Wireless Emergency Response Team (WERT)

Hurricane Katrina Final Report

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WIRELESS EMERGENCY RESPONSE TEAM
Hurricanes Katrina and Rita Participating Organizations

Industry Volunteers

Alltel
American Tower
BatteryCorp
BellSouth
Cingular
Dobson Wireless Systems
Ericsson
Hamilton Relay
IntelSat
Lucent Technologies, Bell Labs
Mitre
Motorola
Nortel
QWEST
Skytel
Sprint
T-Mobile
Telcordia Technologies
USCellular
UTStarcom
Verizon Wireless
WesTower Communications

Government

Department of Homeland Security NCS
Department of Defense, United States Northern Command
Department of Energy
FCC
FEMA
Louisiana Parish Local Governments
Louisiana Public Service Commission
Office of Homeland Security and Emergency Preparedness
Louisiana State Police
Office of U.S. Congressman Ed Royce
United States Coast Guard
United States Marshalls Service, Technical Operations Group
White House Office of Science and Technology

Other

University of Texas

New Orleans Hurricane Katrina Flood

On Sunday August 28, 2005, most of the residents of New Orleans, Louisiana and surrounding area were evacuating for the coming hurricane as they had done many times in previous decades. Preparing for a hurricane is a way of life there. But there were many who were unwilling to leave, and some unable to leave.

The next day Hurricane Katrina struck New Orleans and the Gulf Coast area as predicted. As before, New Orleans had suffered damage but appeared to have survived the hurricane.

But shortly after the hurricane passed, it became evident there was a bigger problem. Several of the levees protecting New Orleans from the waters of Lake Ponchartrain and the Mississippi River had broken and began flooding water into the city. Since New Orleans sits at an elevation several feet below sea level, the city filled up like a bowl. Water levels rose rapidly and dangerously to rooftops across much of the city's neighborhoods. Residents who remained behind were now climbing into attics of their homes or any other high point of safety. The Wireless Emergency Response Team (WERT) envisioned these people would be carrying cell phones with them. But after Hurricane Katrina, much of the telecommunications infrastructure around New Orleans was out-of-service. Television news pictures showed people sitting on rooftops and being pulled from holes cut into attics.

The WERT immediately developed a plan to extend wireless network coverage from helicopters over the areas where normal networks were out-of-service, which allowed contact to be re-established with people trapped by flood waters. In the following hours and days, an unprecedented wireless communications industry mutual-aid effort sprang into action to support search & rescue working with the United States Coast Guard and other organizations. Numerous contacts were made with victims trapped by floodwaters.

Because of the radio spectrum used by multiple service providers and the complex spectrum management requirements, WERT continues to serve in a vital coordination role for this industry-government mutual aid effort and has served as a clearing house for coordination and exchange of ideas. In addition, the WERT activity enabled the coordinated assessment of the condition of most of the wireless networks in the region. This function may be very important in the future.

In response to the strong expressions of appreciation and value from various government agencies, industry organizations, and members of the public at large, the WERT capability will continue to be available. This document is intended to record the event, and as an outline for guidance in moving forward. To the individuals and their organizations who made this effort possible: On behalf of the assisted citizens, rescue workers, and for those who may yet benefit from this capability – Thank You. Knowing that we may have been the only hope that someone would have, reassures us that we have done the right thing.

Bernie Malone

WERT Lead – Hurricane Katrina Response
WIRELESS EMERGENCY RESPONSE TEAM
Technical Manager, LUCENT TECHNOLOGIES

TABLE OF CONTENTS

1 EXECUTIVE SUMMARY

This report documents the activities and Key Learnings and Recommendations of the Wireless Emergency Response Team (WERT). The recommendations are directed to government entities and the wireless industry.

The WERT was established on the night of September 11, 2001 for the purpose of providing coordinated wireless industry mutual-aid support for the search & rescue effort for possible trapped survivors in the World Trade Center rubble in New York City. The WERT response demonstrated that wireless communications could be a highly valuable resource for future search & rescue needs. The September 11 New York City experience resulted in WERT publishing 134 Key Learnings and 23 Recommendations. Since 2001, the experience, planning and preparations allowed WERT to be ready to act when hurricane Katrina and later hurricane Rita hit the United States. The value offered by this new capability in emergency operations has been recognized by numerous government entities, including the National Communications System (NCS) and its National Coordinating Center for Telecommunications (NCC).

Shortly after the high waters from hurricane Katrina flooded areas of New Orleans, the WERT devised a plan to extend wireless network coverage by equipping helicopters with telecommunications network equipment so that engineers on board could place telephone calls to people trapped on the ground with cell phones, a procedure to become known as “reverse 911”. A plan was devised to search for, detect and identify the cell phones on the ground, so that a call could then be placed from the helicopter to the victim on the ground, thereby allowing rescue of people trapped in attics or homes, not visible from the air. Equipment and systems were devised and tested, and arrangements were approved with the United States Coast Guard (USCG) to fly the missions over flooded parts of New Orleans after the initial USCG visual search & rescue.

Many wireless reverse 911 calls were completed from the helicopters to victims with cell phones trapped by floodwaters on the ground. The victims were all appreciative of the effort to locate them, but all were not in need of rescue.

Shortly after completion of the helicopter search & rescue mission, the Network Analysis sub-team, which had been supporting the helicopter search missions, detected that 911 calls were being attempted from cell phones through cell sites in and around New Orleans but were failing to complete to Public Safety Access Points (PSAPs). These calls were not being completed to anyone, because the landline switches or facilities supporting the PSAPs were out of service. The team started to explore how these calls could be re-routed to an alternative number or site prepared to take a 911 call.

As the WERT network team researched the failed 911 calls, it discovered that the scope of the PSAP 911 outages was large. Thousands of 911 calls, across many networks were failing to research several PSAPs in South Louisiana. And any backup plans that might have existed, were of no help. The WERT network team quickly discovered that the normal PSAP agency contacts and backups were out-of-service or un-reachable. So, WERT along with it’s telecommunications network service provider partners, began calling various agencies looking for a place to send the 911 calls. Finally, the Louisiana State Police headquarters in Baton Rouge agreed to accept forwarded 911 calls, and WERT coordinated the re-routes from several out-of-service PSAPs to a Louisiana State Police phone number.

The WERT team followed the network status daily for several weeks until normal PSAP 911 call routing could be re-established.

On September 24, Hurricane Rita made landfall along the Texas/Louisiana Gulf Coast of the United States, between Houston, Texas and Lake Charles, Louisiana. The WERT team again flew the wireless network equipment over the region.

Here are summary statistics of the WERT effort:

- WERT was active for over 60 days
- Hundreds of mobile cellular numbers were registered by helicopter network system
- Dozens of telephone calls were completed from helicopter to ground
- All contacted victims declined rescue during the calls
- Over 22 organizations participated directly
- Hundreds of Industry subject-matter-experts participated
- Two HH-60 helicopters flew two missions each after Hurricane Katrina
- One HH-60 helicopters flew one mission after Hurricane Rita
- At least 10 PSAP re-routes were established
- 87 key learning's and 27 recommendations have been documented

The report outlines seven functions within WERT for hurricane support, each supported by a dedicated sub-team. For each of these functions, a description is provided of the sub-team's: Mission, approach, key learnings, recommendations and participants. The key learnings and recommendations are provided, where applicable. The seven sub-teams are:

- Command & Control
- Network Surveillance and Analysis
- Search
- Flight Coordination & Rescue
- Frequency Coordination
- Research
- Safety and Security

The team recognizes that future disaster sites may have considerably different characteristics. Section 2, *INTRODUCTION*, reviews the relevant characteristics of the New Orleans flood area disaster site. However, because these WERT recommendations are presented from the different functions (e.g., Search, Flight Coordination, etc), recommendations from the sub-teams may be applicable, even though a future search and rescue effort may preclude the need for all seven functions. The details of these Key Learnings and Recommendations are provided in the full body of the report.

Here are some examples – one from each of the functional areas:

Command & Control

Recommendation CC-2
Develop and publicize formal industry contact point for WERT.

Network Surveillance and Analysis

Recommendation NSA-2
Develop and publish recommended list of network metrics that will generally be useful (by network element or function category) in large-scale disasters.

Search

Recommendation SRCH-3
Equipment should be tested and pre-certified for flight or other deployments requiring advanced approval by multiple agencies.

PSAP Re-Routes

Recommendation PSAP-2
Develop and implement an in-region and an out-of-region backup PSAP for every PSAP.

Flight Coordination

Recommendation FLGT-2
Obtain advanced, permanent flight certification of WERT equipment with USCG.

Frequency Coordination

Recommendation FRQC-2
Make available or identify source for industry or government availability of secure, accurate spectrum ownership information reflecting business merger and acquisition activity.

Research

Recommendation R-3
Enhanced methods and resources should be made available for identifying and locating technology and subject-matter-experts.

Safety and Security

Recommendation SS-2
Implement a nationally-recognized process for authorizations and credentials for WERT or similar on-site and COMMAND personnel to have identification and access to resources and disaster locations.

2 INTRODUCTION

The WERT supported the disasters caused by hurricanes Katrina and Rita with advanced wireless industry technologies and expert resources beginning shortly after the first floodwaters and lasting several weeks -- first with search & rescue support, and later with E911 network re-routing support. Because of the nature and scope of this disaster, the WERT spent a long time monitoring network status and resolving issues until networks were fully restored to normal. After many weeks of follow-up and monitoring support through the end of 2005, this FINAL REPORT was prepared in 2006 through a virtual team effort, with contributions from the many subject-matter-expert industry volunteers. Under these circumstances, it reports the most accurate and relevant representation of the team's work for the benefit of the public, the communications industry and the United States Government.

In September of 2005 WERT teamed with the United States Coast Guard, the United States Marshalls Service - Technical Operations Group and many other organizations listed in this report, in a mission to support search and rescue efforts in response to Hurricanes Katrina and Rita which devastated the gulf coast of the United States and displaced thousands of Americans. Figure 1 shows a high level timeline of events.

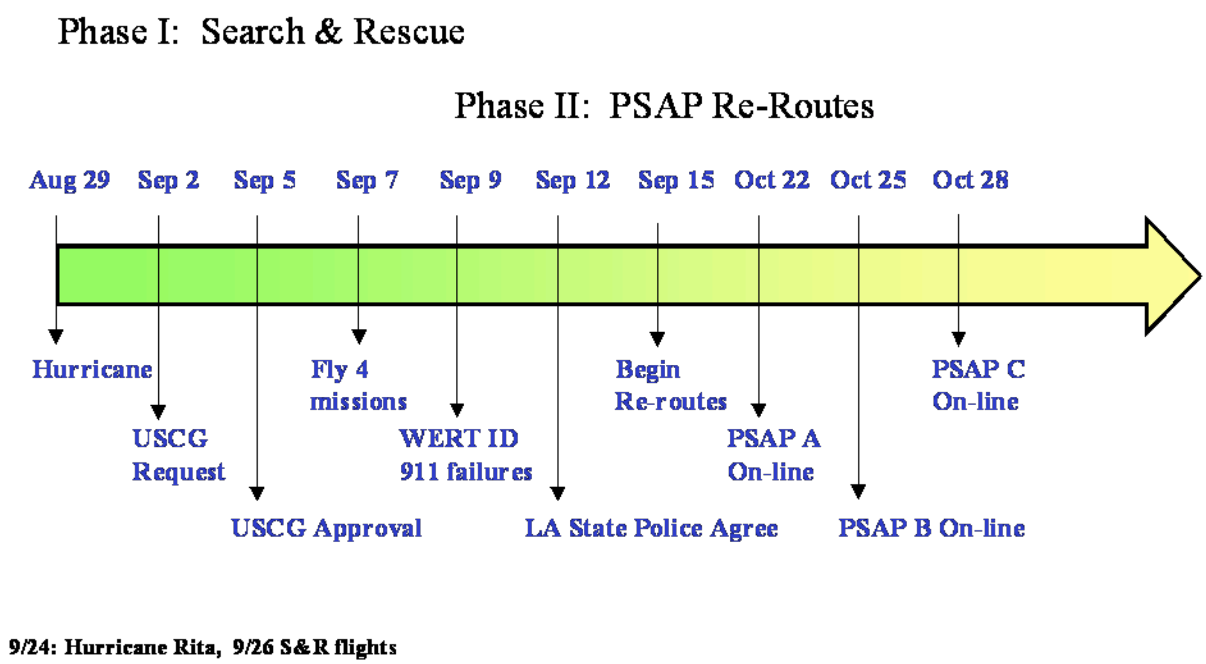

Figure 1 – Timeline of Events

2.1 Team Organization and Structure

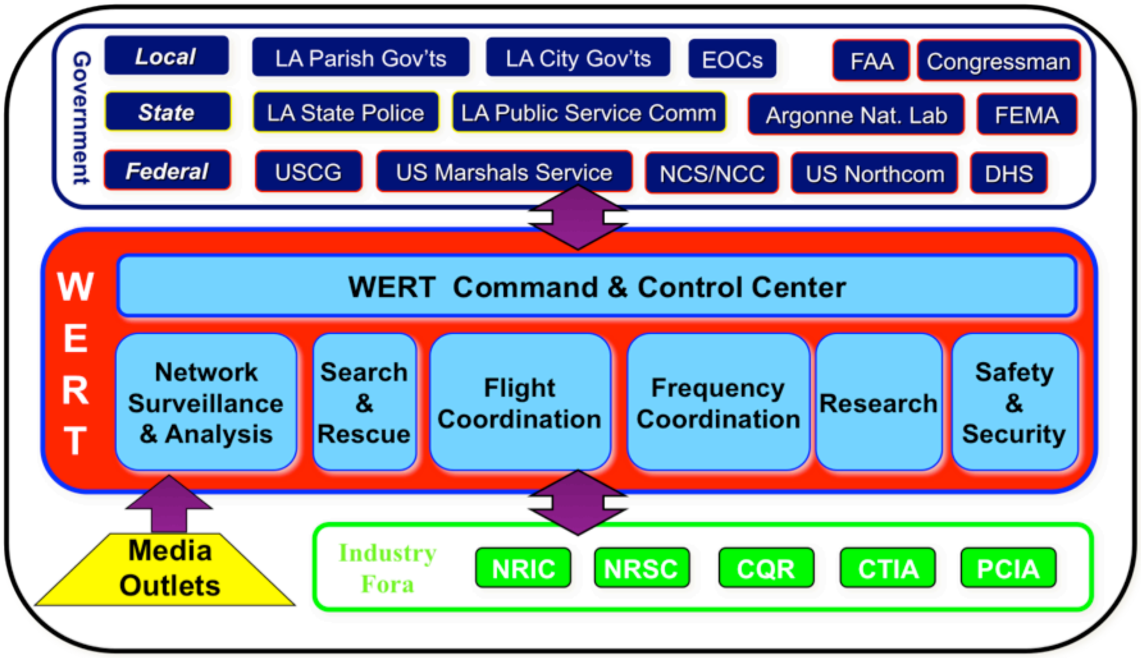

Figure 2 - WERT Structure and Interfaces

As shown in Figure 2, WERT used seven sub-team functions for hurricanes Katrina and Rita. The **Command & Control Center** was the first function established. It provided leadership for the entire team and included responsibilities for situation assessment for needs and resource assembly, coordination with authorities, process encouragement and other improvements and enhancements and facilitating intra-team communications.

