

**EMERGENCY  
COMMUNICATIONS  
INTEROPERABILITY  
WHITE PAPER**

*This paper provides a problems and requirements analysis and a proposed scalable, cost effective solution for comprehensive emergency communications interoperability among all responders, administrators and officials.*

December 2006

Robert S. Block  
Claude (Mac) E. McCormick, Jr.  
Rene Stiegler  
J. Roger Daugherty



## **COMMUNICATIONS INTEROPERABILITY**

Communications interoperability among local, regional, state and national government agencies, healthcare providers and military units is a serious challenge in today's complex and mobile society. The ability of police officers, firemen, medics, public utility personnel and other emergency service providers to share information in an expeditious manner is critical. Every day, across America, there are local emergencies that require interagency communication. They include highway accidents involving hazardous materials, chemical plant fires, gas explosions and severe local storms. Regional and national crises such as 9-11, earthquakes, hurricanes, floods and other weather related disasters have shown that needed functionality is often lacking.

As the authors addressed the problems of implementing and integrating emergency communication systems we learned that technology is not the only problem. Policies and procedures to foster cooperation among the various agencies and departments need to be established and implemented. Turf issues must become secondary to performance.

Many citizens and officials wrongly assume that emergency response agencies and organizations in their region can already communicate with each other effectively, especially within the same jurisdiction. Too often, however, that is not the case.

There are many underlying reasons, both technical and non-technical, for this lack of interoperability. They include incompatible and aging systems, limited and fragmented budget and funding cycles, incomplete and unexercised planning and coordination, inconsistent policies, organizational or political influence, and limited radio spectrum allocation and availability.

During and after 9-11 and Hurricane Katrina, experts revealed that communication systems, devices and networks that should have been used to coordinate an improved response were not used. The reasons for these failures were numerous, including: systems were overlooked, could not be linked to first responder systems, were inaccessible, failed to work, were never installed or no one was trained to operate them. Unfortunately, despite the money spent to build a national response system, most American communities still faces these obstacles.

This white paper describes the problems and solutions for deploying a comprehensive interoperable communications systems appropriately scaled for each community. It identifies the real problems, the critical system components and the optimal solution implementation.

## **WHAT IS COMMUNICATIONS INTEROPERABILITY?**

The first system requirement is to connect a wide range of emergency, public, private, compatible, non-compatible fixed and mobile communication networks. Too often, interoperability discussions focus exclusively on radio voice communication, which is only a part of the information sharing needs of a community facing an emergency. Voice, video and data are all essential to emergency responders, administrators and officials. Responders, administrators, planners and officials must be able to speak with each other and share real-time data, maps, live video and operation plans as their response to the emergency evolves.

The second system requirement is to facilitate quick, efficient access to all the participants. Operators and dispatchers are a critical link in the establishment of communications between the parties that need to share information. During an emergency they are overloaded. Knowing how to make the needed connections and set up the required conferences is not something that should be left to the memory or availability of an operator or dispatcher. Operators and dispatchers must be provided with the information needed to create such connections and conferences.

The third system requirement is to assist the general public in terms of the provision of critical health, safety and survival information. There is often a need to communicate with the public long after the first responder's job has been completed. Communications is an ongoing and integral component of daily life. As a result of many emergencies, local communication



systems may be down for days or weeks after the emergency is otherwise over. That calls for the provision of emergency communication support for the public as well as for responders.

## **EXISTING CONDITIONS**

Failure to Anticipate Problems: As noted above, communications interoperability is not a requirement that suddenly arises when a major crisis occurs. Yet we encounter community wide amazement when various response components are unable to communicate, even though their ability to communicate prior to the event had never been addressed.

Operability precedes Interoperability: Obviously, the police need to communicate with the police, firemen need to communicate with other firemen, healthcare people need to communicate with other healthcare people and so on. In some emergencies, operability breaks down. Repeaters are bombed, blown down or floods make radio systems inoperative, ending operability. Any plan for emergency communications must include means for reestablishing operability quickly and fully. Transportable, high capacity communication facilities should be strategically placed to be delivered to major emergency sites within a few hours. Before interoperability can take place there must be basic operability. The right interoperability approach will provide for this eventuality. To the extent the authors have been able to determine, no consideration has been given to this important issue when specifying interoperability equipment.

Significant Capacity is Required: Most interoperability installations to date are limited to a few voice only radio channels. Typically, that means a maximum of less than a dozen two-party conversations can be active at any one time and also means there can be a maximum of 2 or 3 simultaneous conferences. Such limitations make these systems woefully inadequate for any serious emergency. During an emergency, communication requirements increase, not decrease.

