PSCR

Public Safety Communications Research

U.S. Department of Commerce – Boulder Laboratories

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Public Safety 700-MHz Broadband

Project Description

"There is little doubt that the potential benefits of a nationwide 700 MHz broadband network are enormous — the ability to transmit medical data, to run complex criminal database queries and to download blueprints of a burning building are just a few of the examples noted by public-safety officials."

-Urgent Communications Magazine

SNAPSHOT

Public safety has long struggled with effective cross-agency/jurisdiction communications in the land mobile radio environment, due to stove-piped proprietary systems and non-contiguous spectrum assignments. Congressional legislation has made broadband spectrum cleared by the Digital Television (DTV) transition available to public safety. New public safety broadband communications will allow for a unified system to foster nationwide roaming and interoperability. The Public Safety Communications Research (PSCR) program is deeply involved in the rapidly progressing 700-MHz broadband activities. To help move forward broadband technology for public safety communications, PSCR is building a national public safety broadband demonstration network and providing technical advocacy for the public safety community through requirements gathering and standards development.

BACKGROUND

The Federal Communications Commission (FCC) and Congress have created the public safety 700-MHz broadband spectrum allocations over several years and rulings. This newly freed space opens up an opportunity to establish a unified broadband communications system for public safety agencies with nationwide roaming and interoperability. The FCC is now developing a national broadband plan, which will outline how 700-MHz spectrum activities will move forward. While this is progress, several public safety jurisdictions at the city, county, and state level have already filed waiver requests with the FCC for early deployment of their own 700-MHz broadband networks.

AN INNOVATIVE APPROACH

PSCR is implementing a Public Safety Broadband Demonstration Network to provide manufacturers a location for early deployment and evaluation of their systems in a multi-vendor environment. No government or independent laboratory facilities exist in the United States to test and demonstrate the behaviors of this yet-to-be-deployed first-responder network. The PSCR program's demonstration network will be available to all emergency responders, vendors, carriers, academia, and other pertinent stakeholders to understand through hands-on experience how the broadband systems function and determine how the systems will meet user needs.

PSCR has been active in the following requirements gathering and standards development efforts for 700-MHz broadband since autumn 2006:

- PSCR led the National Public Safety Telecommunications Council's (NPSTC) Broadband Working Group to develop a 700-MHz Broadband Statement of Requirements.
- PSCR led the NPSTC Broadband Task Force Technology Working Group, which addressed interoperability issues, and delivered its report and recommendations in August 2009.
- PSCR is a member of 3GPP, which is developing the standards for the technology (LTE) selected by public safety for 700MHz broadband, to represent public safety and their requirements.

VALUE TO PUBLIC SAFETY

Broadband presents a significant opportunity for public safety communications, and the FCC's new broadband plan will have a large impact on the public safety community. There are as many as 15 million public safety users in the country. The newly available 700-MHz spectrum will let public safety adopt broadband technologies that support high-speed data transmission across long distances creating access to video, mapping, GPS applications, and more. The PSCR program's broadband demonstration network and PSCR participation in the development of requirements and standards will help to ensure that public safety broadband communications purchases are interoperable and meet users' expectations.

Radio Over Wireless Broadband (ROW-B)

Project Description

"I'm eager to see [ROW-B] work and I want the applications…. We're excited about this technology."

-Demetrious Vlassopoulos, deputy fire chief and chief information officer of the Washington, D.C. Fire Department, in *Homeland Security Today*

SNAPSHOT

The Radio Over Wireless Broadband (ROW-B) project successfully integrated radios operating on the District of Columbia's existing Land Mobile Radio (LMR) system with a broadband network, allowing for broadband devices such as computers and cell phones to communicate with radios on the LMR network. This technology enables public sector personnel to have seamless interoperation between broadband and LMR, and have location awareness of users. Not only can emergency responders use this service but it also can be extended to other personnel – such as bus drivers and crossing guards – so that critical information can be easily communicated during an incident.

BACKGROUND

Emergency responders typically use LMR systems that are either hand-held or mounted in vehicles to communicate. These systems provide first responders with critical capabilities (i.e., high reliability, one-to-many communication) often not available from commercial alternatives such as cellular networks. At the same time, responders are increasingly using commercial cellular phone networks as a secondary means of communications and gaining access to other advanced communication capabilities through high-speed, or broadband, wireless connections. As a result, public safety agencies are struggling with interoperability issues between LMR and broadband systems, which were not designed to interoperate.

