTP) [8].

The 100Base-T, also known as 'fast Ethernet' is an 'upgraded form' of the 10Base-T Ethernet and allowed data transfer at a faster rate of 100Mbps meaning that it is ten times faster [4]. There are 3 major standards of 100Base-T; 100Base-TX, 100Base-T4 and 100Base-FX [4]. The 100Base-FX unlike the other Ethernet standards transmit over fibre optic cables and also transmits at 100Mbps.

The 1000Base-T is also called Gigabit Ethernet as it transmits at a rate of 1000Mbps which is equal to 1Gbps. The key advantage of this cabling standard is that existing copper cabling can be utilised instead of having to replace with newer optical fibre cables. [5]

Table 3 below shows the cable type used for each of the mentioned specifications:

Ethernet Specification	Type of Cable	Pairs Used
10Base-T	Category 3 UTP	2
100Base-TX	Category 5 UTP	2
100Base-T4	Category 3 UTP	4
1000Base-T	Category 5 UTP	4
100Base-FX	Multi-mode fibre optic cable	2

Table 3. Ethernet specifications and respective cables utilised

d) What is IP address? Discuss the different between static and dynamic IP Address.

IP stands for 'Internet Protocol'. The IP address gives each device connected to the internet or in other words, a host a unique address which identifies their location. IP addresses are assigned to users by ISPs (Internet Service Providers).

A static IP address is one that always stays the same and is used for instances where a 'permanent' address is needed such as web servers. Static IP addresses need to be configured manually. A dynamic address is one that is provided by an ISP for temporary use. When not in use, a dynamic IP address can simply be assigned to another user. They are assigned by one of two methods; DHCP (Dynamic Host Configuration Protocol) or PPPoE (Point-to-Point Protocol over Ethernet). [1]

e) What is DNS? Provide one example of DNS.

DNS is short for domain name system which is an application layer protocol that translates user-supplied hostnames into IP addresses that are machine readable.

An example would be taking the hostname www.instagram.com which upon carrying out a DNS lookup would show the IP address 179.60.192.174.

f) What is gateway address? Provide one example of gateway address.

A gateway address or 'default gateway' is the private IP address given to the router in a network [11].

An example of finding the default gateway is shown in the steps below:

i) The following keys on the keyboard were pressed; ⊞ **Win + R**

ii) Then 'cmd' was entered and 'OK' was pressed as shown in Figure 13 below.

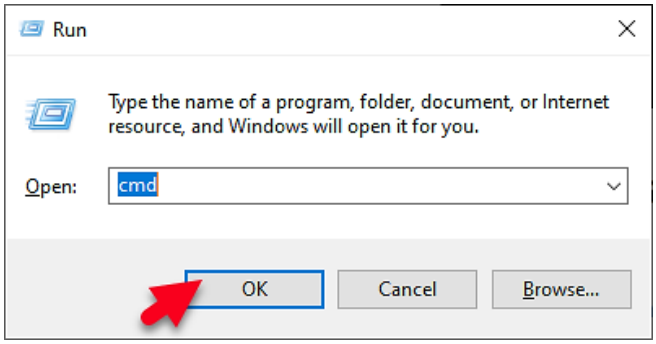

Figure 13. Window for running command prompt

iii) `ipconfig` was entered into the command prompt window and the gateway IP address was found next to Default Gateway. This is shown in Figure 14 below.

