Proposed Support Approach /FEMA

Working Draft: July 2, 2015

Introduction

In May 2015, the Federal Emergency Management Agency's Disaster Emergency Communications Division approached the ARRL National Traffic System to inquire regarding potential support for an upcoming "Grid Down/RF-Only" exercise in which a cyber-attack takes down the nation's primary private switched telephone network. Could the NTS deliver Radiogram messages from FEMA's National Capital Region to their ten Regional Administrators?

This document outlines the NTS' proposed support approach to FEMA's scenario. It builds on our existing radio networks and management structures, expanded to include our developing "NTS Communications Emergency Response Team" concept, which would seem to mesh well with FEMA's stated requirements, little or no modification required.

Our approach is simple, straight-forward, and proven based on a century of ARRL experience in our communications support role and the decades of practical, "boots on the ground" experience of our operators.

We believe it offers realistic assessments of NTS' proven performance and reliability with sufficient agility to satisfy FEMA as well as state and local EMA executives.

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Background

The American Radio Relay League, Inc ("ARRL–the National Association for Amateur Radio") maintains and operates the National Traffic System (NTS), a highly survivable, transcontinental, messaging service designed to provide systematic, accountable transfer of record message traffic. The Federal Emergency Management Agency (FEMA) has expressed an interest in the use of this network as a redundant, survivable messaging layer available for use when "all else fails."

CFR-47, Part 97.1(A) of the Rules and Regulations of the Federal Communications Commission partially defines the basis and purpose of the Amateur Radio Service as "recognition and enhancement of the value of the amateur service to the public as a voluntary, noncommercial communications service, particularly with respect to providing emergency communications." In keeping with this directive, the ARRL has established and maintained the NTS to provide critical messaging service in time of communications emergency.

FEMA does not envision the use of this system as a substitute for government or commercial telecommunications common carrier resources. However, the use of NTS could be envisioned during catastrophic events, which isolate portions of critical telecommunications networks or in which sufficient disaster message traffic exists that additional circuit capacity is required.

Hereafter, the term "NTS" shall apply to all components and levels of the National Traffic System. It will be understood to include all operational modes of communications including the NTSD digital network and Radio email services integrated with the Amateur Radio Service Foundation's Winlink2000 system. Nothing in this document shall be construed as agency acceptance of FEMA or any organization other than the ARRL National Traffic System. Material presented in the appendices is for familiarization purposes only and is not official policy of the NTS.

Recommended framework for cooperation

I. Mission

The NTS will be tasked to perform a basic emergency communications function in support of the Federal Emergency Management Agency. This mission shall activate in a "grid-down" scenario in which government and commercial telecommunications common carrier resources are disrupted or overloaded. The National Traffic System shall not be considered a replacement for government telecommunications networks. Rather, it will act in the capacity of a back-up system to be utilized in a supplemental, emergency communications role only.

The primary task of the National Traffic System will be to provide basic connectivity in the form of text-based record message traffic exchanged between FEMA officials at the national and region levels. Additional tasks may include providing connectivity between FEMA and state or local emergency management agencies on an as-needed basis.

II. Preparedness Action Plan

NTS management will implement a series of planned initiatives, which, over time, will enhance the ability of NTS to better support FEMA in the event of a communications emergency.

A. Summary of Planned Initiatives

Short-Term:	• The development of NTS Communications Emergency Response Teams (NCERT), the primary task of which will be establishing emergency communications connectivity for FEMA regional offices. • Development of Alert and Notification Procedures designed to rapidly activate NTS personnel and networks during the initial response phase of an operation. • Development of NCERT Field Manuals to provide a systematic response to communications support requests.
Mid-Term:	• Implementation of a training and exercise program designed to better prepare NTS members and key stations to facilitate the flow of NCERT priority and EMERGENCY message traffic.
Long-Term:	• The development of NCERT at the ARRL Section level, to support the secondary task of state and local disaster operations and add depth and redundancy to the program.

B. Incident Command

NTS response shall be conducted according to standard NTS procedures but coordination will be conducted in a manner similar to the ICS structure. The NECC shall serve as the default NTS Incident Commander. In his absence, the first available alternate point of contact as defined in the alert and notification procedures shall act as Incident Commander until the role is relinquished. Alternate incident commanders will typically be the three NTS Area Chairman (Eastern, Central and Pacific areas).

III. NTS Communications Emergency Response Teams

The National Traffic System will implement a program to develop of a cadre of specialized "NTS Communications Emergency Response Teams" (NCERT). NCERT formalizes the NTS emergency response function and clarifies how it is implemented and supported by routine NTS operations.

A. Primary mission is to support FEMA.

The NCERT will be capable of establishing a fully operational, message center in the field or its personnel may be used to staff a FEMA communications facility, incident command post, emergency operations center or other key facility already equipped with the necessary communications equipment.

NCERT members may be asked to meet FEMA facilities access requirements, at FEMA's option and expense. Furthermore, NCERT members shall be carefully vetted by their Section Traffic Manager to ensure they have the requisite skills and equipment needed to ensure operational readiness.

FEMA will provide workman's compensation insurance to members deployed at FEMA's request.

B. Secondary mission is to support state and local emergency operations.

The NCERT shall be capable of deploying a temporary message center to any location within its operational area, not exceeding the ARRL Section in which it is based, without the written agreement of the ARRL Section officials involved.

C. NCERT Administration

1. Program Management

The NCERT program will be directly supervised by the three NTS Area Staffs acting as the NCERT working group. Area Chairmen or their designees will have executive authority within their areas.

2. Interagency Coordination - NECC

The NTS Area Staff will appoint a national "NTS Emergency Communications Coordinator" (NECC), who will be responsible for representing NTS to FEMA to facilitate on-going planning and cooperation. This individual will be responsible for basic planning tasks and administrative duties. Approval of policy and proposed changes to policy shall require the consensus approval of the Area Chairmen and appropriate FEMA officials.

3. FEMA Facilities Directory

FEMA will provide NTS management with a directory of contact information for key FEMA facilities. The distribution of this information will be limited to Area Staff and NCERT members and will be used to facilitate delivery and resolve message delivery problems during emergency operations.

FEMA will determine what contact information is appropriate, although the following information might be considered for inclusion in the directory:

Physical addresses	• Regional offices.
Telephone numbers	• Message routers within FEMA EOCs or similar facilities. • Key FEMA officials, to whom record message traffic may be addressed.
Email addresses	• Message routers within FEMA EOCs or similar facilities. • Key FEMA officials, to whom record message traffic may be addressed.
Radio net information	• Amateur Service • Federal stations (e.g., MARS, SHARES, FEMA) • Land Mobile Service

4. Regional Level Teams

Regional NCERT shall be sponsored by the three NTS Area Staffs and will coincide with FCC call regions to the extent possible.

5. Section Level Teams

Section NCERT shall be sponsored by individual ARRL Sections.

6. Mutual Aid

All NCERT will provide each other mutual aid and support to the extent practicable.

7. Training

The NECC shall be responsible for arranging the necessary training for FEMA employees who will be accessing NTS networks.

FEMA will ensure its people are familiar with the NTS program, its capabilities and limitations, as well as NTS recommended "best practices" for message origination, content, and delivery.

8. Network Registration Required

Because advanced network registration is required, FEMA shall be responsible for providing the NECC with a list of those FCC call signs assigned to their national and regional offices.