The purpose of the **Network Surveillance and Analysis** sub-team was to determine the status and health of the telecommunications networks in the hurricane-affected area. This team worked with engineers from the major telecommunications service providers and other agencies, using tools to analyze network log utility reports and operational metrics to identify abnormal performance that would impact call processing.

The **Search** sub-team consisted of volunteer wireless experts who flew on USCG helicopters, operating network equipment over New Orleans, making "reverse 911" telephone contacts with stranded victims in flood waters for the direct purpose of locating and rescuing them.

The **Flight Coordination** sub-team worked closely with the United States Coast Guard, the United States Marshalls Service - Technical Operations Group and other telecommunications organizations to coordinate all the arrangements for the flights including: wireless equipment payload, expert personnel, airframe requirements, Safety-Of-Flight-Test, flight approvals, FAA approvals, staging, transportation and in-flight mission support.

The **Frequency Coordination** sub-team worked closely with engineers from all the wireless telecommunications service providers in the disaster region and other agencies to determine spectrum ownership, frequency usage, and the operational status of wireless networks. This team monitored the daily status of wireless networks and served as a clearinghouse, providing updated network status and mission planning information to the flight Search sub-team.

The **Research** sub-team worked closely with the Frequency Coordination, Flight Coordination, and Search sub-teams, and the U.S. Coast Guard to assess mission requirements, investigate technology and equipment available from the many supporting telecommunications companies and make recommendations to the Command & Control sub-team.

The **Safety and Security** sub-team worked closely with all the supporting teams and members, providing research and making recommendations on matters such as medical immunizations, travel kits and making contacts for support of protective security matters for personnel.

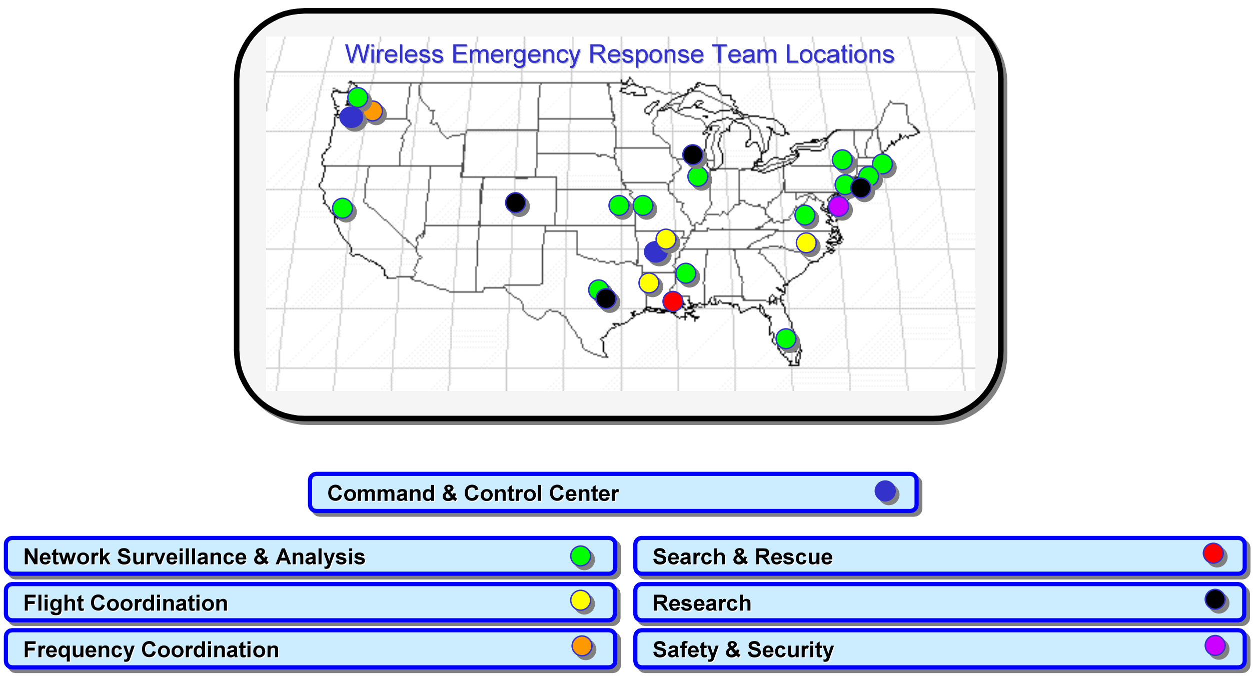

Figure 3 - Locations of WERT Operations

The WERT participants operated from many locations throughout the United Sates, as shown in Figure 3. This model allows for the various, supporting sub-team members to work conveniently from any of their respective locations, and provides for geographic redundancy so that most of the team members are located outside of a typical disaster zone.

2.2 Document Organization and Structure

The structure of this report follows the structure of the WERT sub-teams. This report contains a section for each function, as well as an additional section for the E911 PSAP Re-Routes, which was handled by the Network Surveillance & Analysis team in the organization. Each section follows the following outline and will include key learnings and recommendations if available or appropriate:

X. FUNCTION

Mission Statement for function / sub team, and other logistics

X.1 Approach

X.2 Key Learnings

X.2.1 What Worked Well
X.2.2 Areas for Improvement
X.2.3 Areas Requiring Further Investigation

X.3 Recommendations

X.4 Participants

In some instances, multiple sub-teams have identified similar key learnings or recommendations. In most of these cases, the repetition has been preserved, in order to document the significance from multiple perspectives.

2.3 Characteristics of the Hurricane Katrina and Hurricane Rita and the Resulting Widespread Flooding

The disaster region produced by Hurricanes Katrina, Rita and the flooding had characteristics unlike any from previous disasters. For example, the WERT had documented specific disaster site characteristics of the World Trade Center ground zero rubble site in a FINAL REPORT[i] indicating some very specific and unique physical, electrical and environmental elements related to the collapse of two 110-story steel and concrete buildings which contained thousands of people, all confined to an area of about 14 acres.

By contrast, the hurricane and flood affected region of New Orleans, Louisiana after August 29, 2005 had very different characteristics. It is helpful to recognize that future disasters may be different, and by reviewing the characteristics of past events, better planning for future events is possible. For that reason, potentially significant characteristics are listed here:

a. There was plenty of warning before the hurricane, but no warning before the flooding.
b. The New Orleans affected disaster area encompassed hundreds of square miles.
c. The New Orleans affected disaster area resided inside a bigger disaster area of tens-of-thousands of square miles.
d. Following the hurricane and flood, the weather was generally clear and hot with high temperatures in the 90-degree range and low temperatures in the 70-degree range (Fahrenheit).
e. Much of the city of New Orleans had been evacuated, but thousands of people and pets remained trapped in the city.
f. The city contained several feet of water, flooding streets and buildings.
g. Very limited use of wheeled ground transportation in flood areas was possible. Most transportation was by boat or aircraft.
h. Significant amount of helicopter aircraft traffic over city.

i. Tens-of-thousands of people were stranded at evacuation shelters.
j. Large number of deceased people.
k. Shortage of food and shelter items.
l. No normal transportation or medical services.
m. Hospital and critical medical patients were stranded.
n. The local airport (MSY) was closed.
o. Very limited commercial or city services available.
p. Extremely limited telecommunications available to majority of city.
q. Extremely limited electrical power and fuel available to majority of city.
r. Extreme danger of disease or sickness from contaminated floodwaters.
s. Significant personal security and safety risks.
t. No fuel, food, communications or support for first responders and rescuers.
u. Significant damage to radio and television broadcast capability.
v. Significant telecommunications network outages to Southern Louisiana.
w. Local and state governments unable to communicate easily for several days.

2.4 Wireless Devices

Numerous types of electronic wireless communication devices existed in the region at the time of the hurricane/flood. These include: cellular telephones, 1-way and 2-way pagers, laptops and WiFi hotspots with radio transmitters and satellite phones. In addition, public safety agencies, first responders and rescue operations staff such as the local police and fire department, National Guard and other organizations all used two-way radios.

Additionally, there are different modulation schemes that can be employed by these devices. For example, there are several primary cellular telephone techniques for electromagnetic radio frequency (rf) signals used: TDMA, CDMA, iDEN, AMPS/NAMPS, GSM and UMTS. In addition, the same technology may operate at different frequencies, such as 850 MHz or 1,900 Mhz. Some technologies, such as CDMA, are difficult to track because the modulation scheme makes signals indistinguishable from noise using spectral analysis. Assisted GPS, a positioning technology available today for cellular phone location, is not yet in widespread commercial use, and requires a functioning network in order to be useful.

Given this complex range of possible devices and electromagnetic signals, the WERT teams had to organize a strategy considering the highest possibility for success, with the lowest risk and the best use of available equipment and personnel.

Section 5 SEARCH, Section 8 FREQUENCY COORDINATION and Section 9 RESEARCH, report more on matters related to wireless devices and techniques.

3 COMMAND & CONTROL

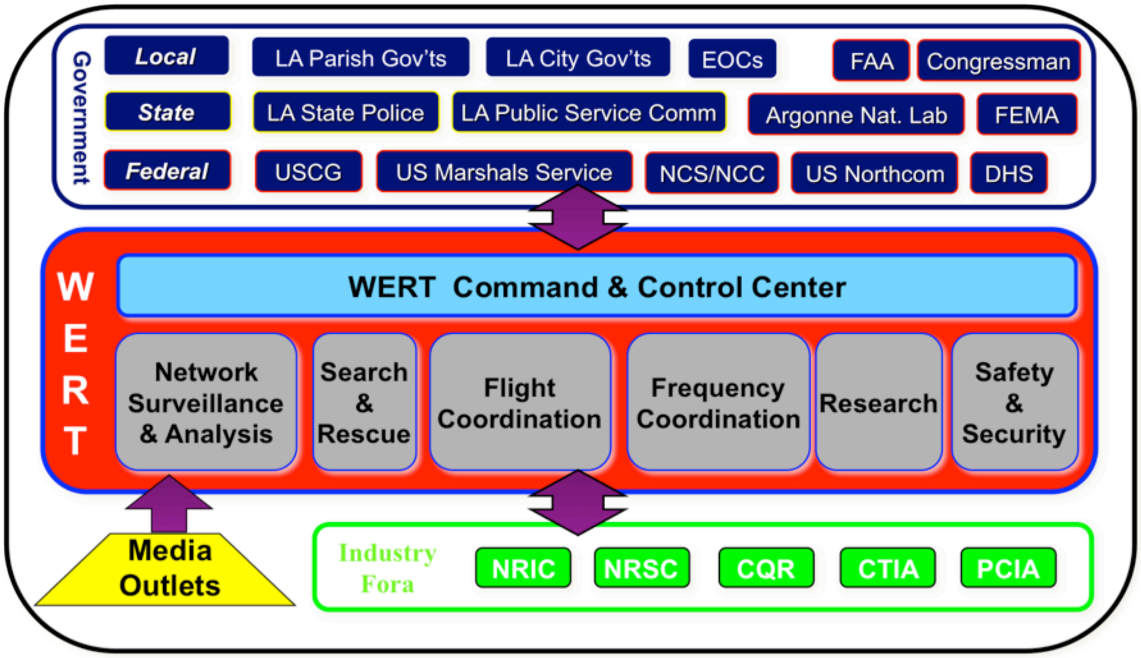

Figure 4 - COMMAND & CONTORL SUB TEAM

The purpose of the WERT Command & Control sub-team was to provide leadership for the entire team and included responsibilities for situation assessment for needs and resource assembly, coordination with authorities, process encouragement and other improvements and enhancements and facilitating intra-team communications and idea exchange across many companies, agencies and organizations. Figure 4 illustrates the organizational model.

The Command & Control sub-team provided a daily operating structure for the entire WERT team facilitating regular briefings and reviews through regularly scheduled conference calls with the virtual team in many locations. The Command & Control function was co-managed between two virtual office locations, one in Little Rock, Arkansas and the other in Washington.

3.1 Approach

3.1.1 Situation Assessment

Just after the August 29th hurricane passed, the levees around New Orleans broke and the flooding began. The majority of the city's resident's had evacuated but thousands of people remained, some in homes and many in evacuation shelters. For a couple of days, television news video showed pictures of thousands of people being picked up from the water by helicopter and boat. Dramatic pictures could be seen of people crawling from attics through holes cut in the roofs of houses. For several days, rescuers picked up people they could see. It also became clear during those initial days that the most communications in and around the region were severely limited or out-of-service. The WERT activated and determined that it could potentially help to locate trapped survivors by use of cellular telephone if portable network equipment could be brought in and flown over the flooded areas where cellular networks were not operating. Within hours, WERT had a plan together and began to obtain the necessary approvals to begin search & rescue using advanced wireless network technology.

Needs Assessment

- Most wireless and landline communications around New Orleans, South Louisiana and the Gulf Coast were out-of-service or severely limited.
- Much of the commercial radio and television service was limited or not functioning.
- Travel around flooded New Orleans had to be by boat or aircraft.
- Immediate repair and restoration to telecommunication facilities was impossible.
- Fuel for backup systems was limited.
- There appeared to be thousands of people still trapped by floodwaters.
- There was no good way to locate trapped survivors who were not visible from the air.
- Rescuers were looking for additional tools to locate and/or communicate with people.
- It was expected that large numbers of trapped people might have cellular phones.
- Battery life of cell phones would be limited, possibly with no re-charge ability.

Capabilities Assessment

- Wireless service providers can monitor their networks to measure performance and specific cellular handset activity.
- Service providers and equipment suppliers have 24-hour technical support centers.
- Electromagnetic cellular phone signals can be detected with the appropriate equipment and antennas.
- The general wireless subscriber population understands the concepts of battery charge depletion and signal strength variation, and carry cellular phones with them everywhere.

