



24 TRIPLETS IN COMMUNICATIONS INTEROPERABILITY

The descriptions, requirements, opinions, and proposed solutions put forth to address communications interoperability can be overwhelming. It is easy to focus on one aspect of this very important issue and lose sight of the overall objective or mistakenly not account for other requirements that can compromise the proposed solution. This paper lists 24 triplets, three item lists, which divide the issues and requirements into manageable areas of focus. After the discussion of these triplets, a solution is described, again in triplets, which addresses each and every one of the requirements listed.

The events of 9/11, Katrina, and Columbine bring back vivid memories for all. As these events unfolded, the need for fast and effective emergency responses became obvious. Each of these events, and the untold number of events before and after them, invariably brought up discussions concerning communications interoperability or more precisely, the lack of communications interoperability and its impact on the responses. Without a doubt, there is broad consensus that this issue must be addressed and resolved. Unfortunately, discussions about communications interoperability cover a wide number of different aspects that often lead to confusion and indecision. This White Paper divides the subject into a number of categories to help create focus. Each category, in turn, is divided into three subject areas – hence the name “24 Triplets in Communications Interoperability”.

Department of Homeland Security's Description of Interoperability

The Department of Homeland Security, Office of Emergency Communications, part of the National Protection and Programs Directorate, through their SAFECOM Program describes communications interoperability as:

“In general, interoperability refers to the ability of emergency responders to work seamlessly with other systems or products without any special effort. Wireless communications interoperability specifically refers to the ability of emergency response officials to share information via voice and data signals on demand, in real time, when needed, and as authorized. For example, when communications systems are interoperable, police and firefighters responding to a routine incident can talk to each other to coordinate efforts. Communications interoperability also makes it possible for emergency response agencies responding to catastrophic accidents or disasters to work effectively together. Finally, it allows emergency response personnel to maximize resources in planning for major predictable events such as the Super Bowl or an inauguration, or for disaster relief and recovery efforts.”

Furthermore:

“According to a report published in February 2003 by the National Task Force on Interoperability, the emergency response community views the following as the key issues hampering emergency response wireless communications:

- Incompatible and aging communications equipment;
- Limited and fragmented budget cycles and funding;
- Limited and fragmented planning and coordination;
- Limited and fragmented radio spectrum;
- And limited equipment standards.”



Department of Homeland Security's Description of Interoperability *(continuation)*

The above definition is focused on the three primary first responder groups of:

ONE	Police
TWO	Fire
THREE	Emergency Medical Services

And they are applicable to:

ONE	Federal
TWO	State
THREE	Local Agencies

As a practical matter, most of the attention has been given to issues surrounding land mobile radio incompatibility which is a major contributor to the lack of cross-agency interoperability.

A Broader Description of Interoperability

While various departments within DHS have developed a number of outstanding guidelines and standards including the National Response Framework, National Incident Management System guidelines, and the Incident Command System, a broader definition can help to better define the problem, the required participants, and the solutions.

Although police, fire, and EMS are the lynch pins of virtually all emergency responses, other public agencies and private enterprises need to participate as well. The three most obvious groups are:

ONE	Hospitals
TWO	Schools
THREE	Public and Private Places of Mass Gathering

When considering the need for responses to:

ONE	Accidents
TWO	Natural Disasters
THREE	Man-made Disasters

That can occur:

ONE	As isolated local incidents
TWO	Over a wide area
THREE	Involving mass casualties

The complexity and permutations become almost overwhelming. Therefore, an interoperable solution must:

ONE	Involve a variable group of public and private institutions
TWO	Be immediately available to deal with accidents or natural or man-made disasters
THREE	Include the ability to involve varying sizes of geographic areas and the appropriate responders



Common Elements to All Incidents

With this expanded description and the need to address potentially:

- ONE** Any type of anomalous event or incident
- TWO** Anywhere
- THREE** Any time

A few common initiating threads emerge:

- ONE** Awareness of the event must occur. This awareness may originate from:
 - a. A 911 call
 - b. A reported security breach
 - c. Another first responder organization
- TWO** Communications to other interested/affected parties needs to be established
- THREE** Collaboration among the involved parties that results in the initial response that is needed

Once the initial response is underway, there is a need for continuous communications to:

- ONE** Coordinate the actions of all involved parties
- TWO** Inform others with a need and interest in the event and response status
- THREE** Adjust actions and involvement as the situation changes

In any incident, change is constant. Quite often seconds count, time is always the enemy. Current information, both from initial input and from a dissemination standpoint is imperative to insure that the actions are being taken by the right people at the right time (another triplet).

