



# Local and Regional Interoperability Solutions Map



### MULTIPLE SUBSCRIBER UNITS

Carrying multiple subscriber units is one of the most basic methods available to achieve interoperability. This approach is often used when multiple agencies use disparate LMR networks. This solution necessitates that personnel from one agency carry their own subscriber unit and a subscriber unit from another agency. In effect, the use of the other agency's radio allows for communications over that agency's system. Two forms of radio exchange, on-scene distribution or permanent installation, can be implemented on any system. Interoperability is then achieved through talk groups or operational channels, depending on the agreement between the agencies.

### **On-scene Distribution**

On-scene distribution occurs when a host agency receives assistance from another agency. The host agency maintains a cache of radios that operate on its system for rapid distribution to agencies providing assistance on a temporary basis. This method is typically used during incidents or emergencies that necessitate interoperability for short periods of time. Once the incident is resolved, the radios are returned to the host agency.

## Advantages

This solution allows for almost immediate interoperability between agencies with incompatible systems. It does not require the licensing and coordination of new frequencies.

### Disadvantages

This solution requires stringent inventory management to prevent the loss of equipment. Furthermore, guest users may encounter or cause problems if they are unfamiliar with host equipment capabilities or procedures. On-scene distribution may require significant capital costs for equipment purchases and maintenance, depending on the number of radios needed.

Boise, Idaho. The National Incident Radio Support Cache (NIRSC), a division of the National Interagency Fire Center (NIFC), maintains the most portable, low-power communications equipment in one location in the entire Nation, NIRSC handles 1,200 "kits" of communication equipment, ranging from basic public address systems to sophisticated satellite telephone systems, and distributes these kits during large-scale incidents.

Maui County, Hawaii. The County of Maui has an EF Johnson 800 MHz trunked radio system. The county has procured 30 additional radios to distribute to local agencies in the counties of Oahu, Hawaii, and Kauai during interjurisdictional incident responses because these agencies operate on disparate 800 MHz and VHF systems.

Arlington County, Virginia. Arlington County operates an 800 MHz Motorola trunked radio system for police, fire, and local government functions. During the response to the Pentagon attack on September 11, 2001, some secondary responding agencies were unable to communicate with Arlington County officials because of incompatible equipment. As a result, Arlington County officials distributed their limited supply of extra portable radios and requested their system vendor to deliver an additional 150 warehoused radios for distribution to on-scene personnel.

# Permanent Installation

Permanent equipment installation occurs when multiple agencies have a long-term need for interoperability, such as common day-to-day, joint operations. Permanent equipment installation is accomplished when one or more agencies provide subscriber units, on a permanent basis, to another agency. In some cases, an agency may purchase the subscriber units itself and coordinate with the host agency on the communications method to be used on the host system. This solution typically requires an MOU between agencies that establishes the type and use of the equipment being shared.

# Advantages

This solution allows interoperability to be easily established between agencies with incompatible systems. It does not require the licensing and coordination of new frequencies. This solution can provide interoperability without high infrastructure costs. Disadvantages

This solution may require significant capital costs for equipment purchases and maintenance depending on the number of radios needed. Permanent equipment installation of radios also necessitates that agencies carry multiple radios at all times. This method of achieving interoperability may not provide the required geographic coverage because the areas of operation of the host agency and those sharing the system may differ.

New Hampshire—Vermont. The State of Vermont operates a conventional UHF repeater system, while the State of New Hampshire operates a conventional VHF repeater system. To facilitate interoperability, VHF radios were installed in Vermont State Police cruisers to complement their existing UHF radios. The VHF radios were programmed with New Hampshire State Police frequencies to allow interoperable communications between the

Yuma, Arizona. Yuma Police and Fire Departments, along with several other public safety agencies and city departments, operate than do Jefferson and Douglas counties. on an 800 MHz trunked radio system. However, the Yuma County Sheriff's Department operates on a VHF system. To achieve interoperable communications with the Yuma County Sheriff's Department, the City of Yuma is installing VHF radios into some public safety vehicles.

La Push, Washington. The La Push Police Department and the Clallam County Sheriff's Department operate on conventional UHF radio systems. The Clallam County Fire District 5, surrounding fire districts, and the Washington State Patrol operate on VHF frequencies. The La Push Police Department and Clallam County Sheriff's Department have permanently installed VHF radios in their police vehicles to communicate with the surrounding agencies operating on VHF radio systems.

