

U.S. Coast Guard Research and Development Center
1082 Shennecossett Road, Groton, CT 06340-6048

Report No. CG-D-06-05

**GLOBAL INCIDENT NOTIFICATION (GIN)
SECONDARY PUBLIC SAFETY ANSWERING POINT (PSAP)
TEST AND EVALUATION**



**FINAL REPORT
April 2005**



This document is available to the U.S. public through the
National Technical Information Service, Springfield, VA 22161

Prepared for:

U.S. Department of Homeland Security
United States Coast Guard
Operations (G-O)
Washington, DC 20593-0001

NOTICE

This document is disseminated under the sponsorship of the Department of Homeland Security in the interest of information exchange. The United States Government assumes no liability for its contents or use thereof.

The United States Government does not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the object of this report.

The contents of this report reflect the views of the Coast Guard Research and Development Center. This report does not constitute a standard, specification, or regulation.



Marc B. Mandler, Ph.D.
Technical Director
United States Coast Guard
Research & Development Center
1082 Shennecossett Road
Groton, CT 06340-6048

Technical Report Documentation Page

1. Report No. CG-D-06-05	2. Government Accession Number	3. Recipient's Catalog No.	
4. Title and Subtitle Global Incident Notification (GIN) Secondary Public Safety Answering Point (PSAP) Test and Evaluation		5. Report Date April 2005	
		6. Performing Organization Code Project No. 9250.9	
7. Author(s) Gregory W. Johnson, Terry Black, Thomas L. Amerson, & Marion J. Lewandowski		8. Performing Organization Report No. R&DC 594	
9. Performing Organization Name and Address John J. McMullen Associates, Inc. 4300 King Street, Suite 400 Alexandria, VA 22302			10. Work Unit No. (TRAIS)
			11. Contract or Grant No. Task Order DTCG32-02-F-100038 Contract DTCG39-00-D-R00020
12. Sponsoring Organization Name and Address U.S. Department of Homeland Security United States Coast Guard Operations (G-O) U.S. Coast Guard Headquarters Washington, DC 20593-0001		13. Type of Report & Period Covered Final	
		14. Sponsoring Agency Code Commandant (G-OPR) U.S. Coast Guard Headquarters Washington, DC 20593-0001	
15. Supplementary Notes The R&D Center's technical point of contact is Dr. Thomas Amerson, 860-441-2894, email: tamerson@rdc.uscg.mil.			
16. Abstract (MAXIMUM 200 WORDS) The number of cellular calls to 9-1-1 has been increasing every year with the increase in cellular telephones. There are currently over 50,000 emergency calls from cell phones a year. If the trend continues, cellular phones could become the source of the majority of all 9-1-1 calls. As the overall usage of cell phones to call 9-1-1 increases, the number of maritime 9-1-1 calls is also likely to increase. Acquisition of Search and Rescue (SAR)-relevant information can be streamlined by integrating the U.S. Coast Guard (CG) as a Secondary Public Safety Answering Point (PSAP) for marine distress cellular calls. In order to assess the pros and cons of Enhanced 9-1-1 (E9-1-1) integration with CG operations, the Research and Development Center established a prototype Secondary PSAP in Woods Hole, Massachusetts, monitored usage, and collected data on the calls handled during the 2004 SAR season. This final report on the project documents the installation of the CG's Secondary PSAP system (both the circuits and the customer premises equipment), discusses the costs of the system, identifies the responses to the various challenges encountered in setting up the prototype, and discusses the operational use and benefits of the system. Based on the information learned in this study, the following recommendations are made: perform a cost-benefit analysis of a full coastal E9-1-1 system, analyze the impact and value of federal E9-1-1 standards, and authorize limited Secondary PSAPs in all coastal areas where allowed by state/local regulations.			
17. Key Words Enhanced 9-1-1, Public Safety Answering Point (PSAP), Secondary PSAP, Search and Rescue, SAR, Maritime Distress		18. Distribution Statement This document is available to the U.S. public through the National Technical Information Service, Springfield, VA 22161	
19. Security Class (This Report) UNCLASSIFIED	20. Security Class (This Page) UNCLASSIFIED	21. No of Pages 89	22. Price

Form DOT F 1700.7 (8/72) Reproduction of form and completed page is authorized

Executive Summary

The number of cellular calls to 9-1-1 has been increasing every year with the increase in cellular telephones. There are currently over 50,000 emergency calls from cell phones a year. Although the impact of increased cellular telephone use on maritime distress calls is unknown, the potential to improve the handling of such calls was a primary factor in conducting this project. Prior to this research effort, the U.S. Coast Guard (CG) did not have a Secondary Public Safety Answering Point (PSAP) connection with a local, state-run, Primary PSAP. Primary PSAP systems provide the 9-1-1 dispatcher with the cellular callback number and, in more advanced phases (e.g., Enhanced 9-1-1), the latitude/longitude (lat/long) of the cellular caller's location. However, Enhanced 9-1-1 (E9-1-1) operators/dispatchers often lack the training and familiarity with maritime environments to handle maritime distress situations efficiently. The protocols and procedures for passing case information to another land-based agency may not provide sufficient data for an informed CG response. Without supporting technology or procedure, the callback number or position of the caller may not be passed to the CG. The Federal Communications Commission (FCC) guidelines for implementation of Enhanced 9-1-1 ensure that future cellular calls will provide the callback number and the receiving cell tower and sector location or address and handset position information. On December 23, 2004 the President strengthened this effort by signing the "Enhance 911 Act of 2004" into law. This act is specific to improving wireless 9-1-1 capabilities at Public Safety Answering Points (PSAP). For the CG, having a caller's position, along with appropriate situation information, could be valuable in reducing initial response efforts for cell-phone originated distress calls.

Receipt of Search and Rescue (SAR)-relevant information can be streamlined by integrating the CG as a Secondary PSAP for marine distress cellular calls. In order to assess the integration of E9-1-1 with CG operations, the Research and Development Center (R&DC) established a prototype Secondary PSAP in Group Woods Hole, Massachusetts, monitored its use, and collected data on the calls handled during the 2004 SAR season. This final report on the project documents the installation of the CG Secondary PSAP system (both the circuits and the customer premises equipment), discusses the costs of the system, identifies the responses to the various challenges encountered in setting up the prototype, and discusses the operational use, limitations, and benefits of the system.

One of the major objectives of this project was to identify problems and areas of concern with the installation of an E9-1-1 system into a CG Operations Center (OPCEN). These issues and their resolution are important for the CG to make informed decisions regarding the use of E9-1-1 systems nationwide. These installation issues were broken down into several generic categories: customer premises equipment (CPE), circuits, interfaces with the state and local 9-1-1 systems, laws/regulations, training, and CG policy changes. In all categories, the resolution of the issue is described as well as recommendations to minimize problems in future installations.

Overall, the secondary PSAP system performed well and without problems. Since the system has almost 100 percent redundancy, single failures will not cause system outages. During the trial, 149 9-1-1 calls were received at the Group Woods Hole secondary PSAP: 108 calls from Massachusetts and 41 calls from Rhode Island. Of this total, only 39 calls were treated as SAR cases; the remainder (110 calls) were considered minor and/or non-emergency situations that did not reach the threshold set by Group Woods Hole to treat as SAR cases. Most of these minor

incident calls were for disabled vessels or problems within a harbor that could be resolved quickly and required no CG action. Some calls were duplicates – as often happens, a single accident can generate numerous calls to 9-1-1 by multiple people observing and reporting the incident. The Rhode Island phone line, since it was a regular line (not a special 9-1-1 trunk), also received some wrong-number calls from outside sources (these are not included in the call statistics). There were five calls that were handed off to Group Boston and one to Group Moriches (these are included in the SAR case totals) because the incidents were located in the other Groups' areas of responsibility.

Though there was no publicity associated with Group Woods Hole being a Secondary PSAP, about 14 percent of the Search and Rescue cases that the Group handled during this trial were based on 9-1-1 calls. The ability to receive such calls and act upon them by taking advantage of federally mandated cell phone technologies could be very helpful in improving CG response to these sometimes problematic distress calls.

Establishing CG Secondary PSAPs increases connectivity between the public and the CG. One benefit is providing direct communication between the 9-1-1 call reporting source and the CG, a feature that is otherwise often not available. The E9-1-1 system also provides the benefit of a callback number and position for the caller

There are two cost options to achieve these benefits: (i) the full Secondary PSAP and (ii) a limited Secondary PSAP with a call transfer only option. Both of these connection methods were tested at the Group Woods Hole PSAP. For Massachusetts, Woods Hole was a full Secondary PSAP with 9-1-1 trunks, Automatic Location Identification database links, and full CPE. For Rhode Island, it was a limited Secondary PSAP with call transfer only.

The full Secondary PSAP option is higher in cost, but provides more capability. For a single Primary PSAP-Secondary PSAP link, there are fixed costs for equipment of \$55-75K and circuit installations of \$6-8K for a total fixed cost of \$60 – 85K. The recurring costs of equipment maintenance (\$2-3K/yr) and circuits (\$10K/yr) present a total cost of \$12-13K/yr. This option provides a system that is easier to use and has greater capability.

The limited Secondary PSAP option is cheaper but has some drawbacks. There are no fixed costs other than one or more regular phone lines which are obtained at a minimal installation cost (perhaps \$200-300). The recurring cost is just the minimal cost of these phone lines, about \$1K/yr. The downside of this option is that it is *not* part of the E9-1-1 system. The lines are *not* E9-1-1 trunks, they are regular phone lines and can be called by other people besides the Primary PSAP (e.g. wrong-number calls). These types of lines are not monitored 24x7 like 9-1-1 trunks, nor do they have priority for restoration in case of an outage (as do the 9-1-1 trunks). This option provides a call transfer to a regular phone line; there is no transfer of the Automatic Number Identification/Automatic Location Identification (ANI/ALI) information or associated display on a screen. All ANI/ALI information must be relayed verbally from the 9-1-1 operator to the CG watchstander or faxed separately. One other potential drawback is that some individual state regulations may not allow call transfer from a PSAP to a non-PSAP entity.

In some areas of the country, the CG has experimented with instituting toll-free numbers for people to contact the CG. While this provides an avenue for getting cellular distress calls to the

answering point that the CG wants, it is not recommended as an optimal solution, and it is in conflict with National Emergency Number Association's (NENA), "One Nation – One Number" theme. One emergency calling number for the Nation ensures that the public will always know how to call for emergency assistance no matter where the emergency is located. The use of multiple emergency calling numbers for different regions or agencies is confusing to the public, complicates the emergency contact process, and is not effective. Therefore, it would be better to use the existing, standard 9-1-1, rather than proliferating additional numbers for CG specific distress calling. The 9-1-1 number carries an identity, position of respect and an expectation of results, qualities to be leveraged.

Based on the results of this study, the following recommendations are made:

- Perform an additional study to determine the full range of issues and costs of implementing CG Secondary PSAPs in a sample of coastal areas. The sample areas should highlight the situations where one Group or Sector has multiple PSAPs in multiple states, or multiple PSAPs in a single station's AOR. This may establish a range of budgetary estimates for CG-wide implementation. This study should also identify for the sample Group/Sector the specific state/local coordination authorities, the relevant laws/regulations, and the existing type of 9-1-1 implementation.
- As a regular end-recipient of 9-1-1 calls, the CG should participate in any future, federal, E9-1-1 standards development program. Outreach to NENA in conjunction with the new E-911 Implementation Coordination Office specified in the "Enhance 911 Act of 2004" could encourage state-to-state interoperability improvements and common procedures.
- Increase liaison at the field level so that emergency call centers are fully aware of CG missions and responsibilities, and the unique reporting requirements for maritime distress incidents.
- For the CG to be part of the E9-1-1 system, the full Secondary PSAP option is the recommended choice. However, from a cost perspective, a limited Secondary PSAP option is recommended where allowed by state regulations.

Table of Contents

<u>SECTION</u>	<u>PAGE</u>
Executive Summary	iv
Table of Contents	vii
List of Illustrations	ix
List of Tables	x
List of Acronyms and Abbreviations	xi
1. INTRODUCTION	1
1.1 Beginning of 9-1-1 in the United States	1
1.2 9-1-1 Systems Statistics	1
1.3 Wireless 9-1-1 Statistics	1
1.4 Project Objective	3
2. BASICS OF 9-1-1	4
2.1 Types of 9-1-1	4
2.2 The Public Safety Answering Point (PSAP) and 9-1-1 Systems	4
2.3 E9-1-1 System Design – “Standard” Systems	5
2.4 Landline E9-1-1 Call-Flow Using a Selective Router	5
2.5 Wireless 9-1-1	6
2.6 Three Phases of Implementing Wireless 9-1-1	6
3. SYSTEM IMPLEMENTATION	6
3.1 Massachusetts	7
3.2 Massachusetts Wireless Call-Flow	9
3.3 Rhode Island	13
3.4 Rhode Island Wireless Call-Flow	14
3.5 Required Circuits	18
4. COSTS	19
4.1 Equipment	19
4.2 Circuits	20
5. INSTALLATION ISSUES	20
5.1 Customer Premises Equipment (CPE)	20
5.1.1 Equipment Selection and Maintenance Issues	20
5.1.2 Recommendations for Future Installations	21
5.2 Circuits	21

5.2.1	Circuit Selection	21
5.2.2	Standard Architecture	21
5.2.3	Non-Standard Architecture	22
5.2.4	Recommendations for Future Installations	23
5.3	Interface with State 9-1-1 Systems	23
5.3.1	Coordination Issues	23
5.3.2	Recommendations for Future Installations	24
5.4	Laws/Regulations	24
5.4.1	State/Local Laws/Regulations/Ordinance Issues	24
5.4.2	Recommendations for Future Installations	24
5.5	Training	25
5.5.1	Training and Certification Issues	25
5.5.2	Recommendations for Future Installations	25
5.6	Coast Guard Policy and Operational Changes	25
5.6.1	Coordination with the Coast Guard Operational Commander	25
6.	SYSTEM OPERATIONAL PERFORMANCE	26
6.1	Statistics on Calls Received	26
6.2	Operational Viewpoint	29
6.2.1	Usability	29
6.2.2	Concept of Operations	29
6.2.3	Training Requirements	30
7.	BENEFITS	30
8.	CONCLUSIONS	31
9.	RECOMMENDATIONS	33
10.	REFERENCES	34
	Appendix A – General 9-1-1 Issues	A-1
	Appendix B – Group Woods Hole Reference Materials	B-1
	Appendix C - Detailed System Architecture	C-1
	Appendix D - Glossary of Terms, Acronyms and Abbreviations	D-1

List of Illustrations

<u>Illustration</u>	<u>Page</u>
Figure 1. 9-1-1 Calls Per Year and Number of Cellular Subscribers.....	2
Figure 2. PSAPs and ESN 604	7
Figure 3. 9-1-1 Generated Cases by Incident Type.....	28
Figure 4. 9-1-1 Generated Cases by Reporting Source	29
Figure C-1. Map of Connecticut, Massachusetts, and Rhode Island Showing PSAPs and Selective Routers as well as Coast Guard Group AOR boundaries.....	C-3
Figure C-2. Massachusetts Emergency Service Zones	C-4
Figure C-3. PSAPs and ESN 604	C-5
Figure C-4. Rhode Island/Massachusetts Connectivity	C-6
Figure C-5. Operations Building Floor Plan	C-7
Figure C-6. Primary 9-1-1 Workstation	C-8
Figure C-7. Equipment Connection Diagram.....	C-8
Figure C-8. TCI Invision ² WS Software	C-9
Figure C-9. TCI Invision ² WS Software – Additional information Screen	C-10
Figure C-10. Secondary 9-1-1 Workstation (top)	C-11
Figure C-11. Server Rack in Telephone Room	C-12
Figure C-12. Card Cage with Trunk and Multiplexer (MUX) Cards.....	C-13
Figure C-13. Alarm and Power Modules	C-13
Figure C-14. Detailed Rack Layout	C-14
Figure C-15. TCI Phone Circuit Connection Photo and Diagram	C-16
Figure C-16. Massachusetts Data connections.....	C-17
Figure C-17. CSU/DSU (Data Circuit interface)	C-17
Figure C-18. Coast Guard Digital Voice Logger (DVL)	C-18

List of Tables

<u>Table</u>	<u>Page</u>
Table 1. Required Circuits - Massachusetts.....	19
Table 2. Equipment Costs	19
Table 3. Circuit Costs.....	20
Table 4. E9-1-1 Calls Received	26
Table 5. Breakdown of 9-1-1 Generated Cases by Incident Type	27
Table 6. 9-1-1 Generated Cases by Reporting Source	28
Table C-1. Circuit Ids.....	C-15

List of Acronyms and Abbreviations

ADSL - Asymmetrical Digital Subscriber Line

ALEC - Alternate Local Exchange Carrier

ALI - Automatic Location Identification

ANI - Automatic Number Identification

AOR - Area of Responsibility

APCO - Association of Public-Safety Communications Officials

APU - Answering Position Unit

CAD - Computer Aided Dispatch

CAS - Call-path Associated Signaling

CLEC - Competitive Local Exchange Carrier

CML - CML Emergency Services, Inc.

CONOPS - Concept of Operations

CPE - Customer Premises Equipment

CSU/DSU - Channel Service Unit/Data Service Unit

CTIA - Cellular Telephone Industry Association

Demarc - Demarcation Point

DBMS - Data Base Management System

DSL - Digital Subscriber Line

DTMF - Dual Tone Multi-Frequency

DVL - Digital Voice Logger

E9-1-1 - Enhanced 9-1-1

EMF - Electronic Multi-Frequency

ESN - Emergency Services Number

ESRD - Emergency Service Routing Digit

ESRI - Emergency Service Routing Identification

ESRK - Emergency Service Routing Key

ESZ - Emergency Service Zone

FCC - Federal Communications Commission

GIS - Geographic Information System

GPS - Global Positioning System

ILEC - Incumbent Local Exchange Carrier

IP - Internet Protocol

ISDN - Integrated Services Digital Network

IXC - Interexchange Carrier

JJMA - John J. McMullen Associates, Inc.

KSU - Key System Unit

LATA - Local Access Transport Area

LEC - Local Exchange Carrier

LNP - Local Number Portability

MDN - Mobile Directory Number

MF - Multi-Frequency

MOU - Memorandum of Understanding

MSC - Mobile Switching Center

MSO - Mobile Switching Office

MUX - Multiplexer

NCAS - Non Call-Path Associated Signaling

NCIC - National Crime Information Center

NENA - National Emergency Number Association

NPA - Numbering Plan Area

NXX - Telephone Number Prefix

OPCEN - Operations Center

OSOW - Operations Specialist of the Watch

OT&E - Operational Test and Evaluation

pANI - Pseudo Automatic Number Identification

PSAP - Public Safety Answering Point

PSTN - Public Switched Telephone Network

QRC - Quick Reference Card

R&DC - Research and Development Center

SDO - Staff Duty Officer

SR - Selective Routing

SQL - Structured Query Language

T1 - Standard Digital Circuit

Tandem CO - Tandem Central Office

TCI - Tel Control, Inc.

Telco - Telephone Company

TDD or TTY - Telephone Device for the Deaf

UMIB - Urgent Marine Information Broadcast

UPS - Uninterruptible Power Supply

VoIP - Voice over Internet Protocol

W911 - Wireless Enhanced 911

WSP - Wireless Service Provider

1. INTRODUCTION

1.1 Beginning of 9-1-1 in the United States

In January 1968 AT&T announced that the digits 9-1-1 were available for use within the Bell System's serving areas for contacting emergency agencies. The code 9-1-1 was chosen because it best fit the needs of all parties involved. First, and most important, it met public requirements because it is brief, easily remembered, and can be dialed quickly. Second, it was a unique number, never having been authorized as an office code, area code, or service code, and was available, not reserved for any specific future use. For these reasons, it best met the long-range numbering plans and switching configurations of the telephone industry.

1.2 9-1-1 Systems Statistics

By the end of 1976, 9-1-1 was serving about 17% of the population of the United States. In 1979, approximately 26% of the population of the United States had 9-1-1 service, and nine states had legislation to implement 9-1-1 systems. At this time, 9-1-1 service was growing at the rate of about 70 new systems per year. By 1987, those figures had grown to indicate that 50% of the United States population had access to 9-1-1 as an emergency service number. At the end of the 20th century, nearly 93% of the population of the United States was covered by some type of 9-1-1 service. Ninety-five percent of that coverage was Enhanced 9-1-1 (E9-1-1). (See Appendix D for a definition of E9-1-1.) Currently, approximately 96% of the geographic United States is covered by some type of 9-1-1. Most of the coastal areas in the United States are in states claiming to have 100% E9-1-1 coverage. Most of the states with a lower percentage of 9-1-1 coverage are in the interior of the country. Because of scattered growth patterns and local control and funding, 9-1-1 did not evolve as a single national system. Only two states, Rhode Island and New Hampshire, have state-wide 9-1-1 systems, and only Rhode Island has a single Public Safety Answering Point (PSAP) for the entire state. Over the remaining states there are thousands of individual 9-1-1 systems and PSAPs at the county and city level, and sometimes at the agency level. For this reason there is not a state-level 9-1-1 regulatory agency or authority in many states.

1.3 Wireless 9-1-1 Statistics

According to the National Emergency Number Association (NENA) there were about 86 million wireless subscribers in 1999. Cellular Telephone Industry Association (CTIA) estimates show 46,000 new wireless subscribers are added every day. In Figure 1, the number of cellular subscribers is indicated by red squares for the years 1985 through 1998 and 2004 (scale on left side of chart). The red line is a polynomial fit trend line to these data.

It is estimated that 150 million calls were made to 9-1-1 in 2000, of which 45 million were made with wireless telephones. That is a ten-fold increase over the numbers in 1990. It is estimated that the number will more than double to 100 million in the next 5 years (NENA, 2004). In Figure 1, the number of cellular 9-1-1 calls is indicated by blue diamonds for the years 1985 through 1998 and 2004 (scale on right side of chart). The blue line is a polynomial fit trend line to these data (CTIA, 2005).

Projections indicate that by 2005, the majority of 9-1-1 calls will be from wireless phone callers. Because of media coverage and 9-1-1 public education programs, there is now a public expectation that a wireless 9-1-1 call will also provide location information at the PSAP.

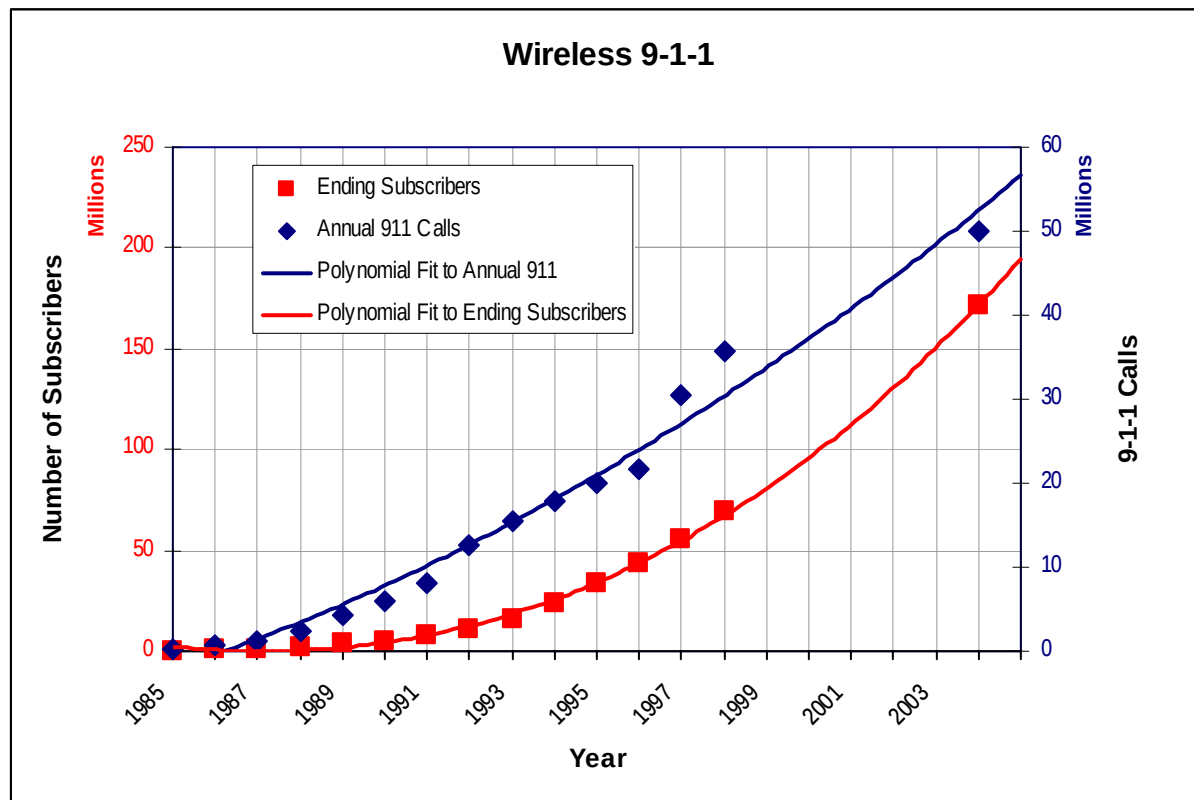


Figure 1. 9-1-1 Calls Per Year and Number of Cellular Subscribers¹.