In order to increase effectiveness, information can be passed on by:

- ONE** Second hand descriptions (manual human re-telling)
- TWO** First hand interaction (live comments and responses)
- THREE** Monitoring live action (seeing/hearing what is happening in real-time)

Obviously the third category becomes most effective by eliminating time lags, minimizing misinterpretations, and providing subtle facts and observations that may be inadvertently omitted. For real-time information to disseminate across disparate groups, a real-time always on multimedia interoperable solution needs to exist that has the capability to link communications resources together across the responder agencies within seconds.

More than Radios

Although land mobile radio (“2-way”) voice will always be the anchor of a field response to an emergency incident, other media plays a vital role in all aspects from the initial awareness of an incident through its final resolution. As the interoperability circle expands to accommodate agencies beyond police, fire, and EMS, the plan to use new state-of-the-art first responder digital radio systems is not practical due to cost, operational issues and FCC restrictions.

To accommodate all users and to take advantage of all types of existing (legacy) communications and information systems, a flexible, multiprotocol, multimedia solution is required. This approach, with each user group relying on the communications media and capabilities that they use every day and with which they are proficient in using, will minimize learning curves and help gather and then disseminate all available community-wide information while minimizing loss of translation.



More than Radios *(continuation)*

Multimedia can be divided into three major categories with subcategories in each as follows:

- ONE** Voice Communications
 - a. Radio Systems
 - i. Terrestrial Land Mobile Radio
 - ii. Satellite Radio (mobile and/or fixed)
 - iii. "Nextel" (any cellular network with push-to-talk)
 - b. Wireline PSTN and Cellular Systems
 - c. Intercom and Public Address Systems
- TWO** Video
 - a. Live one way monitoring
 - b. Live interactive, including video conferencing
 - c. Stored historical (minutes to months ago) video files
- THREE** Data
 - a. File sharing (floor plans, maps, procedures, rosters, wav files, etc.)
 - b. Still image/picture transmission
 - c. Interactive Information Exchange (2-way interactive text, ancillary systems generated data, such as monitors, alarms and databases)

Communications Paths/Multi-Agency Involvement

By their very nature, incident responses invariably involve multiple parties and commonly, individuals from multiple organizations or individuals with different response assignments. During the initial awareness phase of an incident, communications typically occur on a one-on-one basis:

- ONE** With the person reporting the occurrence of an incident; for example, a caller to an E911 operator who provides the initial assessment who then...
- TWO** Contacts dispatch personnel who decide on an initial course of action then if necessary...
- THREE** Contacts other dispatch personnel through a established communications path (possibly a VoIP intercom function) to coordinate a response.

Other than the initial reporting of an event, communications are typically required between groups of individuals.

For example:

- ONE** **One-to-Many:** Typified by a dispatcher or field commander instructing a group of individuals
- TWO** **Many-to-One:** Field personnel responding to a dispatcher or field commander
- THREE** **Many-to-Many:** Groups from one organization communicating and coordinating their actions with each other

All of these communication paths and processes must be established with ease and in a timely manner to minimize handoff distortion (verbal re-telling of "facts") that can easily occur when information is repeated. As the situation evolves and different groups become involved in different activities, the required information and the associated forms of communications may also change. These changes must be quickly and easily accommodated to provide for a continuous flow of information.



