RADIO RELAY INTERNATIONAL

TRAFFIC OPERATIONS FM-001

FIRST INTERIM EDITION 2017

GOVERNANCE AND OPERATIONAL FUNCTIONS OF THE RADIO RELAY INTERNATIONAL AFFILIATED NETWORKS OF THE UNITED STATES OF AMERICA AND CANADA

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About this Manual

This publication is intended to familiarize interested operators with the basic structure, layers and standards in use today:

a) *Section One* is a brief historical perspective and an introduction of our governance and organizational structure, together with planned RRI goals.
b) *Section Two* outlines the traditional manual net structure, including liaison functions and system management.
c) *Section Three* discusses the DTN network.
d) *Section Four* covers the major policies that ensure the system's integrity and healthy functioning.
e) *Section Five* outlines policies concerning emergency communication.
f) *Section Six* introduces the *Methods and Practices Guidelines*, our definitive reference source.
g) *Section Seven* describes the radiogram format, its components and their purposes.
h) *Section Eight* describes message routing for our traditional and digital nets.
i) *Section Nine* and above provide additional references for interested operators.
j) *End Notes* for all marked references are shown at the end of the document.

Acknowledgments

Many traffic handlers contributed to this effort. Al Nollmeyer, W3YVQ and James Wades, WB8SIW deserve special recognition. It also builds on the foresight and definitive contributions of long-serving ARRL communications manager George Hart, W1NJM (SK).

Updates and Corrections

Comments, questions and suggestions regarding this *Traffic Operations Manual* are encouraged. Please direct them to any RRI area staff member. Future editions will be posted on the RRI website, www.radio-relay.org.

Important information about citations and trademarks:

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PREFACE

The first edition of the *Radio Relay International* (RRI) *Traffic Operations Manual* honors the legacy of the Amateur Radio Service in public service communications. Not only does this publication refresh traditional instruction by covering the basic concepts necessary to properly communicate using traditional modes, such as radiotelephone and radiotelegraph, it also introduces the *Digital Traffic Network* and the Radio-email concept exemplified by the Winlink system.

The RRI *Traffic Operations Manual* covers in broad terms the governance and organizational structure of *Radio Relay International*, and the RRI affiliation process and criteria.

Special emphasis is made on subjects important to traffic handlers, including the supporting role RRI can provide to local and state emergency communications organizations, emergency management and relief agencies.

The RRI *Traffic Operations Manual* serves as a handy bridge between other sources of broad treatment and the publication of future RRI internal technical reference material.

INTRODUCTION

Amateur Radio and Public Service Communications

Public service communications support has been a voluntary responsibility of the Amateur Radio Service since 1913, when radio amateurs at the University of Michigan and the Ohio State University, along with numerous individual operators in and around the region, bridged a communications gap within a large, isolated area left by a severe windstorm. In those early days, support efforts were ill-planned and lacked any formal response structure.

The communications support work performed by amateur radio is well structured and a worthy volunteer endeavor, undertaken by a number of organizations in addition to RRI. This includes programs such as MARS, SATERN, Skywarn, various independent nets and programs sponsored by the ARRL.

The RRI mission is cogent; training operators and exercising our networks daily. Our operators warmly add that traffic-handling is fun and personally rewarding. The camaraderie and friendships made are long-lasting. Taken together, RRI is a valuable public resource, particularly in times of need.

To accomplish our mission, RRI operates continuously three-hundred and sixty-five days per year handling local, medium, and long-distance written or “record” message traffic in a standard format. Through its affiliated area staffs, it employs traditional radiotelephone and radiotelegraph nets, manages inter-area liaison functions similar to the Transcontinental

Corps and maintains an automated high frequency Digital Traffic Network using an RF-only hybrid mesh topology for maximum efficiency.

RADIO RELAY INTERNATIONAL

An Historical Perspective on the Founding of RRI

Public service communications have been the cornerstone of the Amateur Radio Service. For more than a century, radio amateurs have used their frequencies and equipment to save lives, alleviate suffering, and bring word from loved ones far away. Early on, it was recognized that an organized relay system was needed to manage the increasing volume of message traffic and the increasing number of stations relaying it.

In 1916 the American Radio Relay League, Inc. proposed a system of dedicated trunk lines spanning the country, manned by qualified operators, to relay radiograms; a popular alternative to postal mail and traditional telegram service. Within two years, six trunk lines were operating, bestowing the League with national scope and purpose.

As communications technology improved, particularly during the 1920s, the League stayed focused and supportive. Procedures were developed to speed messages along accurately. The "Traffic Department," later renamed the "Communications Department," was established at League headquarters. The department worked tirelessly with members, government agencies, and with railroad and telephone companies to improve disaster communications preparedness. In the mid-1920s, volunteer field organizations were set up at the state and local levels to improve disaster response.

The trunk line system was reorganized in 1931 and the Amateur Radio Emergency Corps was formed in 1935, the origin of today's ARRL Amateur Radio Emergency Service. This further improved the efficiency of organized Amateur Radio.

In 1935, spot frequency nets emerged with the establishment of the Michigan QMN Net formed by the Detroit Amateur Radio Association. Thanks to innovations such as "master oscillator power amplifier" transmitters and crystal control techniques, these networks established systematic, scheduled traffic exchange on a single net frequency, typically serving a state or ARRL section. Early spot frequency nets would evolve into the familiar section net concept, well known to traffic operators today. They would also start a shift away from the dominant trunk line concept that served amateur radio well during its first two decades.

Following the Second World War, it became increasingly apparent that the trunk line system had not been keeping up with technical advances and more salient message radio-relay techniques. In 1949 the ARRL introduced the $New\ National\ Traffic\ Plan$.

[1] The plan, patterned after the Army Airways Communications System[2] developed during World War II, led to the formation of a system of layered networks called the *National Traffic*

System. At the upper layer were three area nets facilitating traffic exchange between the Eastern, Central and Pacific areas of North America. Specialized point-to-point circuits, manned by highly skilled operators, carried inter-area traffic flow. Within each area, regional networks directed traffic flow between individual sections. Typically, these regions coincided with FCC call sign districts. At the lowest levels, section and local nets served as entry and exit points for message traffic and provided support for local ARES® operations.

As originally envisioned, NTS at the region and area level was entirely based on radiotelegraph networks, a complete sequential cycle occurring during a single evening. Two decades of operation led to an extension into daytime cycles and the incorporation of voice modes. With the advent of digital modes, NTS became mode neutral and error-correcting modes, relay nodes, and auto-forwarding mailbox operations are in routine use today.

In the 1960s it was decided to integrate field organization programs and the ARRL attempted a consolidated structure that placed ARES, NTS and local units of the Civil Defense RACES program[3] under a single umbrella organization to be called the Amateur Radio Public Service Corps. ARPSC proved a nominal success and a degree of integration was achieved in the ensuing years.

Evolution of the NTS into the 21st century was significant with the advent of robust, error-correcting digital modes, sophisticated auto-forwarding programs, and standardized operating practices. At the heart of this evolution was the digital NTS, commonly known as Digital National Traffic System or simply NTSD. This automated system, independently developed from the original AMTOR network, enabled rapid traffic flow throughout North America and selected locations worldwide as regulations are modified to permit international traffic. NTSD offered interoperability and traffic exchange between traditional nets and the newest station appointment in the ARRL Field Organization, the aptly named Digital Relay Stations."

In 2004, the ARRL Board of Directors, acting on the recommendations of an ad-hoc ARES Committee, authorized the continued development of a Radio-email system based on the Winlink 2000 software to enhance ARES capability with rapid and accurate long range communications. [4]

Over the next several years, the ARESCOM group continued refining the software and protocols needed to achieve this goal. That system is now an operational support component to ARES.[5]

The longstanding ARRL *Public Service Communications* handbook, originally edited by George Hart with a major revision in the 1990s by a team including RRI founder Robert Griffin, served as the basic organizational and operational guide for ARES and the NTS for many years. However, after years of official neglect, it became obsolete in major respects. In 2015, a separate ARES manual was published. At the direction of the ARRL Programs & Services Committee, the NTS Area Staff chairmen and digital managers drafted and

submitted a complementary NTS manual in early 2016. The NTS manual was never published.

In July 2016, the ARRL board of directors ordered the restructuring of NTS area and region volunteer organization, eliminating elected management, and announcing the "pending development of the Second Century Public Service Communications Delivery Plan" – absent stakeholder input and a commitment to upper echelon NTS leadership involvement.

This disenfranchisement and related developments led to the establishment of *Radio Relay International* (RRI) as an independent organization with a dedicated purpose and clear principles, transparent and accountable governance, an elected management structure, and devoted operators.

Establishment of RRI

In August 2016, *Radio Relay International* was incorporated as a nonprofit public benefit section 501(c)(3) organization. Its corporate purpose and principles of operation are stated in explicit terms:

Purpose: The Corporation shall organize and provide a radio communications system in service to the world community, led and operated by trained and mentored licensed amateur radio operators as governed under applicable laws.

Principles: The principles of RRI include:

a. *Accountability*. Governance and management of the corporation shall be strictly accountable to its members, served agencies and partners in furtherance of corporation purposes and these principles.
b. *Transparency*. The conduct of corporation operations by the governing body, officers and members shall be guided by accepted standards of transparency.
c. *Mutual Trust and Respect*. Corporation service and participation shall be founded upon mutual trust and respect.
d. *Skill-Centered*. Corporation service shall emphasize the development and enhancement of operator skills and related conduct.
e. *Technology*. The corporation shall foster relevant public service radio messaging technology.

The RRI governing board has adopted comprehensive bylaws providing for:

a. Elected area and region board representation
b. Primary affiliation of area and region nets, the digital network and inter-area traffic network through approved terms of reference
c. A policy and criteria for the secondary affiliation of other facilities.

RRI articles of incorporation, bylaws, policy statements, area terms of reference, and

other documents are posted on the RRI website.

RRI Traditional Operations

Robust digital networks notwithstanding, RRI manual nets are now active at the area and region levels of operation. Our nets offer an enjoyable operating challenge and serve as the common denominator between digital operations and "the last mile" link for delivery through cooperating state or local nets. Moreover, traditional nets add a layer of survivability to RRI while providing training to enhance compliance with standard procedures and proven traffic handling techniques.

An important national benefit is our ability to deliver messages using only normal name, address, and telephone information; a service that cannot be matched by other automated digital networks. The availability of manual intervention also allows for an operator to confirm that a message has been read and understood in real-time, a feature not afforded by automatic e-mail delivery.

Volunteer Operators and Leaders

As with most volunteer public service programs, RRI relies on and is challenged by an ongoing need of manpower and leadership. The RRI system is sustained by a volunteer cadre that recognizes the importance and pleasure of traffic handling and the rewards of community service. In every sense, RRI is composed of operators and these operators are the RRI.

By design, affiliated nets and the inter-area traffic network, plus the digital network, are the constituent functions of RRI. Our individual operators are active in these functions, and many hold elected and appointed board or area staff positions within the organization. Participation is also recognized through the issuance of station certificates and awards.

Mode Independence

Today, RRI is mode independent for maximum flexibility and compatibility. By encouraging a diversity of modes, survivability and effective emergency capacity is actually enhanced. While the IATN and DTN operate using specific modes, RRI encourages the development of specialized digital modes and related techniques, particularly when proven beneficial for supporting the "last mile" of connectivity at the state or local level.

Naturally, mode availability is subject to FCC regulation, voluntary band plans, staffing resources, and liaison practicalities, but the system is actively managed for maximum flexibility. In each case, modes selection should reinforce our objective of an integrated system.