A new development at the Federal level will increase the rate of implementation of Phase I and Phase II wireless 9-1-1 systems. On December 8, 2004 members of the 108th Congressional session passed H.R. 5419, an act to amend the National Telecommunications and Information Administration Organization Act. This act was signed into Law on December 23, 2004. Bundled into a telecommunications package, H.R. 5419 included the “Enhance 911 Act of 2004.” This act will improve, enhance, and promote the Nation's homeland security, public safety, and citizen-activated emergency response capabilities through the use of enhanced 911 services. PSAP capabilities are upgraded to improve functions related to E9-1-1 calls. The act is specific to improving Phase I and Phase II capabilities at PSAPs². The “Enhance 911 Act of 2004” authorizes federal matching grants to states or 9-1-1 entities, contingent on their directing funding back into E9-1-1 services and technology. Another important aspect of the legislation is that it establishes an E9-1-1 Coordination Office operated jointly by the U.S. Department of Transportation and the National Telecommunications and Information Administration to improve coordination among federal, state and local public safety officials.

¹ Sources: CTIA, Cellular Carriers Association of California, California Highway Patrol, New York, 2004 data: CTIA, NENA

² An explanation of Phase I and Phase II capabilities is given in Section 2.6, Three Phases of Implementing Wireless 9-1-1.

1.4 Project Objective

The CG receives and responds to emergency calls from 9-1-1 systems when the calls pertain to situations in the marine environment. With the rapid proliferation of cell phones and the increase in their use for making emergency calls, it has become important to determine whether the CG could integrate with a 9-1-1 system and what, if any, value would be realized. The premise of the project was that by becoming physically and organizationally integrated with a 9-1-1 system, the CG would improve communication with the initiating caller and acquire information that would improve response. Current 9-1-1 systems provide the dispatcher with the cellular callback number and (in more advanced phases) the lat/long of the cellular caller's location.

9-1-1 operators/dispatchers are often unfamiliar with and untrained in handling maritime distress situations. Although they follow their existing protocols and procedures for passing case information to another land-based agency, the information needed for an efficient CG response is often missed. Specifically, the lack of integration often results in failure to obtain a callback number to the boater in distress or to capture sufficient information to make an effective response based on the nature of distress. The Federal Communications Commission (FCC) guidelines for implementation of Enhanced 9-1-1 (both Phase I and Phase II) ensure that in the future all cellular calls will provide handset position information along with the callback number. Having the caller's position along with appropriate situation information to support Search and Rescue could significantly reduce CG search and response efforts for distress cases originating from a cellular telephone.

Acquisition of SAR-relevant information can be streamlined by integrating the CG as a Secondary PSAP for marine distress cellular calls. In order to assess the pros and cons of E9-1-1 integration with CG operations, the R&DC established a prototype Secondary PSAP in Group Woods Hole, Massachusetts, monitored usage, and collected data on the calls handled during the 2004 SAR season. This final report on the project documents the installation of the CG Secondary PSAP system (both the circuits and the customer premises equipment), discusses the costs of the system, identifies the responses to the various challenges encountered in setting up the prototype, and discusses the operational use and benefits of the system.

Additional reference material that may be useful for those unfamiliar with 9-1-1 systems in the United States is included in the Appendices along with detailed information about the R&D project.

- Appendix A: Issues Facing 9-1-1
- Appendix B: Group Woods Hole Reference Materials.
 - Group Woods Hole Instruction 1500.2A (E911 System Response Policy)
 - USCG Group Woods Hole E911 System Equipment and Circuit Problem Escalation Process
 - Rhode Island Memorandum of Understanding (MOU)
- Appendix C: Detailed System Architecture
- Appendix D: Glossary of Terms, Acronyms and Abbreviations

2. BASICS OF 9-1-1

Before discussing the Group Woods Hole Secondary E9-1-1 PSAP, it is beneficial to provide basic information about 9-1-1, especially as 9-1-1 is configured in the two states within the Group Woods Hole Area of Responsibility (AOR).

2.1 Types of 9-1-1

9-1-1 is simply a three-digit telephone number used to facilitate the reporting of an emergency requiring response by a public safety agency. Basic 9-1-1 (B9-1-1) is an emergency telephone system that automatically connects telephone callers to a designated answering point. Call routing for B9-1-1 is determined only by the telephone company's originating central office. Basic 9-1-1 may or may not support the automatic delivery of the caller's telephone number, called Automatic Number Identification (ANI) and/or the caller's address or location called Automatic Location Information (ALI). Enhanced 9-1-1 (E9-1-1) is an emergency telephone system which includes ANI and ALI, network switching, database and PSAP equipment elements capable of providing Selective Routing of calls to the PSAP associated with the caller's address, Selective Transfer, Fixed Transfer, and caller routing. These features are discussed in Section 2.3 - E9-1-1 System Design - "Standard" Systems. Both systems within the Group Woods Hole AOR are E9-1-1 systems.

2.2 The Public Safety Answering Point (PSAP) and 9-1-1 Systems

With the growth of the 9-1-1 emergency calling number came the need for revamped centers to receive and dispatch and/or send emergency calls to the proper responder. The term Public Safety Answering Point (PSAP) is used to describe these centers. The National Emergency Number Association (NENA) defines PSAP as, "...a Public Safety Answering Point equipped and staffed to receive 9-1-1 calls." A Primary PSAP receives E9-1-1 calls directly from a telephone company's E9-1-1 Selective Router. The E9-1-1 Selective Router is the piece of equipment the telephone company uses to route E9-1-1 calls to the proper PSAP. It uses a database that relates a telephone number to an Emergency Services Number (ESN) code associated with a specific PSAP. The ESN also represents a unique combination of emergency service agencies (Law Enforcement, Fire, and Emergency Medical Service) designated to serve a specific range of addresses within a particular geographical area. If the call is relayed or transferred, the next receiving PSAP is designated as a Secondary PSAP.

In the standard E9-1-1 system, any CG integration would be as a Secondary PSAP so that the call would be handled first by a Primary PSAP. Since the majority of landline and wireless 9-1-1 calls are for non-marine distress cases, this allows the Primary PSAP to filter the calls so that the CG Secondary PSAP only receives calls for maritime distress. This structure is extremely important for the CG in order to not increase the workload of the CG watchstanders answering non-maritime-related 9-1-1 calls.

There are differences in the information provided on the 9-1-1 screen for landline and wireless 9-1-1 calls. There are also differences in the way these calls are routed and delivered to the PSAP. These differences will be discussed throughout the following sections. It is important to realize that while calls from the water will come from wireless telephones, both landline and wireless calls can be transferred to a CG Secondary PSAP.

2.3 E9-1-1 System Design – “Standard” Systems

All NENA standard recommended network solutions use a Selective Router between the landline Central Office (CO) or the Mobile Switching Center (MSC) and the PSAP. A Selective Router, also called a 9-1-1 Tandem or 9-1-1 Control Office, offers the following critical features:

- Alternate Routing - The capability to route 9-1-1 calls to a designated alternate location or locations if all of the 9-1-1 trunks are busy or out of service.
- Default Routing - The capability to route a 9-1-1 call to a designated (default) PSAP when the incoming 9-1-1 call cannot be selectively routed due to an ANI failure or other cause. The call isn't dropped but is routed to a default PSAP.
- Selective Routing - The routing of a 9-1-1 call to the proper PSAP based upon the location of the caller. Selective routing is controlled by the ESN that is derived from the customer location.
- Selective Transfer - PSAP capability for one-button call transfer to a specific response agency (police, fire, EMS) based on the 911 caller's ESN.

The standard NENA system solution provides transfer capabilities including an ALI screen of information. A Selective Router insures that a PSAP does not function as an “island,” cut-off from the rest of the 9-1-1 network, but can communicate with and transfer calls and data to other PSAPs. In fact, most state legislation and tariffs specify three main features that identify an E9-1-1 system: ANI, ALI and Selective Routing.

2.4 Landline E9-1-1 Call-Flow Using a Selective Router

- The person in distress (or person reporting the distress) dials 9-1-1 from a landline telephone
- The call goes to the serving central office that recognizes the 9-1-1 code and sends the call over dedicated trunks to the 9-1-1 Selective Router. The serving central office also sends the caller's telephone number (ANI) with the call.
- The 9-1-1 Selective Router recognizes that it is receiving a 9-1-1 call, and searches the database for the Emergency Services Number (ESN) associated with the ANI. The ESN represents a geographic area of the caller's telephone number and the PSAP that handles emergency calls in that area. The ESN also provides area-specific respondent data (police, fire, ambulance) on the 9-1-1 screen.
- The Selective Router sends the call to the specified PSAP over dedicated trunks. The PSAP equipment sees the 9-1-1 call and sends a signal back to the Selective Router to forward the ANI.
- The PSAP equipment sends the ANI to the E9-1-1 host computer, commonly referred to as a Data Base Management System (DBMS). The host computer is used to create, store and update the data required to provide Selective Routing and/or ALI for E9-1-1 systems. The host computer does a “lookup” on the address information (ALI) associated with the ANI.
- The host computer then sends the ALI back to the PSAP.

- When the PSAP call-taker answers the call, the PSAP screen displays the ANI, ALI and other data used to process emergency calls. The PSAP call-taker handles the call or “one-button transfers” the call to a Secondary PSAP or a responding agency.

2.5 Wireless 9-1-1

In most areas there is Basic or Enhanced 9-1-1 that works well from a landline phone. However, when 9-1-1 calls are made from wireless phones, the call may not be routed to the closest 9-1-1 center, and the call-taker sometimes doesn't receive the callback phone number or the location of the caller. This presents potentially life-threatening problems due to lost response time if callers are unable to speak, don't know where they are, don't know their wireless phone callback number, or the call is dropped. Industry and the FCC have addressed this problem by implementing location information technology.

2.6 Three Phases of Implementing Wireless 9-1-1

The most basic phase of implementing wireless 9-1-1 (sometimes called **Wireless Phase 0**) simply means that when 9-1-1 is dialed from a cell phone, a call-taker at a PSAP answers. Wireless 9-1-1 calls must be transmitted to a PSAP regardless of whether being placed by a wireless service subscriber or a non-subscriber (deactivated cell phone). Wireless Phase 0 is required by basic FCC 9-1-1 rules whether or not Wireless Phase I or Wireless Phase II have been implemented.

Wireless Phase I is the first step towards providing better emergency response service to wireless 9-1-1 callers. When Wireless Phase I has been implemented in a calling area, a wireless 9-1-1 call will come into the PSAP with the wireless phone callback number (caller's wireless phone number). This is important in the event the cell phone call is dropped, and may even allow PSAP staff to work with the wireless company to identify the wireless subscriber. Wireless Phase I information can include the physical location of the cell tower (address) and sometimes the tower sector that received the signal. The FCC-mandated implementation date for carriers to provide Wireless Phase I was April 1, 1998 or within 6 months of being requested by the PSAP, whichever comes later.

Wireless Phase II allows call-takers to receive both the caller's wireless phone number and the location information, usually in the form of latitude/longitude coordinates, from either Global Positioning System (GPS) equipped cell phones (handset-based solution) or cellular tower triangulation (network-based solution). The FCC-mandated date for carriers to provide Wireless Phase II was October 1, 2001, however, extensions have been granted to many carriers. Specific requirements differ for network-based and handset-based solutions.

3. SYSTEM IMPLEMENTATION

This section is a synopsis of the CG Secondary PSAP installed at Group Woods Hole, Massachusetts; a more detailed discussion is included in Appendix C. For the discussion that follows, refer to Figure 2 that shows the geographic area covered by Group Woods Hole, the E9-1-1 boundaries, and the locations of the E9-1-1 centers. Group Woods Hole's AOR covers two states, all of Rhode Island and parts of Massachusetts, so the Group Woods Hole PSAP needed

to be linked into both states' 9-1-1 systems. Each state will be discussed separately as the connections for each state system are different.

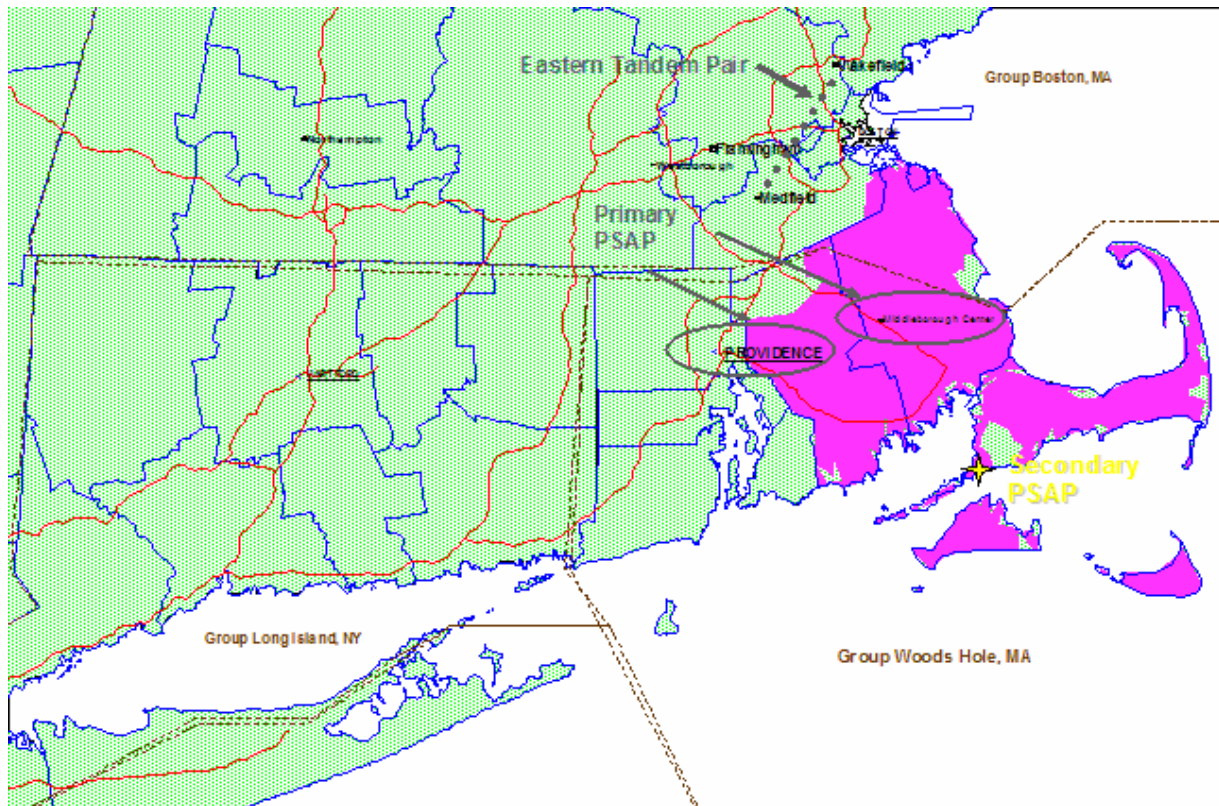


Figure 2. PSAPs and ESN 604.

3.1 Massachusetts

In the United States most E9-1-1 systems use the telephone company to provide call and data routing; this solution is often referred to as a “standard” network solution. Massachusetts is a good example of a “standard” network solution as described above. In Massachusetts, 9-1-1 calls are routed through the Telephone Company’s Enhanced 9-1-1 Selective Routers, which are commonly referred to as Tandems or Control Offices. These Selective Routers are the Central Offices that provide the tandem switching of 9-1-1 calls. These Selective Routers control the delivery of the voice call with the ANI for landline calls and the pseudo Automatic Number Identification (pANI) for wireless calls to designated Primary PSAPs. A pANI is a pseudo telephone number used in the 9-1-1 database to provide the location of the wireless tower and/or tower sector and information about its coverage or serving area (footprint). As previously discussed, the Selective Router also provides Alternate Routing, Default Routing, Selective Routing, Selective Transfer, speed calling, and certain maintenance functions to each PSAP.

Massachusetts is divided into two geographic regions (East and West) with two Selective Routers for each region. These two Selective Routers are fully redundant; each call is handled by

one of the two Routers and one Router can handle the entire region. All wireless 9-1-1 calls are routed via the Selective Routers to one of two Primary PSAPs that are designated to handle wireless 9-1-1 calls for the state. These two PSAPs are located in Framingham and Middleborough. These State Police Primary PSAPs either dispatch State Police units and other emergency responders when the emergency is within their jurisdiction, or they transfer the call and data to the appropriate emergency response agency(s) or PSAP. When calls are transferred from the State Police Primary PSAP to a Secondary PSAP, the connection is back through the Selective Router. Since the CG is usually only concerned with coastal calls, we only needed to connect to the Eastern pair of Selective Routers (Wakefield and Medfield). However, to meet the state required redundancy, two trunks were run to each of these Selective Routers. Massachusetts requires that every PSAP connect to two Selective Routers for redundancy in the event of a Selective Router failure; not all states have this requirement.

In Massachusetts, there are three coastal Emergency Service Zones (ESZ) with corresponding Emergency Service Numbers (ESN): 601, 604, and 607. Only the ESN 604 calls were routed to Woods Hole, the rest continued to be transferred to the First District SAR Line. All ESN 604 calls are handled by the Primary PSAP in Middleborough (Massachusetts State Police), therefore this site was the only one needing one-button transfer capability to Woods Hole.

In Figure 2, the magenta-shaded area of ESN 604 extends slightly to the north of the Group Woods Hole boundary line. The result of this is that calls could be routed to Group Woods Hole even if the caller's location was actually within Group Boston's AOR. This non-alignment of 9-1-1 boundaries with CG boundaries will always be an issue to be dealt with operationally while routing is done based upon predefined areas. In the future, when all 9-1-1 systems are Wireless Phase II capable, (every call has a lat/long associated with it) calls can be routed to the appropriate CG responder based upon the position of the call.

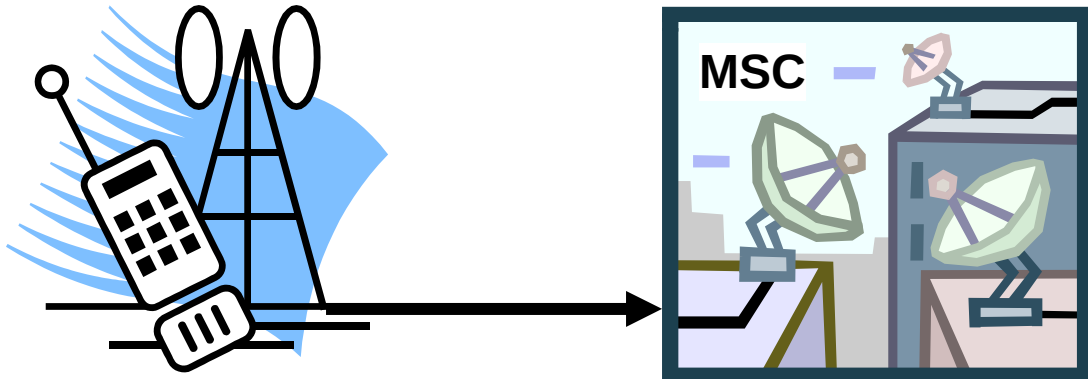
The pANI and ANI (depending upon wireless call provider) were transferred along with the voice call to the CG Secondary PSAP. The pANI is used to query the Verizon ALI database (to return the callback telephone number) and the ALI (cell tower location and sector ID). Data circuits to the two (redundant) ALI databases were installed (Brockton and Hyannis) to enable this lookup.

3.2 Massachusetts Wireless Call-Flow

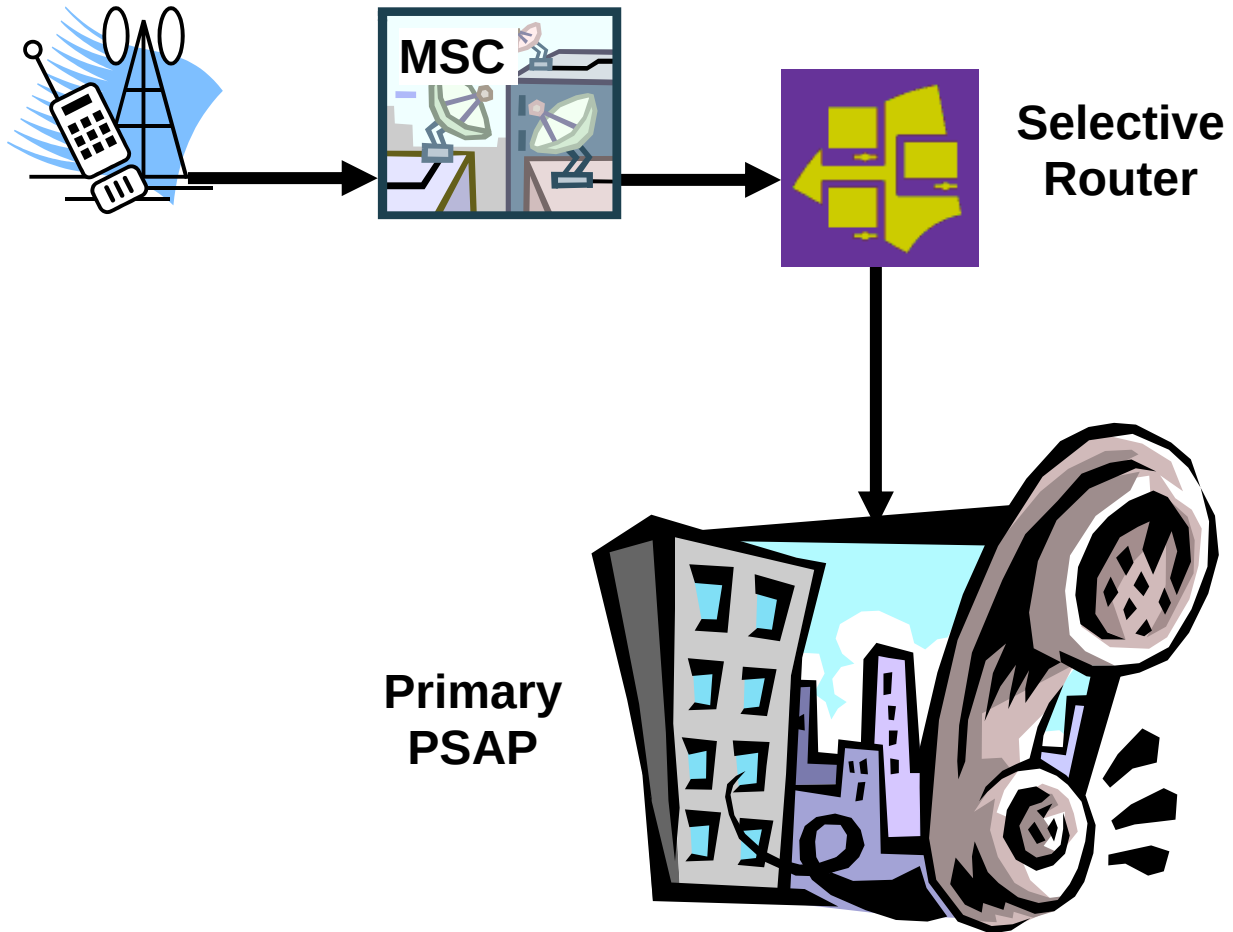
1. The person in distress (or person reporting the distress) dials 9-1-1. The closest tower or the tower with the strongest signal handles the call.



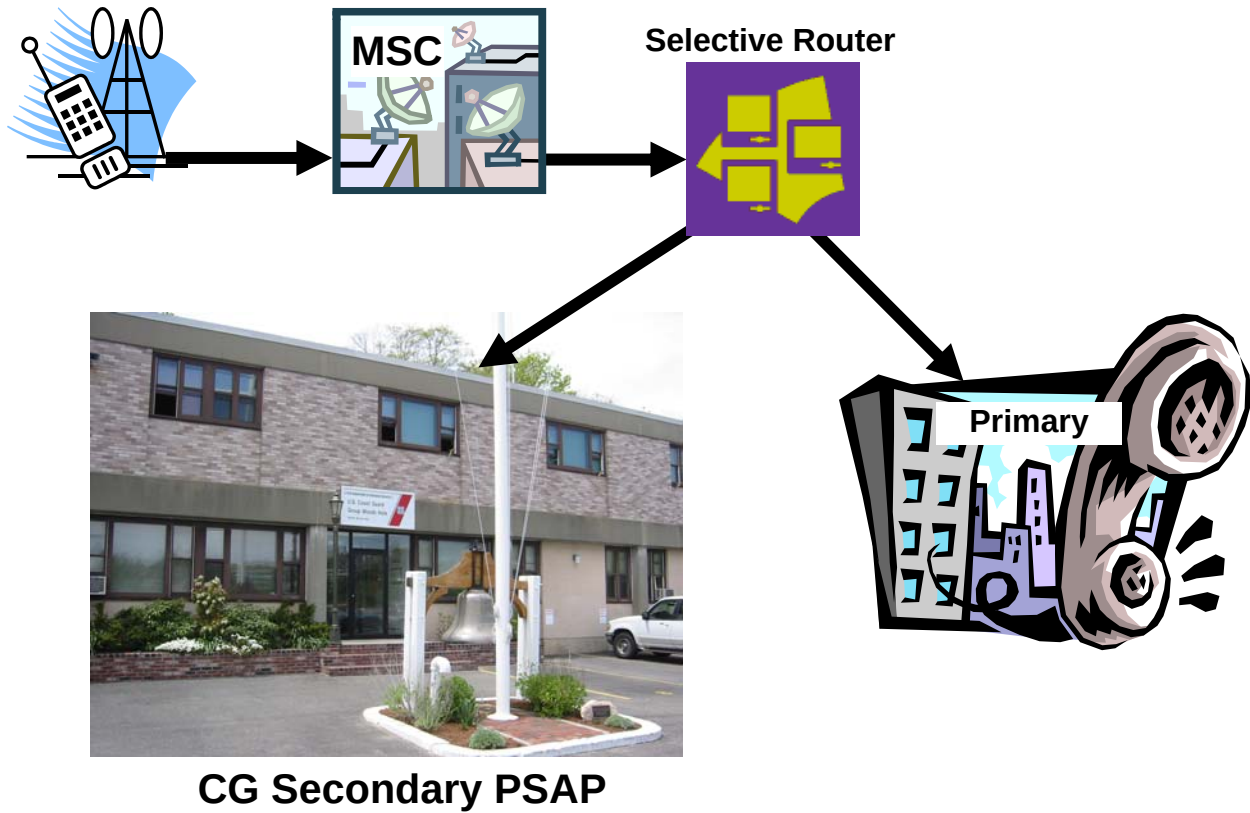
2. The cell towers are all connected to a Mobile Switching Center (MSC).