The Unexpected Should Always be Expected

Although on the surface it may sound counterintuitive, the “plan” is less important than the preparation which is critical to implementing the proper response. General Dwight David Eisenhower once said “In preparing for battle, I have always found that plans are useless, but planning is indispensable”. Unfortunately, initial reports and assessments are often inconsistent at best and quite often in conflict. Rarely does a planned what-if scenario occur or unfold as planned. Seemingly minor incidents can quickly become major emergencies just as often as initial catastrophic speculation can quickly evaporate.

The experience is gained through:

- ONE Planning
- TWO Training
- THREE Field Exercises

Preparation, a word to describe the Triplet above, provides the necessary foundation to allow split-second adaptation to the situation as it unfolds and changes character.

Real-World Constraints

The need for interoperability solutions dates back to the early 1950s when the FCC began to implement spectrum partitioning (different radio bands and eligible radio services). There is no question that the majority is in agreement that the need for inter-agency compatible communications needs to be resolved and implemented. However, a number of major obstacles have impeded progress in resolving this issue.

The three major obstacles are:

- ONE **Cost:** The domestic first responder community has invested billions of dollars in individual systems designed to meet the needs of each group’s daily needs. Although many of these systems maybe considered obsolete by today’s technology standards, they are still functioning and in use. With the present economic situation that has impacted virtually every public and private organization, the wholesale change-out of systems to a common standard is not always practical. Furthermore, a one size fits all approach is simply not effective when one is considering the vastly different user densities, terrain, and basic communications requirements of all potential participants.
- TWO **Synchronized Implementation:** Many proposals have required that all (or most) participants implement a new system at the same time. Budget cycles and constraints, and vastly different priorities has the way of impeding simultaneous adoption.
- THREE **Jurisdictional Integrity:** Many agencies and enterprises must operate within certain legal, political, and historical constraints. Mutual Aid, very commonly used between Fire Departments, is not fully embraced by other agencies. In recent years we all have heard of jurisdictional disputes between different entities.

Meeting the Interoperability Triplet Requirement

With all of the variables previously mentioned, it may seem overwhelming to capture all of the requirements in a simple and straightforward manner. Actually, the solution is easy to explain in the form of another triplet. A communications interoperability system must be:

- ONE Community-wide to encompass public agencies and private enterprises on an as needed case by case basis.
- TWO Able to accommodate a wide variety of multimedia forms of communications that are best suited for each constituent group’s normal activities (no one size fits all approach).
- THREE Scalable at a moment’s notice to change, expand or contract the participation of others based upon the real time circumstances. It needs to have the capability to grow and include multiple communities.



Interoperability Requirements: The Human Side

Technology is rarely the solution to a problem; it is best described as an enabler. Technology that creates interoperability is no exception. During pressure-packed incident responses, the technology that drives the interoperability solution must not interfere with the user's focus on the incident itself. The mark of an elegant solution is its ability to perform sophisticated tasks "under the covers" while never exposing the underlying complexity of the technology. Three characteristics stand out as core requirements for a well designed interoperability solution.

ONE

Simplicity: Any system must be very easy to use and intuitive. During a security breach or disaster response, there is no time to reach for an instruction book or attempt to recall what an instructor said some time ago. The man-made machine interface must be obvious. With employee turnover, shift operations, and hopefully, the rarity of events, complexity will inhibit the actions and success of the participants.

TWO

Flexibility: When the call comes in or the alarm sounds, no one knows what has happened. Incidents are always different. The differences may be subtle or dramatic. The available resources and the required resources may be different. As the event evolves and time passes, new responses involving different resources or strategies may be required. Although we can plan and attempt to foresee scenarios, as Eisenhower implied, the process not the actual plan is the critical ingredient to effectiveness. The unforeseen will be the rule not the exception. The tools cannot inhibit and must provide for real time adaptability.

THREE

Familiarity: In time critical situations, all users must be able to communicate and then collaborate using methods that are second nature to them. Utilizing communications equipment, systems, and protocols that are used every day is the best way to ensure this familiarity. Therefore, from the field personnel's perspective, interoperability needs to be established using their primary communications equipment. Breaking out special equipment and deploying it is not practical on a daily basis, and even if it is available when and where needed, requires time and often causes confusion which can inhibit responses at the most critical time.

