Beyond Radio: Redefining Interoperability to Enhance Public Safety

Abstract

Lack of interoperability in communications is an urgent problem affecting every level of government as well as citizen trust in government. The basic problem is that when different first-responder organizations convene at an incident scene, their radios are incompatible because they operate over different frequencies and use different techniques. The consequences, underscored by recent incidents, are uncoordinated responses and a fragmented chain of command that can hinder the ability to save lives, property, and infrastructure. Communications interoperability is also recognized as a vital element of effective day-to-day public safety services. Incidents ranging from Amber alerts to hurricanes typically require response from multiagency task forces. Members might include government agencies, private assistance groups, and enterprises—all of which typically use incompatible radio systems.

Public safety agencies have tried things like swapping radios, mutual-aid channels, and gateways that bridge two or more radio systems. Although all of these approaches provide some benefit, none completely solves the inherent limitations of radio communications. These limitations include a lack of standards, exclusion of people using devices other than radios, inability to communicate from outside the radio range, and lack of resiliency of the radio infrastructure, such as when towers topple in high winds or fire.

An approach based on IP standards—variously called radio over IP or voice over IP—overcomes these limitations. When radio communications travel over IP networks like any other kind of voice, video, or data traffic, public safety agencies can communicate, collaborate, and coordinate response using any radio system, in any location with a connection to an IP network. Use of IP networks also enables public safety agencies to augment radio with other types of voice traffic as well as video and data, increasing situational awareness by delivering the right information to the right people at the right time and in the right format. The inherent advantages of IP—standards, redundancy and resiliency, and scalability—are especially valuable in public safety environments.

This white paper begins by examining the challenges of communications interoperability for day-to-day operations as well as emergency response. Next it explains how sending radio communications over an IP network addresses the challenges. It concludes with a description of the Cisco® IP Interoperability and Collaboration System (IPICS), in use today by public safety agencies and enterprises to enhance safety.

Challenges of Communications Interoperability—and the Price of its Absence

Immediate Challenge: Radio Interoperability

Today's immediate need is for radio interoperability. First responders from different jurisdictions need the ability to participate in the same talk group so that they can collaborate and better coordinate their response. Even the public is aware of the role that the lack of radio interoperability played in response to recent disasters, and every new failure raises that awareness further.

Government initiatives mitigate the problem somewhat, but not entirely. Regional and state networks are helpful, but if an incident extends or progresses across state lines, the participating agencies cannot all communicate directly: the limits of the radio “island” simply are larger. Similarly, radios based on the new Project 25 (P25) standard mitigate the interoperability problem because they can communicate with older radios using a variety of frequencies and technologies. However, at least one of any two agencies needs P25-compliant radios to communicate, a situation that is not likely to occur for many years because of long funding cycles for radio systems, legislative problems, and long deployment timeframes.

Three reasons underlie this situation:

1. **The radio spectrum is fragmented**. The FCC originally allocated portions of the low end of the frequency range to public safety. As technology improved, the FCC began assigning frequencies in other bands to alleviate congestion. Today, public safety operates in 10 different bands.
2. **Commercial, standards-based technologies have not been available**. Historically, radio systems have been dominated by a few vendors with proprietary technology, and public safety represented a small market. Therefore, public safety could not take advantage of standardized or commercial off-the-shelf technologies, nor did it benefit from innovations in the broader market for communications technology and devices.
3. **Radio equipment has a very long lifecycle, and funding is infrequent**. By the time an agency purchases new radio systems, the new radios often are not compatible with those purchased earlier by neighboring jurisdictions.

Larger Challenge: Interoperability Is About More than Just Radio

In fact, the communications challenge in public safety transcends radio interoperability. Some members of the chain of command inevitably will be outside radio range when an incident occurs. What if they could join the radio channel using cell phones, landline phones, IP phones, or desktop PCs? And what if an incident commander could easily patch in an expert who does not have a radio, such as another country’s expert on a contagious disease or a particular form of contamination? Today these steps require communicating through a dispatcher—a scenario that can delay critical decisions and introduce the possibility of misunderstandings.

