

# ARRL Amateur Radio Education & Technology Program

## Unit 1

### Introduction to Wireless Communication

#### WHAT IS WIRELESS COMMUNICATION?

What are some different ways we communicate? Voice communication is used most often. We talk to our family, friends and others at school and elsewhere. What are some other ways we communicate? Telephone, fax, hand signs (high five) are just a few ways. Can we communicate without speaking? A smile communicates a happy person, warm and friendly. A cold stare can communicate negative feelings with a message, “stay away if you know what’s good for you.”



When we speak we cause air in front of our mouth to move. The air moves in waves, called *sound waves*. Our ears pick up the sound waves and transfer them to our brain for decoding. We can often feel these sound waves. Put your hand up to your mouth and speak. Do you feel the sound waves on your hand?

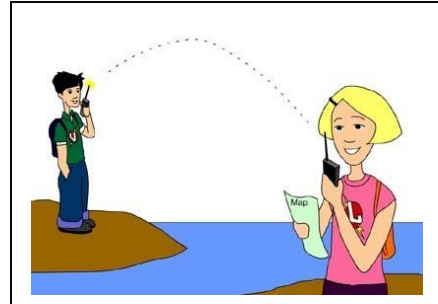
We are limited as to how far we can communicate with sound waves. We need to be within hearing distance for communication to be possible. How can we increase the distance we can be heard? Years ago, the *telegraph* was used to communicate over long distances. Operators used the telegrapher’s code consisting of a series of short and long clicks to represent letters and punctuation. Telegraph wires were usually run along railroad tracks, connecting telegraph stations.

Today we may use a telephone to communicate long distances. How does a telephone help us extend our ability to communicate longer distances? Like the telegraph, wires are often used to connect telephones. When we speak into a telephone, an electrical signal is generated and sent through a wire to a telephone at the other end. Have you ever wondered how it is possible for a person at the other end of the telephone connection to hear you at the very instant you are speaking?

Does someone in your family have a cell phone? How do cell phones work? In this text you will learn the answer to this and other fascinating questions relating to wireless communication.

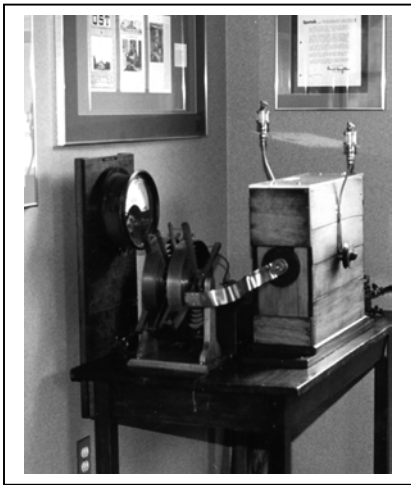
Wireless communication is used to transmit or receive information over long distances without the use of wires. What items do you have in your home that use wireless communication? We already mentioned a cell phone. Do you have an AM/FM radio at home? An AM/FM radio receives a signal from the radio station and processes the radio wave into a sound wave so you can hear music or someone talking. Television can receive signals either through the air (like the radio) or through a cable. If your family has cable TV then it is not considered wireless communications.

How does your radio receive a signal from the radio station? What does it look like? Remember the sound wave? We said the sound wave must travel through the air to reach your ear so you can hear. We are not able to hear *radio waves* like we can sound waves. Radio waves are passing by us all the time. To hear a radio wave, we need a *radio receiver* to receive and process the signal and convert it to an *audio signal* so we can hear it.



In later units we will learn how radio waves are transmitted over long distances. We will also learn about the many different kinds of radios there are and how radio has changed our world.

## THE DEVELOPMENT OF WIRELESS COMMUNICATION



**The Early Years.** Over the past 100 years, wireless communication has grown from a passing interest to a multi-billion dollar industry. Starting with a simple Morse code letter “S” sent across the Atlantic, to *broadcast radio*, to *television*, paging systems and cell phones, wireless communication has evolved into an very important part of our daily lives. Let’s look at how it all started.

The seeds for wireless communication were planted in the 1890’s when an Italian by the name of Guglielmo Marconi began experimenting with *wireless telegraphy*. Soon he was joined by dozens, then hundreds. Some wanted to know how they could use the new technology to make money, while others were interested in using it for fun and recreation.

