Archived Content

Multi-Band Radio Pilot Report

Operational Assessment

December 2012

Homeland Security

Science and Technology

Abbreviations and Acronyms

AES	Advanced Encryption Standard
DES	Data Encryption Standard
DHS	Department of Homeland Security
DoD	Department of Defense
DOJ	Department of Justice
EHF	Extremely High Frequency
EMS	emergency medical services
FRG	First Responders Group
GPS	Global Positioning System
HF	High Frequency
IS	intrinsically safe
kHz	kilohertz
LF	Low Frequency
LMR	Land Mobile Radio
LTE	Long-Term Evolution (a form of "4G" or fourth-generation cellular wireless broadband)
MBR	Multi-Band Radio
MF	Medium Frequency
MHz	megahertz
OFB	output feedback
OIC	Office for Interoperability and Compatibility [of FRG]
OTAR	Over-the-Air Re-Key
P25	Project 25
S&T	Science and Technology Directorate [of DHS]
SHF	Super High Frequency
SOP	standard operating procedure
T&E	test and evaluation
UHF	Ultra High Frequency
VHF	Very High Frequency
VLF	Very Low Frequency

Contents

Figures

Acknowledgments

The Department of Homeland Security (DHS) would like to thank all of the local, state, and Federal agencies that participated in the Multi-Band Radio (MBR) pilot project, especially the lead pilot agencies. Many public-safety agencies were involved in providing the initial requirements necessary for the development of the MBR and provided valuable input throughout the pilot. Without those dedicated public servants, the MBR project would not have been so successful. In addition, manufacturers came to the table with their own resources to make this a true public–private research-and-development effort. In today's economy, manufacturers are cautious about investing in new and emerging technologies that may or may not provide a return on their investment. The capabilities provided by the MBR ensure the safety of our citizens and first responders by providing a tool that bridges known communications gaps.

Without the investment of all parties involved, the MBR would not have come to fruition as a viable alternative to achieve interoperability for public safety as quickly as it has. The following is a list of all lead pilot partners:

- Arizona Emergency Management
- Blaine, WA Police Department / Vancouver Transit Police
- Boise, ID, Fire Department
- Chicago Police Department / Emergency Management
- Hawaii State Civil Defense
- Indianapolis, IN, Fire Department
- Miami/Dade County Public Safety
- Michigan Department of Community Health/EMS and Trauma Systems
- Murray State University
- National Capital Region Public Safety Communications Interoperability Group
- New Orleans, LA, Public Safety
- Phoenix, AZ, Police Department
- U.S. Immigration and Customs Enforcement

Background

Recognizing the Need

For years, interoperable communication was limited to a first responder from one agency calling the dispatcher via radio, who contacted the dispatcher at the other agency via telephone, who then contacted their own agency's responder via radio in order to relay information. This was the only way of communicating even though both radio systems may have operated on the same radio band. The latency in sharing information via this dispatcher-to-dispatcher exchange of information often resulted in delays and, often, in unfavorable consequences. With more than 60,000 first response agencies within the United States, this scenario is all too common.

As illustrated in Figure 1, local and state public-safety agencies generally operate on four primary radio bands: 150–174 megahertz (MHz), 450-470 MHz, 470-512 MHz, 700 MHz, and 800 MHz.

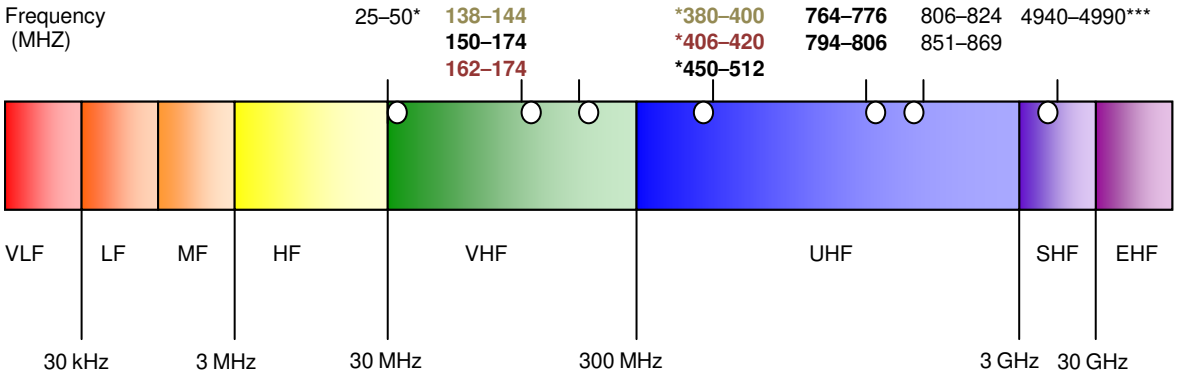

Figure 1. Public safety spectrum.

