

# GHOSTNET OVERVIEW

GhostNet is the overarching term for a collection of communications networks set up to allow users around the world to exchange information without relying on pre-established infrastructure. Far from being just an emergency plan, GhostNet is intended to ease the transition of radio technology into everyday life. Though radio networks cannot truly replace the internet, we hope that we can replace a substantial portion of a person's daily information requirements, and promote a culture of off-grid information sharing.

## Weekly JS8Call Nets on 40m

Once per week (or more often, based on world events), users can gather on JS8Call for a brief chat in a casual atmosphere. JS8 is simple to use, easy to work with, and extremely common among radio hams. Users that are perhaps not as experienced in other HF data modes might find JS8Call to be an easy way to maintain contact. JS8 also serves as a great meeting point in the event of catastrophic communication loss; if a major societal event is occurring, simply hop on JS8 to find out what's going on and to coordinate other communications plans.

## Data Bridges (On Multiple Bands)

In the world of HF radio, everything is a trade-off. The configurations, frequencies, and antennas needed to communicate over long distances are not best suited for local comms, and vice versa. Therefore, to allow users to have the best chance of success with extreme-long range comms, networks have been established to allow links between continents and regions, at the time and frequency that is most effective for each link. Understandably, one weekly net, on only one or two bands is not robust enough to handle substantial message traffic. When we start to consider global partners, and the 24 hours in a day, we realize that a more substantial plan is needed to allow users around the world to communicate. Users in North America can usually only link up with Europeans during certain times of day. Similar situations appear with other long-range links, such as USA/Australia, Mediterranean/South America, Far East/Europe, etc. As such, various comm plans have been established to allow communications to occur between major regions, at the times of day when there is the highest chance of success. In due time, we hope to incorporate major relay stations which can facilitate the movement of traffic 24/7. In this way, a person wishing to communicate with another continent can wait for the data bridge to open at a certain time of day, then use antenna configurations, power levels, frequencies, and data modes that are more suited to long-range communications instead of more local contacts.

## What About My Baofeng?

Unencrypted analog communications are not generally recommended for use in non-permissive environments. Even using brevity codes and other EMCOM procedures, voice recognition, direction finding, and meta-data analysis make analog voice comms a risk on the modern battlefield. However, due to their low cost and extreme popularity, handheld VHF/UHF radios will always have a place in emergency preparedness or for local Line of Sight comms. The GhostNet is not meant to replace local VHF/UHF traffic, which warrants its own comm plan. Rather, GhostNet plans are intended to serve as a more strategic, region-wide communications network using HF transceivers.

## Receive-Only Options (For Decoding RTTY, JS8)

To incorporate those who do not have the ability to transmit radio messages, various networks have been established to allow users to receive crucial information. Radio Teletype, despite being an ancient communication method, is a great tool for transmitting one-way communications, news updates, or other critical information to a wide audience. Those wishing to monitor various JS8Call networks or Data Bridges can also do so with a simple Software Defined Radio (SDR) receiver, a computer/phone, and an appropriate antenna. Understanding that radio communications are difficult, complex, and boring, special emphasis has been placed on creating networks for users who don't want/need to dedicate so much time to radios. In short, we have simple and easy-to-understand networks that users can monitor cheaply and without any technical knowledge at all. And since receiving messages does not require a license (in the US, at least), anyone can listen in. Various tutorials have been created (and are continuing to be made) guiding users step by step through the whole process. The goal for Receive-Only comm networks is to make the process as easy as possible, and incentivize many people to start treating radio as a viable information source, rather than a novelty.

## Ion2G ALE Networks ("Right Now" Comms)

A bit more advanced than JS8, several ALE networks are set up for persistent communication. Automatic Link Establishment protocols are the future of HF radio, and a gold standard for determining the best band/frequency to maintain a comm link. ALE removes the guesswork of which band to choose based on time of day, or other propagation factors. Simply fire up the program, and the software will determine the best frequency for you automatically. This makes comm plans obsolete, and allows for "right now" communications to be possible at any time of day.