9. Emergency Communication Declarations

When necessary, the NECC shall coordinate with FEMA to draft and transmit a request to the FCC for a formal "emergency communication declaration". The declaration may specify certain

frequencies, within its jurisdiction, as off-limits to stations not participating directly in the emergency response effort.

10. NTS Field Manuals

It is envisioned that NTS will develop field manuals explaining NCERT alert, activation and operation procedures, and other topics as required.

D. NCERT Capabilities

1. Operator Proficiency

NCERT operators will hold ORS designation and be skilled in NTS digital operations techniques.

2. Technical Capability

Individual NCERT shall be equipped with the following high frequency communications capabilities:

- High frequency data modem for PACTOR 1, 2, 3 (P-4 encouraged) [1]
- High frequency radiotelephone
- High frequency radiotelegraph
- VHF-FM for local ARES interface
- UHF-FM for local ARES interface
- Antennas suitable for each

3. Materiel and Supplies

Essential materiel and supplies to field a disaster message center for an expected forty-eight hour initial period, such as but not limited to:

- Portable generator(s) and fuel supply
- Shelter for operations and rest
- Ruggedized computer equipment
- Portable printers and necessary peripherals
- Pencils and paper message forms (e.g., Radiogram blanks)
- Additional supplies TBD.

4. Pre-deployment of Antennas and Power Supplies

FEMA facilities should make every effort to pre-deploy suitable, antennas, feedlines, power sources and operating positions before NCERT arrival.

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[1] PACTOR is a licensed trademark of SCS GmbH and an acknowledged standard waveform for civilian high-frequency, high-speed, data communication. It is interoperable with MARS, SHARES, Winlink2000, SailMail and other global networks. Pactor level 4 is not authorized by the FCC for use in the Amateur Radio Service as of the publication date.

E. Personnel

NCERT Staff shall hold Official Relay Station (ORS) appointments as described below. Military Affiliate Radio System (MARS) representation on each NCERT is encouraged to support improved interoperability.

1. Section Traffic Manager

The STM is responsible for managing traffic nets and ORS appointments within his Section. STMs are affiliate members of all three NTS Area Staff organizations. We propose STMs lead the operational NCERT effort in their territories with the approval of his NTS Area Chairman.

Establish Section NCERTs

The STM shall be responsible for establishing at least one NCERT within his jurisdictional boundaries. The STM shall ensure that the NCERT participates in drills and exercises to the greatest extent possible.

Liaison with ARES and State, local EMAs

The STM, in cooperation with the Section Emergency Coordinator (SEC) will establish effective NTS liaison with ARES and state, county, and municipal EMAs. This shall be done in a manner that minimizes the duplication of resources while ensuring seamless message flow between ARES and NTS programs. ORS appointees are to be assigned this duty whenever possible.

Direct Access to NTSD

In cooperation with the SEC, STMs will endeavor to equip state and local emergency operations centers with PACTOR capability for direct access to the NTSD and Radio-email networks. Each EOC so equipped and supervised will be designated by NTS Area Staff as a Digital Relay Station.

Operator and Served Agency Training

The STM, in cooperation with Area Staff or their designee, shall ensure that EMA, ARES, and NTS volunteers are properly trained to access and utilize all NTS networks.

2. Official Relay Stations

- The ARRL *Official Relay Station* (ORS) appointment forms the backbone of NTS at the Section and local levels.
- All NCERT members will hold the ORS designation.
- As part of this agreement, NTS will encourage all ORS to develop high-frequency portable and mobile capabilities to the greatest extent possible.
- Periodic testing of operational readiness can be easily incorporated into our annual Field Day and Simulated Emergency Test exercises.

RACES Operations and Recognition

In the event an incident warrants the restriction of normal Amateur Radio operations under a formal War Powers Act declaration, NTS operations will be restricted to operators and stations holding the ORS appointment, according to FCC regulations in Part 97.401.

For purposes of meeting the Presidential War Powers Act declaration requirements of the FCC's RACES regulations of Part 97.407, the ARRL ORS appointment will be recognized by FEMA as "RACES Certified," meaning the ORS designation will be accepted as FEMA's (i.e., "a civil defense organization") certification of the appointee as (1) an enrolled amateur radio control operator and (2) a registered amateur radio station.

A Note on Fixed Station Capability
NOTE: While not a requirement, as traffic handlers with formal responsibilities, practical necessity implies ORS have robust HF stations with well placed, physically strong, electrically quiet, HF antennas, 100W transmitters, a suitable work desk and a source of backup power. High-power HF linear amplifiers are common as are backup transceivers and antennas.

Likewise, many ORS maintain VHF/UHF base stations for their general use, often as participants in radio club or ARES sponsored local nets. These stations also tend to have external, typically roof-mounted, antennas offering good local coverage.

A Note on Field Station Capability
ORS appointees often have mobile 30-50W VHF or VHF/UHF transceivers and antennas permanently mounted in their vehicles. Quite a few have basic mobile HF capability as well. Portable operation is common, using the same or similar equipment with improved antennas.

A Note on Geographical Dispersion
ORS appointees are widely dispersed throughout North America; therefore, one or more are likely to be located near or within an affected area. As of June, 2015 there are 753 active ORS appointments in the ARRL HQ database. (Because of maintenance issues, the database is known to overstate the number of active appointments.)

3. NCERT Identification

Area Staff will develop an appropriate identification card or credential for selected NTS personnel to facilitate access to disaster areas when in support of FEMA or other agencies. This identification card will be available only to the following NTS U.S. positions:

- Area Chairmen and Staff members (i.e., region and area net managers, TCC directors, ADCs)
- Section Traffic Manager
- Digital Relay Station appointees
- Official Relay Station appointees

NOTE: we anticipate FEMA will have its own requirements for facility access and identification.

IV. Overview of Alert and Activation Process

The National Traffic System shall develop guidelines to activate its networks in a tiered approach. This approach shall be designed to quickly establish initial coordination and basic connectivity between NTS assets utilizing a "guard frequency" concept.

A. *Contact Points*

FEMA shall provide NTS a list of FEMA officials authorized to request NCERT activation.

NTS shall provide FEMA a list of NTS officials authorized to approve an NCERT activation request. By default, these officials are defined as the three Area Chairmen and their designees.

Contact information shall be maintained for each individual and shall include:

- Direct telephone numbers
- Email addresses
- Physical home address (i.e., for messenger or courier service)
- Physical work address (as above)

Authentication Codes may be considered, at least for initial activation and communications.

B. *Alert Phases*

Level	Description
Stand-by	Normal, routine NTS operations
First phase	Mobilization of targeted NTS volunteers in the vicinity of the emergency.
Second phase	Deployment of NCERT assets to key facilities or operations.

C. *Methods*

1. Government methods

Method	Pros	Cons	Discussion
NOAA All-Hazards Radio	--	--	--
Emergency Alert System	--	--	--
RSAN or text paging	--	--	--
Messenger	--	--	--

2. Amateur Radio methods

Method	Pros	Cons	Discussion
Guard Frequency	--	--	--
Selcal (ALE)	--	--	--
Bulletin Stations	--	--	--

D. *Procedures*

1. Spontaneous Alert

When NTS leadership officials are aware that a major disaster or disruptive event is imminent or occurring, they shall maintain a radio watch (QSX) on the defined guard frequencies. The Incident Commander shall utilize "NTS" as the net call when activating the coordinating net. This coordination process may also be used by local and state emergency management to request NTS support for operations during significant emergency events.