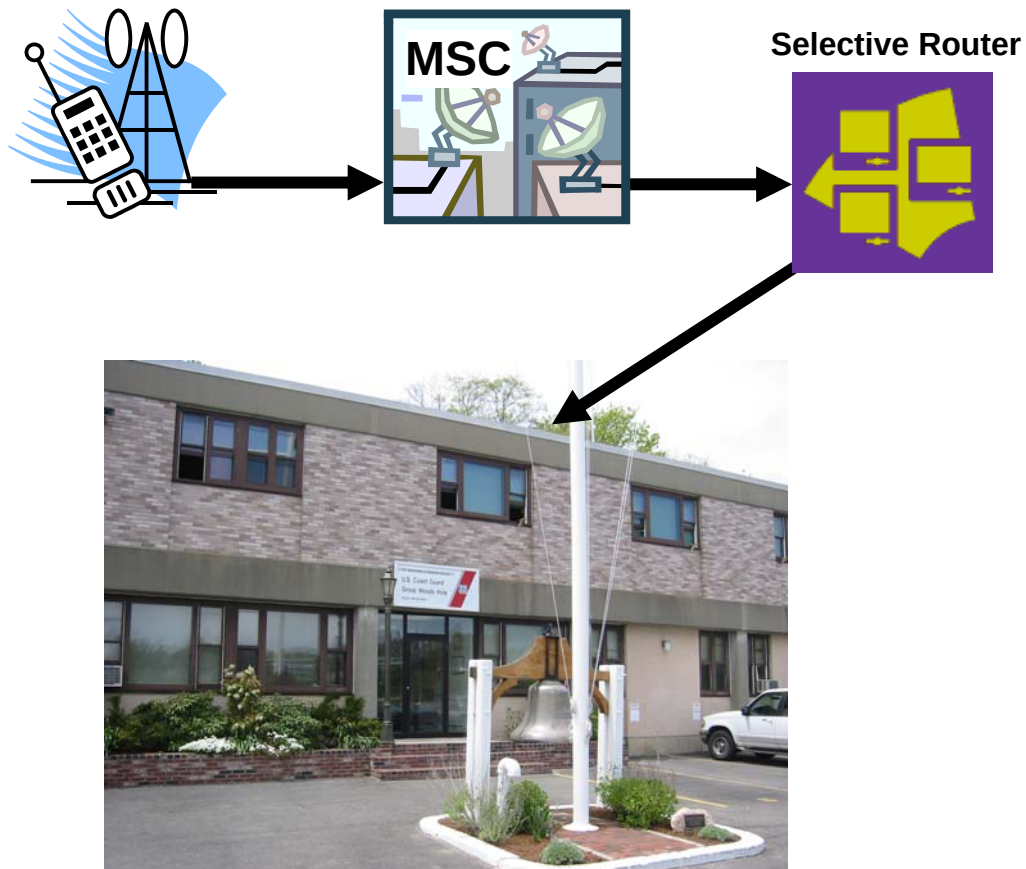
3. From the MSC, the call enters the landline phone network. Based on tower location, one of the Selective Routers transfers the call to the appropriate Primary PSAP. In Massachusetts, the State is separated into two geographic regions, East and West. Each region has a pair of Selective Routers to handle all calls. Each call is only handled by one of the Routers.



4. When the Primary PSAP determines that the incoming call is relevant to the CG, the call-taker presses the one-button transfer to transfer the call to the (CG) Secondary PSAP. The call is connected to the Secondary PSAP directly from the Selective Router through one of the voice trunks. Massachusetts requires at least one pair of trunks to each Selective Router for full redundancy.

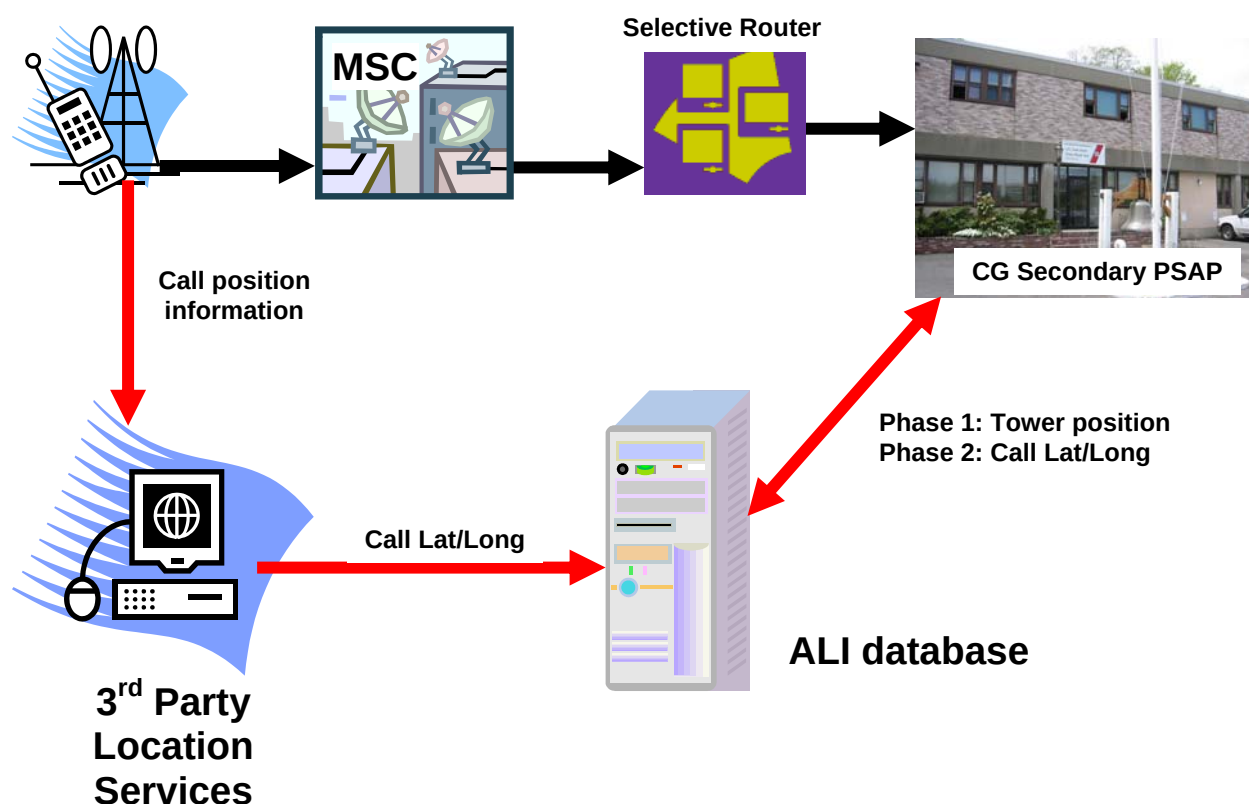


5. When the CG watchstander picks up the call and takes over, the 9-1-1 call-taker at the Primary PSAP hangs up and releases the line. The call is now direct from the person in distress, through the Selective Router, to the Secondary PSAP.



CG Secondary PSAP

6. When the call is received at the Secondary PSAP, the ANI/pANI information is used by the CPE (workstation) to query the ALI database and retrieve the caller's position information – tower location if Phase I or lat/long of caller if Phase II. These databases are maintained by the local phone company (Verizon). The CPE can query either or both until it gets a response. This happens automatically, and typically takes seconds. The lat/long information has been fed into the Verizon ALI database by the third-party location services provider (Intrado or TCS).



3.3 Rhode Island

While the vast majority of E9-1-1 system solutions are accomplished through a Selective Router, there are a few “non-standard” systems in existence. An example of a non-standard system is in Rhode Island where the state 9-1-1 vendor has adopted a non-traditional network solution that bypasses the Local Exchange Carrier (LEC) Selective Routers.

The Rhode Island 9-1-1 System is distinct in the 9-1-1 industry. Rhode Island has only one PSAP, located in North Providence, which takes all 9-1-1 calls from the entire state. The North Providence PSAP does not dispatch emergency responders. The North Providence PSAP transfers voice but not data to dispatch centers throughout the state. Since there is no Selective Routing, these dispatchers do not have a screen with ANI or ALI information available to them. This may be a workable approach to 9-1-1 system design for a lightly-populated state with five counties, however, this approach would not work for larger areas where emergency responders have a need for ANI/ALI information at the dispatch center.

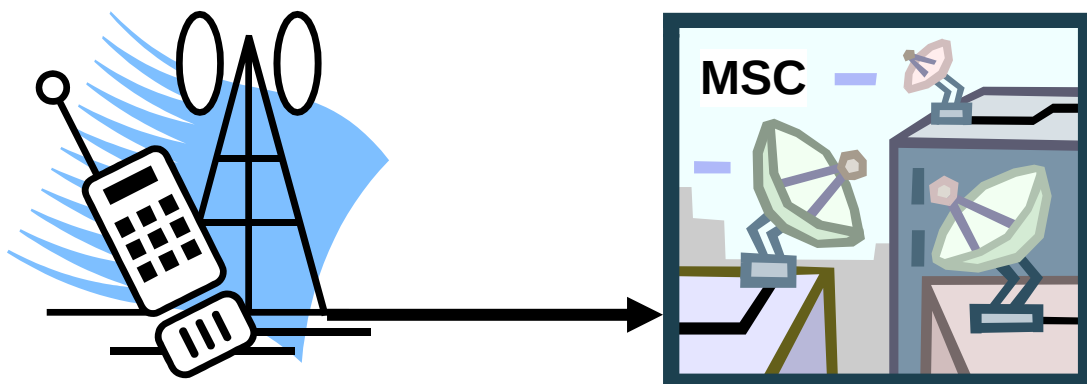
Since the Rhode Island 9-1-1 network solution does not use Selective Routing between the Telephone Company Central Office (CO) or the Mobile Switching Center (MSC) and the PSAP, there was no inexpensive or standard way to connect into their system. A regular, 10-digit call transfer was used. (This transfer is exactly the same as used with a 3-way conference on a regular phone). To achieve this transfer, the Rhode Island Primary PSAP was given the phone number of the regular phone line into Group Woods Hole, making all the E9-1-1 calls arrive on the same phone. Using this method achieved voice connectivity. All E9-1-1 information (callback number, position, etc.) had to be relayed verbally from the Rhode Island PSAP call-taker to the CG watchstander. As a backup, the Rhode Island Primary PSAP was prepared to fax the call data to the Group Woods Hole Secondary PSAP fax number.

3.4 Rhode Island Wireless Call-Flow

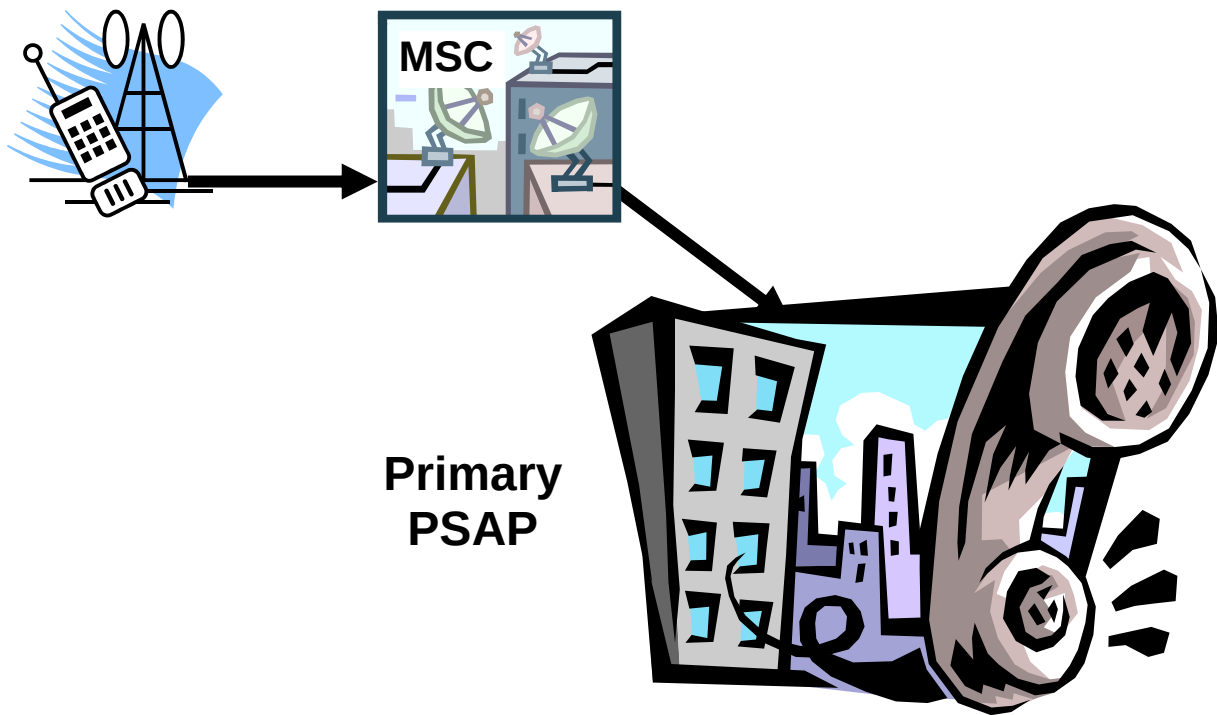
1. The person in distress (or person reporting the distress) dials 9-1-1. The call is handled by the closest tower (strongest signal).



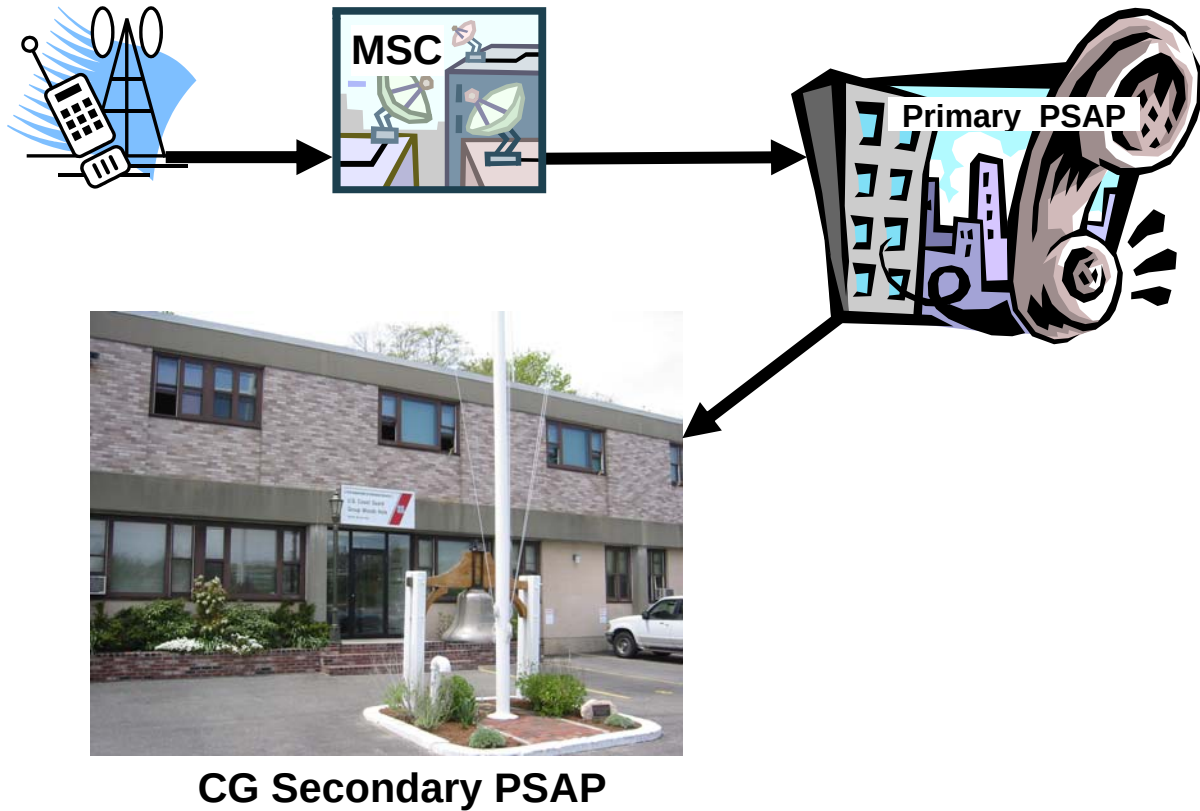
2. The cell towers are all connected to a Mobile Switching Center (MSC).



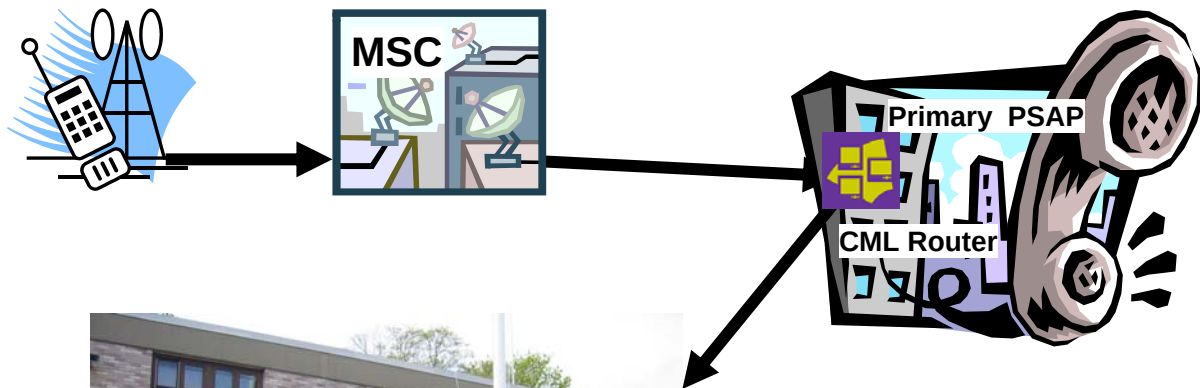
3. From the MSC the call enters the landline phone network and it is connected directly to the Primary PSAP in North Providence.



4. When the Primary PSAP determines that the call is relevant to the CG, the RI call-takers use a speed-dial number to forward the call to the CG Secondary PSAP through the Public Switched Telephone Network (PSTN). The link is not a dedicated line; it goes through the PSTN just as a regular phone call.

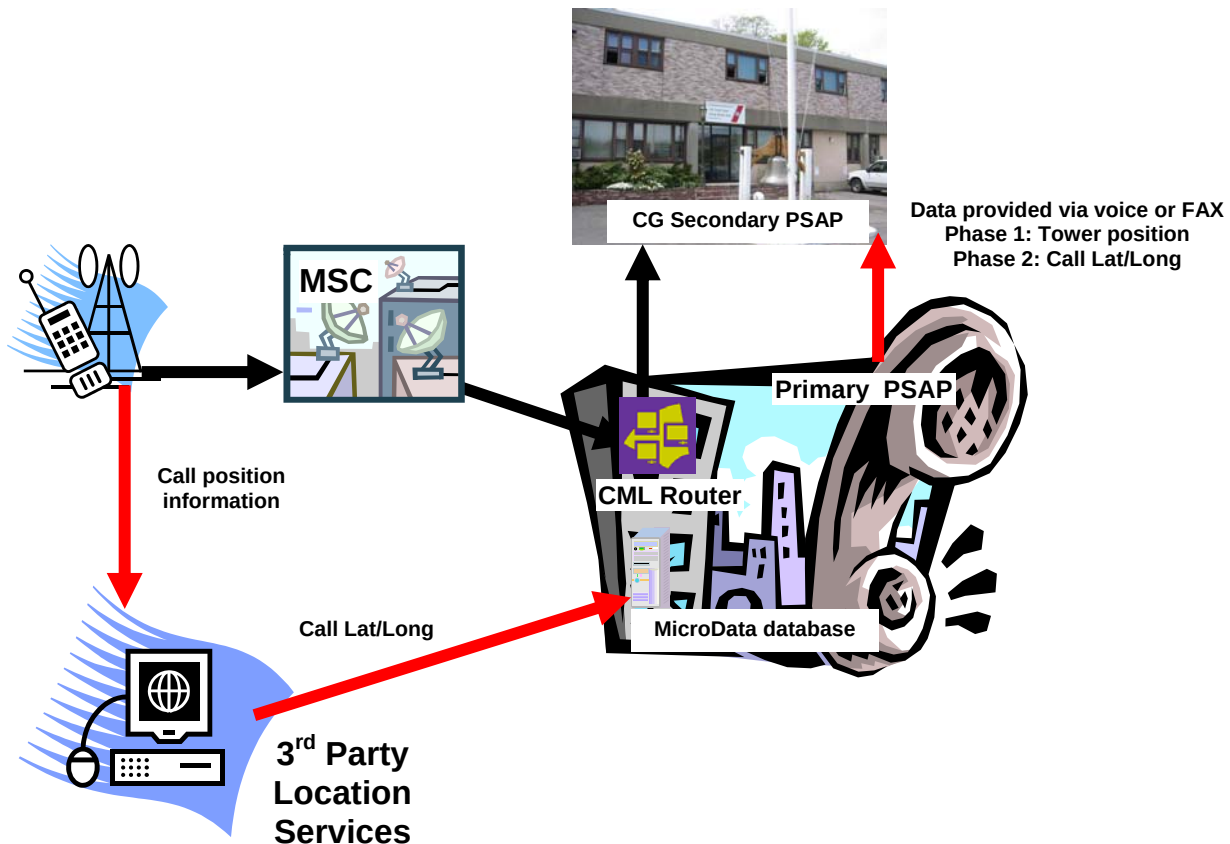


5. When the CG watchstander picks up the call and takes over, the 9-1-1 call-taker at the Primary PSAP hangs up. The call is still handled by the CML Router (a router external to the carrier phone company) in North Providence.



CG Secondary PSAP

6. Only voice is received when the call is forwarded through the PSTN. The Rhode Island 9-1-1 call-taker verbally relays the position and callback number to the CG watchstander. They can then follow this up with a FAX. At the Primary PSAP (RI), ANI/pANI information is used with the proprietary MicroData database located at the PSAP to retrieve caller position information (tower location if Phase I or lat/long of caller if Phase II). The lat/long information is retrieved by the MicroData ALI database from third-party location services provider (Intrado or TCS).



3.5 Required Circuits

The circuits required to link the CG Secondary PSAP into the Massachusetts 9-1-1 system are listed in Table 1. These dedicated circuits were all procured through the Verizon Massachusetts 9-1-1 office. There were no dedicated circuits ordered to link the CG Secondary PSAP into the Rhode Island 9-1-1 system; all connections were through the PSTN. To facilitate this, one extension was added to the Group Woods Hole telephone system. This extension was physically connected into the CPE so that there would be a single phone to answer for both Massachusetts and Rhode Island calls. An additional extension was run to the server to allow for remote dial-up maintenance and software updates by the equipment vendor, Tel Control, Inc. (TCI). A third extension was added to allow for 9-1-1 “training calls.”

Table 1. Required Circuits – Massachusetts.

Selective Router	# Connections (Voice Trunks)
Wakefield	2
Medfield	2
Total voice trunks	4
ALI Database	# Connections (Data Circuits)
Hyannis	1
Brockton	1
Total data circuits	2

A more detailed discussion of the equipment installation at Group Woods Hole is provided in Appendix C.

4. COSTS

The direct cost of the system can be broken down into two major components: equipment and circuits.