# GHOSTNET CONCEPT

Establishing a truly global communications plan is difficult, simply due to the physics of ionospheric propagation. There is no one plan that will allow the globe to communicate at the exact same time; various factors such as time of day, frequency, and scheduling conflicts make this a challenge. Even if a solution can be agreed upon, scheduling conflicts would add in another layer of complexity. Therefore, multiple networks are required. We can get by with two main concepts for communication: Local comms nets, and long-range links with other continents or major population centers. This way, a person can get their gear set up for local information exchange during one comm window, and if so desired can switch their gear and data modes to make contact with extremely long range regions, when band conditions allow for the highest chance of success.

## GhostNet Provides Two Main Paths of Info Exchange

### 40m Networks

For more local communications throughout a region, set up on a schedule that is most convenient for people within that region

Scheduled weekly every Thursday night at times convenient for those working standard business hours.

### Data Bridges

A variety of networks using bands, times, antenna configs, and data modes best for making long range contacts.

Scheduled weekly, every Saturday with time windows to allow for multiple DX contacts.

Most users will likely find great utility in local communications throughout a region. For instance, if an incident were to occur within North America, most people in that region would likely tune in to JS8Call on 40m to obtain more information. This is easy to do with a wide variety of equipment, and can be done even in a comparatively small location. Using a local 40m network, comms can be reliably established even in the worst of times, using minimal gear, and very little power. However, the gear, space, power, and experience needed to make that same network functional around the world is quite a challenge. Different antenna arrangements, and an extensive knowledge of band conditions is usually required to make reliable links with contacts at extremely long ranges. The average radio operator can easily make contact throughout Europe, but making a contact at any time of day from Sweden to Australia is another story entirely. Band conditions alone require very specific parameters to be met to ensure the highest chance of success. Therefore, we need to establish specific times of day, freqs, and antenna configs to make these long range comms reliable.

Though seemingly complex, the plan is quite simple. Need to check in to a local net, or see what's going on throughout your region? Pick up this guide and flip to the card for your local area. Fire up whatever HF transceiver you have (or even just a receiver) and tune in.

Need to send an email around the world? Flip the card over, find the link you want to make, wait until the appropriate Data Bridge comm window opens up, and give it your best shot. This also allows for more complicated relay stations to be set up in the future. For instance, a person in the US might be able to briefly make limited contact with Australia on 80m, but contact might be sketchy or difficult to maintain. To send a full email, they might have to relay longer messages through stations in Africa of the Mediterranean. This comm plan allows for the network to grow and eventually make that a reliable option.

## Leaving Room for Automatic Link Establishment

Ideally, ALE technology would make the concept of Data Bridges irrelevant. Even with enough power, reliable contact can be made at will without waiting for a comm window. These Data Brides are made with the portable operator in mind who might have to rearrange his/her antenna to make long range contacts. With ALE, there is no guesswork to determine which band or time of day is most appropriate for a data link, as the software computes this automatically. This is why ALE is the gold standard for military communications links around the world. However, among radio amateurs, ALE is still in its infancy. Ion2G is the front-runner software package intended to encourage more ALE-based comms in the ham radio world, but the antenna and transceiver requirements make ALE cost prohibitive for most radio operators. However, since ALE is the future, we can still allow for an ALE comm window. ALE is not magic, it simply chooses the best frequency to make a link between two points. At the moment, Ion2G in particular can only really be used for simple text messages, or voice calls. Sending emails must still be done using traditional Winlink P2P methods. This means that ALE can remove the guesswork when it comes to frequency choice, but the time of day must still be chosen by the operator\*, and using different data modes (like RTTY) still requires manual decision making by the radio operator. One must remember that cutting-edge technology (in the ham world anyway), is perhaps not the most reliable in a serious emergency. Therefore, we can allow for the use of Ion2G by creating a specific time window for its use, but we also want to allow for other more manually selected networks to function using the equipment that most people already have.