Los Angeles, California. The Los Angeles Police Department (LAPD) operates on a simulcast, digital, UHF radio system, while the Los Angeles Fire Department (LAFD) and EMS operate on an 800 MHz, analog system. The LAFD/EMS has installed UHF radios in all of its vehicles in order to achieve interoperability with the LAPD and other agencies in the city operating in the UHF band.

### SHARED CHANNELS

Public safety agencies can achieve interoperability by using shared channels that are accessible to all the relevant subscriber equipment. Shared channels may include those channels designated by the FCC for mutual aid, channels designated for interoperability through established agreements, or channels shared on an ad hoc basis via talk around.

Mutual-aid channels can be used for interoperability by providing specific, dedicated conventional channels for shared use by public safety agencies. Mutual-aid channels are commonly used when existing networks and subscriber units can access the same spectrum band but are not otherwise interoperable. Typically, agencies use a base station or repeater whose channel is accessible by all intended users and physically located so it provides coverage for the area where interoperability is required. Mutual-aid channels are not usually used for routine operations. Rather, they are reserved for interagency communications during events that require joint responses (e.g., natural disasters, transportation accidents, and acts of terrorism). The FCC and the NTIA have set aside specific mutual-aid channels for public safety use—four tactical channels (VTAC) and one calling channel (VCALL) in the VHF band, three tactical channels (UTAC) and one calling channel (UCALL) in the UHF band, and National Public Safety Planning Advisory Committee (NPSPAC) channels in the

Mutual-aid channels can minimize confusion when multiple agencies respond to an emergency. Respondents only need to switch to the agreed upon mutual-aid channel to communicate with one another. Dispatchers can control and monitor the use of mutual-aid channels and provide support when necessary. Additionally, this solution can quickly provide wide area coverage, depending on the agreement between agencies and infrastructure

To be effective, this solution requires participating agencies to coordinate multijurisdicitonal implementation, which can be difficult. Additionally, for a wide area implementation, agencies may need to secure additional tower, antenna, and equipment space, resulting in increased costs.

Boston, Massachusetts. The Boston Area Police Emergency Radio Network (BAPERN) is a series of 6 mutual-aid channels in the UHF band that serves more than 100 local police agencies in the metropolitan Boston area. The system is used for daily interagency communications, major incidents, multi-agency training, and any other operations that require interagency communications.

Rhode Island. The State of Rhode Island has a number of coordination channels in the VHF band available for mutual aid. The Rhode Island State Public Emergency Response Network (RISPERN) includes a mutual-aid channel in the VHF band for local law enforcement agencies. RISPERN is available to 39 cities and towns throughout the state and to other law enforcement agencies within the state. The Civil Defense State Radio System (CDSTARS), a single-channel system, is used for emergency coordination by 39 communities, state and federal agencies,

California. The California Law Enforcement Mutual Aid Radio System (CLEMARS) is used for on-scene law enforcement communications. CLEMARS includes VHF, UHF, and 800 MHz channels. The Office of Emergency Services (OES) Fire VHF Network is used to coordinate between the 65 Fire Operational Area Mutual Aid Coordinators, and OES's Fire and Rescue Branch's Emergency Operations Center headquarters in Sacramento. It is also used for communications between OES Fire and Rescue headquarters and OES field staff en route to or at all major emergencies.

Missoula County/Mineral County, Montana. There are 14 mutual-aid channels available in Montana. Three are designated for law enforcement, four for EMS, six for fire, and one, termed GOLD, for all-discipline coordination. All are available statewide, with specific use authorized by the state. The GOLD channel was the key communications interoperability resource used by public safety agencies in the counties of Missoula and Mineral to coordinate interjurisdictional response during the largest chlorine spill and longest interstate highway emergency closure in the

Denver, Colorado. Public safety agencies serving Denver County use an analog conventional repeated channel, known as an I-TAC channel, on their 800 MHz system to communicate with all public safety agencies in Jefferson and Douglas counties during nteriurisdictional responses. The I-TAC channel is used because Denver County operates on a different proprietary 800 MHz system

Elgin, Illinois. The City of Elgin operates on an 800 MHz trunked LMR system that supports all fire, police, and public works communications. The City of Elgin is required to maintain a separate VHF radio system because of its membership in the Mutual Aid Box Alarm System (MABAS), Division II. MABAS is an organization of hundreds of fire departments in Illinois and Southern Wisconsin that provides an orderly deployment of equipment to the scene of fires, accidents, or other incidents. To achieve communications interoperability through MABAS, fire departments operate on a statewide VHF fire mutual-aid channel.

