EPA ARES Digital Network

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Eastern Pennsylvania Section
Amateur Radio Emergency Services (ARES®)

''Digital Communications Guidelines''

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1.0 Purpose

To provide guidelines and suggestions for the Eastern Pennsylvania section Amateur Radio ARES® groups to establish a working and compatible digital communications network--one that can provide modern emergency communication service to government and relief agencies in times of disaster or other incidents.

**2.0 Background **

Internet email has become the globally accepted method for fast written communications for individuals, corporations, government agencies and other served organizations like the Red Cross and Salvation Army. Nevertheless, if a disaster strikes and a community's electrical power or telephone service is disrupted in any way, or the agencies email server goes down, then the Internet link is broken and normal email cannot flow.

The use of an Amateur Radio digital communications network linked to the Internet can then become an effective and important tool in keeping an ARES group and its served agencies connected globally without the normal wired Internet connection. It allows an Amateur station to assist served agencies and keep them connected from inside a disaster area, and without normal email servers or Internet links.
The Eastern Pennsylvania ARES® is dedicated to the use of many forms of communications to transmit messages during times of disaster and/or emergencies. And in order to accomplish our objectives we need to have redundancy and utilize all available communications modes and systems, with a requirement that networks be able to communicate across inter-agency and inter-jurisdictional boundaries. Digital communications has the ability of providing error-free messages to a destination, minimizing public disclosure of sensitive information, and in a written format.

3.0 Requirements

3.1 Interoperability

* There is an absolute requirement that communications networks be able to communicate across interagency and inter-jurisdictional boundaries. This was a key finding of the 9/11 commission and has been incorporated into the National Incident Management System (NIMS) and its Incident Command System (ICS)
* Traffic must be transparent both into and from the ARRL NTS NTSD system.

3.2 Dynamic

* Traffic must be able to move efficiently via whatever route and medium is available
* There must be a built-in system of fallback and failure modes
* The system must be able to handle messages in multiple digital formats and adapt to served agencies day-to-day message handling formats without modification

3.3 Flexibility

* At a user level, the system should use readily available client programs that do not require a served agency to make changes in the way they work in order to accommodate the system
* The network software and client programs must have a short learning curve for both the Amateur Radio operator and the served agency staff
* Both the software and required hardware must be easily deployable in fixed, mobile and portable configurations using a minimum of manpower and a variety of power sources

4.0 Winlink 2000

In order to comply with the ARRL encouragement for ARES® to deploy the Winlink 2000 system (WL2K), Eastern Pennsylvania ARES® strongly encourges use of this system as an additional emergency communication capability.

It offers the best combination of features and reliability, an established worldwide network, and can provide fast radio email service for all served agencies and the public. It can work in harmony with the resources of the existing NTS and NTSD digital services to cover our entire section and beyond, with ARES® providing the connections to served agencies.

Nothing in these guidelines should be construed to limit local groups from using other digital modes or systems within their own group, but these same groups should employ and integrate Winlink 2000 into their operational planning to retain effective communications with the rest of the section and state, and to contribute useful, trained operators for regional and national disasters.

5.0 Recommendations

5.1 Communication Modes

High-speed broadband modes or systems that are interoperable using TCP/IP Ethernet such as IEEE 802.11(x) WiFi or HSMM, D-Star, and commercial Ethernet products that are adaptable for use within the amateur bands, are highly recommended (even preferred) for incorporation into the network wherever their application is appropriate and beneficial. When interoperating with the Winlink system, Telnet is the protocol used over TCP/IP Ethernet.

1200 and 9600 baud packet utilizing AX.25 is the appropriate protocol on VHF/UHF, with 9600 baud preferable. Pactor is currently the best mode for HF digital operations due to its ability to get through interference with integrity. Pactor II and III have a much higher throughput and are highly encouraged where possible.

Non-ARQ protocols and modes such as RTTY, PSK31 and others that do not have error correcting or error checking are not encouraged for emergency communications due to their ability to receive errors without realizing the transmitted message has been changed, by their inability to handle bulk email traffic, and slow transfer speeds.

5.2 Building the Local Network

The network should consist of servers, radio ports, access points and gateways that are interlinked via TCP/IP Ethernet over various media, both RF and the Internet. Stations should be deployed so that outages to any RF or Internet links may be bridged using portable, mobile or fixed stations capable of contact outside the affected outage area.

