

Radio Communications

The use of mobile radio communications has a long standing history within the humanitarian response community, and is still widely used today. There are currently a wide variety of mobile communications devices available to humanitarian responders, however not too long ago radio communication was basically the only way to maintain continuous communication with a distributed network of humanitarian actors.

As radio networks are essentially completely self-maintained by humanitarian agencies, they are still in real terms the fail-safe within a communications network; state or military actors may shut off or disable commercial communications networks, but radios will work as long as the humanitarian agency keeps their radio networks active and well maintained.

Technical Concerns with Radio Communications

National Regulations

The use of radio communications to support humanitarian operations is generally considered an acceptable and legal practice in most countries of operation, however there are a few countries where radio communication may be banned or heavily constrained. Even if the use of radio communications is considered legal, there will almost certainly be a national registration process where owners and operators of radio networks will need to apply for and obtain licenses for lawful use.

The predominant reason that national authorities may wish to track and regulate radio communications is to protect the usefulness and functionality of already used radio frequencies, while deconflicting future use of frequencies. In most countries where humanitarians operate, some form of radio communications is already in use by national and state actors, including police, military, and emergency first responders.

To manage this process, national authorities usually have a pre-allocated frequency range that non state actors such as humanitarian organisations can communicate using. As part of a registration and licensing process, national or local authorities may also allocate specific frequencies to each requesting organisation, so any activities associated with that frequency can be linked directly to the licensed body. Any humanitarian agency granted a specific license will be expected and obligated to utilise the frequencies provided, and will either need to program their own radios or find a means to have those radios programmed.

Constraints of Radio Communications

Distances – Depending on the type of radio, the size of the antenna and the energy source behind the radio, radios may only be able to communicate up to a few kilometres. In urban environments or places with dense vegetation, hills or canyons, this distance may be even less. Agencies or personnel utilising radio communications should have an understanding of the capabilities of the devices they are utilising, and ideally the IT, security and logistics personnel of a humanitarian organisation should have a sense of what geographic areas might be supported by the type of equipment in use.

Dead Spots – Even in areas of overlapping radio coverage, there may still be dead spots, brought on by structures, hills, vehicles, or other materials that might block radio signals. When conducting operations, personnel should be aware of that dead spots may occur, and may need to periodically conduct a radio check to determine if radio is still usable in a specific stationary location.

Interference – Radio signals can and will interact with other electronic equipment. Household appliances such as microwave ovens or other equipment using radio waves such as traditional broadcast TV might impact or impair radio operation. Objects with large electrical charges also produce electromagnetic fields that might impact radios as well – telephone power lines, large transformer boxes, and even large generators may affect a signal. Avoid installing or using radio equipment under or near power lines or radio towers used by other companies or agencies.

Components

Mobile Radio Unit

Mobile Radio/handset units "transceivers" – radio equipment that can both send and receive a signal. Some radio units are completely self-contained and come with batteries to power the device for several hours or a full day, while others require external power sources, like those mounted to vehicles. Additionally radios can be defined as mobile – radios that travel around with persons or vehicles, or as stationary – radios that are permanently connected to a ground station.

Handheld Radio

Vehicle Mounted Radio

Point to Point – when a radio units communicate with each other directly without a base station or a repeater between them, they are conducting point to point communication. Depending on the type of radio and the frequency used, point to point communication may be very limited. Most handheld radios that run off of batteries don't have the energy output or large enough antennas to push signals very far, and will be limited to hundreds of meters of point to point communication.

Networked/Relayed Communication – When two radio units communicate using at least one intermediary device, such as a base station, that communication is not point to point, and can be called a networked or relayed connection.

Antenna

Antennas are what physically enables the radio to capture radio waves and conduct the signal into the unit. The shape, size and overall construction of the antenna is determined by the type of radio, including the width, length, orientation and composition materials. Antennas are essential for the communication process, and users should be wary of damage or obstruction to antennas to avoid communication lapses.

Common Antenna Terms:

- **Antenna Gain** - The factor by which input power to the antenna will be multiplied to provide higher output power. Higher output power results in greater broadcast distance and signal strength.
- **Antenna Bandwidth** - The range of frequencies over which antenna operates satisfactorily. The difference between highest and lowest frequency points is referred as antenna bandwidth.

- **Antenna Efficiency** - The ratio of power radiated or power dissipated in the antenna structure to the power input to the antenna. Higher antenna efficiency means more power is radiated into three dimensional space and less is lost within antenna.
- **Antenna Wavelength** - If wavelength is the distance a radio frequency wave travels during one cycle period, the antenna wavelength is the size of the antenna based on the wavelength. The longer the wavelength, the longer the antenna.
- **Antenna Directivity** - It is the ability of the antenna to focus EM waves in particular direction for transmission and reception.