The Mutualink Solution

The requirements outlined above represent a formidable challenge. Mutualink has risen to this challenge and has developed and implemented a solution that meets all of the requirements listed above. It is in service in a variety of communities today.

As an IP-based multimedia overlay network, the system is designed to leverage the use of existing radio equipment, including disparate systems, as well as next-generation voice, video and data communication technology on all forms of existing or new IP infrastructure. The patented solution is architected to provide unmatched flexibility, reliability and control. Security and Public Safety agencies using Mutualink have the dual benefit of maintaining full control of their radio, voice, video and data resources, while making them available for interoperable connection with other agencies' systems with the click of a mouse. Interconnection with Mutualink's virtual network is achieved without impacting the operation of existing console and remote control equipment.

Mutualink is an always on, always available interoperability solution that can dynamically bridge communications resources as and when needed. The solution blends IP and traditional radio networking technology with application software designed specifically to solve interoperability problems while delivering a solution affordable to everyone. Mutualink is highly scalable, supporting intra- and interagency interoperability scenarios across multiple disciplines and jurisdictions, and is equally applicable to private enterprises such as hospitals and corporations interested in integrating their security systems among themselves and with public safety agencies. The system is also applicable to, and deployed with, other public agencies and entities such as schools, transits, stadiums, parks, etc.



The Mutualink Solution *(continuation)*

Three characteristics, Controllable, Intuitive, and Affordable, are “THE” triplet that sets the Mutualink system apart from any other solution and forms the basis for meeting all of the other requirements previously described in this paper.

ONE **Controllable Solution:** The “political” barriers to interoperability are resolved through Mutualink’s unique invitation-based solution, allowing users to always maintain control of their respective resources by:

- a. Accepting or rejecting invitations to join incident communications sessions
- b. Dynamically contributing or removing communication assets as the incident requires
- c. Establishing or exiting incident sessions

Furthermore:

- d. Each agency remains in complete control over their communication assets.
- e. There is no single agency or “trusted third party” controlling the system because no centralized switches or servers are required, unlike other interoperability solutions.
- f. Each agency purchases their own controllers; they can then communicate directly with each other as desired over the secure encrypted peer-to-peer network.

Mutualink users conduct dynamically configurable, real-time communications sessions that are easily adapted to the stage, status and requirements of an incident.

TWO **Intuitive Ease of Use:** Mutualink’s user interface is quickly learned and easy to use:

- a. It is icon-driven with Drag & Drop controls to add radios, streaming video or phones to an Incident and it uses plain English naming conventions to enhance rapid communication and understanding.
- b. It also incorporates standard IM text format for messaging which mirrors cell phone and online texting.
- c. It has an uncluttered workspace to create and manage multiple concurrent incidents or multimedia communications groups within an incident.

Because of its utility for day-to-day usage, users readily become familiar with usage protocols so that when a large crisis occurs, they are prepared to use the system and respond quickly.

THREE **Affordable and Flexible:** Mutualink’s affordability allows many diverse organizations to improve emergency response through better incident management and interoperability:

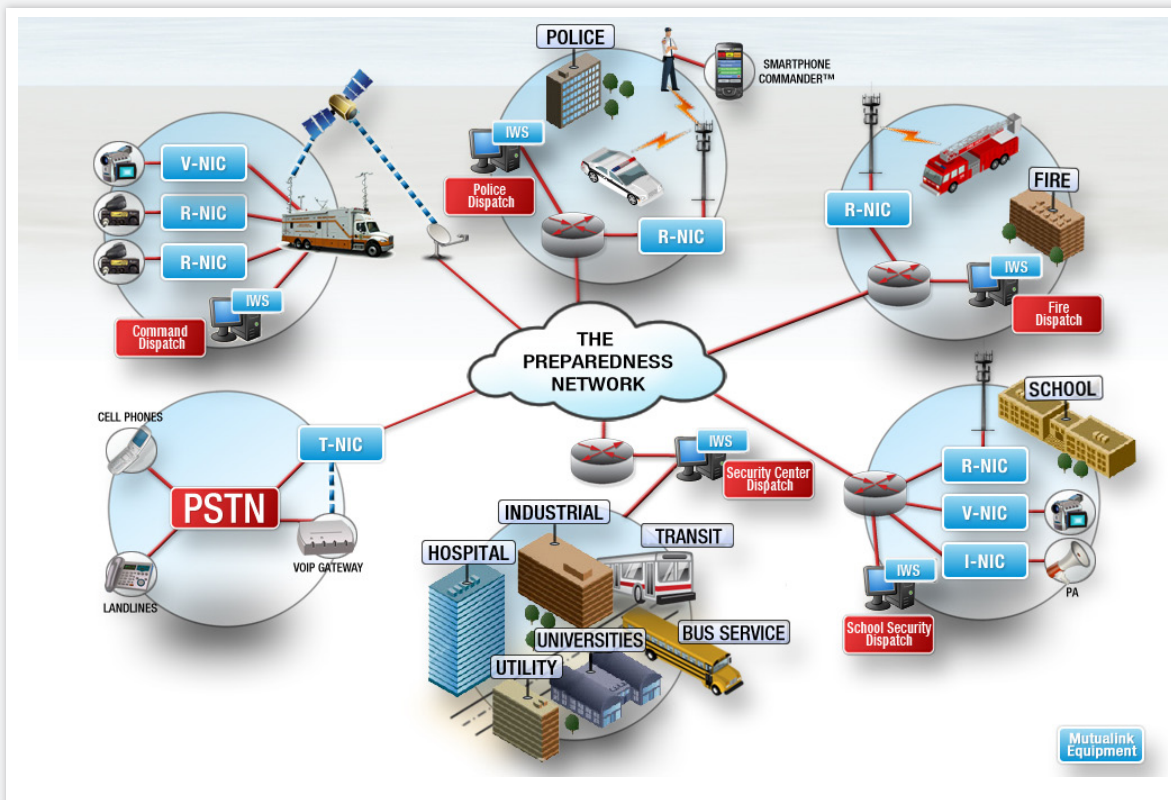
- a. Multiple purchase options are available to eliminate capital barriers
- b. The budget process is shortened with its low cost
- c. The solution is modular allowing for incremental addition of radio, telephone and video controllers which includes an auto-discovery feature that minimizes configuration changes when new facilities are brought into the network.



The Mutualink Solution *(continuation)*

A Mutualink system consists of three major elements:

- ONE** **Interoperability Workstations (IWS):** These devices, available in three different form factors, provides an incident-based highly intuitive graphical user interface (GUI) that can be effectively used by a dispatcher or incident manager or field personnel to communicate with other involved dispatch personnel as well as with units in the field.
- TWO** **Network Interface Controllers (NIC):** Consist of a family of products that provides interfaces to existing radio networks (P25, UHF, VHF, 700MHz, Analog, Digital, etc.), as well as sources of video (cameras, video feeds, streaming video), voice communications (POTS landline, cellular, Nextel, Wi-Fi, VoIP, etc.) and public address systems (including "blue light" systems). The NIC operates in a transparent mode, connecting with the network only when the associated radio channel or other resource such as video is brought into an active incident. The NIC is a highly intelligent interface allowing a simple, effective and low-cost connection to legacy radio systems as well as next generation communications systems.
- THREE** **IP Network Backbone:** The IWS and NIC components, collectively referred to as End Points are connected together through a highly secure, redundant IP wide area virtual network. Communications between the End Points is encrypted and occurs on a peer-to-peer basis. The diagram below shows the many different communication nodes (in blue) connected by a common IP network (called The Preparedness Network). Interoperability between the various nodes is achieved through the Mutualink applications software that converts all communications and information input into IP packets then intelligently and securely routes them to the appropriate destination(s).