2. Directed Alert

(Activation Request process TBD)

V. Activation Procedures

Upon receipt of a request for activation, the NTS Incident Commander (IC) will instruct key NTS assets to meet on a specified frequency for initial coordination. The initial coordination process will utilize both radiotelephone (primary) and radiotelegraph (secondary) for coordination.

Once core NTS assets are assembled, the NTS IC will define the mission scope and task specific individuals and networks as needed to provide the necessary connectivity required by FEMA.

A. Coordination Net

Those NTS officials not specifically involved in the initial response will monitor the coordination net to be readily available should circumstances demand their direct participation. Note: this net is conceptually similar to the "resource net" used by ARES units.

The coordination net shall be a closed net. Participation shall be limited to radio amateurs officially representing FEMA, specified MARS liaison representatives and the following NTS officials:

Agency Personnel	Notes
FEMA	--
MARS	--
NTS • Section Traffic Managers • NTS Net Managers • NTSD Area Digital Coordinators • NTSD DRS stations • Official Relay Stations *as required*	--
Other	--

Figure 1: Communications Plan - Guard Frequencies

Time of Day	Radiotelephone	Radiotelegraph	Data
Daytime	--	--	--
Nighttime	--	--	--

[Specific frequencies shall be determined based on existing band plan and usage patterns TBD]

The coordination net may also be used to dispatch initial EMERGENCY or priority traffic until key stations and specific networks are activated.

NTS operators holding or clearing EMERGENCY or priority traffic may also report into this net to establish initial contact with NTS system and to request activation of specific networks serving their area.

B. Traffic Networks

C. Network Tasking

Networks will be activated in an incremental approach in response to the event. The NTS Incident Commander will determine the most suitable modes and networks to be applied for specific communications tasks. If necessary, specialized point-to-point circuits may be established for specific communications requirements.

VI. Operations

A. FEMA Network Liaison

Establishing a functional liaison net with FEMA is the goal of NCERT activation.

1. Primary Liaison

When available, the primary interface between FEMA stations and NTS shall be the NTSD network, with Radio-email, when available, considered an extended capability.

IMPORTANT: FEMA Amateur Radio Service stations must register in advance as access to NTSD is restricted.

2. Secondary Liaison

Secondary liaison will be via radiotelephone or PACTOR point-to-point circuits operating in the 5-Mhz or 10-Mhz bands depending on conditions.

3. NTS Liaison Stations

The NECC shall work with NTS Area Staff to identify a list of liaison stations authorized to communicate directly with FEMA staff. This list, including name, call sign and contact information shall be provided to FEMA and regularly updated.

4. Frequencies

Liaison frequencies will be determined by the Incident Commander, based on a band-plan TBD

B. Network operations

NCERT network operations will be according to established NTS practices; MPG will apply.

C. Status Levels

Stand-by status	Normal, routine NTS operations
Mobilization phase	Mobilization of targeted NTS volunteers in the vicinity.
Deployment phase	Deployment of ORS or NCERT assets to key facilities or operations.
Operations phase	NCERT networks are functioning to specified efficiency levels
Stand-down phase	Demobilization activity.

D. Operational Considerations

While NTS offers FEMA decentralized, survivable and flexible communication facilities, all high-frequency radio networks must consider interoperability circuit capacity, prioritization, network management, and message integrity if these benefits are to be realized.

1. Interoperability

All traffic will be in ARRL Radiogram format

2. Circuit Capacity

Circuit capacity is a function of mode and regulation but is limited compared to commercial common carriers.

Mode	Bandwidth (Hz)	Throughput (QSP/HR)	Performance Ranking	Pros	Cons	Explanation
CW Morse Code)	500Hz	0.50	High	• Uses less bandwidth • Lowest power consumption • Signal penetrates best thru noise and interference • Most efficient throughput • Most survivable • Simplest equipment • Fast • Uses brain power - no computers needed • Uses pencil and paper • Independent of Internet	• Operator base diminishing • Significant training and practice required • No graphics • Uses pencil and paper	Few operators want to learn CW but it is the superior mode for emergency communications.
SSB (Voice)	3kHz	0.30	Low	• Easiest to operate • Minimal training required • Most common mode among HF amateurs • Civilians can be trained quickly • Uses brain power - no computers needed • Uses paper-and-pencil • Independent of Internet	• Low signal/noise • Noise and interference • Higher power consumption • Most potential for errors • Slow • Uses paper-and-pencil	Most readily available under disaster conditions as the equipment is ubiquitous.
Digital (Data)	3kHz	--	High	• Allows email-like comms • Perfect data integrity • May be fully automated • "store and forward" flexibility • Uses ubiquitous SSB equipment • Easily integrated with Internet	• Expensive • Uses most power of all modes • Requires computer equipment • 100% reliance on technology • High learning curve • Bandwidth restricted by FCC regulations	Works best for contemporary Americans unfamiliar with traditional paper-and-pencil methods.

3. Prioritization

Message precedence is required on all NTS circuits and messages. Precedence can be defined here as follows:

Routine	Daily message traffic of a personal or administrative nature, including network overhead in the form of net reports, and general ARES or NTS business.
Welfare	Radiogram traffic pertaining to the wellbeing of one or more individuals affected by a disaster.
Priority	Served agency traffic, press dispatches, requests for medical or relief supplies or other time-sensitive

	traffic pertaining to emergency operations.
EMERGENCY	Life-critical communications involving the immediate life and safety of an individual or group of individuals. Note: EMERGENCY is always spelled in full and capitalized.

4. Network Management

(TBD)

5. Message Integrity

The standard Radiogram preamble was developed to ensure message integrity through the relay chain. Based on telegraphy, it is common to commercial, military and amateur messaging.

Component	Function
Number	Serial number assigned to message
Precedence	Priority assigned to message by originator
Station of origin	Call letters of station originating the Radiogram, or of the station re-filing the message into NTS from a non-amateur network. Note: this is not to record the location of the signatory.
Handling instructions	Code of optional standardized instructions for relay and delivery operators (optional)
Count	Formal, rules based, word count of message text
Place of Origin	Location of originating station, used for replies and service message routing, usually a municipality and state.
Filing Time	Time usually expressed in UTC/GMT/Zulu if local time zone must be specified
Filing Date	Month (spelled) and Day (numeric), no Year

6. Radiogram origination pointers:

- Messages should be as brief and crisp as possible. FEMA officials are encouraged to eliminate all unnecessary language, salutations, or other content not essential to the meaning of the message. While there is no specific limitation on message length, a goal of 25 to 50 words for an operational message is recommended. The approach formerly used for the drafting of commercial telegrams or Telex messages apply.
- When possible, avoid punctuation beyond the "period", which is translated "X" (pronounced "X-ray") on radio circuits. Other punctuation is spelled, for example "COMMA" on voice and Morse nets. While NTSD supports the full ASCII character set, interoperability requirements strongly suggest limiting the use of punctuation to essential characters only.