5.2.1 Radio Mail Server (RMS or PMBO)

The Radio Mail Server or PMBO is an optional local component to a local network. Regional ARES® PMBOs are in service nationwide and should be used by other local stations freely. However, a local PMBO offers the advantage of hubbing traffic from stations that can connect to it directly, or via stations on its associated RF LAN. Installing a local RMS or PMBO station is appropriate only if local linking conditions and expected local emergency traffic volume warrant it.

RMS or PMBO stations can be configured with a Telnet server (to be a focal point for Telpac gateways and allow broadband access), co-located VHF/UHF gateways, and HF radio ports.

5.2.2 Packet (Telpac) Gateways

Packet gateways allow the exchange of email messages between packet stations and the RMS servers via the Internet or other TCP/IP links. Telpac is the software package recommended to perform this task, and it works with either full-time or dial-up IP connections. ARES groups should install robust local and regional VHF/UHF Telpac gateways, using frequencies coordinated through the Section Assistant SEC for Digital Communications. Existing packet networks may be used for user access to Telpac gateways, but care should be given to limit digipeater or node hops to avoid throughput limits.

Telpac gateways should be planned as a local layered network, in which all the stations use different frequencies, rather than a flat network, where all the nodes share the same frequency. In areas where packet

station density is high or where served agencies require a high volume of traffic in a short time, a flexible-frequency plan is recommended.

During non-activation periods, Telpac gateways in a local region should cluster on the regions' coordinated HOME frequency. This enables user stations multiple targets on a single frequency and automatic Paclink "channel" switching.

During times of activation, however, ARES groups should develop a local frequency plan to migrate all local Telpac stations to different frequencies. Deployed user stations can then be assigned Telpac hosts on specific frequencies, minimizing frequency congestion by spreading users and traffic across multiple channels, effectively increasing the bandwidth and throughput of the network. THIS SHOULD ONLY BE DONE WHEN TRAFFIC DENSITY DEMANDS IT. During activations, packet stations not involved in emergency operations should stop transmitting.

Telpac gateways are configured with three possible IP-addressed host servers, (RMS or PMBOs). Should the first fail in a connection, the remaining are automatically tried in order. We recommend that within your local area, all Telpac stations set the first host to a local or regional server within EPA. All should be set the same to preserve local hubbing. The remaining two should be chosen well outside the area, preferring servers with a hardened physical installation, long-term backup power, robust connectivity, and locations outside frequent natural disaster areas.

5.2.3 Digipeaters

Digipeaters should be utilized in the local network as a last resort, and then planned so that only one hop to a gateway from the user’s position is necessary.

5.2.4 Packet Nodes

Using packet nodes are to be preferred over digipeaters, but a stand-alone node should not be planned where a Telpac gateway could be installed instead. Wherever possible, Telpac gateways should be configured with co-located packet node capability, configured either into the TNC or by software used at the station. This is to allow a user to have a network path to another more distant gateway, should the Telpac gateway loose its internet or Ethernet link.

5.2.5 Broadband Links

ARES(r) groups should incorporate high-speed, point-to-point RF linking (backbones) in addition to internet linking wherever possible. Wherever possible, broadband technologies should be used for new backbone links instead of legacy packet radio technologies. Modern broadband capacity and speed help ARES groups provide the level of speed, service and capability their served agencies are used to, and are increasingly demanding. D-Star, WiFi, HSMM (Amateur High Speed Multimedia) and commercial broadband hardware are successfully used for distances in excess of 30 miles with day-to-day reliability. These tools make sense to add redundancy, or to “deliver the internet” to distant locations serving a Telpac gateway or broadband access point where internet connectivity is not available.

WiFi or HSMM is often used as a convenient link to the Internet from a portable Telpac gateway, which in turn provides outlying user stations

access to the network via packet radio. This allows quick deployment of an ad-hoc packet infrastructure, and can expand bandwidth for packet users by increasing the number of gateways and frequencies. Only open, public, WiFi access points should be used, as opposed to those intended for private operation. Public use access points can often be found at public libraries and colleges, coffee houses and other locations. These access points should be located and confirmed before you need them. Some access points are listed on these sites:

http://www.jwire.com
http://www.wifi411.com

Please note: The ARRL recommends avoiding WiFi channel one due to its proximity to the AO-40 satellite downlink frequency. WiFi equipment used under FCC Part 97 (HSMM) should adhere to ARRL guidelines for compliance. See:

http://www.arrl.org/hsmm

Equipment operating on the 902 MHz band is increasingly available, and is cost effective when compared to new purchases of packet TNCs and packet radios now on the amateur market. It is effective for for broadband Ethernet bridges and point-to-multipoint connections. EPA ARES encourages experimentation and the integration of this equipment into local networks wherever possible.