### **Established Channel-Sharing Agreements**

Established channel-sharing agreements are a solution for achieving interoperability between agencies operating in the same frequency band. Essentially, these agreements allow agencies to program another agency's frequencies in their radios to communicate on the other agency's system. To implement this solution, participating agencies typically develop an MOU that establishes which agency will donate which frequencies, the scenarios for frequency sharing, and the locations where the

Formal agreements allow agencies to meet frequent, recurring interoperability needs and do not require coordinating and licensing of additional frequencies. This solution does not require additional infrastructure or equipment.

Washington, DC, Metropolitan Area. An overwhelming majority of the Washington, DC, metropolitan area's public safety agencies operate on separate 800 MHz trunked systems. Because there is a significant need for interjurisdictional law enforcement response in the area, an MOU was put in place for radio reprogramming between several counties in northern Virginia; Montgomery County in Maryland; and the District of Columbia. All public safety agencies in these jurisdictions have their radios programmed to carry the other jurisdictions' frequency(s). The agencies can then switch to the common frequencies when they are responding to a iurisdiction other than their own.

Wyoming. The State Forestry Division has established an MOU with the Bureau of Land Management (BLM) for fire response, such as wildland fire operations. The MOU establishes reciprocal channel-sharing agreements between BLM, the State Forestry Division, USDA Forest Service, National Park Service, Bureau of Indian Affairs, U.S. Fish and Wildlife Service, and local fire

New Orleans, Louisiana. The Crescent City Connection Police Department has an MOU for radio reprogramming with the New Orleans Office of Emergency Preparedness, the New Orleans Police Department, and the Port of New Orleans Harbor Police. All of these agencies operate on 800 MHz trunked systems but on different frequencies. The MOU gives each agency permission to program the other agencies' frequencies into its radios for use during incident responses occurring on bridges or docks in New Orleans where jurisdictions overlap.

Atlanta, Georgia, Public safety agencies in the City of Atlanta and Dekalb County operate on separate 800 MHz, trunked systems. Because part of the Atlanta Police Department's (APD) Zone 6 is located in Dekalb County, an agreement was reached between the two regions to share channels. To achieve interoperability, APD officers in Zone 6 have Dekalb County channels programmed into their radios, and Dekalb County police officers have APD channels programmed into their radios.

To accomplish talk around, participating agencies switch to a shared channel, which may be any common channel that is accessible by their subscriber units. Unlike the use of mutual-aid channels, in which the dispatcher is a party to all communications, in talk-around mode the dispatcher does not hear the communications between radios because the communications bypass repeaters and base stations. Because this solution does not use existing infrastructure to broadcast the signal, users must be in close range of one another to communicate. This solution can be used between conventional users or between conventional and trunked users, assuming the individual subscriber units can operate in conventional mode. Each radio must be capable of operating in the same frequency band and be programmed to switch to the specific channel being used for talk around.

This solution can be used when responders are out of the coverage range of base stations or repeaters. It can also be used for on-scene communications between users of any combination of trunked and conventional subscriber units.

A dispatcher does not monitor communications, which limits the amount of information that can be shared with entities away from the incident. This solution only provides for short-range communications and is typically not a viable solution for long-term

Lincoln County, Nebraska. Public safety officials in Lincoln County use talk-around channels to communicate with neighboring Sarpy County during interjurisdictional incident responses. Public safety agencies in both counties operate 800 MHz systems and use talk around to communicate and develop tactical strategies on site. Oak Ridge, Tennessee. The City of Oak Ridge and Knox County operate 800 MHz trunked systems. Talk-around channels are used in Oak Ridge for interjurisdictional incident response between the city and neighboring Knox County public safety agencies.