4.1 Equipment

The equipment costs consisted of the Customer Premises Equipment (CPE) purchased from TCI and ancillary equipment. As described in detail in Appendix C, the CPE consists of the computer hardware (server and two workstations), E9-1-1 software, and circuit interface devices. The CPE purchase price included the installation, initial equipment training, and the hardware and software maintenance for 18 months. The cost for the annual hardware/software maintenance is included in the Table 2. The service contract keeps the vendor on call (24x7) for any hardware/software problems and covers any software upgrades. The only additional equipment items that needed to be purchased/provided were Uninterrupted Power Supply (UPS) units for the server and workstations.

Table 2. Equipment Costs.

TCI CPE	\$62,500
Server UPS	\$1,200
Workstation UPS	Provided by USCG
Total Equipment Cost	\$63,700
Annual Maintenance Cost	\$2,250

4.2 Circuits

The circuit costs consisted of two parts: initial installation (one-time cost) and monthly charges for service (recurring costs). The initial installation charge includes the circuit installation fees for all circuits plus a \$3,500 9-1-1 set-up fee (one-time fee charged by Verizon for any new PSAP installation to cover the costs of setting up database entries and routing for the PSAP). These costs are summarized in Table 3. The circuit costs are a function of distance from the PSAP to the termination point (Selective Router or ALI database) so these costs will be different for other PSAP locations.

Table 3. Circuit Costs.

Installation/9-1-1 set-up	\$7,100
Recurring Costs	
Wakefield Selective Router (2 trunks)	\$275/mo
Medfield Selective Router (2trunks)	\$275/mo
Hyannis and Brockton DB lines	\$300/mo
Total recurring costs	\$850/mo

5. INSTALLATION ISSUES

One of the major aspects of this project was to identify problems and areas of concern with the installation of an E9-1-1 system into a CG Operations Center (OPCEN). These issues and their resolution will be important if the CG is to install Secondary E9-1-1 PSAPs nationwide. Installation issues have been broken down into several generic categories.

5.1 Customer Premises Equipment (CPE)

5.1.1 Equipment Selection and Maintenance Issues

Equipment selection to interface the E9-1-1 system is an important consideration, but since there are only a small number of vendors making E9-1-1 PSAP equipment, the options are limited. Most of the equipment is similar and has been designed to be compatible with NENA standards so that selection of the CPE can be done largely on price/value. The biggest issue with equipment is that, in some cases, state laws or regulations mandate equipment standards. These laws and regulations need to be reviewed for each state in which a CG Secondary PSAP is to be established to ensure compliance. For example, most states require Telephone Device for the Deaf (TDD also called TTY) equipment. In states such as Massachusetts, state E9-1-1 regulations require that the PSAP CPE be acquired from an approved vendor. Equipment from other vendors can only be used if approved by the Massachusetts 9-1-1 Telecommunications Board. For the Group Woods Hole PSAP, the CPE (based on price/value) selected was from Tel Control, Inc (TCI). Since this equipment was not on the Massachusetts approved list, the Board was petitioned for approval. Massachusetts also has equipment capability standards. For example, each PSAP must have at least 2 workstations for redundancy, each workstation must

have a battery backup good for at least 30 minutes, the site needs to have a backup generator, etc. Redundancy standards apply throughout the system in Massachusetts.

The other equipment issue that needs to be considered is maintenance. Short-term maintenance (12 – 18 months) is generally included in the purchase price. However, funding for longer-term maintenance needs to be budgeted for both hardware and software. Generally, software maintenance will have to be purchased from the equipment vendor. Hardware maintenance could be accomplished by a combination of vendor and CG personnel (technical ratings normally found in CG Group commands).

5.1.2 Recommendations for Future Installations

- Review state laws and regulations for equipment standards/requirements as part of the site planning process.
- Use standard CPE equipment that follows NENA standards.
- Once an equipment vendor is selected, ensure they have a copy of the state’s equipment capability requirements so that the system can be assembled to meet the requirements.
- As part of the installation process, allow time for testing and resolving data parsing issues and correction of minor problems. A two- week installation window should suffice: one week for installation and one week for testing.

5.2 Circuits

5.2.1 Circuit Selection

The circuit selection process depends upon the Secondary PSAP location, and whether the state has implemented a “standard” 9-1-1 system. At the simplest level, the number of 9-1-1 Selective Routers in the state must be identified, state 9-1-1 regulations must be reviewed to ascertain how many Selective Routers and ALI databases need to be connected, and then the appropriate circuits must be ordered through the state 9-1-1 system. However, if the CG Secondary PSAP has an AOR that covers multiple states then the connection situation is much more complicated. For this reason, the Group Woods Hole location was a good test site as it revealed some of those connectivity issues. Those difficulties go back to the center of the E9-1-1 system integration difficulties, i.e., each state (and many times each county and/or city) make their own 9-1-1 system decisions which could lead to different, incompatible systems in adjoining jurisdictions. For “standard” installations, the circuits between the Selective Routers and the PSAPs are 9-1-1 trunks. These trunks are special analog phone lines that support the 10- or 20-digit ANI/ALI information. Usually the phone company monitors the trunks for outages. The second part of the circuit installation for the ANI/ALI database connection is setting up the data circuits. These are the circuits used by the local CPE to connect to the ALI database to look up the cellular call position, tower location, etc. based upon the 10-or 20-digit ANI/pANI. Standard analog or digital data circuits are used to connect the PSAPs with the ALI databases.

5.2.2 Standard Architecture

Calls are transferred from the Primary PSAP to the CG Secondary PSAP via the Selective Routers. In the simplest case of a single “standard” state, circuits are needed from the CG Secondary PSAP to a Selective Router, and to multiple Selective Routers when redundancy is

required. Depending upon state regulations and the number of Selective Routers, connections may only need to be made to a subset of the Selective Routers.

In the case of an AOR covering multiple, standard states, the situation is similar. Circuits are needed from the CG Secondary PSAP to the Selective Router(s) in the state in which the CG Secondary PSAP is located. Again, depending upon regulations, this arrangement might be a subset of the total number of Selective Routers. In the case of calls originating in an adjoining state, calls are transferred via inter-tandem links. A data circuit (or multiple, if redundancy is required) is established between the CG Secondary PSAP and each ALI database location.

5.2.3 Non-Standard Architecture

If one of the states in the AOR uses non-standard architecture, then the circuit configuration problem becomes more difficult as a non-standard solution needs to be engineered. The Group Woods Hole PSAP installation provides an excellent case study of such a problem. The Woods Hole AOR covers two states: all of Rhode Island and part of Massachusetts. Rhode Island implemented E9-1-1 in a non-standard way. In Rhode Island, all 9-1-1 calls (landline and wireless) are terminated at the (single) Primary PSAP from which there is no data routing through the telephone company's Selective Routers to Secondary PSAPs. For Rhode Island, there was no inexpensive or standard way to connect into their E9-1-1 system. The only solution available was to use a regular, 10-digit call transfer (exactly the same used for a 3-way conference on a regular phone). Using this method achieved voice connectivity, but it did not provide the ANI/ALI transfer. As previously stated, all E9-1-1 information had to be relayed verbally with fax back-up from the Rhode Island dispatcher to the CG watchstander.

The difficulty in engineering a circuit connection for non-standard solutions is that the 9-1-1 part of the phone system uses different standards and terminology from other parts of the phone system. Tariffs (regulated by state Public Utility Commissions) restrict the local telephone company from providing cross-Local Access Transport Area (LATA) circuits (e.g. across a state boundary). The cross-LATA circuits need to be ordered from an Interexchange Carrier (IXC), who generally does not understand 9-1-1 requirements, thus increasing the difficulty of the circuit order process. Special analog trunks generally used for PSAP to Selective Router connections are not available across state boundaries. Several months of project time were spent trying to resolve cross-boundary technical issues. In several cases, a phone company could not even resolve installation/billing issues. Under these circumstances, architectural design options were severely limited. In the case of Rhode Island, one way to make the connection was to purchase a standard T1 connection between Group Woods Hole and North Providence and then purchase/install the T1 interfaces to the 9-1-1 system at each end. This solution would have incurred about \$20,000 in equipment costs (not including installation) and a recurring charge of \$1500/mos for the T1 circuit. These expenses were beyond reason for this research project.

A final circuit issue, one potentially with no resolution, is that total redundancy may not be possible. In some areas (maybe most areas) there are not multiple routes for circuits to the CG Secondary PSAP location. Even though there are redundant circuits, they may all follow the same path in the last mile from the Central Office to the Group Office, and are thus susceptible to backhoe induced outages and the like. This is the case at Group Woods Hole, where there is only a single connection to the Central Office in Falmouth.

5.2.4 Recommendations for Future Installations

- At an early stage, identify (via the state 9-1-1 board) the correct phone company points of contact and bring them into the planning process. Much time was lost in Massachusetts because of initial contact with the incorrect people at the local phone company, people who did not understand the procedure for ordering/installing 9-1-1 trunks.
- For each state in the AOR, identify whether they have implemented standard or non-standard E9-1-1 systems. For standard systems, identify where the Selective Routers are located, review state laws and regulations for requirements regarding the number of connections to the Selective Routers, and identify if the inter-tandem links across state boundaries are present. For a non-standard system, evaluate alternatives and assess the costs/benefits of a custom full connection (dedicated trunk lines) vs. 10-digit call transfer.
- Bring the state(s) 9-1-1 offices into the planning early. They need to approve the circuits and the PSAP before the phone company installs them. Some states, such as Massachusetts, have requirements for redundant circuits.
- When ordering the circuits, allow plenty of lead time. Even when working with the correct people at the phone company, be prepared for 2-3 months to receive the order once it has been placed.
- It was difficult/impossible to get the exact circuit costs prior to installing them. A rough estimate needs to be obtained from the telephone company for project planning purposes and then allow for extra costs in the budget.
- Once the circuits are installed they will need to be tested and then or modified as necessary. Do not assume that the installation will be 100% correct the first time. Allow for unexpected events. This testing also needs to be coordinated with the state 9-1-1 office and the Primary PSAP at all times.
- Typically, the system will require either a phone line or Internet connection to enable remote access for system trouble-shooting and upgrades. The workstation also should have an administrative phone line available for outgoing, non-9-1-1 calls. A third line is also helpful to be used for training purposes (discussed more under the training section).

5.3 Interface with State 9-1-1 Systems

5.3.1 Coordination Issues

As already mentioned, one of the problems with the current 9-1-1 system is the lack of nationwide standardization. Each state and, in some states, each county or city, are responsible for their own portions of the 9-1-1 system. Therefore, the first step in any CG E9-1-1 integration is to identify and contact the states/counties/cities/ agencies that are within the CG Secondary PSAP AOR. For the Group Woods Hole Secondary PSAP, this was the Massachusetts 9-1-1 Telecommunications Board and the Rhode Island 9-1-1 Board. State and local laws and regulations need to be met (especially in the state in which the CG Secondary PSAP is located). Agreements, including written Memoranda of Understanding (MOU), need to be reached with each entity. Early meetings with the state board personnel, their legal counsel, and their telephone services are necessary.

Next, it is important to establish which Primary PSAPs will transfer calls to the CG Secondary PSAP. Ideally, each Primary PSAP that transfers calls to the CG Secondary PSAP will have a one-button transfer capability. This feature typically requires only a small effort. There can be a

cost issue regarding who pays for this feature. Massachusetts 9-1-1 paid for the call-transfer capability from the Primary PSAP to Group Woods Hole Secondary PSAP.

Each PSAP that transfers calls to the CG Secondary PSAP needs to be briefed in conjunction with the state/county/city/agency 9-1-1 office. An MOU should outline types of calls to transfer and the transfer procedures. In some states (like Massachusetts) a limited number of Primary PSAPs (one for each large geographic region) handle all of the wireless calls. This procedure reduces the number of PSAPs that need to be contacted. If transfer capability for landline calls is also desired, then a larger number of Primary PSAPs may need to be contacted..

5.3.2 Recommendations for Future Installations

- Identify all state/county/city/agency 9-1-1 boards/offices that have 9-1-1 system responsibility/jurisdiction within the CG Secondary PSAP AOR.
- Meet with all 9-1-1 entities, involve them in the planning process, identify requirements, and follow up with a Memorandum of Agreement (MOA).
- Identify all Primary PSAPs that need to transfer calls to the CG Secondary PSAP. Set up a MOA covering types of calls to transfer and associated procedures, and determine who will incur the cost for one-button transfer capability. Install the one-button capability and test.

5.4 Laws/Regulations

5.4.1 State/Local Laws/Regulations/Ordinance Issues

The laws and regulations pertaining to the 9-1-1 system are not standard. Every state governs these systems differently. Thus, it is necessary to identify and review the state laws/county regulations/city ordinances for each political entity with a PSAP in the CG AOR where a CG Secondary PSAP will be located. As part of this review, the various requirements for equipment, training, and documentation need to be identified. These requirements can include the following: data backup and retention, TDD/TTY, equipment requirements (type and quantity), redundancy on workstations, servers, and circuits, voice recording, power supply and backup, manning, training, and certification.

Another issue to be investigated in each state is cost recovery. Cost recovery is a process that allows PSAPs to get funding from a 9-1-1 revenue source. Every state has different laws regarding cost recovery. Most states do not cover costs of the CPE for a Secondary PSAP; however, they may cover circuit costs. For the CG Secondary PSAP in Woods Hole, this arrangement was not available; all costs had to be paid by the Secondary PSAP.

5.4.2 Recommendations for Future Installations

- Plan the schedule to identify and review applicable laws and regulations.
- Identify equipment, training, documentation, and other requirements.
- Investigate whether the state has any cost recovery provisions for Secondary PSAP equipment or circuit costs.

5.5 Training

5.5.1 Training and Certification Issues

Each state has different standards for training and certification. Although there is no national PSAP training standard, the Association of Public-Safety Communication Officials (APCO) offers training and certification in almost every field of the Public Safety arena. Many 9-1-1 systems require their dispatchers to be APCO certified.

For a CG Secondary PSAP with an AOR covering multiple states, the location of the CG Secondary PSAP is likely the defining factor for training and certification requirements. Part of the review of laws/regulations and planning with the state 9-1-1 office(s) is the identification of any training/certification requirements. This was the case for the Group Woods Hole Secondary PSAP; Massachusetts required state certification. To meet this requirement, a training plan was developed and approved by the state. This experience showed the importance of ensuring training standards are agreed upon and set in writing at the beginning.

5.5.2 Recommendations for Future Installations

- Identify any training/certification requirements.
- If necessary, develop a training plan and have approved by the state.
- Schedule initial equipment training separate from the equipment installation. Plan one week for installation, one week for testing/troubleshooting, and one week for training.
- Coordinate with the CPE vendor for the initial training – the purchase cost usually includes equipment training. Have the vendor do the training in coordination with the state 9-1-1 office (to cover state requirements) and a CG representative (to cover a CG 9-1-1 overview).
- Establish a training telephone line. The line should be set up so that when the trainer dials 9-1-1, the connection is directly with the CG Secondary PSAP without going through the Primary PSAP. This connection provides a tool for local user training on the system without impacting the Primary PSAP.

5.6 Coast Guard Policy and Operational Changes

5.6.1 Coordination with the Coast Guard Operational Commander

Any installation of new equipment and capabilities causes some disruption to the receiving command. To reduce disruptions as much as possible, maintain frequent, explanatory communications among State (local) PSAP coordinators, the CG, and the service providers (telephone company, CPE installation techs, etc.). The organizational approval of a Concept of Operations (CONOPS) and any MOAs must occur at the earliest decision-making stages. Operational Commanders will need to coordinate and allow for testing, training, and changing policy and procedures (e.g., Emergency Action Plan, local SOP, etc.).

The Group Woods Hole CONOPS and Emergency Action Plan are included in Appendix B as examples of the policy changes required at the local CG level.

6. SYSTEM OPERATIONAL PERFORMANCE

6.1 Statistics on Calls Received

We conducted a Secondary PSAP system evaluation from 3 May through 30 September 2004. During this time, Group Woods Hole registered 274 SAR cases. The Secondary PSAP system performed well and without problems. There was one failure of a computer/telephone interface device on the backup workstation but this did not impact operations. The interface device was replaced by TCI under the hardware/software maintenance contract. In general since the system has almost 100% redundancy, single failures will not cause system outages. There were no other trouble calls due to system failure. Some software work was required to implement the changes to the ALI format when Massachusetts transitioned to Wireless Phase II. This was also completed by TCI under the hardware/software maintenance contract.

Details on the number of calls received are listed in Table 4. During the trial, 149 total calls were received: 108 calls from Massachusetts and 41 calls from Rhode Island. Of this total, only 39 calls were treated as SAR cases; the remaining calls (110) were considered minor and/or non-emergency situations that did not reach the threshold set by the Group to treat as SAR cases. Of these 149 calls, the majority was from wireless callers. However, there were some calls that were received from landline callers (at least four, but data are not available on all of the Rhode Island calls as to whether they were landline or wireless). In the case of Massachusetts, since most of the primary PSAPs did not have one-button transfers to the CG Secondary PSAP, these calls were transferred manually or relayed from the local police or EMS.

Table 4. E9-1-1 Calls Received.

Total Calls	149
MA	108
RI	41
SAR cases	39

Additional detail on the calls is provided in the tables and pie charts below. A meaningful statistical analysis was not possible because an insufficient number of calls was received. Because there were not sufficient records kept from prior SAR seasons, we could not make any comparison with response prior to the E9-1-1 installation. The analysis of the outcomes relies on anecdotal information accompanying many of the cases. Discussions with the Group Woods Hole watchstanders yielded some insights into the system performance and filled in gaps. Another difficulty with the data analysis is that no records are kept on calls that are not treated as actual SAR cases. Each SAR case has a case file with records kept; other calls are not routinely logged. As part of this project, we asked the watchstanders to keep a log of all calls received, but the logs were not 100% complete.

The majority of the calls received were not treated as SAR cases (did not reach the level set by the Group to be called and documented as a SAR case). Most of these calls were for disabled

vessels or problems within a harbor that could be resolved quickly and required no CG action. No analysis is really possible on these calls as minimal records were kept. Some calls were duplicates (as often happens with terrestrial E9-1-1). In such situations, a single accident can generate numerous calls to 9-1-1 by multiple people observing and reporting the incident. Since the Rhode Island phone line was a regular line (not a 9-1-1 trunk), it also received calls from telemarketers (not included in the numbers below). There were also six calls reflected as SAR cases that were handed-off to adjacent Groups because the incidents were located in their AORs.

For each call that was treated as a SAR case, a case file exists and an analysis was done using the information in the case files; again, this information is of varying degrees of completeness. The calls that became SAR cases were a variety of incident types (see Table 5 and Figure 3). Many calls (see Table 6 and Figure 4) were from bystanders for people who were unable to call for assistance on their own (person in water). A majority of the cases that came to the 9-1-1 line were from people who had no other way besides cellular telephone to call for assistance. Looking at the SAR cases, a large number (43%) were reported by someone other than the person/vessel in distress. The call came from a person on shore or in a vehicle on a bridge or near the water that saw the person or vessel in distress and called 9-1-1. These people did not have access to a VHF radio. The second largest reporting source (36%) was from the vessel in distress. Of these calls, the majority either did not have a VHF radio or the radio was inaccessible/inoperable (in one case the vessel was sinking and the radio was unreachable – the caller used his cell phone from a high point on the vessel).

Table 5. Breakdown of 9-1-1 Generated Cases by Incident Type.

39 Cases	Incident Type
8	Disabled vessel
7	Person in water
6	Transferred to Other Group ³
5	Capsized vessel
4	Flare sighting ⁴
4	Taking on water
5	Other ⁵

³ We did not get copies of the SITREPS for the SAR cases transferred to the other Groups, so the nature of those distress cases is not known.

⁴ Flare sighting cases are reports of flares being seen that generated CG searches, but yielded negative results.

⁵ Other includes medical emergency, fireworks explosion on shore, kite-surfer in distress, possible high-speed grounding, and vessel stuck on a rock

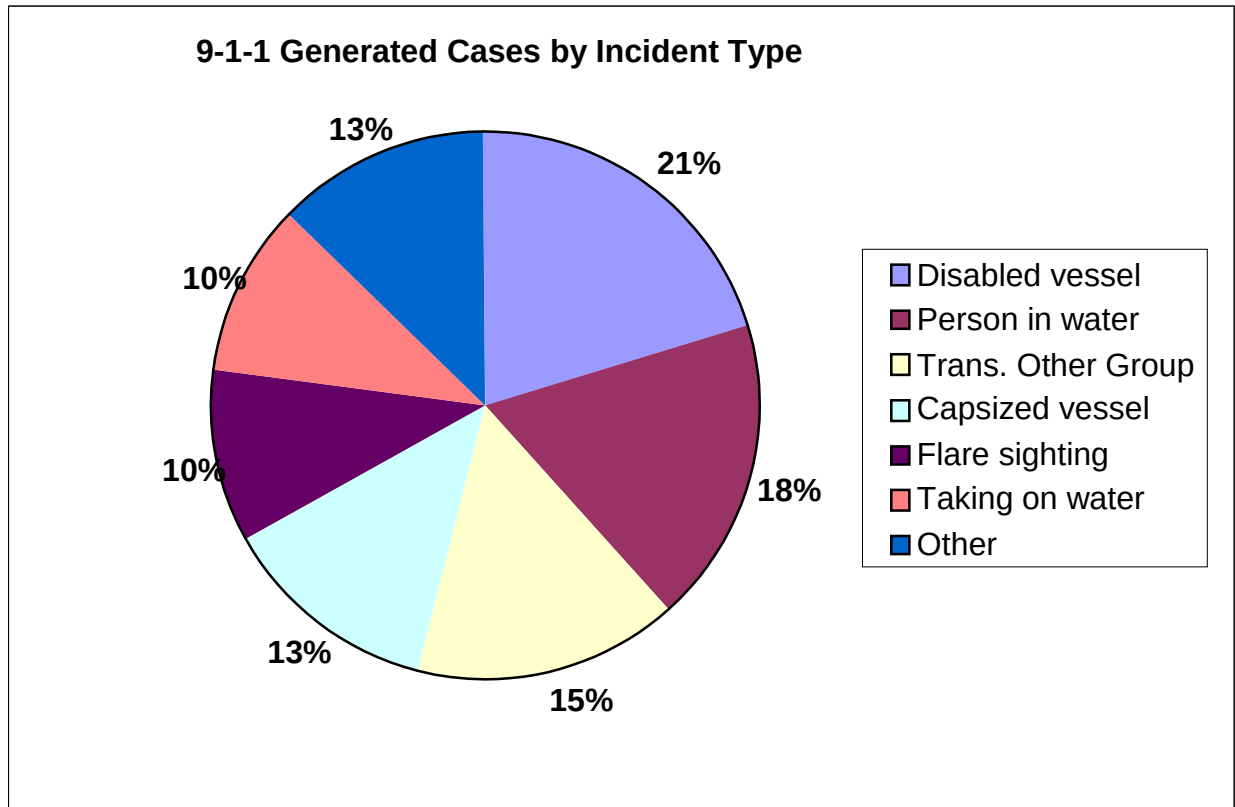


Figure 3. 9-1-1 Generated Cases by Incident Type.

Table 6. 9-1-1 Generated Cases by Reporting Source.

39 Cases	Reporting Source
17	Person on shore
14	Vessel in distress
7	Transfers and other ⁶
1	9-1-1 landline

⁶ No record was kept of the reporting source for the 6 cases transferred to other Groups, and in one Woods Hole case, the file did not include reporting source information.

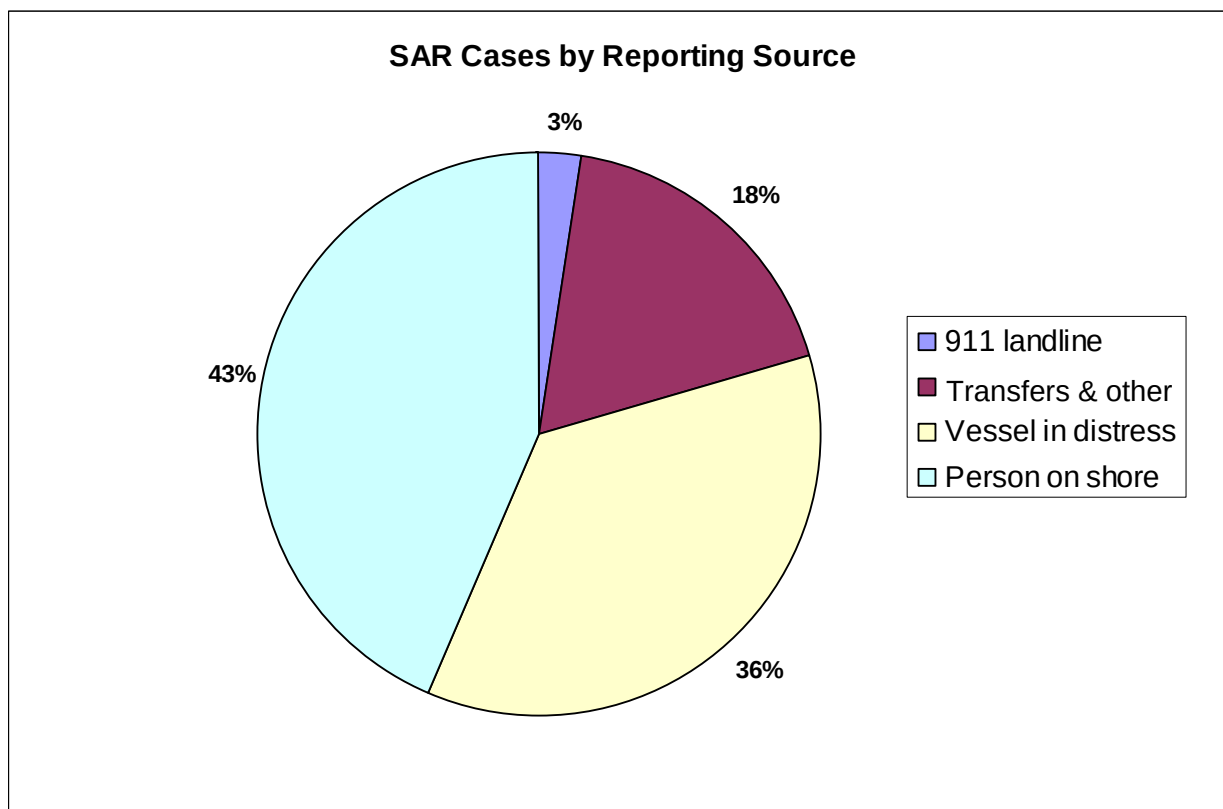


Figure 4. 9-1-1 Generated Cases by Reporting Source.