5.2.6 Broadband Access (High Speed Multi-Media HSMM)
Local ARES(r) groups should favor broadband access points and user hardware over legacy packet technologies when making purchase decisions for new equipment for their ARES(r) local network. Amateur D-Star and commercial WiFi radios on the 900 MHz and higher amateur bands offer a better value and higher performance than purchasing new packet TNCs and FM radios. Legacy packet equipment should be pressed into service as required, but retired when new purchases are made.

D-Star repeaters, WiFi or HSMM access points, and point-to-point and point-to-multipoint link radios all interface into the system via Ethernet connections, allowing user access and interaction with others on the network using common computer application software.

5.2.7 User Stations
User stations can connect and use the network with VHF/UHF packet, HF Pactor, D-Star and with HSMM broadband radios. A healthy mix of user capabilities is highly recommended in all ARES® groups' local networks. In addition, groups should assign priority of the RF modes used according to their effectiveness for emergency communications and how well they serve agencies, as opposed to normal amateur use.
(See Section 7.2, Deployment Priorities.)

5.3 Software and Equipment

5.3.1 Software

The recommended VHF/UHF client software is Paclink combined with AGW Packet Engine or Packet Engine Pro. Alternatively, Airmail is equally

well suited, and offers access the Winlink system via VHF/UHF and HF as well. It, in fact, may be the preferred software for a group for ease of local support and general utility.

Telpac, Paclink and Airmail programs are available on the Internet from links at: http://www.winlink.org/Client.htm

5.3.2 Sound Cards and TNCs

Although most of these programs allow the use of sound card technology, (Airmail's sound card support is imminent) we recommend the use of directly connected standard TNC hardware. Sound card usage can get tricky and has been repeatedly proven unreliable in emergency communications practice. When setting up a station at a served agency in a real incident situation, you need the communications to work – that is not the time for risky alternatives.

6.0 EPA VHF/UHF Networks

6.1 Frequency Coordination

Deployment of Telpac gateways and Radio Mail Servers (RMS or PMBO's) in the Eastern Pennsylvania Section will be coordinated through the Assistant Section Emergency Coordinator (ASEC) to ensure appropriate distribution of assets in the Eastern Pennsylvania Section. The ASEC will also coordinate gateways and servers located near Eastern Pennsylvania state borders with adjoining states/section SEC's. ARES groups in EPA are encourged to participate.

Additional frequency coordination information and current assignments can be found at:

http://epaaresdigital.pbwiki.com/PacketFrequencyCoordination

6.2 VHF/UHF Band Plan

The 2 Meter and 70cm frequencies for gateways in EPA are:

144.91	145.01	145.51	145.61	145.71
144.93	145.03	145.53	145.63	145.73
144.95	145.05	145.55	145.65	145.75
144.97	145.07	145.57	145.67	145.77
144.99	145.09	145.59	145.69	145.79
440.9250	440.9500	440.9750	441.0000	441.0250
441.0500	441.0750			

6.3 ARES® Emcomm HF Network

Radio mail servers (PMBOs) provide HF ports to the network. ARES® PMBOs are not advertised or listed except to Emcomm groups, and remain quietly semi-private. This is to avoid common everyday usage by the general Amateur Radio population and to reserve their bandwidth for Emcomm exercises, incidents and disasters.

The station list is updated as the national network grows and is published at: http://epaaresdigital.pbwiki.com/StatusLinks Frequencies, locations and all necessary information for all Emcomm PMBOs are given, and when downloaded as a text file, may be directly imported into Airmail's station and frequency list.

The EPA Section ARES® PMBO is W3EOC in West Chester, owned and maintained by Chester County Department of Emergency Services.

Public PMBOs are available worldwide and provide day-to-day Winlink radio email service to users of all types. These stations also serve Emcomm operations as needed. Information on these stations is available at:
http://www.winlink.org/stations.htm

They are also listed in a text-format directory that may be imported into Airmail at:
http://users.iafrica.com/z/zs/zs5s/index_buls.html

7.0 Local Priorities

7.1 Official Emergency Stations

* Each ARES® district in Eastern Pennsylvania should have at least one primary and one secondary Official Emergency Station (OES), with digital capability. Preferably one per county.

* These stations should be geographically separated, but located where they are usable throughout the area.

* These stations should be equipped for HF and VHF/UHF digital operations and have backup power available during an extended power failure.