Charleston, South Carolina. Law enforcement, fire, and EMS agencies in the counties of Charleston and Dorchester operate 800 MHz trunked systems. Talk-around channels are used for tactical purposes and interjurisdictional responses.

frequencies will be used.

Coordination can be difficult if more than two agencies are involved. Implementing this solution may require participating agencies to conduct significant advance work to establish an MOU. The solution also requires programming tools and technicians to be available to reprogram the radios at the time of need. Depending on the number of radios used, the process of reprogramming can require a significant amount of time.

> Local and regional public safety personnel depend on reliable radio communications to save lives and safeguard property. Increasingly, these first responders are from different agencies, often resulting in challenges to effective communications interoperability. Despite these challenges, public safety agencies continue to develop and implement solutions to address interoperability. In various parts of the country, public safety agencies are joining together to implement solutions that address their radio communications challenges. These solutions have connected disparate

INTRODUCTION

systems and, as a result, narrowed the communications gap that can hinder effective incident response. To facilitate a greater understanding and awareness of these solutions, the Public Safety Wireless Network (PSWN) Program, a joint initiative sponsored by the Department of Justice and the Department of the Treasury, has developed

this Local and Regional Interoperability Solutions Map. Although this map is not intended to provide an exhaustive list of solutions in the field, it offers a representative snapshot of the diverse set of interoperability solutions employed by local and regional first responders across the Nation. This map not only illustrates the areas of the country implementing the various solutions identified by the PSWN Program, but also explains appropriate uses of the solutions

# and provides examples of how different agencies with specific communications challenges have used these solutions to improve their own communications interoper-

ability. In turn, public safety agencies in search of the "right" interoperability solution may be able to use the map as a guide to improve their own communications capabilities. The layout of this map was chosen to facilitate ease of use and understanding. The interoperability solutions are grouped together under a broader description according to their primary solution type (i.e., multiple subscriber units,

shared channels, interconnects, and standards-based systems). The symbols (i.e.,  $\bigcirc$ ,  $\bigcirc$ ,  $\bigcirc$ , and  $\bigcirc$ ) on the map indicate where each technical solution is employed. The icons act as visual cues to the relative cost, degree of security, ease of implementation, spectrum efficiency, and coordination requirements associated with each technical solution. The description of these icons is as follows-

Indicates the solution requires purchasing relatively little new equipment or infrastructure

Indicates the solution requires purchasing significant equipment or infrastructure

Indicates the solution may introduce additional security risks into the system

Multiple Subscriber Units

Standards-Based Systems

Shared Channels

Interconnects

operational changes

the existing system

Indicates the solution requires significant labor and time because of its technical complexity

Indicates the solution uses existing spectrum more efficiently

Indicates the solution requires additional spectrum

Indicates the solution requires little or no additional coordination with other agencies

Interoperability between disparate public safety radios systems can be achieved through a variety of interconnects. Basically, an interconnect takes the audio signal from a radio transmission and retransmits it on a different radio channel or system. Interconnects Examples can provide interoperability between systems using different technologies or spectrum bands. Types of interconnects include a variety of patching methods, crossband repeaters, audio switches, and solutions associated with connecting trunking controllers.

A patch is a connection between the console dispatches of disparate systems that can accommodate available audio interfaces. This solution can usually be established through a number of methods, including dedicated leased landlines on the public switched telephone network, an RF link, or fiber optics. There are two primary types of patches—temporary and permanent. To achieve interoperability using a temporary patch, a dispatcher must be available at each participating agency to establish and maintain a radio connection. The dispatcher then uses console electronics to link talk groups or conventional channels as necessary. Once the link has been established, the dispatchers can "hand off" the interoperability link to the users and attend to other dispatching operations. In this case, once interoperable communications have concluded, the dispatcher disconnects the console patch, or link, and resumes normal operations. A permanent patch operates similarly except that the link between the systems remains in place, and no dispatcher action is needed beyond the initial establishment of the patch.