\*Ion2G is best used by leaving the software to run 24/7. However, this is not the best option for most radio operators as 1- it ties up resources, and 2- the clicking of relays in the radio 24/7 is not appealing to most people. Various work-arounds exist to make Ion2G a viable persistent system, but as this software is still in development trusting it with one's life is not advised unless a highly reliable backup solution is also in place...like a Data Bridge.

# EMERGENCY C2 NODES

In the event of incidents occurring that require more active monitoring or response from average citizens, ad hoc Tactical Operations Centers may be required for monitoring the situation. Command and Control (C2) nodes may also be needed to coordinate the response of community members. In the event the situation becomes untenable, or if breakout operations are necessary, various considerations and equipment choices can ensure that communications can be maintained, even if on the run.

## Communications are a Priority

No Command and Control is possible without communication with other units, groups, or communities. Among a prepared citizenry, which is not likely to be as organized, hierarchical, or disciplined as a formal military unit, communications will be difficult during the best of times. If there is any hope of maintaining even the most basic coordination during a time of crisis, extremely robust plans and standards must be in place. Constant training and practice must be routinely carried out, specifically with communications equipment, to ensure that at a moment's notice, alternative communications plans can instantly put in place, without any loss of capability. Snap drills simulating a widespread cellular/internet outage are great for ensuring skills do not become rusty.

## HF vs VHF/UHF Radios and the Fog of War

Though handheld VHF/UHF radios are far more common, if a C2 Node needs to relocate to ensure safety, or in the worst case, is on the run and being pursued by vastly superior forces, chances are the escapees will quickly be far out of range of Line of Sight communications. In that case, HF radio is really the only feasible option to maintain contact without using preestablished infrastructure. HF radio equipment must be as compact and lightweight as possible, in the event that evasion plans are enacted. Maintaining small QRP (low-power) HF transceivers may not be as powerful as larger 50- 100 watt radios, but smaller rigs are easier to take with you when you break out of encirclement, break contact from an ambush, survive a drone strike, or any number of serious issues. QRP radios allow the possibility of establishing emergency C2 nodes upon rallying locals following an attack. Though usually discarded as being underpowered, a lot can be done with little power using digital modes such as JS8Call, VarAC, Winlink, or any other data modes.

## Waking up in the middle of the night to the distant thumping of artillery rounds is never pleasant.

What do you do? Do you stay put and take cover, or do you enact your escape plan before you become encircled by enemy forces? Who do you need to talk to, or coordinate with? And how will you do this? And how will you communicate with those around the region to share the news, or determine where the front lines are? All of this requires substantial communications planning, equipment, expertise, and dedication even when you don't know what to do. When you are groggily standing in your living room, listening to the war inching closer, it would be preferable to be combat effective, instead of the only option being running for one's life. Having a plan to get comms up, rallying local contacts, beginning an incident response plan, and getting ready for the fight ahead makes you a valuable asset to your community, instead of a noncombatant.

## Setting Expectations

If you are in the middle of a crisis that requires you to relocate for your personal safety, it is unrealistic to expect a professional TOC to be set up, with all the amenities and perfect communications. You may be cold, tired, hungry, and living out of a vehicle...yet still expected to provide critical communications for your community during a crisis. Obviously, the bare minimum communications and battle tracking capabilities are the only feasible options in situations of desperation. If you can get an HF radio up on JS8Call, that might be the best you can do.

Expectations must be tempered in the civilian environment; it is a hard to expect someone to establish communications in extreme circumstances. However, nothing worth having is free...and nothing worth doing comes easy. For a minimum investment, the average person can be vastly more prepared. And for a moderate investment, can be infinitely capable in a changing world.