The above needs and capabilities assessment was conducted by the WERT along with many industry and government partners beginning hours after the floods began. Based on this assessment, a decision was made to move forward with an emergency response effort.

3.1.2 Coordination with Authorities

The WERT worked closely with numerous government entities. This section summarizes key relationships.

FCC
FEMA
NCS / NCC
United States Coast Guard
United States Marshalls Service, Technical Operations Group

3.1.3 Resource Assembly

Lucent Technologies provided a 24-hour technical support telephone bridge for the WERT. This bridge was used as the central communications post. Wireless service providers operating in the area were contacted to join the bridge: Sprint/Nextel, Verizon Wireless, Cingular, AT&T. Equipment suppliers were also invited and joined, as well as other organizations with critical roles. Some service providers were reached through their known contacts of their equipment suppliers.

3.1.4 Team Communications

The Command & Control sub-team also managed communications for all the WERT sub-teams. Team communications consisted of a 24-hour conference bridge, email, Instant messaging via Internet, 2-way pager messages, Short-message-service (SMS) text messages and offline telephone calls. A back-up telephone bridge was established for redundancy. It is also important to note that through the weeks, many of the WERT participants also were using personal email accounts as backups because various company and government agency primary networks were unavailable at times. For the first week of operation, the Command & Control sub-team received telephone calls on the order of hundreds, and emails on the order of thousands.

3.2 Key Learnings

3.2.1 What Worked Well

The following items have been documented as potential best practices for a Command & Control sub-team for a wireless emergency response for this type of crisis.

1. Have a clear center of coordination and WERT leadership
2. Minimum of two WERT leaders to share leadership, with 3rd backup identified. Should be from different organizations, and different geographic regions.
3. Real-Time engagement of expertise and capabilities
4. Problem-solving brainstorming sessions
5. High level of expertise for functions
6. Ability to conduct rapid research
7. High commitment of professionals and their organizations
8. Pre-established federal coordination function
9. Ability to articulate WERT capabilities to the appropriate decision-makers rapidly
10. Overall access to government and industry critical points of contact
11. Mutual aid cooperation among parties
12. Availability of secondary and backup email accounts and use of cellular SMS text messaging for team communications.
13. Primary and backup teleconference bridges provided by WERT participating companies.

3.2.2 Areas for Improvement

The following items have been documented as potential areas for improvement for a Command & Control function for a wireless emergency response for this type of crisis.

1. Develop formal industry contact point which knows how to reach WERT.
2. Publicize WERT capabilities and contact information through appropriate channels.
3. Rotate WERT team personnel for extended disasters for relief.

4. Expand the pool of trained WERT leaders.
5. Create templates of WERT leadership for various size disasters; local, regional or national (include team lists, contact sheets, duties and roles).
6. Create pre-defined processes, status definitions and templates for various team tasks would improve efficiency and communication.
7. Earlier identification of all service providers involved would allow for even quicker assembly of all critical industry parties. Industry mergers and acquisitions creates a changing environment of ownership of telecommunications network assets. Need to determine best method – source needs to be most accurate, comprehensive and reliable.
8. Utilize an Internet website for WERT team management, collection and distribution of templates, forms, authorizations, team lists and other team management information and tools. Set up FTP capabilities for large file transfer such as satellite and photo imagery and RF plots.
9. Set up and utilize wireless messaging text/email services with team lists for automated management and distribution of WERT team communications.
10. Identify and formalize a process for travel authorizations and restricted area access for mobilizing people and equipment.
11. Designate WERT members as "Emergency Responders" by U.S. Government.
12. Develop and use a resource list of key websites containing critical disaster information such as: news; transportation; webcam directory; satellite imagery; airports; medical info; hospitals. For WERT team use only. Post on WERT internal management website.
13. Recommend all WERT members have backup/secondary email, telephone and SMS text capability.
14. Include new team members in WERT with new technology capabilities such as WiFi.

3.2.3 Areas Requiring Further Investigation

The following items have been documented as areas that require further investigation in order to provide a Command & Control sub-team for a wireless emergency response for this type of crisis.

1. While the team moved forward as a life and death situation demands, a pre-established legal framework should be developed for such disaster wireless emergency responses.
2. Identify and pre-determine a list of companies or organizations which can provide air transportation across the United States during a disaster, such as corporate or private jets, or helicopters. Also identify priority access to ground transportation such as with rental car companies or government agencies.
3. Investigate possible cooperation with amateur radio community.

3.3 Recommendations

The following recommendations are made to provide an improved Command & Control function for a wireless emergency response for this type of crisis.

Recommendation CC-1

The WERT Command & Control key learnings should be reviewed by the larger wireless communications industry for inclusion in industry Best Practices.

Recommendation CC-2
Develop and publicize formal industry contact point for WERT.

Recommendation CC-3
Develop and utilize a secure website for WERT team operation.

Recommendation CC-4
Designate WERT team members as "Emergency Responders" by U.S. Government.

3.4 Command & Control Sub Team Participants

The Coordination Command Center consisted of the following participants:

Bernie Malone	WERT Executive Director (Lucent Technologies)
Karl Rauscher	WERT President
Russ Waughman	Cingular
Richard Krock	Lucent Technologies

4 NETWORK SURVIELLENCE AND ANALYSIS

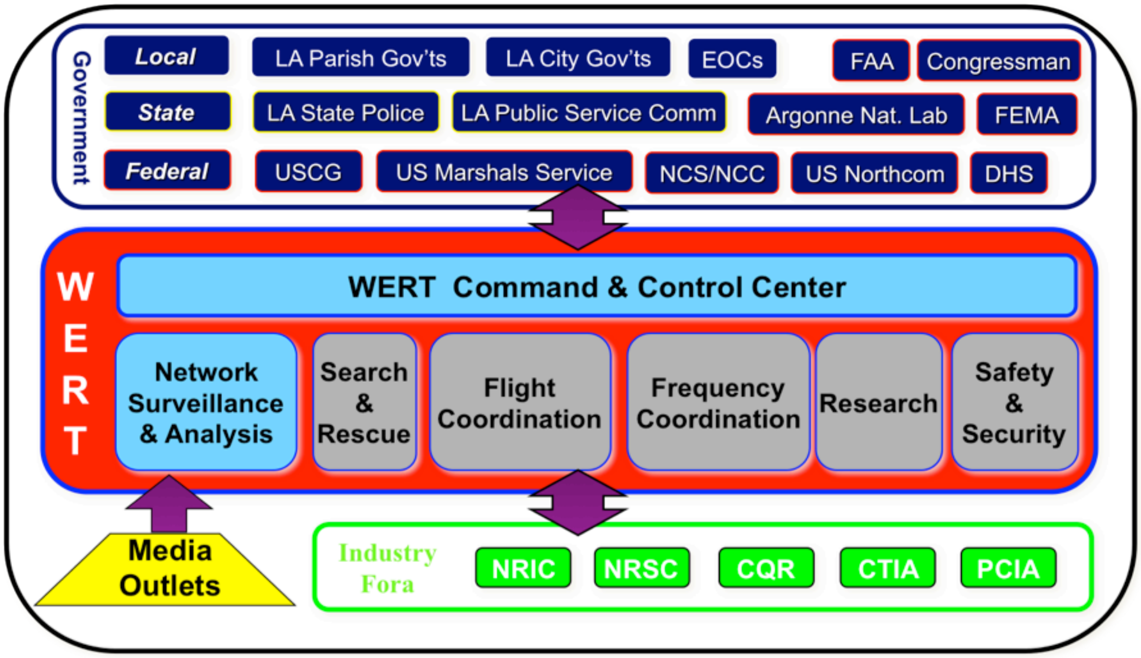

Figure 5 - Network Surveillance & Analysis

The purpose of the Network Surveillance and Analysis sub-team was to determine the status and health of the telecommunications networks in the hurricane-affected area, specifically in support of a search & rescue mission. This work began in support of the search & rescue mission to provide network status information to the crews in the helicopters for the flights over New Orleans with telecommunications network equipment. Later, the sub-team shifted it's work to support PSAP outages for 911 calls. This was done by analyzing network log utility reports and operational metrics to identify nodal platforms that exhibited abnormally low network performance percentages that would impact call processing.

The work performed by the Network Surveillance and Analysis sub-team supported two phases – 1) Search & Rescue, 2) E911 & Network Support. This section of the report describes the network analysis work primarily in support of the Search & Rescue phase. Section 6 of this report describes the E911 PSAP re-routes and network analysis. Figure 6 contains a timeline of events.

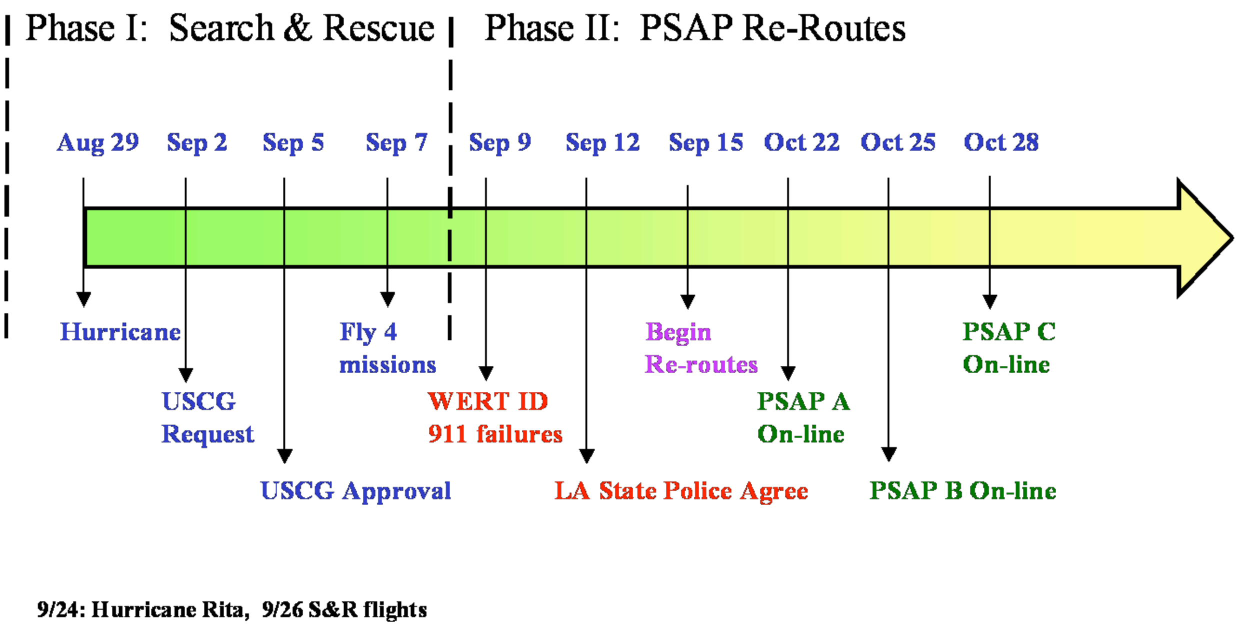

Figure 6 – PSAP Timeline

4.1 Approach

The Network Surveillance and Analysis team began work to support the search & rescue flights. The WERT team generally consisted of engineers from the various networks' companies, each reviewing their own network. The team generally met by conference call twice per day. Each member was able to report a general status of his or her networks in the New Orleans area. The team was able to review and summarize details of network performance. This provided a good indication of which networks and specifically, wireless cell sites, were in service and on –the-air. This collective review and sharing of information allowed to team to determine whether a wireless search & rescue mission could be conducted in certain radio frequency spectrum, for a particular service providers network on a certain day. From this, a plan was formed with the U.S. Coast Guard and individual wireless service providers, using certain frequencies, on certain days. This then allowed the planning of resources and equipment from the various WERT supporting companies.

Near the conclusion of the search & rescue mission, the Network Surveillance and Analysis team engineers reviewing network performance data began noticing E911 call failures. This led to the next phase of work for the Network Surveillance and Analysis team supporting the E911 PSAP re-routes. The re-route phase is described in section 6 of this report.

It is important to recognize that the initial search & rescue work phase of this team was useful for it's original purpose but also allowed the opportunity to review all network performance activity, which led to the rapid discovery of the E911 failures.

4.2 Key Learnings

4.2.1 What Worked Well

The following items have been documented as potential best practices for a Network Surveillance and Analysis team for a wireless emergency response for this type of crisis.

1. Virtual team effort with members of various network companies is crucial to success of this sub-team. Participation was excellent.
2. Allowing each network company's engineer to monitor and support from their own network perspective works because they are experts representing their network.
3. Virtual team environment across companies with connections to NCC/NCS provides a current situation assessment allowing all parties to have awareness of the full scope of the disaster.

4.2.2 Areas for Improvement

The following items have been documented as potential areas for improvement for a Network Surveillance and Analysis team function for a wireless emergency response for this type of crisis.

1. Develop recommendation for an organized report review of all network performance metrics in areas of cell-site, backhaul, intra-call processing, inter-call processing, E911 and RF performance that would be optimized for information critical in a disaster.
2. Develop lists of useful metrics in advance of disaster. Post on WERT website. Classify into network functional areas.

4.2.3 Areas Requiring Further Investigation

The following items have been documented as areas that require further investigation in order to provide a Network Surveillance and Analysis team for a wireless emergency response for this type of crisis.

1. Identify reliable sources for up-to-date lists of networks, bands, technologies, and licensees.
2. Identify and make available up-to-date lists of networks, switches, tandems, and PSAPs.

4.3 Recommendations

The following recommendations are made to provide an improved Network Surveillance and Analysis team function for a wireless emergency response for this type of crisis.

Recommendation NSA-1
The WERT Network Surveillance and Analysis team key learnings should be reviewed by the larger wireless communications industry for inclusion in industry Best Practices.

Recommendation NSA-2

Develop and publish recommended list of network metrics that will generally be useful (by network element or function category) in large-scale disasters.

