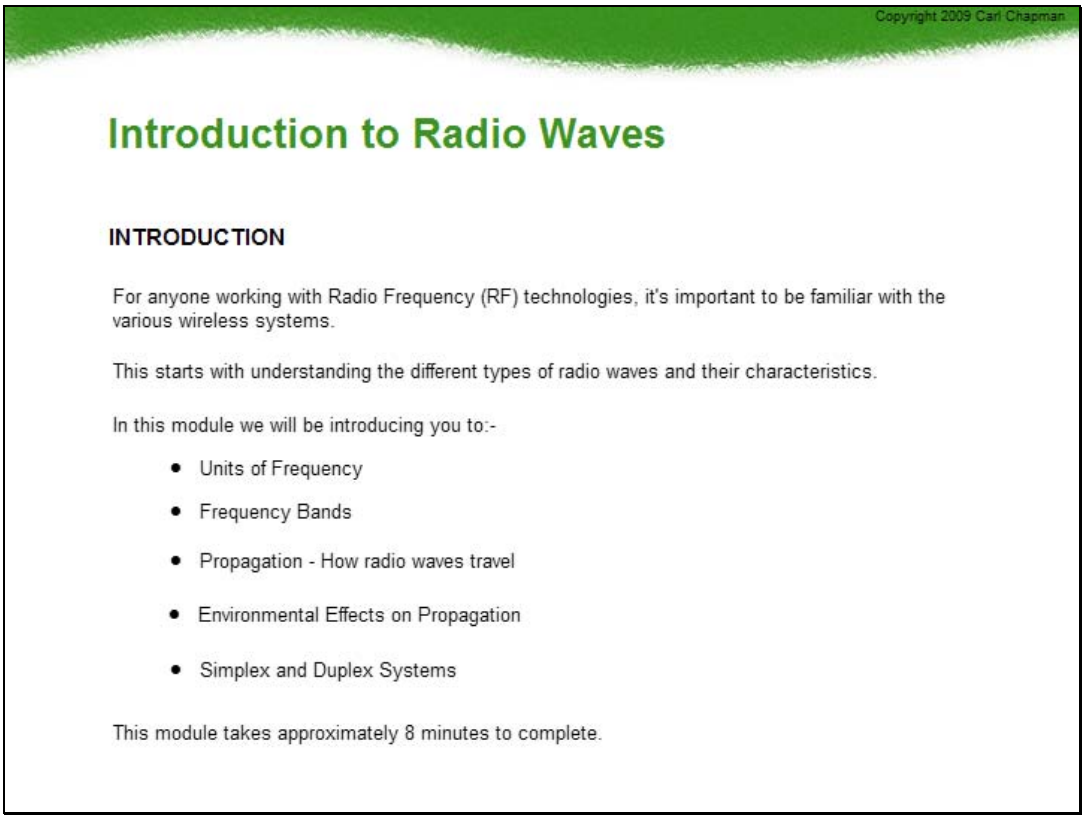
Introduction to Radio Waves



Introduction

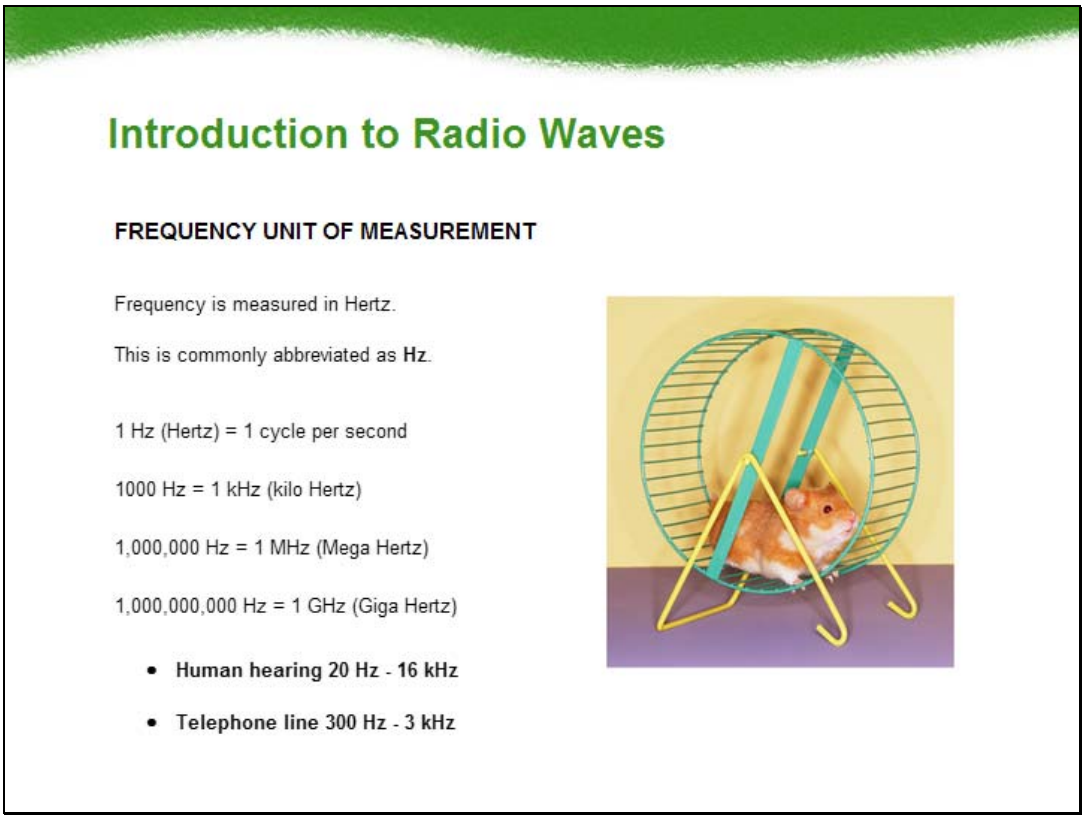
For anyone working with Radio Frequency technologies, it's important to be familiar with the various wireless systems.

This starts with understanding the different types of radio waves and their characteristics.

In this module we will be introducing you to:-

- Units of frequency
- Frequency bands
- Propagation and how radio waves travel
- Environmental effects on propagation, and
- Simples and Duplex Systems.