7. Digital Radiogram Best Practice

When digital circuits are available and meet FEMA reliability measures, NTSD may be used. However, NTSD remains an HF resource and certain considerations must be made. Note: it is vital to consider message integrity if there is any possibility of being refiled into a voice or Morse net.

IMPORTANT: Messages transferred from digital circuits to manual nets will not be case-protected. Message routers should make originators aware of this conversion when message traffic is not contained to digital circuits.

- NTS digital circuits and Radio-email systems are case sensitive and include all characters supported by the ASCII standard (Windows ISO formatting should be avoided for technical reasons). Mixed case text and symbols will be transferred as drafted by the message originator.

- NTS voice and radiotelegraph networks are restricted to the Latin alphabet, Arabic numerals, and a limited set of punctuation marks and prosigns. Text defaults to "ALL CAPITALS" following telegraphy protocols.
- Messages originated in IC213 format will be converted to Radiogram format for essential network management and routing. One might view this as the equivalent of embedding an IC213 memo into an email but significant caveats apply.
- Lengthy message traffic, or traffic with file attachments, should be originated as Radio-email if at all possible. Radio-email is bandwidth intensive and works best when Internet service is available at one end of the circuit, i.e., outside the disaster area.

VII. Drills and Exercises

NTS will exercise NCERT during the ARRL's annual Field Day and Simulated Emergency Test exercises.

A. ARRL Field Day

From Wikipedia: Field Day is an annual amateur radio exercise, widely sponsored by IARU regions and member organizations, encouraging emergency communications preparedness among amateur radio operators. In the United States, it is typically the largest single emergency preparedness exercise in the country, with over 30,000 operators participating each year. Field Day is always the fourth full weekend of June, beginning at 1800 UTC Saturday and running through 2059 UTC Sunday.

Since the first ARRL Field Day in 1933, radio amateurs throughout North America have practiced the rapid deployment of radio communications equipment in environments ranging from operations under tents in remote areas to operations inside emergency operations centers (EOCs). Operations using emergency and alternative power sources are highly encouraged, since electricity and other public infrastructures are often among the first to fail during a natural disaster or severe weather.

B. Simulated Emergency Test

From Wikipedia: The annual Simulated Emergency Test (SET) is a training exercise involving the Amateur Radio Emergency Service (ARES) and the National Traffic System (NTS), a message-handling service of amateur radio. The American Radio Relay League is a prime mover in this event, which is organized somewhat like a contest. Its primary purposes are to evaluate strengths and weaknesses in emergency preparedness and communications, and to demonstrate amateur radio to the public.

Note: SET is commonly conducted during the first full weekend in October although ARRL rules permit local variance of up to two weeks to accommodate existing events and EMA schedules.

C. FEMA Exercises

FEMA agrees to incorporate NTS networks in occasional federal exercises.

D. Test Messages

FEMA agrees to provide occasional test messages ("injects") for use in periodic drills.

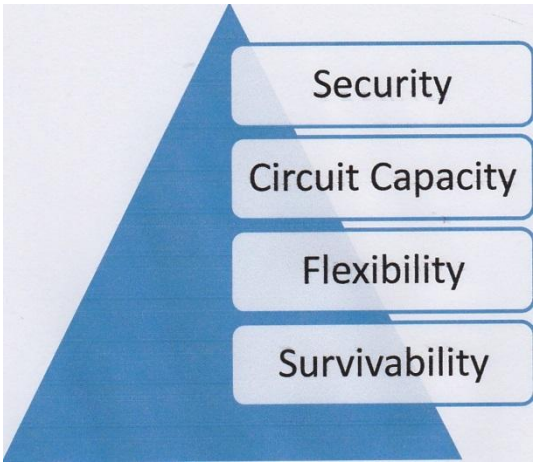
E. Activation Tests

NTS Area Staff shall work with the NECC to regularly test the alert and notification procedures and activate networks to ensure operational readiness. These latter tests may utilize messages generated outside of FEMA to test network response capabilities. This latter process will be conducted as an internal process of the National Traffic System.

Appendix 1: Basic Philosophy of National Traffic System Network

NTS might be viewed as a survivable "last resort" network designed to operate when public safety, government and commercial telecommunications common carrier resources are disrupted or overloaded. The following graphic illustrates this philosophy:

Figure 2: The NTS Emergency Communications Pyramid.



Survivability

The primary requirement of NTS is survivability. The ability to communicate when "all else fails" is at the foundation of NTS and Amateur Radio emergency communications in general. Without survivability all other operational and technical issues are moot.

Flexibility

After survivability, flexibility is the next consideration. The speed or efficiency offered by a telecommunications tool is of little value if that tool cannot be deployed to the location where it is needed. NTS resources are already dispersed throughout the United States (and the World), thereby offering a level of flexibility unavailable to many other resources.

Circuit Capacity

Once survivability and flexibility are established, circuit capacity then applies. The ability to handle greater amounts of data offers significant advantages, provided the service survives an event and provided the capability can be deployed to where it is needed.

Security
Security applies to specialized circumstances. Many disaster operations do not present significant communications security concerns. Furthermore, NTS encryption or similar security techniques are prohibited by FCC regulation. NTS data and radiotelegraph methods are generally immune to media intercept, offering a degree of confidentiality for important communications.

Therefore, one might envision the NTS philosophy as a pyramid, at the foundation of which is survivability and, in order of importance, flexibility, circuit capacity (i.e., "bandwidth") and then security.

Appendix 2: Overview of NTS Management Structure

Area Staff
The NTS Area Staff is responsible for both policy implementation and the day-to-day operations of the national network. It is comprised of the Area's Net Managers, Digital Coordinators, and three Members-at-Large who may represent specific functional and technical areas of expertise.

Three NTS operational areas are defined, these being the Eastern Area, Central Area and Pacific Area. Each Area operates under the direction of an Area Chairman, who serves as the senior manager for operations. The Area Chairman then assigns specialists in various areas to assist with the administration of the program. His staff is then responsible for carrying out the specific details of network management. The Area Digital Coordinator acts as the lead official responsible for maintaining operations of the digital network at the Area and Region levels.

Digital Relay Stations (DRS)
The Digital Relay Station typically operates at the section level. This volunteer maintains the section gateway between the NTS digital network (NTSD) and NTS section and local networks. Volunteers appointed as DRS operators must make a significant commitment to the program by purchasing specialized equipment facilitating PACTOR operations. Key stations, such as those at emergency operations centers or those associated with a team of operators can also be designated a DRS.

Net Managers
The Net Manager (NM) is responsible for the staffing and operation of a specific NTS local, section, region or area network. The NM appoints net control operators, liaison stations and schedules routine net operations to interface with associated network layers as seamlessly as possible.

At the Section and Local levels, NMs are usually appointed by the Section Traffic Manager. Region and Area Managers are elected by their respective Area Staffs.

Official Relay Stations (ORS)
Appointed by the Section Traffic Manager, these NTS volunteers have been carefully screened to ensure they have the requisite experience needed to be considered reliable and "professional" in their operating technique. An ORS appointment typically recognizes significant experience in NTS and emergency communications techniques.

Section Emergency Coordinator

The Section Emergency Coordinator (SEC) is appointed at the section level to manage the ARES program throughout a state. ARES units are typically structured to support county emergency management and relief organization. Each county or municipal ARES organization operates under the authority of a local Emergency Coordinator (EC). More information on ARES can be found in Appendix 4.

