Tools of the Trade for Supporting Critical Communications of Last Resort

An Operational Practice prepared for SCTE by

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1. Introduction – The Why

The cable broadband industry has had a tremendous expansion of products and services since its initial launch. With each expansion of service, the importance of having a plan to help contend with threats has grown. Technology in general has flourished and impacted societies greatly, and cable has been impacting and often driving a lot of that change. Let's take a moment to review some history.

Cable was born to bring better television experience to communities. Reception was poor down in valleys and technology solved that problem of getting to local programming. Next was the expansion of access to more television content, where content providers leveraged the controlled means of signal delivery to the paying customer in an effort to protect their private programming. The third phase of growth marked the first tipping point of criticality of service offering by the industry – voice service. With the advent of voice service, cable began to expand beyond the world of entertainment and increased the importance of the connection. Calling 911 depends on a reliable voice service, so providers needed to pay closer attention to the target of 100% availability. Legacy copper telco phone service was one of the last things that didn't work during a local subscriber power outage and cable voice subscribers desired the same level of service. The fourth phase of cable evolution is high speed Internet access. With the expansion of e-commerce and migration from physical to "digital everything," subscribers could realize an almost unlimited resource that can reshape everyday lives. Today, we are in the midst of the fifth phase of our industry's expansion and continued rise of criticality of service with the promotion of the 10G Platform. With 10G our subscribers will depend on information and services enabled such as telehealth/telemedicine, home/business security monitoring, e-education and a host of undreamed critical Internet based services.

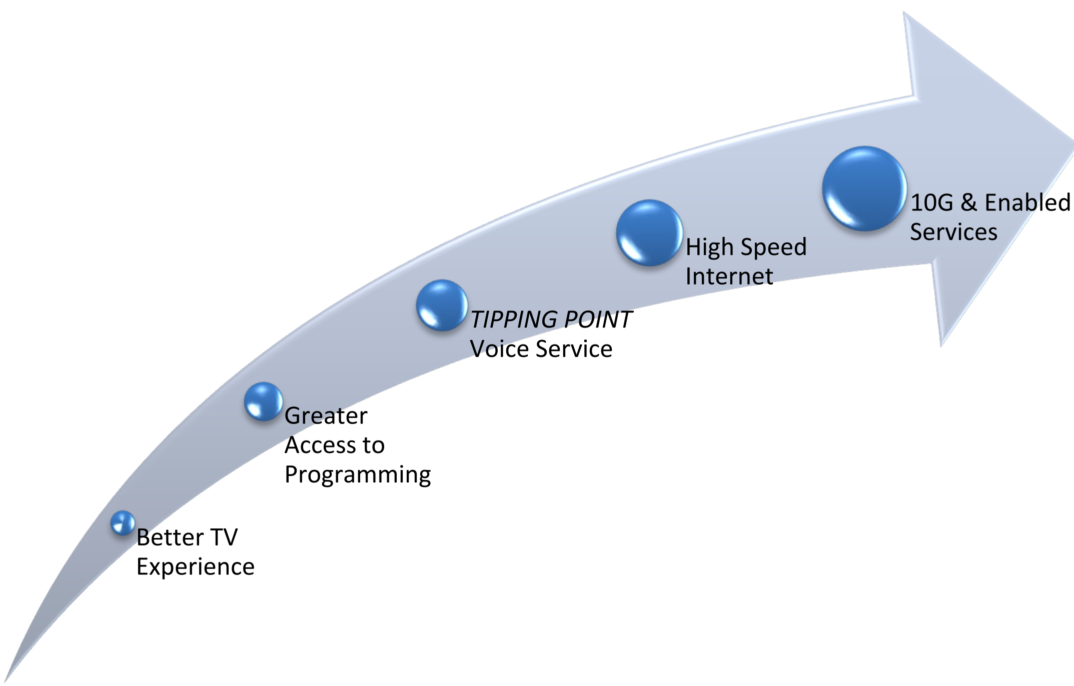

Figure 1 - Cable Industry Importance of Service Milestone Markers

Given this next phase of the cable broadband evolution, let's ask, "What is our game plan when threats to our infrastructure strike?" Natural events, such as earthquakes, hurricanes, fires, floods, winter weather and solar storms; along with manmade threats such as physical attacks, cyberattacks, and electromagnetic

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(EM) attacks posing risk to the electric grid could have cascading effects and leave our critical facilities and networks requiring their own power generation and energy storage capabilities for an extended period of time. We are doing a good job at preparing and deepening our resiliency as an industry, however even the strongest plans can and will be tested by unpreventable natural events. This paper will outline high frequency (HF) radio based resources (in particular SHARES) broadband providers can leverage (with proper upfront planning) when all traditional lines of communications are down and we need to reach out for information and request aid typically in the form of security, access, and fuel.

2. What is SHARES?

The SHAred RESources (SHARES) HF radio United States government program administered by Department of Homeland Security (DHS) provides a means for users with a national security and emergency preparedness mission to communicate when all traditional means of communications are unavailable. SHARES members use existing high frequency radio resources to coordinate and transmit messages needed to perform critical functions, including leadership, safety, maintenance of law and order, finance, and public health. SHARES is available on a 24-hour basis to provide an emergency communications link to support intra or inter-sector mission requirements. The use of SHARES requires no prior coordination or activation to transmit messages. A signed non-disclosure agreement (NDA) submitted to DHS is required to obtain proper call sign and access to net frequencies, the SHARES participation directory, and key SHARES resources.