### Sensors

ADS-B Receiver

SDR

Scanner

HackRF One

### Basic Equipment



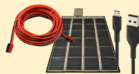
HF Transceiver



Multiband HF Antenna



Windows/Linux Rugged PC



Solar Power and All Necessary Cables

### Data Links

JS8Call

Ion2G ALE

Winlink

RTTY

# GHOSTNET SURVIVABILITY

We all live in strange and uncertain times. What is certain, however, is that accurate information is necessary for survival. Consequently, censorship has become a household term as most citizens around the world become victims of information warfare. This plainly obvious truth, while largely unspoken in the ham radio community, is a fact of life for most of the Earth. Therefore, network survivability must be a priority, but not in the ways that we traditionally think of. Yes, we must prepare for power outages, systems going down, or any number of natural disasters. The ham radio world is well prepared for these contingencies. What tends to get ignored, are the more nefarious communications issues. Repeaters being kinetically targeted. Ham radio club members being arrested. Jamming. And of course, surveillance. These real world events are not fear-mongering, these events have already occurred and are fairly routine around the world. We mustn't dwell on this negativity, but we have to acknowledge that a substantial portion of the ham radio infrastructure is not entirely suited to operate in a contested or non-permissive environment. What good is a radio network if it reports directly to agencies that are targeting it in the first place? And what does this mean for those of us who do wish to operate in a less-than-friendly environment?

**Organization will be haphazard:** No net control or "main" station means that a single airstrike cannot disrupt communications...taking out the leader won't work when there is no one leader. This makes for haphazard and disorganized communications, but it's the best that we can hope for in a situation of desperation.

**Competing Interests Cloud Information Exchange:** It's easy to create echo chambers, and only allow the free speech that a particular group of people agree on. However, if one has the very broad goal of simply allowing others to communicate with each other over long distances, when all other methods of communication are either surveilled or not available, ideology, politics, and personalities will become a problem over time. Everyone is different, and has different ideas of solutions to the world's problems. With no strong, top-down leadership, a system such as this has the potential to descend into cliques, political echo chambers, and general chaos. As HF radio is not super popular right now amongst the general public, these kinds of communications networks tend to attract the more dedicated and altruistic personalities, which is why this is not a large problem for now. Over time, as censorship becomes even more constricting, it becomes ever more important for every user to be the best person they can be, and reflect the goodness they wish to see in the world.

**The Issue of Timing:** One of the first questions we must ask ourselves when responding to any issue is: How much time do we have to work with? Though this idea is a concern with more formalized public-service incident and Rescue organizations, from a more "prepared citizenry" perspective, timing is more important. Unlike public services, which have strict "work the problem until it's solved, escalating assistance to higher levels as needed until mission complete" mindset, the average citizen might have to "break contact" while working an incident if it is determined that not enough time remains to be of any use.

**Complications and the Fog of War:** "No plan survives first contact". This phrase, a common utterance on the battlefield, also most certainly applies to the entire field of communications...especially the communications on the battlefield. Reliable communications in combat, while rarely given credit when things go well...is the most often cited complaint when people get killed. Communications is not alluring to most, but if you don't get it right, your chances of survival are remote. This is why understanding the unique nature of combat is necessary for success; if comms are good, clean, and efficient during peacetime, they might be barely successful during wartime. But if comms are nonexistent during the best of times, it will be impossible to establish comms during the worst of times. Communications in war is often times utter chaos; an adventure of utter madness, with no one knowing what's going on until the combat situation has reached a conclusion. Thus, we must often times choose the communications methods that are not the best, or even the most efficient...but rather the comms methods that are functional, rugged, reliable, repeatable, and accessible by the lowest common denominator. However, despite the assertions that "simple is best", a certain level of complexity is required in order to ensure that all the bases are covered, and as many situations as possible are planned for.