Addressing the challenge requires reframing it—from radio interoperability to more general communications interoperability (Figure 1). Situational awareness improves when first responders and commanders can access:

- Video sent from surveillance cameras
- Data sent to and from the mobile data terminals in law enforcement vehicles, which operate over push-to-talk (PTT) networks
- Instant messages sent from computers and handheld personal digital assistants (PDAs) carried by field personnel
- Geographic information systems
- Hazardous materials databases
- Data from earthquake, air quality, and other environmental sensors

The ability to deliver video and data to first responders in real time enhances situational awareness beyond what voice alone can provide. For example, streaming video helps a field commander organize resources commensurate with the threat, such as overwhelming force for a hostage situation or coordinated fire, police, and emergency medical services during a chemical spill or fire.

Today, the different forms of communications vital to decision making in public safety—radio, voice, data, and video—are isolated on their own networks. Ideally, agencies that make an investment in radio or voice interoperability should be able to capitalize on it also for sharing data and streaming video.

Figure 1. Expanding the Definition of Interoperability in Public Safety

Why the Need Has Become Urgent

Increased Interjurisdictional Cooperation

Recent developments have increased the urgency of communications interoperability in public safety. For example, today it is far more likely than ever before that multiple jurisdictions will cooperate in incident response. One reason is the need for intelligent, responsive counterterrorism. Another is the increased attention paid to protecting facility access, critical infrastructure in the public and private sector, and emergency response services. Yet another is society's increasing vulnerability to severe hurricanes and other weather-related disasters.

Interjurisdictional collaboration also applies to day-to-day public safety operations as well as emergency response. Examples include the Olympic Games and other major sporting events, political and diplomatic events, and conventions. Similarly, agencies increasingly expect to collaborate during crimes that span agency jurisdictions, such as car chases, gang crimes, and Amber alerts.

Proliferation of New Communications Technologies

Recently introduced communications technologies also exacerbate interoperability problems. When multiple agencies convene, the mix of communications devices might include:

- Traditional UHF, VHF, 700-MHz, and 800-MHz radios
- PTT radios
- Outdoor wireless radios using new public radio frequency allocations at 2.4 GHz and 4.9 GHz
- New trunking systems, which conserve spectrum and establish a queue to handle demand for voice or data channels
- PTT-over-cellular phones
- PDAs with instant messaging (IM) capability, especially useful for relaying numerical information such as location coordinates

In the absence of an interoperability solution, these different, incompatible communications technologies effectively isolate first responders even as they work side by side.

Limitations of Existing Interoperability Approaches

Public safety agencies have attempted to work around the lack of radio interoperability in the following ways:

- **Swapping gear**—In mutual-aid situations, some agencies equip first responders with multiple voice devices, such as two or three radios and a cell phone. This solution is an effective low-cost one for small events, such as crowd control, but it is ineffective for larger events and disasters. Furthermore, if the radio infrastructure sustains damage, communications cease—and command structures crumble.
- **Mutual-aid channels**—National or regional mutual-aid channels are set aside for use by multiple agencies that are collaborating for incident response. Although useful, mutual-aid channels can be difficult to use because of restrictions and guidelines governing usage. In addition, after first responders set their handsets to the mutual-aid channel, they cannot participate in their own agency's operational channel during the incident.
- **Relaying communication through dispatchers**—If decision makers in different agencies need to communicate through their respective dispatchers, escalating response can take longer. In addition, the inability to directly hear background noise or the urgency in the first responder's voice can compromise situational awareness.
- **Radio interoperability gateways**—These tactical solutions enable personnel using two or more different radio systems to join the same channel. But they do not provide a long-term solution to communications interoperability because they do not support standard phones, they do not enable commanders to monitor situations from outside the radio range, they are costly, and by tying up multiple frequencies they increase the likelihood that someone cannot join a channel, impeding effective response.

IP: A New Approach to Public Safety Interoperability and Collaboration

A technology that solves the challenges of communications interoperability already exists, in Internet Protocol. Radio traffic from existing radio systems can travel over existing IP networks just like any other kind of voice, video, or data traffic. An IP-based interoperability solution enables public safety agencies to continue using their existing radio and communications systems while gaining the inherent benefits of IP networks, which include resiliency, scalability, and management using widely available skills and tools.