4.4 Network Surveillance Sub-team Participants

The Network Surveillance and Analysis sub-team consisted of the following organizations and associated employees:

Tony Anastasio	Nortel Network Emergency and Recovery
Russ Waughman	Cingular Wireless
Michael Flanagan	Lucent Technologies

5 SEARCH

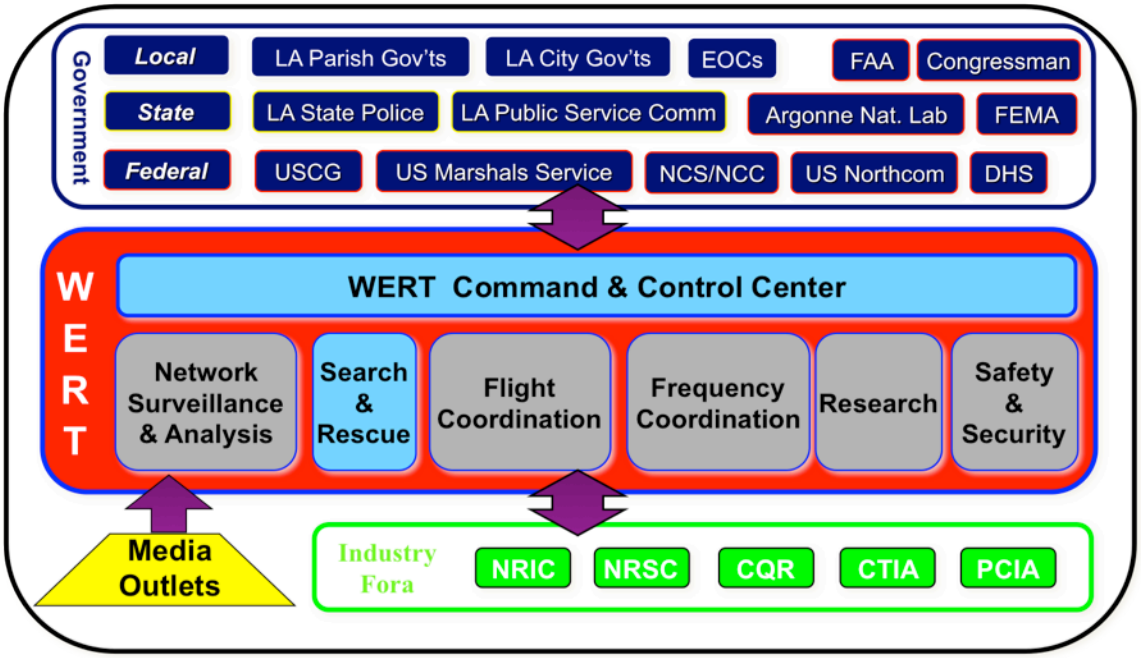

Figure 8 - Search Sub-team

On August 29, 2005 Katrina, a Category 4 hurricane came ashore near New Orleans, Louisiana. The event caused several levees to break, which immediately flooded over 80 percent of the city area. The U.S. Coast Guard immediately began flying search and rescue missions, picking up people trapped in the waters by helicopter. By September 7th, 4,732 sorties were flown by the U.S. Coast Guard, rescuing 7,212 people[1]. During the first several days after the hurricane and flooding, thousands of people needing rescue were easily visible from the air. Rescue aircraft were busy for several days, picking up people they could see in plain sight. By the fourth day after the flooding, it became clear to rescuers since the water had risen so high, that there were likely large numbers of people trapped inside building structures which could not be seen in plain sight from the air. Some people, trapped in attics of homes, were cutting holes through the roofs and crawling out. Rescuers wondered how many people might be inside attics and unable to cut their way out. It was believed that since much of the local commercial wireless, cellular networks were out of service, people might be trapped in their homes and trying to place cellular calls for help, but with no success. On Friday September 2nd, the Wireless Emergency Response Team (WERT) was notified that their advanced communication capabilities would be helpful to the search and rescue operations. At this request, the WERT team assembled portable cellular communication and advanced thermal imaging equipment across several corporations. The equipment was deployed to the U.S. Coast Guard Air Station in Alexandria, Louisiana on Tuesday, September 6th.

On Wednesday, September 7th the equipment was deployed in the field using two U.S. Coast Guard search and rescue HH-60 Jayhawk helicopters. The mission had two technology components. The first was to search for victims using Global System Mobile (GSM) and Code

[1] New Orleans Situation Summary

Division Multiple Access (CDMA) cellular communications. The other was to locate users trapped in their houses using the thermal imaging capability. In this brief operation, only the GSM capability was actually deployed in the disaster area on four flights flown in two groups.

Standard search and rescue patterns were flown in the south and east sections of New Orleans. The telecommunication equipment was successfully deployed and during the entire operation, hundreds of user handsets registered to the network, cellular communication was established with dozens of users, and all of them declined rescue assistance.

5.1 Approach

The WERT Search team assembled standard GSM, CDMA2000, and IS-136 remote communication capabilities with assets across several corporations. Search and rescue personnel could communicate with potential victims using this mobile communication technology without the need of additional telecommunication infrastructure, using what can be described as a “Reverse 911” technique. This is especially valuable in the early stages of a disaster when the traditional cellular coverage can be compromised. In the New Orleans mission, GSM technology was deployed first because it was the first available WERT emergency equipment. Time was even more critical because WERT was deployed well after the initial event (since the USCG was busy rescuing people they could visibly see in the first few days). The CDMA2000 and IS-136 equipment was available on standby. All the equipment was self-contained, portable, and battery powered. Two-way communication was established using a mobile-to-mobile connection established within this equipment on-board the helicopter. During the deployment, WERT had one person operating the equipment and another making the phone calls.

To limit the communication area to within the surrounding area of the helicopter, a relatively low transmit power of 1 Watt was used because of the flat propagation environment surrounding New Orleans and the flight search altitude of approximately 100 feet above ground level. Under these conditions we expected the line-of-sight COST 231[2] model to be appropriate, the expected cell radius defined by a transmitter antenna height of 100 feet, power of 1 Watt, transmit frequency of 1900 MHz, antenna gain of 6 dBi, and a minimum mobile receiver sensitivity (-110 dBm) is approximately 15 km, (reference[3]). To limit this further, we down-tilted the antenna and focused our attention on mobiles with a received signal strength indicator (RSSI) of -85 dBm or better. We expected these would be within a radius of 2 km from the helicopter.

Two USCG HH-60J helicopters were equipped with this advanced technology and both flew two missions each. The first mission started at sunrise on Wednesday, September 7th and was completed by early afternoon. After a brief refueling we began the second mission, which concluded at sunset. Search and rescue operations were conducted over south and east sections of New Orleans. During the missions, hundreds of mobiles registered to our airborne network and dozens of calls completed with individuals. All of the contacted mobile users declined rescue. We also attempted to get their street address for future rescue operations and to quantify our communication radius. We were not able to get that information so we were never able to calibrate our equipment for coverage area parameters.

[2] COST 231 Model Source reference
[3] Rappapport, New Orleans Situation Summary

5.1.1 Equipment, Configuration & Operational Techniques

This section briefly describes the equipment, configuration and operational techniques employed.

System:

- **TacBSR –** Field deployable Overlay Communications and Search & Rescue GSM base station.
  - Weight - ~40lbs
  - Size – 19"x16"x3.5"
  - Power input – 9V-30V @ 80w
  - Max RF Transmit Power - +35dBm (~5 watts)
- **Control Handset –** Commercial Nokia GSM Tri-Band handset
  - **Ear fob (Katrina only)**
  - **Headset (Rita only)**
    - Noise canceling
    - Self Powered 2 AA Batteries (25 hours)
    - Mobile phone jack interface
- **Battery –** Lead Acid
  - Weight – ~80lbs
  - Size – 19"x16"x5.5"
  - Life - ~4 hrs
- **Antenna**
  - Patch Antenna, high-gain, 1900 MHz
  - 6 dBi gain
- **Laptop Computer**
  - Panasonic Toughbook model #73
  - Mapping software with GPS feed for location ID
- **Noise canceling Headset (Rita only)**
  - Helicopter Grade
  - Self Powered 2 AA Batteries (25 hours)
  - Mobile phone jack interface
- **Aircraft Platform**
  - United States Coast Guard HH-60 "Jayhawk"

Configuration

- **TacBSR –** GSM Base station configured to broadcast on a clear channel as "USA" cellular provider.
- **Control Handset** – Mobile Handset utilized by WET personnel to call potential GSM mobiles "survivors" that have roamed to the TACBSR GSM base station.
- **Antenna –** Patch antenna mounted in helicopter window with an approximate 45 degree down tilt

Strategy

1. TacBSR Transmit "USA" cellular signal

2. GSM mobiles “survivors” roam to TACBSR if not connected to service provider (T-Mobile, Cingular, …).
3. Control Handset attempts call to GSM mobiles “survivors”
    a. Control Handset user identifies self as U.S. Coast Guard
    b. Control Handset user announces - “Reverse 911” call
    c. Control Handset user ask GSM mobile “survivor” if he or she requires assistance.
    d. If GSM mobile “survivor” request assistance Control Handset user requests relative directions to “survivor”.

Operational Scenario

- **“Reverse 911”**
    1. TacBSR system transmits GSM signal over approximately 2-block area.
    2. GSM mobile phones in TACBSR coverage area roam to TACBSR if not connected to a service provider (T-Mobile, Cingular, …).

- **HH-60** – Helicopter crew maintain an approximate altitude of 100’ above ground level while flying a block-by-block grid pattern.

5.1.2 Thermography

Thermography (thermal imaging) is a powerful tool in a very compact package. Many military and industrial organizations use some form of thermography in certain missions and jobs. Infrared cameras can be used day or night; however, the larger temperature differences between the human body and night air make the tool more useful in the cool of night. Unfortunately, night helicopter flights proved too dangerous with the large amount of damage and power lines that draped trees and buildings in the total darkness of the hurricane battered City of New Orleans. This, in combination with the high amount of helicopter air traffic, made night flights more risky.

The infrared camera team had equipment and personnel readied for action and deployment in less than 2 hours. This short preparation time enables the opportunity to respond to an emergency as quickly as possible. The infrared equipment is compact, about the size of a small suitcase (the camera itself is approximately the size of a typical video camera), battery powered, high resolution, has multiple lenses and can be utilized on land, in the air or on the water, making it an extremely versatile tool for search and rescue efforts.

The proposed use of thermal imaging equipment for the Hurricanes Katrina and Rita rescue was based on the idea that the hand-held thermal imaging cameras would be used from the helicopters to scan the ground below during the flights when the cellular equipment was being used. The theory was that, if a victim using a cellular phone trapped inside a building was in two-way communication with the helicopter crew, but could not be seen from the air, the thermal imaging equipment could aid in locating a victim by using the heat of the victim’s body. An infrared, or thermal imaging camera, cannot ‘see’ through glass or solid objects. However, if a victim were in thermal contact (touching) the solid object, such as a window or pressed against the underside of a rooftop, the victim’s body heat would transfer through the material making it visible from outside of the building. This would allow the helicopter rescue crew to more quickly pinpoint the location of the trapped caller from among the many buildings below and target the correct building for rescue. The thermal camera could also be used to pinpoint the location of a victim outdoors that may have been disabled and unable to flag a rescue team down, this would prove especially useful in the dark of night. In addition the thermal camera could be used to scan the ground below during flights with the cellular equipment team to locate victims on the ground that did not have a working cell phone.

The technique would be most effective at night, when the temperature difference between a live human body and it's surroundings would be greatest. Since the USCG helicopter search and rescue missions were flown during daytime, and additional space on the helicopters were unavailable, this technique was not deployed.

Figure 9 is a thermal image taken inside of a home during cold winter months. The indoor heat is being drawn through the wall to the outdoors making the wall studs clearly visible. Similarly, a victim's body pressed against a wall would transfer heat through the wall making it visible on the opposite side of the wall.

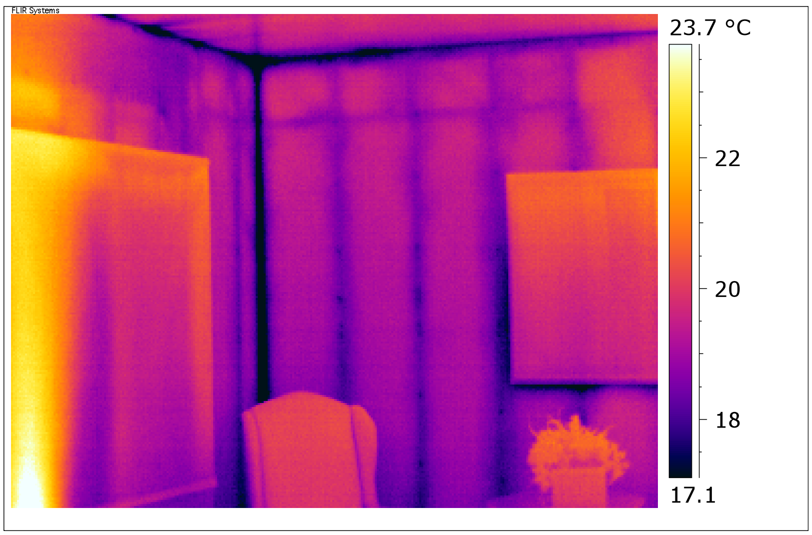

Figure 9 - Wall studs hidden behind the drywall are clearly visible

5.2 Key Learnings

5.2.1 What Worked Well

Mobile phone penetration has reached the point where emergency response personnel have the capability to remotely communicate with disaster victims. This is a tremendous advantage over conventional approaches, particularly when the victim could be covered by debris or trapped in hidden locations and difficult to locate.

The following items have been documented as potential best practices for a Search team using advanced wireless techniques for a wireless emergency response for this type of crisis.

1. Actual calls were completed between helicopter rescuers and flood victims on the ground. The overall technique of communicating with victims this way worked very well.
2. The small size, portability and battery power made the equipment easy to install on the helicopters.
3. The cellular equipment using a “Reverse 911” operational strategy to call victims worked very well.
4. Close cooperation and planning with the pilot and flight crew for planning flight altitude, coverage area requirements and search patterns worked well.
5. The technical concept of remote, airborne communications between people in air and on the ground worked well. This approach did not require any other existing, ground based telecommunications infrastructure.
6. Some victims who were communicated with on the ground still had battery power for their handsets one week after the hurricane and flood.
7. Because of the initial work with Hurricane Katrina, the WERT Search team was prepared and deployed in advance of Hurricane Rita and was deployed very quickly.
8. Use of Short Message Service (SMS) text messaging between WERT engineers in helicopter and WERT Command & Control Center worked well and was the only means of communications available during the flights.

5.2.2 Areas for Improvement

The following items have been documented as potential areas of improvement for a Search team using advanced wireless techniques for a wireless emergency response for this type of crisis.