* Internet connection is required for Telpac operation; an always-on connection is preferred, but dial-up is acceptable.

7.2 Emcomm Deployment Priorities

First priority should be for a local group to establish at least two portable OES stations with NVIS antennas that can use HF Pactor II or III and Airmail when deployed in the field. These stations will be operational where needed, and rely on no local infrastructure. If all else fails, these stations remain in operation and become essential. Further, these stations have the highest value as mutual aid data resources when needed outside your local area. The HF frequencies used are dependent on location and propagation conditions.

Second priority should be to take stock of locally available equipment. If there is an abundance of legacy packet hardware available, put it into service. Establish secure, reliable Telpac gateways at good RF locations in your local area. As more operators are trained, more Telpacs should be added to expand and deepen your UHF/VHF infrastructure.

Alternatively, consider installing or pre-deploying multi-mode TNCs and radio equipment at the city and county EOCs and other key public safety and disaster relief organizations such as hospitals, or Red Cross EOCs. Simple VHF/UHF TNCs such as the Kantronics KPC-3 (Version 5.2 and above) or the KPC-9612 can be centrally located within a county or district for portable use.

Next priority should be to encourage and train a group of local operators to become proficient with packet operations and to build field-deployable portable stations. These may be the easiest to put into place, owing to much legacy packet equipment being available.

ARES® groups should prepare portable packet kits that can be deployed anywhere on short notice. These kits must include enough gear to communicate via 1200 baud VHF packet at a minimum. Also included should be a computer (ideally a laptop) with at least Airmail loaded to provide connectivity to the Winlink system via Telpac gateways. Ideally, these kits would also include UHF capability and 9600-baud capability as well.

If packet hardware is not abundantly available without purchase, or after other station types are in place and a local infrastructure begin to grow, moving to broadband field stations is highly recommended.

This document is not intended to be a reference for training or technical information. For the best information on the Emcomm use of Winlink, and how to get started see:

http://www.activeham.com/winlink/wiki

http://www.winlink.org

7.3 Operation: Connection Priorities

To deliver messages with the most efficiency and speed:

Determine if the served agencies for which you have messages have Internet access and email service.
Determine if you have local internet connectivity. If so, send your messages to their destination using regular email or through the Winlink system using a Telnet connection.
If connectivity is missing at either end, determine the best RF path and frequency from your location to the best gateway or PMBO. The best may be an HF connection to a PMBO three states away. Or it may be to your local Telpac gateway. Send your messages through the gateway or PMBO.
If gateways or PMBOs are not available, consider sending your message via another local Airmail station (only Airmail-equipped stations are capable of peer-to-peer connections). Local groups should designate a single Airmail station to act as a ‘hub’ if other infrastructure is not available. All surrounding stations should connect to that ‘hub’ station to send and retrieve mail. When used this way, the "post to" address must be that of the destination station or email address, and the "post via" address must be the next ‘hub’, or forwarding station and not the default of "WL2K."

The principle here is to use the internet or high-speed links wherever possible in the path and keep RF channels as open and uncongested as possible.

8.0 Suggested TNC Parameters

Standardized parameters make a tremendous difference in the throughput of the network. These suggested VHF/UHF parameters are for smoother 1200bps AX.25 packet operations.

SSID for Telpac nodes should be -10 to standardize with other Telpac nodes across Eastern Pennsylvania and the rest of the country.

8.1 Normal Users TNC Parameters

Frack 4
ID E 45 Minutes
BE E 0 Minutes (no beacons please)
Numnodes 0
MaxFrame 2
MAXUSERS 10
Paclen 128
Persist 63ms*
Response 2
Retries 10
Slottime 10ms* (adjust to 30 when used with TCP/IP systems)
TXDelay 35 (adjusted based on your transmitter)
Unproto Airmail Station via (node you hit normally)
Users 10

8.2 Telpac Gateway TNC Parameters

Beacon E 89 Minutes
Digipeat On
Frack 4
Heard List 25
Link Retries 10
MaxFrame 2
No Activity Timeout 600 seconds
Node Broadcast 30 Minutes
Obsolescence Count Initial Value 5
Obsolesence Count Minimal Value 3
PPersist 63
Minimum Quality for Auto update 63
Radio Channel Quality (HDLC) 192
RS232 Port Quality 255
Response 2
TXDelay 35 (adjusted based on your transmitter)

This document would not be possible without inspiration from Harris County, Texas ARES®, Missouri ARES® and the Georgia ARES® groups.

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