This module takes approximately 8 minutes to complete.



Units of Frequency

Frequency is measured in a unit called Hertz.

1 Hertz is equivalent to 1 cycle per second. Using the analogy of a hamster or a mouse on a wheel, if the wheel moves one rotation in one second it's moving at a rate of 1 Hertz.

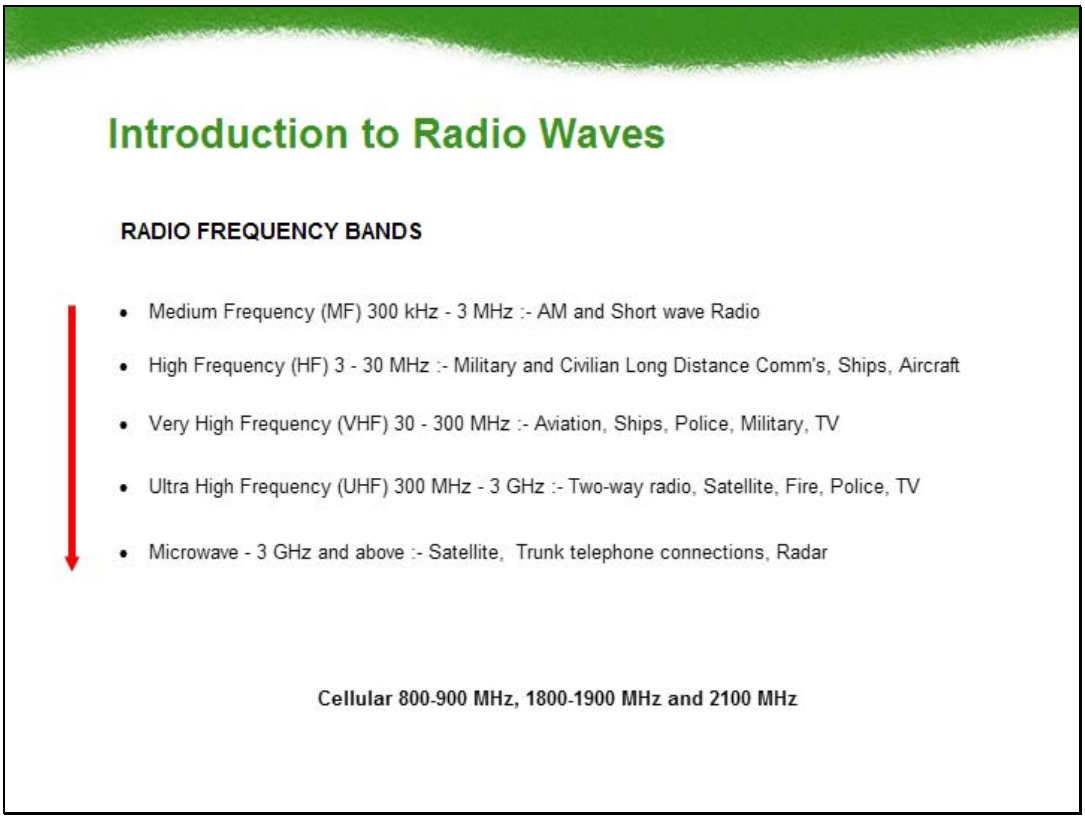
If the hamster starts running fast enough for the wheel to rotate at 1000 rotations per second it will be generating a 1000 Hz or 1 kHz frequency, which sounds like a whistle.