This solution is relatively easy to implement at a minimal cost. Dispatchers can easily establish and remove patches in a variety

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During emergencies, the delay introduced while dispatchers establish a connection with a temporary patch can be undesirable. It requires users to be trained to accommodate patch delays. However, there is no dispatcher delay when using a permanent patch. In cases where conventional and trunked systems are patched, not all of the trunking features are available to the conventional system's users. Unlike the trunked system user, the conventional system user does not receive a notification when a channel has been assigned. Therefore, a patch between a trunked and conventional system may not provide reliable communications. Additionally, when RF links are used, FCC licenses for each system must be modified to detail each agency's additional radio control points. Depending on the design, this solution may necessitate an unencrypted link between radios, thereby reducing

Miami, Florida. The Border Patrol, FBI, U.S. Coast Guard, and Monroe County all operate on separate VHF conventional radio systems in the south Florida region. Miami-Dade County public safety agencies operate on a M/A-Com 800 MHz trunking system, while Broward County operates on a Motorola 800 MHz trunking system. The Florida Department of Law Enforcement (FDLE), Florida Highway Patrol (FHP), and Florida Department of Transportation also operate on a Motorola 800 MHz trunking system. Realizing the need for interoperability, each participating agency established a circuit that connects to the Border Patrol dispatch center at Pembroke Pines, Florida. The INS and FDLE in Miami have a full-time console-to-console link via a leased telephone circuit. The link is used primarily to provide interoperability between INS agents and FHP officers. This interoperability solution has been expanded to include links from INS to the FBI, Metro-Dade County Police Department, Monroe County, Broward County, and the U.S. Coast Guard.

El Paso, Texas. The City of El Paso operates an 800 MHz trunked radio system that serves the city's police, fire, and EMS agencies along with the transit authority. A temporary patch is used to connect selected police talk groups to coordinate movement of sensitive government equipment along a selected route through El Paso, which may last only a few hours.

Las Cruces, New Mexico, and El Paso, Texas. Las Cruces, New Mexico, and the City of El Paso, Texas, operate disparate proprietary systems from different vendors. A fixed-site, wireless talk-group-to-talk-group interoperability link connects the cities. This temporary patching solution establishes interoperability between the two cities and with the agencies that use the cities' trunked radio networks.

Houston, Texas. The City of Houston Police operates on a UHF conventional system while the Harris County Sheriff's Office operates an 800 MHz trunked system. A permanent four-wire leased line is used to establish a permanent patch between the systems. The patch does not require dispatcher intervention for users on the two systems to communicate on a unit-to-unit basis A dispatcher is required only for coordination and to direct specific units to the patched channel or talk group as needed. Los Angeles, California. The California Highway Patrol, Los Angeles County Sheriff's Department, and Los Angeles County

Fire Department operate on different radio frequencies. The

California Highway Patrol operates on a VHF system, while the

Los Angeles County Sheriff's Department operates on a UHF the UHF band in the field to establish communications with Los Angeles Command and Control dispatch and in the VHF band for communications in the field between units. Realizing that the three agencies shared a common microwave site, the agencies concluded that an inexpensive patch could be implemented among the three microwave systems, which would easily tie all three systems together. The patch solution allows a dispatcher to establish a communications link that allows personnel from the participating departments to talk directly to one another instead of having to relay information back and forth through dispatchers.

Salt Lake City, Utah. To achieve interoperability in the Salt Lake City region during the 2002 Winter Olympic Games, connectivity was established between several area dispatch consoles via base station interface module (BIM)-to-BIM patches. The patches connected the Utah Communications Agency Network (UCAN), Salt Lake County Sheriff's Office, and the Department of Justice dispatch centers. Since the conclusion of the Olympics, this solution remains in place.

Daphne, Alabama. Public safety agencies in Daphne and Mobile operate disparate, proprietary, trunked, analog, 800 MHz systems. For mutual-aid purposes, the Daphne Fire Department established a permanent talk-group patch with the Mobile Fire Department's system. Additionally, the Daphne Police has the capability to patch any of its police talk groups to the Mobile Police "PD Main" or to the Mobile County "Mutual Aid" talk group from the

San Diego, California. The Regional Communications System (RCS) in San Diego County is an 800 MHz trunked voice and data system that provides communications for 168 public safety and public service agencies. However, the City of San Diego does not operate on this system and, instead, maintains a separate 800 MHz trunked system. To achieve interoperability between the two entities, the RCS connects to the city system using a common microwave remote transmitter site, which makes RCS resources available to the city. City of San Diego dispatchers can select the RCS resource on their dispatch console and patch any of their talk groups to the RCS. Likewise, RCS dispatchers can patch together any of their talk groups with the City of San Diego system. Clark County, Nevada. Clark County and the Department of Energy (DOE) operate on disparate trunking systems but can interoperate using the State of Nevada's trunking system as a common platform. The Clark County and DOE systems are connected to the state system via BIM-to-BIM patches. By connecting to the state system, Clark County and DOE can not only communicate with one