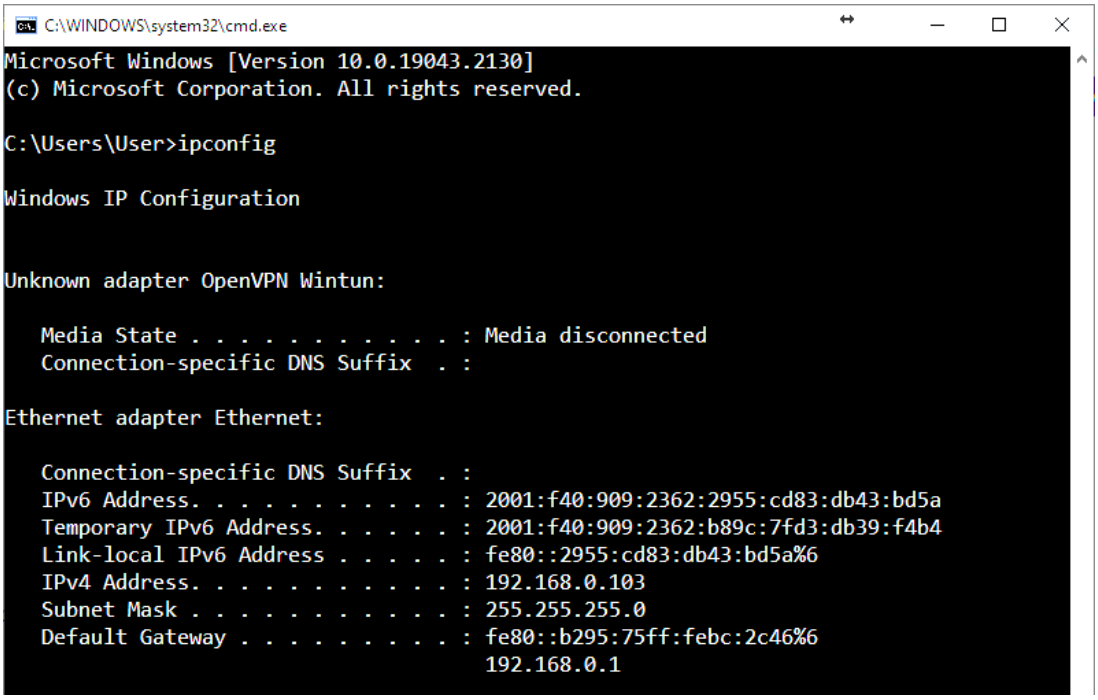

Figure 14. Command prompt window after `ipconfig` *command was entered*

The IPv4 gateway IP address that is seen from Figure 14 is `192.168.0.1` and the IPv6 gateway IP address is `fe80::b295:75ff:febc:2c46%6`.

g) What is netmask address? Provide one example of netmask address.

A netmask address consists of 32 bits and is used to divide an IP address and to specify the available hosts in a particular network [12]. The netmask defines how 'large' a network is. As an example, the netmask address from Figure 14 above is `255.255.255.0` which applies to IP addresses ranging from `192.168.55.0` to `192.168.55.255`.

h) Discuss about Ping command.

The 'ping' command is a command-line utility that is available on any operating system that are connected to a network. It tests to see if a 'networked device' is reachable. The command sends a request over the network to a particular device. When a ping is successful, a response is gotten from the computer that was pinged back to the originating computer. [13]

i) Discuss your achievements and problems encountered during the laboratory session.

Overall, the laboratory session was successful. The tasks of splicing the UTP cables into the two configurations; straight-through and crossover, were achieved without any major setbacks. The success of the splicing is demonstrated by the output obtained from the network cable tester. In the cases of both cabling techniques, there was no 'red-light' output therefore the cables were not faulty and the desired 'pattern' of light sequence was achieved as seen from Figure 10 and Figure 11. A summary and comparison of the LED outputs of the cable tester is shown in Table 1 below.

Configuration	LED sequence			
Straight-through	1&2	3&6	4&5	7&8
Crossover	3&6	1&2	4&5	7&8

Table 1. Summary of outputs of straight-through and crossover configurations

There were two namely minor non-technical challenges faced; the first was that the inner cables were very prone to being cut when using the cable stripper and the second being that clipping the cables required a considerable amount of force which posed the risk of uneven cutting. The first issue was overcome simply by very gently scoring the outer covering of the cable and then pulling it off to prevent the risk of the inner cables being damaged. The second issue was overcome by proper gripping technique of the cable stripper to ensure swift action.

7.0 Conclusion

The objectives of the laboratory session were fulfilled successfully as the desired results were obtained. The straight-through and crossover configurations were made from UTP ethernet cables of the TIA/EIA-568-A standard. The cables were tested using a network cable tester and there were no errors detected. The purposes of these two configurations were investigated as well as the different available specifications.

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