AN INNOVATIVE APPROACH

Working with industry and the Department of Homeland Security Office for Interoperability and Compatibility, PSCR developed a common method (otherwise known as an implementation profile) to connect LMRs together from multiple manufacturers using the Internet Protocol. This profile, called the Bridging Systems Interface (BSI), leveraged work from PSCR's Voice over Internet Protocol (VoIP) project. PSCR piloted the BSI in August 2008 in Washington, DC. ROW-B demonstrates an innovative method to:

- Address a critical interoperability gap quickly and outside of the formal standards process.
- Provide public safety and other personnel access to a broad set of advanced features, such as Push-To-Talk (PTT) radio calls on wireless broadband mobile devices, which also connect to a LMR radio system and Geographic Information Sharing (GIS) system.

VALUE TO PUBLIC SAFETY

PSCR's ROW-B project demonstrates how:

- Localities nationwide can integrate legacy and emerging, cutting-edge communications systems to provide additional interoperability without having to build out additional expensive LMR infrastructure.
- A single user can reach multiple users through talk groups on the broadband cellular network, reducing the need to place several calls to coordinate a group and saving critical response time.
- Agencies will increase efficiency and effectiveness of response efforts by using real-time location mapping and location-based group calls, enabling emergency responders to access the locations of critical resources—such as equipment and personnel—in real time and to form dynamic talk groups based on proximity.
- The emergency response community can employ innovative technologies to create entirely new methods of communicating.

RESULTS

Interoperability between incompatible LMR and broadband systems has been a long-term goal until now. ROW-B will extend the capabilities of existing public safety communication systems and enable seamless voice communications between LMR and broadband systems. By demonstrating interoperability between broadband technologies and an existing LMR network, PSCR's ROW-B demonstrated how public safety can integrate new technologies with existing emergency response communications systems.

Project 25 Compliance Assessment Program (P25 CAP)

Project Description

"Today there are more digital radios in the P25 marketplace than ever before, and competitive pressures are reducing prices. Meanwhile, more agencies are acquiring two-way radio equipment that complies with the P25 standard. There are more sellers and buyers."

-Urgent Communications

SNAPSHOT

After years of effort, industry is incorporating standards into the radio and communications equipment used by public safety, but until now there was no independent method for purchasers to verify that the equipment is compliant with the standards. Past research indicates that some radios currently sold under the Project 25 (P25) label do not in fact meet all of the standards' requirements. To address this issue, the Public Safety Communications Research (PSCR) program, with the DHS Office for Interoperability and Compatibility (OIC), built a coalition of public safety users and communications equipment manufacturers to create an independent compliance assessment program to recognize laboratories that test equipment for standards compliance.

BACKGROUND

For several decades, public safety agencies have been purchasing and using equipment developed by disparate manufacturers and operating on different spectrum. As a result, this equipment often cannot interoperate, preventing many public safety agencies from communicating when responding to critical incidents that threaten lives and property. Public safety and industry have partnered through P25 on developing standards that allow radios and other components to interoperate regardless of manufacturer—enabling emergency responders to exchange critical communications. The goal of P25 is to specify formal standards for interfaces between the various components of a land mobile radio (LMR) system, commonly used by emergency responders. Until recently, there was no compliance assessment process in place where a laboratory could confirm that equipment, advertised by manufacturers as P25-compliant, adheres to critical components of the P25 suite of standards.

AN INNOVATIVE APPROACH

The P25 Compliance Assessment Program:

- Is a voluntary program that allows P25 equipment suppliers to formally demonstrate their products' compliance with a select group of requirements by testing it in recognized labs.
- Is a cost-effective solution. PSCR is working to recognize existing independent laboratories to conduct equipment testing rather than building a large centralized facility.
- Is a partnership of PSCR, DHS/OIC, the P25 CAP Governing Board, industry, and the public safety community.
- Is an example of government undertaking a minimal investment that catalyzes industry and the community it serves to develop a solution that will affect billions of dollars in purchases.