MANUAL NETS

A System of Layered Affiliated Nets

The RRI is primarily a cycle of layered, affiliated area and region nets that meet on a synchronized schedule. Traffic is exchanged by liaison stations (the *Inter-Area Traffic Network* or *IATN*) representing their respective nets throughout the RRI system. (See below.)

RRI relies upon cooperating local and section nets for the critical roles of originating and delivering third-party message traffic. This "last mile" function is essential to ensuring a robust level of rapid, professional customer service.

Cooperating Local and Section Nets

Local and Section nets cooperating with RRI may also seek and be approved as secondary RRI affiliates.

Local Nets:

The most basic net is the *local net*. There are generally two types of local networks,

Local emcomm nets serve a dual purpose of both training net for the local emcomm organization as well as a traffic network. In the latter case, the traffic routed through the network provides training value for local emcomm volunteers. These nets typically convene one to two days per week for operational tests and may handle formal traffic with schedules scaled to meet operational requirements.

Local traffic nets meet at convenient times to facilitate prompt traffic relay and delivery. In this case, their primary purpose is traffic handling. Such nets often meet daily to ensure that routine message traffic can be delivered promptly. Most local traffic nets operate on wide coverage repeaters serving large metropolitan areas. Because of relatively limited service areas, they serve primarily for the final delivery and initial origination points for traffic. To be effective, liaison must be maintained with the next higher echelon, typically a section net.

Section Nets:

A section net is the most common dedicated traffic net. In most cases, a section net will facilitate the flow of traffic throughout a state. In some large or populous states, there may be several sections, each with a separate traffic net.

Most section nets meet on 80 or 75-meters within the high frequency spectrum. The most common modes utilized are radiotelephone (ssb) and radiotelegraph (cw). However, some sections are currently developing digital section nets for the transmission of radiogram traffic at the section level.

When traffic is listed for a location outside the jurisdiction of the section net, commonly called *through traffic*, it is taken by an assigned liaison station to the next echelon, the region net.

Region Nets:

The Region net typically covers a single call sign district. For example, Michigan, Ohio, and West Virginia, all of which make up the eighth call district, fall within the jurisdiction of the Eighth Region Net (8RN). This net provides for the exchange of traffic between these three states.

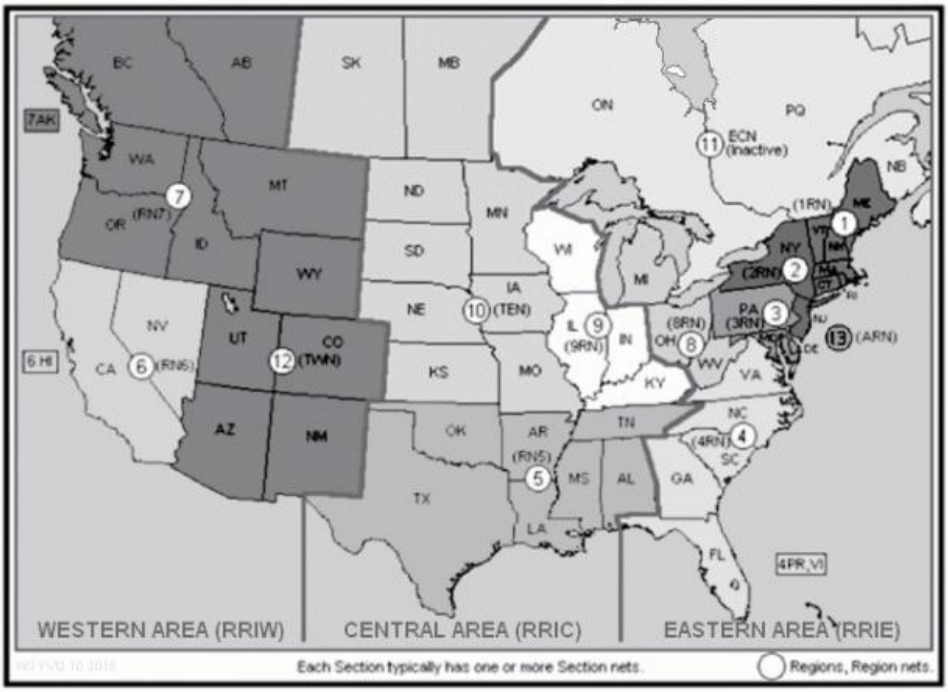


Figure 1: Map showing RRI designated regions and areas.

Region nets usually operate as closed nets. Only assigned liaison stations representing section or area nets should report into a region net. Exceptions include stations holding priority or emergency traffic, which must be injected quickly. Should a station check-in without traffic while not representing a particular section or area net, he may be excused politely by the net control station. An exception to this may be a station listing priority or emergency traffic or stations functioning within a special routing set-up during disaster operations.

Prohibition of Welfare Query Traffic

In consideration of limited network capacity, inbound Welfare or Query traffic is not accepted during the initial days of a response. External stations are requested to hold such traffic until the RRI traffic manager gives the go-ahead.

If a piece of traffic destined for a location outside of the jurisdiction of the region net is listed, it is taken by an assigned liaison station to the area net.

Area Nets

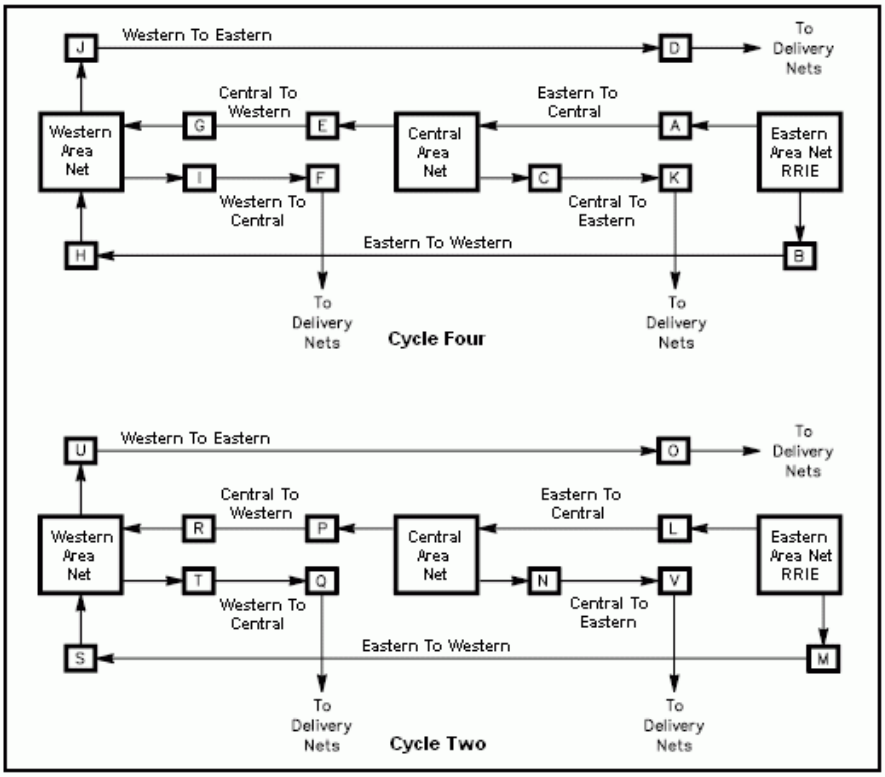
Area nets cover a broad portion of North America. There are three area nets covering the Eastern, Central, and Western service areas of the United States and Canada. These nets provide for the exchange of traffic between region nets within their respective service areas.

Traffic addressed outside the territory of an area net is passed to its destination area net via special point-to-point communications schedules which make up the Inter-Area Traffic Network.

Inter-Area Traffic Network (IATN)

The IATN is an established system of traffic schedules managed by area managers. These nets employ a group of highly skilled operators who meet to relay messages between areas. These communications circuits are typically high-speed radiotelegraph circuits or part of the Digital Traffic Network (DTN). For example, a message from New York to California, after reaching the RRI East Net, would need to be transmitted to the Western Area Net (RRIW) via an IATN schedule before it could be passed down the Western Area Net-layers to its destination for subsequent delivery. (*See Table 1.*)

Figure 2: IATN Station Functions



Message Routing Examples

Message from Michigan to Florida: A message is introduced on a Michigan section net. It then flows upward to Eighth Region Net (8RN) and then to the RRI East Net, where it is picked-up by a Fourth Region Net (4RN) liaison station. A Florida section net liaison station then transfers it from 4RN to the section net for subsequent routing and delivery.

Texas to West Virginia: A message is introduced into the Texas section net. It flows upward to Fifth Region Net (RN5) and then to Central Area Net (CAN). It is then transferred to the RRI East Net via an IATN schedule via from assigned station Charlie to station Kilo. From the RRI East Net (RRIE) the message flows down through the layers to the Eighth region net (8RN) and then to the West Virginia section net for delivery or transfer to a local net.

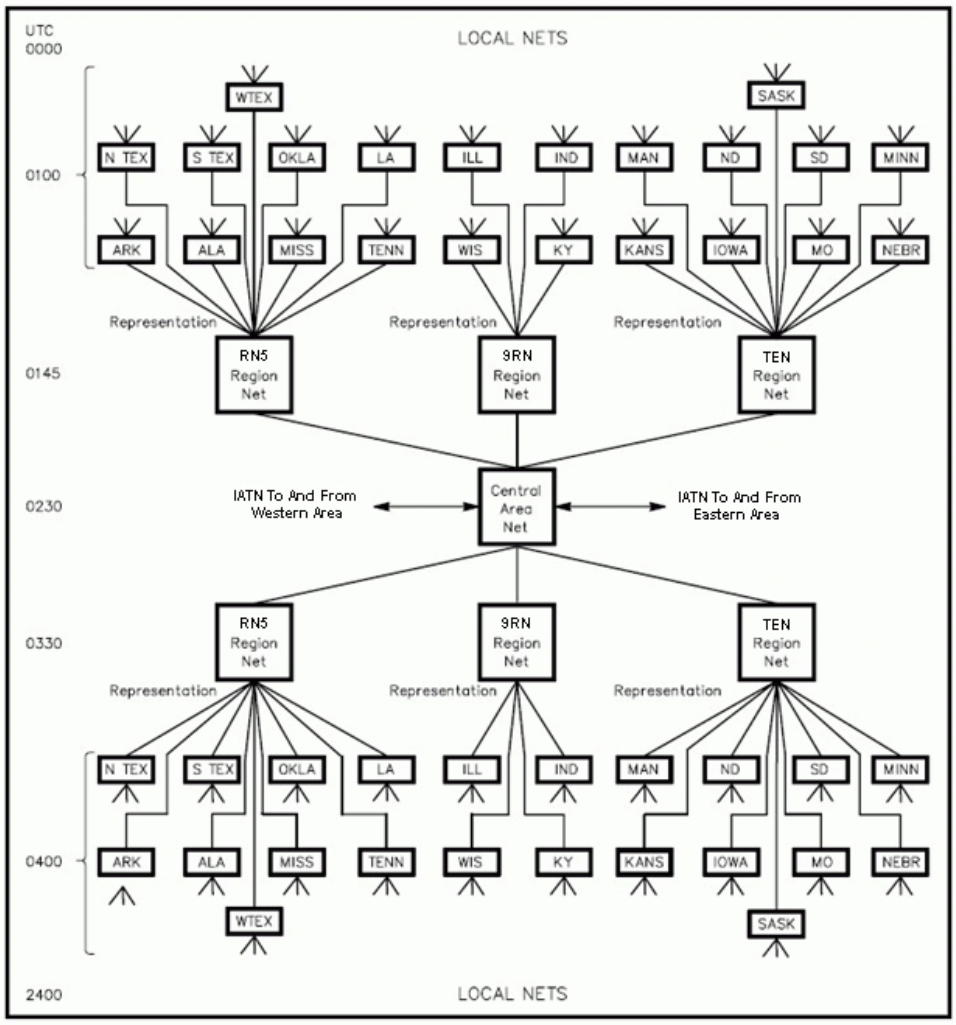


Figure 3: Example of Manual Net Structure

Cycles of Operation

There are daily cycles of operation within the Radio Relay International system. Each cycle represents a complete exchange of traffic between all manual mode nets. Only two cycles operate on a routine basis, these being cycles two (daytime) and four (evening). The daytime cycle is typically built around radiotelephone nets, and the evening cycle is built around radiotelegraph nets.

