Achieving Interoperability Within and Among Federal, State and Local Agencies and Private Non-Government Organizations

Introduction

Despite a decade of significant investment and concerted efforts, a pervasive, national interoperable communications solution for emergency response has remained a bridge too far with, at best, small pockets among a few select agencies. Emergency events such as the World Trade Center attacks, the Sandy Hook School shootings, Hurricane Katrina, the Deepwater Horizon oil spill, the Aurora CO movie theater shootings and host of other natural, accidental and man-made incidents exposed and will continue to expose the persistent and prevailing problem of a lack of effective, coordinated communications between first responders and other emergency support and critical infrastructure organizations that are critical to responding to, mitigating and recovering from disasters. Perhaps we have been trying to solve the wrong problem, or at least we have been trying to solve it the wrong way.

For years, the nation has wrestled with the interoperability issue. The desired end state has been codified through the 2015 Department of Homeland Security (DHS) Interoperable Communications Act[1] (and others) setting the requirement of interoperable communications within and among the various DHS components and with the states and locals.

In this paper, we argue that a broad-based national interoperable communications and multimedia collaboration platform can be achieved quickly and affordably through an everything-over-IP (EOIP) sovereign-controlled, peer-based virtual network. This approach leverages existing communications and media infrastructure, as well as next generation broadband efforts including FirstNet, to create an adaptive, resilient, and scalable collaboration framework that achieves ubiquitous capabilities among first responders as well as critical infrastructure entities.

FirstNet and the Promise of an Interoperable Broadband Network

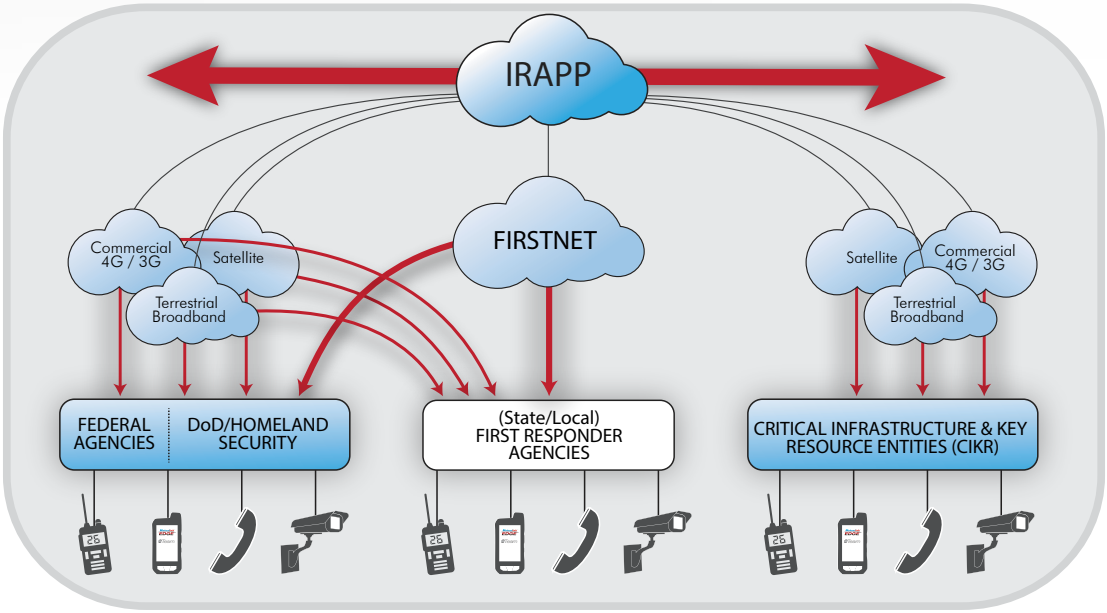
The National Telecommunications & Information Administration (NTIA) introduced FirstNet as follows:

> *"In February 2012, Congress enacted The Middle Class Tax Relief and Job Creation Act, containing landmark provisions to create a much-needed nationwide interoperable broadband network that will help police, firefighters, emergency medical service professionals and other public safety officials stay safe and do their jobs. The law's governing framework for the deployment and operation of this network, which is to be based on single, national network architecture, is the new "First Responder Network Authority" (FirstNet), an independent authority within NTIA. FirstNet will hold the spectrum license for the network, and is charged with taking "all actions necessary" to build, deploy, and operate the network, in consultation with Federal, State, tribal and local public safety entities, and other key stakeholders".*