More than 1,400 HF radio stations—representing 104 federal, state, and industry organizations located in all 50 states, the District of Columbia, and several locations overseas—are resource contributors to the SHARES HF radio program also referred to as the SHARES HF network or net for short. Nearly 500 emergency planning and response personnel participate in SHARES. Approximately 200 HF radio reserved channels are available for use by SHARES members. SCTE is the recognized coordinating registration lead for the cable broadband industry. Cable broadband providers interested in deploying a supporting station can contact me for assistance submitting the necessary paperwork and station planning. There is no associated membership or participation fee to get involved.

Membership in the SHARES program is voluntary. As mentioned, the SHARES network is available on a 24-hour basis and requires no prior coordination or activation to transmit messages. Members consult a SHARES handbook hosted at the SHARES private website to find stations, frequencies and/or automatic link establishment (ALE) addresses of participating organizations they need to communicate/coordinate with. Participating SHARES HF radio stations accept and relay messages until a receiving station is able to deliver the message to the intended recipient.

The SHARES program has three operating levels:

- **Operational Level 3** - No emergency exists. The allocated frequencies may be used for training, the weekly SHARES net, on-the-air testing and configuration of SHARES stations, and exercises.
- **Operational Level 2** – An emergency potential exists. Non-essential on-the-air activities on some or all SHARES net channels may be suspended. The SHARES coordinating network monitoring is increased, and regional coordinators for SHARES (RCS) are contacted and advised of potential US Emergency Support Functions (ESF) #2 activation. SHARES net control stations may maintain watch on designated channels to provide stations with an opportunity to test their equipment, and to receive or relay situational awareness messages.
- **Operational Level 1** – An emergency exists, or the potential for an emergency is enough to warrant net activation.

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The SHARES Program is organized into several regions and Table 1 represents the geographic breakdown of how the states are organized. The organization is aligned with the Federal Emergency Management Agency (FEMA) regions.

Table 1 - SHARES to FEMA Regions Breakdown

SHARES Region	FEMA Region/States & Territories
Northeast	*FEMA: I, II*, III* CT MA ME NH RI VT NJ NY DC DE MD PA VA WV * PR and VI are in FEMA Region II but are in SHARES Region SE
Southeast	*FEMA: IV* AL FL GA KY MS NC SC TN PR V
South	*FEMA:VI* AR LA NM OK TX
Southwest	*FEMA: IX* AZ CA HI NV American Samoa, Guam, Northern Mariana Islands, FM (Federated States of Micronesia (FM) is not a U.S. Territory but receives certain government services from the U.S.)
Northwest	*FEMA: X* AK ID OR WA
North	*FEMA: V, VII, VIII* IL IN MI MN OH WI IA KS MO NE CO MT ND SD UT WY