The cyclical design ensures the smooth flow of traffic during periods of heavy volume, such as holidays or communication emergencies. Cycles 1 and 3 may be activated to handle an unusually heavy volume of routine or disaster welfare traffic.

Within a cycle, the section net has some scheduling flexibility. However, region and area nets conform to their respective cycles' time slots, allowing the liaison process to work effectively. (*See Table 1.*)

Cycle One		Cycle Two	
10:00 AM	Section	1:00 PM	Section
10:45 AM	Region	1:45 PM	Region
11:30 AM	Area	2:30 PM	Area
12:30 AM	Region	3:30 PM	Region
Cycle Three		**Cycle Four**	
4:00 PM	Section	7:00 PM	Section
4:45 PM	Region	7:45 PM	Region
5:30 PM	Area	8:30 PM	Area
6:30 PM	Region	9:30 PM	Region
--	--	10:00 PM	Section

Table 1: **RRI** Cycle Timing

Note that local nets operate about half an hour before the first section net and half an hour after the last section net. The times shown are valid in the Eastern, Central, and Western (Pacific and Mountain) time zones. All nets meet at the same local time year-round regardless of the change to or from daylight time.

Operation in Disasters

RRI is not designed to replace the public switched telephone network or the Internet. Rather, RRI maintains a highly survivable, all-rf network for use during emergencies that may require medium to long-haul communication capabilities. It stresses training and practice in standard network procedure and general operating skills.

During normal times, deviation from the routing system is considered detrimental to the health of the system as it undermines liaison functions and diminishes training value. However, in emergencies, management can activate additional cycles and establish special

routings or point-to-point circuits for important message traffic. These temporary routings may bypass portions of the system to support essential operations and ensure the timely routing and delivery of priority or emergency traffic.

Cooperation with other Programs

RRI is an independent system. Its affiliated nets, digital network and other facilities function on a cooperative basis with other traffic-handling programs and services such as the American Radio Relay League's ARES® program.

DIGITAL OPERATIONS

A robust, continuous and fully integrated hf digital system – the *Digital Traffic Network* (DTN) -- operates as an independent system affiliated and coordinated with RRI. DTN is also structured on geographical lines and is supervised by three Area Digital Managers (ADM) who are members of their respective area staffs. The ADM appoints region hubs and Digital Traffic Stations and sets area operational practices. Integration of the area and region hubs is a major collaborative effort of the ADMs. [6]

Overview

The DTN is a network of computer assisted, automatic digital stations serving as forwarding hubs or "mailbox operations" assigned to standard frequencies established for automatic control.[7] *Digital Traffic Stations* (DTS) connect to their local hubs for message posting and retrieval according to defined routing logic. The DTN functions in parallel with RRI affiliated nets and facilities, with traffic exchange occurring between the DTS and section or local level nets.

Hf circuits are used for area and regional hubs, while dedicated vhf packet bbs or node facilities often provide local and, in some cases, section coverage. The high frequency infrastructure is built around Pactor 3 methods, designed for automatic operation and capable of reliable throughput under a wide variety of propagation conditions.

It is important to understand that DTN is an all-rf network. It offers a number of advantages over manual traffic nets, including low staffing overhead and the ability to operate continuously. The Pactor network is also backwards compatible with older, inexpensive Pactor 1 modems, permitting system access for many amateurs who otherwise would be excluded.

While the term *mailbox operation* or MBO, is used interchangeably with *hub*, DTN MBOs do not suffer the limitations of early packet mailbox systems. DTN hubs are highly versatile, automated network nodes capable of performing numerous functions, far exceeding those early packet radio applications.

Policy Framework

DTN digital stations and MBO hubs subscribe and adhere to the *DTN Guidelines*, the *Terms of Reference* for the RRI system. Area and region hubs may promulgate more detailed guidance within its jurisdiction. [8], [9], [10]

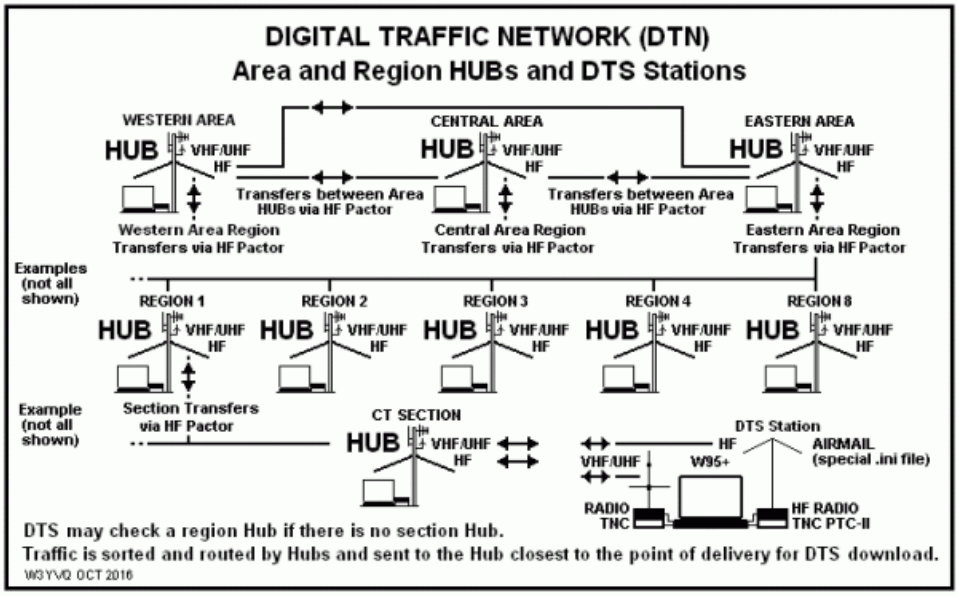


Figure 4: Digital Hub Operation

Digital Practices

As DTN operations have matured, coupled with improved and more sophisticated computer software, the area digital managers have developed and put in place standard practices to help assure an effective system. DTN hubs contain many advanced features that are superior to the older packet mailbox systems with which many radio amateurs are familiar. The *Methods and Practices Guidelines* should be referenced to learn more about these advanced capabilities.[11]

The DTN system handles standard radiograms and the hybrid form of radiograms carrying email-formatted texts, such as ICS-213 form content. Messages of either type are routed to the closest point of delivery using the state and zip code entered in the radiogram address.

The area DTN hubs, with assistance as required from DTS stations, can also provide the means to forward Radio-email traffic anywhere in the country via HF Pactor, station-to-station, radio-all-the-way.

Area DTN hubs are equipped to access the Radio-email system and can accept radiogram traffic for posting as text files attached to Radio-email messages in the batch file format. This provides a bridge between emcomm-designated stations to permit posting of volumes of radiogram messages from anywhere via hf Pactor, particularly within the last

mile of disaster areas. *All radiograms posted to the DTN must be in individual format and booking is not permitted*.[12]

The Digital Traffic Station Function

The Digital Traffic Station function deserves special treatment in this overview due to its position as an interface to both manual RRI-affiliated modes as well as directly to served agencies or other emcomm facilities.

The DTS is appointed by the area digital manager, on a consultative basis, as an authorized user of DTN. It is equivalent to a liaison station for manual nets and may be assigned various responsibilities:

Liaison to section and local nets: The DTS may act as liaison to cooperating section and local manual-mode traffic nets. In this respect, he functions in the same manner as a region net representative. In doing so, he downloads message traffic destined for his assigned section and transfers that traffic to section or local nets using radiotelephone, radiotelegraph, or other data modes. Likewise, he may accept traffic destined for outside his section (through traffic) and upload it to the region mailbox for subsequent automatic routing via DTN.

Liaison to emcomm net: A DTS may be appointed to act as liaison between a local emcomm network and DTN. In such cases, the DTS should regularly originate and accept traffic for the weekly emcomm net in order to maintain the necessary skills and competency needed to function effectively on the network in time of emergency when high traffic volumes can be expected.

Direct liaison to state and Federal Agencies: A properly trained and equipped radio amateur may be appointed to facilitate DTN access to a state or Federal or other supported emergency response agency through an in-house facility equipped with Pactor. This is typically authorized under a memorandum of agreement with RRI.

DTS functions within NCERT: Each RRI *National Communications Emergency Response Team* (NCERT) is equipped with advanced Pactor capability in addition to other RRI-affiliated manual modes of communications. This means NCERTs are also classified as DTS. [13]

Last-mile connectivity: The DTS function adds a high degree of flexibility to the DTN system by facilitating the transfer of radiogram traffic to manual-mode networks for last mile routing to a disaster area. This facilitates access to DTN from VHF or HF portable, mobile or basic fixed station equipment that lacks Pactor capability. Examples might include a NCERT member using a low-power CW transceiver or manpack radio unit from within a disaster area.

Radio-email Connectivity: The DTS may act as liaison to cooperating section and local

manual-mode traffic nets for handling messages on the Radio-email layer. A DTS may connect to the Radio-email layer through a Winlink gateway and should be capable of station-to-station relay of Radio-email. This is to say a DTS may check into local and section nets as the DTN or Winlink liaison. (*See the Radio-email section below.*)[14]

The Radio-email System

Radio-email capability offers real-time, continuously operating, nation-wide digital messaging services in the standard email format between all stations, including those at served agencies, at locations with public welfare messaging needs, and at stations coordinating the emergency communications response via amateur radio.

The Radio-email system draws on DTN and other qualified stations operating on the Winlink network to exchange Radio-email, station-to-station, with "RF-all-the-way" linking. The Radio-email system provides messaging in the standard email format with multiple addressees and copies plus binary attachments. The Winlink network also provides a messaging path to and from addressees on the public Internet, through a firewall and whitelist security bridge. Radio-email may also be used to transport bulk radiogram traffic in the batch file format to DTN area hub stations for posting and forwarding, and can carry radiograms between all client stations and addressees on the public internet.

The Radio-email system is an additional layer of communications separate from DTN or RRI; however, stations participating in other public service communications programs or services may use Radio-email to intercommunicate using Winlink or station-to-station linking. Thus Radio-email becomes a common layer for total agency interoperability communications via amateur radio, using the familiar email format.[15]

POLICIES

RRI Affiliation and Support

The RRI governing board has adopted a primary area, region, IATN and digital system affiliation process, and a secondary affiliation procedure and criteria for other nets. Through affiliation, these nets and facilities commit to important RRI principles, policies, standards and procedures – and gain representation on the area staffs and governing board, as well as access to RRI and affiliated support services.

Sequence of Nets

Routine net sequencing:

Proper net sequencing is essential to the balance between voluntary cooperation and RRI policies and procedures. A symmetrical, four-cycle sequence is the current standard scheme.

