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Amateur Radio

What is Amateur Radio?

Amateur Radio or ham radio as it is often called is a worldwide radio service that is licensed by the Federal Communications Commission (FCC), at least in the United States. Other countries have their own licensing authorities, but all amateur radio operators must be licensed in order to transmit on any amateur frequency. According to the FCC, "The amateur and amateur-satellite services are for qualified persons of any age who are interested in radio technique solely with a personal aim and without pecuniary interest." Twenty-seven frequency spectrum allocations exist internationally for amateur radio operators to use. Amateur radio operators are also allowed to transmit, "some 1,300 digital, analog, pulse, and spread-spectrum emission types…," according to the FCC. Amateur operators are also given the ability to design, create, modify, repair, and experiment with radio equipment within the designated frequency spectrum allowed by the class of license the user holds.

Currently there are three license classes issued by the Federal Communications Commission: Technician, General, and Extra. Each class of license is earned through examination of a potential operator's skill and knowledge in operating an amateur radio station. The lowest level is the technician class license and the highest level is the extra class license (FCC). The exam questions come from a pool of questions that have been made public, according to the FCC. The technician class exam consists of thirty-five multiple choice questions

regarding rules, regulations, and the safety of operating an amateur radio station. The general class license exam also has thirty-five questions and is more difficult as it includes more radio and electronics theory. The extra class license exam, being the highest class of license available from the Federal Communications Commission consists of fifty multiple choice questions that contain a lot of radio theory, electronics theory, safe operating practices, more rules, regulations, and limits.

Emergency Services

Amateur radio is also used as an emergency communications service during times of disaster (ARRL). Typically, amateurs are used during emergencies that cause a loss of power and damage to infrastructure-dependent communications methods (i.e. Cell Phones). Amateur radio operators are often involved in local, state, and national communications organizations. One local organization is the McKean County Emergency Communications Team, which is part of the McKean County Emergency Management Agency. At the national level, amateur operators can work through the Radio Amateur Civil Emergency Service which is coordinated by the Federal Emergency Management Agency (FEMA) and the Amateur Radio Emergency Service (ARES), which is coordinated by the American Radio Relay League (ARRL). Some amateur radio operators may also be involved in Skywarn which is coordinated by the National Weather Service. Amateurs involved in Skywarn provide weather information to the National Weather Service for analysis and dissemination to the public (ARRL).

Repeaters

A repeater is a radio that listens on one frequency and simultaneously retransmits that signal on another frequency (Butler). Typically, repeaters are used on Very High Frequency (VHF) and Ultra High Frequency (UHF) radio frequencies. The reason for this is that VHF and

UHF radio waves do not travel very far. A well-placed repeater can easily cover hundreds of miles. Repeaters generally produce higher power than a typical mobile or handheld radio and usually use very efficient high gain antenna systems (Butler). Basically, this means that a user's weak, low powered signal is being retransmitted with higher power output into a better antenna and in turn this produces a greater coverage area.

One of the more interesting components of a repeater is the duplexer. This allows the repeater station to use a single antenna for both transmit and receive. According to Donald Butler, duplexers often look like large tall cans. A duplexer is a device that isolates the transmit and receive frequencies so that the repeater does not hear itself. A duplexer also has a very narrow band pass, which allows the repeater to hear stations on its receive frequency and to reject other signals on nearby frequencies (Butler). This helps a repeater to reject signals from nearby repeaters or transmitters and to reject radio frequency (RF) interference (Butler). A repeater can be setup without duplexers, however it will require a very large spacing between the transmit & receive antennas and a larger frequency offset.

Frequency offsets are used due to repeaters transmitting on one frequency and receiving on another. The actual amount of offset between the two frequencies varies by the band. For instance, the popular VHF band two meters (144-148Mhz) typically has an offset of 600 kilohertz, according to Donald Butler. The popular UHF band, 70 centimeters (420-450Mhz in the USA) typically has an offset of 5 megahertz (Butler). These offsets typically increase as the frequency increases; this is to avoid having the transmitter and receiver interfere with one another.