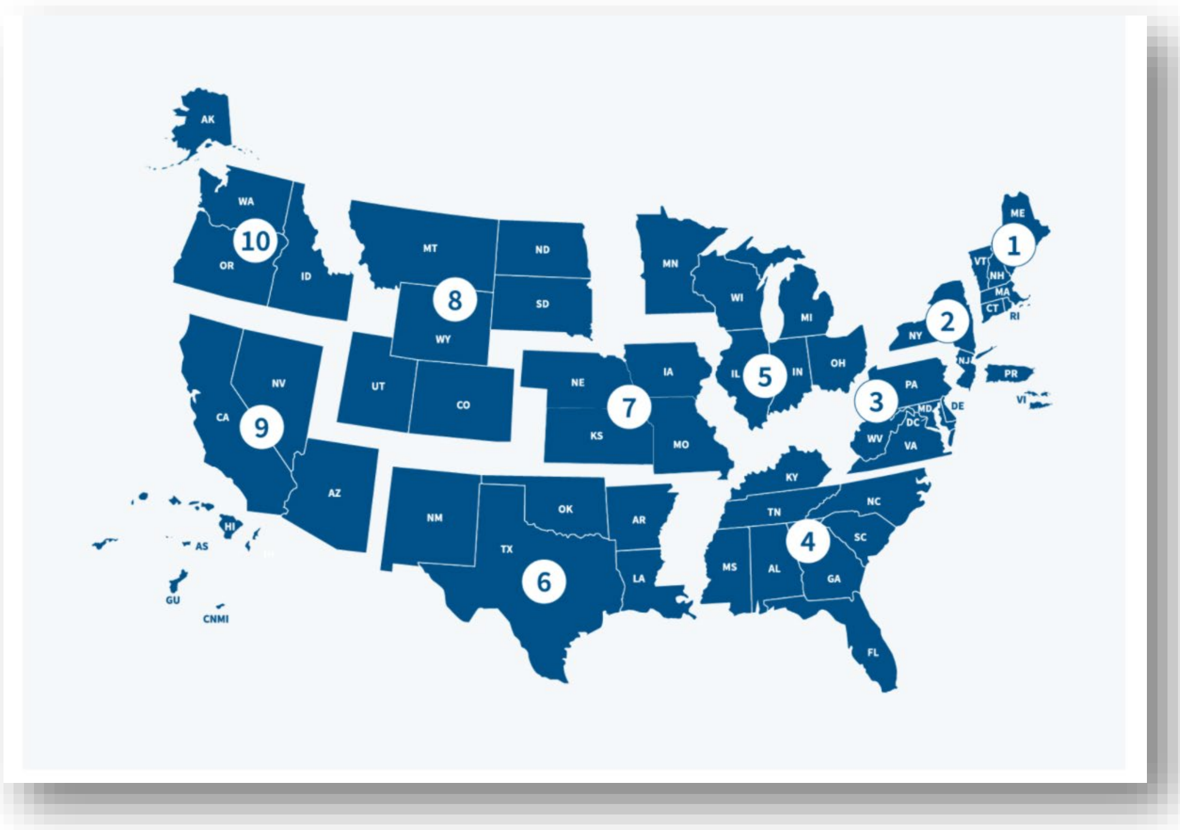

Figure 2 - Federal Emergency Management Agency Ten Regions

Cable broadband providers are present in all ten regions and ideally each operator should evaluate and deploy where they have a need to cover both areas prone to natural disasters as well as zones that could act as critical information relay stations throughout the country.

3. What is HF?

HF operates from 3MHz to 30MHz bands and can be found right above the medium frequency and below very high frequency (VHF) spectrums. Each band has its advantages and use cases. The HF space is used by military, police, emergency services, disaster relief organizations and SHARES. The transmission of communications is called propagation, that is moving of transmissions across the open air. Note there is no physical infrastructure required to carry the message. Up to 1.5 kW single side band (SSB, a form of modulation) and 1 kW carrier wave and data modes can be utilized to get the communication on the net. The national net frequencies often have the capability of transmitting messages coast to coast.

3.1. Propagation Methods

Ground wave propagation takes place when the antenna is configured parallel to the Earth's surface and the range decreases as frequencies increase. The terrain will determine how far the signal will travel. Line-of-sight waves travel point-to-point and are typically found in use for air traffic communications. HF is able to leverage a powerful mode of propagation that takes advantage of the Ionosphere in Earth's atmosphere to refract signals from one point to another. This is called sky wave propagation. Performance using this method will vary by hour of the day, night-day, winter-summer, and allocated frequencies.

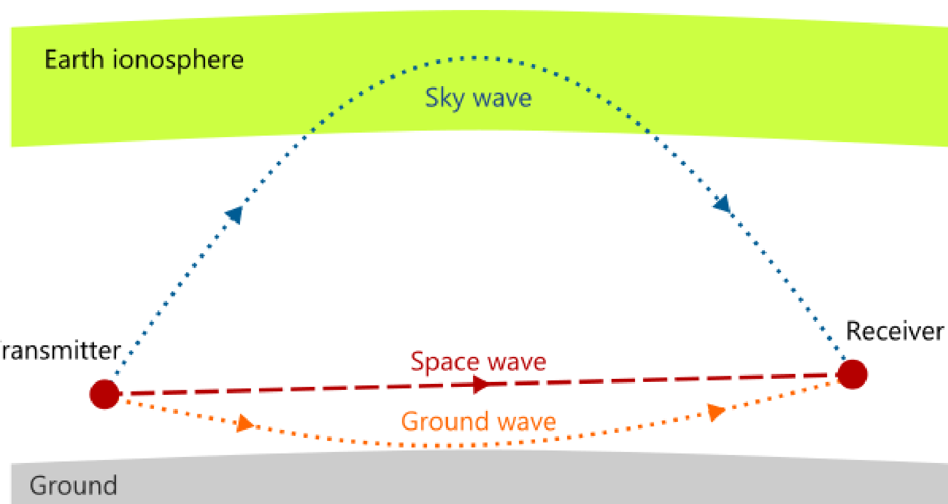

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Figure 3 - Common Modes of Propagation

The Earth's magnetic field can play a role in propagation as well. This phenomenon is witnessed in the aurora borealis (northern lights). Space weather or solar winds impact not only the aurora but HF propagation as well. There is a US government service that tracks the space weather conditions like traditional weather forecasting. The United States Space Weather Prediction Center that is part of National Oceanic and Atmospheric Administration (NOAA), has an email alert service that will provide statistics for planetary A and K indexes. These indexes help station operators get a sense of space weather conditions that could be impacting propagation. It is helpful to subscribe to the service at: https://pss.swpc.noaa.gov/ProductSubscriptionService/RegistrationForm.aspx. The K index is computed every three hours by readings of magnetometers, and conditions tend to be more favorable when K is 3 or lower on a scale of 0-9. The A index is calculated from the previous 8 K index readings and favorable A conditions would be a value of 15 or lower in a recognized range of 0-400. If you like to learn more about space weather, NOAA has released a short video https://www.youtube.com/watch?v=HrloxznL93s.