The hearing range of a healthy young adult is around 20 Hz (which is a low dull hum) to 16 kHz (which is a high pitched tone). This range decreases with age.

The telephone line uses only 300 Hz to 3 kHz. Frequencies above 3 kHz are filtered out to allow efficient transmission of voice down the telephone line, and this is why people, and the music from a CD sound different on the telephone.

If we give the hamster a lot of coffee and he turns the wheel 1,000,000 rotations per second, a 1 MHz signal is generated. This could be heard on your AM or short wave radio at 1,000 kHz.

Your FM radio works in the MHz range, so your favourite station at 95.1 is actually 95.1 MHz.
1 GHz is 1,000,000,000 cycles per second.



Radio Frequency Bands

Radio waves are grouped into frequency bands. These bands have different characteristics and are used to provide different types of communications.

Medium Frequency in the range 300 kHz to 3 MHz, is commonly used for AM and short wave radios.

The High Frequency band is 3 to 30 MHz. This band is used for military and civilian long distance communication, with examples including ships, aircraft, CB radio, etc.

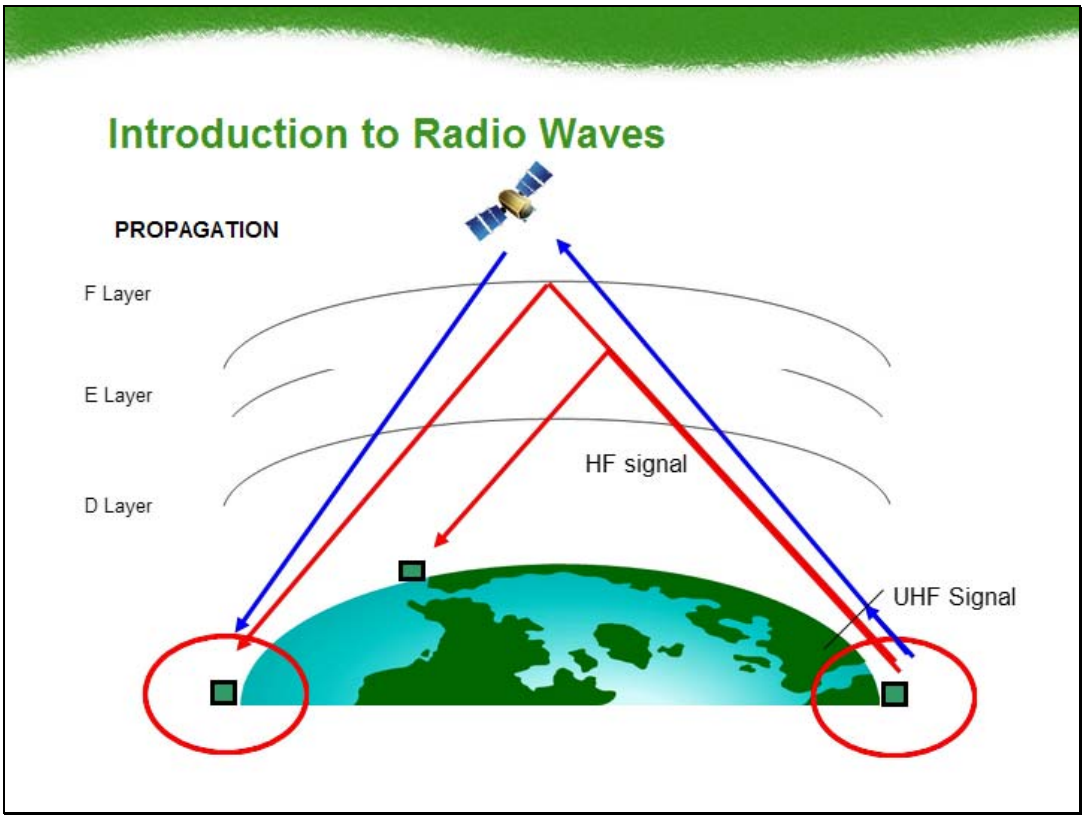
Very High Frequency signals in the 30 to 300 MHz band are commonly used for aviation, ships, police, military and over air broadcast TV.