Section Traffic Manager

The Section Traffic Manager (STM) is appointed at the section level (typically a state) to manage the NTS program throughout a state or a portion of a state. The STM appoints local and state network managers, provides communications training for ARES and NTS personnel and ensures operational readiness at the state or local "customer" level. He is also responsible for coordinating with the Section Emergency Coordinator (SEC) to ensure that NTS assets interact efficiently with Amateur Radio Emergency Service (ARES) assets.

Transcontinental Corps (TCC)

The Transcontinental Corps traces its history to the earliest days of radiotelegraphy, the “Iron Men” of the old trunk line system. TCC operates in all three NTS Areas on tightly orchestrated but very efficient, inter-area relay schedules, usually on CW. The TCC also links together the various NTS cycles and their importance cannot be overstated.

In addition to these key management positions, a variety of volunteers conduct specialized tasks on a day-to-day basis.

Winlink2000

Winlink2000 or simply “WL2K” is a hybrid radio-email system designed around HF and VHF Radio Mail Servers (RMS) independently feeding SMTP-based Central Mail Servers (CMS) linked via redundant Internet circuits. Winlink2000 is independently operated and sponsored by the Amateur Radio Safety Foundation, Inc, a 501(c)(3) entity based in Florida. The network is closely aligned with *SailMail*, a supplier of subscription-based radio-email for the pleasure boating community. ARSFI have generously made their system available for use at no charge to amateur radio operators. NTS has a long-standing MOU with ARSFI for interoperation with the NTSD network.

Appendix 3: Overview of NTS Network Operations

The NTS is a system of layered communications networks, which are maintained in continuous operation by volunteer FCC licensed radio amateurs. During routine operation, record message traffic, similar to telegrams, and which are of an administrative or personal nature, are exchanged to maintain operational readiness and to provide training content for volunteers. This training process ensures operational readiness at all times. These messages are referred to as Radiogram messages.

Two parallel systems within NTS are maintained in active, daily operation. These systems may be described as:

The National Traffic System (NTS)

NTS is defined as a system of layered networks operating on a sequential schedule to facilitate the flow of Radiogram traffic throughout North America. This older system relies primarily on highly survivable and decentralized high frequency networks structured in a layered approach.

One might envision the network topography as an inverted pyramid, with local and section (statewide) traffic exchanged at lower network levels while traffic destined for more distant locations flows upward to overarching network layers designed to facilitate traffic flow over greater distances such as throughout a region (several states) or across-country.

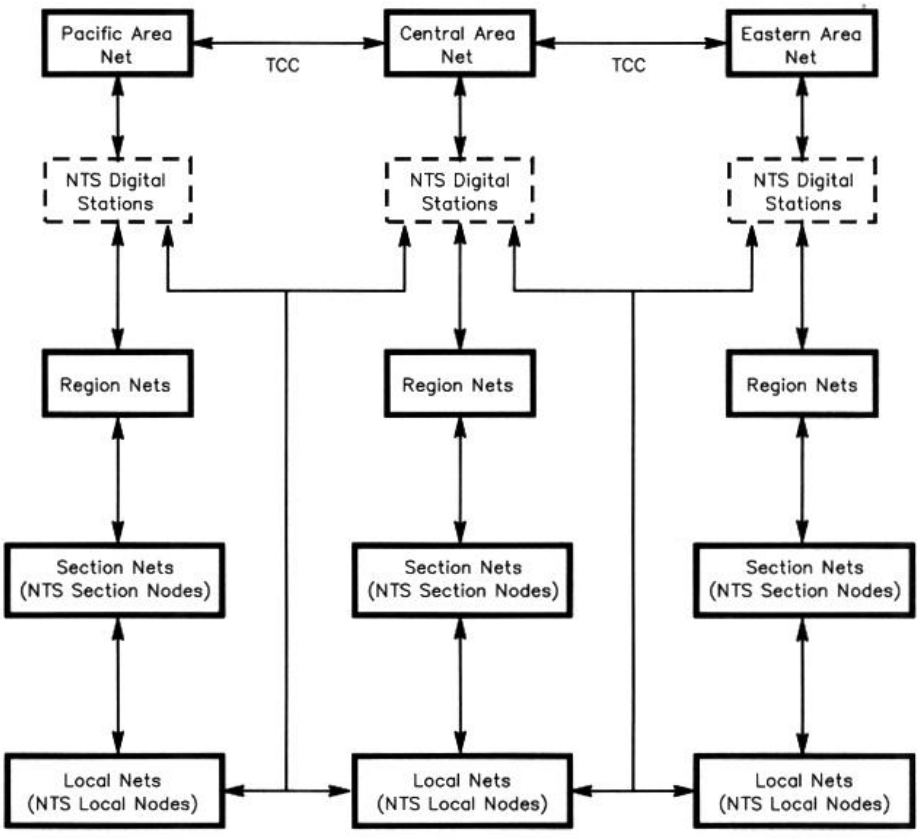
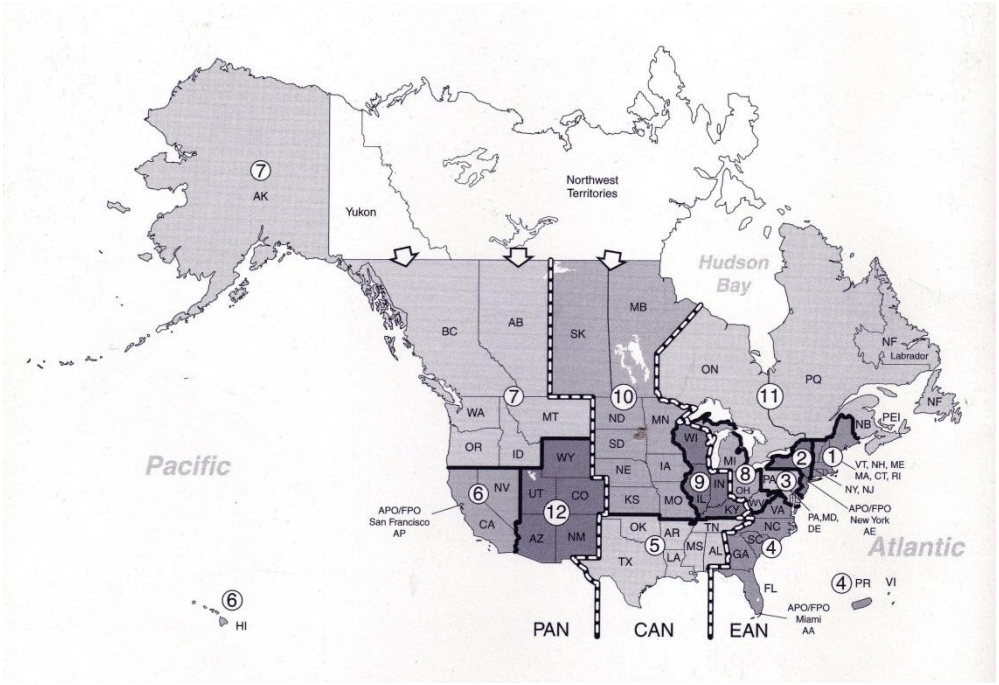


Figure 3: NTS System Map showing Area, Region and Section Nets



The National Traffic System is built upon basic, common-denominator methods of communications; primarily radiotelephone networks and radiotelegraph networks. These networks offer the following advantages:

Radiotelephone (voice)
These networks offer a basic level of accessibility. Operators are more easily trained to conduct basic radiotelephone communications. The techniques utilized are consistent with standard communications procedures used in many government services. Voice networks offer the greatest number of decentralized volunteers distributed throughout the United States.