6.2 Operational Viewpoint

The information in the following sections is derived primarily from a discussion held with all of the Group watchstanders at the beginning of October 2004.

6.2.1 Usability

The watchstanders all found the equipment easy to use and had no difficulties. They commented that they liked having the call information (callback number and position) available electronically and the digital voice playback of the calls. They also liked the addition of Delorme StreetMaps software to the E9-1-1 computer. This software allowed quick plotting of latitude and longitude coordinates or the street address of a call.

6.2.2 Concept of Operations

The Secondary PSAP system fit into the normal mode of operations with minimal changes in procedures. Prior to the trial period, Group Woods Hole modified some of their Quick Reference Cards (QRCs) to reflect the E9-1-1 system. The Group also developed an Instruction to document the new procedures and a CONOPS that was approved by First District. The Group Woods Hole Instruction with E9-1-1-system troubleshooting documents are included in Appendix B.

6.2.3 Training Requirements

The training requirements have been discussed in a previous section 5.5. The watchstanders claimed they did not feel overly burdened by the training requirement (2 days) and felt confident with the system after handling a couple of calls. Having a training 9-1-1 line is very beneficial; watchstanders can practice handling calls with the system both during initial qualification and for refresher training. The biggest time investment with the training was in coordinating with Massachusetts 9-1-1 to get a training program developed that the state found acceptable. The training for new personnel will be integrated into the rest of their watch qualification and will not impose additional training requirements. The primary “cost” to the Group is for those personnel already qualified who must undergo additional training to meet state requirements.

7. BENEFITS

One of the main benefits of the system was the enabling of direct communication between the CG watchstander and the reporting source. This, in turn, reduces time, caller frustration and human error by cutting out the third party. The CG Group watchstanders were unanimous in their belief that this direct communication was a key benefit. The direct communication allowed minor incidents to be handled quickly and expeditiously, and prevented many from becoming larger incidents that would have required CG resources to respond. By being in direct communication with the reporting source, the CG watchstander could ensure that the situation was resolved at the appropriate level.

CG Secondary PSAPs are in line with public expectations. The public expectation is that dialing 9-1-1 in an emergency gets the assistance needed. Having the CG connected into this system allows this expectation to be promptly met. There is no separate number to call the CG; there are no intermediaries receiving the call and attempting to describe the salient points to the CG.

One of the major benefits of the E9-1-1 system is that it provides the position of the caller. With Wireless Phase I, it provides a cellular callback number and the address of the cell tower and sectors. This information can be used to narrow down the possible search area. The Group was given Excel® spreadsheets with the coordinates of the towers and the sectors on each tower to aid in resolving the caller’s location from the cell tower ID. With Wireless Phase II, the E9-1-1 system provides a screen of information including a cellular callback number and lat/long coordinates that are updated when the caller location changes. This can dramatically reduce the time required for the CG to find and reach the caller. In the event that Wireless Phase II information is not available, the system still delivers Wireless Phase I data. In this study there were no instances where the ANI/ALI made any difference in how a case was handled by Group Woods Hole.

CG Secondary PSAPs improve communications with emergency dispatch agencies and emergency responders. By being linked into the E9-1-1 system, all of the Primary PSAPs have a known, standard way to transfer calls to the CG. They are no longer dependent upon local CG units to provide and keep an updated telephone number for the Primary PSAP to reach the CG (or multiple numbers for different stations). The E9-1-1 system is fully familiar to the many civilian emergency response organizations.

Another benefit of the E9-1-1 system is that it can help catch hoaxes by providing lat/long. Lat/long values not corresponding to the message details allow the watchstander to confirm the hoax and potentially direct law enforcement to the site of the call. Hoax calls are not a problem with cell phones in the 9-1-1 system. No hoax calls were received by Group Woods Hole through E9-1-1 during the test period.

8. CONCLUSIONS

The number of cellular calls to 9-1-1 has been increasing every year with the increase in cellular telephones. There are currently over 50,000 emergency calls from cell phones a year; a number that is expected to increase. Cellular phones may soon be the source of the majority of all 9-1-1 calls. Although the impact of increased cellular telephone use on maritime distress calls is unknown, the potential to improve the handling of such calls was a primary factor in conducting this project. About 14% of the SAR cases that Group Woods Hole handled during the trial came from cell phone calls. It is important to track this source of distress calls and note any impact on CG response.

Having 14% or more of the total SAR cases initiated by cell phone calls is not insignificant. The ability to receive such calls and act upon them by taking advantage of the rapidly improving federally-mandated cell phone technologies could be viewed by the CG as an opportunity to serve the public better. A CG decision to join the 9-1-1 system reflects positively on its concern to be more accessible to a growing source of maritime distress calls.

Establishing Secondary CG PSAPs increases connectivity between the maritime public and the CG. It has the benefit of providing a method of direct communication between the reporting source and the CG that is otherwise often not there. The E9-1-1 system also provides a callback number for the caller and position (of the caller if Wireless Phase II and of the cell tower if Wireless Phase I).

There are two cost options for achieving these benefits: (i) the full Secondary PSAP and (ii) a limited Secondary PSAP with a call transfer only option. Both of these connection methods were tested at the Woods Hole PSAP. From the Massachusetts perspective, Woods Hole was a full Secondary PSAP with 9-1-1 trunks, ALI database links, and full CPE. From the Rhode Island perspective, as described previously, it was a limited Secondary PSAP with call transfer only.

The full Secondary PSAP option is the highest cost and provides the most capability. For a single Secondary PSAP there are fixed costs for equipment of \$55-75K and circuit installations of \$6-8K for a total fixed cost of \$60 – 85K. The recurring costs of equipment maintenance (\$2-3K/yr) and circuits (\$10K/yr) present a total cost of \$12-13K/yr. This option provides a system that is easy to use and has full E9-1-1 capability.

The limited Secondary PSAP option is much less expensive but has some drawbacks. There are no fixed costs other than one or more regular phone lines which are obtained at a minimal installation cost (perhaps \$100-200). The recurring cost is only the minimal cost of these phone lines, about \$500/yr. The downside of this option is that it is NOT officially part of the E9-1-1 system. The lines are not E9-1-1 trunks, they are regular phone lines and can be called by other people besides the Primary PSAP. These types of lines are not continuously monitored like 9-1-1

trunks, nor do they have priority for restoration in case of an outage (as do the 9-1-1 trunks). This option provides only call transfer to a regular phone line; there is no transfer of the ANI/ALI information or associated screen display. All ANI/ALI information must be relayed verbally from the 9-1-1 operator to the CG watchstander or faxed separately. It is also important to note that a limited Secondary PSAP may not be possible in some states due to regulatory requirements.

In some areas of the country, the CG has experimented with instituting toll-free numbers for people to contact the CG. While this approach provides an avenue for getting cellular distress calls to the answering point that the CG wants, it is not an optimal solution. It is in conflict with NENA's, "One Nation – One Number" theme. One emergency calling number for the Nation insures that the public will always know how to call for emergency assistance no matter where the emergency is located. Multiple emergency calling numbers for different regions or agencies can be confusing to the public, complicating the emergency contact process. It would be better to use the existing standard 9-1-1 rather than proliferating additional numbers for distress calling. The 9-1-1 number carries an unmistakable identity, respect and an expectation of results.

It makes sense for the CG to be connected into the E9-1-1 system in some fashion. With adequate funding, the full Secondary PSAP option would be the best choice. However, from a cost-benefit perspective and given the CG's budget constraints, the limited Secondary PSAP option is the recommended option for those areas where allowed by state regulations. This option provides most of the benefits of a full Secondary PSAP without the cost associated with the CPE and 9-1-1 trunks. The verbal relaying of ANI/ALI information worked satisfactorily in the trial and would probably continue to work well as long as the call volume remains low. However, if the call volume increases to the point where the verbal relay becomes too time consuming, then the site could be upgraded to a full Secondary PSAP. The call transfer option is a good first step. Much of the work involved with connecting to the E9-1-1 system is the coordination with local entities. This work would need to be done regardless of which option is chosen.

In states such as Massachusetts, wireless 9-1-1 calls are relayed to PSAPs located with the State Police. Landline 9-1-1 calls are relayed to a variety of PSAP locations, not necessarily the same as with the wireless calls. The CG Secondary PSAP may receive its calls from either originating source and must be set up accordingly so that the PSAPs are appropriately "mapped" to the proper CG area of responsibility. This can be especially important in the event that multiple calls, wireless and landline, are received reporting the same incidents.

When implementing Secondary PSAPs, regardless of which of the two options is chosen (full or limited Secondary PSAP), the CG should pick the implementation order of the Groups/Sectors based on hard data, principally the number of wireless, maritime-related 9-1-1 calls received by PSAPs in the Group/Sector AOR.

Based on these data, priority consideration for establishing CG Secondary PSAPs should be given to areas that have already implemented Wireless Phase II so the CG Secondary PSAP would have immediate benefit of the lat/long data.

9. RECOMMENDATIONS

Based on the information learned in this study, the following recommendations are made.

- Perform an additional study to determine the full range of issues and costs of implementing CG Secondary PSAPs in a sample of coastal areas. The sample areas should highlight the situations where one Group or Sector has multiple PSAPs in multiple states, or multiple PSAPs in a single station's AOR. This may establish a range of budgetary estimates for CG-wide implementation. This study should also identify for the sample Group/Sector the specific state/local coordination authorities, the relevant laws/regulations, and the existing type of 9-1-1 implementation.
- As a regular end-recipient of 9-1-1 calls, the CG should participate in any future, federal, E9-1-1 standards development program. Outreach to NENA in conjunction with the new E-911 Implementation Coordination Office specified in the "Enhance 911 Act of 2004" could encourage state-to-state interoperability improvements and common procedures.
- Increase liaison at the field level so that emergency call centers are fully aware of CG missions and responsibilities, and the unique reporting requirements for maritime distress incidents.
- For the CG to be part of the E9-1-1 system, the full Secondary PSAP option is the recommended choice. However, from a cost perspective, a limited Secondary PSAP option is recommended where allowed by state regulations.

10. REFERENCES

Research and Statistics (2005). Cellular Industry Telephone Association (CITA) [On-line],
Available: http://www.wow-com.com/research_statistics/index.cfm/AID/216.

Wireless 9-1-1 Overview (2004). National Emergency Number Association (NENA) [On-line],
Available: <http://www.nena.org/Wireless911/Overview.htm#Wireless%20Statistics>.

Appendix A – General 9-1-1 Issues⁷

Local Number Portability

The breakup of the Bell System, designed to open up competition in the telecommunications industry, brought about many changes but perhaps none has affected the way the telephone companies update and maintain the 9-1-1 database as much as Local Number Portability (LNP).

When competition in local exchanges began, the new competing dial tone providers saw the inability of customers to switch from one telephone company to another while retaining the same telephone number as a huge advantage for the incumbent companies and major barrier to competition. As a result, the Telecommunications Act of 1996 mandated that, “all telecommunications service providers, to the extent technically feasible, provide telephone number portability in accordance with the requirements prescribed by the Federal Communications Commission.” The telecommunications act defines Local Number Portability as, “the ability of users of telecommunications services to retain, at the same location, existing telecommunications numbers without impairment of quality, reliability, or convenience when switching from one telecommunications carrier to another.”

To the Competing or Certified Local Exchange Carrier (CLEC), the Alternate Local Exchange Carrier (ALEC) and the Incumbent Local Exchange Carrier (ILEC), implementing LNP meant making major changes in billing systems, service order processing systems as well as almost every downstream system including 9-1-1. (See Attachment D, “Glossary of Terms” for a definition of ALEC, CLEC and ILEC).

Tens of millions of dollars were spent to come into compliance with the FCC mandate. However, the most drastic changes were in the way calls are routed when the subscriber changes carriers and keeps the same number.

Call routing is based on the Numbering Plan Area (NPA) commonly known as the Area Code, and the Numbering for Exchange Code (NXX) commonly known as the Local Office Code or Telephone Number Prefix. Presently LNP is done only within the same geographic areas or “rate center.” Before LNP, it was possible to tell the state or area of the state and the area of a city by the NPA/NXX. With LNP this is no longer possible. With LNP when a subscriber changes carriers and keeps the same number, the telephone central office uses a call forwarding process to switch the call. There is the old telephone number, displayed on caller IDs, and the “real” telephone number, transparent to the caller, which uses the NPA/NXX of the new central office. This solution (two numbers for one subscriber) has severely impacted the bank of telephone numbers available for assignment to new subscribers and is one of the reasons for the proliferation of area code splits throughout the nation.

Landline Local Number Portability

Landline LNP was first deployed in late 1998. A serious problem for 9-1-1 systems has been the time it takes to migrate the telephone number in the 9-1-1 database when a subscriber changes to

⁷ Detailed material in this Appendix gathered from <http://ftp.fcc.gov/cgb/NumberPortability/#whatis> and previous NENA reference

a different service provider but keeps the same telephone number. Migration refers to changing data to update certain fields of information used by the PSAP. The ILECs, CLECs and ALECs have all been guilty of slowing down the process. The complexities of the process, different service order systems, different LNP methods and communications between the companies have been at fault.

The most troublesome condition appears when the donor company fails to unlock the telephone number record in the 9-1-1 database so that it can be migrated to the recipient company. In this instance, when there isn't a change of location, the problem can simply be an incorrect Telco ID on the 9-1-1 screen. However, when there is a change of location, the old address will be displayed until the record is updated in the 9-1-1 database. This is just one of the reasons why most PSAP Standard Operating Procedures require the call taker to verify the address (location) of the emergency rather than solely relying on the address displayed on the 9-1-1 screen.

Wireless Local Number Portability

According to the FCC, "Wireless Local Number Portability (WLNP) is a wireless consumer's ability to change service providers within the same local area and still keep the same phone number. WLNP allows consumers to switch from one wireless carrier to another within the same general metropolitan area. It does not allow consumers to keep the same phone number when moving to a new town or city outside of the local area. WLNP also allows consumers to move a phone number from a landline phone to a wireless phone in some cases."

The FCC established November 24, 2003 as the deadline to implement WLNP in the largest 100 Mobile Switching Areas (MSA). Beginning May 24, 2004, customers in areas outside the 100 largest MSAs will also be able to experience the benefits of WLNP. Wireless carriers serving areas outside the 100 largest markets were directed to be capable of porting by May 24, 2004.

Intermodal Local Number Portability

Like WLNP the FCC established November 24, 2003 as the deadline to implement Intermodal LNP (ILNP). Intermodal Local Number Portability refers to porting a number from a landline carrier to wireless carriers and vice versa. Intermodal LNP is not available in all wireless markets.

Satellite Telephones

Satellite Telephones are primarily used by governments, the military and anyone in remote land areas or oceans where there isn't access to landline or cellular phones. When satellite users need to access an emergency service agency they must remember that the satellite companies use different technology than landline and wireless companies.

Satellite telephones are not local telephone companies and are not based on an NPA/NXX that is tied to a 9-1-1 system with a location database. Some satellite companies are worldwide and others cover countries or continents. They may or may not be able to determine the caller's location or how to contact emergency services for that location. Some satellite companies have a 9-1-1 number on their telephone switch but others don't. Some satellite service providers have implemented their own response centers for emergency calls. In any case, the point to remember is that satellite phone systems are not tied into the standard 9-1-1 system.

Strongest Signal

The term “Strongest Signal” refers to the concept that a wireless 9-1-1 call should be routed to the cell site with the strongest link to the phone, regardless of which carrier holds the caller as a customer. A study in the mid 1990’s determined that there were “dead spots” in many cell coverage areas. These dead spots fall into two categories, “no signal” or “insufficient signal.” Calls placed from phones programmed to access only one cellular system were not connected if the call is made from a dead zone. Cell phones programmed to switch to another cellular system in the absence of a signal sometimes may lock in to a weak signal and not switch over. The call is not completed in either case. After strong lobbying from a consumer group, the FCC ordered that analog wireless phones must use any available transmission method and carrier to complete a 9-1-1 call. Now, wireless phone manufacturers are marketing compliant phones.

Non-initialized Phones

When the FCC issued its original rules on Wireless 9-1-1, they required wireless companies to accept and pass along 9-1-1 calls from any wireless phone, even those that had not been subscribed with a carrier. The intention was to ensure that emergency calls would be processed and then routed to the PSAP. Two issues have arisen over the use of these phones:

- The user does not pay any 9-1-1 surcharge that might be levied by the local or state jurisdiction to pay for improvements to the 9-1-1 system. The user doesn't help pay for Wireless Phase I or II features, even though receiving Wireless Phase II when dialing 9-1-1.
- Since the phone has no phone number, the caller cannot be recalled by the dispatcher if it becomes necessary. First, the caller's phone number won't be displayed, and the caller can't supply a number verbally to the dispatcher.

In December of 2001, NENA addressed this problem to the FCC. In November of 2003 the FCC changed the requirement to program non-initialized phones to the telephone number 123-456-7890. The same month, NENA published, “Guidelines for Minimum Response to Wireless 9-1-1 Calls.”

Unintentional 9-1-1 Calls

Unintentional calls to 9-1-1 have always been a problem. These calls can be expensive and time consuming since standard operating procedures for most PSAPs require dispatching services to the calling location when there is a 9-1-1 call disconnect, and no one answers on the dispatcher's callback.

Cellular phones have caused the majority of unintentional 9-1-1 calls. Some cell phones have a 9-1-1 one-button calling feature that has caused accidental calls when the keypad lock feature isn't used. Unintentional wireless 9-1-1 calls have made up an estimated 30-50 percent of the total wireless 9-1-1 calls. These calls have been a major problem for PSAPs since it takes a long time to determine that they are accidental.

In December 2001 NENA wrote wireless carriers describing the problem and asked them to work on the unintentional call from cellular phones issue. In January 2001 NENA and APCO asked the FCC to study this issue. In December 2002, the FCC released a staff report on unintentional wireless 9-1-1 calls. The report confirmed that unintentional wireless 9-1-1 calls

posed a significant problem for PSAPs and outlined steps that industry participants could and should take to address the problem. For example, the major wireless carriers have requested that their vendors cease shipping phones with an active auto dial 9-1-1 feature. Wireless phones distributed by these carriers have rarely had an auto dial 9-1-1 feature since February 2002. In addition, the Cellular Telecommunications and Internet Association (CTIA) has modified its handset certification program such that certified hand sets may not be pre-programmed with an auto-dial 9-1-1 feature.

Voice over Internet Protocol (VoIP)

Voice over Internet Protocol (VoIP) technology enables a subscriber to make calls over their DSL or cable Internet Connection using their existing telephone and router. VoIP, also referred to as (Voice over IP), provides distinct packetized voice information in digital format using the Internet Protocol rather than using the public switched telephone network. The Internet Protocol (IP) address assigned to the user's telephone number may be static or dynamic.

The FCC requires 9-1-1 calls from landline and cellular phones to display the calling number and its location, but there are no similar requirements for VoIP. The telephone number associated with the VoIP call is in a format the 9-1-1 system does not recognize, and is not associated with a location in the 9-1-1 database.

While the FCC debates if VoIP providers should be subject to the same regulation as other service providers, NENA is evaluating information recently made available on methods for bringing VoIP 9-1-1 calling into E9-1-1 systems. These methods provide Selective Routing and Automatic Location Information (ALI). NENA is likely to recommend that Voice over Internet providers use newly available interfaces into the E9-1-1 systems for customers that have fixed locations and are using telephone numbers from their local area code.

Appendix B – Group Woods Hole Reference Materials

U.S. Department of
Homeland Security

United States
Coast Guard



Commanding Officer
United States Coast Guard
Group Woods Hole

1 Little Harbor Road
Woods Hole, MA 02543
Staff Symbol: OPS
Phone: 508-457-3412

1500.2A

GROUP WOODS HOLE INSTRUCTION 1500.2A

Subj: E-911 SYSTEM RESPONSE POLICY

Ref: CCGDONE Search and Rescue (SAR) Plan, CCGDONEINST M16101.1D
U.S. Coast Guard Addendum to the United States National Search and Rescue Supplement (NSS) to the International Aeronautical and Maritime Search and Rescue Manual (IMSAR), COMDTINST M16130.2C
Massachusetts Enhanced 9-1-1 Telecommunicator Training Manual, Second Edition (revised 08/89)

1. **PURPOSE** This instruction establishes policy for responding to wireless calls transferred by the Massachusetts State Police to the Group Woods Hole Secondary Public Safety Answering Point (PSAP).
2. **ACTION** All Group Woods Hole Staff Duty Officers (SDO) and Operations Specialists of the Watch (OSOW) are to comply with the requirements of this instruction.
3. **DIRECTIVES AFFECTED** None
4. **DISCUSSION** Due to an increase in popularity of wireless communications in the United States, many mariners now use wireless (cellular) telephones as a primary/secondary means of communication on the water. Although the Coast Guard discourages use of cellular telephones as a primary means of distress alerting we can expect this problem will persist. Beyond this, we can expect that certain segments of the recreational boating community will operate vessels not normally equipped with marine band VHF radios (e.g. canoes, kayaks, sailboard, etc.). In marine incidents involving these increasingly popular vessels it is probable that distress alerting will be attempted via cellular telephone and that the distress calls will be directed to the coastal state 911 emergency response system. Enhanced 9-1-1 (E911) is the latest version of a program designed to provide an easily remembered, 3-digit emergency number for the entire country. As a result, the Coast Guard often receives requests for assistance from mariners that have been transferred from the state E911 system. The Massachusetts Statewide Emergency Telecommunications Boards have given Group Woods Hole authorization to conduct an operational test and evaluation (OT&E) as a Full Secondary PSAP. All wireless calls from mariners in need of Coast

Guard assistance off of the Massachusetts coastline will be forwarded to the Group Woods Hole PSAP from the Massachusetts State Police wireless call centers.

Receipt of E911 maritime distress calls and assistance requests directly in the Group Woods Hole Command Center will effectively remove the intermediary (the state 911 dispatcher) and improve the quality of incident information by placing the reporting source in direct contact with Coast Guard search and rescue authorities. In addition, these calls will be accompanied by positional information that the Coast Guard can exploit to reduce the uncertainty regarding the location of the reporting source. This would be particularly valuable in cases involving vessels without effective navigational equipment and disoriented boaters. Positional information currently consists of two types: Phase I and Phase II. Phase I information provides the carrier identification, the call back number of the caller, the address of the cellular telephone tower which received the call and sector information. Each cellular tower has three sectors and this information can be used to determine the general direction from which the call originated. Position information can be refined based on the location of the cellular tower and the sector on which the call was received. Phase II information provides identical information as that provided by Phase I but also includes the position of the caller described by latitude and longitude. Two methods can be employed in the Phase II system to establish the caller's position. The first method relies upon triangulation between multiple cellular towers and produces a position reliable to within 300 meters 95% of the time. The second method relies upon a global positioning system (GPS) chip in the telephone handset which provides a position accurate to within 150 meters 95% of the time.

The State of Massachusetts currently employs Phase I technology but is moving toward implementation of Phase II technology. Due to the limitations of certain cellular phones and systems positional information may not always be available.

5. **PROCEDURE**

a. Call Handling Procedures

1. Incoming calls shall be promptly answered with the following standard greeting:
“Coast Guard Search and Rescue, what is your maritime emergency?”
2. Determine the caller's position, number of persons on board the vessel, the nature of distress and get a description of the vessel. Verify the call-back number displayed on the Automatic Number Identification (ANI) screen.
3. Instruct the caller to dial 9-1-1 again if communications are lost.
4. Determine whether alternate means of communications exist. If the caller's vessel is equipped with a VHF radio attempt to establish communications on Channel 16 or 22, as appropriate to the situation.
5. Fill out an initial SAR check list.