On December 12, 1901, Marconi made the first transatlantic wireless transmission between England and Canada, by using Morse code. By 1904, the French set up a commercial maritime radio network between ships at sea.

The first broadcast radio station in the US was started in 1920. Some countries used radio for education while others used it strictly for entertainment.

In the US the federal government decided it needed to control the new technology. In 1934 the Federal Communication Commission (FCC) was set up to over-see radio communication. By 1938 radios were in over 26 million homes in the US.



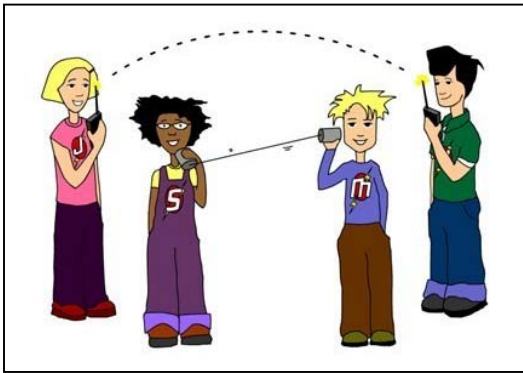
**Post WWII.** After World War television stations were starting. The type of programming found on radio in the 40’s and 50’s moved to television in the form of variety shows, and radio shifted its programming to music, news and talk shows.

Hams began setting up their stations and experimented with new technology they found available. Hams even experimented with sending television signals to one another.

Radio played an important role in the US entering the space race. In 1957, the Russians sent up the first satellite, *Sputnik*, which was nothing more than a small radio transmitter sending out a faint signal as it circled the Earth. That simple signal sent shock waves through the United States and sparked the space race of the 60's. Today we have the International Space Station (ISS) with an Amateur Radio station as a backup radio. This allows school children around the world to talk to astronauts as they circle overhead.

Since it was invented, radio has changed the way we live our lives. It has changed the way business is done. Can you imagine what our world would be like if radios didn't exist? What difference would it make in your life?

**WIRELESS COMMUNICATION.** *Wireless communication* can be defined as information sent or received without direct aid of a telephone line. What does that mean to you and me? Sending information – using a radio to transmit (send) information- over the airwaves.



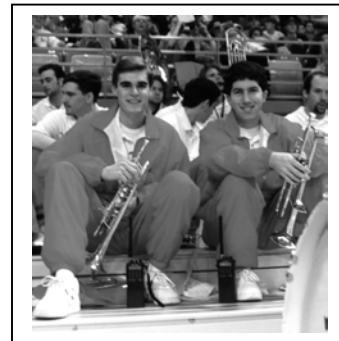
As we go through our everyday lives we are surrounded by wireless signals. We cannot feel them, nor can we see them. All we have to do is turn on a radio or television and we see the result of the radio waves. We use the term “radio,” but “*wireless*” better describes these signals. Whether one-way (like a broadcast station) or two-way wireless signals play a big part in our lives. In this unit we will be looking at the many ways wireless communication is used in everyday life.

### WHO USES WIRELESS COMMUNICATIONS?

Many people around the world use wireless communications. In this section we will look at these people and see how they make use of wireless communication.

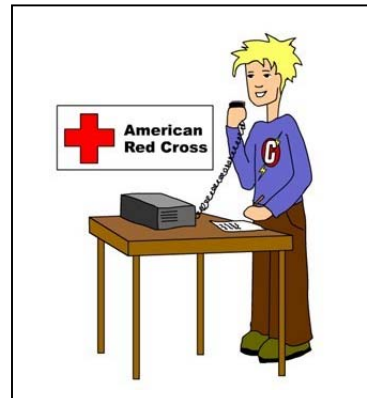
**Commercial Radio and Television.** We all listen to commercial radio. What is your favorite radio station? Why do you like that station? They play the kind of music you like. They advertise (that's where the word *commercial* comes from) things you like to buy. What about your favorite television program? Why do you like that program? What kind of things do they advertise?

In the beginning, all TV signals were transmitted through the air just like radio. In recent years, however, more and more homes have installed cable TV. Cable TV receives its signals through a coaxial cable (thus the name cable TV). We also have satellite TV systems that use “dish” antennas to receive signals sent from satellites. Even



cable TV signals are sent, at some point, through satellites and the airwaves. So, if you listen to radio or watch TV, you are a user of wireless technology.