VALUE TO PUBLIC SAFETY

The P25 CAP will provide the more than 60,000 emergency response agencies nationwide with a consistent and traceable method to gather P25 compliance information on the products they buy. This program, through grant guidance, provides a means of verifying that Federal grant dollars are being invested in standardized solutions and equipment that promote interoperability for the public safety community. The P25 CAP also generates manufacturer competition, resulting in more affordable technologies.

RESULTS

The P25 Compliance Assessment Program:

- Impacts billions of dollars in purchases of public safety equipment to ensure that it improves interoperability.
- Supports the migration from proprietary and stove-piped communications systems to open, standards-based systems.
- Ensures that emergency response technologies effectively meet the needs of practitioners in the field.

Project 25 Standards Development

Project Description

SNAPSHOT

The open standards developed in the Telecommunications Industry Association (TIA) TR-8/Project 25 (P25) define how land mobile radio (LMR) equipment and systems should operate, and more importantly, how key system interface standards that, when implemented, would allow radios and infrastructure from different manufacturers to interoperate. The catalog of competitively offered P25 equipment continues to grow, with broad adoption by public safety organizations in the U.S. and by public safety organizations in over 54 countries. The Public Safety Communications Research (PSCR) program actively participates in the development of these standards in support of practitioner requirements for their use of digital land mobile radios.

BACKGROUND

P25 is a user-driven effort to develop a suite of standards for digital land-mobile radio systems—a critical communications resource for first responders, and these practitioners actively participate in the standards development process alongside the LMR manufacturers. P25 was created in 1989 in order to enable public safety agencies to communicate with each other, regardless of their LMR system manufacturers, and is the only open voluntary consensus standards development group focused on emergency responder digital LMR communications.

AN INNOVATIVE APPROACH

PSCR, on behalf of the Department of Homeland Security Office for Interoperability and Compatibility, has facilitated the accelerated development of P25 standards to meet the increasing user needs for functionally enhanced P25 equipment and systems, and to satisfy Congressional requirements concerning allocation of Federal funding for P25-compliant equipment and systems. PSCR leverages its subject matter engineering expertise to:

- Create draft standards and assist in the development of technical requirements for P25 standards
- Hold various leadership positions in the standards development groups and committees and participate in formal P25 voting activities
- Evaluate technical proposals submitted by manufacturers and conduct relevant testing programs to validate the technical submissions
- Maintain the P25 Document Suite Reference, which provides users, manufacturers, and government agencies a roadmap for charting progress and prioritizing standards development

VALUE TO PUBLIC SAFETY

Standards development for Congressionally mandated interoperability interfaces allows for more vendor solutions being offered to the public safety community. As standards development moves forward, public safety practitioners continue to need objective technical experts that can advocate on their behalf during the technical development of the standards. PSCR ensures that public safety's technical needs are being accurately represented with the vendors and in P25.

RESULTS

PSCR's efforts in P25 standards development have helped accelerate standards publication for key interoperability interfaces, which, in turn, has led to a larger number of vendor solutions offered in the P25 marketplace.

Project 25 Security Tools

Project Description

SNAPSHOT

As public safety adopts emerging technologies for wireless communication, the potential for security vulnerabilities increases just as computer network vulnerabilities have increased with the development of the Internet. To protect public safety communication and information systems, the security implications of new technologies must be broadly understood.

BACKGROUND

Security is an important component of Project 25 (P25), and while many security researchers work with *theoretical* vulnerabilities, on behalf of the Department of Homeland Security Office for Interoperability and Compatibility (DHS/OIC), PSCR is developing *practical* security tools for P25 radio systems. For example, one could read the P25 standards and come to the conclusion that P25 radios are vulnerable to unauthorized inhibit commands. However, until such an attack is attempted, this vulnerability remains purely theoretical.

