Unit 10, Assignment 2

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Task One (P5)

Representing Data

Bits
A bit is a unit of the binary counting system. It is either a 1 or a 0.

Bytes
A byte is a sequence of eight bits.

Segments
A segment is an encapsulated piece of data at the transport layer (four) of the OSI model. It contains information about the protocol used to send data across the network.

Packets
A packet is an encapsulated segment at the network/internet layer (three) of the OSI model. It contains IP address source/destination information in the header.

Frames
A frame is an encapsulated packet that has source/destination MAC address information appended.

Synchronous & Asynchronous

A synchronous transfer is one that is continuous with data sent and received at the same time through the use of a clock signal that dictates when data is transmitted. This makes it a full-duplex method since both parties can send and receive at the same time.

An asynchronous network is one where data is transmitted intermittently and without any scheduling. Because of this is it is half-duplex; only one device can send at a time.

Error Detection & Correction

The process of error detection and correction is important to ensure data completeness and data integrity. Using checksums, parity bits or cyclic checking.

Bandwidth Limitations

Bandwidth refers to the maximum amount of data that can be sent along a medium in a given timeframe. A lower amount of bandwidth means less data can travel across a network. For example, a Category 6 ethernet cable is capable of transmitting 10 gigabits of data per second.

Noise

Noise refers to a disturbance in a transmission of data that introduces unwanted signals or interferes with the data being sent. An example of noise would be electromagnetic interference due to nearby power cables.

Task Two (P6, M2)

Coaxial

A coaxial cable consists of an inner conductor and an outer conductor separated by an insulating material. They are commonly used for providing broadband internet connections and television service. They are also used to connect antennas and ariels. In the UK, Virgin Media uses Coaxial cable from their street cabinets to customers' homes making use of the EuroDOCSIS standard to transmit internet and television information.

Coaxial cable is often inflexible and bending a cable too significantly can cause intermittent data transmission, making it more suitable for permanent installations that are unlikely to be modified. Coaxial cables with poor shielding can suffer from data leakage and can cause interference meaning they cannot be positioned too close to metallic surfaces or power cabling.

The bandwidth of a coaxial cable depends on the quality of the cable's construction as well as the standard being used to send and receive data.

Optical Fibre

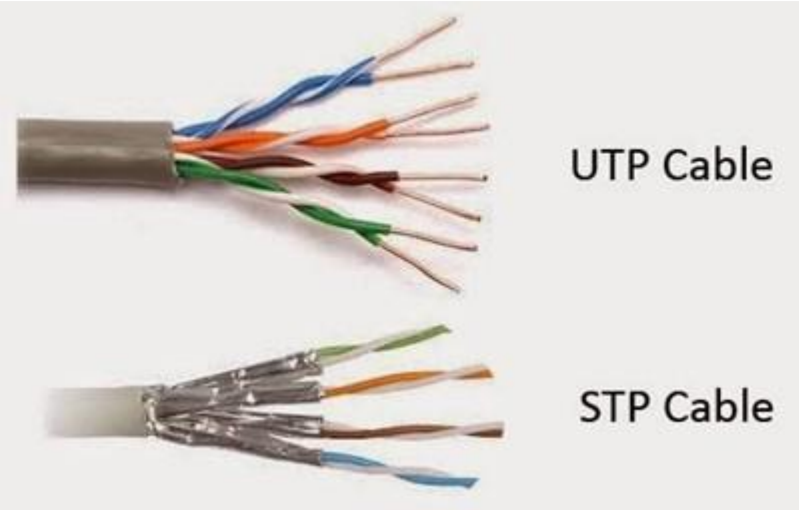
Optical fibres are glass/plastic fibres used to transmit light. They facilitate extremely long-distance communication at high speed; the undersea backbone of the Internet is made up of thousands of strands of fibre optic cabling. A single optical fibre using laser transmitters has been able to reach a transfer rate of 5.4TB/s—fast enough to transmit the entire contents of an average home computer’s hard drive over three hundred times a minute.

Due to their high bandwidth capacities, they are used for high-speed networks in home and businesses, most commonly to link pieces of network infrastructure—such as switches and routers—to one another.