**Public Safety Agencies & Organizations.** The majority of emergency response organizations such as Police, Fire and Emergency Medical Departments depend primarily on Wireless Communication to communicate. Imagine the delays and problems that would occur for a police officer if immediate assistance is needed for an emergency and there was no wireless communication, only a telephone located far away from the emergency. If there were no wireless communication, consider the delays and problems for fire fighters or medical emergency technicians trying to call for assistance or to clarify a correct address about where is the emergency location.



Many groups whose job it is to protect us, use two-way radios. Police, firefighters, airplane pilots, the military, and others use two-way radios to talk to each other. Ham radio operators are another group that use radios to serve the public. During disasters like floods and tornados, hams offer their services to local and national emergency groups. When regular public safety radio systems are destroyed by these disasters, hams have the skills and equipment to help out.

**Military.** The military (Army, Navy & Air Force etc.) has been using two-way radios for many years. Generals in command need to speak to the soldiers in the field. Before radios, field commanders would use “runners” and even pigeons to relay messages to headquarters. As the technology was developed, phone lines were installed as the troops moved in the field so a phone system could be used. These phone lines were often cut or broken and sometimes the enemy would “tap” into the line so they could hear what was being said. Field commanders started using radios to communicate because they were easier to use and didn’t require phone lines. Both Morse code and voice communications were used. Many different “code” systems were developed to make communication to



the field possible without the enemy being able to understand what was said. Today, the military uses satellite systems and other wireless technologies that allow them to communicate directly with commanders anywhere in the world, at any time.

**Government.** City, county, state and national governmental organizations, such as public works

and civil defense use wireless communications to run the business of government. Radio systems allow government officials (mayors, governors and legislators) to move around without fear of being out of touch with their staffs. Radios also link local, state and national government officials together to coordinate important events efficiently.

**Marine Radio Service.** Before we had wireless technology, there was no way for ships to communicate with each other once they were out of sight of each other. The invention of the radio was a major event in the early part of the 20<sup>th</sup> century. The movie “Titanic” shows the important role wireless plays in maritime (ships at sea) communications. The Titanic only had a crude radio system, but was still able to communicate the distress signal to other ships in the area, thus saving many lives.

Today, even small boats have radio systems available that allow them to communicate with other boats at sea, as well as shore stations around the world. Many boats also have Amateur Radio stations on board to help keep in touch with friends and family while traveling the world.

**Amateur Radio Operators.** Amateur Radio operators use their radios to communicate with each other. Some times they are just talking to someone across the street and other times they are talking to someone on the other side of the world. Also known as “hams,” these people enjoy communicating in a variety of ways with others who have the same interest. Hams volunteer their time, talents and equipment during natural disasters when



other forms of communication fail. They build international good will by making friends with hams in foreign countries. Hams like to experiment with new radio systems and are responsible for many new inventions in wireless communication.

Hams often participate in contests, by trying to make the most number of contacts during a 48-hour period. They also teach classes to people interested in becoming hams. They even talk to each other through satellites and sometimes with astronauts on the International Space Station.

**Citizens Band Radio.** Have you heard of Citizen Band Radio (CB)? Does someone in your family have a CB radio in their car or truck? CB’s have been around for many years. Best know for its use by truck drivers to communicate with each other while cruising down the Interstate highways, CB radio is also used for short distance emergency communication along with Amateur Radio. No license is required for CB operation, which makes it popular with those wishing to get started in radio communications.



**Family Radio Service.** Do you have a set of Family Radio Service (FRS) radios at home? Many families use these handy radios to keep in touch with each other while at the mall,

amusement park or camping. Communication is limited to less than one mile, but for most situations involving families, this is enough. It's fun to use FRS transceivers to practice talking on the radio while studying for your Amateur Radio license.

## **THE DIFFERENT TYPES AND MODES OF WIRELESS COMMUNICATIONS**

Take a moment to think of all the different ways people communicate using wireless technology. Do you have a *pager*? How about a *cordless phone* at home? Many young people carry a *cell phone* as an added safety measure when traveling to school or to the mall. Have you had an opportunity to try out the Family Radio Service "walkie-talkie" radios?

These are all wireless devices used to communicate. The technology used by these devices to transmit and receive signals varies with the type of device and where they are used. Let's take a moment to look at some of these devices and their technology.