The FirstNet initiative is a crucial part of an essential national capability that will allocate a "big, fat, fast" pipe to first responders that should eventually enable substantial multimedia communication among first responders as media is developed and adapted for that pipe. However, the opportunity also exists to advocate for, and include, technologies that will more closely align FirstNet with the broad and inclusive universe of national policies (such as Critical Infrastructure and Key Resources (CIKR) and Presidential Policy Directive Eight (PPD8)). Specifically, the FirstNet initiative can be enhanced by ensuring that organizations contemplated in our national policies can cooperatively share communications resources with those who are utilizing FirstNet capabilities. Furthermore, this inclusive approach will accelerate FirstNet adoption and operational use by providing increased opportunities to share multimedia communication not only across the diverse entities envisioned in national policy, but across the myriad networks utilized by the participants, while simultaneously providing a bridge to legacy first responder networks and facilitating a seamless transition to FirstNet. Moreover, this same capability could serve as the overarching FirstNet management mechanism, orchestrating the infinitely complex combination of multimedia communication sessions within and among all the participants.

1 Public Law No: 114-29, https://www.congress.gov/bill/114th-congress/house-bill/615

So, what is this inclusive capability that will so effectively round out and complete the goals and intent of FirstNet and national policy? The Interoperable Response and Preparedness Platform (IRAPP) network enables the disparate types of organizations contemplated throughout the breadth of national policy to securely share their multimedia communication resources with anyone else on the platform, irrespective of location, entity type or network being utilized, creating a ubiquitous national capability. By combining the capability of the IRAPP network with the power of FirstNet and by focusing on the desired end state of national policy for an inclusive, ubiquitous, national capability for all the types of organizations contemplated in those policies, we as a nation can largely put the issue of interoperable communications behind us.



A Brief History of Communications Interoperability for First Responders

The issue of a lack of interoperable public safety communications came to the forefront after the events of September 11, 2001. The 9-11 Commission discovered that a lack of interoperable communications between fire and police was a serious problem that hampered evacuations and contributed to the deaths of personnel after the attacks on the World Trade Center buildings[2].

The Department of Homeland Security (DHS) National Emergency Communications Plan (NECP) defines ''interoperability'' as follows:

> *"The ability of emergency responders to communicate among jurisdictions, disciplines, and levels of government, using a variety of frequency bands, as needed and as authorized..."*[3]

The implicit communications capability within this definition is centered on the Land Mobile Radio Service[4], commonly referred to as LMR or two-way radio. Curiously, this definition focuses solely on governmental agencies and their interaction with each other when most other aspects of national policy are explicitly more inclusive. Further, it does not yet specifically address other forms of communications such as real-time video, sensory information, data exchanges, or file/image transfer.

2 https://govinfo.library.unt.edu/911/report/911Report.pdf 9-11 Commission Report at p.293

3 https://www.dhs.gov/xlibrary/assets/national_emergency_communications_plan.pdf Appendix 8, page A-26

4 https://en.wikipedia.org/wiki/Land_Mobile_Radio_System

Broadly speaking, DHS-based policies recognize and embrace an inclusive notion of interoperability through a broad-based and scalable inter-agency and inter-jurisdictional collaboration approach to emergency preparedness, response and recovery. Specifically, the National Response Framework (NRF)[5] details how all levels of the government, private companies, and non-government organizations (NGOs) need to be involved in the response to natural and man-made disasters, referred to as an "all-hazards, all-discipline" approach as described in the National Response Framework (NRF)[6] (formerly the National Response Plan (NRP)). This notion of broad-based interdependency and collaborative emergency response is also implemented in DHS's National Infrastructure and Protection Plan (NIPP)[7] through its doctrine regarding Critical Infrastructure and Key Resources (CIKR), which categorizes 18 "all discipline sectors", as well as in the National Incident Management System (NIMS)[8]. Mr. Craig Fugate, then Administrator of the Federal Emergency Management Agency (FEMA), in congressional testimony, said "Government can and will continue to serve disaster survivors. However, we fully recognize that a government-centric approach to disaster management will not be enough to meet the challenges posed by a catastrophic incident. That is why we must fully engage our entire societal capacity...."[9]