“Mutualink Architecture”



The Mutualink Solution *(continuation)*

Mutualink Interoperability Workstation (IWS): More Details

There are three different form factors for the IWS. Any combination, in any number can be used by an agency or any other member of the interoperability network. The three variations are:

- ONE** **Stand-a-lone Desktop PC:** This is the base unit and is most commonly used at dispatch or fixed command locations or larger vehicular command centers.
- TWO** **Laptop PC:** Ruggedized or standard PCs offer the same functionality as the Stand-a-lone Desktop IWS but are designed for field deployment used by on-site commanders or where mobility is required. It can use a variety of wireless communications networks including Wi-Fi, cellular, or satellite links to connect with the core IP backbone.
- THREE** **Smartphone:** The Mutualink Smartphone Commander™ (SC) brings an unmatched level of portability to interoperability control. Based on the Google Android operating system, the SC allows a field user with cellular or Wi-Fi connectivity to actually set up, manage, and participate in ad hoc interoperability networks from their smartphone. Field users equipped with an SC can fully participate in incidents, including monitoring video or streaming live video from their handset back to dispatch or other field personnel while en route to an incident or command center. It thereby can eliminate the time/distance dark spots and provide users with interoperability and mobility at previously unheard of levels.



“Mutualink User Interface: Powerful Capabilities and **EASY** to Use.”

The screenshot displays the Mutualink Interoperability Workstation interface. On the left, a 'New Incident' panel lists various agencies under 'All IWSS' and 'IWS Lists'. The main area is divided into several functional windows: 'School Intruder' with TX and Intercom buttons and a members list; 'School Videofeed' showing a live video of a person in a school hallway; and 'School Layout' showing a floor plan of a high school. A 'Messages' window displays a timeline of events including 'Intruder is in main lobby' and 'swat team on the way'. A 'Shared Files' section is also visible at the bottom.



Real World Example

One example of a Mutualink system that meets all of requirements described in this White Paper is in operation today in New Jersey. This system provides a common multimedia communications overlay system that links several dozen different agencies and entities together allowing each agency/entity to use their existing communications equipment to communicate with each other. The network consists of law enforcement agencies responsible for dozens of communities spread out over eight counties representing a population of five million people as well as Fire and EMS agencies, the Statewide transit agency, various agency's command vehicles, a rescue boat, twenty four hospitals, shopping malls, a sports arena, and schools. Expansion of the system is ongoing with additional facilities representing first responders, critical infrastructure and places of mass gathering being added throughout the State on a regular basis. With such a diverse user base, a program was developed to ensure the system and the associated personnel remain ready and able to respond when needed. The voluntary program involves random roll call tests conducted multiple times each week. During the roll call process, the roll call administrator contacts an agency on its IWS and asks them to participate in a brief training incident. The invitee then brings appropriate NICS that control voice and video resources of field personnel into the mock incident and, optionally, contacts other participant agencies on their IWS who would then add their communications resources of their field personnel to the Incident. If any questions arise during the exercise, the administrator can provide real time, hands-on training to address the issue. NIMS and ICS compliant procedures are used in the roll call process and if operational issues should arise, appropriate follow-on training can be conducted. A typical roll call exercise takes only one to two minutes due to the system's simple and intuitive user interface. By varying the types of actions requested during the roll call process, users become accustomed to responding to a wide variety of scenarios. Finally, the two to three times a week process covering all shifts ensures that new as well as experienced users alike maintain their familiarity with the system. All participants have enthusiastically embraced the system and the roll call process. The underlying Mutualink technology provides the means to communicate but most importantly the users make the system effective and are ready to respond when the need arises through the continuous reinforcement of the system's operation.

Conclusion

Meeting the needs of the extended first responder community is a daunting task. By carefully parsing the requirements into logical subgroups it is possible to formulate, develop, and deploy a highly flexible, affordable and scalable solution. Mutualink has accomplished this difficult task and has proven its viability with actual, diverse field deployments. The triplets presented in this White Paper can serve as a benchmark to determine each community's needs and alternative approaches. Clearly, community-wide involvement with multimedia communications that is flexible and scalable are common threads across the country and are equally applicable when responding to security breaches, accidents, natural or manmade disasters.

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