Neighboring jurisdictions that may need to communicate with one another in the event of a mutual aid response are often on different bands, making it difficult for them to communicate with one another. In the event that Federal agencies become involved, another issue arises: There are two Federal radio bands: 162–174 MHz and 406.1–420 MHz. Most public-safety radios cannot operate on the 406.1–420 MHz band. If the Department of Defense (DoD) becomes involved, it further complicates the situation, as the DoD operates in the 138–144 MHz and 380–400 MHz bands. Figure 2 shows that agencies operate on disparate radio bands and are unable to communicate. Conventional systems use repeaters: A remote site picks up a transmission, amplifies it, and retransmits it on another frequency. The repeater can be bypassed and units can talk "direct" to each other, using the repeater's output channel. This mode is also known as **talk-around** or **simplex**. Larger agencies use more efficient **trunking systems**. A group of channels is controlled by a single **control channel** that assigns unused channels to individual users when they need to use the system. Trunking systems can be more costly and complex to operate and maintain.

	Frequency Band								
	138–144 MHz	150–174 MHz	162–174 MHz	380–400 MHz	406–420 MHz	450–470 MHz	470–512 MHz	700 MHz	800 MHz
Public Safety Agencies		✦				✦	✦	✦	✦
Department of Defense (DoD)	✦			✦					
Federal Agencies (non-DoD)			✦		✦				

Figure 2. Land Mobile Radio Bands in use by local, state, and Federal public safety as well as the Department of Defense.

Public safety's need for improved interoperability has long been documented. In 2004, the United States Conference of Mayors published an Interoperability Survey [1] of 192 cities in 41 states and Puerto Rico. The survey measured the level of communications interoperability a given agency had with internal and external departments and agencies. Their findings showed a shocking lack of communications interoperability, both internally (within an agency) and externally (between agencies):

- 77 percent had interoperability across police and fire departments (internal).
- 66 percent had interoperability across police, fire, and Emergency Medical Services (EMS) (internal).
- 57 percent did not have interoperability with state emergency management.
- 49 percent did not have interoperability with state police.
- 86 percent did not have interoperability with state transportation department.
- 80 percent did not have interoperability with the DHS or the Department of Justice (DOJ).
- 88 percent did not have interoperability with DHS (including the Federal Emergency Management Agency and the U.S. Customs and Border Protection).
- 83 percent did not have interoperability with DOJ agencies such as the Federal Bureau of Investigation, the Joint Terrorism Task Force, and the Bureau of Alcohol, Tobacco, Firearms and Explosives.
- 60 percent did not have interoperability with state emergency operation centers.
- 97 percent did not have interoperability with chemical plant, police, fire, and EMS.

[1] http://usmayors.org/72ndAnnualMeeting/interoperabilityreport_062804.pdf

- 92 percent of agencies in cities with a seaport did not have interoperability with police, fire, and EMS.
- 94 percent with a major rail facility did not have interoperability with police, fire, and EMS.

Use of Audio Switch or Patching Devices

For many years, the only way to bridge these interoperability gaps required manual intervention by relaying information between dispatchers in order to exchange critical information, often creating delays. As technologies matured and new solutions were developed, audio switches entered the marketplace. These switches connect, transmit, and receive audio together to form a radio bridge. Most of these patch solutions use dedicated portable or mobile radios that are preprogrammed with shared channels identified for interoperability. Some audio switch technologies are simple and easy to use, while others require a higher level of training to activate the patch. One drawback to the use of these devices is the **open microphone problem**, where a microphone is inadvertently keyed, transmitting background noise. The noise is transmitted across all patched radio channels, rendering the patch useless while tying up twice the number of channels.

Equipment or Channel Sharing

Another short-term solution was to lend spare radio equipment to other agencies, provided the lender had set aside these loaners. In some locations, the use of a common mutual-aid regional or statewide radio channel, if available, offered some relief if the equipment in use had additional channels available and obtained permission from the licensee to operate on that channel. Some agencies installed police scanners to monitor other-agency radio traffic; in some cases, this practice became a cross-scanner form of communications, where both agencies installed scanners in their mobile units, each programming channels for the other.