6. Exploit PSAP system equipment and Phase I/Phase II data to reduce/resolve positional uncertainty as necessary.
7. Should a call be inadvertently transferred to the Group Woods Hole PSAP, gather the necessary information, call the appropriate agency and relay the information.
8. Prosecute the call (case) in accordance with established Coast Guard procedure, as outlined in references (a) and (b).

b. Lost Call Procedures

1. In the event that a call is lost prior to obtaining the caller's position, immediately try to reestablish communications by calling the number displayed on the automatic number identification (ANI) screen.
2. If unable to re-establish communications with the caller, immediately review the recorded call in order to verify information.
3. Evaluate the emergency phase.
4. Exploit PSAP equipment and Phase I/Phase II data, as appropriate, to establish the general location of the caller. This information will be displayed on the Automatic Location Identification (ALI) screen.
5. Issue an urgent marine information broadcast (UMIB) as appropriate. The UMIB should inform mariners that the Coast Guard received a call for assistance via cellular phone. Any information regarding the caller's position, nature of distress and vessel description should be included in the broadcast. The UMIB shall be broadcast for at least one hour at 15-minute intervals.
6. Dispatch SRU(s) if appropriate.
7. If no position information was obtained and the SDO is unable to reestablish communications with the caller, continue prosecuting the case as an Uncorrelated Mayday using established guidelines and procedures.

c. Silent Call Procedures

1. There is a remote possibility of receiving a silent call on a Secondary PSAP. A silent call is one in which a telephone connection is established but there is no verbal communication between the caller and E911 responders. In such cases the shall be processed as a TDD (Telecommunication for the Deaf) call and the following procedures employed.
2. Verify the call-back number contained in the ALI screen.
3. Activate the TDD challenge function on the answering position unit (APU). The APU will automatically place the unit in the TDD mode.

4. If there is no response, click the “Cancel” button on the APU screen and initial the TDD Challenge function again.
5. If the caller responds, gather further information by following standard TDD procedures and etiquette.
6. If there is still no response, attempt to establish communications with the caller using the number displayed in the ALI screen

d. Equipment Failure Procedures

1. In the event of an equipment failure, immediately contact the Massachusetts State Police PSAP in Middleboro at 508-xxx-xxxx. Advise them that Coast Guard Group Woods Hole has experienced an equipment failure and request that all E911 calls be routed to the Coast Guard District One Command Center at 617-xxx-xxxx. Immediately thereafter advise District One that Group Woods Hole is experiencing an equipment failure and that E911 calls normally directed to the Group are being routed to the District Command Center. Instruct the Massachusetts PSAP that Group Woods Hole will contact them when the equipment failure has been corrected and the Secondary PSAP become operational.
2. Immediately after making the notifications indicated above, contact one of the system administrators using the phone list below. The system administrator will determine whether or not the problem is a circuit problem or equipment related. If it is an equipment related problem the administrator will attempt to clear the trouble using TCI Administrator procedures. The Administrator will subsequently log all problem incidents. If unable to resolve the problem the Administrator will refer the problem to The 911 Company, Inc. (POC: Mr. Terry Black), a contractor servicing the E911 equipment who reports to the Coast Guard R&D Center.

e. Potential Casualty Scenarios and Response Actions

SCENARIO: Smoke begins emanating from the E-911 CPU.

ACTION: Secure the power to the CPU. Contact the PSAP(s) and advise them that Coast Guard Group Woods Hole is experiencing equipment problems and request that all E911 calls destined for Group be routed to the Coast Guard District One Command Center until further notice. Contact a system operator. If the system operator cannot resolve the situation refer the problem to The 911 Company, Inc.

SCENARIO: The 911 trunk located in the phone room fails and calls cannot be routed to the Woods Hole Command Center.

ACTION: Contact the PSAP(s) and advise them that Coast Guard Group Woods Hole is experiencing phone line problems and request that all E911 calls destined for Group Woods Hole be routed to the Coast Guard District One Command Center until further notice. Contact a system operator. If it is determined that the problem is with Verizon or MCI, contact their respective service numbers to check the phone lines.

SCENARIO: A construction crew accidentally severs the phone lines to the Group Operations Building thereby disrupting all phone communications.

ACTION: Employ an emergency cellular telephone to contact the PSAPs. Advise them that we are experiencing phone line problems and request that all E911 calls destined for Group Woods Hole be routed to the Coast Guard District One Command Center until further notice. Contact the telephone service provider that is being affected and advise them that our “emergency” phone lines have been cut. Request an emergency response be dispatched.

f. Important Phone Numbers

Massachusetts PSAP	508-XXX-XXXX
System Operators	
Jay Deal, Ed Mills and Steve Kent	See Recall List.
The 911 Company Inc. (Terry Black)	877-XXX-XXXX or 501-XXX-XXXX
TCI Trouble Reports 24/7	888-XXX-XXXX
Verizon Services Response Center	800-XXX-XXXX for MA
MCI Services Response Center	800-XXX-XXXX for RI
USCG Centrex Lines Response Center	800-XXX-XXXX or 617-XXX-XXXX

g. Circuit Identification Numbers

1. You may be asked for Circuit ID Numbers so that they may troubleshoot the lines, use the information provided below to aid their troubleshooting.

Massachusetts:

Data Circuit:	LEC ID:
Voice Circuit:	LEC ID:
ALI Database Links:	20.HRDA. 20.HRDA.
Trunks:	20.EMNT. (Medfield) 20.EMNT. (Wakefield) Centrex Lines: ⁸

⁸ All phone numbers and circuit numbers have been redacted or eliminated for privacy and security.

USCG Group Woods Hole E911 System

Equipment and Circuit Problem Escalation Process

1. The Watchstander on duty will immediately refer TCI alarms and 9-1-1 circuit problems to the USCG TCI Equipment Administrator (hereafter referred to as SysAdmin) on duty. If the E911 workstation is OOC then the watchstander will immediately switch to the backup workstation. This will occur within 10 minutes of the alarm. TCI Equipment Administrators are:
 - Primary: Ed Mills
 - Secondary: Steve Kent
 - Backup: Terry Black
2. The USCG SysAdmin will investigate the alarm/error and attempt to determine if the problem is a local problem, an equipment problem, or a circuit problem. The SysAdmin will log all problem incidents. Repairs/problem correction is to be initiated within 2 hours.
3. If the problem is a local problem (power failure, operator error, etc.) the SysAdmin will correct the problem.
4. If equipment related, the SysAdmin will attempt to clear trouble using TCI Administrator procedures. If unable to resolve the equipment problem within 1 hour, the SysAdmin will call the TCI 24x7 Helpline for assistance. The SysAdmin will then refer the incident to Terry Black for follow-up tracking and assistance. Terry Black will track the problem through to repair completion with TCI, calling upon additional resources as needed. Onsite assistance will be provided by SysAdmin if possible or by JJMA if needed.
5. If the problem is circuit related, the Administrator will call the Verizon SRC to report the outage. The SysAdmin will then refer the incident to Terry Black for follow-up tracking and assistance. Terry Black will track the problem through to repair completion with Verizon, calling upon additional resources as needed.
6. If the Woods Hole Secondary PSAP is totally OOC (both workstations are down, all circuits are down, or there is some catastrophe rendering the building unusable) notify the MA Primary PSAP at Middleborough and the RI Primary PSAP at Providence to transfer all calls to the backup site (D1)

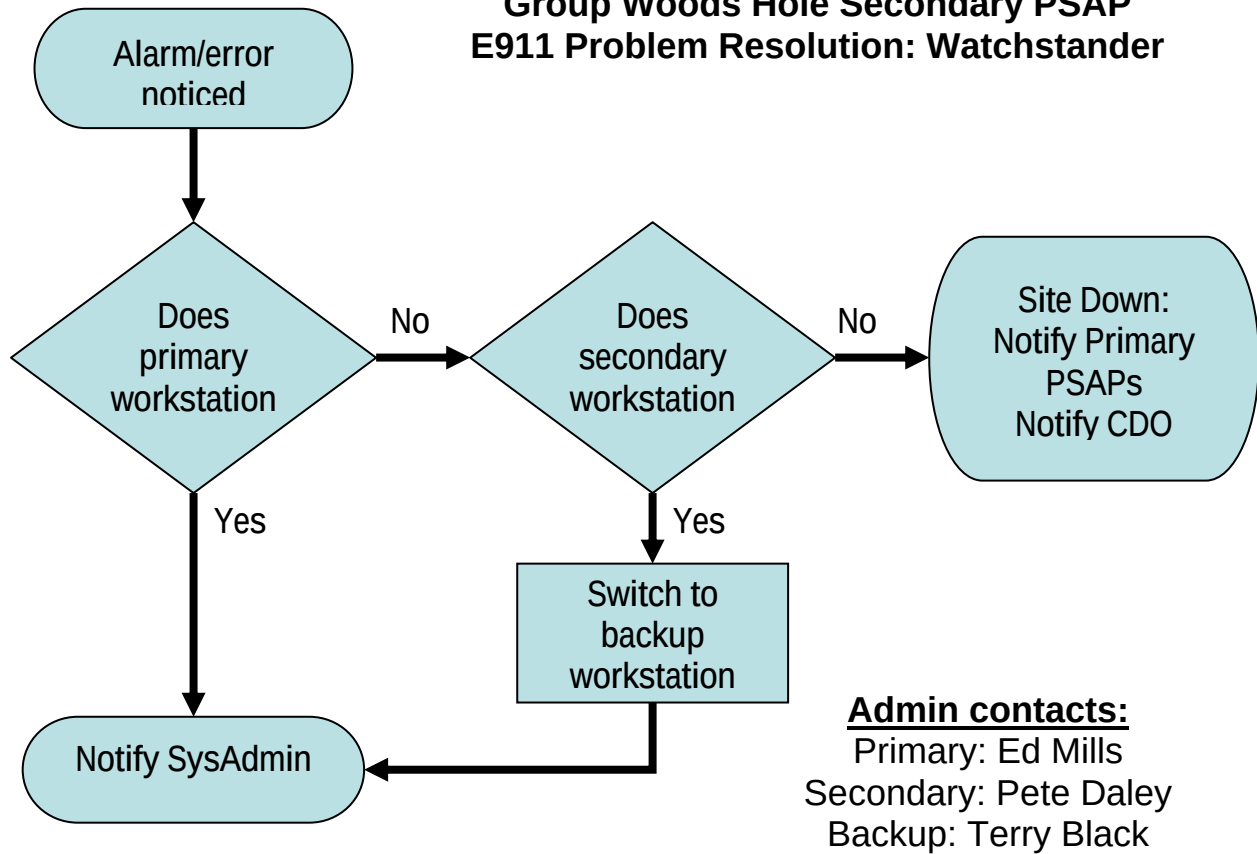
Contact Information

Ed Mills (Primary SysAdmin)	
Phone	Home - xxx-xxx-xxxx Cell - xxx-xxx-xxxx
Pete Daley (Secondary SysAdmin)	
Phone	Home - xxx-xxx-xxxx, Cell - xxx-xxx-xxxx
Terry Black (Backup SysAdmin & Trouble follow-up/tracking)	
Pager	xxx-xxx-xxxx
Cell	xxx-xxx-xxxx
TCI Help Desk	
24/7 Phone	xxx-xxx-xxxx
Verizon Service Response Center (SRC)	
24/7 Phone	xxx-xxx-xxxx
USCG Centrex Lines	
Verizon	xxx-xxx-xxxx xxx-xxx-xxxx
MA Primary PSAP Supervisor	
Middlebury – Phone	xxx-xxx-xxxx
RI Primary PSAP Supervisor	
Providence – Phone	xxx-xxx-xxxx
CG Watch Supervisor	
Phone	xxx-xxx-xxxx
Fax	xxx-xxx-xxxx

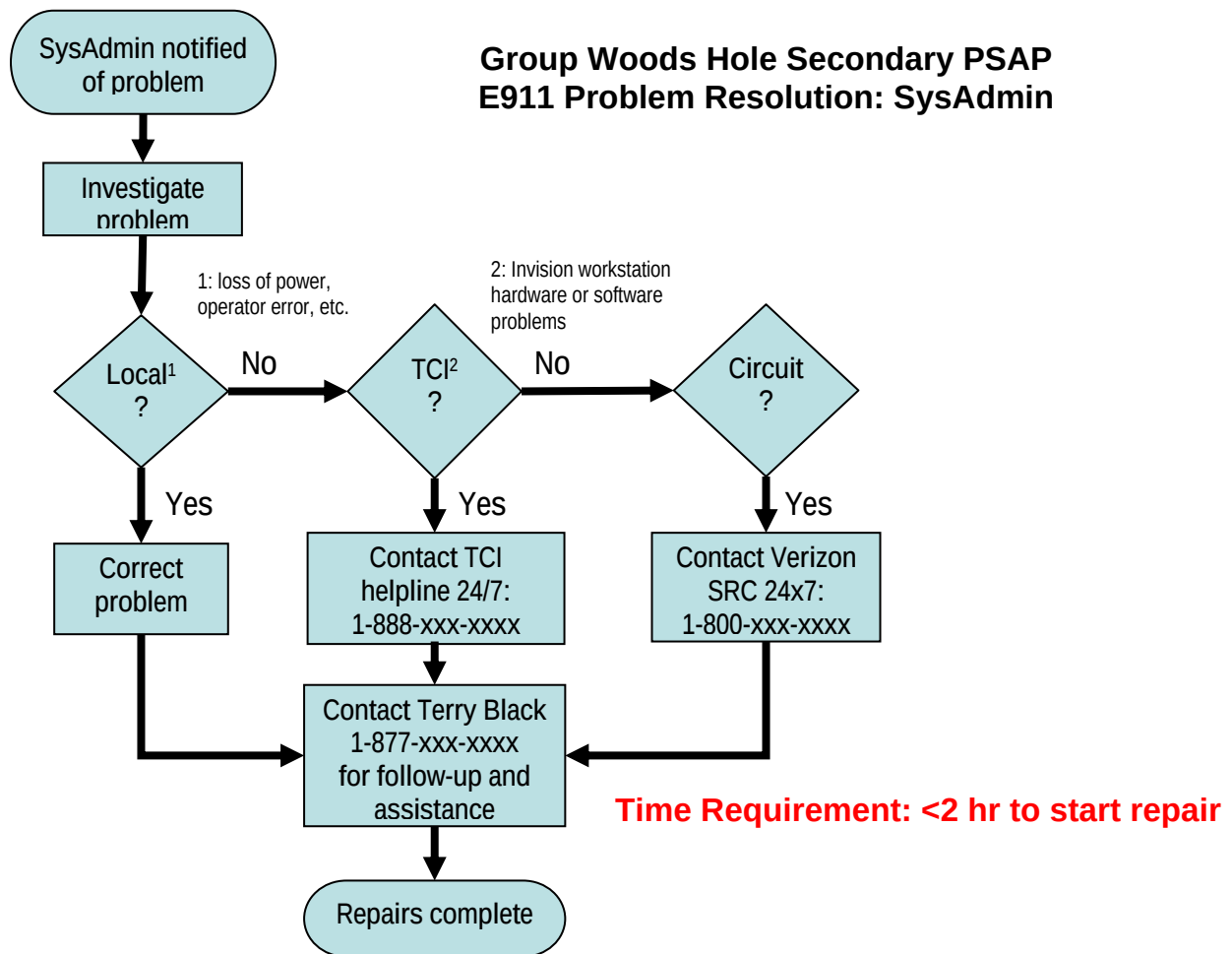
Circuit Information

ALI Database lines	Connects to:
20.HRDA.	Conklin, then to serial port on server.
20.HRDA.	Conklin, then to serial port on server.
Medfield Trunks	Connects to:
20.EMNT. xxx-xxx-xxxx	Trunk Card 1
20.EMNT. xxx-xxx-xxxx	Trunk Card 2
Wakefield Trunks	Connects to:
20.EMNT.	Trunk Card 1
20.EMNT.	Trunk Card 2
Rhode Island Line	Connects to:
xxx-xxx-xxxx	Trunk Card 3
TCI Dial-in Line	Connects to:
xxx-xxx-xxxx	Server modem

**Group Woods Hole Secondary PSAP
E911 Problem Resolution: Watchstander**



Time Requirement: <10 min. to notify SysAdmin



April 21, 2004

United States Coast Guard
Woods Hole Station
Woods Hole, MA

PARTIES IN ATTENDANCE

Coast Guard

Thomas L. Amerson, Ph.D.
Human Factors Research Scientist

Gregory W. Johnson, MSEE
Program Manager

Edward L. Mills
Operations Specialist First Class

Rick Uronis
Operations Center Supervisor

Rhode Island E 9-1-1

Gregory M. Scungio, PPM
Rhode Island E 9-1-1

William P. Gasbarro, CSO
Rhode Island E 9-1-1

Kenneth J. Pomposelli, PM
Rhode Island E 9-1-1

Leo Baillargeon
AK Associates, Technical Consultant

Thomas A. Kraus
AK Associates, Technical Consultant

MEMORANDUM OF UNDERSTANDING

This memorandum is intended to memorialize the discussions, agreements, and understanding among and between the above referenced parties relative to the meeting at Rhode Island E 9-1-1 on April 21, 2004.

Rhode Island E 9-1-1 will adhere to the following protocols:

1. Upon our Call Center receiving a landline emergency phone call originating on or about the waterways of Rhode Island, we will be provided with the caller's name, telephone number and location.
2. If the call originates on a wireless cellular phone that is equipped with a global positioning satellite chip, we will be provided with a call back number and XY (Latitude and Longitude) coordinates.

3. In either event, we will, if possible, confirm the location of the emergency and transfer the caller to the Woods Hole Coast Guard Station.
4. In the event the caller hangs up or is disconnected, the telecommunicator will relay all pertinent information to the dispatcher at the Woods Hole Coast Guard Station.
5. The primary number used to contact Woods Hole will be the following: 1-508-XXX-XXXX.
6. If we are **not** able to contact Woods Hole or, in the alternative, are placed on “hold”, we will hang up and proceed to contact the Coast Guard Station at either Castle Hill or Point Judith, Rhode Island.
7. In an abundance of caution, after completion of our call to one of the aforementioned Coast Guard Stations, we will contact the local municipal police, fire or rescue services.
8. To the extent practicable, if time and call center constraints allow, the Call Center Supervisor will fax the map and accompanying XY coordinates to the Woods Hole Station by way of the following number: 1-508-XXX-XXXX.

United States Coast Guard will adhere to the following protocols:

1. The Coast Guard will respond to waterborne incidents originating on or around the waterways of Rhode Island as long as the water depth is sufficient and/or there are aircraft available in the surrounding area.
2. The above referenced water depth or aircraft availability will be determined by the Coast Guard.
3. Additionally, the Coast Guard at Woods Hole will decide whether to dispatch rescue crews and equipment from the Woods Hole Station or alternatively from the Castle Hill or Point Judith Stations.
4. The three aforementioned Coast Guard Stations will have qualified personnel available 24 hours a day, 7 days a week, 365 days per year.
5. The Coast Guard will immediately notify our Call Center if they should lose contact with the caller. Call inquiries and notifications will come in by way of our administrative line: 1-401-XXX-XXXX.
6. The Coast Guard will inform us anytime they are going off-line, and will contact us as soon as they are back on-line.

7. The Coast Guard will make provisions that the phone number: 1-508-XXX-XXXX, is a dedicated phone line for use exclusively by Rhode Island E 9-1-1 for incoming emergency calls.
8. The Coast Guard will provide us with a wall map that indicates their Area of Responsibility (AOR).
9. The Coast Guard will arrange for a series of test calls, prior to the start-up date of May 3, 2004, with Kenneth Pomposelli, Project Manager for our agency.
10. If the test call results are acceptable to our agency, the effective date for the above referenced procedures will be on May 3, 2004, at 12:00 A.M.
11. All information and/or documentation provided to the Coast Guard by E 9-1-1 is confidential and protected by various Rhode Island statutes. This statutory duty of care mandates that any and all information and/or documentation provided must be kept in the strictest of confidences and disposed of in accordance with the statutory intent created by the Rhode Island Legislature.
12. It is expressly understood and agreed by the Coast Guard that this document is merged, attached and incorporated into that document entitled "SECONDARY PUBLIC SAFETY ANSWERING POINT AGREEMENT", and that both documents will be duly executed as of same date by both RHODE ISLAND E 9-1-1 and the UNITED STATES COAST GUARD.

Appendix C - Detailed System Architecture

This Appendix is an expansion upon the information contained in Section 3 of the Report.

Because Group Woods Hole's Area of Responsibility (AOR) covers parts of two states (Massachusetts and Rhode Island), the Coast Guard Secondary PSAP needed to be linked into two state's 9-1-1 systems. For the following discussion refer to Figures C-1 and C-2.

Massachusetts

Massachusetts uses a "standard" E9-1-1 network; wireless calls are routed through the Selective Routers to designated Primary PSAPs. In Massachusetts, the state is divided into two geographic regions (East and West) with two Selective Routers for each region. These two Selective Routers are fully redundant; each call is handled by only one of the two Routers and one Router can handle the entire region. All wireless 9-1-1 calls are routed via the Selective Routers to one of two Primary PSAPs that are designated to handle wireless 9-1-1 calls for the state. These two PSAPs are located in Framingham and Middleborough.

When calls are transferred from the Primary to the Secondary the connection is back through the Selective Router. Massachusetts' regulations typically require connections from a PSAP to ALL Selective Routers. However, since the Coast Guard is only concerned with coastal calls, we only needed to connect to the Eastern pair of Selective Routers (located in Wakefield and Medfield). This change from the typical installation was approved by the Massachusetts E9-1-1 Board. However, to meet the state required redundancy, two trunks were run to each Selective Router for a total of four trunk lines.

There are three coastal Emergency Service Numbers (ESN): 601, 604, and 607 (See Figure C-2). Only the ESN 604 calls were routed to Woods Hole; the rest of the calls continued to be transferred to the District One SAR Line. All ESN 604 calls are handled by the Primary PSAP in Middleborough; therefore, they (Middleborough State Police) were the only ones that needed to have the one-button transfer capability to Woods Hole.

Figure 3 has these two areas overlaid. You will notice that the magenta-shaded area of ESN 604 extends slightly to the North of the Group Woods Hole boundary line. This non-alignment of 9-1-1 boundaries with Coast Guard boundaries will always be an issue to be dealt with operationally until all 9-1-1 systems are Wireless Phase II capable and Selective Routing can be done on the basis of position.

The Pseudo Automatic Number Identification (pANI), and depending upon wireless call provider, the ANI was transferred along with the voice call to the Coast Guard Secondary PSAP. The term ANI refers to the access line from which a call originates (callback number). The term pANI refers to a pseudo telephone number associated with a specific cell tower and/or a sector of the tower receiving a cellular call. The pANI is used to query the Verizon ALI database to return the callback telephone number and the ALI (cell tower location and sector ID). Data circuits to the two (redundant) ALI databases were installed (Brockton and Hyannis) to enable this lookup.

Rhode Island

The situation in Rhode Island is very distinctive in the 9-1-1 industry. Most state's legislation and tariffs identify three main features that define an E9-1-1 system: Automatic Number Identification (ANI), Automatic Location Identification (ALI) and Selective Routing (SR). However, the Rhode Island 9-1-1 network solution does not use Selective Routing to get data to the emergency dispatchers. In Rhode Island, all 9-1-1 calls with accompanying ANI/ALI are routed to the state Primary PSAP in North Providence by the telephone companies. The state PSAP does not dispatch emergency responders. Voice and data are not selectively routed from the North Providence PSAP to the individual dispatch centers. Rather, voice only is "one-button" transferred to these emergency dispatch centers. This is different from 9-1-1 systems in the higher population areas throughout the United States. Essentially, Rhode Island has only one E9-1-1 PSAP for the whole state but it doesn't dispatch emergency responders. This can be efficient for a state with 5 counties; however, this approach would not work for large coverage areas with large populations.

Due to these differences, there was no inexpensive or standard way to connect into the Rhode Island E9-1-1 system. We were forced to use a regular 10-digit call transfer – exactly the same as used with a 3-way conference call on a regular phone. To achieve this, the Rhode Island Primary PSAP was given the phone number of the regular phone line run into the Customer Premises Equipment (CPE) at Group Woods Hole so at least all of the E9-1-1 calls would arrive on the same phone. Using this method achieved voice connectivity but not the ANI/ALI transfer. All E9-1-1 information (callback number, position, etc.) had to be relayed verbally from the Rhode Island call-taker to the Coast Guard watch stander with fax backup.