Over the years, various approaches have been implemented to address the interoperability problem as defined by DHS. Virtually all are in use today. To some degree, these systems address certain aspects of the interoperability problem, but none contemplate an inclusive national capability. These solutions largely ignored the inclusion of other public agencies and private enterprise, following the notion that incident response was the sole responsibility of first responder agencies. Furthermore, their focus was primarily on technology rather than on the underlying problem and the desired end result. In this case, interoperability is not the fundamental goal. Instead, classically defined interoperability is just one of the requirements to meet the national policy goals of inclusive, broad-based communications collaboration to enable all relevant organizations to prepare for, respond to, and recover from incidents in a coordinated and collaborative manner.

Given the articulated national goals, an interoperability solution must address three fundamental areas involving collaboration: 1) who should be involved, 2) how they will be able to communicate and exchange information in order to effectively collaborate and formulate responses, and most importantly, 3) how do you make the universe of potential network members willing to participate in the first place in light of massively diverse legacy infrastructure, limited financial resources, and issues of sovereign control, privacy and differing responsibilities and primary objectives.

In fairness, the problem is massively complex. National policy as described in the NRF, NIPP, PPD8[10], NIMS, etc. (and logic) contemplate close collaboration and coordinated efforts among first responder agencies and critical community partners in preparation for, response to and recovery from emergencies of all types. This concept is encapsulated in the notion of a scalable, all-hazards and all-disciplines approach to emergencies. This type of multi-agency and community partner interaction necessitates a level of connectivity among and between potential incident participants (at federal, state and local levels) and their varied communication assets that calls for a very different approach from those undertaken to date.

The Challenges

Tremendous amounts of communications media infrastructure (radio, video, mobile communications, sensory information, telephony, data files and chat) exist in disconnected silos in both vertical (large hierarchical organizations) and across horizontal (cross-agency, critical infrastructure partners) environments. Usually, agencies - whether they are local, state or federal sovereign government entities or private owners - control their own communications and media assets. Each of these owners is unlikely to (and probably shouldn't) relinquish control over its critical communication resources to other entities. Furthermore, these sovereign owners are not likely to share their information and communications resources in an environment that is not secure. Many valid reasons exist for maintaining control of communication assets that range

5 https://www.fema.gov/pdf/emergency/nrf/nrf-core.pdf
6 https://en.wikipedia.org/wiki/National_Response_Plan
7 https://www.dhs.gov/xlibrary/assets/NIPP_Plan.pdf
8 https://www.fema.gov/pdf/emergency/nims/NIMS_core.pdf
9 Administrator Craig Fugate, Federal Emergency Management Agency, before the United States House Transportation & Infrastructure Committee, Subcommittee on Economic Development, Public Buildings, and Emergency Management at the Rayburn House Office Building, March 30, 2011.
10 https://www.fema.gov/ppd8

from privacy issues, regulatory restrictions and mandates, differing jurisdictional and functional responsibilities, different stakeholders, and political implications, among numerous others. The nature of the subject matter further complicates this mosaic of interests.

Emergencies are unpredictable, and the nature of risk dictates that one does not know with whom one will need to coordinate, where that person is or what form of communications and information will be required to mitigate or manage the issues that arise. Additionally, emergency environments are not static events; new primary, secondary and tertiary effects can rapidly emerge. Therefore, communications are needed with those both in immediate proximity and considerably more remote. The real world exists in an infinite number of intersecting concentric circles with complex inter-dependencies; perhaps our approach to communications should reflect this reality. Additionally, the individuals who are tasked with running these communication systems can themselves be bandwidth challenged, given the increasing complexity of technology they are required to master while facing increasingly tighter budgets.