1. Access to the disaster site. The longer the time before WERT deployment, the more the cell phone batteries will be depleted. Transportation, fuel, and security clearance were difficult. Airline travel to the disaster region was difficult.
2. A broader range of wireless technologies should be available and on stand-by. GSM was the most rapidly deployable equipment. CDMA, UMTS and other technologies should be made available for this type of public service rescue work.
3. Background noise on the aircraft caused extreme difficulty for communicating using cell phones on the aircraft for victim contact. Need to always use aircraft-grade, noise-cancelling headsets that connect directly to the cellular handsets.
4. Pre-mission preparation of this type of search and rescue support in advance of disasters would greatly enhance operations.
5. Because such a large scale disaster of this type and it’s response was difficult to imagine, valuable planning days were spent which could have be done in advance of the disaster.

5.2.3 Areas Requiring Further Investigation

The following items have been documented as potential areas requiring further investigation for a Search team using advanced wireless techniques for a wireless emergency response for this type of crisis.

1. This WERT wireless search & rescue capability could potentially be used by other agencies for use over land such as National Guard.

2. Investigate the use of this Reverse 911 technique and similar cellular network rescue techniques in other disaster scenarios.
3. The wireless communications industry should consider making more equipment covering all current technologies (CDMA, TDMA, GSM, UMTS, etc) available and ready to deploy on very short notice.
4. WERT should permanently certify available equipment for use on agency aircraft such as the U.S. Coast Guard. Having Safety Of Flight Test (SOFT) completed in advance would save valuable time during disasters.
5. Investigate how thermal imaging might be used safely with wireless technologies.
6. Investigate techniques for marking houses, buildings or victim locations possibly with RFID tags, GPS or other technologies and automated mapping techniques.
7. Investigate the use of an airborne cellular communications network with multiple nodes and significant traffic-carrying capability, capable of operating for extended periods during disasters, and rapidly deployable.

5.3 Recommendations

The following recommendations are made to provide an improved Search team function using advanced wireless techniques for a wireless emergency response for this type of crisis.

Recommendation SRCH-1
The WERT Search team key learnings should be reviewed by the larger wireless communications industry for inclusion in industry Best Practices.

Recommendation SRCH-2
Industry should make a broader range of equipment available covering more wireless technologies (CDMA, TDMA, UMTS, other).

Recommendation SRCH-3
Equipment should be tested and pre-certified for flight or other deployments requiring advanced approval by multiple agencies.

Recommendation SRCH-4
Investigate the use of an airborne cellular communications network with multiple nodes and significant traffic-carrying capability, capable of operating for extended periods during disasters, and rapidly deployable for providing two-way cellular communications.

5.4 Search Sub-team Participants

Capt. Therry Gilbreath	United States Coast Guard
LCDR Scott Langum	United States Coast Guard
LCDR Chuck Bell	United States Coast Guard
LTJG Shelley Decker	United States Coast Guard
LT Kevin Hill	United States Coast Guard
LCDR Mark Ward	United States Coast Guard
Tom Daniel	Motorola
Roberto Martinez	Motorola

Doug Gould	Motorola
Mark Fernandes	Motorola
Raj Ambati	Motorola
Neal Foster	Motorola
Firass Badaruzzaman	Motorola
Tom Urschel	Motorola
Kevin Brennan	Motorola
Arthur Nguyen	Motorola
Felix Mancuso	Motorola
Mike Schiksnis	Motorola
Jay Macor	Motorola
George Peopples	Motorola
George (Gee) Rittenhouse	Lucent Technologies
Ted Fidder	Lucent Technologies
Sidney Johnson	Lucent Technologies
Sandra North	Lucent Technologies
Bill Scofield	Lucent Technologies
Phil Fair	Lucent Technologies
Casey Reynolds	Lucent Technologies
Mark Nguyen	Lucent Technologies
Don Gallagher	Lucent Technologies

6 E911 PSAP Re-Routes

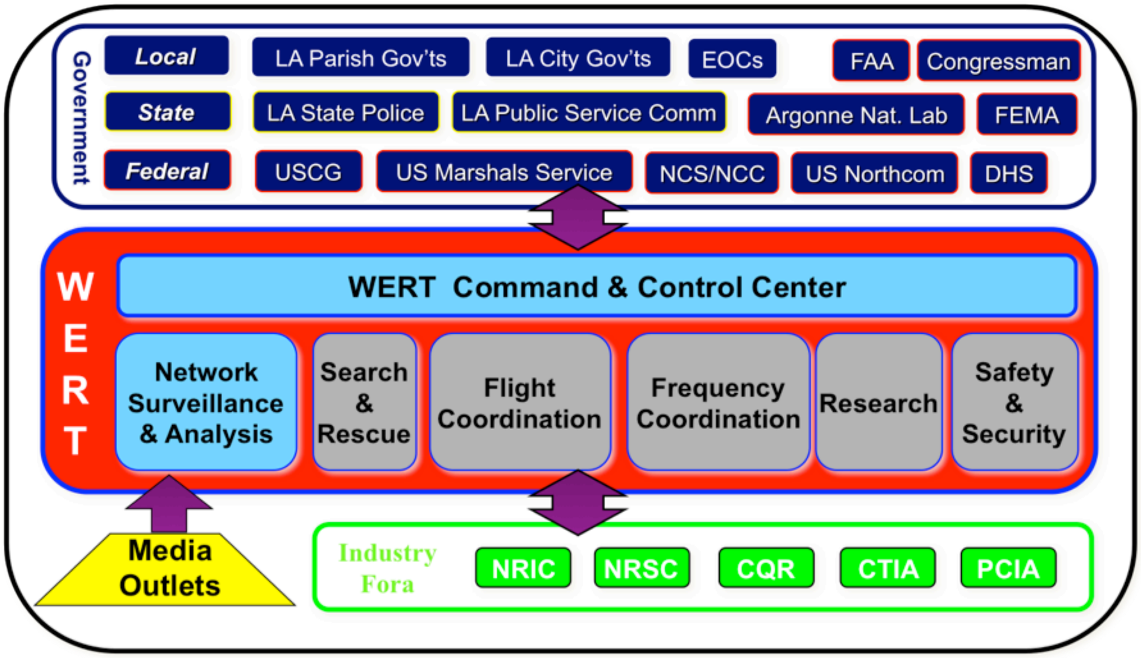

Figure 10 - Network Surveillance & Analysis – Re-Routes

The E911 PSAP Re-Routes sub-team was the same as the Network Surveillance and Analysis sub-team. The team's work began in support of the search & rescue mission to provide network status information to the crews in the helicopters for the flights over New Orleans with telecommunications network equipment. After completion of the first search & rescue flights on September 7th, the network team began to notice wireless 911 call attempts originating from cell phones on various carriers networks in the South Louisiana area which were making it to the Mobile Switching Center (MSC) but not continuing on to their PSAP final destination. The WERT network team spent some time verifying the failed call information and confirming that the routes to the PSAPs were indeed out of service. The WERT network team consulted with wireless carriers and industry contacts and confirmed that thousands of wireless 911 calls for help were going unanswered. Since the wireless search & rescue flights were then completed, the team shifted focus of it's work to support PSAP outages. During this later phase, the team's purpose was to determine the status and health of the telecommunications PSAP routes, monitor the status, and find and establish alternate routes and answering points. For several weeks following this discovery, this team did that.

In South Louisiana after Hurricane Katrina, generally, 911 calls were coming into the wireless switches, and the switch would attempt to route the call to the appropriate PSAP. However, since trunk groups were out of service, calls would not complete to the PSAP destination. In some cases, service providers were identifying out-of-service trunk groups, and then finding alternate trunks groups with different routes, using them. For example, some PSAP calls were routed over trunk groups to Dallas, Texas, then back into Baton Rouge, Louisiana. Every PSAP or route outage had to have careful attention and planning to find alternate routes and/or answering points.

6.1 Approach

6.1.1 Process

Although telecommunication network design can be complex, the goal of the PSAP network is to provide a route and an answering point (PSAP) for emergency calls. Since the routes and/or PSAPs in South Louisiana were out of service during this time, the WERT goal became to assist with establishing new answering points. The task was simply to identify alternate routes and/or new parties who could receive incoming emergency calls. This WERT process was developed for the E911 Re-Route support.

1. Problem Discovery - Accurate Problem Description and Impact Assessment

   Service provider engineers used various tools, data sources and processes to first assess network condition and performance, in areas such as:

   - Trunk outage reports.
   - Environmental, Logistics and Damage Assessment for Disaster Area.
   - Current Office Records, Drawings and Specifications
   - Identify all detailed information for critical service provided by the affected office.
   - (Fire, Police, Military, Nuclear Sites, Key Customers)
   - Key Resources and Subject Matter Experts and their contact information.
   - All resources will need to be available as required to facilitate real-time decision-making.
   - Temporary communication plan until interim service can be restored.
   - Billing Methods / Purchase Orders pre-arranged internally prior to actual disaster

2. Identify failed 911 calls

   By gaining authorized access to the switch, remote monitoring of 911 activity was achieved. Examples:

   - XXXSYS -This measurement group defines system-level registers related to Emergency Services (ES) & Value Added Services (VAS) position determination.

   - E911 Session - This measurement increments when the MSC-S starts an IS-801 session upon receipt of the first SMDPP with Service Indicator value of X and no prior LSE VAS session state information available. This register is only incremented for active mobiles.

3. Investigation/confirmation of call failures

   To confirm 911 call failures were real:

   a. Verify incoming / outgoing trunk connection rates
   b. Verify E911 calls that went to treatment.

c. Mobile-to-Treatment - pegs (increments) a counter when a mobile station (MS) originates a call that ends up in treatment for any of a number of reasons. In the case of a call getting as far as a page response or setting a land up for ringing and then a failure occurs, a peg of the original call type is pegged, followed by an MTRT peg.

4. Identified Re-Routes and new answer points

   WERT network team members worked closely with wireless service provider engineers and telephone company facilities representatives to identify new routes and implement the appropriate switch translations. In addition, since some PSAPs were not reachable, WERT members and partnering service providers made numerous phone calls, eventually finding the Louisiana State Police willing to accept 911 calls from any parish (parishes are similar to counties in other states).

5. Monitor status

   Calls were scheduled twice a day to monitor status during this re-routing activity. Service provider network operation centers monitored trunk connect operational measurements and verified that the 911 calls were properly routed out of the switch to the tandem office and then routed to the final PSAP location.

6. Provide real-time coordinate lookup service

   See section 6.1.3 below.

Engineers working with WERT who are part of the wireless service providers were able to review their respective network call performance data. Through this, they were able to identify failed 911 call attempts. They re-reviewed this data enough to confirm it was accurate.

The WERT team along with wireless service provider managers and facilities providers, researched their existing PSAP routes and government contacts to confirm the problem and status. This group then began contacting alternate organizations to determine which were capable of receiving the 911 calls. Once the new answering points were identified, the new destination phone numbers were set up and all the appropriate switch translations were completed. The team then monitored all the route and re-routes for weeks to come.

Nortel was able to use a complete set of tools to provide latitude and longitude position information based on the cell site ID. Lucent Technologies' Bell Labs was also able to use data analysis tools to process call measurement data from some of the 911 calls to extract location information. This information was then translated into address information in near-real-time and passed along to authorities at the new PSAP answering point. This was very useful because the new PSAP was often far away from the emergency 911 caller, in another governmental jurisdiction. In effect, this new PSAP was providing remote emergency assistance for an un-familiar area. So having some general idea of an address, was a benefit in dispatching emergency responders remotely.

Other tools of use included:

CALEA - Department of Justice.

Paging tools – Some data registers monitor the number of completed handoffs for subscriber units from a particular serving subcell to a particular target subcell. This indicates the traffic flow from a particular subcell by showing which target subcells are receiving handoffs. This measurement group is keyed to a specified cell site and the type of power class information pertaining to the subscriber unit using the specified cell site.

XXXREQIV – This measurement is incremented when requests related to mobile position determination for E911 Phase 2 or LCS is triggered by the mobile placing an E911 call or dialing digits related to LBS. This corresponds to number of attempted mobile initiated position requests.

LCS - E911 emergency services uses mobile positioning technology to pinpoint
mobile users for purposes of providing wireless emergency dispatch services (including fire, ambulance, and police) to mobile phone users.

The **Location Services Enhancements (LSE)** standard, PN4747, extends J-STD-036-A network elements for locating mobiles in an active non-emergency call or in idle mode for the purpose of location services. LSE enables carriers to recoup some of the cost with revenue generating location based services using the same equipment and network elements deployed for Wireless Emergency Services (WES)/E911-Phase-2 are used for LCS.

PDE (Position Determining Entity): The PDE determines the precise position or geographic location of a wireless terminal when the MS starts a call or while the MS engages in a call. Each PDE supports one or more position determining technologies. Multiple PDEs using the same technology may serve the coverage area of an MPC and multiple PDEs each using a different technology may serve the same coverage area of an MPC.

MPC (Mobile Position Center): The MPC selects a PDE to determine the position of an MS. The MPC may restrict access to position information (e.g., require that the MS be engaged in an emergency services call or only release position information to authorized nodes.)

6.1.2 Re-Route Tracker

As mentioned before, the team's goal was to monitor existing routes and establish new routes to alternate answering points. This simple tracker, in figure 11, was developed to map existing PSAPs to new answer points.

Acadia Parish	route normally	
Alabama	route normally	
Acscension Parish	225-[redacted]-XXXX	The PSAP is fully functional. Use this number only if unable to connect to the SR
Assumption Parish	985-[redacted]-XXXX	The PSAP is fully functional. Use this number only if unable to connect to the SR
Bogalusa, City of	985-[redacted]-XXXX	
Franklinton, City of	985-[redacted]-XXXX	
Jefferson Parish LA	504-[redacted]-XXXX	
Kenner, City of	504-[redacted]-XXXX	
LaFouche Parish	985-[redacted]-XXXX	The PSAP is fully functional. Use this number only if unable to connect to the SR
Mississippi	route normally	
Orleans Parish	504-[redacted]-XXXX	
Plaquemines Parish	504-[redacted]-XXXX	
St Bernard Parish	504-[redacted]-XXXX	
St Charles Parish	985-[redacted]-XXXX	The PSAP is fully functional. Use this number only if unable to connect to the SR
St John the Baptist Parish	985-[redacted]-XXXX	The PSAP is fully functional. Use this number only if unable to connect to the SR
St Tammany Parish	985-[redacted]-XXXX	
Tangipahoa Parish	985-[redacted]-XXXX	
Terrebonne	985-[redacted]-XXXX	The PSAP is fully functional. Use this number only if unable to connect to the SR
Washington Parish	985-[redacted]-XXXX	

Figure 11 – Re-route Tracker

6.1.3 Location Identification

Sprint PCS provided call measurement data records for E911 calls to Lucent Technologies, Bell Laboratories for analysis. Records are generated each time a call is placed and contain useful information regarding the subscriber telephone number, base stations that the mobile was able to monitor and timing information about those base stations. This allows the geo-location of subscribers making E911 calls. Geo-location of E911 calls is particularly important during disasters because callers may either have moved to an unfamiliar territory (e.g., to escape rising waters) or cannot recognize the surroundings due to extensive damage.