The shortage of available channels within a single radio band resulted in the expansion of public safety systems into multiple radio bands. In some cases, individual departments were forced into operating in multiple bands, often with law enforcement using one band and fire/rescue and EMS using another. This split required that each vehicle have two or more radios installed, one for each radio band. Incident commanders were often required to carry two or more portable radios to carry out command and control at the scene of an incident. In some cases, the cost of the all equipment, including the radios required in each vehicle, exceeded the cost of the vehicle itself.

Responding to the Need

Public safety has wanted a single, portable or handheld land mobile radio (LMR) capable of operating across disparate radio bands and modes for many years. Emergency managers involved in major events that require support from outside agencies have often faced a communications gap since radios have only operated on a single radio band while outside agencies have operated on other bands. At the request of first responders, the DHS Science and Technology Directorate (S&T)'s First Responders Group (FRG) challenged LMR manufacturers to develop a single radio capable of operating on more than one

radio band. FRG was established to strengthen the first response community's ability to protect the homeland and respond to disasters. By engaging first responders at every stage, FRG pursues a better understanding of needs and requirements, and develops innovative solutions to the most pressing challenges faced during day-to-day and large-scale emergencies. The MBR, a handheld radio, allows emergency responders to communicate with partner agencies—regardless of the band on which they operate. FRG's Office for Interoperability and Compatibility (OIC) facilitated the requirements-gathering process and supported the testing and evaluation of the MBR technology through demonstrations and pilots. As the number of MBR manufacturers grew, OIC's test and evaluation activities grew as well. OIC conducted pilot testing, using equipment from two manufacturers at 13 locations across the nation; additional agencies participated in test demonstrations that preceded the pilots.

The findings described in this report cover the timeframe from the initial receipt of prototype radios with limited features that were evaluated during test demonstrations at multiple locations through long-duration test and evaluation pilots of MBRs with advanced features at additional locations across the United States. The report does not identify any specific manufacturer or product line, nor does it include recent functionality enhancements that have been developed through new software features and hardware updates by all manufacturers since the conclusion of the pilots. Additionally, DHS does not recognize specific manufacturers, nor does it endorse any specific product or services.

Challenges

When OIC launched this project, there were myriad challenges, a number of which were engineering-focused. Among the questions asked were these:

- How do you migrate four radio bands into one radio?
- How do you develop a single radio antenna capable of operating on all bands in the 138-174, 380-512 and 700/800 MHz range?
- How do you keep the MBR as small and light as a single-band radio?
- How do you develop a new radio battery pack capable of operating for longer duration?
- How can you keep the cost of a MBR comparable to the cost of a single band radio?

Other industry-related challenges existed as well. Some manufacturers have long-benefitted by requiring their users to buy multiple radios to communicate across the disparate radio bands. How can these manufacturers be persuaded to invest in the development of a MBR? At the same time, S&T was looking at ways to spur multiple manufacturers to develop MBRs so that responders could take advantage of natural market competition, driving down the price of each unit so that they would be able to purchase the radios using their limited funding.

Requirements

OIC entered into contracts with two major radio manufacturers to conduct research, development, testing, and evaluation for MBRs. The basic requirements were identified by the user community and through research. These requirements were then included in contracts that DHS established with these manufacturers. These requirements were as follows:

- Capability of operating on public safety spectrum at 136 to 174 MHz, 380 to 520 MHz, 700 MHz, and 800 MHz.
- Capability of operating using encryption including Output Feedback (OFB) Data Encryption Standard (DES), Advanced Encryption Standard (AES), and Over the Air Re-Key (OTAR).
- Package dimensions equivalent to, or smaller than, available single-band LMRs—8 × 3 × 2 inches, excluding the antenna.
- Package weight that is equivalent to, or lighter than, existing single-band radios—about 2 pounds (32 ounces) when equipped with a standard battery.
- Battery life that is equivalent to or longer than existing single-band radios—about 8 hours under normal operating conditions.
- Regulatory and performance specifications-compliant:
    - Federal Communications Commission
    - National Telecommunications and Information Administration Redbook
    - National Institute of Standards and Technology Federal Information Processing Standards 140
    - Intrinsically Safe (IS)
    - Telecommunications Industry Association-102/603 FCC Class A radio performance [2] in all bands. (Class B is used for Private LMR equipment.)
- Built to military specification (MIL-STD-810G) for moisture resistance and submersion. [3] (The exposed radio speaker, exposed radio knobs, antenna connection, push-to-talk switch, accessory pad, additional programmable side buttons, battery connection, and other potential points of entry were included during testing.)
- Durable, ruggedized radio built to survive in the environments where responders often operate—for example, in the extreme heat inside a burning building or along the southwestern border, in the extreme cold along the northern border during the winter, and in the extreme dusty conditions in desert areas.
- Hardened to survive being dropped from a 3-foot level onto hardened concrete. The test included dropping the radio on the corners of the radio, on the antenna, and on the different switches.