Dispatcher Console: One of the weak links in existing systems is the dispatcher console. As noted above, how does the dispatcher know which communication device a particular person is using? Currently, searching for someone takes precious time. The system should perform this task for the dispatcher. Such technology exists but is not in place.

Technical limitations: A variety of communication systems are used by cities, counties, states, private sector entities and the military. These systems include multiple radio models operating on various radio frequencies using different modulation techniques, voice protocols, control centers, etc.

Systems that operate in the same frequency band yet are not interoperable are a result of using different proprietary radio systems or simply not programming the radios to cover adjacent channels. Due to the fact that most agencies have their own budgets and requirements, there is a high likelihood that the number of systems involved within any political boundary will grow and make interoperability more complex. When systems growth is coupled with the fact that during emergencies, neighboring responders, federal, state and military personnel may come to help, bringing their own equipment, incompatibilities are likely to grow. The dream of all agencies using the same radios is not likely to come true for many years, if ever. The equipment is very costly as is the re-training.

Beyond the issues of practicality, time to deployment and cost, the establishment of a single approach to communications technology would discourage innovation for many years. One thing is certain; change is pervasive in the world of technology. It is much better to accommodate change than to stifle it.

Federal Mandates: According to Government Executive magazine, the federal government, especially the Department of Homeland Security (DHS), can often hinder the planning and implementation of local and regional interoperability solutions. Mandated system requirement changes, available assistance starts and stops, and frequent changes in direction cause federal program support for interoperability to be abandoned or suspended without warning.



## WHAT IS NEEDED?

For emergencies, along with day-to-day activities, response entities need to have a comprehensive approach to operability and interoperability. There are three basic ways to achieve this.

1. All agencies that need to communicate with each other adopt identical radios or communications system, replacing existing equipment as required. As stated previously, this solution is not practical or desirable.
2. A converged network by integrating as many existing communication methods as possible into an intelligent IP network.<sup>1</sup> While this approach has many benefits, there are inherent limitations to using VoIP over radio, including conferencing limitations and vulnerability to Denial of Service attacks.
3. A gateway overlay network facilitates communications and collaboration between different systems, including voice, data and video and VOIP.<sup>2</sup>

After careful study, the authors of this White Paper unanimously agree that the gateway overlay network meets the interoperable emergency communications requirements at all levels in the most economical, efficient and comprehensive manner. Based on this conclusion, the authors propose the following needed system.

Local Emergencies: Local agencies must have a fully operational interoperable communication system adequate to support first responders 24-7 for typical routine operations and local emergencies. The system must also be able to overcome degradation of first responder and public communication systems (Public Switched Telephone Networks, Cellular and Internet) that typically occur during times of crisis due to the increase in usage by both First Responders and the general population.

A locally installed gateway overlay network can provide voice, video and high speed data connectivity among all authorized agencies including law enforcement, fire, public health, the US National Guard and other US military and Reserve units, etc., at a nominal cost without having to replace any existing equipment such as radios or local control centers.

The authors recommend that local interoperability implementations include at least one fixed and one mobile local operating control center, which will provide backup for individual responder systems.

Major Catastrophes: To respond to major catastrophes, transportable communication systems able to reestablish operability and expand interoperability resources should be strategically placed so that they can be delivered to any emergency site within a few hours. These systems should be able to provide communication services for up to 35 miles in any direction (70 mile diameter). Multiple deployments could expand the area or increase the available resources.

These transportable gateway network communication systems could then:

- Interface with and if necessary, control the local interoperability center(s)
- Re-establish first responder communication operability
- Establish voice, video and data interoperability among responder systems

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<sup>1</sup> A converged network is based on translating all data, voice and other traffic to the Internet Protocol (IP) and handling the switching, distribution, and conferencing through computer management with optional operator interface.

<sup>2</sup> Gateway Networks use locally operated network switches to connect disparate radio systems and can also connect these systems to no-radio systems such as the Public Switched Telephone Network (PSTN) and the Internet.



- Provide cellular telephone, high-speed data and video service to a defined group of users in the coverage area.
- Provide emergency radio and television services for the responders and the public.

With rare exception, such requirements are not met by the existing installations.

The less expensive gateway overlay network approach can provide an economical City-by-City, County-by-County and State-by-State solution, which can be adopted nationally, in both the public and private sectors. An example of a gateway overlay network for voice, data, and video that creates such a platform is described on a web site at <http://www.ShipCom.com/SNP>.