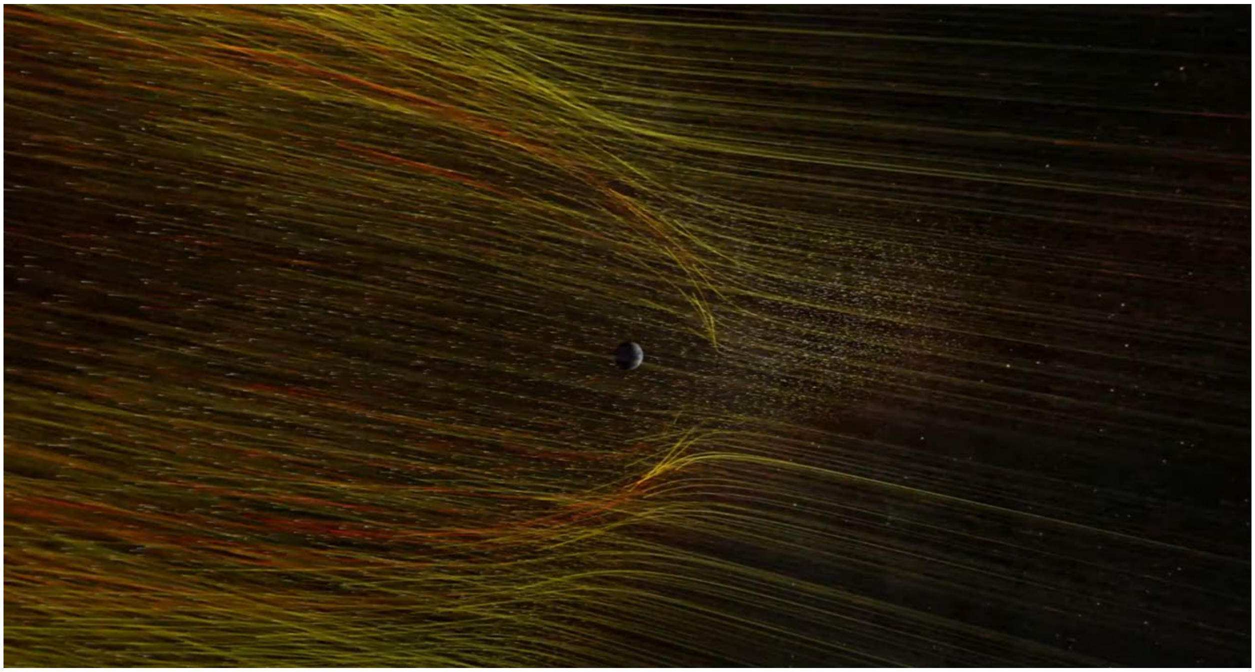

Figure 4 - Space Weather Simulated NOAA Example

When leveraging sky wave propagation, use of an antenna designed for maximizing near vertical incidence sky wave (NVIS used interchangeably with sky wave) will help achieve the receipt of signal. On average NVIS propagation can cover distances between 30-400 miles. The angle of the antenna in comparison to the sky will affect how close/far the signal will return to the earth. It is possible to “bounce” the signal up and down however, strength of signal will diminish with each hop. NVIS frequencies for SHARES will be found between 3 and 12MHz. It is important to note that there is an area between ground wave propagation and the HF hop called the skip zone. In this area, there could be no HF signal received. Alternate means of radio communication could be used to fill in these “HF dead zones.” Ionosphere HF conditional monitoring can be found at https://www.sws.bom.gov.au/HF_Systems/6/5.

4. Station Operator Needs

One of the most essential pieces of the SHARES radio station is the operator. Proper planning for the human factor cannot be overlooked or under-planned. This planning begins at home. Before you depart to tend to station needs during times of activation, be sure to have your home plan in order. If you are unable to dedicate focus on your safety and mission of relaying message during incident because your thoughts are trying to react to needs at home then there may be gaps in your own home care planning. Proper home planning is beyond the scope of this paper but is important and worth the mention. Please have a home plan in place to provide peace of mind.

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For station deployment needs, simple everyday items should be included in a key assets bag. A search online search for "emergency survival bag/kit –with 72 hours of disaster preparedness" can provide many pre-built options. Suggested items in such a kit can include:

- hammer/mallet
- gloves
- masks
- nylon rope
- bottles of water/water filtering device
- first aid kit
- shade/rain canopy
- rechargeable weather radio
- three days of food and water/water purification system
- sunglasses/safety glasses
- sleeping support needs (bag, tent, etc.)
- personal hygiene support items such as toothbrush/paste, TP, extra socks, undergarments, and showerless cleaning towels
- chair
- small table if possible
- pen and pad of paper
- LED flashlight or evening lighting/battery powered lantern
- waterproof storage bag
- insect repellent
- duct tape and/or electrical tape

5. Station Hardware

As the SHARES Program implies, it depends on access to appropriate hardware to transmit and receive HF signals. Stations generally consist of the person operating the hardware, the HF/RF unit itself and the supporting antenna. When selecting the necessary hardware, it is important to consider the use case and location the station will be deployed. For example, an urban major city with skyscrapers will limit the amount of physical space an antenna can be erected. Please examine the location before making the antenna selection. SCTE has secured both fixed and portable versions of SHARES station equipment to allow for optimum flexibility of deployment. Also, when matching antenna to RF until capability, be sure to analyze the output power of the transmitting equipment to what the highest power capacity of the antenna is rated for. The SCTE equipment can produce transmissions as great at 125 watts; therefore, our antennas should be able to transmit signals output power of at least 125 watts.

5.1. Radio

When selecting a radio for SHARES one should ensure the feature set matches capabilities of other key stations on the network. For example, the ability to store frequencies (software defined radios) in a list format and rapidly change from one frequency to another can save a lot of time and limit frustration especially during challenging times like net activation. Other commonly deployed station qualities include rugged construction (not necessarily military grade but approaching that quality of construction). During activation, having well built equipment will relieve some anxiety about station reliability and allow the operator to perform the key task of relaying information.