Cycles two (daytime) and four (evening) are operational in all three areas. In addition, cycle one may be partially implemented by some nets in the Western area, and cycle three is implemented in the Eastern area to facilitate inra-area and west-to-east traffic flow. Cycles one and three were initially designed for high-volume situations to improve and enhance the response to emergency and overload situations. However, the entire four-cycle sequence can be activated in three-hour shifts when needed. [16]

The sequencing plan calls for area nets at 11:30am, 2:30pm, 5:30pm, and 8:30pm local time, lasting no more than sixty minutes to clear inter- and intra-area traffic through assigned IATN functions and liaison schedules. The system is symmetrical, regular, and repeatable. It ensures net sequencing is consistent from area to area, while sessions remain naturally staggered by virtue of their local time zones. It should be noted that stations within the Mountain Time zone operate with the Western Area using Pacific Time.[17]

IATN Function Scheduling:

IATN functions are out of net schedules, arranged between operators with complete discretion as to band and mode selection as well as a degree of scheduling flexibility.

For example, the gap between WAN cycle two and EAN cycle four is enough time for a complete IATN schedule, followed by a direct check-in to an Eastern Area section net. With such efficiency, same-day radiogram delivery is routine.

Thanks to time zone progression, IATN schedules flow within the same cycle for westbound traffic, but eastbound traffic flows from one cycle to the next.

For another example, eastbound IATN functions connect Pacific daytime sessions with Eastern evening nets, while Western area evening sessions connect with the first Eastern net of the next day.

Emergency sequence expansion:

Emergency sequence expansion, beyond the four standard cycles, augments system capacity while preserving normal daily sessions. This is important to maintain order, minimize confusion, and provide a predictable gateway for ENCOMM-related services and other operators joining our nets under stressful conditions.

Expansion duplicates an existing schedule in an adjacent three-hour period. Additional area sessions can be held, along with associated region, section and local nets, as traffic necessitates.

The significance of this concept is that it combines the discipline and training of a predetermined schedule, with the spontaneous determination of the level of activity required for any specific emergency exercise.

a. The goals of the four-cycle plan are as follows:
b. Ensure daytime and evening RRI-affiliated services are part of a single, unified system
c. Resolve net-time conflicts between areas
d. Enhance daytime/evening participation
e. Ensure IATN functions provide daytime/evening crossovers, so that traffic is delivered in the next available cycle of RRI, regardless of time of day or mode.
f. Ensure the system will be consistent from area to area, from cycle to cycle.
g. Ensure evening participants will understand and support the daytime cycle and vice versa with no additional training and traffic flow or net functions will not be compromised by irregular net sequencing.

Options

RRI is a volunteer-operator traffic system, and it is not always practical to find volunteer operators who are able to participate in nets at various levels at particular times. While in principle RRI-affiliated nets find the operators who can participate at the time designated, rather than change the time to suit the operator, there is occasionally a necessity for a certain amount of non-uniformity in net meeting times. In such cases, options may be exercised at the discretion of the net manager. However, any such options are to be considered temporary and a return to normal RRI-recommended operating times should be made as soon as possible. Cooperating local and section management should be consulted and advised when establishing or modifying a net schedule.

Whenever changes from normal routings and sequences are made, the appropriate area staff coordinator and designated RRI officers should be notified so that accurate net information will be available at a centralized point. In RRI, the right hand should always know what the left hand is doing. *No RRI-affiliated net should be considered independent of, or unconcerned with, the functioning of other parts of the system.*

Deviations from Normal Routing

Failure to use the normal routings described above, if carried to the extreme, will result in strangulation of one or more RRI-affiliated nets at the region or area level. That is, if cooperating section nets send representatives to other section nets to clear traffic direct instead of through the region net, the region net will starve for traffic. Similarly, if region nets maintain direct liaison with each other instead of through the common medium of the area net, the latter will have little traffic and will not prosper. It is in the interest of efficiency, organization, training and conservation of skilled personnel to use the RRI structure as it is intended to be used. However, some deviation is permitted under normal conditions if absolutely necessary to ensure timely delivery of message traffic.

Any station participating in an RRI-affiliated network, regardless of the function the operator performs, who receives a message destined to a point in his local calling area, should deliver that message rather than filter it further through the system. There are many metropolitan areas that straddle net coverage boundaries but have common toll-free telephone coverage. One must exercise good judgment, however, by not abusing toll-free telephone service to starve local nets.

Adherence to Schedules

Since RRI depends on chronology of net meetings to achieve efficiency, it naturally follows that adherence to RRI schedules is of great importance. In particular, IATN and liaison stations should not be held on any affiliated net beyond the time they are scheduled to meet another net, even if all their traffic has not yet been cleared. Leftover traffic should be held, put on alternate routes including the DTN system, or handled by special schedule later.

Along the same lines, RRI-affiliated nets should not operate beyond the time allotted to them. The time sequence in $Table\ 1$ also defines the normal maximum length on nets at the various levels.

Alternate Routings

Deviations are made from normal routings only when normal channels are unavailable or emergency response requirements dictate a deviation. A return to the use of routine RRI-affiliated channels should be made as soon as possible. The net manager shall be the judge as to whether normal facilities are available, satisfactory or adequate when making any deviations. Alternate routing, if and when necessary, may include the use of established or specially arranged schedules, direct liaison to the destination net, use of digital options or independent nets.

Net Check-in Policy

Local and section level traffic-handling nets typically invite amateurs located within the coverage area of the net to participate. At the higher RRI-affiliated levels, participation is normally restricted to designated liaison stations.

Stations outside the coverage area of the net, or other undesignated operators checking in with traffic will be cleared provided they can maintain the pace of the net as to procedure and speed. Such stations reporting in without traffic should be promptly excused by the NCS unless they can supply outlets unavailable through normal channels. Visitors to RRI-affiliated nets should bear in mind that these nets operate on a strict time schedule and that discourtesy is not intended in observance of the above check-in policy.

Boundaries

RRI-primary affiliated net coverage areas are strictly defined and strictly observed in daily operation of the system. At the region level sections are combined into boundaries based generally on FCC call districts, (First, Second, Third, and Eighth), but some region nets cover parts of two or more FCC call sign districts. At area level the original basis was standard time zones, and the boundaries still roughly follow these lines without dividing any sections. The RRI routing guide gives details of boundaries of the levels of operation. [18]

The DTN system of designated hubs is organized at the area and region levels, with an area digital manager in charge of operations across an area.

Nomenclature

RRI-affiliated nets at the region and area level officially carry the name of the region or area they cover such as Sixth Region Net, Western Area Net, etc. Net designations at these levels vary somewhat e.g., First Region Net is 1RN, Fifth Region Net is RN5, Twelfth Region Net is TWN and Eleventh Region Net, the only Canadian region net, calls itself Eastern Canada Net and uses the designation ECN.

Lower level RRI-secondary affiliated or cooperating nets customarily allude to the name of the state or sections they cover, but the actual name used is determined at the discretion of the net. Some examples of section net names include the “Pine Tree Net” of Maine, Ohio’s “Buckeye Net,” the “Northern California Net” of five California sections and QMN the Michigan CW Net.

DTN hubs are usually named for their respective regional nets abbreviated in the manner of “DTN-3” etc.

Combined Section Nets

Some states with little or no traffic interest have not organized section nets. In such cases, two or more sections have combined their facilities into a single net operating at section level. This latter practice is considered a desirable one when circumstances make it necessary and feasible, and such a combined-section net can cooperate with RRI-affiliated nets in the same way as any other section net, with liaison to upper echelon nets supporting the covered sections or network.

It is recommended that traffic handlers and emergency communications personnel in states without a section traffic net or digital node take steps to organize one with liaison representation to an RRI-affiliated region net or DTN region hub via the DTS function.

Limited Load Policy

Because RRI-affiliated manual facilities operate on a time sequenced schedule combined with a definite flow pattern, heavy load situations present issues common to all

communications systems. Thus, in normal times, the system observes a limited load policy. It is the general policy of RRI to strive for handling the greatest quantity of traffic through efficiency rather than through long hours of operation. RRI-affiliated nets must begin and terminate within certain time limits in order that liaison can be maintained without delay. If traffic is not all cleared within the time limit, it is considered overflow traffic and must use alternative routings including the Digital Traffic Network, or it must be held over for a subsequent net session.

Load capacity can be increased by providing additional stations to carry on liaison functions and IATN operations; by providing separate receive and transmit stations; and by pre-net sorting of traffic by region and area, concentrating the traffic in the hands of separate operators. This allows more expeditious operation in the area net. Use of the DTN is also encouraged.

Observation of Schedule Times

In order to avoid confusion and effect standardization, RRI-affiliated nets should endeavor to meet at their designated times. Where temporary deviations from schedule are necessary, care should be taken to avoid adversely affecting the traffic flow. Likewise, such deviations should not cause interference to other RRI nets because of time differences. Scheduled nets should never be left unguarded. The net manager is responsible for ensuring that sufficient net control operators are available for all net schedules. Individual net members should be prepared to call a net (QNG) if it is not called by the assigned NCS within a few minutes of its scheduled time.

Frequencies

With the exception of the RRI National Response Plan frequency/mode matrix, there is no specific RRI frequency plan. Each RRI-affiliated net selects its own operating frequency based on consideration of its requirements. Because in an emergency it may be necessary to operate many nets simultaneously, which ordinarily operate at different times, it is desirable for nets within normal interference range of each other to use different center frequencies when possible. Within this consideration, it is also desirable to concentrate net operations on as few spot frequencies as possible to conserve frequency space and to make full use of those spot frequencies in order to help establish occupancy. Nets may also designate primary, secondary and tertiary frequencies to facilitate flexibility based on propagation or emergency sessions, which may occur at unscheduled times.[19]

Selection of Managers and Other Appointees

By RRI policy, primary affiliate net, IATN and digital hub managers are chosen by the respective active operators who qualify as net members. These managers serve on the area

staff and elect from the staff membership an area staff coordinator. The area staff coordinator and area staff full members are elected by each area staff as representatives on the RRI governing board.

The area digital managers are responsible for appointing HF region hubs and DTS.

RRI Certification

RRI net certificates are available at all network levels. An RRI operator is eligible for a net certificate when he has completed three months of performance, at least once per week, on an assigned basis, of one or more of three essential duties:

a. *Regular participation as a net station:* This includes regularly checking into the net and availability to accept or originate message traffic. No credit is given in region or area nets for random participation.
b. *Net Control Stations:* Operators serving as NCS of net sessions on an assigned basis.
c. *Liaison Assignments:* This applies only to regular liaison with their proper region or area nets; in the case of area nets, liaison with other area nets through regularly-assigned functions within the IATN.
d. *IATN Certificates:* Certification as an IATN operator is available through the IATN area manager on completion of at least three months of regular performance of an assigned function.
e. *DTN Certificates:* area digital managers issue certificates to DTN region hub operators and DTS operators based on similar criteria. IATN and DTN managers have the discretion to excuse any station working for a certificate if that station is unable to perform its regular duty in any specific instance.

Managers shall exercise sole discretion in designating active operators for the rosters, and as to whether a duty, even though performed regularly, is performed adequately to merit certification.

Special Liaison Methods

Managers at region and area levels will often find that, while one section or region can send few or no liaison stations, others have sufficient personnel to send several. In such cases, it is possible and perfectly permissible for the higher-level manager to propose to the lower-level manager an arrangement by which any excess operators can be used to effect liaison. For example; if a region net manager finds that many stations are available to represent section A in his region, but section B is seldom represented, he may then contact the manager of the section B net and propose that a section A station be sent to the early

meeting of section B to take its through traffic. This station then brings such traffic to the region to be distributed amongst net stations as required.

In addition, a section A station in turn may be designated to receive all section B traffic; this station then reports into the section B net to clear this traffic. Both receiving and transmitting functions must be completed for full representation. The above technique is an alternative method of getting the traffic through and is under no circumstances to be used in preference to having each section directly represented on its respective region net.