**Broadcast Radio.** You may already be aware of the two types of broadcast radio – AM and FM. Do you know what AM and FM mean? I'm going to get a little technical here but you can impress your friends with this information. AM stands for *Amplitude Modulation* and FM stands for *Frequency Modulation*. For our purposes, modulation can be defined as a process of varying a radio wave in some way to send information. What does that mean? It's how we send a voice or music through the air. Which type do you listen to the most? If you like to listen to music, you are probably listening to an FM station. We will discuss more about this in another unit, but for now you should be aware of the two types.

**Television.** We are all familiar with television. Television is all around us. Most homes in the America have at least one television set. Did you know that television uses both AM and FM to bring the program into your home? Wouldn't it be interesting to know how this works?

**Two-Way Radio.** The term *two-way* refers to the ability of a radio to transmit as well as receive a signal. A radio that can transmit and receive is called a *transceiver*. This allows people to communicate directly using one small compact radio. Who uses two-way radios? Police and fire departments, city and state government employees, the military and even ham radio operators all use two-way radios. Can you think of other people who use two-way radios to do their work?



**Pagers.** Do you have a *pager*? A numeric (one that only uses numbers) pager allows someone to contact you via their telephone by dialing your specific pager number and entering their phone number. This lets you know they would like to talk to you. A voice

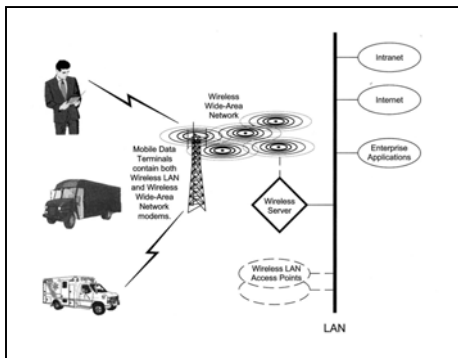
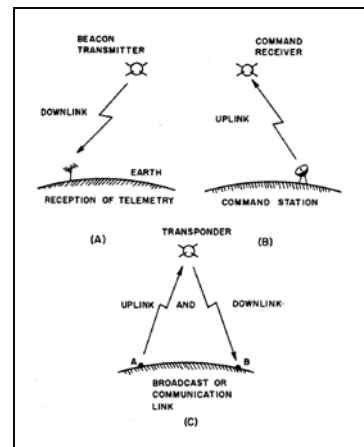
pager lets you hear the person's actual voice. Many cell phones also include voice paging as part of their service.

**Cell Phones.** Cell phones are fast becoming a national necessity. Everywhere you look, you see people sitting, walking or driving while talking on cell phones. Have you ever wondered how cell phones work? How does your voice get from your cell phone to the person you're talking too without going through the telephone line? We will be discussing this issue in another unit later.

**Radio Astronomy.** Did you know that we can use radio to study the Universe? When we look at the night sky, we see the visible light from distant stars, or reflected from planets and other bodies. But did you know that the Universe is also filled with radio signals created by these same objects? By using sensitive receivers and large antennas, radio astronomers can study the cosmos by analyzing these radio signals.

**Satellites and Radio.** How are satellites used to transmit radio signals? Satellites receive signals from ground stations and relay the signals to other satellites or directly back to Earth. Look at some of the homes in your neighborhood. Do some homes have little dishes on their roofs? Those are satellite antennas for receiving satellite TV.

The International Space Station (ISS) is a satellite. Circling the earth every 90 minutes, the ISS communicates with ground stations delivering important scientific information. How would you like to talk to the astronauts on the ISS? What questions would you like to ask them?



**Wireless Internet.** We should all be familiar with the Internet. Connecting your computer to your local Internet provider provides you with a window to the world. Did you know you can also connect to the Internet through a wireless system

**Software Defined Radio.** We usually think of radios as being made of various kinds of electronic parts that work together to receive a signal from a broadcast radio station. In recent years, however, microprocessors and software have been used to do many of these same tasks. Such a "software defined radio" is extremely flexible because simply changing the software can change the function of the radio.

We have covered some of the more popular uses of wireless communications in this section. Some are familiar to you, others you may not have heard of. You should be aware of the technology used so you can make good decisions in the future about your use of this technology.