

Starting a Two-Way Radio Network

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Objective: Provide basic information to encourage independent, private citizen emergency networks.

Topics:

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Role of Two-Way Radios

What happens if the Internet, cell phones, and the electrical power grid become unreliable? How will you communicate with your family, friends, and even neighbors?

Satellite phones could be useful, but are expensive for most people, and everyone you want to communicate with will need one. There is also no guarantee satellite service providers will continue to operate, or be able to handle the peak customer load effectively, during an emergency.

Enter two-way radios, or devices that receive and transmit radio frequencies. Two-way radios can operate with minimal, rechargeable power, require little technical knowledge, and function without societal infrastructure or corporate service plans and support.

Unlicensed Options

Many two-way radios can operate on unlicensed frequencies based essentially by line-of-sight. If you can draw a line from you to the other person without going through terrain or too many buildings, trees, etc., you can probably communicate.

Line-of-sight signals in the Very High Frequency (VHF) range can be useful in event of an emergency. These include five unlicensed Multi-Use Radio Service (MURS) frequencies set aside for general public use by the Federal Communications Commission (FCC) and restricted to a maximum of 2 watts of transmitting power. Learn more about MURS:

<https://www.fcc.gov/wireless/bureau-divisions/mobility-division/multi-use-radio-service-murs>

The FCC also designated specific frequencies for non-licensed “business use,” and these can likewise be used in emergencies. A complete list of all frequencies assigned for business use, and their wattage limits, is found in federal code “47 CFR 90.35.” Or try this simpler resource:

https://wiki.radioreference.com/index.php/Common_Itinerant_and_Business

Note: “Itinerant” means you only operate a given frequency at varying locations and for unspecified periods of time.

These VHF options are conducive for longer distances and tend to be less trafficked. Through a combination of favorable geography, maximum wattage permitted, and improved antennas, communications can exceed 20 miles, with a few miles as typical.

The FCC also designated several frequencies in the UHF range called the “Family Radio Service” (FRS). You’ve probably seen common FRS two-way radios referred to as “walkie talkies.” The FCC limited FRS to only half a watt of transmitting power, making it less effective. Because it is inexpensive, unlicensed, and simple to use, FRS has become commonplace for casual users, meaning you’re more likely to be interrupted.

Popular radios like many Baofeng UV-5R models can be programmed to transmit using MURS, “business use,” and also FRS frequencies. Most Baofeng radios can also be set to transmit at lower wattage to comply with FCC wattage regulations for MURS and “business use” frequencies (though not low enough for the half-watt maximum required to use FRS in non-emergency situations).

Note: “Citizen Band” (CB) also has potential, but we view it as less effective and reliable for most situations.

Licensed Options

Operating by line-of-sight has obvious limitations. Mountain ranges become a problem, for example. VHF signals struggle through buildings and concrete, while UHF signals struggle over longer distances.

Traditional government and private “ham” band repeaters placed on higher elevations can serve a purpose, to include connecting radio users on opposite sides of mountain ranges. If you can reach a repeater with your transmission, it essentially takes your signal, amplifies it, and transmits it out again. Unless responding to an emergency in progress, however, a ham license is required to *transmit* a signal to a repeater.

Private General Mobile Radio Service (GMRS, in the UHF range) repeaters can also be set up for those who have the funds and a strategic (i.e. high and unimpeded) site to place them. This requires a more dedicated power source. It also requires a GMRS license, which costs \$35 for 10 years. No test is required and a single GMRS license covers you and your immediate family. A GMRS license also allows you to transmit on several GMRS frequencies at higher wattage than FRS. This page walks you through purchasing a GMRS license:

<https://www.notarubicon.com/how-to-get-a-gmrs-license-easy-guide-to-gmrs-licensing-on-the-fcc-website/>

Keep in mind that while repeaters can be useful, they can be disrupted by disasters, prolonged power outages, and malevolent parties. Relying solely on them may therefore be insufficient.

High Frequency (HF, often referred to as “shortwave radio”) can play a useful role in connecting communities. These signals bounce off the atmosphere and can also overcome geographic obstacles like mountains if the conditions are right. HF requires a larger commitment in the form of equipment, training and experience to obtain proficiency, and a more technical test for government licensure.

Here are a few basic lists and explanations for more information on different radio waves:

<https://www.dummies.com/programming/ham-radio/basics-of-radio-waves/>

Selecting Equipment & Tutorials

Most people start with something like the aforementioned Baofeng UV-5R, because it is affordable, not too complicated, relatively easy to program on your computer (we like the free app “CHIRP”), and a lay person can use it adequately with a couple minutes of instruction. These radios can transmit in VHF and UHF frequencies discussed above.

The Baofeng UV-5R can be found on eBay or Amazon for around \$35. Even if you plan on purchasing other, more expensive radios, a few of these are handy to share with others and keep as backups.

When purchasing radios, look for sellers with decent track records. Baofeng UV-5Rs can be purchased with additional power (max output of 8 watts versus 5 watts), accessories like a cigarette charger for your vehicle, better/more batteries, a programming cable (recommended), etc.

Radios should ideally receive ("RX") and transmit ("TX") in the 137-174 VHF frequency range, and should definitely include the MURS and "business" frequencies range (about 150-160). For UHF applications, they should also receive and transmit in the 400-520 frequency range (where most repeaters operate). Check the product specifications before you purchase.

Disclaimer: The following resources are examples only. We are not affiliated with them.