Normally, liaison from a lower-level to a higher-level net is the responsibility of the lower-level net manager.

Volume Routine Traffic[20]

A number of stations generate routine traffic in volume as a replacement for traditional, person-to-person radiograms, rare since the advent of universal Internet access and toll-free long distance calling. These messages have an important role, as they may represent most of a traffic net's routine activity. Many delivery operators enjoy them outright as a means to welcome new hams to our hobby and as a way to make new friends in the process.

If proper care is taken when generating such traffic, for example, targeting new radio amateurs for "welcome wagon" greetings[21] and restricting HXC requests, such messages can be a bonanza for training, recruiting and public relations for local clubs, emcomm units and anyone interested in promoting amateur radio to the general public.

Volume routine traffic is a natural fit with our digital network, which supports file import through a number of applications. If you are interested in originating such traffic, please confer with your local net manager or section traffic manager and your area staff coordinator before commencing.

EMERGENCY SUPPORT OPERATIONS

Overview

RRI shifts its role when called upon to handle health and welfare third-party messages or to provide served-agency support traffic. If support conditions require, RRI is capable of expanding its cyclic operations, or it may add special routings and point-to-point circuits to add message load capacity and relay speed.

In the event of a communications emergency, the emcomm coordinator(s) assigned to the emergency situation assesses communications needs with responding served agencies. The allocation of communications resources to specific emergency response functions then follows.

If it is determined that RRI support is required, the decision and resulting action to alert RRI management may be performed by any combination of appropriate officials, depending

on the urgency of the situation.

Health and Welfare Messages

One of the biggest problems in a disaster is the handling of so-called health and welfare traffic and disaster welfare inquiries. The recommended precedence for this type of traffic is *W* or *Welfare*. Such message traffic is handled before routine traffic, but after priority or emergency traffic. [22]

The proper management of welfare messages requires a full understanding of the differences between disaster welfare inquiries originated outside a disaster area and welfare message traffic originated from within a disaster area:

Disaster Welfare Inquiries: When a message is originated outside a disaster area and addressed to an individual within the affected area, the odds of timely delivery are quite low. By definition, disasters displace individuals. Local telecommunications infrastructure is often inoperative. Roads may be impassible and access to many locations may be restricted. Familiar landmarks, street signs and street numbers are often missing, making a direct hand delivery of an inquiry message difficult at best. Often, personnel are not available for such tasks.

As a matter of policy, disaster welfare inquiry traffic directed into a disaster area is discouraged for all of the above reasons. Even when the addressee can be located, such messages consume significant manpower and double the demand on circuit capacity by either generating a reply or a service message in response to the original message.

Welfare Message Originations: A better option for managing welfare message traffic is for emcomm organizations and RRI management to work together to develop guidelines for originating welfare messages from within a disaster area. Welfare messages can be generated from locations at which displaced individuals congregate, such as relief agency shelters, hotels, or even rest areas along evacuation routes. By originating outbound welfare message traffic, one has a reasonable assurance that the address to which the message is directed is valid and the addressee can be conveniently contacted.

While served agency traffic always takes priority, welfare messages can be originated during quiet periods on alternate radio circuits or when personnel and network circuit capacity is available to do so.

The modern DTN and Radio-email digital systems may be used effectively for moving welfare traffic out of a disaster area by DTS stations or other trained operators, directly from the point of origin, by connection with DTN area hubs, Winlink gateway stations, or station-to-station Radio-email connections, thus avoiding loading local emergency nets busy with other traffic. No additional intermediate manpower is required.

Unfortunately, full control over the origination of welfare messages is not always possible. In some cases, the influx of disaster welfare inquiry traffic into the disaster area

may be large, and RRI may be called on to assist with this overload. The RRI policy with respect to the handling of such traffic is to handle as much of it as possible, but to adhere to its precedence. Higher-precedence traffic must be handled first, with welfare traffic handled only when the circuit is free. Routine traffic is not normally handled by an RRI-affiliated net operating under emergency conditions, because limited circuit capacity is allocated to higher precedence message traffic. However, should a disaster circuit be temporarily available, there is no reason why it cannot be utilized for welfare traffic until it again becomes occupied with higher-precedence traffic.

Experience shows DTS and Radio-email stations can be used effectively to receive and archive incoming welfare inquiries for review by stations in the affected area, thereby facilitating delivery as conditions permit or for handing such traffic off to relief agencies for subsequent disposition. No additional intermediate manpower is required, but consideration must be given to the loading of digital circuits used for other emergency related traffic.

There are a number of ways in which the public interface can be managed, but few of

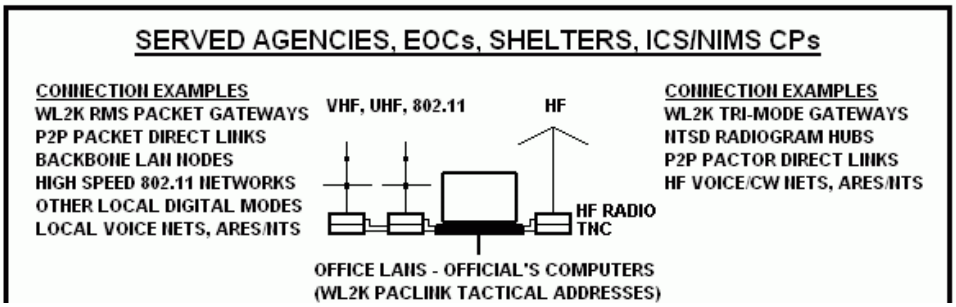


Figure 5: Station Deployment Example

them are consistent with public relations objectives. The best way to handle such situations is to maintain close contact with the Red Cross or the Salvation Army as appropriate, since most inquiries are handled through these organizations. However, until or unless a means for handling such traffic is established, it is usually wise not to accept it from the general public, or to do so only with an explicit understanding that chances of delivery are not guaranteed.[23]

Radio-email System Support

The need for medium and long-haul messaging during emergencies creates special demands on communication resources, which are sometimes unsuitable for local networks. Emergency response agencies have identified a critical need for back-up communications between agencies and for wide, even national, coverage. The Radio-email system is designed to meet that challenge. Its purpose is to provide, as much as practical, total agency interoperability and automated messaging services on a real-time basis without the need for intermediate manual relaying manpower.

The Radio-email system is uniquely suited to providing Winlink access and peer-to-peer linking by assigned stations and trained operators. The approach provides a fully integrated messaging layer to last mile communications and interoperability. The message formatting choices include the regular email format familiar to officials, the ability to carry ICS form text content, the ability to carry radiograms, and the ability to access public internet email services available outside the last mile via Winlink over radio. The layer also provides an intercom bridging function between suitably equipped stations in all functional nets. Both Winlink and peer-to-peer connections provide communications during periods of total ground infrastructure loss.[24]

Trained emcomm and RRI-operator stations, including DTS and stations operating in NCERT, can provide a rich variety of traditional and digital services. The choice of equipment is based on that suite of services needed by the agencies, EOCs, and deployment sites. Multimode TNCs for Pactor 1 may be used for DTN interfaces, Pactor 3 modems for DTN, Winlink and other high speed Radio-email functions, for example:

a. Radio-email service to all elements participating in a response, whether via packet, Winlink gateways or point-to-point connections.
b. extension of Radio-email service over areas under NIMS command when such areas extend beyond normal section boundaries, nets, and networks.
c. email service to and from public Internet addresses via rf Winlink.
d. posting radiograms to area hubs using hf radio.
e. efficient digital exchange of agency and radiogram messaging between stations in designated jurisdictions.
f. radiogram posting and delivery via NCERT DTS.
g. tactical address service for multiple agency work stations through Winlink.
h. an efficient means for generating and posting public welfare radiogram traffic where email addresses are not available.
i. receiving and archiving incoming welfare traffic for local processing.
j. connectivity to local digital networks, digitally and via repeater audio.
k. linkage to wide area backbone networks.
l. hf/vhf/uhf voice connections on local nets.
m. a terminal point for local high speed TCP/IP, 802.11, networking.
n. D-Star or data link terminal point.

The key consideration is total agency interoperability, without the need for intermediate relaying manpower or manual message manipulation, on virtually a real-time basis, anywhere. The use of Radio-email in conjunction with other emcomm support and related capability achieves these objectives and provides better integration of the services brought

to bear in the situation. In fact, Radio-email reaches across all deployments.

National Communications Emergency Response Teams

The RRI governing board has authorized the development and maintenance of *National Communications Emergency Response Teams* or the *NCERT Concept*. These are specialized teams of dedicated volunteers capable of establishing a message center either within a disaster area or at a key served agency facility, such as an emergency operations center. The NCERT concept is not designed to compete with other emcomm support services. Rather, it is intended to deploy a specialized emergency messaging capability. Each NCERT is equipped with all common traffic handling modes including radiotelegraph, radiotelephone, digital Pactor, and selected local modes for direct interface to other emcomm support assets. This includes DTS capabilities for packet, Pactor Winlink gateway and peer-to-peer Radio-email connections, as well as direct DTN hub connections.

NCERTs are chartered by their respective RRI area coordinator. Membership should include operators recommended by local net managers in cooperation with the area staff coordinator. Partnership and close cooperation with emcomm support management is encouraged.[25]

National Emergency Communications Coordinator

The RRI governing board may appoint a National Emergency Communications Coordinator. The NECC is responsible for developing and maintaining an up-to-date National Emergency Communications Response Plan in cooperation with stakeholders; coordinating RRI participation in Federal and other emcomm support program exercises; developing, implementing and evaluating periodic RRI emergency messaging drills; and developing, implementing and evaluating periodic RRI disaster communications exercises.

The NECC functions in coordination with the area staff coordinators and reports to the RRI governing board chair. This position typically has both an extensive background in RRI-related operations, solid emcomm support experience and professional experience in emergency management operations.

GUIDELINES

Overview and References

RRI has adopted a comprehensive document for its functions, which places particular emphasis on the conduct of nets. These formal methods and practices are ideal for promoting operator training and improving the effectiveness of net operations. These guidelines serve as the standard for all training materials and functions as well as serving as a guide for individual on-air operation. This document is referred to as the *Methods and*

Practices Guidelines or commonly the MPG.

RRI operators should consider the MPG an essential reference document for specific questions about operating procedures, net practices and other policy details. It is a compilation of traditional and digital messaging-handling procedures, and Radio-email protocols; a useful guide for preparing local tutorials covering emcomm support and traffic-handling. Additional tips and technical articles are made available on various web sites maintained by RRI.

Alternate Training Materials

A review of available training material developed by numerous individuals and nets throughout the United States and Canada reveals some variation. Much of this information is helpful and it can therefore offer additional insights for RRI volunteers. However, such information does not supersede the definitive content contained within the *Methods and Practices Guidelines* document. At all times, the latter resource should be considered the primary source for questions involving RRI methods and practices.

MESSAGE FORMATTING

Overview

Effective radio communications support is based on a variety of factors including accountability, accuracy and network management. Therefore, any message filed for origination via a communications network must include data that assigns responsibility for message content to the originator; identifies the station which introduced the message into the network; specifies context, such as from where the message originated, the date and time at which the message was drafted and presented for origination, defines network topology and facilitates the transmission of replies, service messages and inquiries from the point of delivery.

These requirements are particularly critical in the case of served agency traffic originated in time of emergency. Furthermore, there is a strong consensus by all stakeholders that supports the use of a common, universal message format for both routine and emergency situations.

There are several message formats available for use:

The *standard radiogram*, which uses capital letters, figures, or slant bars, with text usually limited to about 25 word groups (except for agency traffic during emergencies where higher practical limits are permitted). This is the version normally used for all-mode messaging.