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[2] Class A radio performance pertains to Private Land Mobile Radio receivers with enhanced interference protection.

[3] Radio must survive being underwater for 20 minutes at a depth of 3 feet.

The size of the radio was another concern for participants. The length of the antenna was the number one concern, with weight being the number two concern.

Comments provided varied by discipline; some disciplines opted for a more durable radio rather than one that weighs less.

Undercover law enforcement officers wanted a smaller, lighter, pocket-sized radio that could be easily concealed.

Firefighters wanted a radio with larger knobs that were capable of being operated while wearing turnout gloves and one that could survive in the extreme heat and wet environment in which they operate.

Firefighters and the U.S. Coast Guard have a requirement for IS radios that were certified as being compliant with applicable standards. [4] IS-certified radios generally command higher prices than others due to the level of engineering required to meet the IS standards. Radios that are designed and certified as IS must use batteries and accessories that are also IS-certified. A non-IS certified battery or device cannot be mixed with an IS-certified radio and retain the certification.

The ability to use disposable batteries was a lesson learned from major weather-related emergencies (including Hurricane Katrina) and a requirement provided by smoke jumpers so the radios could be used when there is no ability to recharge them.

Finally, the radio would need to include a Global Positioning System (GPS) receiver so it could be tracked. When an emergency button on the top panel would be activated, the user's GPS coordinates would be sent to the dispatcher or on-scene commander, providing the user's location.

Testing and Evaluation

Two manufacturers participated in the MBR demonstrations and pilots over a two-year period. The first test and evaluations (T&Es) were demonstrations using early prototype radios to see how they performed with whatever features were available. The second and final test and evaluations were full pilots using radios that were nearly production-ready, with the majority of features available. In-person interviews, telephone interviews, and written reviews were used to obtain input from the technical community and the operational user community. Some agencies took the lead and conducted internal evaluations of the MBR technology and provided DHS with their results.

Early T&E efforts began with test demonstrations consisting of a multiphase process, using limited-production prototype equipment. Over the course of two years, a multiphase test demonstration process was developed. Under this process, testers evaluated

- the basic transceiver—basic functionality and limited to features available at the time from the manufacturer.
- an advanced transceiver—basic functionality and limited features available at the time but capable of DES-OFB and AES encryption.

[4] An Intrinsically Safe (IS) radio is incapable of releasing sufficient electrical or thermal energy under normal or abnormal conditions to cause ignition of flammable gases or fuels.

- the full-featured transceiver—containing all features and capabilities as advertised by the manufacturer. [5]

The following table lists the pilot locations, together with the lead pilot partners and the dates when the pilots occurred.

Lead Pilot Partners	Pilot Locations	Dates
Arizona Emergency Management	Various locations across the state	Feb.–April 2011
Blaine Police Department / Vancouver Transit Police	Blaine, WA and Vancouver, CA	Aug. 2009; Jan.–March 2010
Boise Fire Department	Boise, ID	Jan.–Sept. 2009
Chicago Police Department / Emergency Management	Chicago, IL	Sept–Oct. 2011
Hawaii State Civil Defense	Various locations across the state	Oct.–Dec. 2009
Indianapolis Fire Department	Indianapolis, IN	June 2009–Feb. 2012
Miami/Dade County Public Safety	Miami, FL	June–Aug. 2011
Michigan Department of Community Health/EMS and Trauma Systems	Various locations across the state	Dec. 2010–Jan. 2011
Murray State University	Murray, KY	Jan.–March 2010
National Capital Region Public Safety Communications Interoperability Group	Washington Metropolitan Area	Jan.–Sept. 2010
New Orleans Public Safety	New Orleans, LA	May–June 2011
Phoenix Police Department	Phoenix, AZ	Feb.–March 2011
U.S. Immigration and Customs Enforcement	Various locations	June 2012

Test demonstrations using prototype equipment are always challenging. To that end, unanticipated hardware and software issues were identified throughout this phase. Software issues were sometimes easier to resolve. Hardware issues can take more time and effort because they involve retooling for the production of machined components, most of which require changing the housing's mold, assembly, materials, or cutouts.