Through the use of accepted standards, IP-based interoperability systems protect an agency's existing and future investments in equipment. Agencies can continue using their existing PTT radio systems and freely add new radios and IP phones that coexist with existing radios from any vendor. The standards-based approach also reduces the costs of acquiring technology, an advantage that has largely eluded public safety agencies because of their reliance on proprietary radio systems. Agencies that use the IP network for radio communications are free to purchase whatever radio and voice system best meets their needs because any system can communicate with any other over an IP network.

Following are the major advantages of IP for solving the challenges of communications interoperability.

- **IP supports new communications devices and technologies in addition to radios**—Radios do not talk to radios; rather, people communicate with people. With IP standards-based technologies, people can communicate with other people regardless of the type of device or communications technology they are using. IP enables PTT everywhere, using radios, cell phones, IP phones, or analog phones. The location of the user becomes far less important, facilitating centralized or distributed command and control. That is, decision makers can monitor talk groups from home or even another country because of the global reach of IP. Furthermore, users can switch from one device to another—from cell phone to radio, for example—as events dictate or as people travel.
- **IP enables flexible command and control and multiagency collaboration**—With existing approaches to radio interoperability, anyone who has been issued a radio—or has seized one—can access channels. It is not possible to dynamically control access as the incident escalates and deescalates. With IP, in contrast, a dispatcher or incident commander can dynamically control all assets from a Web browser, enabling agencies to better support collaborative emergency services and communications. A communications interoperability system based on IP standards enables agencies to preserve their existing command and control and standard operating procedures. They gain more flexibility regarding how, when, and where they will engage in incident response, and how they will communicate with other organizations—irrespective of their location or radio technology.
- **IP enables resilience**—Radio infrastructures are subject to physical failures from fire, earthquake, power outage, and more. So is the public switched telephone network (PSTN). For example, months after Katrina, multiple primary public safety answering points (PSAPs), which relied on PSTN connectivity, were still not operational. "From Katrina, we learned that we cannot rely on any specific infrastructure: PSTN, radio tower, or other," says Kevin Ross of the New York State Emergency Management Office. "We need the option of reconstituting communications from a disaster recovery site that is on a different power grid, with different phone providers."

- **IP scales for any size emergency**—Tactical radio-to-radio interoperability bridges can falter under the high traffic volume of large-scale emergencies. They can also tie up multiple frequencies, potentially preventing first responders and commanders from joining a channel. With an IP-based system for communications interoperability, agencies can use a central, Web-based interface to scale and dynamically extend their span of control.

Cisco IP Interoperability and Collaboration System

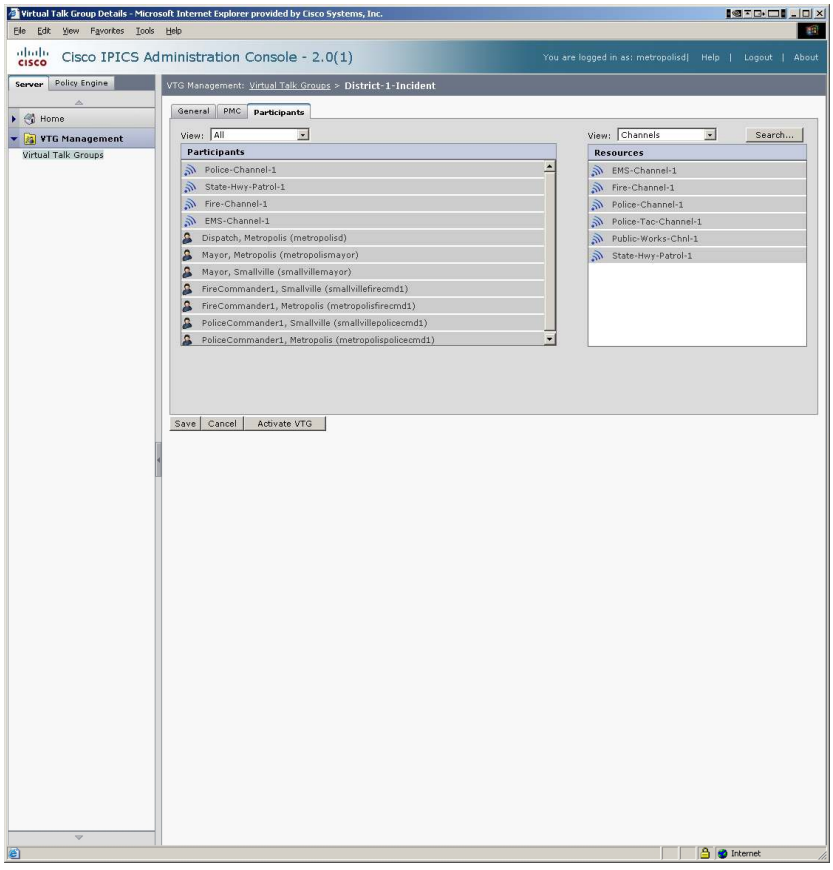
The Cisco IPICS system, already in use in U.S. organizations in the public and private sector, transcends radio interoperability to provide comprehensive communications interoperability. Phase 1, available now, combines radio and voice interoperability, enabling people to join the same talk group using any type of radio as well as cell phones, IP phones, and standard phones.