There are multiple types of fibre connections: single-mode and multi-mode.

An example of their use by an ISP is Openreach who now provide multi-gigabit fibre-to-the-premises connections to homes and businesses in the UK.

Twisted Pair



Twisted pair cabling refers to the strands of individual wire inside of a cable being twisted together into pairs, which helps to reduce noise.

They are used in ethernet networks as well as for analogue telephones. Depending on the specification of the cable, they can transfer upwards of 10Gbps.

Shielded (STP) cables have an additional layer of foil surrounding the internal wires that helps to further reduce electromagnetic interference when compared with unshielded (UTP) cables. This allows for faster data throughput and longer cable runs with less signal degradation.

Radio

Radio transmissions are able to transfer data without the use of a cable.

They are generally less reliable and more prone to error than other methods of transmitting data. Radio waves can be broadcast omni-directionally or as a point-to-point transmission.

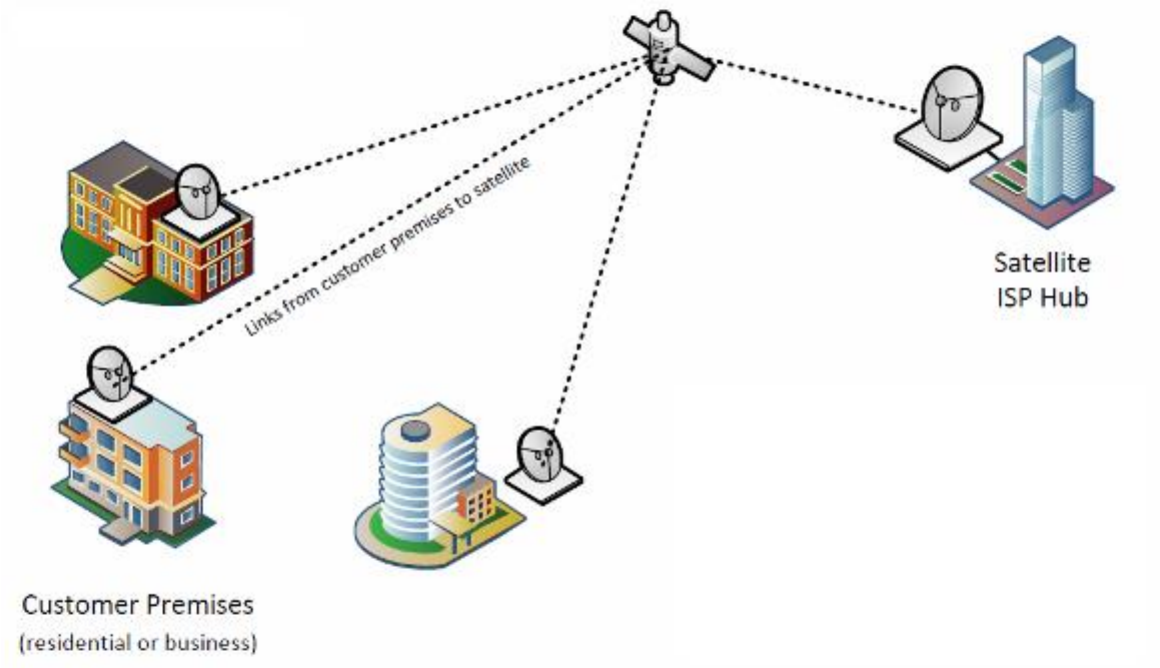
Lower frequency waves are able to disperse through obstructions such as buildings while facilitating less bandwidth, whereas higher frequency waves can be stopped by such obstacles though they are able to facilitate a greater data rate.

Wi-Fi and cellular data networks (4G, 5G, etc) are all radio transmissions.

A point-to-point radio link is useful in situations where it is not practical to run a cable, for example over a long distance or when a cable may be at risk of tampering. An example of this use case would be between different buildings of an office complex. PtP links are often able to reach speeds of several gigabits per second.

Omnidirectional transmissions are broadcast in every direction from a transmitter to cover a broad area. These transmissions are often used for one-way communications, such as broadcasting TV or radio stations.