Under ordinary circumstances, subscriber locations can be assessed using Assisted-GPS (A-GPS) processing equipment at the PSAPs. However, the damage caused by the hurricanes frequently resulted in the loss of this ability (e.g., due to PSAP outages). In these circumstances, the PCMD records provided a trace to where the E911 were made. Given a list of E911 calls, estimated caller locations were produced to assist any rescue teams following up on those calls.

A maximum-likelihood technique was employed to determine where calls were made. This approach was robust to base station outages (due to hurricane damage). The overall technique was enhanced to provide street address information in addition to Latitude/Longitude to better assist rescue teams.

A simple process was established to provide this geo-location service.

1. Louisiana State Police or the wireless service provider would call WERT and provide the mobile phone number of the wireless E911 caller. WERT would forward this information to Bell Labs.
2. Bell Labs would process the PCMD and determine the location of the base stations, which received the call from the subscriber handset. A latitude/longitude mapping look-up was also performed and translate to a nearby municipal street address.
3. The street address and mobile number was provided back to the Louisiana State Police.

6.2 Key Learnings

6.2.1 What Worked Well

The following items have been documented as potential best practices for a Network Surveillance and Analysis function regarding PSAP outages for a wireless emergency response for this type of crisis.

Network performance tools and operational measurements can be used to very accurately determine the health of the network. They also provide the key indicators to identify major platform faults and outage identification and resolution.

In a wireless network, the network performance tools can also provide detailed granularity into the various distributed processing platforms and functional operational areas within the switching platform. By drilling down into the performance metrics, it is possible to identify the percentage of E911 calls that are able to complete to the PSAP centers. The tools can also view mobile-to-mobile, mobile-to-land, land-to-mobile and tandem calls that are routed through the switch.

These tools were critical in the identification and recovery of wireless networks within the devastated areas.

1. Existing industry network performance tools work well.
2. Partnership with the switch service provider engineers to monitor and resolve the situation.
3. Use of existing switch management tools and metrics to monitor and confirm call completion rates.
4. Use of call measurement records and associated tools to provide geo-location for E911 callers.
5. Louisiana State Police agreement to accept 911 calls from parishes was good, manual, alternate plan.
6. WERT acted as a clearinghouse to establish re-route numbers and notify all other carriers of changes.

6.2.2 Areas for Improvement

The following items have been documented as potential areas for improvement for a Network Surveillance and Analysis function regarding PSAP outages for a wireless emergency response for this type of crisis.

E911 PSAP centers did not always have alternate translations in place to properly route traffic. Once the telephone companies were notified that 911 calls did not terminate on the PSAP, they proceeded to install the alternate translations to remedy the problem.

Additionally, it appears that emergency preparations had possibly not considered a disaster of this scope and magnitude.

1. There was no backup plan for PSAP reroutes in a disaster of such large scope, or it was unavailable or not accessible.
2. There was difficulty in establishing new re-route paths.
3. There was difficulty in contacting and communicating with local and regional authorities.
4. People or entities that could provide re-route paths were in the disaster area.
5. There was no easy method of determining which PSAPs were functioning.
6. Two alternate PSAPs should be identified for every PSAP (one in-region, and one out-of-region).
7. Telecommunications facilities service providers to PSAPs should identify and pre-arrange alternate routes to PSAPs, and to backup PSAPs.
8. Develop list of all critical people resources involved in restoring service to a PSAP. This should include multiple backup numbers, email, etc, and alternate people contacts. Ideally, there should be some geographic diversity in contacts so that some are out of a regional disaster area.
9. PSAPs should develop a plan for reporting their status to a state or federal command center (possibly NCC/NCS). Some sort of hotline communications link should be developed.

6.2.3 Areas Requiring Further Investigation

The following items have been documented as areas that require further investigation in order to provide a Network Surveillance and Analysis function regarding PSAP outages for a wireless emergency response for this type of crisis.

1. Investigate whether an automated status system could be developed and used providing a real-time display of PSAP status, providing a view at either the national, state or local level.
2. Investigate whether the NCS/NCC or similar agency could or should act as a central command center contact that all PSAPs would report to in a disaster or crisis situation. All telephone facilities providers could also report to this command center.
3. Investigate the implications of a very large-scale disaster, which would render all the PSAPs in a state out-of-service. Determine the impact and whether any further study is appropriate.

6.3 Recommendations

The following recommendations are made to provide an improved Network Surveillance and Analysis function regarding PSAP outages for a wireless emergency response for this type of crisis.

Recommendation PSAP-1
The WERT PSAP Re-route key learnings should be reviewed by the larger wireless communications industry for inclusion in industry Best Practices.

Recommendation PSAP-2
Develop and implement an in-region and an out-of-region backup PSAP for every PSAP.

Recommendation PSAP-3
Develop alternate routes and translations for all primary and backup PSAPs.

Recommendation PSAP-4
All PSAPs and telephone company facilities providers should prepare and use key people contact lists with backups and diversity. Make list available to WERT or similar national command center response function. These critical resources should be well known and published and accessible nationally.

Recommendation PSAP-5
Develop PSAP condition automated status reporting system with national visibility and communications hotline reporting function.

6.4 Network Surveillance and Analysis Sub-team Participants

The Network Surveillance and Analysis Sub-team consisted of the following organizations and associated employees:

Tony Anastasio	Nortel Network Emergency and Recovery
Russ Waughman	Cingular Wireless
Michael Flanagan	Lucent Technologies

7 FLIGHT COORDINATION

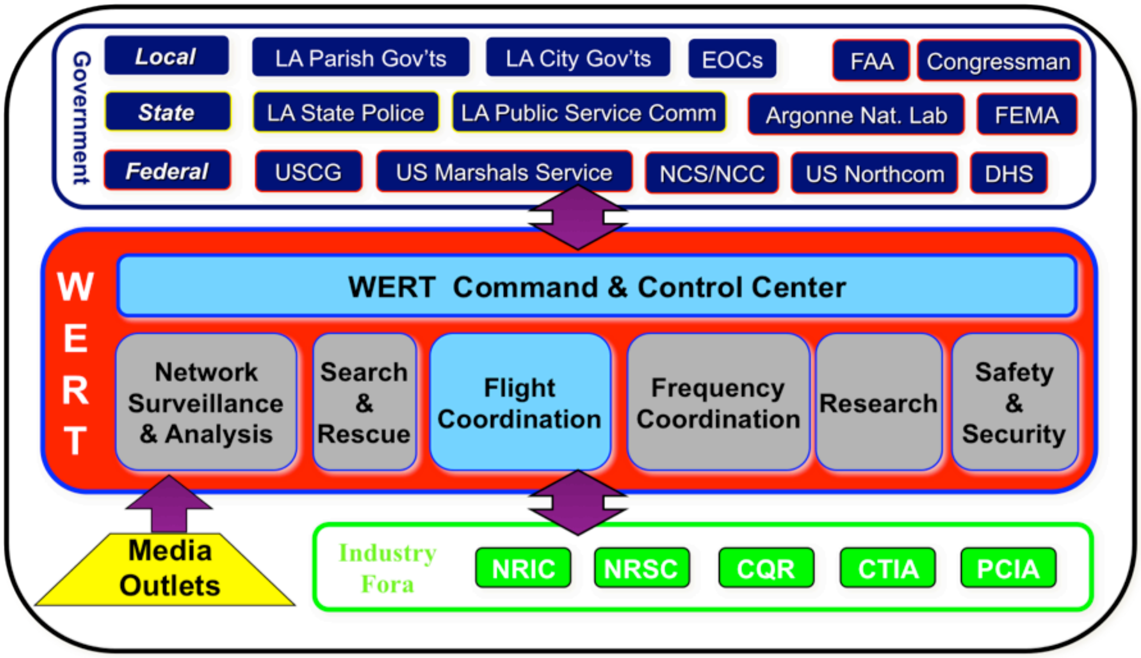

Figure 12 – FLIGHT COORDINATION

The United States Coast Guard (USCG) had completed preparations in advance of Hurricane Katrina and had resources positioned in key locations to be ready to move into the New Orleans and Gulf Coast area after the hurricane. In the first days after the hurricane made landfall, WERT was in contact with the USCG about the possibility of using advanced wireless equipment and techniques to search for trapped hurricane survivors with cell phones needing rescue in areas where the commercial wireless networks had been knocked out of service.

WERT began advanced planning of a potential mission and developed the sub-team structure as described in this report. The WERT sub-team FLIGHT COORDINATION (figure 12) was established and led from a virtual office location in Little Rock, Arkansas. The mission of the WERT FLIGHT COORDINATION sub-team was to provide an interface between WERT and the USCG and determine and implement all details necessary to execute the flights. This team's work was to support flight coordination of the wireless rescue flights over flooded New Orleans.

FIGURE 13 - USCG AIRCRAFT: HH-65B, C-130J , HU-25, HH-60J

7.1 Approach

7.1.1 HURRICANE KATRINA RESPONSE

WERT personnel contacted the U.S. Coast Guard (USCG) Incident Command Post (ICP) in Alexandria, Louisiana and gave a brief explanation of the technology and offered to assist the USCG in their on-going search and rescue efforts in the aftermath of Hurricane Katrina. USCG ICP personnel presented the information to the night shift supervisor and then passed it on to the day shift for follow up. Day Shift obtained a waiver from USCG Aircraft Repair & Supply Center's (ARSC) in Elizabeth City, NC to deviate from standard protocols for installation of non-standard equipment onboard a USCG Helicopter. Once the waiver was obtained, WERT personnel were informed and logistics were worked so WERT personnel could arrive in Alexandria as soon as possible.

Alexandria, LA was the chosen location to stage the WERT project primarily because the USCG had two HH-60J aircraft and crew ready and willing to fly with the WERT equipment and personnel. WERT personnel were able to easily procure air transportation to Houston, TX, with plans to drive rental vehicles from Houston to Alexandria. To expedite the arrival of WERT personnel and get the helicopters in the air sooner, the USCG flew a HU-25 Falcon aircraft to Houston to pick up and deliver WERT personnel to Alexandria.

Once in Alexandria, WERT personnel and USCG pilots and crew all met and discussed what equipment would be used, who would be going in the aircraft, USCG Safety-of-Flight Tests (SOFT) required as part of the waiver, and the flight search plan. After a short installation period and a ground-based Safety-of-Flight Test, the equipment was approved by the pilots for flight.

Two HH-60J aircraft flew in formation from Alexandria, LA to New Orleans, LA and proceeded to fly over the search area. During the flight, WERT communications specialists were able to communicate with people on the ground that had operational cell phones prior to returning to Alexandria for fuel.

While in Alexandria, WERT and USCG personnel flew four separate events, communicated with people during each flight, was able to successfully ascertain the physical status of Hurricane Katrina survivors still within the disaster zone. Fortunately, none of the remaining survivors were in desperate need of an airlift rescue and were confident in their own safety. Team members were able to gather information to assist the USCG in the event that the survivor's situation changed and needed evacuation in the future.

7.1.2 HURRICANE RITA RESPONSE

USCG personnel contacted WERT personnel two or three days prior to Hurricane Rita's land fall to ascertain whether or not WERT personnel would be interested in assisting the USCG again, this time in response to Hurricane Rita. USCG personnel obtained another waiver from ARSC to install WERT equipment onboard HH-60J aircraft (a routed request for long term approval was still in process). USCG and WERT determined Corpus Christi, TX to be the best location to assemble WERT members since USCG Air Station Houston was evacuating it's own aircraft to Air Station Corpus Christi, TX and would be flying back to Houston as soon as Hurricane Rita hit landfall to begin search and rescue efforts.

WERT team members were transported from Air Station Corpus Christi to Air Station Houston onboard a USCG C-130. In Houston, approval was received from the USCG Houston Incident Command Post and a HH-60J was dedicated to fly a WERT mission over key disaster areas near Galveston. After successful completion of another Safety-of-Flight Test, WERT personnel and equipment were flown to the scene and were able to communicate with hurricane survivors on the ground. Survivors on the ground explained that they were not in harms way and did not desire to be evacuated.

7.2 Key Learnings

7.2.1 What Worked Well

The following items have been documented as potential best practices for a Flight Coordination function for a wireless emergency response for this type of crisis.

The success of the WERT missions was due to good communications between WERT personnel and USCG personnel in the USCG Incident Command Post in Alexandria, LA. WERT contacted the USCG ICP directly and offered its services; ICP personnel recognized the potential of the equipment for Hurricane Katrina response as well as future uses for USCG Search and Rescue missions. Multiple phone conferences, emails and phone calls took place to organize the logistics involved in bringing WERT members from various locations in the USA to Alexandria, LA.

Prior to the WERT personnel arriving in Alexandria, the USCG had sent two HH-60J helicopters to Alexandria, LA to assist the ICP with air logistics. The helicopter pilots and crew were willing and ready for the WERT mission, when the USCG Falcon aircraft landed inbound from Houston with the remaining WERT personnel. USCG airlift of WERT resources was crucial because most commercial flights in the region were cancelled and airports closed.

Equipment was easily installed on the helicopters and WERT personnel brought enough additional batteries to ensure the equipment would function for the duration of the flight without needing to be connected to the aircraft's electrical power system. Thus much more complicated certification was determined to be unnecessary. U.S. Coast Guard flight personnel had proactively worked the necessary flight certification issues prior to the teams arrival and had established very clear and straight forward procedures for the team and the flight crews that allowed the certification that the flights could be accomplished safely while operating the cellular equipment on-board.

For Hurricane RITA, USCG personnel contacted WERT a few days prior to landfall and WERT had been preparing prior to the call. This gave additional time to prepare and get everyone involved together and ready for the helicopter flights. Prior to landfall, WERT and USCG personnel were ready to respond.