### **ADDING CAPACITY TO COMMUNICATIONS**

In addition to integrating an appropriate interoperability solution in each community, there are some approaches and techniques that will maximize the effectiveness of existing communication systems, which for the most part have been overlooked. During an emergency, and in its aftermath, it is important to use every available communication resource efficiently.

The local Cellular Telephone system is generally the first to fail, followed soon by the Public Switched Telephone Network (PSTN). Because of the emergency responders' requirements, and the natural desire of the general public to communicate with friends and relatives, public communication systems such as the telephone and cellular telephone services quickly become overloaded. These systems are not designed to handle the huge increase in traffic occasioned by a major emergency.

The solution for this condition is to create a priority system so that emergency responders will have access to all communication systems and not be blocked by general public callers. The priority system will not limit the capacity of these services to serve the general public except to the extent a priority is given to emergency responders, government officials and other priority personnel such as the healthcare community.

There are many other communication resources that are often overlooked for inclusion in emergency situations and solutions. The adoption of transportable and redundant solutions, such as the gateway systems described herein, make it economically possible to equip these platforms with interfaces which can be used to fill communication gaps during large-scale disasters when much of the communications infrastructure has been rendered inoperable. Such platforms include:

- **Multichannel Multipoint Distribution Systems (MMDS) and Instructional Television Fixed Services (ITFS):** There is a band of frequencies used by MMDS and ITFS operators in cities across the United States that deliver up to 31 TV channels of service to users within a 35 to 50 mile radius. The most recent FCC rules are turning these facilities into high-speed wireless Internet services. These facilities could be of enormous help under emergency conditions.
- **Commercial Radio:** AM and FM radios could be interfaced with the network to provide additional means for disseminating information, and for coordinating the activities of civilian and volunteers assisting in recovery efforts.
- **WI-FI, WiMAX and Other Data Services:** Existing data services could provide important data connectivity among responders, civilian groups, company personnel, etc.
- **Amateur Radio:** Amateur radio offers a large cache of equipment accompanied by operators who are very familiar with communication techniques and technical operation of radio equipment. Many amateurs are members of organizations that conduct regular training in passing message traffic under adverse conditions.

Amateur radio consists of a broad spectrum of communication resources from local area coverage to National or International coverage. The nature of the HF frequencies used by many Amateurs is such that effective and reliable



long-range communications networks can be readily established. VHF and UHF repeater systems can provide connectivity to the PSTN and can provide extended coverage for hand held and portable or mobile radios. In some cases these systems are interlinked to other repeater systems and to other locations via VOIP networks.

Many Amateur Radio systems are capable of sending data in the form of email or text messages.

- **Unlicensed Bands:** Public systems such as Citizens Band (CB), family walkie-talkie radios and private 2-Way business radios have a large installed base.

Most interstate commercial trucks have CB radios used by drivers to communicate amongst themselves while on the road. A base station operating in a disaster area could be used to broadcast important information regarding road closures, and to coordinate the activities of vehicles that may be transporting emergency relief supplies into the affected area.

These and other existing communication systems could be used to obtain information from the field not otherwise available during and in the immediate aftermath of a disaster.

Finally these systems could be used to provide a measure of emergency news and communication services for the public when normal communications systems are inoperative. The range of these systems can be greatly extended by temporarily deploying elevated or airborne antenna sites connected to base stations that are linked into the interoperability system.

Making these auxiliary systems interoperable with first responders may also prove to be beneficial by allowing civilian volunteers to communicate directly with first responder organizations for the purpose of coordinating search and rescue and recovery efforts.

A gateway network could connect these systems to first responder systems as needed in a controlled fashion to produce an orderly, organized, coordinated and widely disseminated communications system.

In short, a well designed emergency communication system should have the capacity to seamlessly integrate any communication system to any other communication system.

## **THE UNDERLYING PROBLEMS**

As noted in the NIJ funded study of 1998 (State and Local Law Enforcement; Wireless Communications and interoperability: A Quantitative Analysis) <sup>8</sup> the most frequent primary underlying impediments to effective implementation of good operability in communications are budgetary and policy related.

With respect to emergency and non-emergency communications, we believe that current, limited approaches to Interoperability are inadequate. A few of the many reasons we believe a more comprehensive approach needs to be taken include:

- The number of communication paths currently planned for interoperability is, in most cases, insufficient for real emergency communications. This problem is often identified as the most severe restriction in many communities.
- Voice communications are necessary but not sufficient – video and high-speed data are also needed.
- Current conferencing facilities are not adequate. Managers and responders need to establish conferences on the fly. Some proposed systems cannot support more than two or three people in a conference. Some cannot support more than one or two conferences at a time.