Whereas other vendors have approached radio interoperability by layering an application on top of the IP network, Cisco IPICS is designed to take full advantage of the inherent attributes of IP, including open standards, availability, redundancy, resiliency, and scalability. Agencies that deploy Cisco IPICS for radio interoperability can use the same IP network infrastructure for other types of voice, video, and data traffic, including IM and sensor information. Integrated IP makes Cisco IPICS a comprehensive platform that is faster and has a longer life than interoperability systems that use IP for transport alone. Because it reflects Cisco's expertise in IP networks, Cisco IPICS provides several distinct advantages.

- **Unifies the chain of command**—By delivering voice when needed, anywhere in the world with a network connection, Cisco IPICS makes it easier to extend, delegate, and escalate across the chain of command. If a riot breaks out, for example, a police chief who is away from the city and outside the coverage area can log in using a cell phone and participate in the event in real time. The Cisco IPICS solution can actually increase the effectiveness of mutual-aid channels by bringing them back from the scene to the IP network and distributing those channels to command and control at the dispatch center. Unlike public safety solutions designed for one layer in the chain of command, Cisco IPICS delivers actionable information to every layer: headquarters, field headquarters, PSAP and emergency operations center, mobile incident command, and field personnel and vehicles. By unifying the entire chain of command, Cisco IPICS enables public safety networking.
- **Provides global reach**—With Cisco IPICS, the physical location of commanders, field resources, and dispatchers becomes less of a concern. For example, an expert on a particular disease can provide real-time guidance to field personnel anywhere in the world from any Internet-connected PC, IP phone, telephone, or mobile cell phone. Public safety agencies with Cisco IPICS can also collaborate with enterprises, which become valuable resources for public safety when they give government agencies permission to use their IP-based resources such as streaming video of a hostage situation or fire, intelligent building management systems, and hazardous materials databases.
- **Speeds decision making**—By enabling people to communicate directly instead of through a dispatcher, Cisco IPICS enables people to more quickly obtain the information they need to make decisions. Members of the chain of command can participate from any location, using any radio system, IP phone, telephone, cell phone, or PC with the appropriate software.

- **Improves flexibility of command and control**—Cisco IPICS enables more flexible command and control for day-to-day operations as well as emergency response. Agencies can apply established memoranda of understanding defining policy and governance, such as controlling how many people can join a channel during normal operations and emergencies. Incident commanders can give permission for participants to talk or require participants to engage in listen-only mode. At emergency scenes, commanders can connect disparate radio and phone systems at any location with IP connectivity. The dispatch center does not have to be in the same location as the equipment. The Cisco IPICS system can reside in any hardened facility: a network operations center, PSAP, emergency operations center, or mobile command vehicle.
- **Increases personnel effectiveness by reducing information overload**—First responders can be overwhelmed by nonpertinent information transmitted over radio channels. Cisco IPICS enables incident commanders to selectively deliver information only to the people who need it, relieving specialized personnel from having to determine which communications are pertinent to their immediate responsibility. The incident command can push information to any individual on the system and can quickly integrate individuals into an incident talk group.
- **Offers ease of use**—Unlike radio interoperability gateways, Cisco IPICS provides an intuitive, Web-based interface that is easy for network administrators to use and maintain (Figure 2). Cisco IPICS features an incident management console that supports distribution of command and control as well as converged incident management communications systems, modalities, devices, and services.