Traditional approaches to these communication challenges focus mainly on "interoperability" for a small subset of the necessary participants. The problem with the way classic interoperability addresses this complex problem is multifold. Interoperability, defined as one system communicating with another at the system level, is non-scalable in horizontal environments and it certainly does not contemplate the notion of infinite intersecting concentric circles nor the dynamic and unpredictable nature of risk and response. Of equal importance, these solutions are by their nature non-inclusive, only addressing the problems of some traditional first responders or other public sector entities (e.g., P25 radio networks), excluding most of the universe of necessary participants. Other approaches have featured architecture that breaches the sovereignty and/or security requirements of the communication resource owners, or unwittingly transfers liability to partner agencies, all of which doom these approaches to lack of adoption from inception.

From a problem-solving perspective, these interoperability approaches share a common yet faulty presumption; that figuring out with whom you are most likely to communicate can solve the problem. While this may be a logical and practical approach on the surface, it perpetuates the mistakes which lie at the heart of the complexity of the problem. If we were able to predict the nature, scope and collateral effects of any disaster, then there would be no need to respond because they could be predicted and mitigated in advance. The truth is much more complicated; the true scope and risks of any disaster extend in untold numbers of directions as viewed from any number of different but interconnected perspectives. A new approach to this complex problem is needed to begin to solve this issue on a national level once and for all.

A Better Approach - Communication Resource Sharing vs. Interoperability

If classic silo interoperability is not the answer, perhaps a new notion of interoperability that contemplates the critical issues outlined above is the solution. This new notion of interoperability is more about sharing communication resources than it is about getting all of these diverse systems from diverse and geographically dislocated owners to agree en masse to communicate and interact down to the systems and event scenario level. Communication resource sharing allows one entity (or multiple entities) to securely hear, talk with and share information with other entities as required, irrespective of who those entities are, where they physically reside or what forms of media and content they choose to use.

Applications and Capabilities

As noted above, the result of previous, well-intentioned efforts is a mish-mash of unconnected silos (non-intersecting non-concentric circles) of applications. Applications solve only small slices of this overall issue and prevent the required ubiquity. What are needed are efforts to unite these silos and transform them into a national capability. A capability that allows the right information to get to the right people at the right time must necessarily be unlimited in scale to effectively embrace the notion of intersecting concentric circles; similarly, this capability must also allow any combination of participants and communications resource types to come together in an ad hoc fashion to respond to the demands of unpredictability.

View of Nationwide IRAPP

 US Patents #7,643,445, #8,364,153, #8,320,874, #8,811,940, #8,929,851, #9,426,433

Pipes and Media

Simplistically viewed, communications can be viewed in two overall categories - pipes and media: pipes are the transport methodology (including FirstNet as the pipe for the first responder community and the IRAPP as the pipe for the remaining CIKR categories); and media is the content and applications that do or could ride on those pipes. Substantial resources have gone into developing world-class transport networks and media and content of every imaginable stripe. Similar investment is needed to bring that entire universe of media onto those pipes in a secure fashion, in a manner that is respectful of the sovereignty of its owner, so they are willing to share it, at will, among and across the spectrum of relevant participants.

No Middle, No Problem; or Protecting Sovereignty through Architecture

Two of the primary and substantial challenges in making entities willing to participate in multi-agency interoperable environments are respecting the sovereignty of their communication resources and ensuring a secure environment over which those resources may be shared. One way that the sovereignty of control of resources can be assured is through the fundamental architecture of the system that connects them. A classic approach to communication network design is the "hub and spoke". While this can certainly be a fine technical solution, it does not address some of the key human challenges to attaining a multi-agency interoperable communications environment. Principally, it does not respect the sovereignty of the individual participants' own communications assets because one of the entities is hierarchically superior (hub) to the others (spokes). If, in such a system, one were to remove the controlling central hub and place the control and intelligence of the system out at the edge, proximate to each of the owners of the various communication resources, a network of peers would emerge, substantially mitigating concerns regarding control sovereignty. Furthermore, in this peer-to-peer[11] environment, through technology, each communication endpoint device is knowledgeable of all other endpoints and knows how to directly reach them to establish a communications path between them without the aid of an intermediary host server. As for the issue of security, it can be addressed in three categories: platform or operating system (OS); validation of participants; and transport mechanism. An environment having a secure OS, utilizing a dynamic Public Key Infrastructure (PKI)[12] to mutually and securely validate participants, and wrapping the transport in encrypted tunnels would address security concerns of the participants. Taken together, these technical attributes serve as the foundation upon which a large-scale capability can be built.