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Another consideration when choosing an HF radio is how easily can the radio be changed without needing to replace the entire device. Typically, this is accomplished via a software defined method and many of the higher end devices support the ability to manipulate the handset appearance, what features are restricted/enabled, and many more operating functions. A good practice would include a plan to purchase this equipment once and anticipate having this gear in service for many years (unlike laptops or cell phones). Finally, a built-in standing wave ratio (SWR) meter is very handy to help troubleshoot antenna issues to help optimize power throughput to the system. Standing wave ratio meters help determine how much of the RF unit's output power actually gets transmitted, and the optimum meter ratio is 1:1. A solid target of 1:3 or less is optimal. If the ratio is much higher, antenna adjustments are needed such as adjusting the mast height, ends of antenna height or distance of feedline run.

Figure 5 - SCTE Portable Radio and Power Supply

Assembling the radio should be practiced and familiarized by the station operator. A common setup will have: copper ground wire connected to the ground screw, HF 50 Ohm antenna feeder coax cable, power supply, handset connector cable and audio out like a small speaker or headphone connection. Make sure the surrounding area is clean and without obstruction of airflow. Also leave room for a pad of paper and pen to capture notes. Remember, the area may be lacking good light and air conditioning due to the situation that warrants the operator being at the station. If there is notice that wind-based storm could be the cause of the deployment do not deploy the equipment until after the storm has subsided. If the antenna (in particular) is exposed to the elements during storm conditions, it could be subject to serious damage or even blown away.

5.2. Antenna

The SHARES program has many frequencies allocated for use by authorized licensed participants. Versatile antenna systems should be secured to allow for transmission across many of the confidential frequencies. Some antennas are deployed and configured to transmit optimally on a particular frequency. That approach is good for the national net that will leverage one or two frequencies. However, to have the greatest flexibility and readiness to deal with the unknown of the deployment as well as propagation

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conditions, it is recommended to select an antenna system that is either tunable or broadband in nature. Tunable antennas can match the maximum output power to the frequency the radio is set to transmit on.

A broadband antenna is very flexible. Usually this is a terminated folded dipole (TFD or T2FD). These are available in many lengths and while all will work, length determines the lowest effective frequency supported by the antenna. Typical TFD lengths can be 60, 90 or even 120 feet long. For NVIS communications the TFD should be mounted in an "inverted V" configuration with the center apex up about 5-10m with the ends sloping downward to a height of about 2-3m from the ground. Precise height values and shape are not critical, often deploying the emergency station will present unique installation opportunities and antenna manufacturers will also offer installation recommendations. The antenna is connected to the transceiver using coaxial cable. A high-quality double-shielded 50 Ohm cable such as RG-214 or LMR-400 is recommended. Up-front planning is essential to ensuring readiness in time of true need.

Figure 6 - SCTE Portable Broadband Antenna and Mast Kit

One item to note, HF communications is subject to propagation condition changes that are impacted by time of day, sun activity, time of year and station location. Propagation is probably the biggest wildcard in the art of emergency HF communications. SHARES leverage many HF channels to help offer various opportunity to find a frequency where propagation is less of an interference factor. As mentioned above, online solar index resources such as the United States Weather Prediction Center

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(https://www.swpc.noaa.gov/products/planetary-k-index) offers reports of geomagnetic conditions that can impact station experience. Another notable resource to have programmed in the radio is the United States National Institute of Standards 5MHz 10MHz 15MHz and 20MHz channels. This service will help give station operators a sense of how that range of frequencies are performing at that time. The government service announces the time along with other important information such as Atlantic high seas warnings at 8 and 9 minutes after the hour, and a Pacific high seas warning is broadcast at 10 minutes after the hour.

6. Station Powering Considerations

As mentioned in the introduction, power is essential to the services we provide. Looking at the current state of the utility grid here in the US, as our importance of service to our subscribers increases so shall the level of preparedness be adjusted to match that expectation. The good news is that deepening our power resiliency for our last lines of communication does not need to drain capital budgets. Looking at flexible, renewable, portable, power stations to support an "off grid" mentality to our last line of communications is commercially viable at the time of this publication. A search for 2000kWh with peak power output of 4000W would provide a good reference point to power the station for several days with moderate use. Some of the newer portable power stations can incorporate multi-modes of charging to include solar, traditional AC and even DC from automobiles.

By way of reference, Cybersecurity and Infrastructure Security Agency (CISA) has released recommended guidelines for critical communication infrastructure. This can be found at: https://www.cisa.gov/sites/default/files/publications/Factsheet%20Resilient%20Power%20Best%20Practices.pdf. As suggested, there are various levels of power preparedness that are recommended when removing risks for vital communications. This breakdown provides different levels of backup to grid power that can be considered:

- **Level 1**– Least-cost best practices that provide a commercially reasonable chance of maintaining power for at least **three days/72 hours** under all-hazard conditions (for example, three days of fuel is stored onsite to maintain critical loads).
- **Level 2**– Provides a best-efforts approach to maintain power for at least **seven days** under all hazards.
- **Level 3**– Generally covers the most critical infrastructure where power should be sustained under all-hazard conditions for a minimum of **30 days**.
- **Level 4**– Typically limited to the most critical military/federal/National Essential Functions communications infrastructure where power should be sustained with no unplanned downtime under all hazards in **excess of 30 days**.