## A Plan Comes Together

All of this means that there is no one single communications method... each communications choice can compliment each other method. 20m HF transmissions can be used for extreme-long-range comms, with 40m filling regional comms requirements, and VHF/UHF comms can handle close range messaging needs. There are other options, such as Automatic Link Establishment programs, which are vastly more capable (and automated). But remember: Communications, much like training, defaults to the lowest common denominator. If you have a high speed HF ALE data-link setup, but the person you need to talk to has a Baofeng, your communications efforts will be in vain. Everything is a balance...a balance of what everyone on the net is capable of, all being influenced by the unpredictable and confusing nature of the Fog of War.

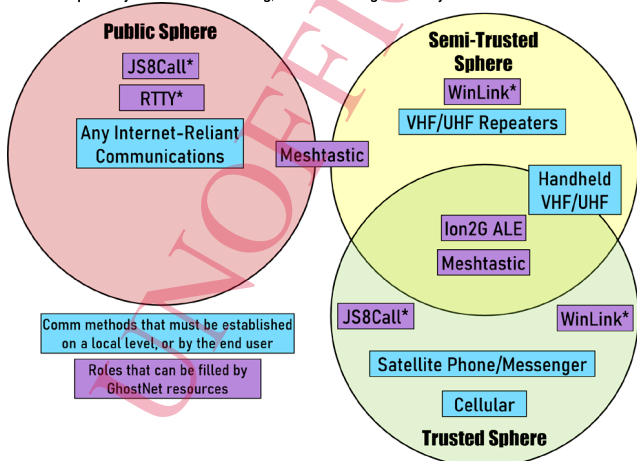
# ARCHITECTURE OF PRIVACY

Operational Security (OPSEC) is of great concern to those wishing to establish communications networks in non-permissive environments. However, if maximum OPSEC procedures were to be followed 24/7, no one would ever communicate at all. Therefore a careful balance must be struck, allowing for some communications to be completely public (for the masses to consume), while other communications methods are only shared with trusted users, or those who have a vested interest in a local area (semi-trusted entities). Trust is a finite resource, and once it's gone, it's very difficult to obtain again. Why does this matter for communications?

- You need to exchange information and communicate with people, but powerful entities have invested significantly in making that difficult. You want to find like minded people, but you need to communicate to do that, and all internet based comms are surveilled. You need to organize, but the moment you get too popular, you meet Icarus' fate. Everything is a balance between keeping your head down, and flying to close to the sun (so to speak). GhostNet should enable everyone to participate at their own pace (and risk level), allowing people to assume an appropriate level of risk in order to make progress, but also not take on so much risk that safety is compromised. GhostNet should allow people to ride the line between doing nothing, and risking it all.
- You may have friends or family that know your cell phone number, but you wouldn't give out that cell phone number to just anyone. On the other hand, you may program in national calling freqs into your handheld radio, with the full intention of maybe having to talk to strangers during an emergency. There are many layers of communication between these two examples, and many ways of building networks on varying levels of trust.

## Modular Privacy

With Operational Security (OPSEC) being a very important consideration, GhostNet comms can fit into any local or private communications plan. If you need to make contact with trusted contacts, or even people you don't know (but have a shared interest, such as for community defense), GhostNet hopes to enable this. On a more strategic level, GhostNet can fill a need for strategic communications, where no pre-organized solution is available. If an entity doesn't wish to use GhostNet, anyone can duplicate the idea fairly easily, and tailor a plan to their own needs. Communications cannot be established after a disaster, only before....but most people still will not plan for this. So even if a group of prepared citizens wants to create their own plan, GhostNet can temporarily serve as something, where nothing currently exists.



\*Radio based communications can require a license, depending on the situation. For daily use in a non-permissive environment, a license would be required. However, in an apocalyptic-level emergency where users are no longer concerned with regulations, many radio modes can technically be used regardless of caltsign. This means that privacy, while non-existent under normal ham radio operating conditions, is extremely feasible in the event of an emergency.