The *optional radiogram* using capital letters, figures, or slant bars for all parts except the text which may be entered in email-format using case sensitive letters, figures, and

normal email punctuation. This hybrid format retains the necessary network management data, but is intended for transmission via the DTN digital hub system for delivery by DTS stations by digital means. It is typically used for sending ICS form and similar texts through the DTN system. [26]

Radio-email messaging in full email format with multiple addressees, copies, and binary attachments, used for sending messages via Winlink or peer-to-peer connections to clients anywhere. There are four subtypes of Radio-email:

a. *Type 1* carrying radiograms sent to only one client
b. *Type 2* regular email format
c. *Type 3* sent to only one client with a radiogram preamble and address in the body text for manual delivery, and
d. *Type 4* Radio-emails sent to a client by peer-to-peer connection to be forwarded onto the Winlink, DTN, or other networks to other addressees. [27]

Standard Radiogram Format and Components

The radiogram format incorporates *essential* accountability and network data required for effective transfer of record message traffic through both manual-mode nets and through digital system circuits. The radiogram format ensures full interoperability by facilitating the transfer of intact accountability and network management data in association with essential message content through multiple network layers and between all available modes of communications. (*See Figure 6.*)

The radiogram message format is required for traffic transferred through the RRI system. Its application has been found to serve as a baseline for a wide variety of formal messaging and its essential components are shared with other agency messaging formats.

A standard radiogram contains a *preamble*, *address*, *text*, *signature*. The *preamble* consists of the essential network management data and address. *Addresses* should include full name, street address, institution name, city, state, ZIP code, and telephone number for delivery. An email address may be included.

Only capital letters, figures, and slant-bars are permitted in the radiogram. The letter X is used as a substitute for the period in the *text*. The letter R is used as a substitute for the decimal point in figure groups. The word DASH is used to offset the extra four digits of long zip codes (five-digit zip code are the default standard). The word DOT is used as a substitute for the period symbol in URLs and email addresses. These sequences must be re-written to use only permitted word groups, figures, or slant-bars, in such a way as to permit reconstruction of the address by the delivering station. No other punctuation symbols are used in the message, except spelled out as word groups in the *text* where needed. No part of the radiogram is altered once it is entered into the system, except for amending the *check*

in case of discrepancies by adding a slant-bar followed by the corrected check, or addition of op note information which may be helpful for routing, delivery, or servicing discovered by subsequent handlers.

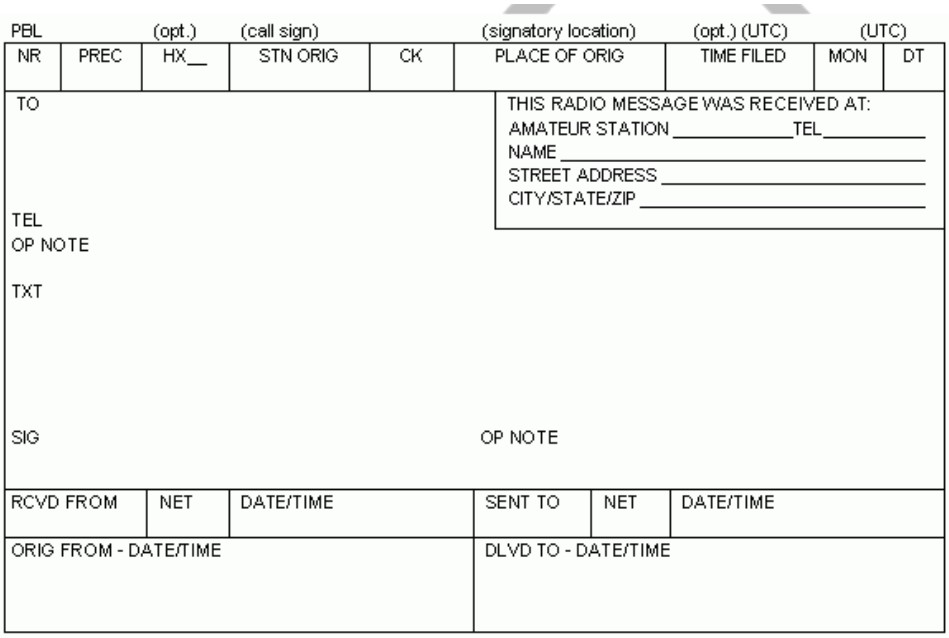


Figure 6: Standard Radiogram Format

Preamble Components

Message Number: A serial number is assigned to all messages originated by an amateur station. It is preserved during relay and delivery and should be referenced in related replies and service messages. The message serial number greatly speeds the process of locating a message in a large file within an emergency operations center, command post or busy station.

Message Precedence: Each message is assigned a *precedence*, which is a declaration of its relative importance based on consultation with the originator. A *precedence* allows stations to prioritize traffic order when communications circuit capacity is limited Use only the single letters *R*, *W*, or *P* except for *EMERGENCY* which is always spelled in full. Exercise and drill traffic not marked *Routine* must add *TEST* before the designator.

Handling Instructions: abbreviated HX, provide special instructions to relaying and delivery stations. Its use is optional with the originating station but once inserted is mandatory for all relaying stations.[28] More details on handling instructions are provided below.

Station of Origin: This is the call sign of the first station to place the radiogram into the network. Even if a message is transmitted on behalf of another radio amateur, the

station of origin remains the call sign of the station that introduced the radiogram into the relaying system. This helps define network topography and facilitates the origination of replies or service messages.

Check: The check or group count numbers words or character groups in the text of the message. This promotes accuracy by requiring the receiving operator to count the groups as received in order to compare them against the check indicated in the message preamble before acknowledging receipt of the message traffic. Disparities between the number of groups received and the check should always be investigated and resolved before a message is confirmed as received. If a discrepancy cannot be resolved, the corrected value of the check is then appended to the original following a slant bar. The check is preceded by the letters ARL and a space if there are one or more ARL numbered radiograms in the text.[29]

Place of Origin: This is the location of the individual or agency whose signature appears in the body of the radiogram. This is particularly important when routing reply or service messages. Please note that place of origin should not be confused with the physical location of the originating station who introduces the message into the network.

Time of origin: is the time, in UTC, at which the message was presented for transmission. In an EOC or incident command environment, this would be the time at which the message was written out or e-mailed to the message router. Time of origin is typically unnecessary for routine traffic, but should be considered essential for time-sensitive traffic, such as that with a priority or emergency designation.

Many local agencies prefer to use local time in which case the 24-hour formatted time figures must be entered followed by a time-zone designator, such as EST, or CST, with no space, as in 2310EST MAY 2. The month and date must agree with the local time used. See the section below. Optionally the letter L is sometimes used for local time, or the military zone designator such as R or Q, etc. Generally, these latter procedures are discouraged because they can introduce confusion. *Whenever possible, utilize standard UTC and then convert as appropriate to local time.*

Date of Origin: This is the calendar day on which a message was originated, in UTC. Please note that the new radio-day starts at 0001 UTC. Local time may also be used as prescribed by the agency served. The format for entry is the three letters of the month, a space, and the date figures with no leading zeros. No punctuation is permitted. Examples with filing time included: 2310 MAY 2 using the default UTC date/time or 1910ET MAY 1 using the local time equivalent. Again, UTC is the default standard and should be used whenever possible.

Address: The address for which the radiogram is destined should be as complete as possible. It may contain an optional second telephone number, e-mail or similar alternate contact information. The word DOT is used as a substitute for the period symbol, and the

word ATSIGN for the symbol @ in URLs and email addresses. These sequences must be re-written to use only permitted word groups, figures, or slant-bars, in such a way as to permit reconstruction of the address by the delivering station.

Punctuation symbols are not used in the address or phone numbers, though the slant-bar may be used to append a call sign or title but not to separate other parts of the address.

A city, state and ZIP code are required for all messages transmitted via RRI, including service messages, to facilitate routing within the DTN. This requirement also applies to messages originated using fone or cw in order to ensure complete interoperability between the manual and digital layers.

The address may be followed by an op note if necessary, which may contain information useful for delivery. Op Notes are generally not delivered to the recipient.

Text: for routine radiograms, a limited text length of not more than 25 groups is encouraged. *There is no limit on text length for served agency messages*. However, emcomm support operators should encourage brevity and clarity at all times, keeping in mind that a message may need to pass between several network layers to facilitate routing to the last-mile delivery point.

No punctuation or other symbols are permitted in the text apart from the allowed slant-bar. The substitute X for period where needed for clarity (but omitted at the end of the text), the DOT for a period and ATSIGN for @ in email addresses, the R for the decimal point in figure groups, and QUERY for the question mark figure are used with all other punctuation spelled out as separate word groups. The use of COMMA within the message text is generally unnecessary and discouraged.

Signature: for routine radiograms, a simple first or last name or call sign is adequate. However, for served agency traffic, a full name, title and agency is required. Traffic handling operators must ensure the veracity of a message is confirmed within the NIMS or EOC environment.

The *Signature* may be followed by an op note, introduced with those groups, which may contain information useful for replies or servicing. Op notes are generally not read to the recipient.

Relay and Delivery Records

A required part of the radiogram is the records section shown at the bottom of the form in

. The handling station must record the originated or received, and sent or delivered data. This is essential for tracking messages and compiling operational logs, such as the ICS-214, at the handling station. The operator is not done with the message until the records are complete. [30]

Formatting examples

Here is a radiogram as typed into a simple computer utility:

```
223 P W8ZZ 19 HIGHLAND PARK MI 2330 JUN 22
MICHIGAN STATE POLICE OPERATIONS
LT WALTER HAGEN 5300 CANAL ST
LANSING MI 48504
517 555 5234
BT
PLEASE ADVISE ETA MOBILE COMMAND POST TO BE STAGED AT
DETROIT FIRE STATION 22 LOCATED AT 23665 MCNICHOLS AVENUE
BT
CAPT ROBERT TRENT JONES
MSP DISTRICT TWO COORDINATOR
```

This message is ready for packet radio transmission:

```
ST 48504@NTSMI < K6JT
P LANSING 517 555

223 P W8ZZ 19 HIGHLAND PARK MI 2330 JUN 22
MICHIGAN STATE POLICE OPERATIONS
LT WALTER HAGEN 5300 CANAL ST
LANSING MI 48504
517 555 5234
BT
PLEASE ADVISE ETA MOBILE COMMAND POST TO BE STAGED AT
DETROIT FIRE STATION 22 LOCATED AT 23665 MCNICHOLS AVENUE
BT
CAPT ROBERT TRENT JONES
MSP DISTRICT TWO COORDINATOR

/EX
```

This example carries priority precedence and is filed using UTC, the default time zone for radiograms. Routine traffic does not ordinarily include filing time, which is optional. While, local agencies often use local time for their messages, it is important to remember that UTC prevents confusion when a message must pass across one or more time zones. If local time must be used, the originating station must indicate local time with the correct indicator and take care that the date of origin also matches the time zone.[31]

The Batch File Format

Field deployed stations often face high volume traffic flows, especially outbound health and welfare messages. Emergency nets must not be burdened with lower priority traffic. The batch file format was developed in response to this requirement and preserves net capacity by making efficient use of existing links to hubs and Winlink gateways.

Operationally, digital hub operators keep watch for this traffic and apply a simple framing process before relaying it. The frame adds two lines ahead and one line after a Radio-email, converting it into proper DTN format. Detailed information is given in the MPG document.