Radiotelegraph (CW)
These networks offer a very high level of survivability. They combine narrow-band efficiency with circuit capacity that often exceeds that of voice networks, particularly during solar disturbances or other events that impact high frequency radio propagation.

NTS Advantages
Radiotelegraph and radiotelephone networks offer great flexibility. A simple high frequency man-pack radio transceiver using rechargeable battery packs can operate indefinitely from a disaster area. Renewable resources, such as solar power, can be efficiently applied to radiotelegraph networks due to the efficiency afforded by the narrow bandwidth signal emitted. High frequency transceivers capable of radiotelephone communications are a universal common denominator in most emergency operations centers and key agencies throughout the United States.

EMP Events

The use of radiotelephone and radiotelegraph networks also allows many NTS Network volunteers to maintain redundant equipment that is resistant to an EMP event. This equipment serves as a back-up to more sensitive, microprocessor controlled communications equipment common in today's operating environment. This older equipment is quite serviceable when applied to standard "manual mode" networks utilizing voice or radiotelegraphy.

Digital National Traffic System (NTSD)

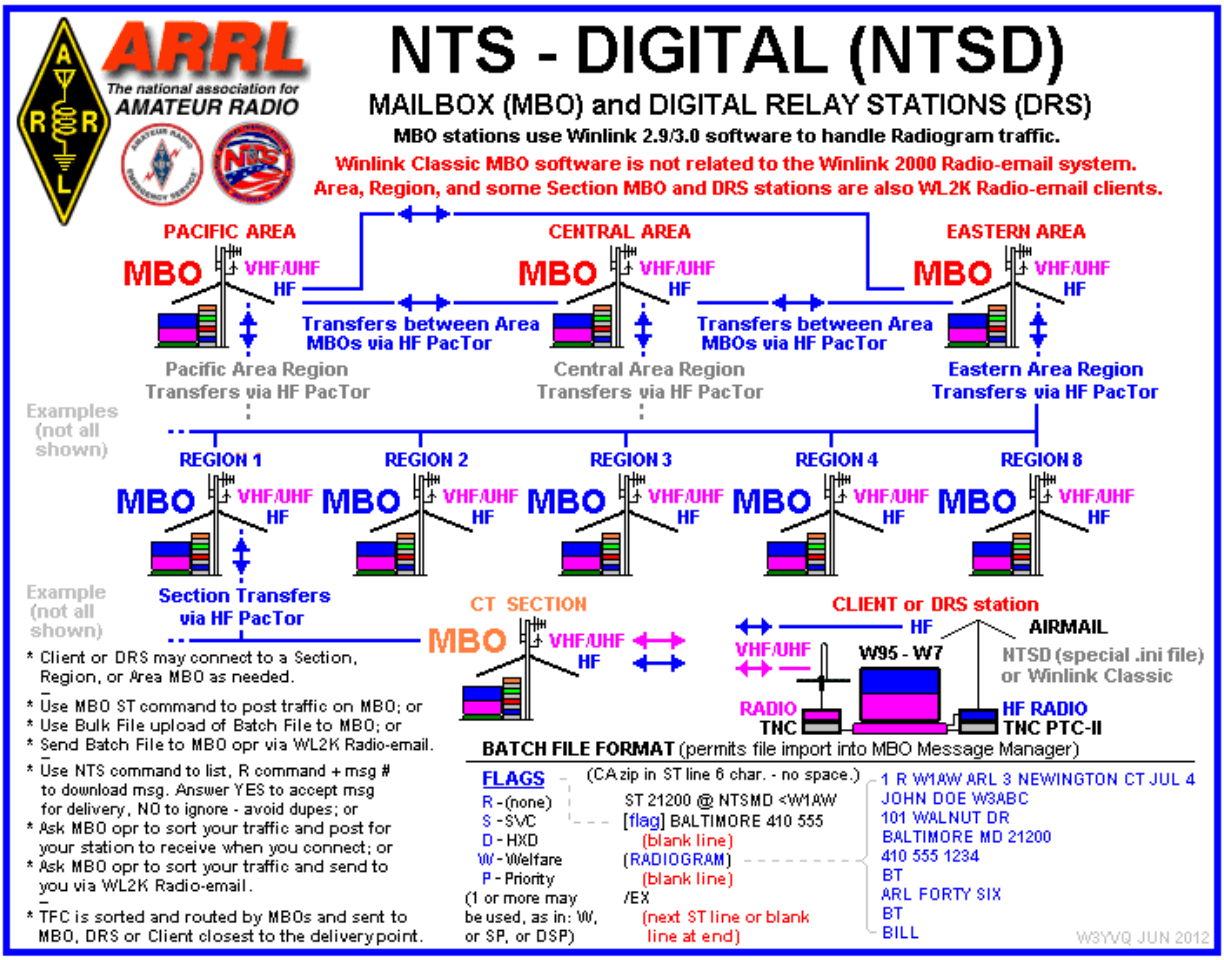
The National Traffic System Digital is a modern, automated system built around a network of automated "PACTOR" (Packet Telex over Radio) nodes and gateways. Like the manual mode nets, NTSD is layered. However, it offers the significant advantage of automation as well as greater circuit capacity under most solar conditions.

Message traffic injected into NTSD is automatically stored and then forwarded through the network using an approach that is similar to "Automatic Link Establishment" techniques used in the military and government sector. The automated PACTOR stations scan selected frequencies throughout the High Frequency spectrum and select the frequency most suitable to establish automatic message routing based on propagation conditions.

Message traffic propagates quickly through these automated networks, which are capable of operating in an unattended manner 24-hours per day. In addition, techniques are in place to facilitate the attachment of small binary files to selected message traffic.

Figure 2: NTSD Stations 2015

Figure 4: NTSD network topography

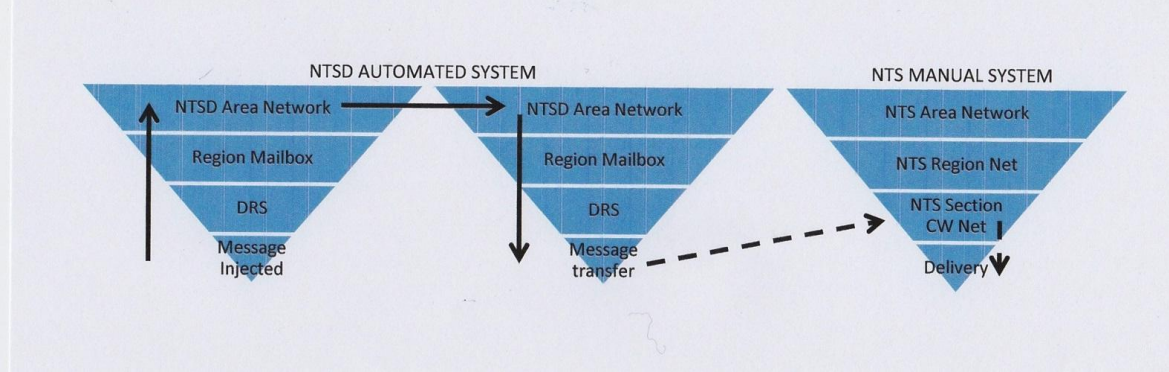


Interoperability

At the most basic level, NTSD is accessed via a Digital Relay Station. The DRS can enter message traffic directly into the system. Likewise, he can download message traffic for his assigned area and deliver it directly when appropriate. When a served agency is equipped with the requisite PACTOR modem and high frequency transceiver, qualified, licensed operators at that agency can directly access NTSD for messaging purposes.