Base Station

Radio base stations are also transceivers, usually installed in a fixed location in an office or living compound. The fundamental programming and etiquette of a radio base station isn't different than mobile radio units, however base stations can have significantly larger antenna arrays, and can supply greater power from the grid or generator to boost the signal to much further distances than mobile radios. The antenna arrays of base stations usually are more complex than mobile or hand held radios, often with two separate antenna structures separated by up to a meter or more – one antenna to receive incoming signals and another to broadcast outgoing signals, segregated so multiple communications do not interfere with each other.

Base station radios can also be configured to function as repeaters – taking a signal coming from one mobile radio unit, and amplifying it/rebroadcasting it so that it can reach a much further distance. Occasionally, specialised radio base stations are designed to accommodate multiple types of radio configurations at once, HF/VHF/UHF and others. These types of multi modal communications base units are highly specialised and typically used by agencies with professional radio and communications experts.

Example of a Base Station

Repeaters/Repeater Networks

Radio Repeaters are devices that can receive a radio signal, and rebroadcast it while at the same time amplifying its signal. In terms of voice communication, this means that a mobile handheld radio working off a radio repeater will be able to stay in continuous communication over longer distances. If two or more mobile radios are working off the same radio repeater, and are programmed to the same channel and frequency, they will be able to maintain direct communication while being far outside of point to point communication range. The requirements for a repeater are similar to a base station, in that a large external antenna array with multiple antennas and an external power source will be required to provide continued communications.

In some instances, governments or agencies may install what is called repeater network – more than one repeater arranged a pre-determined network that can continually share voice and data signals between them. A well-established repeater network can cover a wide area of terrain, however it will also require maintenance. If a repeater is installed in an insecure location, or in a location with intermittent access to power it will no longer serve its core

function and may not be worth the effort or cost.

Simplex vs Duplex

The concepts of simplex and duplex apply to any form of communication, however they are especially important for radio communications.

Simplex

Simplex communication is best described as “one way” radio – a configuration in which voice or data can only be broadcast in one direction. The basic example of a simplex network is a traditional TV or music radio broadcast signal; a primary source broadcasts a signal and a receiver with the appropriate hardware can pick up the reception.

Duplex

Duplex communication is best described as “two way” radio – both ends of the radio transmission can send and receive a signal. Radios used by humanitarian agencies for coordination and security would only really make sense utilising duplex communication, and the vast majority of radio communications equipment available on the market is built around duplex communication.

The concept of duplex communication is an oversimplification of how most mobile radios work, however. A true duplex configuration requires two more independent antennas, each broadcasting on a slightly different frequency so that signals can be broadcast and received simultaneously. Simultaneous broadcasts would in effect allow users to both talk and hear voice commands at the same time, not too dissimilar to modern phones.

Most mobile radios however frequently do not possess the ability to both send and receive a signal at the same time. There are multiple reasons for this, but fundamentally duplex mobile radios would be bulky and expensive and the trade-off includes using what is sometimes referred to as **half duplex**. In half duplex, a single antenna is used to both send and receive a signal, and users utilise “push to talk” communication. When the user of a mobile radio unit is depressing the talk button, they cannot hear incoming signal, and vice versa. Though a base station may be able to manage and interpret multiple signals, users in the field on a mobile unit will not. It is important that users understand this – if they depress the button continuously they may miss important messages.

Operating Security

There are a variety of security constraints pertaining directly to radio usage in humanitarian contexts. Radios are widely available and used throughout the world, and humanitarian actors may be utilising radios alongside police, military and non-state armed actors.

Unencrypted Signals

The majority of radio communications used by humanitarian actors operate on open frequencies, and are not encrypted. An unencrypted signal means that anyone on the same frequency can listen and hear all communications. Many governments may require agencies to not use encrypted signals simply because they too wish to monitor activities of humanitarian agencies. National legislation may also limit the types of data that can be transmitted over radio, such as data. Even if an organisation is using a fully encrypted radio signal, if a radio is lost or stolen by a bad-faith actor they may still be able to eaves drop on radio communications.

Some radio networks are highly advanced, and allow users to call each other directly through a numerical dialling system, similar to a telephone. In instances where users may reach each other directly, it is advised to carry out as much communication directly as possible. The majority of radio networks operate on a “broadcast all” system however, meaning anything said into one radio unit can be heard across all units within reception and listening range.

Agencies using mobile radio for voice communication should always operate as if someone else is listening in on communications.

- Users should communicate only using calls signs – referring to themselves or each other by each persons assigned call sign. The list of call signs can be generated based on organisational structure or the local security personnel.
- Users should avoid talking about money, high value shipments, sensitive personnel issues, or anything else that might attract violence or theft. If certain key issues must be discussed over the radio, users should utilise pre-defined and mutually agreed upon code words or phrases.
- Users should establish common codes for identifying vehicles, geographic locations or buildings. Use of these codes will help speed up communication or remove ambiguity, but also make it harder for listeners to know exactly who is where.
- If at any time a radio is lost or unaccounted for, it should be reported immediately to the respective security focal point.