Ultimately it will be up to each of the broadband providers to determine what level of readiness each station should adhere to. History has demonstrated that having 72 hours of standby off grid power is a good model.

7. SHARES Station Setup

Pre-planning for this all-important asset is vital. Identifying who in the employee pool will be authorized (both at the company level and SHARES NDA level) and familiar with the equipment before deployment is critical. It is important to plan for both a fixed and portable station to help ready your organization for the disaster that warrants the activation of the SHARES network. Flexibility of the portable kit enables the operator to move the asset into and out of areas of need. Having a lightweight mast, antenna, hardened radio, and power source will provide the reliable equipment in time of need. Practicing setting

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up and properly packing up the station during non-activation days will provide the operator skills necessary to deal with the stresses of getting vital information in and out of areas impacted by incident. A permanent station located at a mission critical building that already has plans for continuity can extend its value during disruptions. The roof can serve as a good permanent deployment location for an antenna and proper site survey is advised prior to selecting an antenna. Be sure to secure the station equipment as you would any valuable network asset.

Turning to the portable deployment needs, procedure wise, setting up the station in a logical manner can help ensure quick readiness to get on the air. First, identify available space for the antenna, RF unit and power supply. This will normally be limited to how much length coax feed line that connects the antenna to the RF unit is on hand. Experience has demonstrated that 100' is a practical length of a portable setup. Also, try to select an area where shade is readily available. Being present at the station for long hours and the added impact of the sun could result in additional bodily stress. Having a portable canopy is recommended.

The next steps involve setting up the station and all its components. After the location for the station has been determined, begin to setup the mast, necessary guy wires and antenna. Remember to connect the coax to the antenna before hoisting the antenna. Next connect the coax feedline to the RF unit. This will prevent accidental transmission by the RF unit without a load attached that may result in equipment damage. After the RF unit is connected to the antenna, connect the RF unit to the power supply. Finally, refer to the radio manufacturer's manual/recommendation for proper grounding technique as this will vary from radio to radio. However, typically there is a grounding screw on the back of the power supply that would allow for copper ground wire to be attached to a metal ground rod.

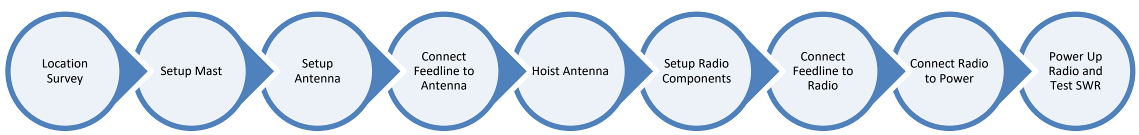

Figure 7 - Simplified Portable Station Deployment Steps

These basic steps should allow an operator to now transmit and receive signals on the SHARES frequencies. If performance is poor, conduct a simple SWR test and adjust the antenna as necessary. Actions could include raising/lowering the center mast or ends of the antenna or confirming a good dry fit of the feed line to the connections on the RF unit and/or antenna. Another opportunity to help improve performance is to run a simple metal cable on the ground under the antenna from one end to the other.

8. Digital Modes

In this section some common modes of digital communications or non-push-to-talk methods of message delivery are discussed.

8.1. HF Email

Email is such a valuable asset. It is hard to imagine conducting business without this method of communication. Disaster communications can leverage Winlink Global Radio Email®. Winlink is an all-volunteer project of the Amateur Radio Safety Foundation, Inc. (ARSFI), a non-profit public benefit corporation with no beneficial owners. Its original purpose (started in 1999) was to provide a very long-

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range radio path for radio amateurs who did not have access to "land-line" communications needed to send and receive email messages. Subsequent uses have been oriented toward providing partial backup of email services for emergency communication service agencies during a local commercial communications outage or communications overload. Transfer speeds and available bandwidth do not allow for complete replacement of traditional Internet based email services but when essential messages need to be relayed reliably, Winlink can get the job done.

SHARES Winlink HF email system operates on approximately 80 dedicated channels which are not listed in the SHARES channel list or net list. The channels are known to the SHARES Winlink Express software and are updated electronically via Internet on a regular basis (preferred) or over the air (very slow). Winlink needs to be downloaded off the Internet to a viable laptop/desktop in advance, configured and tested. An authorized and registered separate call sign is required for the Winlink station. Like traditional Internet based email, Winlink requires a unique email address that is routable by both the Winlink platform as well as traditional Internet based email. When local Internet access is down, the email client will communicate via a HF modem connected to the computer and HF radio. Mail routing can leverage BOTH traditional SMTP and Winlink delivery methods. The Winlink client is configured to connect to a remote Winlink email gateway where the message can be properly relayed to either another operator on the Winlink network or Internet.

Figure 8 - SCTE HF Enabled Email Station

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During a "worst case scenario" where traditional Internet/email is unavailable, station operators can leverage the radio-only Winlink mode. Messages are transferred to remote message servers (RMS) designated by the recipients as their message pickup stations. Each Winlink user can register up to three message pickup stations for redundancy. Modems specially designed for HF transmission (Pactor for example) are used to establish and route the traffic over the specific frequencies.