The user community played a critical role in the evaluation process of this new technology. Users provided detailed evaluations of the equipment capability. They recommended ways to enhance and improve the radio. Those recommendations were provided to the manufacturers for consideration even if they were outside the scope of the project. Many of the recommendations required manufacturers to redesign and reengineer the production line. For example, manufacturers moved the location of switches so that they could be easily manipulated by firefighters wearing gloves.

Key Findings / Lessons Learned

This section documents the results of findings based upon input from the user community and input from the DHS program manager. These findings are general in nature and not specific to any manufacturer. There has to be a balance between the requirements

[5] Since software was unavailable, no full-featured equipment was tested and evaluated during the project.

and the capabilities. One requirement, the ability to have a sufficient battery life to complete a full 10-hour or longer shift, was deemed essential. The solution resulted in a battery that was heavier than existing radios, even when it used the latest battery technology. There has to be a tradeoff with the user to either accept the weight or accept the limited battery capacity. During the initial testing of limited feature prototype MBRs, some users were not satisfied with the limited features as noted their disappointment in their evaluations. As new software features were added to the radio, complaints diminished. As testing continued additional requirements were identified, including the addition of MDC-1200, a signaling protocol/capability that displays the ID of the individual user of the radio (to someone at a console) when the push-to-talk button is depressed. Since this requirement was not identified from the initial requirements research it was not included in the project, but manufacturers were notified that the user community considered this capability as an additional requirement.

Additionally, early testing did not include all of the functionality that the radios possessed in later tests. For example, early testing of the basic transceiver was limited to using analog FM and digital Project 25 (P25) across multiple radio bands. P25 trunking was not available and not tested during the early phase, but was available on a limited basis later during the pilot testing phase.

Findings submitted by law enforcement differed from findings submitted by the fire services and EMS:

- Since law enforcement officers carry the majority of their equipment on a belt around their waists, they have concerns over the size and weight of the radio. They carry a firearm; spare ammunition; night stick, or asp; handcuffs; keys; and other equipment, so they were concerned about the radio's weight and its weight distribution.
- A firefighter, by contrast, generally only carries a radio in a pocket and needs both hands free to climb a ladder, extricate a victim from a building, and control the nozzle at an active fire.
- An emergency medical technician likely has a radio and limited equipment such as protective gear on the belt, but may require the use of both hands to perform CPR or control bleeding on a patient.
- A bomb squad technician may require the use of both hands to defuse an explosive device.

Most of the issues captured were related to the MBR technology. However, technology is only one element of the Interoperability Continuum, [6] as illustrated in Figure 3. For the most part, the technological gap has been bridged. The real challenges remain in the areas of governance, standard operating procedures (SOPs), training and exercises, and usage. Many agencies are still reluctant to partner with other agencies. Many agencies do not have SOPs that enable emergency responders to successfully coordinate an incident response across disciplines and jurisdictions. There is also a lack of effective training and exercise programs that allow responders to practice communications interoperability to ensure that the technology works and responders are able to effectively communicate

[6] The SAFECOM Interoperability Continuum was developed by the public safety community and identified five elements of interoperability.

during emergencies. Additionally, not all solutions are used regularly to allow responders to become familiar with their use.