# the state system and with other local, state, and federal agencies that are connected to the state system.

A crossband repeater allows agencies to achieve interoperability between systems operating in different frequency bands. Essentially, the crossband repeater receives an audio transmission on one agency's channel and rebroadcasts the same audio signal to one or more other agencies on their respective frequencies. Crossband repeating can be achieved through a base station—base station interconnection or a mobile radio-mobile radio interconnection.

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# Advantages

If a single interoperable channel per base station is chosen, this solution requires little or no dispatcher involvement and allows each participating agency to use its own subscriber equipment. Subscriber equipment does not require any special features, and there is no need to switch between frequency bands or modes of operation. The crossband repeater solution typically does not require additional spectrum but it does require that users be licensed on the rebroadcast frequency.

## Disadvantages

To implement this solution across several bands (e.g., VHF to UHF and VHF to 800 MHz) requires several crossband repeaters, which in turn, increase costs. Costs also increase if extra base station equipment is required to interconnect with a repeater system. The solution also requires participants to decide which agency has primary control of interoperability equipment, which can cause difficulties for agencies that want complete control of their infrastructure and channels. Depending on the design, this solution may necessitate an unencrypted link between radios, thereby reducing system security.

Minneapolis-St. Paul, Minnesota. Public safety personnel from Carver County, the City of Minneapolis, Hennepin County, Metro Transit, Minnesota Department of Transportation, and North Memorial Transportation Service in the Minneapolis-St. Paul, Minnesota, metropolitan area share an 800 MHz digital system with the state. Area public safety agencies operating on the VHF and UHF band that are not included in the 800 MHz system can connect to the system via crossband repeaters. The repeaters are

Fort Polk, Louisiana. Fort Polk initially installed a 39-channel, B-site UHF system. Because of heavy usage, Fort Polk decided to install a second system. Due to a lack of available spectrum, the only available channels for the new system were in the VHF band. To provide crossband interoperability, a base station—base station crosshand reneater is used to link the Joint Readiness Training Center's UHF Observer Controller system to agencies operating on the VHF system.

used during interjurisdictional emergency responses.

An audio switch uses digital signal processing to allow radio systems operating on different protocols or frequencies to receive the voice communication transmitted on one system, reconfigure the audio signal, and transmit the communication on the disparate system's channel or protocol. The switch can ture or can be used as a mobile interoperability solution. A switch, but it is typically mounted in transit cases or a mobile scene interoperability and possibly expanded coverage that may

combination of radio systems. It is a versatile option that can be configured guickly to link systems across several frequency bands at any given time. This solution does not require the licensing of

Audio switches can be costly. If more than two agencies are involved, coordination can be difficult. Implementation of this solution requires participating agencies to conduct significant advance work to establish an MOU.

respective agency's fixed wireless infrastructure. The TSPRIU is mounted in transit cases, allowing the system to be easily transin Albuquerque, New Mexico; Denver, Colorado; Phoenix, Arizona; Quantico, Virginia; Salt Lake City, Utah; and San Diego, California. Alexandria, Virginia. To facilitate interoperability between the Alexandria Police Department (APD); Metropolitan Police Department in Washington, DC; the U.S. Park Police; and the Metro Transit Police, an audio switch was installed at the APD. The APD operates an 800 MHz system while the Metropolitar Police Department operates a UHF system and the U.S. Park Police and Metro Transit Police operate VHF systems. At least one repeater connected to the switch is located within each urisdiction to provide coverage throughout that jurisdiction. The system is used to provide interoperability among the

### another, but they can also communicate with all user groups on Norfolk, Virginia. The U.S. Army Corps of Engineers (USACE) has installed an audio switch to achieve interoperability with neighboring public safety agencies. The system is designed to interconnect unencrypted analog voice communications over

military VHF, HF, UHF, SATCOM, cellular telephones, and landline telephones. During emergency operations, the system allows USACE personnel to link to military facilities in the region as well as to local law enforcement and public safety agencies. During emergencies, an operator is stationed at the console and can switch between four VHF radios to monitor those communications channels