Example of the batch file format:

ST 21201@NTSMD < W1MK	ST LINE, MSG 1*
P BALTIMORE 410 555	FLAG + TOWN LINE*
	BLANK LINE
8 P W1MK 19 NEWINGTON CT SEP 20	MSG 1
BACI EOC	
BALTIMORE MD 21201	
410 555 1212	
BT	TEXT BREAK
TWENTY FOUR SUPPORT OPERATORS WAITING	
AT YOUR EOC STAGING AREA	5 groups/line, each
X PLEASE ARRANGE ESCORT TO	followed by a space.
ENTER SECURED EOC AREA	
BT	TEXT BREAK
STEVE AT W1MK	
	BLANK LINE
/EX	END MESSAGE*
ST 20707@NTSMD < W1MK	ST LINE, MSG 2*
P LAUREL 410 555	FLAG + TOWN LINE*
	BLANK LINE
9 P W1MK 22 NEWINGTON CT SEP 20	
JIM CROSS WI3N MDC SM	
25 MAIN ST	MSG 2
LAUREL MD 20707	
410 555 0123	
OP NOTE MAY BE MOBILE ON 146R67/107R2	
BT	TEXT BREAK
PLEASE ADVISE Winlink ARESMAT TEAM	
FOR WELFARE TRAFFIC HANDLING IN	5 groups/line, each
THE LAST MILE IN DE	followed by a space.
TO REPORT TO DOVER POLICE	
STAGING AREA	
BT	TEXT BREAK
STEVE AT W1MK	

/EX	BLANK LINE END OF TRAFFIC* BLANK LINE*

*** Batch File frame required entries:**
ST [zip code]@NTS[st] < [stn of orig]
[flags] [town] [area] [exchange]
(Radiogram with a blank line before and after.)
/EX
(Following line must be either a new message ST line or blank line if the last message in the Batch File. In other words, hit the return key in the text editor after the last /EX. Note the space between < and [stn of orig].)

Flags: Routine - no flag
S, D, SD
W, SW, WD, SWD
P, SP, PD, SPD

(S = SVC), (D = HXD),
(W = Welfare), (P = Priority)

Enter Canadian zip codes in ST line as 6 characters with no space.

Figure 7. Batch File Format

ICS-213 hybrid radiogram

Form ICS-213 is FEMA's general message standard and many emcomm organizations endorse its use. (*See Figure 8.*) It comes to us from the California fire service, developed in the 1970s as a three-part interoffice memo used to record, memorialize and account decisions and actions taken during an event. *As such it was designed for legal and financial accountability within a physical office building and did not contemplate radio relay.* For RRI purposes, ICS-213 does not contain the network management elements required for reliable interoperability, routing and tracking across our complex network layers.

When ICS-213 messages are relayed over amateur networks, special consideration must be given to network requirements. Through the clever use of an *envelope* or *wrapper* of a standard radiogram preamble, the original message in its entirety becomes the *Text*.[32]

Certain considerations must be made for ICS-213 messages. Message length is not restricted to the customary twenty-five words, upper and lower case characters are used, as are the standard keyboard punctuation marks. Further, ICS-213 serves as both origination and reply form.

ICS-213 memos are part of an event's permanent record and must be carefully preserved. They must be transferred in their entirety to the incident commander at the conclusion of amateur radio support involvement.

Additional guidance, including use of specialty software and for handling ICS content over other digital networks is available on request from DTN area digital managers.

ICS-213 is divided into defined blocks of text. Amateurs transmit the basic text while including the block titles and punctuation. The content is filled in after a single space following the block title.

GENERAL MESSAGE (ICS 213)

1. Incident Name (Optional):		
2. To (Name and Position):		
3. From (Name and Position):		
4. Subject:	**5. Date:**	**6. Time**
7. Message:		
8. Approved by: Name: _____ Signature: _____ Position/Title: _____		
9. Reply:		
10. Replied by: Name: _____ Position/Title: _____ Signature: _____		
ICS 213	Date/Time: _____	

Figure 8: Standard Form ICS-213 Multipart Memo

All block titles and block content provided may be placed between the breaks (BT) of the radiogram format.[33] The radiogram's preamble, address and op note, and signature and op note, are formatted exactly as done for the standard radiogram. Note that some agencies require that only blocks 1 through 8 are transmitted for an original message without a reply, but the full block sequence is shown here to be compliant with FEMA's guidelines.

Note ICS-213 blocks 1, 2 and 3, have parenthetical information following the block number and block name. The parenthetical items are optional and not included or transmitted with the derived and reformatted text.

Figure 9: Example of complex text to be send using the ICS-213 memo

GENERAL MESSAGE (ICS 213)
1. Incident Name: Test Viral Pandemic
2. To: Jeffrey Fineman MD, UW Health Executive Officer
3. From: Daniel Medefsky MD, UT Southwestern Medical Director
4. Subject: TEST Antiviral Resources Available
5. Date: 2015 10 01
6. Time 1432Z
7. Message: TEST MESSAGE
UT Southwestern has the following antiviral supplies available to assist with treatment of your pandemic victims. Please advise what you need and where to ship them via FedEx. Contact doctor Stevens at 972-555-1212 or respond to this message.

Drug Dosage	Units	Available
Tamiflu	75mg	1200
Relenza 5mg	650 (Inhaler)	
Rapivab	600mg	200 (IV vial)
Amantadine*	750mg	1500 (Tablets)
Flumadine	100mg	2500 (Tablets)

* Note not for use with Influenza type A
TEST MESSAGE
8. Approved by:
Name: Dr. Philip Stevens
Signature:
Position/Title: UT SW Coordinator

9. Reply:

10. Replied by:
Name:
Position
Title:
Signature:
Date/Time:
ICS 213

Figure 10 presents an example of complex text that could be transmitted as the *Text*

of a hybrid radiogram (*see Figure 10*) or Radio-email. It may also be send as a text file attachment to a Radio-email message.

Example of hybrid radiogram with priority precedence:

101 P K6JT ICS XX PLANO TX 1432 OCT 1 JEFFREY FINEMAN MD UW HEALTH EXECUTIVE OFFICER (Full address with city/state/zip and telephone number and/or email address.) BT [GENERAL MESSAGE (ICS 213)—the ICS block text content above.] BT DANIEL MEDEFSKY MD UT SOUTHWESTERN MEDICAL DIRECTOR (Full address with city/state/zip and telephone number and/or email address for reply.)	
(Originating/Receiving records)	(Sending/Delivering records)

Figure 10: ICS-213 Text Block Title Data for Transmission

The preamble check of the hybrid radiogram becomes *ICS XX* to indicate its ICS-213 content. *Addressee* and *Signature*-line op notes may be added for delivery and reply instructions, as with ordinary radiograms.

Digital Network Interoperability Requirements

Unlike traditional traffic nets that route messages by city and state, automated digital routing relies on destination ZIP codes. To preserve interoperability between manual and digital modes, every effort should be made to determine and include accurate ZIP codes for all "radiogram" messages as missing or incorrect ZIP codes will delay or prevent delivery!

While Radio-email does not restrict letter case or punctuation, fone and cw circuits cannot handle them without adding significant burden on a net.

While the originating operator is responsible for proper formatting of a radiogram, ICS-213 messages must be transmitted as received with case and punctuation symbols preserved, allowing the delivery operator to reconstitute its original format.[34]

Originating operators should brief agency officials and message routers on these limitations to encourage message content that is not sensitive to letter case and avoids unnecessary punctuation. Be sure to explain that this facilitates interoperability by ensuring that rapid delivery can be effected using any available mode or communications network in an isolated area.

Some served agency data will be case sensitive and great care must be taken to ensure message integrity no matter which mode is used. Even when an all-digital circuit is available, it is advisable to spell out case sensitive terms, which may be confused not only by radio operators but by recipients working under great stress. This is especially true with chemical,

scientific, engineering and medical data.

Radio-email and ICS-213 Transport

Generally speaking, Radio-email is composed using a standard Winlink client like Airmail or Winlink Express. As with Internet email, Radio-email allows multiple addresses in the TO and CC lines, mixing winlink.org and public addresses as desired, separated with commas. The $Subject$ line is also used. If a response is desired the phrase, "Please QSL this email" is added to the $Subject$ line.

A note on text editors

ICS type content can be pasted into the body of a Radio-email message, or attached as a plain text file, shown as ICS0705Z.TXT. ($See\ Figure\ 10.$) When preparing ICS messages, whether for hybrid radiograms or Radio-email, a true ASCII editor is recommended, such as Notepad++. Windows Notepad uses the slightly different ANSI standard and does not create the proper line-ending, carriage-return pairs expected by packet radio systems. Much like the hybrid radiogram envelope, Radio-email client software generates email headers with network tracking data automatically embedded.[35]

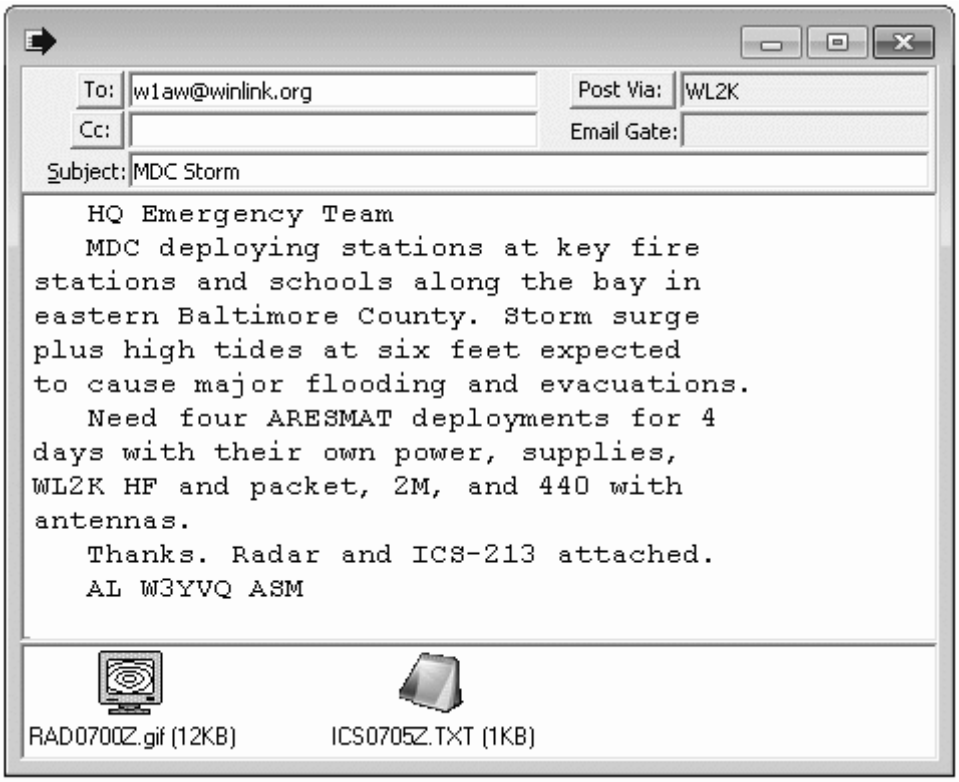


Figure 11: Standard Type 2 Radio-email Message

ROUTING

Manual Routing

Under normal operating conditions, message routing should follow designated RRI circuits. As discussed previously, these are traditional and well defined, following cyclical hierarchies based on the addressee's designated section, region and area.[36] DTN hubs are permitted some flexibility under the guidance of area digital managers.

In all cases, routing should move traffic to its destination as closely and quickly as possible, preferring reliable stations that can be counted on for responsible operation under RRI authority and direction.

The same applies to VHF packet nodes at the local and section levels. Section traffic managers, net managers and sysops must ensure traffic is cleared or otherwise handled expeditiously.