Satellite



A satellite connection is most commonly used to gain internet access in extremely remote areas. Additional uses include for transmitting television (eg: Sky TV) or for providing positioning data (eg: GPS, GLONASS, Galileo).

They use high-frequency, directional radio waves to send and receive data over the long distance required.

The latency introduced by sending and receiving a signal to a satellite orbiting the earth can often be upwards of 500ms, making real-time communication a challenge. This is more than ten times less responsive than an average fixed-line connection.

Task Three (D2)

Transmission Method	Maximum Speed	Maximum Distance	Common Use
Coaxial	Dependant on cable length and specification. Can be anywhere from as low as 10Mbps to as high as 1Gbps+	500+ metres depending on cable specification and transmission standard	Television, Antennas, Aerials, Broadband via DOCSIS
Optical Fibre	Over a single fibre, upwards of 40 Terabits/s of bandwidth have been recorded. Though outside of a lab, speeds are more likely to be 1/10/100 Gigabits/s.	Depending on the standard and the transmission method (laser or LED), fibre can be run for hundreds of kilometres. At greater than 10Gbps with OM3 multimode fibre, the maximum distance is about 300 metres before a repeater is necessary.	High-speed and long-distance 'backbone' networks. Linking interconnection devices.
UTP/STP	Cat6, 6a and 7 UTP cabling can achieve speeds of up to 10Gbps Cat5e up to 1Gbps Cat5 up to 100Mbps	Cat7 UTP can sustain 10Gbps over a distance of 100 metres. Cat6 and 6a can sustain 10Gbps over 55 metres Cat5 and 5e can both sustain their maximum speeds over 100 metres Shielded cabling can make a longer run more reliable, but the maximum lengths remain the same as unshielded cables.	Home and business networks, connecting end devices to interconnection devices.
Radio	The latest commonly used Wi-Fi standard—WiFi 6—has a theoretical maximum speed of 9.6Gbps across multiple channels. 5G can provide portable devices with speeds of 4Gbps in ideal circumstances.	A home Wi-Fi access point will provide coverage over about 50-100 metres. Depending on its positioning and power, a 4G/5G antenna could cover several kilometres A point-to-point microwave link could communicate over dozens of kilometres	Providing connectivity to mobile devices and over long-distances where it is impractical to run a cable
Satellite	A satellite internet connection typically reaches peak speeds of 100-200Mbps, though faster speeds are achievable through a higher density array of satellites and more expensive client equipment.	Providing both the sender and receiver have line-of-sight to the satellite, the increased distance will simply introduce more latency. Often, satellites used for providing internet connections are able to communicate with each other which allows a connection to be made anywhere on the globe.	Connections over extreme distances and for providing connectivity to areas where other options are unavailable, for example extremely rural areas or in poorer countries.

Task Four (M3)

Transfer Rate

The transfer rate of a transfer method is the amount of data that can be sent and received in a given amount of time. Depending on the use case and user need, a higher or lower transfer rate may be acceptable. For example, a single user who only intends on sending emails and writing documents could get away with a slower connection than a whole house full of people streaming.

Wired transfer methods can facilitate high-speed transmission of data. Twisted pair ethernet cables are able to transfer up to 10Gbps whereas optical fibre cables are able to transfer terabytes of data per second.

Wireless mediums are not able to transfer data at speeds as high as wired mediums. WiFi 6 and 6e support speeds of up to 4.6Gbps across multiple devices. Commercial Point-to-Point wireless bridges are able to reach speeds upwards of 20Gbps over short distances.

A wireless medium is able to be disrupted or blocked by objects in the path which can reduce the reliability and effectiveness of the transfer. This is significantly more likely than any amount of cable interference.

Ease of Use

For an end user, a wireless solution that “just works” is often the most preferable and convenient. Many people, especially those who did not grow up with large personal computers at their desk, are not accustomed to using a wired connection. Additionally, a wired connection tethers a user to a fixed physical location. This is acceptable for a fixed-location device such as a desktop, server or laptop dock, however it is less acceptable for a portable device such as a mobile phone.

A wireless network can be easier to set up for an administrator since access points can be provided strategically around an area. These can be connected via a mesh system or wired individually. This could be more convenient than providing a wired connection to every device in an area.