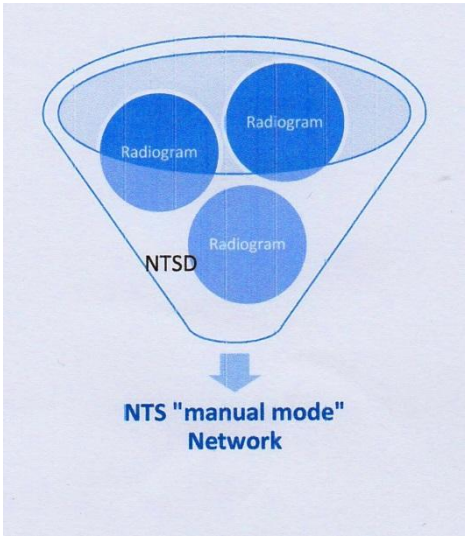
Under normal operating conditions, the DRS is also tasked with arranging liaison between NTSD and the standard NTS manual mode networks. This facilitates message flow from the digital network to dispersed, decentralized, radio operators in the field. For example, one might imagine a scenario in which communications must be established with a field location within a disaster area. Because of operational limitations, a NTS volunteer might establish communications using a low power high frequency transceiver equipped for radiotelegraphy or voice methods. He would then link to the DRS who would serve as a gateway to the NTSD system. Traffic would then flow between NTS and NTSD in a manner that would appear seamless to the end users.

Figure 5: Interoperability example of a message transfer. Multiple message injection and transfer.



It should be noted that circuit capacity or "bandwidth" differs between the NTSD network and the NTS manual systems. Therefore, use of the system requires some knowledge of network topography. Furthermore, proper application of the network requires adherence to some basic principles of network management including message brevity and, where applicable, limitations on the size of binary files attached to digital messages originated via either NTSD or WL2K. These issues are discussed elsewhere in this document. Suffice to say, one might view message transfer from NTS digital to NTS manual nets via the DRS function as a funnel. When it is necessary to transfer message traffic from the automated digital network to radiotelephone or radiotelegraph networks, the flow and distribution of record message traffic must be managed. One might envision this constraint as a process funnel.

Figure 6: High volumes of Radiogram traffic originated via NTSD to dispersed locations within a widespread disaster area could be slowed. Therefore message brevity and simplicity is advantageous.

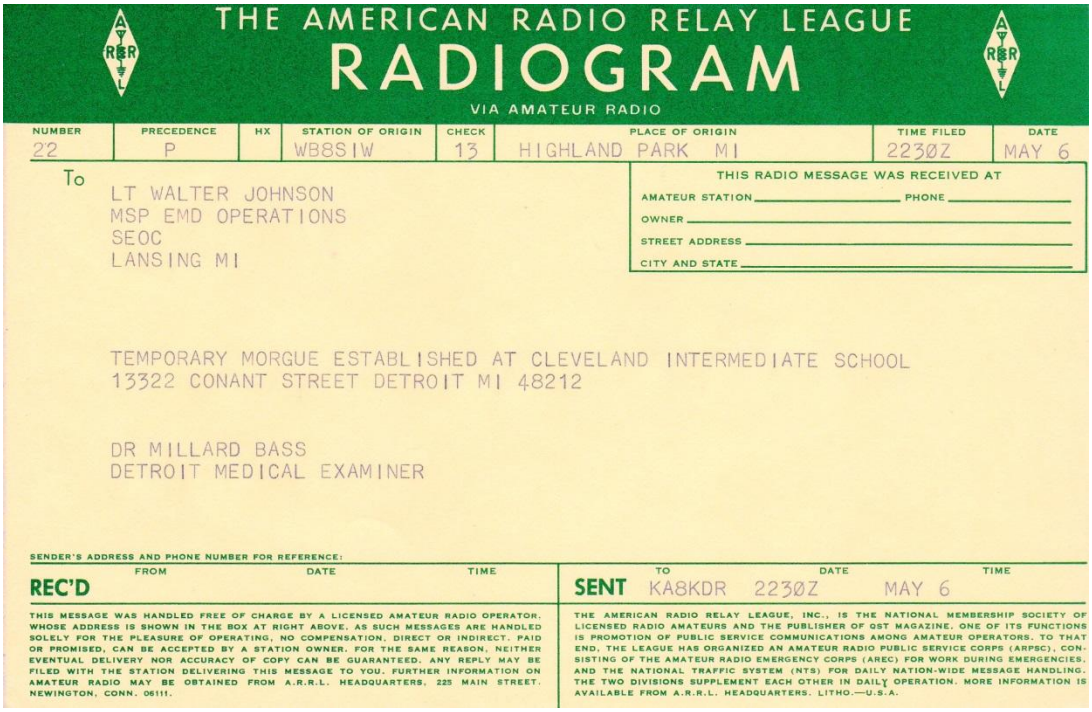


Universal Message Format (Radiogram)

NTS and NTSD are built around a common message format, which facilitates the transfer of record message traffic across modes and multiple network boundaries. This format, called the Radiogram is similar to the telegram or Department of Defense message formats and is designed to facilitate interoperability. While it includes all of the minimum accountability data associated with the IC213 message format, it also adds critical network management data, which is essential to facilitating message flow through both manual and automated systems. This network management data also facilitates the routing of service messages referring to content discrepancies, delivery changes, delays or other administrative tasks needed to ensure full accountability in a diverse, long-haul messaging environment.

The use of Radiogram format is essential to ensuring that message traffic maintains accountability as it propagates through the network layers or when message traffic must be transferred to a more survivable mode for routing into a disaster area. For a more detailed discussion of the differences between IC213 and the Radiogram format, please request our Executive Summary explaining the relationship between these two message formats.

Figure 7: Example of a standard Radiogram message addressed to Michigan state Police Emergency Management Division.