Routine message IATN routing example

This example follows a message originating in South Carolina on its way to Los Angeles during evening cycle 4. All times are UTC (the RRI standard).

a. W4ABC has been asked to originate a message to Los Angeles. He writes the radiogram and lists it on the South Carolina section net at 0001Z and sends it to W4ANK, the designated liaison to the fourth region net, 4RN.
b. W4ANK takes the message to 4RN at 0045Z, and relays it to N4GHI, the designated liaison to the RRI-East Net.
c. N4GHI reports the message into the area net at 0130Z and transmits it to W3PQ, who is IATN Station B.
d. W3PQ keeps an IATN out-of-net schedule with K6YR, who is IATN Station H, and sends him the message. This is a transcontinental hop and they are at liberty to pick any frequency or mode in any band to expeditiously exchange their traffic. The exchange must be completed by 0430Z when WAN meets.
e. K6YR reports the message into WAN (RRI-West) at 0430Z and relays it to K9JM, the RN6 representative.
f. K9JM reports the message into RN6 at 0530Z, and transmits it to K6HTN, the Southern California liaison.
g. K6HTN then lists it on Southern California Net at 0600Z and passes it to K6FRG, the Los Angeles station nearest the destination.
h. K6FRG can telephone or otherwise deliver the message to the addressee on receipt.

The message originated in South Carolina at 0001Z and could be delivered in Los Angeles before 0630Z.

Digital routing

The foundation and strength of DTN is its automatic routing process. In the following example, we follow inter-area activity but the regional process is similar. Hubs form a modified mesh network, communicating with area and regional hubs in a defined sequence until clearing traffic through the best available station under parameters configured in software. DTS routes for section level relays are much the same, although they are manually controlled and connect only once or twice on a given day.

It should be noted DTN takes pains to operate using the best amateur and engineering practice. Using detection algorithms embedded in the Pactor controller itself, outgoing connections are forbidden on a busy channel. In fact, automatic connections are attempted only when a hub holds traffic for a particular hub. This eliminates unnecessary congestion of the extremely limited bandwidth designated for automatic control.

Digital routing example

This example follows traffic going from the East Coast to the West Coast:

a. The Eastern Area Hub holds traffic for the West coast and initiates a connection attempt to the Western Area Hub.
b. The Pactor controller listens for activity fifteen seconds before transmission is permitted. If no activity is detected, the Eastern Area Hub calls the Western Area Hub on a propagation-appropriate frequency.
c. If the connection is successful, traffic is transferred at high speed using Pactor 3. All area and regional hubs have Pactor 3 capability although connections initiate using Pactor 1 and negotiate higher speeds based on conditions. This allows legacy modems to participate in the network. Following a successful transfer, the sending station queries for inbound traffic, which is transferred in the same session.
d. If the attempt is unsuccessful, the Eastern Area Hub calls the Central Area Hub to serve as an intermediate relay to the Western hub. If this is unsuccessful, the Alternate Western Area Hub is called, then the Alternate Central Area Hub.
e. If all four attempts fail, the entire process is repeated at roughly half-hour intervals, but in case of emergency, this is reduced to about ten minutes.
f. Failing even this, there may be one final attempt made with a direct connection to an alternate Eastern Area Hub, which would then attempt to move the traffic using its own routing logic. Continuing the example; a connection attempt will be made to area alternate hubs KW1U or W3JY. KW1U has directional antennas pointed westward and is the first station attempted.

It is important to note that these functions are all automatic, programmed into the hub's operating software which runs twenty-four hours per day. Of course, manual control is

possible at any time at the system operator's discretion.

Once transferred to the closest regional hub, a message is routed to the DTS closest to the final destination ZIP code. Transfer is automatic and the first DTS to connect in the target location receive the message through automatic transfer.

The message is either delivered immediately by the DTS operator or it is taken to a last-mile net for delivery. DTS stations are required to connect with their assigned hub at least once per day. During an emergency situation, the DTS will generally check as often as possible; hourly at a minimum.

Often message routings are a combination of digital operations and net liaison work, making use of all RRI-affiliated and cooperating modes and exercising the complete system.

Independent Nets and Foreign Connections

Beyond the RRI routing system, wide-coverage independent nets and direct connections to key cities or digital systems in foreign countries are available or planned. Key cities are usually accessed through independent nets that have been especially valuable with disaster communications in Central and South America. Independent nets take on a variety of forms with many of the most active heard daily on 40 and 20 meters. The 20-meter nets, particularly the International Assistance and Traffic Net, are especially important in covering the areas of the Caribbean, Central, North and South America.

In Europe, radiograms have enjoyed something of a popular revival for emergency use and as a pleasant alternative to email and texting services. DTN has formalized relationships with operators in Germany, England, and other EU states and is testing formal routes to Oceania and East Asia, to send and receive radiogram traffic on a daily basis using cw or hf Pactor. Locally, traffic is relayed through gateways to several European packet networks. International regulations are liberalizing third-party traffic restrictions as the radiogram continues to demonstrate its usefulness as a disaster response tool. RRI is pleased and encouraged by such developments and do what can be done to promote continued international traffic handling.

REFERENCES

NOTE: Where hyperlinks are given, if they do not operate correctly, copy and paste the full URL into your web client.

Methods & Practices Guidelines

This is the working reference manual on message formatting, exchanging traffic with other stations, directed traffic net operations, servicing and delivering messages, and digital mode operations within the RRI.

RRI Users Guide [under development]

The RRI *Users Guide* is a planned publication intended for use by served agencies and for RRI partners and associates.

The ARRL Online Net Directory

This on-line net directory lists Amateur Radio nets that have been registered with ARRL Headquarters. It primarily covers nets that are of interest to US and Canada operators, featuring worldwide coverage, maritime service, as well as traffic and ARES nets.

The ARRL Public Service Communications Handbook

The ARRL Public Service Communications Handbook serves as a practical guide to radio communications for community events, emergencies, and disasters. Part 4 includes selected general and detailed material formerly contained in the ARRL Public Service Communications Manual, particularly dealing with ARES, and traffic nets.

Amateur Radio Emergency Service® Manual

The ARRL ARES® Manual is a restatement and expansion of more detailed information formerly contained in section one of the ARRL Public Service Communications Manual (2/96 amended).

Area Terms of Reference

Each of the three RRI area staffs operates under written and approved Terms of Reference. The TOR covers duties associated with each staff member, the conduct of elections, staff composition, the role of the coordinator, and other administrative practices.

a. Eastern Area http://www.radio-relay.org/eas
b. Central Area http://www.radio-relay.org/cas
c. Western Area http://www.radio-relay.org/was

Inter-Area Traffic Network Station Functions List

This list details each of the RRI IATN liaison functions and assignments. If no current URL is listed, please contact the area coordinator for current information

http://www.radio-relay.org/iatn

Digital Traffic Network Operating Guide

http://www.radio-relay.org/dtn

NCERT Standard Operating Guidelines

http://www.radio-relay.org/NCERT

AREA STAFF CONTACTS

RRI operational leadership centers on the three designated area staff members, each under an elected coordinator. Rosters are maintained by each area, while STM

appointments are listed at the official webpage of each section. Area contacts, as of publication date:

a. Western Area Staff Coordinator
   Robert Griffin K6YR
   robert.griffin@radio-relay.org
b. Central Area Staff Coordinator
   Steven Phillips K6JT
   steve.phillips@radio-relay.org
c. Eastern Area Staff Coordinator
   Jeff Miller WB8WKQ
   jeff.miller@radio-relay.org

ENDNOTES

[1] http://www.southgatearc.org/news/march2013/george_hart_w1njm_sk.htm
[2] http://www.cbi-history.com/part_v.html
[3] http://www.delcoares.org/ARDC_Files/RACES_History.html
[4] Ad Hoc Committee on ARES Communications (ARESCOM), July 2004, Final Progress Report & Recommendations
[5] Ref: section Seven; and section 11.1, *NTS Methods and Practices Guidelines* at Chapter 6.
[6] Ref: section Seven below; section 11.1, NTS *Methods* & Practices Guidelines, Chapter 6
[7] §97.221 Automatically controlled digital station. http://www.ecfr.gov/cgi-bin/text-idx?c=ecfr&sid=1fd042880fafafd63f70c7382a7efee2&rgn=div5&view=text&node=47:5.0.1.1.6&idno=47#se47.5.97_1221
[8] EAS: http://www.radio-relay.org/eas
[9] CAS: http://www.radio-relay.org/cas
[10] WAS: http://www.radio-relay.org/dtn
[11] http://www.arrl.org/appendix-b-nts-methods-and-practices-guidelines
[12] See the MPG, Chapter 6, support documents, Batch File & Plain Text Guidance, and ICS Guidance
[13] More information regarding the NCERT program is available in section 5.4, National Communications Emergency Response Teams, and in section 9, the NCERT Standard Operating Guidelines document.
[14] The technical details of DTN are beyond the scope of this document. However, complete details are available at http://k6jt.com/RRI.
[15] NTS Methods & Practices Guidelines, Chapters 6; section 11.4 ARRL Public Service Communications Handbook, page 113
[16] See section 2.2 for a more detailed treatment of this subject.
[17] George Hart's original traffic plan envisioned a Mountain area but it never materialized for want of interest. "The New National Traffic Plan", George Hart, QST, Sept 1949.
[18] Figure 2 and section 8
[19] ARRL Online Net Directory (http://www.arrl.org/arrl-net-directory-search)
[20] For the RRI policy on origination and delivery of bulk radiogram traffic, please visit the TFC-OPS Yahoo group (invitation required) and download document "RRI Guidance NTS-003 for Message Origination and Delivery" at http://www.radio-relay.org/publications
[21] EPA Section "Welcome Wagon" http://www.epa-arrl.org/%EF%BB%BF%EF%BB%BFhelp-wanted-local-delivery-operators-needed-for-epa-welcome-wagon/
[22] See section, Message Formatting
[23] Section 11.1 NTS Methods & Practices Guidelines, Chapters 4 and 5; section 11.4 ARRL Public Service Communications Handbook, page 112.
[24] NTS Methods & Practices Guidelines, Chapter 6
[25] NCERT Standard Operating Guidelines – See section 9
[26] See below. Protocols for sending such texts on voice and CW are presented in the MPG Chapter 6 support document, *ICS Guidance*];

[27] Detailed information about these formats may be in found in the MPG Chapter 6 support documents, *Batch File and Plain Text Guidance,* and *ICS Guidance*.

[28] See FSD-218 for the list of handling instructions.

[29] See FSD-218

[30] NTS Methods & Practices Guidelines, Chapter 1; 11.4 ARRL Public Service Communications Handbook, First Ed., 2012, pages 120-125; 11.5 The ARRL ARES Manual, section 5.6.

[31] Note GMT/UTC time is marked "Z". Alternately, operators may use "EST" or "EDT" etc. so long as care is taken to match date with time. (See also http://www.timeanddate.com/time/zones/military)

[32] Section 11.5 ARES Manual, section 5.2 & 5.4; NTS MPG Chapter 6 support document ICS Guidelines; FEMA/NIMS Forms Pamphlet 502-2.

[33] The prosign "BT" comes to us from the American Morse code for double dash, written "=". It indicates the start of a new paragraph and, despite appearances, does not mean "equals". See https://en.wikipedia.org/wiki/American_Morse_code

[34] FEMA/NIMS form pamphlet 502-2 as revised.

[35] Section 11.1 *NTS Methods & Practices Guidelines,* Chapters 1 and 6; section 11.2 NTS Users Guide, section XX; and section 11.4 ARRL Public Service Communications Handbook, page 120.

[36] Detailed specifications for NTS routing may be found in NTS Methods & Practices Guidelines document MPGRV14A.