Distance

Wired repeaters can allow the use of twisted-pair copper ethernet cables to be used over longer distances than standards traditionally permit. For example, a Cat 6 UTP cable can transmit 10Gbps over up to 100 metres.

Wireless point-to-point links are able to transmit data over several kilometres at acceptable speeds of hundreds of megabits per second.

Often if the path is clear enough and the antennae are aligned correctly, gigabits per second can be achieved over long distances. Point-to-point links can connect buildings without the expense of running cables where it would not be practical.

Wireless satellite links can allow people remote areas to access the internet where they otherwise would not. Satellites in Low Earth Orbit are 1200 miles away and are able to provide connections of several dozen megabits per second. This is oftentimes faster than the wired connections available in these rural areas.

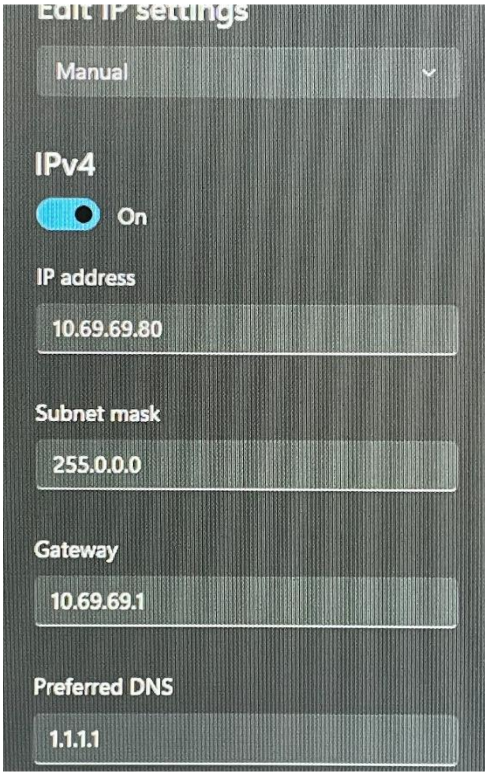
Conclusion

In conclusion, a wireless networks are primarily important where convenience is a factor and where portable devices are commonplace. A wired connection is preferable when reliability, speed and data integrity are significant factors. A wireless link can be suitable for long-distance communication where running a cable is impractical, but a wired optical connection would provide better reliability and speed.

Task Five & Six (P7, P8)

Creating a Network Between Two Computers

Step One: Configuring the Computers' Network Settings

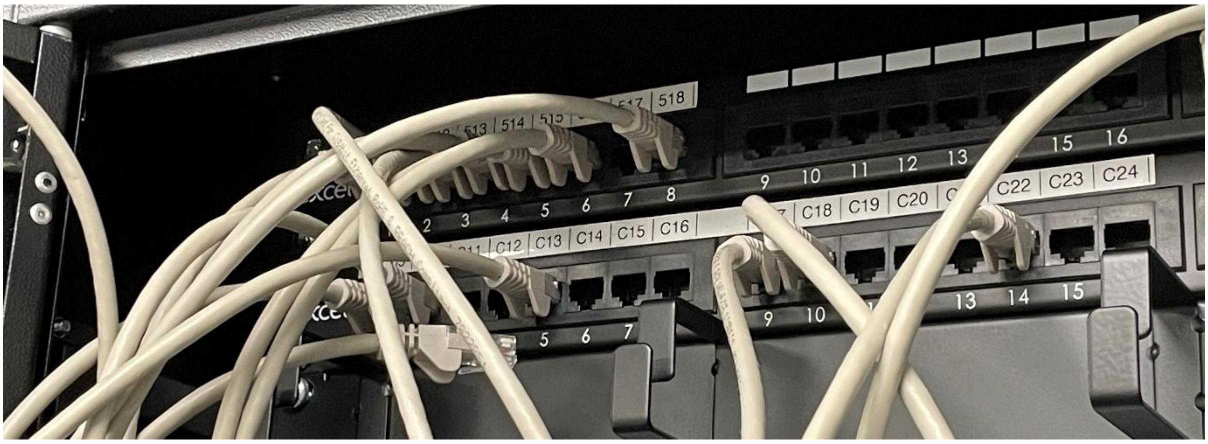


Before the PCs can be connected physically, the software on the computers must be configured correctly. In this case, both PCs were assigned unique static IP addresses on the same subnet. The IP addresses used were 10.69.69.69 and 10.69.69.80. For a Class A Private network like this, the subnet mask is traditionally 255.0.0.0, which allows millions more the two devices used in this example.