The Ultra High Frequency band at 300 MHz to 3 GHz is used for two-way radio communication with fire, police, taxis, broadcast and cable TV and some satellite communication.

At 3 GHz and above we have the microwave band. This is typically used for satellite, trunk telephone connections and radar.

Depending on the license of the cellular operator, they can operate in the 800 to 900 MHz, 1800 to 1900 MHz and 2100 MHz bands.

As the frequency of the radio signal increases, the reception range and size of the antenna become smaller, but more data can be transmitted.



Propagation

Different frequency bands travel in different ways. This is commonly called Radio Wave Propagation.

The atmosphere is made up of a number of layers, typically named the D, E and F layers, etc. HF signals reflect off these atmospheric layers and travel back to earth, allowing long distance communication. If you want to receive a HF signal you must be located within direct receiving range of the originating signal, or where the reflected signal comes back to earth.

Through out the day and night the layers of the atmosphere move up and down, making the reflected signal move along the earths surface. This is why at night time you tend to hear signals from far away on your short wave or AM radio.

Different frequencies also reflect off different layers in the atmosphere.

For long distance communication with HF signals, the radio operator will normally change the channel frequency at regular intervals to maintain contact with a particular location. Lower frequencies are typically used in the night time, and higher frequencies in the day.

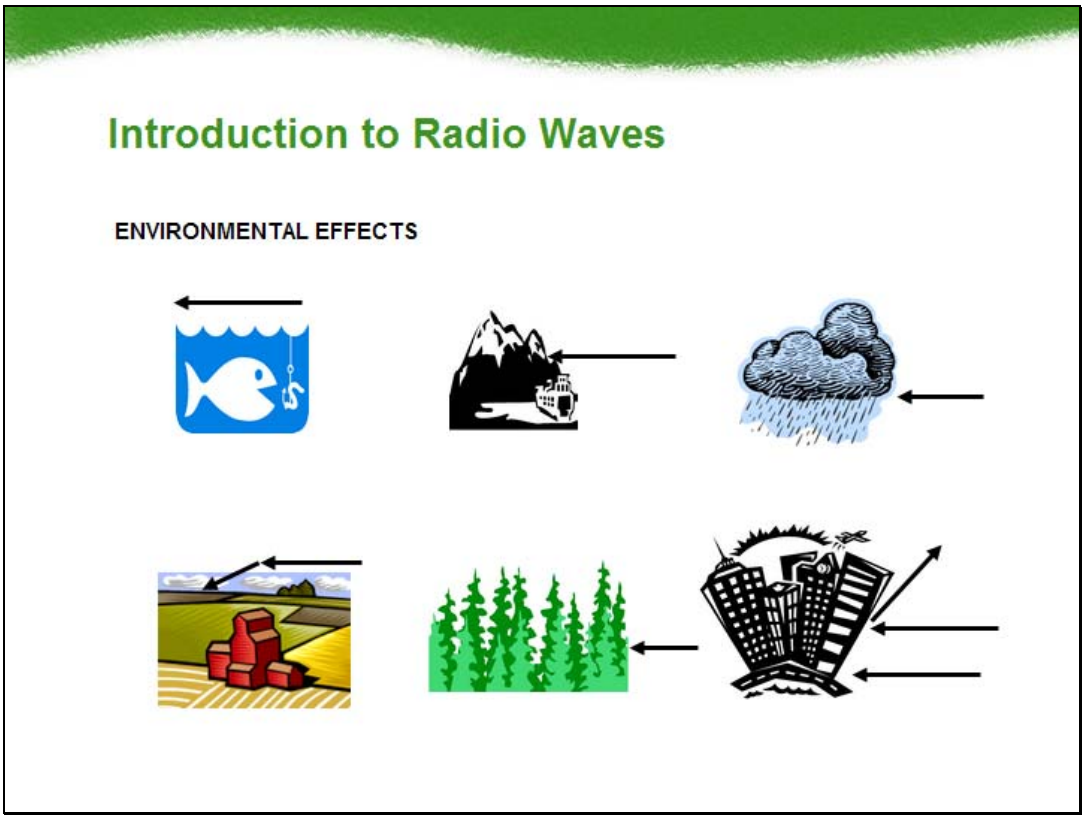
If you are on the ground, the maximum range for a UHF signal such as cellular or two-way radio is the horizon, or what is referred to as line-of-sight.