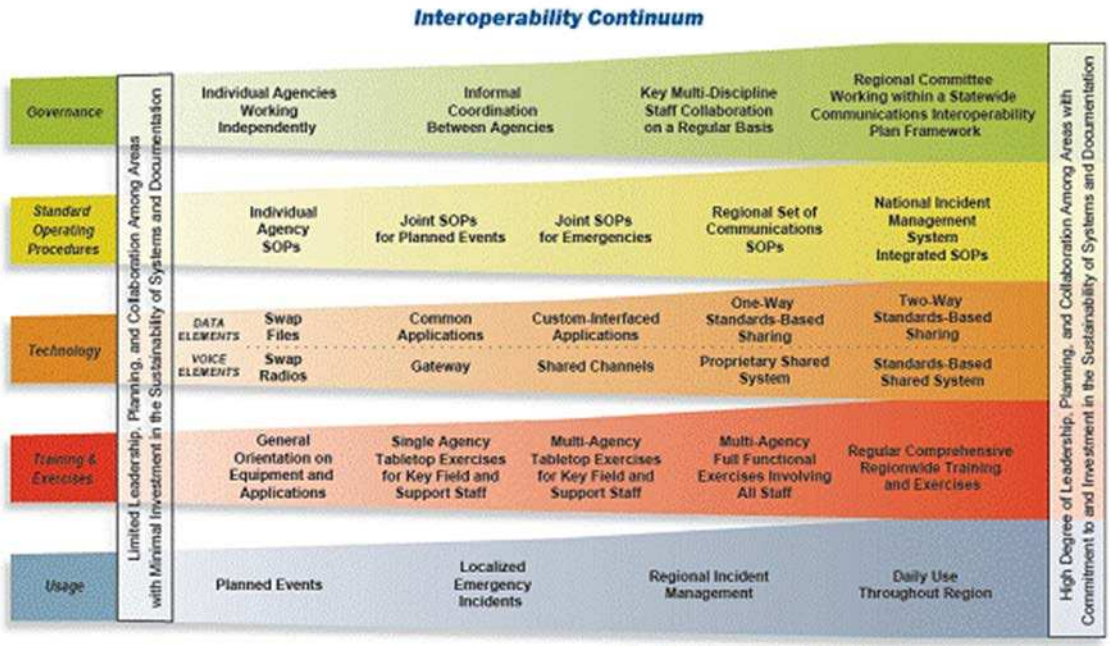

Figure 3. Interoperability continuum.

A simplified form of spiral development was used during the MBR project. Spiral development generally relates to software applications but can be expanded to include other capabilities. MBR technology can be considered a first-generation software-defined portable MBR built to public safety requirements. As prototypes were being built, ongoing test demonstrations, software development, and validation occurred to ensure that the operational needs of first responders were appropriately identified and met. Additional requirements were continually identified, such as the need for mixed conventional and trunking channels located in the same zone, the capability to scan those mixed channels in the same zone, and encryption. Spiral development included physical feature challenges and changes related to the placement, replacement, and improvement of physical control features that included larger control knobs, knobs capable of withstanding the intense heat in a fire, and smaller, more durable antennas that are less susceptible to failure. As new requirements were identified, they were incorporated into new versions of the prototypes whenever possible.

During the final phases of the MBR project, as the technology was approaching full commercialization, the manufacturers began conducting research and development of new, emerging wireless technologies based on broadband over Long-Term Evolution (LTE). Manufacturers were conducting research and development on potential internal feature upgrades and external-dongle devices, accessories that could be attached to the MBR to provide access to cellular networks. This spiral development will eventually lead to an MBR capable of operating on broadband/LTE and incorporating newer technologies into first-generation technologies. Future iterations will likely include a multi-band or cognitive radio capable of selecting unused spectrum that can be identified for use within a network or networks. The vision is that the next-generation solution will be

capable of operating voice, data, and video modes on any recognized and authorized spectrum available.

Successes

The pilots and demonstrations included several key successes:

- The ability to communicate across the three known disparate radio bands—Very High Frequency (VHF), Ultra High Frequency (UHF), and 700/800 MHz—using a single radio removes technology as a gap in interoperable communications.
- The MBR offers a capability to operate on non-public safety radio bands, the Marine VHF band, and two amateur radio bands.
- Generally, the simple and easy-to-use capability to program channels into the radio allows the on-scene commander to expand the capabilities of the MBR.
- The ease of moving between menus and zones with limited training is valuable.
- The MBR also provides easy access to different frequency bands by just turning the channel knob.
- The large color display allows the MBR to be read under various conditions.
- The GPS feature (as available) is useful in asset tracking, particularly when the user is away from a mobile unit or not assigned to a mobile unit—for example, when the user is a police officer walking a beat or a bicycle officer on patrol.
- The alkaline battery pack is essential for users who may not have easy access to a recharging station. These users include wildland firefighters or smokejumpers operating out of bases located in multiple locations in the western United States and fall under the U.S. Forest Service. [7] These wildland firefighters often parachute from aircraft to fight remote fires. In addition, this capability is essential in the event of catastrophic loss of commercial power or the loss of mobile platforms that would offer the capability to recharge batteries.

Remaining Issues

Most remaining issues identified can be applied to all public-safety-grade, land mobile, single-band radios; they are not unique to the MBR. As stated previously, a number of the issues below have been addressed by manufacturers in later production versions.

- Weight remains a concern.
- Physical size was a concern to users with smaller hands.
- The antenna was too long, often inflexible, and subject to failure.
- Cost remains a factor; users want a portable radio that costs less than $1,000.
- The MBR was not capable of operating on proprietary trunked radio systems.