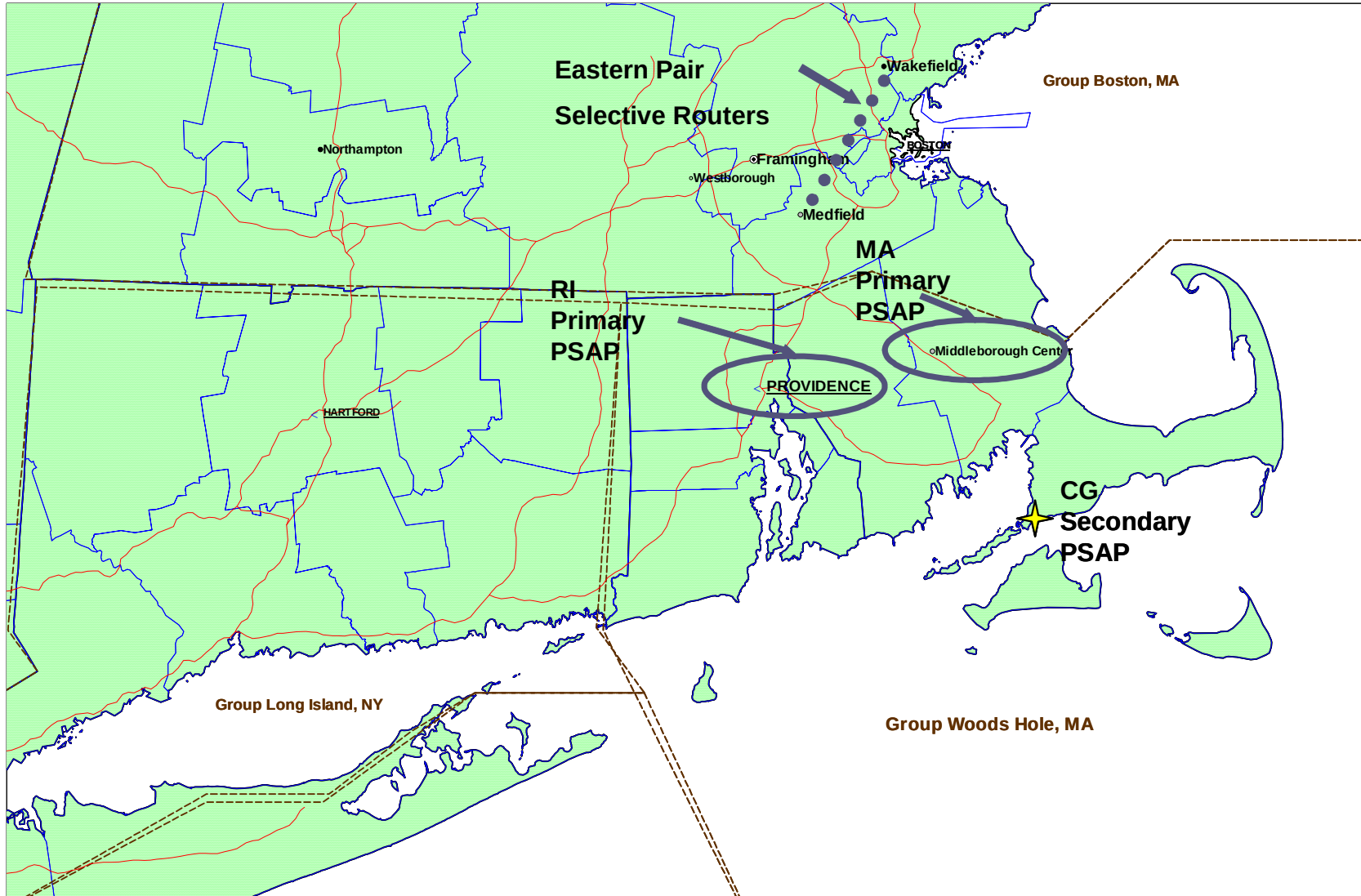


Figure C-1. Map of Connecticut, Massachusetts, and Rhode Island Showing PSAPs and Selective Routers as well as Coast Guard Group AOR boundaries.

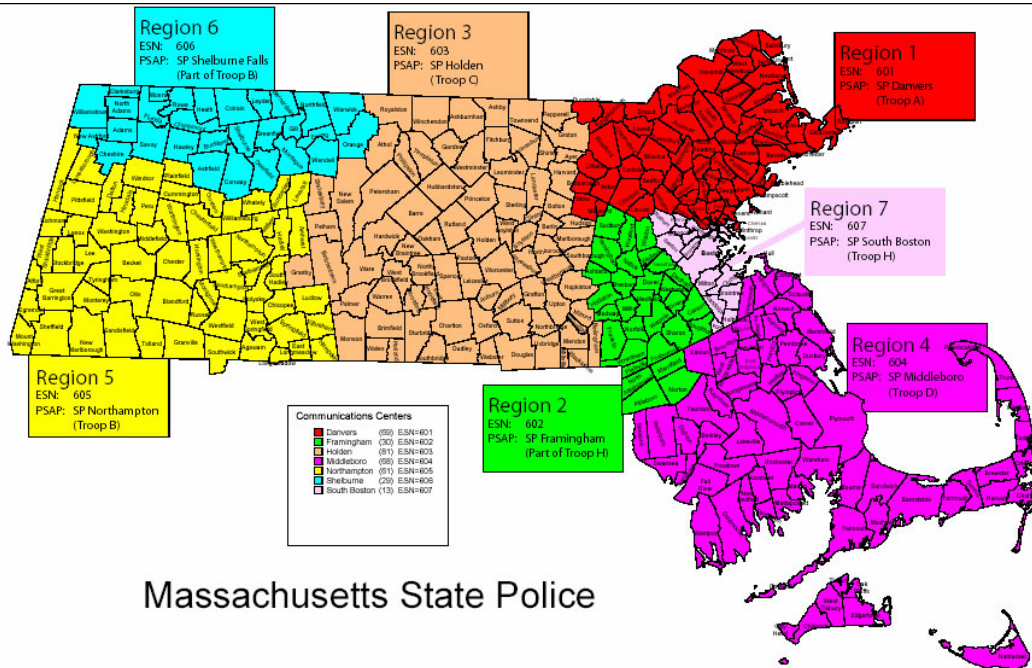


Figure C-2. Massachusetts Emergency Service Zones.

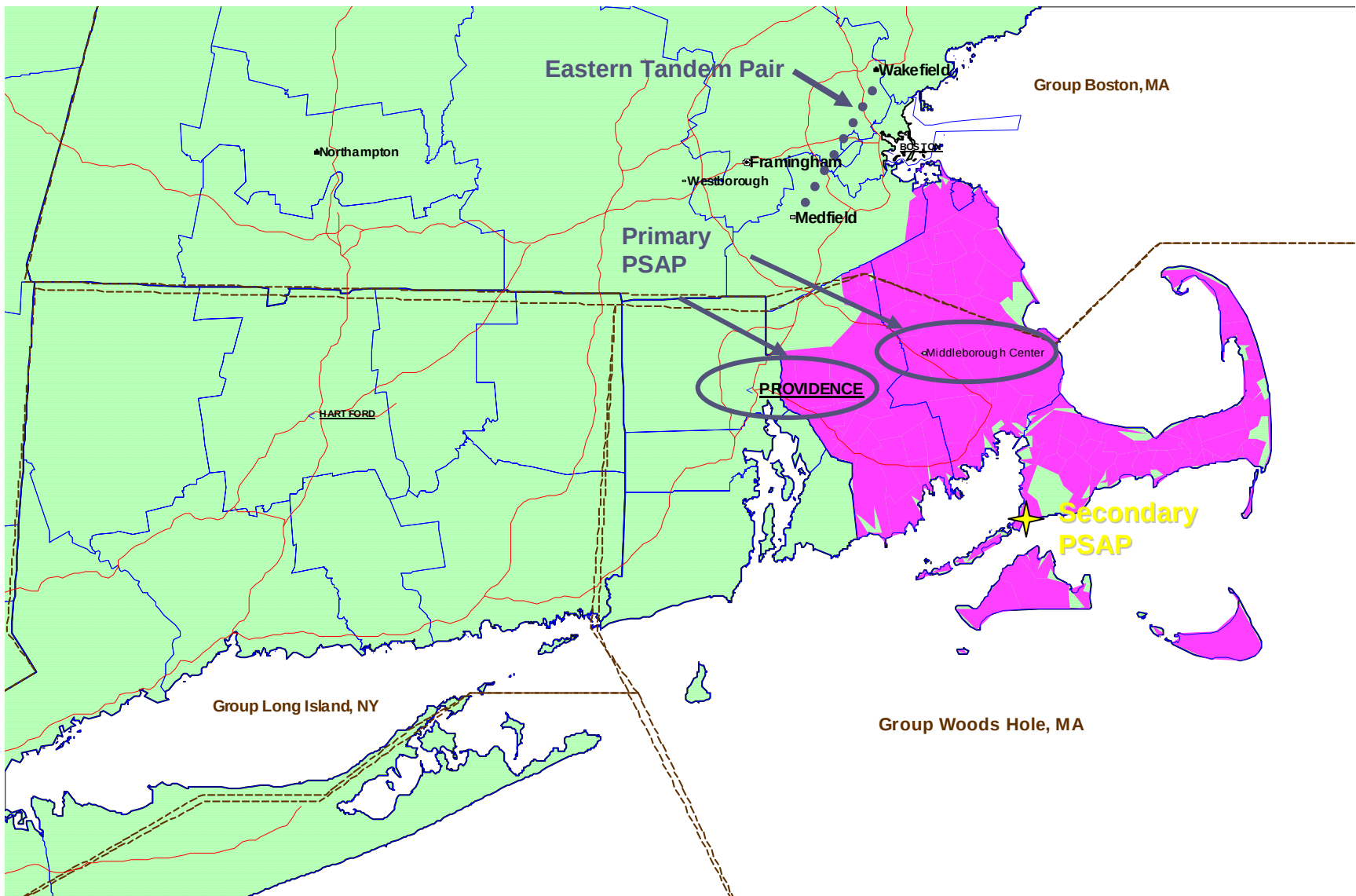


Figure C-3. PSAPs and ESN 604.

Required Circuits

The circuit connectivity is shown in Figure C4. Calls received at a cell tower are handled by the cellular phone company's Mobile Switching Centers (MSC). The MSCs route the calls to the Primary PSAP (directly in Rhode Island and through the Selective Routers in Massachusetts). The Primary PSAP transfers the call to the Secondary PSAP along with the ANI. This is used to query the ALI database to return the call information. In Massachusetts, calls are transferred through the Selective Routers, which for redundancy and fault tolerance, work together in pairs, and two trunks are required for each pair as illustrated by the solid red lines in Figure C-4. The single data circuits to each of the two (redundant) databases are shown by the red dotted lines. For Rhode Island just a single regular phone line is used – a 10-digit call transfer from North Providence to Woods Hole (solid yellow line). The FAX line for sending the data is shown in dashed yellow.

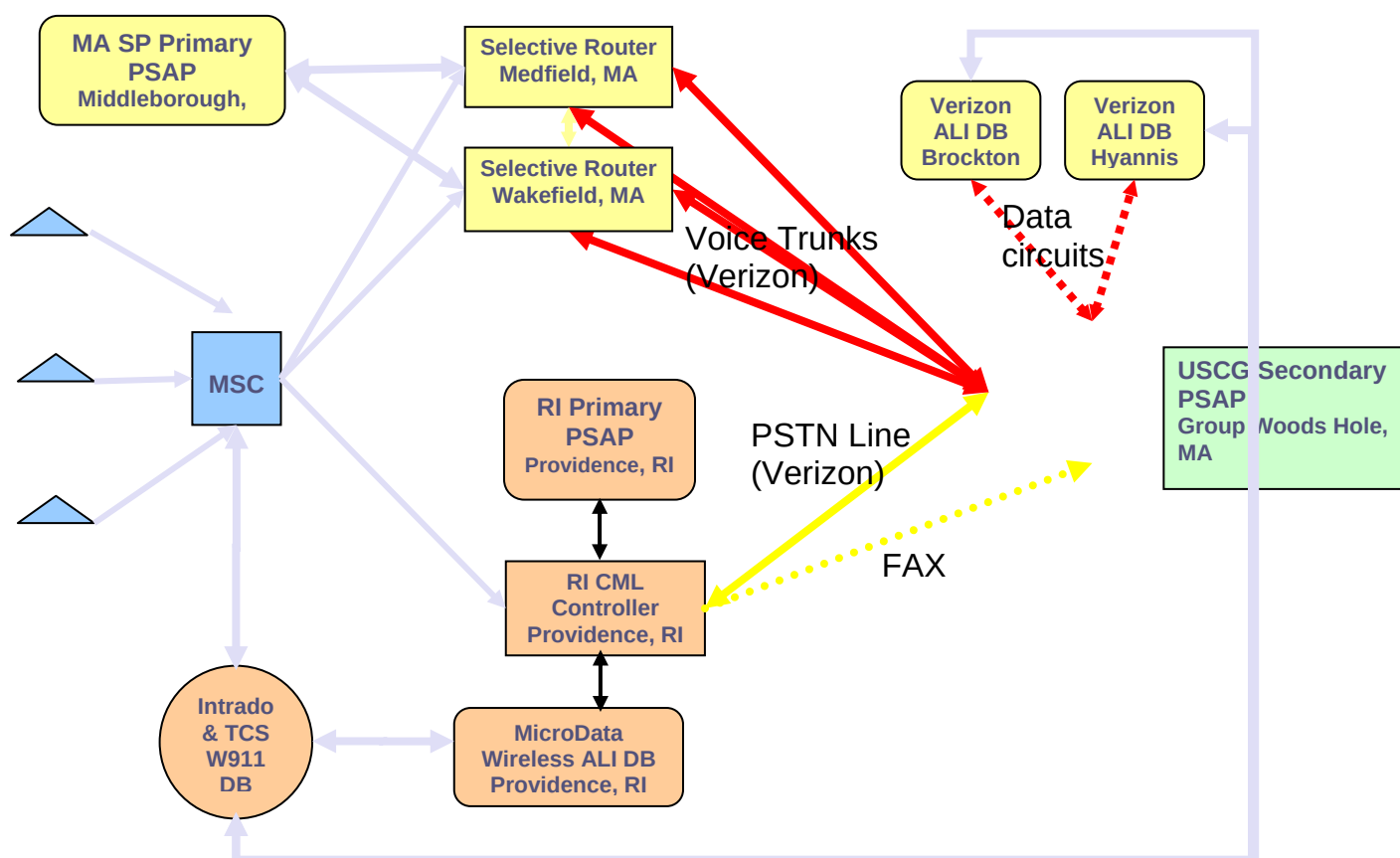


Figure C-4. Rhode Island/Massachusetts Connectivity.

Secondary PSAP Location

The Secondary PSAP was installed at Group Woods Hole, 1 Little Harbor Rd, MA, in the Group Operations building. A PSAP requires specialized equipment along with several circuits (described above). The circuits were all terminated in the telephone room. The server and telephone interface equipment were also installed in the telephone room. The operator

workstations were installed in the Communications Center and Operations Center (see Figure C-5 for a floor plan.).

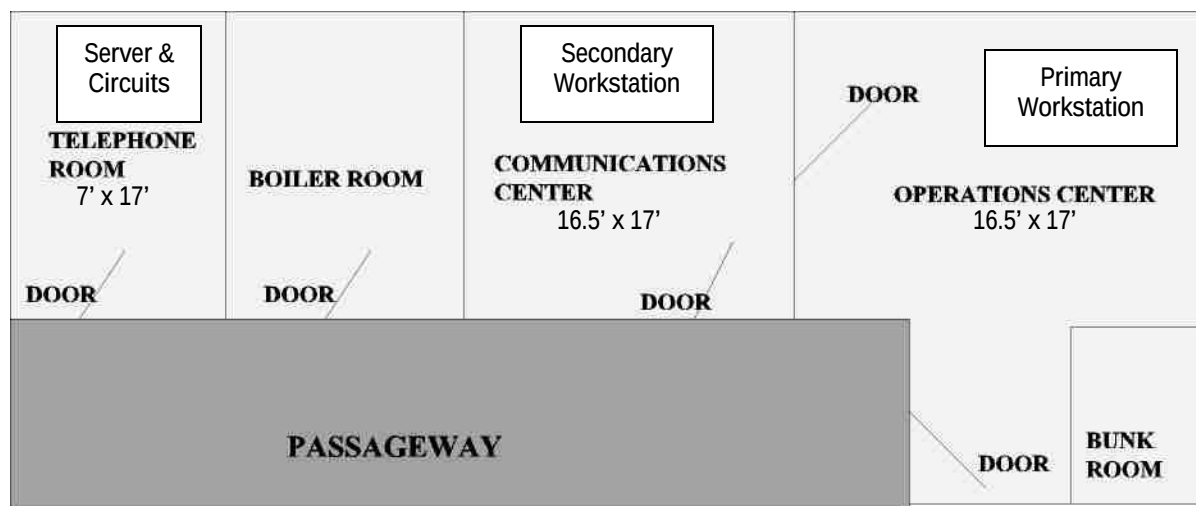


Figure C-5. Operations Building Floor Plan.

User Equipment

The Tel Control, Inc. (TCI) operator console consists of a computer running the TCI Invision² Work Station and Delorme Street Atlas software and some telephone equipment. The primary workstation (Figure C-6) is located in the Operations Center. A diagram of the equipment and connections is contained in Figure C-7. The system can be controlled in most cases from the software or by buttons on the phone. There are two fully redundant workstations. The secondary workstation (Figure C-10) is located in the Communications Center. The secondary workstation will not be used unless there is a problem with the primary workstation. A close-up of the screen showing the TCI software running is in Figures C-8 and C-9. Figure C-8 shows the main screen with call information from a test call. Figure C-9 shows the additional information that is displayed when the red MORE INFO button is pressed. This screen contains the latitude and longitude of the caller if the call is a Phase II call. If the call is Phase I then the position is that of the cell tower handling the call.



Figure C-6. Primary 9-1-1 Workstation.

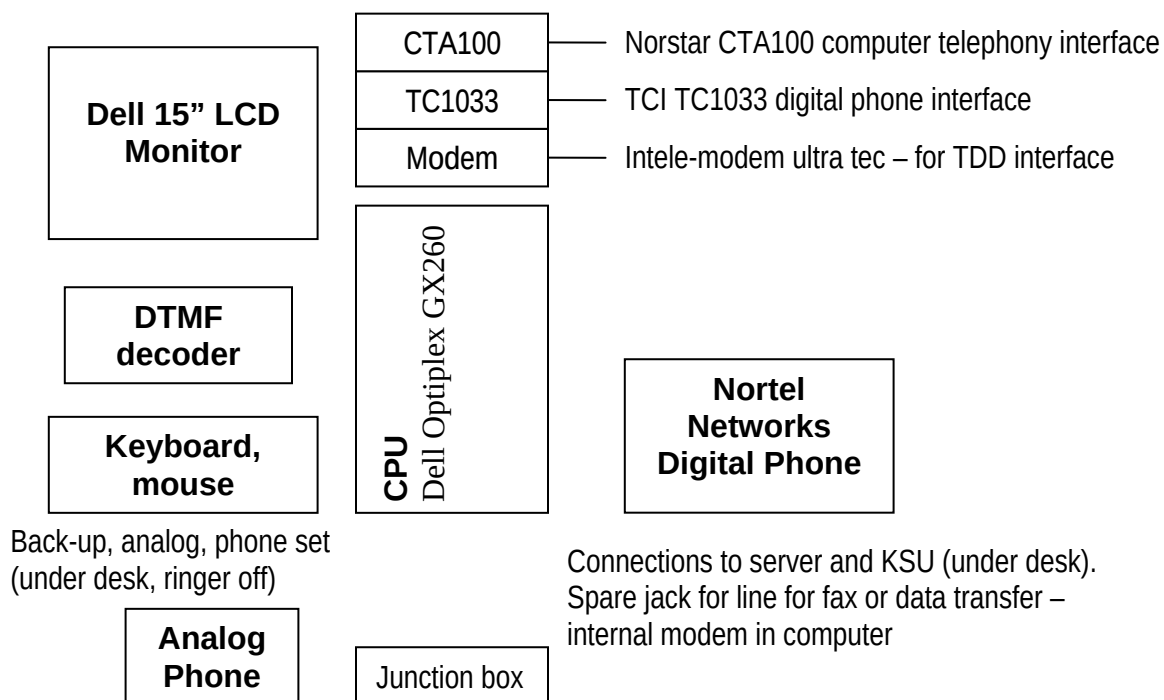


Figure C-7. Equipment Connection Diagram.

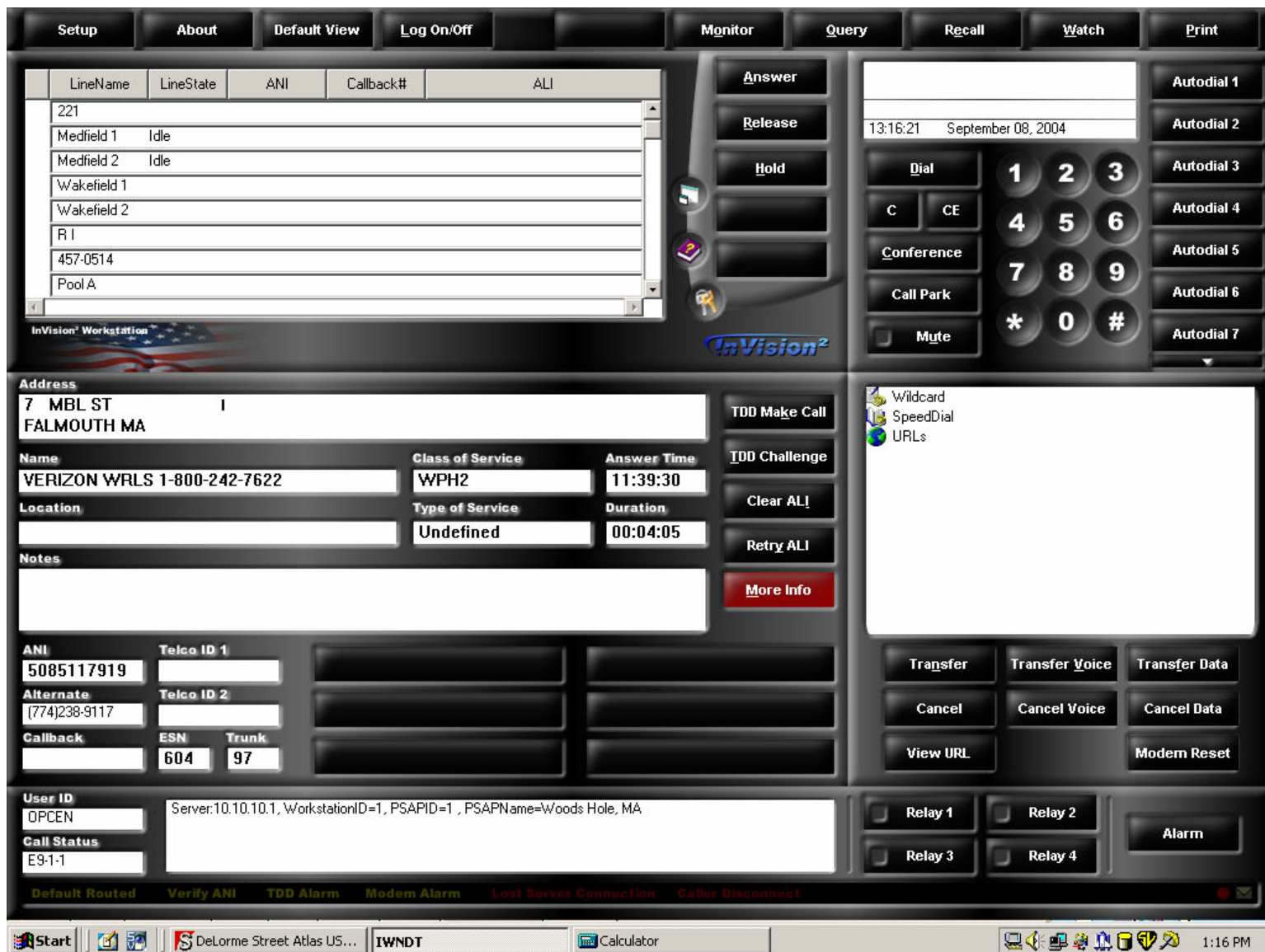


Figure C-8. TCI Invision² WS Software.