1. Good communication between WERT and USCG Incident Command Post.
2. Backup and secondary email accounts were essential for maintaining contact 24 hours per day.
3. USCG expert advanced planning and logistics ability.
4. USCG availability of aircraft to transport WERT resources to location.
5. USCG very clear procedures for approval and Safety-Of-Flight-Test (SOFT).
6. USCG assistance with clearance, access and recommendations for lodging, etc.
7. USCG staffing, backup personnel and alternate contacts.
8. USCG knowledge and professionalism.
9. WERT and USCG advanced planning and approvals for Hurricane RITA.

7.2.2 Areas for Improvement

The following items have been documented as potential areas for improvement for a Flight Coordination function for a wireless emergency response for this type of crisis.

There is always room for improvement and these two events (Hurricanes Katrina and Rita) are no exception. Some potential areas include visibility, response time, logistics, and communications. Few USCG members know that WERT can assist with search and rescue efforts or what technology and capabilities it has at it's disposal. WERT and USCG members can work together to improve WERT's visibility and spread the word that WERT can assist the USCG for future events.

After Hurricane Katrina made landfall, the USCG was approached by WERT and offered assistance. A few days passed before the WERT mission flights took off, which possibly reduced the possibility of locating people in actual distress. Cell phone batteries do not last long without a charge and without electricity, stranded people had no way to charge their phones.

Prior to Hurricane Rita, communications and preparation for the response allowed WERT personnel to be ready prior to landfall. Obtaining permission for WERT flights was more of a challenge than for Hurricane Katrina as key USCG ICP were not aware of WERT and how WERT could help. However, once the proper ICP personnel had been located and informed permission for flight was quickly granted. Advanced contact of the proper ICP personnel in the future could prevent WERT personnel from arriving and waiting for the authorization to fly the missions.

Logistics were challenging for both events, which is normal when attempting to gather people from various parts of the USA in a short period of time and to an evacuation zone. Most commercial flights were cancelled, preventing the staging site from being relatively close to the location of the hurricane's landfall. Personnel from WERT and the USCG could possibly find a suitable location for commercial flights, and arrange transportation via military aircraft to the USCG staging site from which the WERT flights would originate.

1. Increase awareness of WERT capabilities within the USCG.
2. Streamline disaster response preparedness between WERT and USCG.
3. Obtain advanced, permanent flight certification of WERT equipment with USCG.
4. Obtain advanced USCG approvals and clear decision authority process.

7.2.3 Areas Requiring Further Investigation

The following items have been documented as areas that require further investigation for a Flight Coordination function for a wireless emergency response for this type of crisis.

The USCG and WERT can both learn from the two hurricane responses and work together to be ready to respond to other events. WERT equipment should receive approval through normal USCG ARSC methods that will provide authorization for any future installations of the equipment and insure the safety of WERT flights. The first steps (Safety-of-Flight test and submission of an Aircraft Configuration Change) of the process has already taken place and additional testing by actual ARSC personnel may be required; WERT and ARSC could work together to make this happen.

Another area for investigation would be to develop an agreement between WERT and the USCG that would provide a template for how the USCG and WERT can work together responding to events in the future. This could include info on what type of equipment would be available for use by both organizations (USCG Helos, WERT gear, etc) as well as a general outline of how logistics would be worked out including the possible use of USCG aircraft for transportation of WERT personnel & equipment, possible staging locations, etc.

1. Test, certify and approve WERT equipment for use on all USCG aircraft.
2. Develop an agreement of cooperation between USCG and WERT for work in future disaster scenarios.
3. Investigate whether it is appropriate to test, certify and approve WERT equipment for use on the aircraft of other military branches.

7.3 Recommendations

The following recommendations are made to provide an improved Flight Coordination function for a wireless emergency response for this type of crisis.

Recommendation FLGT-1
The WERT Flight Coordination key learnings should be reviewed by the larger wireless communications industry for inclusion in industry Best Practices.

Recommendation FLGT-2
Obtain advanced, permanent flight certification of WERT equipment with USCG.

Recommendation FLGT-3

Streamline disaster response preparedness between WERT and USCG.

Recommendation FLGT-4
Obtain advanced USCG approvals and clear decision authority process.

7.4 Flight Coordination Sub-team Participants

LTJG Shelley Decker	United States Coast Guard
LT Kevin Hill	United States Coast Guard
LCDR Mark Ward	United States Coast Guard
Captain J. H. Korn	United States Coast Guard
Captain Terry Gilbreath	United States Coast Guard
CDR Timothy McGuire	United States Coast Guard
Captain Norman Schweizer	United States Coast Guard
LCDR Scott Langum	United States Coast Guard
LCDR Chuck Bell	United States Coast Guard
Rick Krock	Lucent Technologies
Karl Rauscher	WERT President
Bernie Malone	WERT Executive Director (Lucent Technologies)

8 FREQUENCY COORDINATION

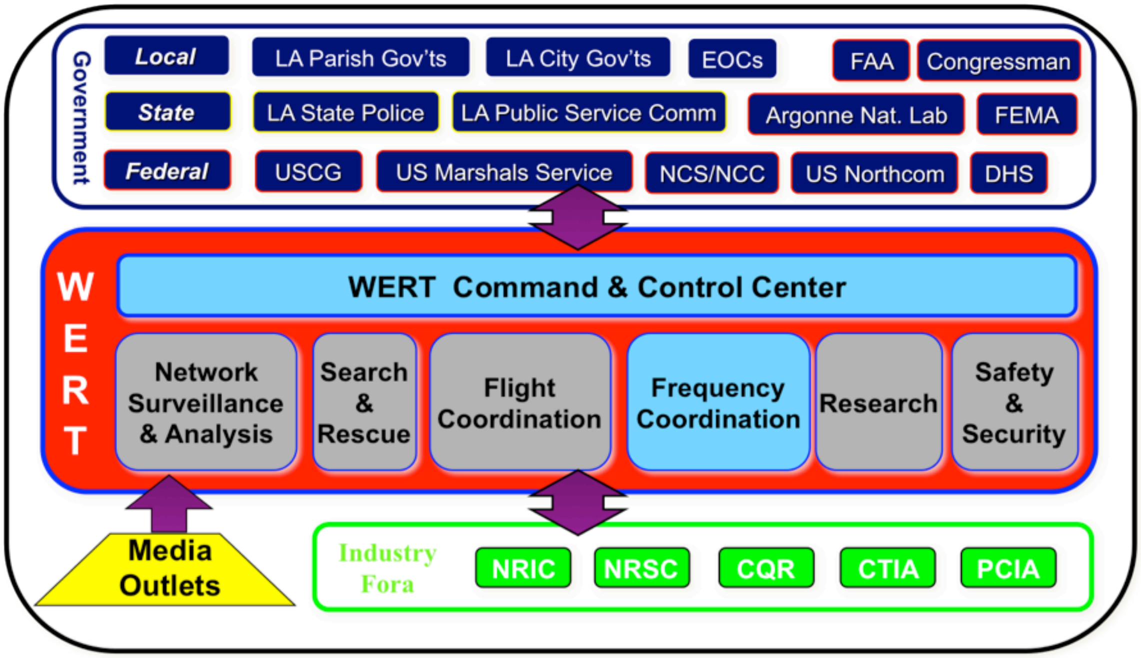

Figure 14 - Frequency Coordination

The purpose of the Frequency Coordination sub-team (figure 14) was to understand the radio frequency spectrum normally in use by wireless service providers in New Orleans, and determine and monitor which frequencies, or radio carriers, were on-air and which were off-the-air, of the respective networks. This was necessary in support of the search & rescue mission in order for the WERT teams on the helicopters to have the latest information during a flight about which wireless networks were operational, allowing them to formulate a wireless search plan without creating any interference to normal network operations. This team's function was performed for both Hurricane's Katrina and Rita.

8.1 Approach

Engineers from the network equipment suppliers including Motorola and Lucent Technologies provided publicly-available band-plan, ownership and carrier ID information in spreadsheets as a starting reference. Engineers from the affected wireless service providers in New Orleans provided updated maps containing cell locations, frequencies and status in real time. Other WERT members monitored overall telecommunications status as reported twice daily on the NCC / NCS government status calls. This layered approach allowed for very accurate and real time status of frequency usage in the cellular bands in New Orleans. Obviously, it was essential to have very accurate information, and to have direct involvement of the cellular service providers engineers' and/or company representatives, to have clear authority to transmit from the helicopters in their bands.

8.2 Key Learnings

8.2.1 What Worked Well

The following items have been documented as potential best practices for a Frequency Coordination function for a wireless emergency response for this type of crisis.

1. Using public spectrum information (FCC and other sources) was helpful.
2. Involvement from cellular carriers worked well and was essential.
3. Twice-daily situation status calls were useful and essential.
4. Last-minute updates before flight time were helpful.

8.2.2 Areas for Improvement

The following items have been documented as potential areas for improvement for a Frequency Coordination function for a wireless emergency response for this type of crisis.

1. It was difficult to determine accurate SID codes because of recent business merger activity. Ownership data sometimes required detective work to identify the true, current owner/licensee of spectrum (and switches).

8.2.3 Areas Requiring Further Investigation

The following items have been documented as areas that require further investigation in order to provide a Frequency Coordination function for a wireless emergency response for this type of crisis.

1. It would be productive to have a secure source for very accurate ownership data of telecom assets including spectrum, switches, signaling, routes, databases and other network elements for use by authorized personnel in critical situations.
2. Investigate the use of agreements or Memorandum-of-Understandings (MOU) that describe or support protocol for such frequency borrowing or sharing for use during major disasters by authorized disaster / rescue agencies.

8.3 Recommendations

The following recommendations are made to provide an improved Flight Coordination function for a wireless emergency response for this type of crisis.

Recommendation FRQC-1
The WERT Frequency Coordination key learnings should be reviewed by the larger wireless communications industry for inclusion in industry Best Practices.

Recommendation FRQC-2
Make available or identify source for industry or government availability of secure, accurate spectrum ownership information reflecting business merger and acquisition activity.

8.4 Frequency Coordination Sub-team Participants

The Frequency Coordination sub-team consisted of the following organizations and associated employees:

Tony Anastasio	Nortel Network Emergency and Recovery
Chris Blackwood	Nortel
Russ Waughman	Cingular Wireless
Garry Bowling	Cingular Wireless
Mohammad Ali	Cingular Wireless
Robert Jones	Cingular Wireless
Scott Jones	Dobson
Rick Krock	Lucent Technologies
Joe Tarallo	Lucent Technologies
Chitra Venkatraman	Lucent Technologies
Paul Taylor	Sprint
Brian King	T-Mobile
Vijay Patel	T-Mobile
Felix Mancuso	Motorola
Tom Daniel	Motorola
Hal Moore	NORTHCOM
Norm Michaels	NORTHCOM

9 RESEARCH

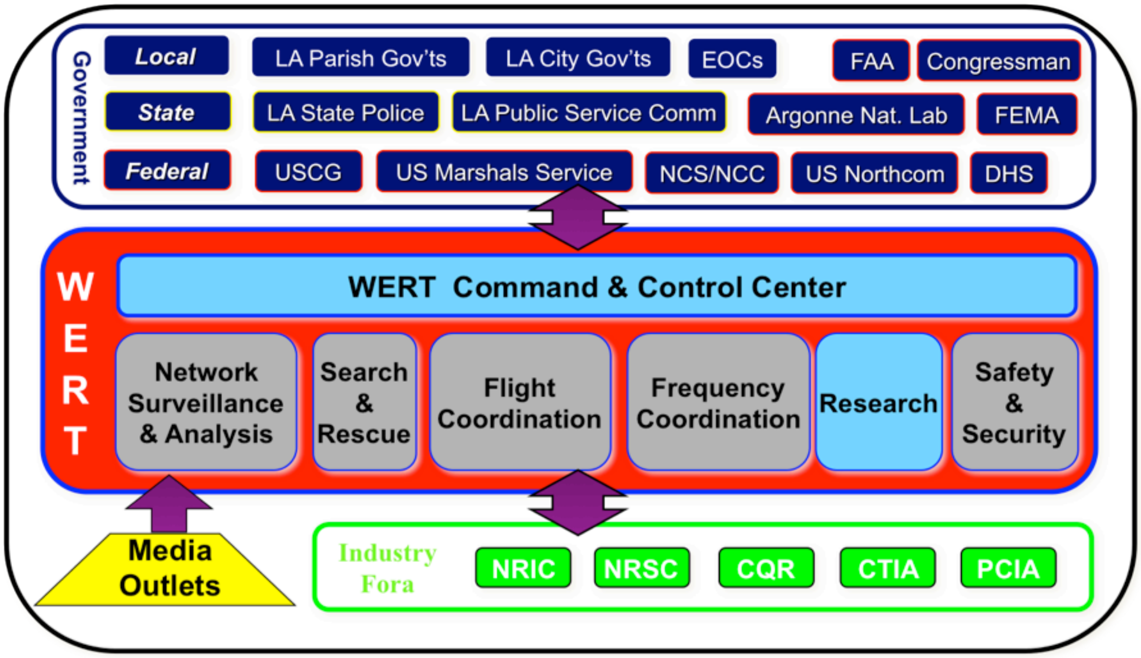

Figure 15 - Research

The purpose of the Research sub-team (figure 15) was to provide near real-time technical research by the best experts from industry and academia. This team participated in daily meetings with other WERT teams and the USCG to understand the rescue mission requirements and make recommendations on equipment, technology and techniques which could be quickly assembled, tested, deployed and had high probability of being useful in the search.

This team provided a variety of services including proposing technologies, recommending products and tools, building software, testing and working with the USCG on SOFT flight approvals for the equipment.

This team's function was performed for both Hurricane's Katrina and Rita.

9.1 Approach

The team's effort started with initial brainstorming and an assessment of which technologies and products might be useful. This had to be balanced with time-to-implement, portability for flight, approval for flight, ease-of-use, likelihood of success, and risk. Since the goal was to locate and communicate with trapped hurricane flood victims, the research focused primarily on tools that could achieve two-way communications. Secondly, tools were identified that could aid in the final location determination of the victim.

Immediately after the flooding of New Orleans began, the USCG initiated and conducted helicopter rescue missions over the city, rescuing thousands of people trapped in neighborhoods. During the first couple of days, the people needing rescue could be visibly seen during daylight from the air. It was also observed that people were cutting holes in roofs and climbing out of attics. This led to the possibility that more people could be trapped inside attics and unable to cut through to the outside to signal for help. There might also be people still on lower levels of homes and buildings, unable to go outside because of the flood water or climb to a higher position. Considering the possibility that these people might have cellular phones, the WERT team, along with the USCG, concluded that a primary mission would be to try to communicate with these victims. Since much of the commercial cellular network service in the region was not working, this led to the WERT research team designing a solution to bring a portable, airborne cellular network to the flooded area on a helicopter to try to establish communications.