From within the Windows 11 settings program, the aforementioned details were entered, along with 1.1.1.1 as the DNS server, since Windows requires this for the settings to be saved—though this will be unreachable with no internet access. Likewise, a gateway was entered, though this is not necessary for these two hosts to communicate with each other.

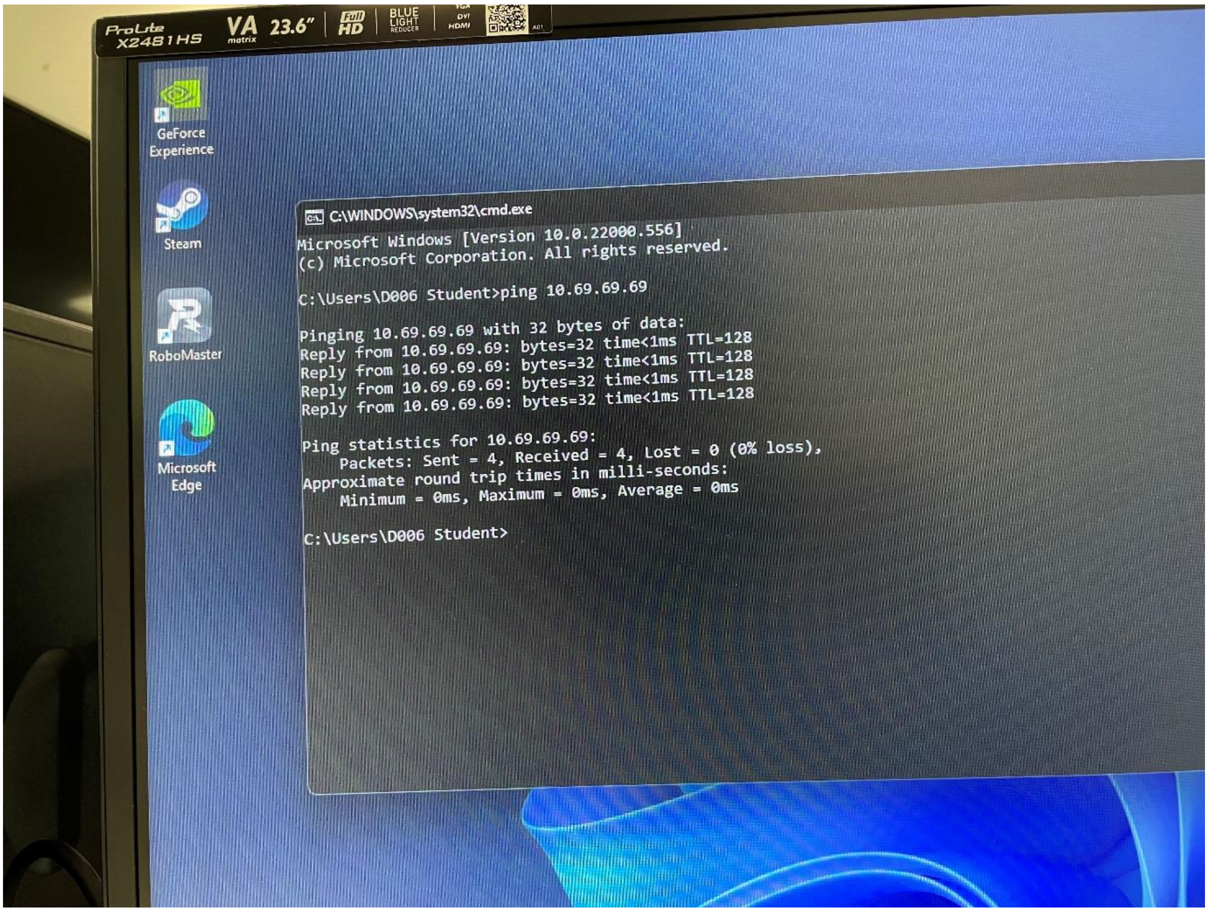
Step Two: Connecting the PCs Physically

A direct connection was established between the two NICs on each computer with an ethernet cable. This was done via a patch panel.