One way repeaters avoid interfering with each other is through the use of Continuous Tone Coded Squelch System (CTCSS) tones or PL tones. According to Butler, PL is an acronym

meaning “private line” and is Motorola’s proprietary name for CTCSS. These tones allow a repeater to reject all signals without the proper CTCSS tone encoded in the radios transmission to the repeater. This is helpful in repeater-congested areas where many repeaters’ frequencies may be close or the same (Butler). Essentially, if a repeater is using CTCSS tones, it will not hear radio stations that are not sending that tone.

History of Amateur Radio

Marconi first communicated across the Atlantic Ocean in 1901, but prior to his experiments, James Clerk Maxwell theorized electromagnetism in 1873. Marconi’s first communication across the Atlantic used high power and giant antennas. Due to the high power, interference was a problem leading the United States Congress to approve the Radio Act of 1912. This piece of legislation required amateur radio operators to be licensed by the Federal Communications Commission and limited these amateurs to a wavelength of 200 meters or frequencies below 1,500 kilohertz (ARRL).

The American Radio Relay League was founded by Hiram Percy Maxim in 1914. Maxim found that sending messages over the radio could be done more reliably if there were relay stations. This led Maxim to create the American Radio Relay League which was an organization of amateur radio operators who acted as these relay stations. Amateurs began testing the transmission and reception of signals across the Atlantic in 1921. According to the American Radio Relay League, “…by July 1960 the first two-way contact via the Moon took place on 1296 Mhz.” Today, amateur radio operators use various modes of communication bouncing signals off the moon, the ground, and the ionosphere. Amateur radio operators exist in almost every country on Earth and range in age from ten years old to more than one hundred years old (ARRL).

Modern Communication Modes

Modern amateur radio includes more ways to communicate than just voice or Morse Code. Amateur radio operators use a variety of different modes including Digital Smart Technology Amateur Radio (DSTAR) and Digital Mobile Radio (DMR). DSTAR was designed for amateur radio by the Japanese Radio League (DSTAR Info). DMR on the other hand was designed for commercial use and later adapted by amateur radio operators to work as an amateur radio system. These different modes can be used to send voice, text messages, images, files, and all kinds of other data types.

Digital Smart Technology Amateur Radio (DSTAR)

DSTAR or Digital Smart Technology Amateur Radio, is a mode that allows digital voice, text messages, files, pictures, and GPS location data to be transmitted and received. DSTAR also allows repeaters to link to other repeaters through the internet. Repeaters may also be connected together in what are called “reflectors” which are basically like conference servers (DSTAR 101). Repeaters are linked by the user’s transceiver by sending an eight-character code that tells the repeater what to do (DSTAR 101). For instance, to link to the local DSTAR repeater who’s callsign or license number is “KC3ESS”, the following code would be used without quotes, “KC3ESSBL”. The callsign and the module, which in this case is “B”, is used along with the “L” for “link”. The module indicates the frequency of the repeater where “B” is 70cm or around 440 megahertz and “C” is 2m or around 144 megahertz. There are also other commands which are always in the eighth character location such as the unlink command which is the letter “U”, the echo command which is the letter “E”, and the information query command which is the letter “I”. Since callsigns vary in length from three-character special event stations to six-character

station callsigns, all commands are padded with spaces if there are not enough characters to reach that eighth position.

Digital Smart Technology Amateur Radio also allows slow speed data to be sent over the radio. This data can include GPS location data, images, and even files. Some DSTAR radios, such as those from Icom, a manufacturer of radios, can be interfaced with Icom's Android and iOS app called, "RS-MS1A." This app allows full control of the transceiver as well as the ability to send photographs and files through the radio. According to Icom America, a software called DRATS was designed for amateur radio first responders within the Amateur Radio Emergency Service (ARES) and the Radio Amateur Civil Emergency Service (RACES) and can be used with any DSTAR radio. The software includes the ability to chat via instant message, send structured emergency forms, send GPS position reports, and transfer files with error detection over amateur radio (Icom America).