Radio Checks

The act of intentionally calling from one radio to another to ensure proper connectivity is known as a “radio check.” The need and frequency of radio checks depend on the security constraints of the organisation and the operating contexts. In any context, it is advisable to conduct regular checks to ensure operational continuity. Unlike modern mobile phones, many radios generally cannot identify signal strength, and users may not know if they are within communication range or not.

- **Routine checks** – organisations may wish to conduct routine radio checks, including daily, weekly or monthly, depending on the security needs of the site. The routine checks might include a base station calling every single radio user separately by call sign, and asking the radio user to respond. Radio users should be advised of the radio check schedule, and their adherence to the schedule should be recorded. Any radio user that does not check in may be a sign of a faulty radio, or lack of understanding of the system.
- **Movement Checks** – Agencies may also wish to establish routine checks dedicated to the movement of vehicles. Depending on the security context, vehicles may be required to check in at pre-set intervals – usually every 1-2 hours – to provide status and location. This ensures that the base knows where the vehicle is, and that the vehicle is still within radio range to avoid possible gaps in coverage in case of incident.

Dedicated Radio Operators

As part of routine security measures, many humanitarian agencies choose to hire and train full time radio operators. The profile of a radio operator might vary, but the general function is to physically sit near a base station, route messages and conduct radio checks as needed. A dedicated radio operator is usually cross trained in variety of radios and communications devices, and may be expected to operate multiple communications base stations at once.

Radio operators are usually used in larger operations with multiple parties moving between different locations at once. Radio operators also work closely with IT, vehicle fleet and security personnel in the process of tracking movement, flagging emergencies and ensuring proper

communications are functioning at all time.

The duties of a radio operator might include:

- Updating a manual tracking system indicating where vehicles are.
- Conducting daily radio checks.
- Sending out updates or emergency signals.

When conducting daily radio checks, radio operators should have a list of all personnel and call signs, and should keep a running daily tally of who may be in the area and who is responding to radio checks. While conducting routine checks on vehicles in movement, radio operators may be expected to update movement boards or even record movements on a map. The rules and requirements for both routine checks and movement monitoring will depend on the needs of the agency and the security context.

Usage Requirements

Depending on the contexts, users may be required to keep a radio near them and on at all times. To facilitate this, all users should have access to:

- Spare batteries.
- Charging equipment.
- Carrying equipment (cases, clips).
- Maintenance instructions.

Programming of Radio Equipment

The act of programming a radio might include pre-defining:

- Frequencies of operation.
- Communications channels.
- Radio specific IDs for direct calling.
- Password protection.
- Encryption or other special functions.

Not all radios have the same functions, and even different models of radio coming from the same manufacturer might have a different set of functions. As an example, not all radios units will have the ability to establish direct calling links or offer higher levels of security such as encryption – these are usually specified at the time of procurement.

At a bare minimum, radios used by humanitarian agencies should have programmable frequencies and multiple communications channels:

- The **specific frequency** of use is usually defined by state or national authorities, and use of unauthorised frequencies may result in punishment. Different types of radio equipment have a defined spectrum in which they can operate, but within this band there are numerous specific frequencies that multiple parties may use at the same time without interfering with each other.
- The **communications channels** used are usually defined by the humanitarian agency. It is very common to define channels numerically (1, 2, 3...) however some agencies may wish to use specific names such as “calling channel” and “emergency channel” for clarity sake. A properly programmed radio will display the pre-defined channel name on the readout screen, if available. In instances where multiple agencies are using the same network, the channel names/numbers are usually defined by the lead agency controlling the network.

Programming radio equipment can be a very complicated task. Different manufacturers of radio equipment have different proprietary hardware and software packages to enable programming, and there is no one single method of programming all radios.

When agencies are planning a radio communication network they should consider the following:

- Who will be responsible for programming the devices? Does the humanitarian organisation in question have the capacity to program the radios themselves, or will the process need to be outsourced?
- What types of features are required for radios in their radio network?
- What is the plan for servicing equipment or making changes in the future?

Many accredited radio equipment sellers will have the capacity to program radios to the client's specifications for a fee, however the client will need to know all the required information up front. Prior to purchasing radios, humanitarian organisations should investigate what state and local laws are to avoid any restrictions, and should investigate the process for applying for any licenses or waivers utilising open airwaves.

Agencies may also investigate hiring a dedicated radio technician who can install, program and troubleshoot radio networks as needed. Another possibility is speaking with other NGOs or UN agencies to determine who may have spare capacity to support programming, or who may offer services for a small fee.