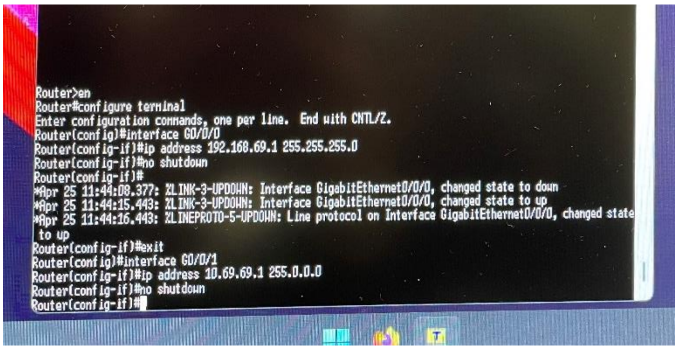
Step Three: Testing

To test the communication between the two computers, the *ping* command was used. The successful reply from the other computer (final octet of .69) indicates the connection has been established and is working. The same test was performed from the second computer (pinging .80 from .69). This was also successful.



Adding an Interconnection Device

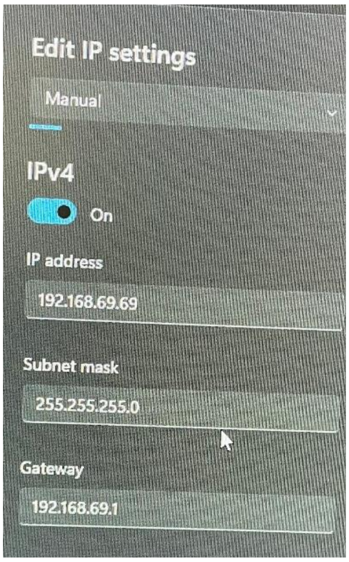
Step One: Router Configuration



Before the computers can be connected, the router needs to be configured with the appropriate addresses on the interfaces that we will be connecting our computers two.

In this example, two private networks were created – a Class C on port G/0/0/0 with the IP address space of 192.168.69.0/24 (255.255.255.0) with the router at 192.168.69.1 and a Class A on port G/0/0/1 with the IP address space 10.69.69.0/8 (255.0.0.0) with the router at 10.69.69.1.

This Cisco router was configured via the serial interface using CLI (command line interface) commands in Tera Term. Alternatives software includes PuTTY. Many modern routers are also configurable remotely via SSH or a web interface.

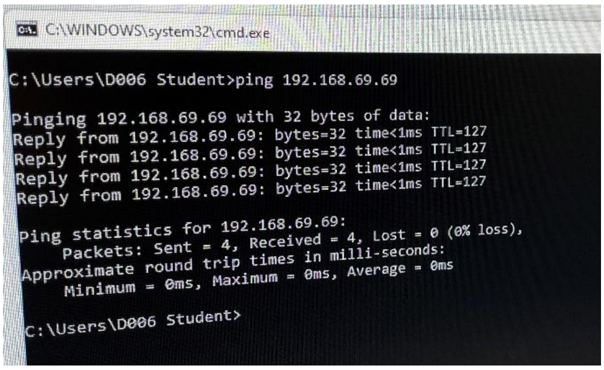


Before connecting the PCs, both ports were enabled.

Step Two: Windows Network Settings

These new networks were entered into the Windows 11 settings as before. This time, the first computer received the IP address of 192.168.69.69 with a gateway of 192.168.69.1 and the second computer received the IP address of 10.69.69.69 with the gateway residing at 10.69.69.1.

The gateway (router, in this case) allows the computers to talk to each other despite being on different subnets across networks.



Step Three: Testing

As before, the *ping* command was used to confirm the successful connection. 192.168.69.69 was able to ping 10.69.69.69 successfully and vice-versa, which proves that the two computers are able to communicate over the network via the interconnection device (router).