The Lowest Common Denominator and Enabling Your Media

From a problem-solving perspective, what if, as opposed to trying to figure out who needs to talk to whom and then implementing a series of separate application silos, this problem set was approached from the perspective of the lowest common denominator, with communications media being the lowest common denominator? What if, instead, all this various media were simply enabled from where it is concentrated onto a secure network that respects the sovereignty and security concerns of the owners of the media, resulting in, not a series of discrete applications, but rather a distributed but unified capability? It is suggested that many previously daunting, and perhaps unrelated, communication challenges will fade away if this approach is adopted. Individuals from within complex entities and among unrelated entities making the same decision - to simply enable their media - will solve more problems than they set out to solve.

Make it Easy and Affordable

With the increasing complexity of technology, it becomes more and more incumbent upon the maker of technology to make the user experience as simple and intuitive as possible so that the value of the technology is not lost through cumbersome interfaces. Additionally, as cost is always a consideration and in order to have the participation of all the relevant entities, a solution priced low enough could attain viral attributes.

11 https://en.wikipedia.org/wiki/Peer-to-peer

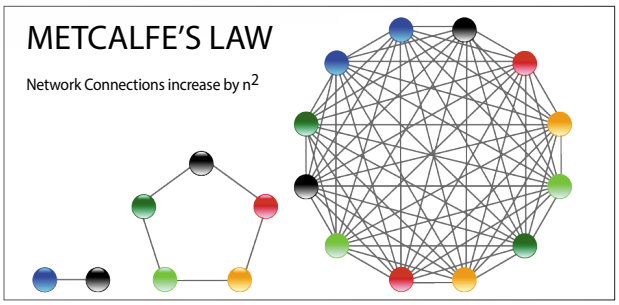
12 https://en.wikipedia.org/wiki/Public_key_infrastructure

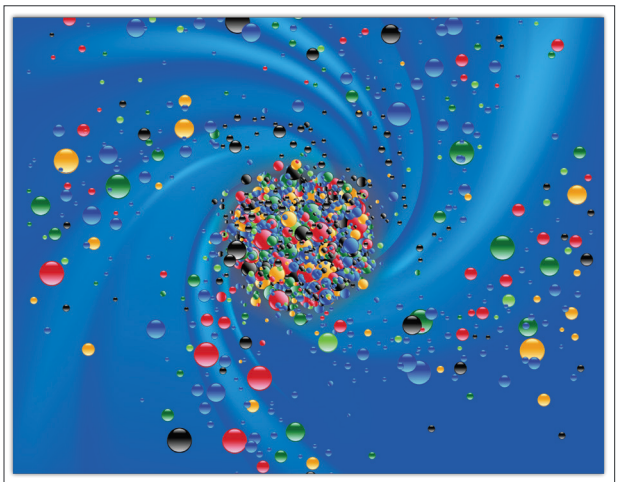
You Mean I Don't Need a Lawyer?

In our peer-to-peer, media-enabled communications environment, there emerges another benefit. In order to engage in an ad hoc multi-agency communications session, someone needs to be invited (or to invite someone). This invitation-and-acceptance mode of operation eliminates the need for traditional Memorandums of Understanding (MoU)[13]. Historically, MoU's have been used between agencies to articulate the circumstances under which these various communication resources can be "tied" together; this is due to the centralized nature of the traditional hierarchical architecture that was used. In our new evolutionary model, the MoU is not necessary because each individual session invitation and acceptance serves as a rolling MoU.

The Emerging Network Factor

As this concept of securely enabled media is adopted, it becomes clear that the old axiom of Metcalfe's law - "the value of a telecommunications network is proportional to the square of the number of connected users of the system" - is also true for the world of interoperable communications. Imagine being presented with this choice; you are the communications coordinator for your county and you wish to unify communications of the towns within your county. You are presented with two options: the first communication system fulfills your initial goal of unifying the communication within your county's government agencies and only your county; the second communication system will provide the same functionality but will also allow secure and sovereign communication with private sector assets within your community, and both public and private sector assets in surrounding communities and beyond. Both are the same price, which would you buy?