AN INNOVATIVE APPROACH

PSCR is particularly well equipped to develop practical security tools for radio systems. PSCR is:

- Demonstrating vulnerabilities that have never been implemented in practice
- Working with the Telecommunications Industry Association (TIA) to address security concerns
- Developing tools that can be used by manufacturers, researchers, and users to test the security of their systems
- Developing a P25 Common Air Interface monitor, an essential tool for future security research, and for testing the security of deployed systems

VALUE TO PUBLIC SAFETY

In order to make appropriate deployment decisions, users need complete information about security strengths and weaknesses. The strength of digital radio and P25 is that many security concerns can be mitigated. PSCR, with DHS/OIC, will fulfill several important functions for the public safety community:

- Security Information: Provide a central point for both collection and dissemination of security information.
- Awareness: Promote awareness of P25 security strengths and weaknesses among the standards, manufacturing, and user communities
- Mitigation: Document each known security vulnerability, consider mitigation options for each vulnerability, and document mitigation decisions (even a decision not to mitigate a particular vulnerability) within TIA

RESULTS

Though PSCR's P25 security work is in the early stages, significant progress has been made, including:

- An initial enumeration of wireless communication security needs for public safety is included in the Public Safety Statement of Requirements.
- Considerable work has been done to develop security assessments specifically for P25.
- The SAFECOM Executive Committee and the P25 Steering Committee have been briefed on security concerns and are aware of the needed next steps.
- A growing awareness of security issues is apparent throughout the public safety community, standards development organizations, technology developers, and the public.

ISSI Test Tool (ITT) Development

Project Description

SNAPSHOT

The Inter-RF Subsystem Interface (ISSI) Test Tool (ITT), which is currently under development, will allow public safety users to ensure that systems they purchase will meet their requirements and satisfy the applicable standards developed for the ISSI, a key interface for interoperability. Since these types of test tools are highly specialized, the market for selling them is extremely narrow and limited. Test tools for the ISSI developed by commercial vendors do not currently exist.

BACKGROUND

Because land mobile radio (LMR) systems from some manufacturers use proprietary protocols that are not capable of communicating with another manufacturer's LMR system, the Project 25 (P25) ISSI was developed by the Telecommunications Industry Association (TIA) in conjunction with the P25 Steering Committee. The ISSI enables Radio-Frequency Sub-Systems (RFSS) from different manufacturers to be connected together. However, emergency response organizations that are purchasing radio systems lack tools to help them execute ISSI conformance, performance, and interoperability tests on the systems they purchase. PSCR is developing the open-source ISSI Test Tool to stimulate this testing of P25 LMR systems containing an ISSI interface.

AN INNOVATIVE APPROACH

PSCR, on behalf of the Department of Homeland Security Office for Interoperability and Compatibility, is developing the ITT to test emerging ISSI implementations, but testing wireline-based interfaces—such as the ISSI—poses special challenges, including the need for new test equipment and metrology. Once complete, the tool:

- will emulate a P25 RFSS and exercise the protocol defined in the ISSI standard.
- will implement all of the ISSI conformance test standards being developed. Future incremental enhancements to ITT will enable it to support ISSI performance testing.
- will include a packet capture and visualization tool that will support system analysis and troubleshooting.
- contains architecture that is also capable of supporting conformance and performance testing for other P25 interfaces.

VALUE TO PUBLIC SAFETY

Emergency response agencies can use ITT to verify that that they are receiving a P25 LMR system that contains an ISSI that meets the P25 standards. This will help to ensure interoperability between radio systems that are produced by different manufacturers. When vendor implementations interoperate, customers have choices, which in turn drives down equipment costs. The ISSI Test Tool, in its current version, is available open-source, free of charge.

RESULTS

Both manufacturers and users are excited about the ITT. Vendors see it as a way to help improve the robustness of their implementations, and users see it as a way to ensure that the systems they purchase satisfy their requirements and meet important interoperability-related standards. Several vendors have implemented the ITT in their work environment, and they have provided feedback to help refine the tool.

The P25 ITT project received the Department of Commerce Gold Medal Award for Scientific/Engineering Achievement on November 18, 2008. The Department cited ITT's "exceptional ingenuity and initiative." The Gold Medal is the highest honor given by the Department.

Voice over Internet Protocol (VoIP)

Project Description

"What's most promising about (the VoIP profile) for us is the possibility that we'll be able to quickly share data, in addition to voice, across these different systems. That will be critical for our first responders."