Once the signal drops below the horizon it is blocked by the earth.

The amount of transmit power being used and the operating environment may also effect this range.

UHF and microwave signals can also travel through the atmosphere without reflection, which makes them ideal for space and satellite communication.

Satellites can be used to re-transmit signals back to earth. They can be located at different distances above the earth, and have different coverage areas. Some move around the earth and some are stationary. To access a satellite, you must be in the coverage area of the satellite and must point your antenna toward it.



Environment Effects

If your transmitter is beaming a UHF or VHF signal over the water, your receive range is to the horizon.

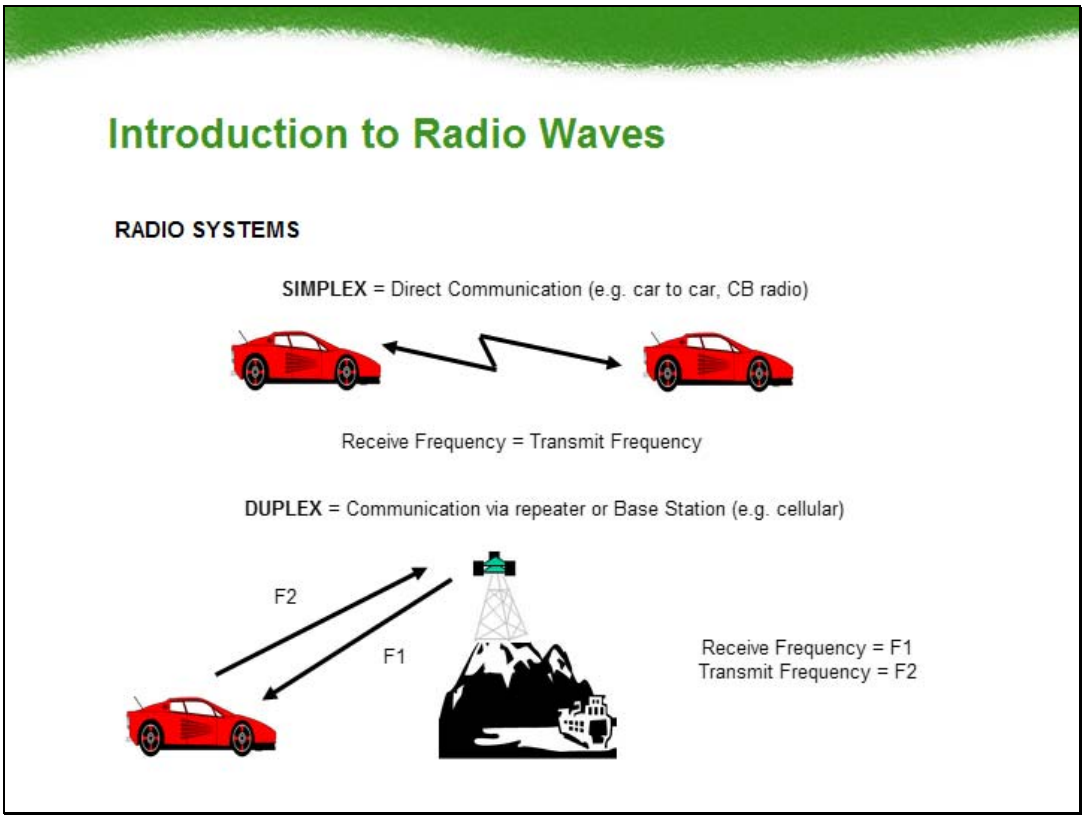
As radio waves travel over land, they are absorbed by the earth, so your reception range is reduced.