- Responders need the ability to easily and fluidly share information, voice data and video. That is not possible with most deployed systems.
- Dispatchers need to know how to connect people that need to share information. Overworked and overloaded dispatchers can bring down the system. Multiple operators with comprehensive directories linking people to systems, places and cross references such as police car number, fire truck number, radio frequency, telephone number, location, etc., are required for smooth operation in an emergency.
- Maps, traffic conditions, video, electronic white boards and data exchange need to be supported for real-time communications.
- The nature of an emergency changes during the life of the event. Therefore, the emergency communication system must be responsive and re-configurable to meet the changing nature of the emergency.
- When communication systems go down, they may be out of order for days and perhaps weeks following an emergency. The emergency response system will need to provide backup systems that will continue a measure of service to the community through Public Call Stations or other communication facilities shared with the public once the immediate emergency is under control.

In addition to the above there is another non-technical approach to interoperability that needs to be addressed. When all the technical barriers are removed there is the problem of basic human communications. Unless all agencies adopt a common or plain language to communicate the radios will work, but some participants may not understand what is being said. Certainly code based radio discipline (e.g. code such as the 10 codes) is an example of the potential for lack of understanding by non-departmental personnel. Many agencies use codes that are incompatible and have different meanings for the same code. Even the phonetic alphabets used by different agencies differ. The minor possible loss in security and time savings that occurs by abandoning these codes in favor of plain English is more than offset by the improved comprehension of all network users. The press has reported numerous instances where government agencies have begun to move in this direction.

## **CONCLUSIONS**

Interoperable communications are critical to both public and private sectors. There are many factors affecting interoperability, including technical challenges with current solutions and non-technical issues such as politics/politicians, inadequate funding, poor leadership and spectrum allocation. It is critical that any selected interoperability solution be flexible and modular to incorporate new technologies as well as guaranteeing investment protection. The post 9/11 environment requires emergency response agencies to seek interoperability solutions that support strategic future needs for integration.

The gateway overlay network approach best addresses all the Interoperability requirements. It is cost effective, completely scalable and can be rapidly deployed and/or expanded. In addition, no changes to existing field equipment are required and only nominal changes to training and procedures are needed. Best of all, it is the natural, seamless way to integrate current and future emergency communications networks with the Internet, the local telephone company, cellular systems and other communications systems.



*Referenced documents.*

(A) **Dotty Communications**

DHS muddles federal, state and local information sharing, critics say. *By David Perera*

**Government Executive Magazine.** See: <http://www.govexec.com/features/0906-01/0906-01nal.htm>

(B) National Institute of Justice Research Report -- State and Local Law Enforcement; Wireless Communications and interoperability: A Quantitative Analysis (See summary below). See: <http://www.ncjrs.org/pdffiles1/168961.pdf>

**Radio Communications Systems Compatibility (Interoperability) Study**

In 1998, NLECTC Rocky Mountain completed a study to quantify current and planned telecommunications infrastructure, interoperability requirements, interoperability shortfalls, and the knowledge level of state and local law enforcement agencies regarding interoperability technologies and issues. The study goes beyond technological issues to address current policies and procedures, which affect interoperability. It examines existing regulatory issues, which may limit or prevent a cost effective solution to the interoperability problem. It defines how state and local law enforcement currently uses commercial services such as cellular and paging. How commercial services can further enhance and support future interoperability requirements as digital radio technology matures is also explored.

(C) A story about cities abandoning 10-4 radio codes was carried by AP Wire on November 18, 2006, and published in many places, including South Carolina's "The State". Also see: <http://www.thestate.com/mld/state/news/nation/16045465.htm>.

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*The Authors:*

1. *Robert S. Black is widely known for his pioneering work in communications, information and management technologies. He is the inventor and patent owner of more than 150 issued US and International patents. His inventions are licensed to most of the major consumer electronic manufacturers and have influenced entertainment, sports and information and education services worldwide. Black currently has multiple patents pending, including applications relating to interoperability of non-compatible radio systems.*
2. *Claude (Mac) E. McCormick, Jr., NCE, has been in the telecommunications industry for 40 years and is Executive Vice President of TEK Consulting, Inc. He is a certified Telecommunications Engineer with the National Association of Radio and Telecommunications Engineers (NARTE) since 1989.*
3. *Rene Stiegler is President of ShipCom LLC, the owner and operator of Maritime Public Coast Stations. Mr. Stiegler has over 40 years experience in the communications industry including paging, cellular, maritime, broadcasting and public safety.*
4. *J. Roger Daugherty has more than 30 years experience as an international consultant in the fields of Telecommunications and Information Systems, and is President of Claviger Corporation, an Internet Application Services Provider.*