THE AMERICAN RADIO RELAY LEAGUE

RADIOGRAM

VIA AMATEUR RADIO

NUMBER	PRECEDENCE	HX	STATION OF ORIGIN	CHECK	PLACE OF ORIGIN	TIME FILED	DATE
22	P		WB8SIW	13	HIGHLAND PARK MI	2230Z	MAY 6

To

LT WALTER JOHNSON
MSP EMD OPERATIONS
SEOC
LANSING MI

THIS RADIO MESSAGE WAS RECEIVED AT
AMATEUR STATION _____ PHONE _____
OWNER _____
STREET ADDRESS _____
CITY AND STATE _____

TEMPORARY MORGUE ESTABLISHED AT CLEVELAND INTERMEDIATE SCHOOL
13322 CONANT STREET DETROIT MI 48212

DR MILLARD BASS
DETROIT MEDICAL EXAMINER

SENDER'S ADDRESS AND PHONE NUMBER FOR REFERENCE:

REC'D — FROM — DATE — TIME

SENT KA8KDR 2230Z MAY 6 — TO — DATE — TIME

THIS MESSAGE WAS HANDLED FREE OF CHARGE BY A LICENSED AMATEUR RADIO OPERATOR, WHOSE ADDRESS IS SHOWN IN THE BOX AT RIGHT ABOVE. AS SUCH MESSAGES ARE HANDLED SOLELY FOR THE PLEASURE OF OPERATING, NO COMPENSATION, DIRECT OR INDIRECT, PAID OR PROMISED, CAN BE ACCEPTED BY A STATION OWNER. FOR THE SAME REASON, NEITHER EVENTUAL DELIVERY NOR ACCURACY OF COPY CAN BE GUARANTEED. ANY REPLY MAY BE FILED WITH THE STATION DELIVERING THIS MESSAGE TO YOU. FURTHER INFORMATION ON AMATEUR RADIO MAY BE OBTAINED FROM A.R.R.L. HEADQUARTERS, 225 MAIN STREET, NEWINGTON, CONN. 06111.

THE AMERICAN RADIO RELAY LEAGUE, INC., IS THE NATIONAL MEMBERSHIP SOCIETY OF LICENSED RADIO AMATEURS AND THE PUBLISHER OF QST MAGAZINE. ONE OF ITS FUNCTIONS IS PROMOTION OF PUBLIC SERVICE COMMUNICATIONS AMONG AMATEUR OPERATORS, TO THAT END, THE LEAGUE HAS ORGANIZED AN AMATEUR RADIO PUBLIC SERVICE CORPS (ARPSC), CONSISTING OF THE AMATEUR RADIO EMERGENCY CORPS (AREC) FOR WORK DURING EMERGENCIES, AND THE NATIONAL TRAFFIC SYSTEM (NTS) FOR DAILY NATION-WIDE MESSAGE HANDLING. THE TWO DIVISIONS SUPPLEMENT EACH OTHER IN DAILY OPERATION. MORE INFORMATION IS AVAILABLE FROM A.R.R.L. HEADQUARTERS. LITHO.—U.S.A.

Radio email and WinLink2000

The same automated PACTOR network that supports NTSD also provides automated gateways to and from the Internet via Amateur Radio Safety Foundation's Winlink2000 network, according to the terms of a long standing MOU. An authorized amateur radio station or agency can originate an email message via the Internet to an agency or individual assigned a winlink.org domain email address. It will then be pulled from the Internet and routed via the automated PACTOR network where it can be held on a radio network server for downloading by the addressee. This process

also works in reverse. In other words, an agency or authorized individual can originate an email via radio, which will then be transferred to the Internet as necessary.

Radio-email can be used in a variety of scenarios ranging from an entire grid down scenario to a partial Internet outage. For example, consider the following scenarios:

1. *Internet is only available at the point of origination*
   A FEMA official at the point of origination need only address an email to the appropriate radio station representing the served agency to which the email is addressed. This email can be originated via any Internet connected device. For example, if an addressee at a FEMA regional office is isolated from the Internet, but a NTS Radio-email equipped radio station is available, a FEMA official in DC could originate a message via the Internet to the appropriate *callsign*@winlink.org address representing that office. The message would then propagate from the WL2K internet server to the PACTOR radio network, where it would be downloaded via radio to that regional office. The DRS operator at the regional office would then route that email to the appropriate official within the regional office environment.

2. *Internet is only available at the point of destination*
   In this example, a FEMA official could use a NTS Radio-email equipped radio station to originate an email. The automated Radio-email gateway would then connect to the PACTOR network via radio. The message would propagate via radio to a working Internet gateway where it would enter the cloud in the same manner as any email message might via an exchange server.

3. Internet is unavailable at both point of origination and point of delivery
   In this example, both the originator and addressee for the email message would require access to a NTS/WL2K equipped radio station. In such an example, the email message would propagate entirely via the automated PACTOR radio infrastructure.

Registration Required

For technical, network management, and regulatory reasons, access to the Radio-email system requires advanced station registration. In other words, those individuals or agencies not already registered with the network will be unable to originate or receive emails via the Radio-email system. For the same reasons and to the same effect, this is also a requirement of the Winlink2000 system.

A positive consequence of strict station registration is that demand on circuit capacity is naturally limited. In time of emergency, network delays are minimized as email traffic propagates through the system, unhindered by casual traffic.

Limitations of NTSD and Radio-email

The high frequency radio spectrum offers excellent survivability. However, the nature of this portion of the radio spectrum is such that it is subject to selective fading, background noise and solar anomalies. Therefore, circuit capacity is limited by bandwidth and propagation issues. As such, it is essential that any Radio-email traffic be as brief as possible. If file attachments are included for transmission via Radio-email (e.g. an IC213 form), these should be limited in size with emphasis on text as opposed to graphics. In exchange for bandwidth limitations, one attains access to a survivable communications network that is decentralized and which operates without any terrestrial infrastructure.

It should be noted that Radio-email lacks some of the flexibility of standard NTSD techniques. First, users of the Radio-email system must be vetted and approved before email traffic can be exchanged using the system. This is true for NTS Radio-email as well as the ARSF's Winklink2000 radio email network and limits the ability of the system to respond dynamically to some unique disaster communications needs. For example, one might need to originate a message from FEMA to a public safety official not equipped or registered for Radio-email capability. In such a case, NTS Radiogram service would be utilized instead of WL2K Radio-email service. Second, unlike the manual delivery methods utilized with Radiogram traffic, there may be no assurance that a message was actually read or acted upon once it reaches the addressee's email "in-box." Users of email for important communications must take independent steps to ensure important message traffic is delivered and actually read.

Appendix 4: Differences between ARES® and NTS

The Amateur Radio Emergency Service (ARES®) is traditionally aligned with NTS, but its mission emphasizes the support of local emergency management functions. In many cases, ARES operators are trained to facilitate local tactical communications functions, with minimal emphasis on medium and long-haul network management and record message traffic techniques.

ARES organizations are typically structured to mirror the local emergency management process. In most cases, individual ARES unit operate at the county level. In some cases, such as large metropolitan areas, municipal ARES organizations may be established. Each local ARES program is supervised by an Emergency Coordinator (EC) who is appointed by the Section Emergency Coordinator (SEC).

Ideally, each ARES organization maintains liaison with NTS networks. However, in practice, ARES organizations are often heavily influenced by differing priorities defined by their local emergency manager. Furthermore, individual resources within an ARES organization may be reassigned based on the demands of an evolving emergency situation.

Steps are being taken to build a base of stable cooperation between the two related organizations. In the meantime, one might view NTS as the organization specializing in record message traffic and long haul messaging capabilities while ARES might be viewed as an organization specializing in local tactical functions. In reality, these tasks often overlap, particularly when message origination and delivery functions must occur at the local emergency management level.

Based on these conditions, we propose a model of FEMA support, which will emphasize the use of experienced NTS volunteers and specialized teams dedicated to a primary support role for FEMA, Liaison to local ARES programs will provides connectivity to local emergency management programs and local emergency operations centers when necessary. This arrangement will ensure that ARES volunteer resources are not diverted from local EMA tactical communications functions to support medium or long-haul networks supporting FEMA record message traffic requirements.

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