Mountains block radio waves. If your transmitter is on one side of the mountain, you must be on the same side of the mountain to receive the signal.

The forest and jungle absorb the radio signals a lot. In heavy jungle your reception range maybe down to less than 500 meters.

Some satellite and microwave signals can also be effected by rain or heavy cloud, and this is why you lose ESPN on the satellite TV during a rain storm.

Buildings in the city can both absorb and reflect radio signals, making it the most complex operating environment for wireless systems.



Simplex and Duplex Systems

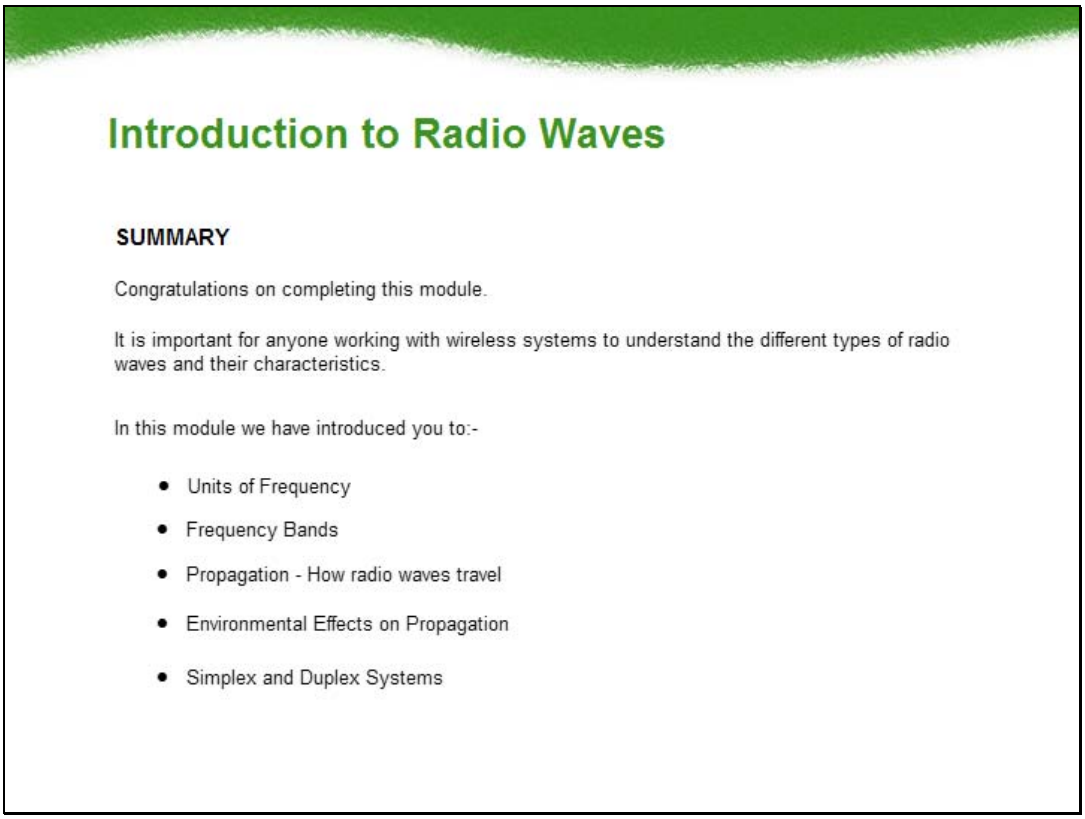
Radio systems are basically divided into two groups:- Simplex and Duplex.

Simplex signals use the same frequency for transmit and receive, and are typically used for direct communication. An example is CB radio. One user presses the button to talk, and the other user listens on the same frequency.

Both sides of the conversation use the same radio channel in a simplex system.

Duplex systems use different receive and transmit frequencies, with cellular as a common example. Duplex systems also typically use repeaters of base stations to control signals and boost range, which we will be discussing in a future module.

In a duplex system, each side of the conversation is on a different radio channel.



Summary

Congratulations on completing this module.

It is important for anyone working with wireless systems to understand the different types of radio waves and their characteristics.

In this module we have introduced you to:-

- Units of frequency
- Frequency bands
- Propagation and how radio waves travel
- Environmental effects on propagation, and
- Simplex and Duplex systems