[7] http://www.fs.fed.us/fire/people/smokejumpers/

- The MBR can't operate on VHF AM Aviation Band channels.
- The MBR can't operate on VHF Low Band 30-50 MHz.
- Boot up time, the time from when the radio is turned on until it can be used varies by manufacturer, is too long.
- In its current size, the MBR will be difficult to conceal during an undercover operation.
- The MBR can't combine conventional and trunked radio channels in a single zone.
- The MBR relies on non-standard accessory connections for speaker/microphones and earpieces.
- The use of some accessories precluded the use of other accessories when both were needed.
- Accessories are lacking for specific disciplines, such as SWAT and Explosives Ordnance Disposal.
- The MBR should include an internal cross-band repeater capability.
- Some users desire a dual receive capability, the ability to receive two channels at once, similar to a guard channel, with dual volume control. Perhaps a dual receive/transmit capability can be developed. Most radios have multiple programmable buttons near the push-to-talk; perhaps this could be the answer.
- There is no capability to clone a single-zone, channel bank or group, and no cut-and-paste capability.
- Users reported that programming software upgrades by nearly all vendors created problems, since each subscriber unit had to be "touched" to update.
- Battery life is too short to last through a long shift (10+ hours).
- MBR signals can't be encrypted.
- Volume isn't loud enough.
- The backlight screen can be too bright; there's no way to dim it or shut it off.

Additional Comments

- Programming software can be difficult to use; this problem is manufacturer-specific: Some software was easier to use and understand than others.
- Users need a way to import code plugs from a spreadsheet into the radio.
- Users would like a cross-band repeater capability.
- Users want a separate guard channel that can be continuously monitored.
- Users want interchangeable accessories so they do not have to buy new accessories when a new product line is introduced.

- Users are seeking an emergency channel capability that establishes a specific channel for emergency evacuation orders that preempts all ongoing communications.
- The ability to "modify display names via the keypad" would be useful.
- OTAR should be more stable and reliable.
- Users need the ability to scan across conventional and trunking channels.
- An MBR variant is needed that could would allow someone in an aircraft to communicate with first responders on the ground.
- Some Federal agencies continue to use Analog Wideband OTAR systems that rely on DES encryption. Yet some MBR products do not support wideband DES rekey.
- Some agencies use dynamic regrouping, another capability that is offered but limited to specific manufacturers.

Issues That Have Been Addressed or are Currently Being Addressed

Since the conclusion of the demonstrations and pilots, the manufacturers continue to further advance the MBRs. For example:

- Software continues to evolve; periodic updates are the norm.
- Codeplug update features are becoming available from manufacturers.
- Some manufacturers offer easy-to-program channels from the front keypad.
- Battery life will continue to be an issue for any portable device. New and emerging battery technology will continue to evolve, reducing radio size and weight.
- The emergency button has been relocated to prevent a user from accidentally hitting the button.
- Some manufacturers needed additional licenses for features, including:
    - Trunking Failsoft
    - Trunking Dynamic Regrouping
    - Trunking Supergroup
    - Conventional MDC-1200 operation
    - Scanning between conventional channels and a trunked system or between multiple trunked systems.

Project Impact

Operational Impact

The MBR has proven to be a valuable tool in bridging the communications interoperability gap by providing the capability to communicate between local, state, and Federal agencies regardless of the radio band in use.

- For the state trooper patrolling highways across multiple jurisdictions, the MBR provides a capability to communicate with multiple jurisdictions seamlessly, if nonproprietary systems are in use.
- For task force operations consisting of multiple jurisdictions, the MBR allows members to communicate on any regional system in place.
- For the firefighter responding to calls for mutual aid in support of neighboring jurisdictions, the MBR provides the tool to communicate.
- For the military base that has mutual aid agreements in place with surrounding jurisdictions, the MBR allows the base fire department or military police officer a means to communicate.
- For the National Guard Civil Support Teams that often respond to calls for support from jurisdictions located within their state, the MBR provides true multi-band functionality.
- For a large radio cache, an MBR is the ideal solution to allow interoperable communications because it can be pre-programmed with nationally recognized and authorized interoperability channels often held in reserve at specific locations for use during major events. [8] Cache radios allow agencies the flexibility to travel outside their jurisdictions in support with multiple agencies and provide a source of equipment to be distributed to outside agencies responding to mutual aid requests.