Metcalfe's Law defines network growth. Participants gravitate toward an ever-increasing network.

The Fallacy of the Common Operating Picture

The notion of a Common Operating Picture (COP) is most often a fallacy; there are really only operating pictures. Each entity involved in incident resolution has its own unique and important perspective of that incident, so for any incident underway there are many operating pictures. Perhaps there is a COP from any number of intra-departmental perspectives, but there is likely not one from an incident-wide inter-departmental perspective. If the individual agencies involved in the incident enabled the media that is their operating picture, their media, too, could be shared with other incident participants, creating a true COP.

A National Vision for an Interoperable Response & Preparedness Platform (IRAPP)

As was just articulated, the need is known, the policies exist, the participants have been identified, the challenges understood, and the technology now exists to create a national capability that securely unites the communication resources of those charged with protecting life and property from both the public and private sectors onto a national Interoperable Response and Preparedness Platform (IRAPP). The IRAPP's inherent capabilities allow new, existing, and vintage communication systems to share communication resources through a methodology of securing existing terrestrial and wireless IP-based networks. The notion of combining FirstNet and the IRAPP is not merely ethereal. Working in conjunction with FirstNet infrastructure providers, the IRAPP's capabilities have been successfully demonstrated operating on FirstNet, and importantly, securely bridging multi-media communications from FirstNet to other terrestrial and wireless networks.

13 https://en.wikipedia.org/wiki/Memorandum_of_understanding

 US Patents #7,643,445, #8,364,153, #8,320,874, #8,811,940, #8,929,851, #9,426,433

The Federal Government Joins In

Beginning in 2014, the Federal Emergency Management Agency (FEMA) began testing and evaluating this same solution. Initial deployments for FEMA were done at Aberdeen Proving Ground's (APG) Joint On-Demand Interoperability Network (JOIN) in Maryland. Initially the capability was siloed for use only within FEMA. Recently FEMA has opened its silo to communications with the states and locals. FEMA has also started the Authority To Operate (ATO) process to certify the solution for official use on federal networks. Simultaneously FEMA has been coordinating with the Department of Homeland Security (DHS) to transfer the capability to DHS for department-wide use. The utility within the department is multifold: improve communications within components, improve communications among components and improve communications with the states and locals.

Among state and local agencies and private enterprise, the IRAPP network is being embraced on both coasts in several large metropolitan areas, including the States of New York and New Jersey and Northern California's Bay Region, even before FirstNet takes hold. One practical example of interagency, multimedia interoperable communication resource sharing took place in Jersey City, New Jersey during the recovery operations of US Airways Flight 1549, "Miracle on the Hudson"[14] plane crash. Jersey City first responders were able to share live video and voice communications they had previously enabled from their harbor side cameras and their Emergency Operation Center with area hospitals and public safety organizations allowing each to assess the situation and plan their response accordingly. Key to the success of the communications response to this incident was that Jersey City proactively chose, and encouraged others, to join an inclusive system while ensuring it was regularly used and exercised so when the crisis hit there was no hesitation in turning to it.

The momentum for a national secure multimedia communication resource sharing capability is growing throughout the country. The Northern California Regional Intelligence Center sponsors an alliance of agencies and private sector entities that share information and collaborate in real time on a daily basis. In New Jersey, hospitals, casinos, malls, schools, transits, municipalities, etc. and first responders participate in the same always-on, always-ready virtual network referenced in the Miracle on the Hudson incident cited above. There is no longer a reason agencies and key infrastructure in every community in our country cannot seamlessly communicate and collaborate during times of crisis, like they do in New Jersey, the Bay Area, and other regions in the US. National multimedia interoperability and resource sharing can be achieved immediately on the IRAPP network and advanced even further as FirstNet rolls out. The key to this effort starts with community leaders being willing to transform their communities, in a simple yet powerfully effective way. The IRAPP network achieves interoperability without complex and costly large-scale communications projects. Instead, this transformative and incremental approach can be taken to catapult communities forward. Through these many acts of community leadership, a national fabric will be woven into existence solving our nation's emergency communications challenges.

14 https://en.wikipedia.org/wiki/US_Airways_Flight_1549

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