Figure 2. Intuitive Interface Reduces Training Requirements



- Reduces costs—Cisco IPICS takes advantage of the same IP network that the agency already uses for data. By converging its previously separate radio, voice, video, and data networks, the New York State Emergency Management Office reduced recurring costs enough to fully fund a disaster recovery site. The return on investment results from lower labor costs associated with managing and maintaining communications technologies, dispatch, and interoperability systems and from enabling faster, better, and more effective emergency response.

Consider the following scenarios and the improved outcomes that Cisco IPICS makes possible.

Scenario 1: During a highway chase that spans multiple jurisdictions, an officer calls the dispatcher for help because of shots fired.

- **Before**: The dispatcher in one jurisdiction calls the dispatcher in the other and relays the information, creating delays that can affect the outcome.
- **After**: The dispatcher in the second jurisdiction listens in, speeding the decision-making loop. Or, if the jurisdictions have a memorandum of understanding, the officer can communicate directly with the local dispatcher with a radio or cell phone. When multiple agencies converge in one area, they can use multiple communications technologies to reach their own networks and operational teams and stay in touch by a variety of channels.

Scenario 2: The National Center for Missing and Exploited Children arrives at a disaster site to help connect missing people to those looking for them.

- **Before**: The number of volunteer groups searching the area is limited by the number of available radios.
- **After**: More search groups can be dispatched because they can use cell phones to patch into channels.

Scenario 3: A large protest occurs while the police chief is away from the city.

- **Before**: The chief uses a cell phone to call a dispatcher, who relays information between the chief and personnel at the scene.
- **After**: The chief uses a cell phone to patch into the radio environment, increasing situational awareness and decreasing delays.

Scenario 4: In September 2005, the New York State Emergency Management Office was deployed to Camp Smith, in Westchester County, to help process hurricane evacuees from New Orleans.

- **Before**: Communications would have been severely limited for the three or four days the phone company needed to bring in phone lines and T1 lines for Internet connectivity.
- **After**: Using Cisco IPICS, the agency established communications available over an 800-MHz trunking system in just 2.5 hours, using a satellite dish for network connectivity.

Conclusion

Radio interoperability is just one part of the larger goal of communications interoperability, a vital aspect of public safety. IP brings low cost, resiliency, and global reach to the service of communications interoperability, extending the life and value of existing radio systems and giving public safety agencies an important tool for more efficient day-to-day operations as well as disaster preparedness and response.

Cisco IPICS is integrated with the IP network rather than simply using the IP network for transport. This innovation enhances the effectiveness of public safety agencies in emergency response as well as in day-to-day operations by improving availability, redundancy, resiliency, and scalability. In addition, because Cisco IPICS is based on IP standards, agencies can freely acquire new IP-standards-based communications technologies as they become available, positioning the agency to take advantage of future innovations.

For More Information

For more information about Cisco IPICS, visit: http://www.cisco.com/go/ipics.

For more information about Cisco Unified Communications solutions, visit http://www.cisco.com/go/voice.

Americas Headquarters
Cisco Systems, Inc.
170 West Tasman Drive
San Jose, CA 95134-1706
USA
www.cisco.com
Tel: 408 526-4000
800 553-NETS (6387)
Fax: 408 527-0883

Asia Pacific Headquarters
Cisco Systems, Inc.
168 Robinson Road
#28-01 Capital Tower
Singapore 068912
www.cisco.com
Tel: +65 6317 7777
Fax: +65 6317 7799

Europe Headquarters
Cisco Systems International BV
Haarlerbergpark
Haarlerbergweg 13-19
1101 CH Amsterdam
The Netherlands
www-europe.cisco.com
Tel: +31 0 800 020 0791
Fax: +31 0 20 357 1100

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Printed in USA

C11-364833-01 03/07