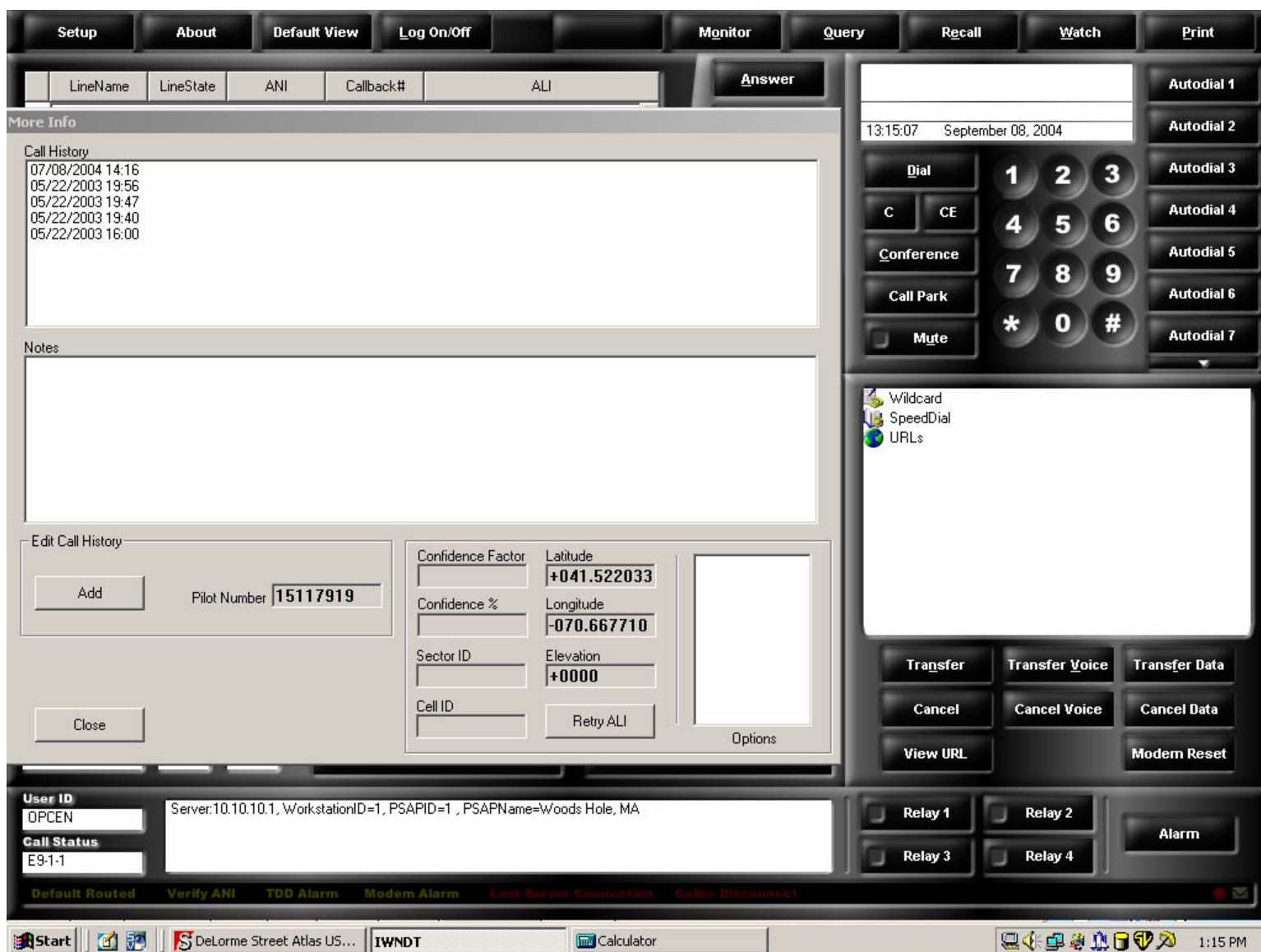


Figure C-9. TCI Invasion² WS Software – Additional information Screen.



Figure C-10. Secondary 9-1-1 Workstation (top).

Backroom Equipment

All circuits are terminated at the telephone company's demarcation point in the Telephone Room. The TCI Server and associated equipment are located in the rack in the Telephone Room. The server connects to the primary workstation and the secondary (backup) workstation using a private Local Area Network. This configuration is illustrated in more detail in the following sections.

Server Rack

The server rack contains most of the back room equipment. A picture of the full rack is in Figure C-11, followed by close-ups of some of the equipment in Figures C-12 and C-13 and a detailed diagram in Figure C-14. The server controls the system and logs all of the calls on both the data log printer and in a Structured Query Language (SQL) database on the server.



Figure C-11. Server Rack in Telephone Room.



Figure C-12. Card Cage with Trunk and Multiplexer (MUX) Cards.



Figure C-13. Alarm and Power Modules.

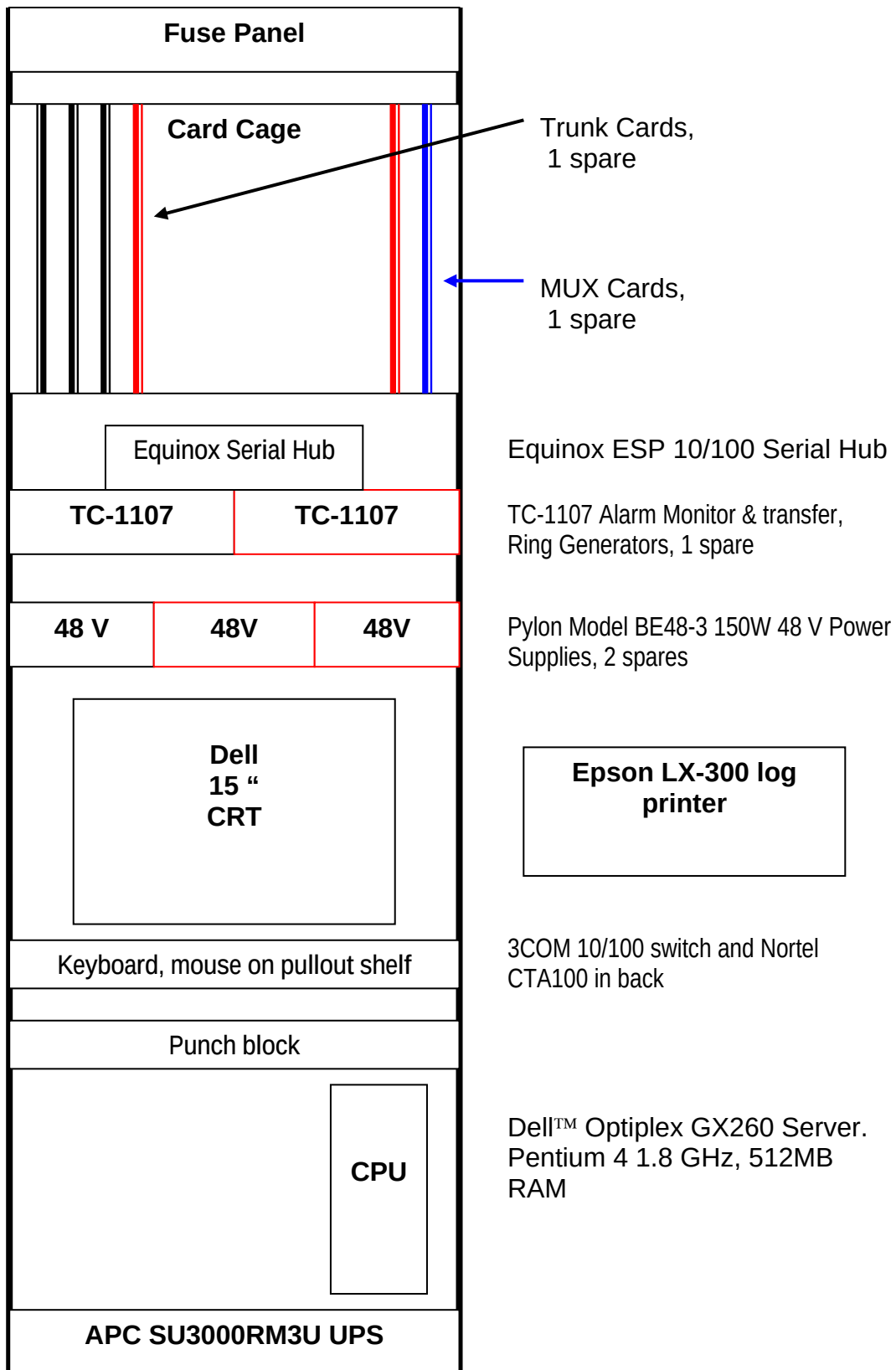


Figure C-14. Detailed Rack Layout.

Telephone Circuits

There are a number of circuits required to make the system function as described above. The specific circuit IDs are listed in Table C-1 below. In addition to the trunks and ALI database circuits, three regular phone lines were ordered through CG District One for the use of the 9-1-1 system. 24-hour support for the circuits is provided by the Verizon 9-1-1 System Response Center (MA).

Table C-1. Circuit Ids.

MA Links	
ALI Database lines	Connects to:
20.HRDA.	Conklin, then to serial port on server.
20.HRDA.	Conklin, then to serial port on server.
Medfield Trunks	
20.EMNT.	Trunk Card 1
20.EMNT.	Trunk Card 2
Wakefield Trunks	
20.EMNT.	Trunk Card 1
20.EMNT.	Trunk Card 2
RI Links	
Voice Line	Connects to:
508-xxx-xxxx	Phone set for voice use
Admin Lines	
508-xxx-xxxx	Server modem
508-xxx-xxxx	Phone set for training use

Circuit Connections

Connections between the TCI equipment and phone trunks.)are made at the TCI punch block (Figure C-16). The two ALI database circuits run from the punchblock to a pair of jacks (Figure C-17). The Conklin Channel Service Unit/Data Service Units (CSU/DSU), one for each circuit, are plugged into these jacks. The CSU/DSU units (Figure C-18) are connected to serial ports on the computers. For fault tolerance purposes, one unit connects to the server and one to the workstation (using the Equinox 10/100 serial hub).

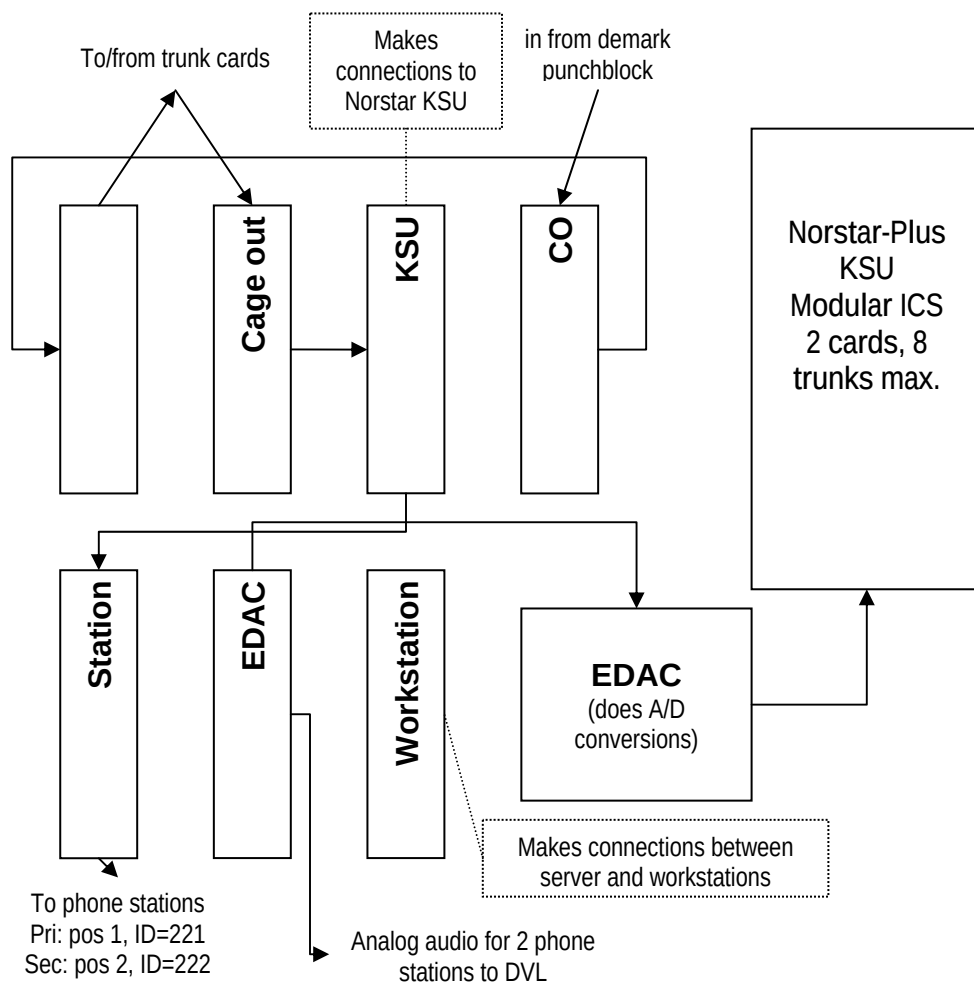


Figure C-15. TCI Phone Circuit Connection Photo and Diagram.

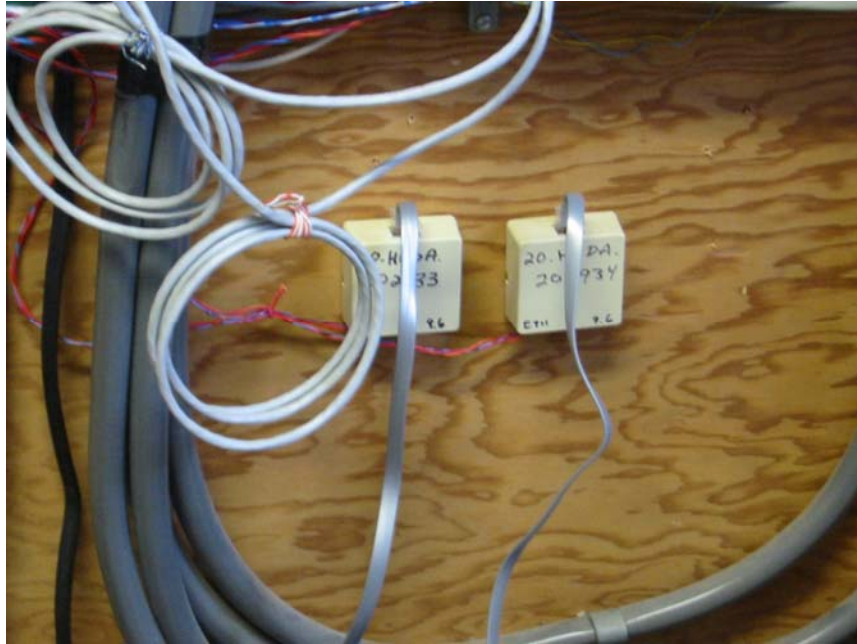


Figure C-16. Massachusetts Data connections.



Figure C-17. CSU/DSU (Data Circuit interface).

Call Records

Every 9-1-1 call received is tracked by the system. The details of the call (time received, duration, when answered, etc.) are automatically logged into the SQL database, and a record is printed out on the log printer. A digital file of the audio of the call is also created automatically as a .wav file on the operator workstation. The system keeps the audio files for the last 25 calls, available for instant playback. In addition, the audio for each of the two phone sets are routed to two spare channels on the Coast Guard's Digital Voice Logger (Figure C-19) for long-term archiving on optical disk.



Figure C-18. Coast Guard Digital Voice Logger (DVL).

Appendix D - Glossary of Terms, Acronyms and Abbreviations

ADSL	Asymmetrical Digital Subscriber Line A multi-channel modulation method for subscriber line access, unidirectional, running at 1-6 Mbls from the end office to the end user.
ALEC	Alternate Local Exchange Carrier (See LEC)
ALI	Automatic Location Identification Location information associated with the physical address of the calling telephone for a landline call and the location of the tower and vector for a wireless call.
ANI	Automatic Number Identification Telephone number associated with the access line from which a call originates.
AOR	Area of Responsibility
APCO	Association of Public-Safety Communications Officials An International association dedicated to the enhancement of public safety communications.
APU	Answering Position Unit
CAD	Computer Aided Dispatch Storage of location specific information.
CAS	Call-Path Associated Signaling A method for delivery of wireless 9-1-1 calls in which the Mobile Directory Number (MDN) and other call associated data are passed from the Mobile Switching Center (MSC) to the PSAP via the voice path.
CLEC	Competitive Local Exchange Carrier (See LEC)
CML	CML Emergency Services, Inc. A company that provides products and services to the 9-1-1 Industry including: PSAP products, Network products, Radio Dispatch, Customer Solutions, and other products and services. CML is the 9-1-1 vendor to the state of Rhode Island.
CONOPS	Concept of Operations
CPE	Customer Premises Equipment Communications or terminal equipment located in the customer's facilities. Terminal equipment at a PSAP.
CSU/DSU	Channel Service Unit/Data Service Unit The CSU is a device that connects a terminal to a digital line. The DSU is a

device that performs protective and diagnostic functions for a telecommunications line. You can think of it as a very high-powered and expensive modem. Such a device is required for both ends of a T-1 or T-3 connection, and the units at both ends must be set to the same communications standard. Typically, the two devices are packaged as a single unit.

CTIA

Cellular Telephone Industry Association

CTIA is the international organization that represents all sectors of wireless communications-cellular, personal communication services and enhanced specialized mobile radio. CTIA serves the interests of service providers, manufacturers, wireless data and Internet companies and other contributors to the wireless universe.

Demarc

Demarcation Point

That point at which operational control or ownership of telephone company facilities changes from one organizational entity to another. The demarcation point is usually the interface point between customer-premises equipment and external network service provider equipment.

DBMS

Data Base Management System

A system of manual procedures and computer programs used to create, store and update the data required to provide Selective Routing and/or Automatic Location Identification for 9-1-1 systems.

DMT

Discrete Multi Tone

The transmission medium for ADSL.

DSL

Digital Subscriber Line (See ADSL)

DTMF

Dual Tone Multi-Frequency

The transmission of a selected number or symbol (*, #) via the generation of a specific pair of tones when that number's or symbol's button on a push button telephone is pressed. Also known as Touch-Tone. The tones are audible and transmitted within the voice band.

DVL

Digital Voice Logger

E9-1-1

Enhanced 9-1-1

An emergency telephone system which includes network switching, database and CPE elements capable of providing Selective Routing, Selective Transfer, Fixed Transfer, caller routing and location information.

EMF

Electronic Multi-Frequency

Digital trunk between the Selective Router and the PSAP.

ESN	Emergency Services Number An ESN is a three to five digit number representing a unique combination of emergency service agencies (Law Enforcement, Fire, and Emergency Medical Service) designated to serve a specific range of addresses within a particular geographical area. The ESN facilitates selective routing and selective transfer, if required, to the appropriate PSAP and the dispatching of the proper service agency(ies).
ESRD	Emergency Services Routing Digit A pseudo ANI (pANI) typically used with Call-Path Associated Signaling (CAS) or CAS Hybrid architectures that identify the cell site or cell sector from which a wireless 9-1-1 call originates. The ESRD may also be used as the key field to retrieve the ALI associated with the call.
ESRI	Emergency Service Routing Identification Same meaning as pANI, except it relates to NCAS deployments and will not have a one to one relationship with towers or faces; hence the term “pANI pooling”. (See pANI.)
ESRK	Emergency Service Routing Key Same meaning and relationship as pANI; used in CAS and HCAS deployments. (See pANI.)
ESZ	Emergency Service Zone (See ESN)
FCC	Federal Communications Commission The Federal Communications Commission (FCC) is an independent United States government agency, directly responsible to Congress. The FCC was established by the Communications Act of 1934 and is charged with regulating interstate and international communications by radio, television, wire, satellite and cable. The FCC's jurisdiction covers the 50 states, the District of Columbia, and U.S. possessions.
FIXED TRANSFER	The capability of a PSAP attendant to transfer a 9-1-1 call to a pre-determined location by activating a single button.
GIS	Geographic Information System A computer software system that enables one to visualize geographic aspects of a body of data. It contains the ability to translate implicit geographic data (such as a street address) into an explicit map location. It has the ability to query and analyze data in order to receive the results in the form of a map. It can also be used to geographically display coordinates on a map. i.e. lat/long from a wireless 9-1-1 call.
GPS	Global Positioning System A satellite based Location Determination Technology (LDT)
ILEC	Incumbent Local Exchange Carrier (See LEC)

IP	Internet Protocol The method by which data is sent from on computer to another on the Internet or other networks.
ISDN	Integrated Services Digital Network A digital interface providing multiple channels for simultaneous functions between the network and CPE.
IXC	Interexchange Carrier (i.e., AT&T, Sprint) – Telecommunications Company that can cross LATA and state boundaries.
JJMA	John J. McMullen Associates, Inc. JJMA is a leader among naval architecture and marine engineering firms providing service to Government, commercial, and international clients. JJMA is contracted to provide services for the Coast Guard GIN Project.
LATA	Local Assess Transport Area End to end calls within a local area, usually served by a LEC.
LEC	Local Exchange Carrier A Telecommunications Carrier (TC) under the state/local Public Utilities Act that provide local exchange telecommunications services. Also known as Incumbent Local Exchange Carriers (ILEC). ILEC's are generally the historical dial tone provider in a telephone exchange or rate zone. ILEC's have a telephone switch. Alternate Local Exchange Carriers (ALEC). ALEC's are generally new companies, historically speaking, that are competing with the ILEC's and CLEC's. ALEC's generally do not own a telephone switch and resell dial-tone that they buy from a LEC or CLEC. Competitive Local Exchange Carriers (CLEC). CLEC's generally are new competitors, historically speaking, that own their own telephone switch.
LNP	Local Number Portability A process by which a telephone number may be reassigned from one local exchange carrier to another.
MDN	Mobile Directory Number The call back number associated with a wireless telephone. (Similar to ANI for landline telephones.)
MF	Multi-Frequency A type of signaling used on analog interoffice and 9-1-1 trunks.
MOU	Memorandum of Understanding.
MSC	Mobile Switching Center The wireless equivalent of a Central Office, which provides switching functions from wireless calls.
MSO	Mobile Switching Office (See Mobile switching Center (MSC))

MUX	Multiplexer A circuit that funnels several different streams of data over a common communications line. Multiplexers are used to attach several communications lines to a fewer number of communications ports or to attach a large number of communications ports to a smaller number of communications lines.
NCAS	Non Call-Path Associated Signaling A method for delivery of wireless 9-1-1 calls in which the Mobile Directory Number and other call associated data are passed from the Mobile Switching Center to the PSAP outside the voice path.
NCIC	National Crime Information Center A computerized index of criminal justice information (i.e. - criminal record history information, fugitives, stolen properties, missing persons). It is available to Federal, state, and local law enforcement and other criminal justice agencies and is operational 24 hours a day, 365 days a year.
NENA	National Emergency Number Association NENA is a not-for-profit corporation established in 1982 to further the goal of “one Nation-One Number.” NENA is a networking source and promotes research, planning and training. NENA strives to educate, set standards and provide certification programs, legislative representation and technical assistance for implementing and managing 9-1-1 systems
NPA	Numbering Plan Area An established three-digit area code for a particular calling area where the first position is any number 2 through 9 and the last two (2) positions are 0 through 9.
NXX	A three digit code in which N is any digit 2 through 9 and X is any digit 0 through 9. Typically used in describing the “Exchange Code” fields of the North American Numbering Plan telephone number. The full numbering system is in the format of “Area Code” + “Line Number” or NPA-NXX-XXXX. A central office will have one or more area and exchange codes.
OPCEN	Operations Center
OSOW	Operations Specialist of the Watch
OT&E	Operational Test and Evaluation
pANI	Pseudo Automatic Location Identification A “fake” telephone number associated with a physical address, usually the address of a cellular tower. Used to provide the location of the wireless cell or sector and information about its coverage or serving area (footprint). Also see ESRI and ESRK.
PSAP	Public Safety Answering Point A facility equipped and staffed to receive 9-1-1 calls. A <u>Primary PSAP</u> receives the calls directly. If the call is relayed or transferred, the next receiving PSAP is designated a <u>Secondary PSAP</u>.

PSTN	Public Switched Telephone Network The network of equipment, lines, and controls assembled to establish communications paths between calling and called parties in North America.
QRC	Quick Reference Card A checklist of procedures to follow when responding to a SAR case. Locally developed by the Group
R&DC	USCG Research & Development Center The U.S. Coast Guard's center for research, located in Groton, CT.
SR	Selective Routing The routing of a 9-1-1 call to the proper PSAP based upon the location of the caller. Selective routing is controlled by the ESN which is derived from the customer location. (See Tandem CO)
Selective Transfer	The capability to transfer a 9-1-1 call to a response agency by operation of one of several buttons typically designated as police, fire, and emergency medical; based on the ESN of the caller.
SQL	Structured Query Language A specialized programming language for sending queries to databases.
SDO	Staff Duty Officer
T1	Standard Digital Circuit Provides 1.544 Mbps data or 24 standard phone circuits.
Tandem CO	Tandem Central Office The Central Office that provides the tandem switching of 9-1-1 calls. It controls delivery of the voice call with ANI to the PSAP and provides Selective Routing, Speed Calling, Selective Transfer, and certain maintenance functions for each PSAP. Also known as 9-1-1 Selective Routing Tandem or Selective Router.
TCI	Tel Control, Inc. A PSAP equipment vendor.
Telco	Telephone Company
TDD	Telephone Device for the Deaf
TTY	Telephone Device for the Deaf
UMIB	Urgent Marine Information Broadcast
UPS	Uninterruptible Power Supply An auxiliary power unit for a telephone system which provides continuous battery backup power in the event of a commercial power failure.

VoIP	Voice over Internet Protocol A telecommunications protocol where voice and data utilize the same packet.
W911	Wireless Enhanced 911 Wireless 9-1-1 service providing Phase 0, Phase I or Phase II.
Wireless	Means any Commercial Mobile Radio Service (CMRS) that falls under the FCC's Docket 94-102 requirement for wireless enhanced 9-1-1 service.
Wireless Phase I	Required by FCC Report and Order 96-264 pursuant to Notice of Proposed Rulemaking (NPRM) 94-102. The delivery of a wireless 9-1-1 call with call-back number and identification of the cell-tower from which the call originated. Call routing is usually determined by cell-sector.
Wireless Phase II	Required by FCC Report and Order 96-264 pursuant to Notice of Proposed Rulemaking (NPRM) 94-102. The delivery of a wireless 9-1-1 call with Wireless Phase I requirements plus location of the caller within 125 meters 67% of the time and Selective Routing based upon those coordinates. Subsequent FCC rulings have redefined the accuracy requirements.
WSP	Wireless Service Provider Telecommunications Company that provides non-landline service