-Boulder County Sheriff's Office Communications Chief Jim Smith

SNAPSHOT

Public safety agencies are investing millions of dollars in devices that allow agencies to patch non-interoperable radio systems together. These are commonly referred to as bridging systems, and many of these systems use Voice over Internet Protocol (VoIP) technology. While IP itself is a formal standard that allows for interoperability, the VoIP technology built on top of that standard is often proprietary and prevents interoperability. Therefore, the Public Safety Communications Research (PSCR) program, on behalf of the Department of Homeland Security Office for Interoperability and Compatibility, is leading a coalition of public safety officials and VoIP vendors in an effort to bypass lengthy and traditional standards processes to ensure that disparate radio systems can interoperate using today's VoIP technologies.

BACKGROUND

The nation's emergency responders traditionally have used two-way radios—known as Land Mobile Radios (LMRs)—to communicate with each other when responding to both day-to-day incidents and large-scale emergencies. Even the most powerful of these radios are often not interoperable with each other because they broadcast in different frequency bands or use proprietary equipment. When responding agencies need to connect radio systems, emergency responders rely on bridging solutions, which increasingly use Voice over Internet Protocol-based connections to transmit voice communications. Although VoIP itself is standards based, there are many aspects of VoIP bridging technologies that remain proprietary. As a result, there is no guarantee that one manufacturer's VoIP-based equipment will successfully interface with another's, even though they may both use standards.

AN INNOVATIVE APPROACH

This project is an example of how the Federal government can act as a catalyst to address an interoperability gap quickly and outside of the formal standards process. PSCR:

- Formed the Public Safety VoIP Working Group, comprised of industry representatives, public safety practitioners, the research community, and other Federal partners to develop common requirements for bridging interoperability.
- Worked with that group to develop common ways to connect bridging systems based on usage scenarios. These common ways to connect are referred to as "profiles."
- Brought together six of the leading VoIP vendors (Cisco, Clarity Communications, Motorola, Sytech, Twisted Pair, and Valcom) in April 2008 to demonstrate interoperability using the profiles developed by the working groups.
- Published "BSI Best Practices" to assist agency technicians and administrators in procuring and operating bridging systems to achieve best results.

VALUE TO PUBLIC SAFETY

Public safety agencies are investing millions of dollars in bridging technologies. The recent $1 billion Federal Public Safety Interoperable Communications Grant Program will be funding the purchase of many VoIP-based bridging systems over the next three years. PSCR's ability to make a VoIP specification available quickly will:

- Reduce costs for system design and installation saving Federal, State, and local dollars.
- Harness the benefits of IP technologies by helping one emergency response agency seamlessly connect its radio system to another agency's system over a network—regardless of manufacturer.

RESULTS

PSCR acted as a catalyst to:

- Coalesce industry and public safety representatives around a technical solution that closes an interoperability gap that would have widened with new Federal grant funding.
- Inform and accelerate industry's development of interoperable public safety products.

Public Safety Audio Quality

Project Description

"Boise Fire Department has identified audio quality and intelligibility issues related to digital communication that compromise firefighter safety... Until there is sufficient improvement to audio quality and intelligibility with digital radio communication Boise Fire Department will utilize analog radio communication."

-Boise Fire Department Captain Paul Roberts

SNAPSHOT

When a firefighter's life is in danger, the ability to communicate a call for help and to warn others is essential. However, some background noises created by firefighting equipment, such as chainsaws and personal alert safety systems, can interfere with digital communication. Sometimes this interference is so severe that it can prevent a firefighter and the person talking with them from understanding each other at the most critical moments. To understand how background noise affects voice communications and to determine what technology improvements are needed to overcome any background noise issues, the Public Safety Communications Research (PSCR) program, on behalf of the Department of Homeland Security Office for Interoperability and Compatibility, has worked with practitioners to develop and implement tests that measure how digital radios operate in the presence of loud background noise.

BACKGROUND

The voice coder or vocoder is a hardware/software component in every digital radio, which uses a speech analyzer to convert voice into a digital signal and from a digital signal back to audio. While many emergency response agencies are using digital radio systems with success, field reports indicate that during light to moderate background noise, the digital radio system may distort voice communications. In loud background noise scenarios, the digital radio system may make voice communications completely unintelligible—potentially compromising mission-critical operations.