Here is an eBay seller for the 5-watt Baofeng UV-5R radio:

<https://www.ebay.com/itm/194163584685>

This seller offers an 8-watt Baofeng UV-5R radio, but note that lead times are longer as they are coming from China:

<https://www.ebay.com/itm/393355037395>

To program your radios, rather than risk problematic programming cables that can't automatically detect and download drivers, consider the following:

https://www.amazon.com/dp/B00HUB0ONK/?ref=idea_lv_dp

Many utilize the CHIRP application to program their Baofeng radios. See

<https://chirp.danplanet.com/projects/chirp/wiki/Download>

Here are larger batteries that should last longer than the smaller ones:

<https://www.ebay.com/itm/274309147027>

Your car battery is also a great way to recharge your radio. Most cars now feature a standard plug, but a special car charger can be handy:

<https://www.ebay.com/itm/304041643101>

Here is a beginner tutorial on using your UV-5R:

<https://www.youtube.com/watch?v=0wCLbiHvsMg>

Here is a 39-second tutorial on how to adjust the Baofeng squelch, which often needs to be lowered/adjusted (normally set at 1):

<https://m.youtube.com/watch?v=1ZxErIqdj30>

Here is a tutorial on other Baofeng settings that may be useful:

<https://m.youtube.com/watch?v=9PERVtaiH8>

If you already have a Baofeng handheld radio, but it does not transmit in the frequencies recommended above, note that they can sometimes be reset to factory settings and thereafter work just fine. To find out, turn off your radio, press the PTT, MON, and VFO/MR buttons at the same time, and turn the radio on. See the following video for more information:

<https://www.youtube.com/watch?v=2sg3RJf1ZEA>

As another experiment, we purchased a couple 8-watt Baofeng UV-5R radios that specifically did NOT transmit in the frequencies recommend above:

<https://www.ebay.com/itm/314181680239>

We performed a “factory reset” on them and they now transmit in those frequencies. No guarantees, but our experiment turned out to be a bargain.

In most cases, the most significant way to increase the range of reception and transmission is to improve your position. This means getting your radio to higher ground and clear of surrounding structures and terrain.

Sometimes improving the antenna quality is helpful, however we’ve found only marginal improvements (at best) with most Baofeng handhelds. We’ve also learned that antennas that are “too good” can essentially overwhelm the receivers in these Baofengs, and render them incapable of receiving any signal at all. You’ll have to test it yourself. We’re attempting to create an inexpensive directional antenna that does NOT overwhelm these radios.

After basic handheld equipment is acquired and tested, other improvements can be considered, such as more rugged handhelds that work well with a variety of antennas, base stations, magnetic mounted antennas (“mag mount”) for vehicles, stationary antennas mounted to your home and/or business, private GMRS repeaters (discussed previously), and means of recharging/operating your radios without conventional power.

Guidelines for Emergencies

Most people who purchase radios fail to program them with useful frequencies. They put them in a closet or bag somewhere and forget about them. In a real emergency, you may as well hold a rock to your ear.

In order for information to be effectively dispersed in an emergency, everyone involved needs to:

- (1) Possess basic, programmed radios,
- (2) Know others who have radios, and
- (3) Be familiar with which channels to go to and what protocols to follow.

On this last point, people can't afford to surf channels at all hours of the day and night — hoping to connect with someone. Your network should establish clear guidelines everyone can reasonably follow under stress. They should know what frequencies to listen to, when to listen, who to listen for, what kind of information they should (and should not) share, etc.

Military communicators utilize the acronym PACE, which stands for Primary, Alternate, Contingency, and Emergency. If the Primary frequency you plan to communicate with is blocked, too heavily trafficked, or otherwise unavailable, move to your Contingency frequency, and so on.

Importance of Practice

Once guidelines are established, test them at least once per month. Everyone you wish to communicate with should become, and remain, competent operators. Work out all the problems you can while things are *relatively* calm and equipment and expertise are available.

Periodic tests are useful to:

- (1) Become familiar with the potential and limitations of your equipment in various circumstances. We've learned a lot by trying different antennas and positions in, and out, of our homes and vehicles. Geography, weather, buildings, and other factors can make a significant difference.
- (2) Determine how well you can connect with others in different areas around you. Encourage participants to share the city they are transmitting from, or, if on the move, a more precise location. For personal security, however, we recommend NOT sharing home or work addresses over the air.
- (3) Learn how to practically improve for future tests and potential emergencies. When a real emergency happens, it is too late to work through critical details that can make, or break, an important connection.

When testing, it is important to:

- (1) Announce yourself and call for a "radio check" when you first come online so others know you're present.
- (2) Use the term "Over" at the end of your transmission, so everyone knows when they can talk. This helps people avoid talking over each other, as that creates static interference.
- (3) Keep discussion professional and centered on testing. After the formal test is done, people can relax and play around (which also constitutes useful practice).

Glossary of Acronyms:

FCC: Federal Communications Commission.

Frequency: Numeric measurement of how often a radio wave oscillates or cycles (goes up and down). Its numeric value is followed by the unit of measurement, such as "146.700 MHz" (Megahertz), "600 kHz" (Kilohertz), or "5 Hz" (Hertz).

FRS: Family Radio Service frequencies in the UHF range.

GMRS: General Mobile Radio Service frequencies in the UHF range.

Ham: Amateur radio.

HF: High Frequency signals (operators in this range often refer to it as "shortwave radio").

MURS: Multi-Use Radio Service frequencies in the VHF range.

VHF: Very High Frequency signals.

UHF: Ultra High Frequency signals.