DRATS can also be used to send email messages to regular email users, provided the emails are not business related and there is no money involved. Amateur radio is not for profit and to use it to make money is illegal. DRATS users can send data through radio waves to another DRATS station called an "internet gateway" and from there the message or email can be sent to any regular email user (Icom America). According to Icom America's DRATS brochure, this process can also be reversed allowing regular emails to be sent to an amateur radio station over radio.

Digital Mobile Radio (DMR)

Digital Mobile Radio or DMR for short, is another digital communications mode that is similar to DSTAR. What makes DMR different according to Bentvision LLC, is that it uses Time Division Multiple Access or TDMA to divide a single frequency into two "timeslots."

These two timeslots can support two completely different conversations simultaneously on the same frequency. Instead of using a callsign to identify the radio, like DSTAR uses, DMR utilizes a unique radio identification number. This radio ID number uniquely identifies your radio on the DMR network (Bentvision LLC). Radio ID numbers are very similar to a computer's IP address or a person's telephone number.

Much like DSTAR, DMR uses the internet to connect repeaters together around the world. Digital Mobile Radio utilizes what are called "talkgroups" to organize or group unique radio identification numbers together. This allows a DMR repeater to connect to a talkgroup and hear all of the stations that are connected as well as transmit to all of the connected stations, very similar to a DSTAR reflector (Bentvision LLC). Talkgroups are also identified by a unique number which is used to connect a repeater to them. Talkgroups can be static or dynamic meaning a repeater can have a static or permanently connected talkgroup or the repeaters may allow dynamic talkgroups in which end users are able to connect to various talkgroups as they please (Bentvision LLC). There are a couple of different DMR networks, one of which is the Brandmeister network (Bentvision LLC).

BrandMeister is an operating software for DMR master servers or repeaters. This software allows these servers to communicate with each other amongst a worldwide infrastructure network consisting of amateur radio digital voice systems (BrandMeister). According to BrandMeister, their network allows the following features: two-way text messaging, sending position reports, making private calls to other amateur radio operators, making worldwide group calls to other amateur radio operators, and roaming between repeaters.

Works Cited

ARRL. *Amateur Radio Emergency Communication*. n.d. 10 November 2018. <http://www.arrl.org/amateur-radio-emergency-communication>.

—. *Ham Radio History*. n.d. 10 November 2018. <http://www.arrl.org/ham-radio-history>.

Bentvision LLC. *DMR Talkgroups*. n.d. 11 November 2018. <http://www.dmrfordummies.com/talkgroups/>.

—. *What is DMR?* n.d. 11 November 2018. <http://www.dmrfordummies.com/library/>.

BrandMeister. *What is BrandMeister*. n.d. 11 November 2018. <https://wiki.brandmeister.network/index.php/What_is_BrandMeister>.

Butler, Donald I. *How to Use Amateur (Ham Radio) Repeaters*. n.d. 11 November 2018. <http://www.hamuniverse.com/repeater.html>.

DSTAR 101. *What is DSTAR?* n.d. 10 November 2018. <http://www.dstar101.com/whatisdstar.htm>.

DSTAR Info. *Frequently Asked Questions*. n.d. 11 November 2018. <http://dstarinfo.com/faq.aspx>.

FCC. *Amateur Radio Service*. 6 July 2017. 10 November 2018. <https://www.fcc.gov/wireless/bureau-divisions/mobility-division/amateur-radio-service>.

Icom America. "dratsbrochure.pdf." 15 May 2009. *Icom America.* 10 November 2018. <http://www.icomamerica.com/en/products/amateur/dstar/dstar/dratsbrochure.pdf>.