AN INNOVATIVE APPROACH

PSCR designs and conducts subjective listening experiments that enabled definition of performance parameters and associated values. Disseminating this information ensures that voice implementations by manufacturers will meet the operational needs of public safety officials, PSCR:

- Partnered with practitioners from various agencies to conduct numerous tests with three different communications systems in nine different noise environments.
- Tested each radio system/communications technology within each noise environment by requiring listeners to distinguish words spoken over the background noise of chainsaws, hose sprays, alarms, and other fireground sounds.
- Identified immediate behavioral, procedural, and technical steps agencies can take to avoid or minimize emergency response background noise.
- Spearheads a Telecommunications Industry Association (TIA) working group in order to affect change to industry standards. The working group is currently one of the organization's largest, with more than 100 participants.

VALUE TO PUBLIC SAFETY

Audio voice communications are essential to the success of emergency response operations. PSCR:

- Works with practitioners to identify the causes of and potential solutions for this critical communications problem found in digital radios.
- Defines, quantifies, and articulates public safety's audio requirements so that manufacturers can redesign systems to remedy this problem. PSCR serves as a technical advocate to represent the needs of public safety to the standards committees to ensure that newly-developed technologies improve the quality of audio communications rather than impair it.

RESULTS

A technical report was published in June 2008 describing the testing and results. The report, which is available at www.its.bldrdoc.gov/pub/ntia-rpt/08-453/:

- Notes that in some environments analog radios performed better than digital radios.
- Explains that in some environments no radios performed well.
- Is supplemented by a July 2008 report from the International Association of Fire Chiefs, which recommends operational changes for fire agencies using digital radios. The IAFC report is available at www.iafc.org.

Public Safety Video Quality

Project Description

"Video is becoming an increasingly important tool for public safety. Responders can wear cameras to provide incident commanders with situation information in a burning building while looking for victims or during a SWAT raid. Aerial videography can aid decisions for deploying personnel by providing a bird's eye view of a wildfire or the pursuit of a suspect on foot or in a car. Video remote controlled robots can dismantle bombs."

-Evidence Magazine

SNAPSHOT

Anyone who has seen video action break up or block out while watching a live televised sporting event knows the frustration of missing a key play because of a poor picture. For public safety practitioners using incident video services, however, a clear picture could mean the difference between life and death. Currently, manufacturers are setting the agenda as to what public safety can and can't have with regard to video capability. The Public Safety Communications Research (PSCR) program, on behalf of the Department of Homeland Security Office for Interoperability and Compatibility, is helping to develop quality requirements for public safety video applications.

BACKGROUND

Public safety's forays into video deployment continue to be fractured. A lack of coordinated information causes agencies to implement one-off or stove-pipe systems. Additionally, the use of video by public safety agencies is wide and varied. Despite these different approaches, video is often used in tasks that require the same elements, including:

- Definitions
- Procedural standards and best practices
- Quality measurement method standards and guidelines
- Subjective test design
- Standards for measurement results reporting

AN INNOVATIVE APPROACH

Alongside the public safety practitioner community, PSCR:

- Designed and conducted subjective viewing experiments that enable definition of performance parameters, ensuring video implementations by manufacturers will meet the operational needs of public safety.
- Filled a void in the public safety community by developing this subjective testing methodology. PSCR's work has now been incorporated into International Telecommunication Union (ITU) standards.
- Formed the Public Safety Video Users Group (PSVUG) to coordinate efforts between organizations and agencies that are developing standards for their own use of video, to minimize duplication of effort. In February 2010, PSCR hosted its second Video Quality in Public Safety (VQiPS) conference to gather stakeholders in support of this goal.

VALUE TO PUBLIC SAFETY

Video has been used by public safety organizations for years; it is not new. But as public safety agencies migrate to more powerful broadband systems, the use of video will undoubtedly increase. PSCR has become the bridge between diverse agencies with potentially duplicative or competing efforts to define and deploy video systems. Currently, vendors tell public safety agencies what they need in order to support video, rather than vice versa. PSCR is acting as an objective technical resource to ensure manufacturers are driven by public safety's requirements.

RESULTS

By working with practitioners, PSCR defined video requirements, liberating public safety from manufacturers' claims of "good enough" systems and equipment. These requirements are published in the Statement of Requirements (SoR) for public safety communications interoperability, which is available on the SAFECOM website (www.safecomprogram.gov).