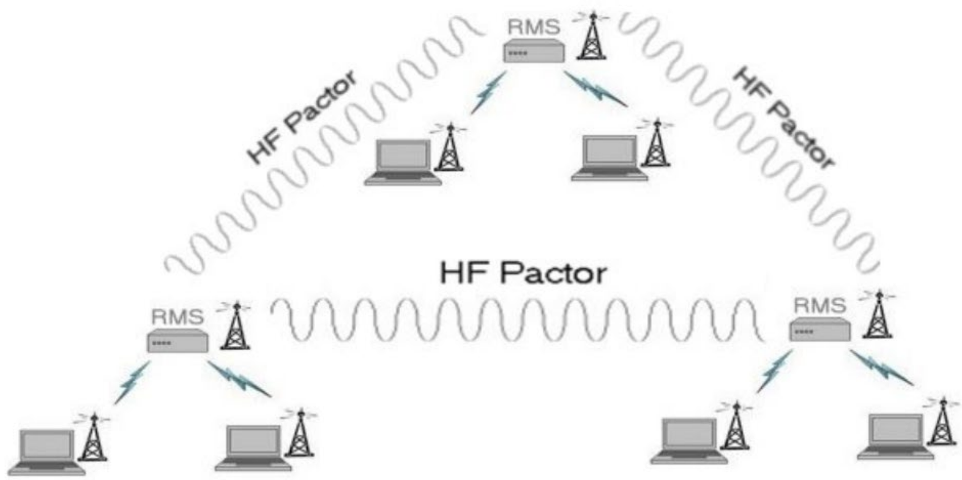

Figure 9 - Winlink HF Email Routing

Note, using this method of moving messages will be slower than what we are accustomed to with highspeed based Internet mail routing. Wherever possible the message should be plain text, simple and to the point as to avoid congesting the remote message servers.

8.2. Automatic Link Establishment

Automatic Link Establishment (ALE) is an automated calling system that brings telephone-like functionality to HF communications. Instead of forcing operators to listen for calls, ALE uses digital signals to indicate that one station wishes to connect/call another. The receiving transceiver then alerts its operator (much like a ringing telephone), who can then accept the call. Once the call is accepted the two stations can use voice communications or switch to a digital mode, e.g. MT63, to transfer data, much like using a modem on a telephone call.

ALE is designated for use on the channels designated "SHARES ALE Net." SHARES stations are encouraged to program these frequencies into their ALE radios. Sounding is a process to determine link quality analysis can be enabled to measure connectivity with other ALE stations. The ALE radio should not exercise its sounding function more than one-hour interval (ninety minutes is the preferred setting for equipment that supports it). ALE address codes and ALE frequencies are provided to licensed SHARES operators when completing their application to the program. The availability of ALE operations may be different from the hours of operation for voice nets. One of the strengths of using ALE is the radio will help optimize the experience/voice performance based on up to the minute propagation conditions.

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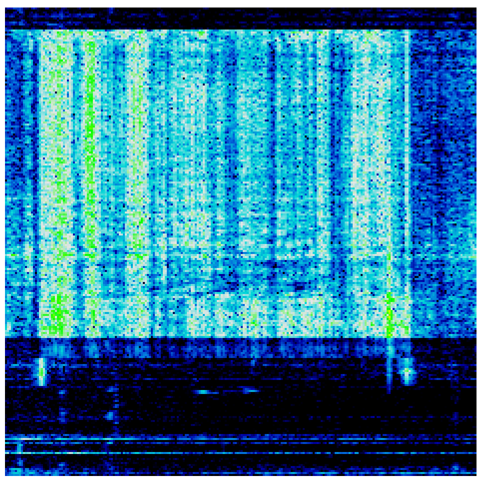
8.3. MT63

During times of poor propagation, station operators and SHARES net controllers can leverage a broadcast technique to help get the important message through. SHARES has standardized on MT63 modulation/demodulation methods for this use case. MT63 is an orthogonal frequency division multiplexed (OFDM) digital data mode aimed for use in high noise environments. MT63 was developed by Paweł Jałocha. MT63 is designed for keyboard-to-keyboard (like text messaging) conversation modes on HF bands. MT63 distributes the encoding of each character over a long time period and over several tones. This code and symbol spreading implementation is key to its robustness under less than ideal conditions. The MT63 mode is very tolerant of mistuning, as most software will handle 120 Hz tuning offsets under normal conditions. MT63 uses 64 binary phase shift keying (BPSK) (2-PSK) channels placed in 500, 1000, and 2000Hz of bandwidth. There are 2 main modes of transmission: short interleaving and long interleaving. With short interleaving, MT63's robustness is somewhat compromised in exchange for lower latency (time to end of transmission). With long interleaving (what SHARES leverages), MT63 operates at its best robustness in exchange for a longer latency (about double the latency of short interleaving). Figure 10 represents the source broadcast visual and the computer converted text.



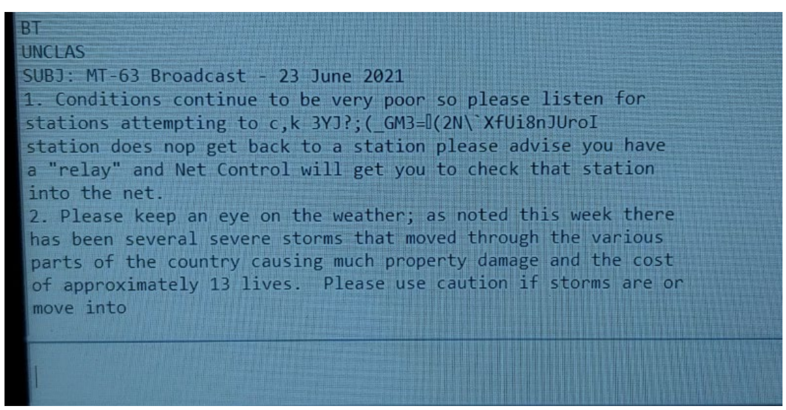


Figure 10 - Visualization of MT63 Transmission

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8.4. Encryption

The SHARES network does permit the use of encryption of messages. Traffic exchanged should be unclassified in nature. The use and access to the encryption software is restricted to SHARES members. Note, if a message is being encrypted, be sure that employees having the authority to permit such a message to the SHARES recipient is approved by senior company employees. Remember, the nature of SHARES is to exchange important information pertinent to the continuation of restoring conditions to business as usual.