### Syracuse, New York. The Syracuse Police Department purchased a transportable audio switch interconnect unit to provide interoperability between the Syracuse Police Department, the Onondaga County Sheriff's Department, the New York State Police, the New York Emergency Management Office, and the city's fire and rescue units. These departments operate on a

variety of frequency bands, including VHF, UHF, and 800 MHz. Central Maryland. Seven audio switches are being deployed at strategic locations across the central area of the state to ease communications interoperability obstacles. The switches will link various local, state, and federal public safety providers operating on multiple frequency bands from the western part of the Eastern Shore to western Frederick County and from Washington, DC, to

Chicago, Illinois. Chicago's Office of Emergency Management and Communications (OEMC) has procured six transportable audio switch interconnect units to connect disparate radio systems. Currently, the Chicago Police Department and Chicago Fire Department's (CFD) Emergency Medical Services operate in the UHF band, while the CFD's Fire Suppression and Rescue personnel operate in the VHF band. To support on-scene interoperable communications, the OEMC has transformed a former CFD ambulance into a mobile communications suite consisting of an audio switch and eight radios from different systems. The unit has successfully connected radio users in the

low bands through 900 MHz cellular telephone users. Lakewood, Colorado. An audio cross-connect switching unit is being installed at the Lakewood Police Department to provide interoperability between local, state, and federal authorities. The system will mainly be used by the Drug Enforcement Administration and local authorities during operations that take place over several jurisdictions.

A networked trunked LMR system is a system that links multiple trunked systems with common proprietary protocols into one wide-area trunked system. This configuration allows for wide-area roaming and multi-agency interoperability among the connected systems, which in turn, allows for operations consolidation among participating agencies. The solution allows the individual trunked systems to maintain separate operations for day-to-day matters while providing the capability for large-scale interoperability

This solution allows operational consolidation and increases system reliability through infrastructure redundancy. It reuses existing infrastructure, radios, and expertise to achieve costeffective, wide-area communication among multiple agencies. private systems, and makes interoperable communications independent of frequency bands. Network management

This solution requires complex network and security managemen and a high level of coordination. It may also require several system and end-user equipment upgrades resulting in a significantly higher cost. This solution depends on proprietary architecture.

*Michigan.* Many organizations within the state have indicated interest in joining the State of Michigan's statewide Motorola OmniLink digital trunked radio system, which currently serves 83 local, state, and federal agencies. An OmniLink switch links multiple SmartZone systems into a single, statewide trunking system. The system allows for seamless interoperability across all levels of government throughout the state.

King County, Washington. King County has implemented a SmartZone mixed-mode analog and digital trunked radio communications system that supports nearly 14,000 users. The countywide network contains three wide-area simulcast subsystems and numerous standalone sites. All sites are connected through the SmartZone switch, allowing communications by all system users over a 2,200 square mile area. In addition, several VHF, UHF, and 800 MHz mutual-aid channels are tied into the audio switching and console systems to allow crossband interoperability throughout the county, as needed.

ndianapolis, Indiana. Sixty-eight counties in the State of Indiana will be able to achieve interoperable communications using a statewide Motorola OmniLink digital, trunked voice system. The system will operate in dual modes, analog and digital, and will enable county and state agencies to use their existing voice radios on the new statewide backbone. An OmniLink switch will be used and symposiums nationwide, and provides comprehensive to manage and link the system's multiple sites into one integrated radio communications system.

Chicago, Illinois. The Illinois State Police have implemented an 800 MHz wide-area, digital, trunked simulcast system. The system provides communications throughout the Chicago metropolitan area, including Cook and DuPage counties. The wide-area system consists of two simulcast subsystems, one to the north of the city and one to the south of the city. Each of the subsystems is composed of three transmit and six receive sites. The two subsystems are networked together via an Integrated

### **STANDARDS-BASED SYSTEMS**

The implementation of standards-based systems for public safety communications can play an important role in achieving interoperability among various wireless networks used by the public safety community. Standards-based systems provide a common, open platform for agencies to communicate.