# "WHAT'S THE POINT?"

Understandably, such a seemingly complicated plan/infrastructure is bound to result in the question "Why even bother with all this?". Though the answers should be fairly obvious, below are few concepts that are perhaps not adequately explained in the field of emergency communications:

- **He who owns the wires, owns the communication.** All internet communications are vulnerable to censorship, surveillance, entrapment, manipulation, and information warfare. Granted, this can apply to all communications on Earth, but there is a reason that powerful entities have spent substantial portions of defense budgets on information warfare and censorship tools. You can jump from platform to platform, being banned from one social media site before moving to the next. But the inconvenient truth is that radio is exceptionally difficult to influence by anyone. Though this may change in the future, radio is the ONLY option for communicating over long distances, without using anyone else's infrastructure.
- **Comms can't be established after a disaster, only before.** No meaningful comms network has ever been set up after a natural disaster strikes, and certainly not after a man-made disaster (such as war) breaks out in a region. During a crisis, people tend to be rather busy as the time-saving conveniences that make our modern society function stop working. There are only so many hours in the day, and if a person has to spend a lot of time establishing even the most basic comms links (and assuming risk doing so), this is time lost that could have been better spent on other tasks. It's better to create the plan, practice it, and integrate it into daily life NOW, so that when all other comms are shut down or censored, the transition to radio is as seamless as possible.
- **A couple of "prepper freqs" is not good enough.** Shouting into your radio handset on doomsday is hardly likely to be effective. In 2023, even during significant emergencies, traditional voice comms that hams are known for are extremely ineffective. If we factor in the sheer number of people who own radios (even HF radios), we can clearly see that more significant network planning is needed. If the HF bands are so busy that the average user has a hard time breaking through on the average sunny Saturday afternoon, during a time of emergency comms won't be possible at all. Thus the need for more substantial networks, modes, and methods that can handle higher volumes of varying kinds of traffic.
- **The average citizen is now playing for keeps.** No one lives forever, and in today's world many people are finding out how true that adage really is. As such, resiliency in the face of an airstrike/raid is paramount. If a ham radio group cannot survive even a basic raid, they are of no help when the chips are down. This means that a "work-in-progress" plan is better than no plan at all. And more importantly, a non-hierarchical framework is essential for the network's survival in the event of kinetic targeting.

## Typical Use Case Examples

**Standard natural disaster preparedness:** A great use of the GhostNet would be to serve as a common network that many people can use to share news regarding natural disasters which may have degraded cellular networks.

**Decentralized, uncensorable, off-grid news network:** The unique nature of HF radio makes censorship very very difficult. If someone wanted to stop a station from transmitting, they would have to either jam that station, or physically visit the actual location of the station, and physically stop the transmission. As the world discovered from the Cuban Jamming incident of 2021, even military grade jamming is not entirely effective enough to totally stop all communications. Where there is a will, there is a way, and JS8Call (and other tools) make alternative communications not just possible, but a reliable alternative for the average user.

**Group Messaging:** JS8Call is a powerful group messaging tool. Due to the nature of using offsets, many people can send messages at the same exact time, only being limited by the time one is transmitting themselves. A listen-only user can pull up JS8Call and automatically decode multiple messages simultaneously, receiving messages from many different regions. JS8's store-and-forward capability allows users to send messages far beyond their own station's range. This forms a very basic form of a mesh network, which although not a true mesh, still offers many of the capabilities of exchanging messages far beyond the line of sight of just one station.

**ATAK Compatibility:** Through the use of various plugins, the TAK suite of software can function within JS8Call. Obviously sending extremely high amounts of CoTs data is not best suited to HF radio, but this could be a useful feature for those who wish to integrate HF comms into their TAK network.

**GhostNet is simply meant to help ensure communications. It's not intended to replace anything, or override any pre-existing networks or plans. If you want to use it, Great! If not, that's fine too. But it's there for those that need a reliable plan, where nothing similar currently exists.**