9. Voice

The most common mode of communication for SHARES is voice. When operating the station, it is important to remember this service has a mission of safety and vital information exchange so providing the minimal amount of information that is required to get the message across is key. A typical exchange would be:

"This is SHARES CALL SIGN (spelled out phonetically) I repeat SHARES CALL SIGN (no phonetical spelling) in STATE of OPERATION (physical location) with the following priority traffic for the SHARES NET: insert message."

Listening stations will often acknowledge the message and request additional information such as how long you will remain on frequency, status of station power (estimated runtime) and wellbeing of people/operator at the station.

It is important to log any corresponding messages and call signs that are engaged with the exchange of information. Several hours could pass, conditions may change, or additional information could be received that impact an initial touch base with another SHARES operator and it is important to remain in contact with the NET for proper up to the minute information relay.

10. Local Communications

In the area where the HF skip zone is experienced (region under the NVIS propagation where there is very little to weak signal) an alternate supporting means of radio communication is required. This could be a man-pack designed for short distance HF communications (like in the military). This solution would be very tactical in nature supporting the actions of actual restoration processes. Key for this plan is not to depend on towers like in the case of cellular infrastructure as this infrastructure may not be present (why SHARES is being activated).

11. Conclusion

A key provision to having a solid plan for business continuity is to have the necessary tools for addressing the situation ahead of time and not trying to scramble and find the tools needed DURING an incident. SHARES station deployment needs to be planned for ahead of time, coordinated with team members on when to exercise (ideally monthly) the equipment and keep up to date with the SHARES coordinating office to ensure the latest frequencies/information is at hand when and where it is needed.

In summary, here are key components required to get on the SHARES network:

1. ALE ready HF radio

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2. Broadband HF antenna capable of transmitting and receiving on frequencies between 3 MHz and 30 MHz
3. Antenna mast system
4. Proper space and elevation of 10 feet or higher to enable radio signal propagation
5. Necessary coax cabling to connect antenna to radio
6. Reliable power supply compatible with the selected HF radio
7. Backup power in the event primary power fails
8. Laptop computer with digital broadcast demodulation software such as MixW or Fldigi configured to receive MT63 transmissions

Finally, when evaluating the setup of radio stations, consider securing both a fixed and portable solution. The portable solution can be shipped/setup when and where needed. A logical location for a fixed station should be at a hardened facility such as a data center, network operations center (NOC) or other strategic critical facility designed to meet SCTE 226 Class A specifications. This 2021 Cable-Tec Expo paper along with SCTE 206 and SCTE 239 best practices will assist cable broadband providers optimize their readiness of major disasters.

Abbreviations

ALE	automatic link establishment
ARSFI	Amateur Radio Safety Foundation
BPSK	binary phase shift keying
CISA	Cybersecurity and Infrastructure Security Agency
EM	electromagnetic
DHS	Department of Homeland Security
FEMA	Federal Emergency Management Agency
HF	high frequency
kW	kilowatt
LED	light emitting diode
MHz	megahertz
NDA	non-disclosure agreement
NET	network
NOAA	National Oceanic and Atmospheric Administration
NOC	network operation center
NVIS	near vertical incidence sky wave
OFDM	orthogonal frequency division multiplexed
Ohm	ohms
RCS	regional coordinators for SHARES
RF	radio frequency
RMS	remote message server
SCTE	Society of Cable Telecommunications Engineers
SHARES	SHAred RESources
SMTP	simple mail transport protocol
SSB	single side band
SWR	standing wave ratio
TFD (T2FD)	terminated folded dipole
TP	toilet paper

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US	United States
VHF	very high frequency

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CISA Power Best Practices:
https://www.cisa.gov/sites/default/files/publications/Factsheet%20Resilient%20Power%20Best%20Practices.pdf

History of Cable by California Cable & Telecommunications Association:
https://calcable.org/learn/history-of-cable/

A collection of documents and forms related to the SHAred RESources (SHARES) High Frequency (HF) Radio Program: https://www.cisa.gov/publication/shares-documents

WinLink HF Email: https://winlink.org/

Guide for the Selection of Communication Equipment for Emergency First Responders:
https://www.ojp.gov/pdffiles1/nij/191160.pdf

ARRL Resources

Emergency Power for Radio Communications 2012
https://www.arrl.org/shop/Emergency-Power-for-Radio-Communications

Portable Operating for Amateur Radio 2108
http://www.arrl.org/shop/Portable-Operating-for-Amateur-Radio

Seven days of ionospheric conditions as observed by a global network of ionosondes
https://www.sws.bom.gov.au/HF_Systems/6/5

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