Therefore, much of WERT's work initially was focused on establishing this airborne communications capability to communicate with flood victims. From there, additional technologies were considered which would expand or enhance the primary communications mission. WERT specialists designed and readied a thermal imaging system to accompany the communications equipment to aid in pinpointing the location of the victims in cell phone contact. The primary technology/product used was portable GSM base station equipment configured to work in stand-alone mode. This allowed two-way communication to be established with victims possessing standard cellular handsets.

In a later phase of the WERT support mission, emphasis shifted to PSAP route failures. During this phase, the RESEARCH team was also valuable in reviewing any potential ideas for reroutes as well resources, tools, applications, available data for location identification of the 911 caller.

In a mission such as this, there were many specific team functions such as described in this report. Each of the sub-team members were engaged in intense planning and activities. Since there is so much activity, it moves fast, and lives may be at risk, it is imperative to keep the sub-teams clearly distinct, and each focused on it's assigned task. It was important here to have a RESEARCH team who were expert at their task, dedicated, and unencumbered by other mission duties. This allowed for expert and quick research support.

The WERT Research team conducted conference calls with experts from various locations around the world each day, discussing technologies, products and their implementation.

9.2 Key Learnings

9.2.1 What Worked Well

The following items have been documented as potential best practices for a Research function for a wireless emergency response for this type of crisis. This section of the report does not attempt to summarize the technical nature of the RESEARCH function, but rather the administrative nature. The technical elements involved would be dynamic and different for each type of disaster or geographic location.

1. Having dedicated researchers, unencumbered by other mission duties.

2. Having expert subject-matter-experts who make final technology recommendations, in this case with the partner rescue agency (USCG).
3. Allowing final deployment decision go/no-go between the subject-matter-experts and the rescue agency.

9.2.2 Areas for Improvement

The following items have been documented as potential areas for improvement for a Research function for a wireless emergency response for this type of crisis.

1. It was sometimes difficult to identify enterprises or sources of experts or technology needed. A better system of locating experts and technology would be valuable.

9.2.3 Areas Requiring Further Investigation

The following items have been documented as areas that require further investigation in order to provide a Research function for a wireless emergency response for this type of crisis.

1. More formal identification of think-tank, educational, research and technology organizations related to a variety of technologies that might potentially be useful in disasters, with cross references to contacts, experts and technology could speed the research effort.

9.3 Recommendations

The following recommendations are made to provide an improved Research function for a wireless emergency response for this type of crisis.

Recommendation R-1
The WERT Research key learnings should be reviewed by the larger wireless communications industry for inclusion in industry Best Practices.

Recommendation R-2
Wireless industry companies should be encouraged to develop and make available more wireless communications equipment suitable for disaster deployment covering modern communications modes.

Recommendation R-3
Enhanced methods and resources should be made available for identifying and locating technology and subject-matter-experts.

9.4 Research Sub-team Participants

The Research sub-team was supported by the following organizations and associated employees:

Tom Daniel	Motorola

Roberto Martinez	Motorola
Doug Gould	Motorola
Mark Fernandes	Motorola
Raj Ambati	Motorola
Neal Foster	Motorola
Firass Badaruzzaman	Motorola
Tom Urschel	Motorola
Kevin Brennan	Motorola
Arthur Nguyen	Motorola
Felix Mancuso	Motorola
Mike Schiksnis	Motorola
Jay Macor	Motorola
George Peopples	Motorola
George (Gee) Rittenhouse	Lucent Technologies
Ted Fidder	Lucent Technologies
Sidney Johnson	Lucent Technologies
Sandra North	Lucent Technologies
Bill Scofield	Lucent Technologies
Casey Reynolds	Lucent Technologies
Mark Nguyen	Lucent Technologies
Don Gallagher	Lucent Technologies
Michael Flanagan	Lucent Technologies
Joe Tarallo	Lucent Technologies
Bill Zucker	Lucent Technologies
Clark DeHaven	Lucent Technologies
Stuart Goldman	Lucent Technologies
Charlie Meyer	Lucent Technologies
Lois Lazar	Lucent Technologies
Chitra Venkatraman	Lucent Technologies
James Reddig	Lucent Technologies
Mark Hinch	Lucent Technologies
Tuan Do	Lucent Technologies
Rick Krock	Lucent Technologies
Phil Fair	Lucent Technologies
Ted Rappaport	University of Texas
Judy Harkins	Gallaudet
Sandra Bittner	Argonne National Laboratory

10 SAFETY AND SECURITY

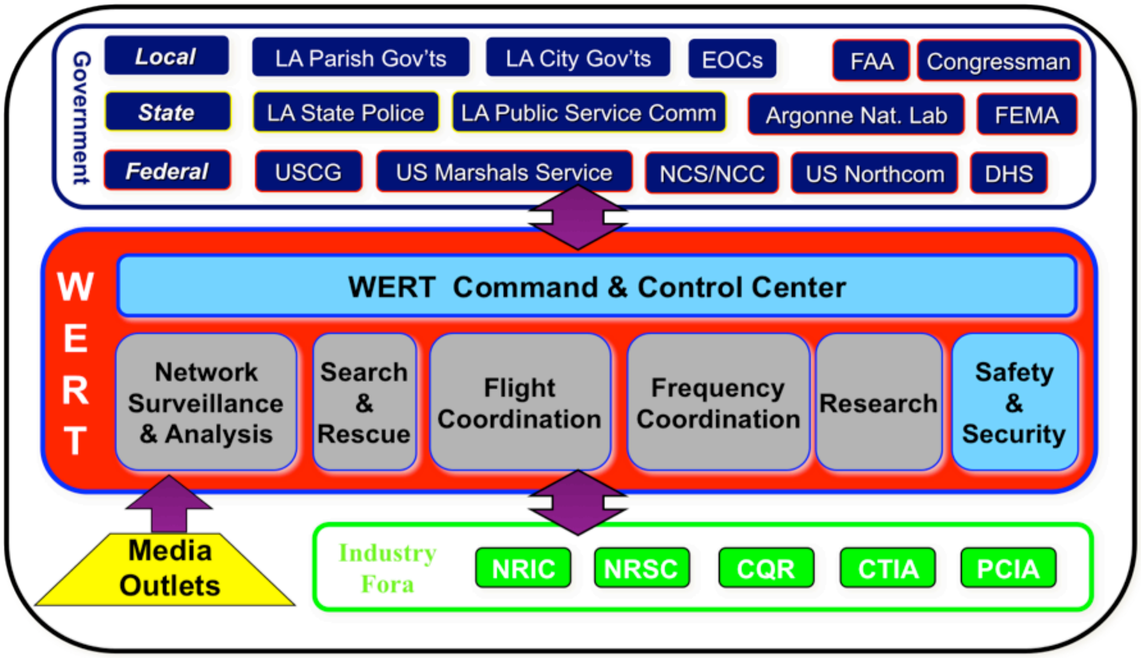

Figure 16 - Safety and Security

The purpose of the Safety and Security sub-team (figure 16) was to provide logistical support for safety and security of the WERT volunteers who were traveling to Louisiana and Texas to support and fly the helicopter wireless search missions.

10.1 Approach

This team provided a variety of logistical services needed for the team members who traveled to New Orleans for the flights. These services included planning and details for:

1. Travel to Louisiana and Texas from around the U.S.
2. Lodging & ground transportation.
3. Local scene situation reports and updates on travel, food, shelter.
4. Health, medical and immunization recommendations.
5. FEMA credentials for drivers.
6. FEMA access authorization letters.
7. Personal safety and security guidelines.
8. Other waivers.
9. Daily situation status updates.

On Monday morning, September 5, 2006 all individuals of the Denver GCL Lab response team went to local hospitals to receive inoculations recommended by Health Services personnel. On Monday evening the GCL team departed Denver International Airport for Houston and ultimately on Tuesday Alexandria, LA. This team's function was performed for both Hurricane's Katrina and Rita.

10.2 Key Learnings

10.2.1 What Worked Well

The following items have been documented as potential best practices for a Safety and Security function for a wireless emergency response for this type of crisis.

1. Having a dedicated staff with knowledge of these topics was efficient.
2. Periodic planning and status updates was essential because in the disaster area there was a severe lack of most resources needed.
3. WERT personnel were provided lodging at USCG locations.

10.2.2 Areas for Improvement

The following items have been documented as potential areas for improvement for a Safety and Security function for a wireless emergency response for this type of crisis.

1. Lack of government authorizations and credentials often caused significant delays.
2. Methods of identifying transportation and lodging in the disaster area and nearby were difficult and almost non-existent.
3. Getting immunizations on short notice can be difficult and time consuming.

10.2.3 Areas Requiring Further Investigation

The following items have been documented as areas that require further investigation in order to provide a Safety and Security function for a wireless emergency response for this type of crisis.

1. Government credentials and authorizations for on-site personnel.
2. Sources for lodging and transportation for on-site disaster personnel.

10.3 Recommendations

The following recommendations are made to provide an improved Research function for a wireless emergency response for this type of crisis.

Recommendation SS-1
The WERT Safety and Security key learnings should be reviewed by the larger wireless communications industry for inclusion in industry Best Practices.

Recommendation SS-2
Implement a nationally-recognized process for authorizations and credentials for WERT or similar on-site and COMMAND personnel to have identification and access to resources and disaster locations.

Recommendation SS-3
Research the use of existing government assets such as the Centers For Disease Control and Prevention (CDC) as a source for the latest relevant information for emergency responders.

10.4 Safety and Security Sub-team Participants

The Safety and Security sub-team was supported by the following organizations and associated employees:

Tom Finley, CIH	Lucent Technologies
Rick Krock	Lucent Technologies
Marianna Perry	Lucent Technologies
Rose Quinsay	Lucent Technologies
Dr. Bob Sioss	Lucent Technologies
LT Kevin Hill	USCG

11 ACKNOWLEDGEMENTS

Many organizations and individuals supported or contributed, directly or indirectly, to the efforts described in this report. Attempts were made to log and identify everyone. Undoubtedly, during the crisis, it was not possible to record every name of people providing remote expertise. A list of the major supporters is provided at the beginning of this report.

In addition, a very sincere thank you is offered to Russ Waughman, Karl Rauscher and Rick Krock for their leadership role in WERT and continuing support of national disaster response.

A very special thank you is also offered to the countless corporations, which support or allow their key employees to support these efforts during a national disaster. This type of industry-government, mutual-aid effort would not be possible without the unquestioning support of experts from various companies and agencies.

12 GLOSSARY

AMPS/NAMPS - Analog and Narrow Band Analogue cellular systems

ANI - Automatic Number Identification, particularly useful in 911 situations when a call may be dropped.

ARSC – Aircraft Repair & Supply Center – U.S. Coast Guard's centralized location for repairing all USCG aircraft and is also the location for development and installation testing of new technology for use onboard USCG aircraft.

CALEA - Commission on Accreditation for Law Enforcement Agencies

CDMA - Code Division Multiple Access, also IS-95, CDMA2000. A modulation scheme which independently codes data in multiple channels for transmission over a single wideband (spread spectrum) communication link. It may be used as an access method that permits carriers from different stations to use the same transmission equipment by using a wider bandwidth that the individual carriers otherwise require. Upon reception, each carrier is distinguished from the others by means of a specific modulation code. This enables reception of signals that were originally overlapping in frequency and time.

COW – Cell-on-Wheels, these are self-contained cellular base transceiver stations typically installed on small trailers, capable of being towed by truck.

DF – Directional Finding

DTMF – Dual-Tone Multi-Frequency, telephone touch tone sounds

ES – Emergency Services

ESN - Electronic Serial Number, A 32-bit binary number. The ESN is assigned by the manufacturer and can never be changed

FAA – Federal Aviation Administration

FOB - Short strap, ribbon, or chain used to attach electronic communicator for convenience

GPS - Global Positioning Systems, used primarily for pinpointing a location off satellite information this technology is more useful for grand scales than narrow locations.

GSM - Global Standard for Mobile Communications. GSM uses narrowband TDMA, This is the primary system used in Europe and Asia.

HLR - Home Location Register, cellular home network of a handset.

ICP - Incident Command Post - A location where Incident Command Members work in response to disasters as part of the larger Incident Command System Structure.

ICS – Incident Command System - A standardized on-scene incident management concept designed specifically to allow responders to adopt an integrated organizational structure equal to the complexity and demands of any single incident or multiple incidents without being hindered by jurisdictional boundaries.

IDEN - Integrated Digital Enhanced Network. digital technology that enables users to take full advantage of the benefits of the wireless world by integrating four communications services into one network specifically features of dispatch radio, full-duplex telephone interconnect, short message service and data transmission.

IS-801 – TIA Position Determination Standard for mobile devices

LNA - Low Noise Amplifier, lab test equipment

LSE VAS – A telecommunications network element monitoring tool.

MIN - Mobile Identification Number, A ten-digit number that is similar to a landline phone number in that it has a three-digit area code and a seven-digit phone number. The MIN is assigned by the cellular service provider and can be changed, such as when changing service providers.

MS – Mobile Station

MTRT – A telecommunications network element monitoring tool.

NOC - Network Operations Center

PRL - Preferred Roaming List

PSAP - Public Safety Answering Point

RFID – Radio Frequency Identification

RSSI - Received signal strength indicator

SMS - Short Message Service is the transmission of short text messages to and from a mobile phone, fax machine and/or IP address. Messages must be no longer than 160 alpha-numeric characters and contain no images or graphics.

SOFT – Safety-Of-Flight Test

TacBSR – Tactical Base Station Router – small cellular base transceiver station with additional network functionality built in.

TDMA - Time Division Multiple Access (IS-136)

TDOA - Time Difference Of Arrival

UMTS – Universal Mobile Telecommunications System

USA – United States of America

USCG – United States Coast Guard

VAS – Value Added Services

WiFi – IEEE 802.11 wireless transmission standard

XXXSYS – A telecommunications network element monitoring tool

13 REFERENCES

ATIS Network Reliability Steering Committee (NRSC), www.atis.org

Network Reliability and Interoperability Best Practices, www.nric.org

United States Coast Guard Aircraft Repair & Supply Center, www.uscg.mil/hq/arsc/index.HTM

Wireless Emergency Response Team (WERT), www.wert-help.org

[i] FINAL REPORT for the September 11, 2001 World Trade Center Terrorist Attack at www.wert-help.org