Throughout the test demonstrations and pilots, the MBR was heralded as an exceptional tool for the incident commander who often had to communicate with multiple agencies during large-scale events using multiple radios. However, smaller jurisdictions in many rural areas may have access to sufficient spectrum in a single radio band and may have no need for this capability. Lower-cost single-band radio equipment may meet all of their communications requirements. Larger metropolitan agencies that may operate on disparate radio bands may find the MBR to be a viable solution.

Technological Impact

Technology is no longer the de facto problem with interoperability: in most cases, the technology exists, but as mentioned previously, challenges often remain in the areas of governance, SOPs, training and exercises, and usage. An MBR provides a solution that bridges the existing communications gap and enhances the capability to communicate with other response agencies outside the public safety field. With the adoption of the P25 suite of open standards, all manufacturers can compete in the market.

The project required manufacturers to engage their engineering departments to develop the software necessary to run the technology. Mechanical engineers were engaged to

[8] Recognized channels set aside for interoperability can be found within the DHS National Interoperability Field Operations Guide (NIFOG). This guide is a valuable resource in the identification of authorized interoperability channels. DHS recommends that all interoperability channels be pre-programmed into MBRs if channel capacity allows. (Channel capacity varies by manufacturer.) Initially released in 2007, version 1.4 is available today at http://www.dhs.gov/files/publications/gc_1297699887997.shtm.

ensure that the internal components were shielded from interference and secondary manufacturers often built the accessories used with the radio.

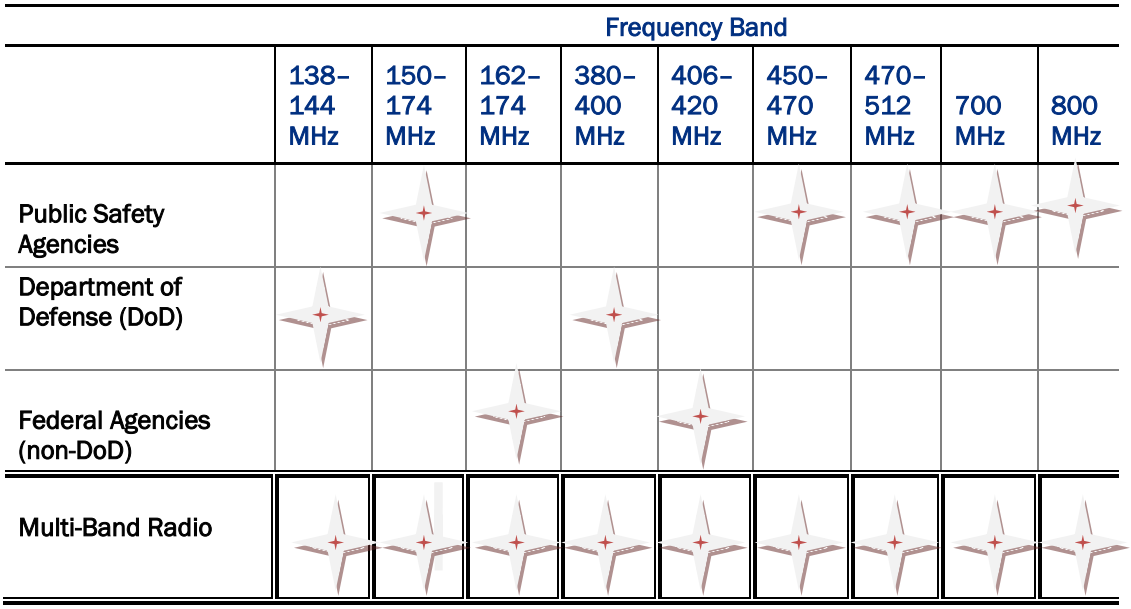

Figure 4. Disparate radio bands in use by public safety agencies, DoD, and Federal agencies.

Marketplace Impact

Once the MBR was announced, additional manufacturers showed an interest in entering the market and to date have marketed competing versions of both portable and mobile dual-band and MBR equipment suitable for public-safety use.

Manufacturer interest resulted in increased competition, thus reducing the cost of subscriber units. Currently, three manufacturers offer dual-band radios or full MBRs additional manufacturers have announced their intent to follow suit. The MBR project encouraged competition in the marketplace and is resulting in a lower cost per radio. The cost of a MBR is now comparable to the cost of similar high-end single-band radios.

Today, manufacturers continue to explore the capability of using the MBR technology to expand the capabilities outside the scope of the initial MBR project. These technology enhancements may include the addition of commercial wireless functionality and other capabilities in the near future as well as enhanced accessories.