The P25 standard is a suite of standards for LMR equipment The suite includes digital and analog modulation schemes and protocols, and trunking and conventional architecture guidelines that require equipment to be backward compatible (i.e., operate on both digital and analog systems) and non-proprietary. Ultimately, the standard ensures that all the defined services are accessible to any subscriber unit or system built to the P25 specifications.

# Advantages

P25 systems are backward compatible, which allows for easier system migration to new equipment and permits agencies to easily communicate with other agencies that have not transitioned to digital equipment. This solution is spectrally efficient because it supports narrowbanding from 25 kHz systems to 12.5 kHz systems. This solution also supports wide-area roaming.

### Disadvantages

Currently, a limited number of manufacturers sell P25 infrastructure equipment. Recause this solution would be a new system. that requires new infrastructure and subscriber units, the costs can be significant.

Installing a P25 system ensures compatibility with adjacent jurisdictions that have already implemented P25 systems. A sampling of states and regions that are in the process of or have implemented P25 systems includes *Phoenix and Mesa, Arizona*; Honolulu, Hawaii: Polk County, Florida: Cedar Rapids, Iowa: Kansas City, Missouri; South Dakota; and Forsyth County, North Carolina.

# Voice-Over Internet Protocol (VoIP)

Recent developments in technology have resulted in a possible migration in the LMR industry from the existing circuit-switched architecture to a packet-based architecture using the Internet Protocol (IP). In general, VoIP refers to the method of transporting voice communications via digital packets using an IP backbone. Packet switching allows for increased system capacity and redundancy. Unlike circuit-based networks, which may require consistent use of specific manufacturers' and types of equipment to maintain compatibility, VoIP systems use commercially available off-the-shelf switching equipment and standard software.

## Advantages

IP network infrastructure can provide faster, more efficient, and more secure voice and data communications. Additionally, an IP console is software based and can run on a laptop computer, which could nearly eliminate expensive, bulky, back-room electronics as well as increase system flexibility

Currently, there is no P25 VoIP standard; as a result, users of equipment from different vendors may not consistently talk with each other via IP. Additionally, because public safety has stringent requirements for real-time voice, a separate, private data network is typically required. The net result to date is that the VoIP architectures have not realized their potential for drastically reducing leased line costs. Additionally, the only products

The following locations are implementing 800 MHz VoIP systems:

currently available for VoIP are in the 800 MHz band.

Ohio; Oakland County, Michigan.

ACRONYMS **EMS** Emergency Medical Services **FBI** Federal Bureau of Investigation

**FCC** Federal Communications Commission Immigration and Naturalization Service

LMR Land Mobile Radio

MHz Megahertz **MOU** Memorandum of Understanding NTIA National Telecommunications and

Information Administration **P25** Project 25 (standards suite) **PSWN** Public Safety Wireless Network

**VoIP** Voice-Over Internet Protocol

Radio Frequency **UHF** Ultra High Frequency VHF Very High Frequency

# **ABOUT THE PSWN PROGRAM**

The PSWN Program works in partnership with officials from local, state, federal, and tribal governments to improve wireless interoperability among the Nation's law enforcement, fire, and emergency medical services. The program conducts pilot projects information on wireless interoperability. For additional information and resources, contact the PSWN Program at 1.800.565.PSWN, via e-mail at information@pswn.gov, or visit the Web site at www.pswn.gov. To learn more about technical, policy, and piloted interoperability solutions, please visit www.publicsafetywins.gov. We also invite you to contact us to share your unique interoperability solutions with the program and your fellow first responders.

# Indicates the solution may provide greater security than

Indicates the solution requires basic

Indicates the solution requires additional agreements

communicate by distributing the audio signals from one system or set of radios to another system or set of radios connected to the switch. Depending on the type of switch, the audio switch can be used to connect subscriber units, base stations, or repeaters Audio switches can be a permanent part of a system's infrastrucmobile audio switch operates in the same manner as the fixed communications vehicle. This mobile solution allows for on-the-

# not be available through the fixed infrastructure

An audio switch provides interoperability between almost any

# additional frequencies.

ransportable Public Safety Radio Interoperability Unit (TPSRIU). The TPSRIU uses audio cross-connect switches to link mobile radio units of participating agencies so they can communicate with their ported to the scene of an incident. The systems were implemented



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