

Land Mobile Radio (LMR) 101

Part 1: Educating Decision-Makers on LMR Technologies

INTRODUCTION

Every day, dedicated men and women risk their lives to make our communities safe and secure. The job of emergency responders at every level of government—federal, state, local, tribal, and territorial—is to respond to and manage incidents of varying size and scope, and assist communities with recovery efforts. This mission requires timely decision-making and coordination among law enforcement and fire personnel, emergency medical services, 911 staff, emergency managers, and health care professionals. As Figure 1 represents, multiple response agencies are involved in a single incident. Communications is a critical part of that response; a breakdown of communication at any one of these junctures could negatively affect response, risking life and property.

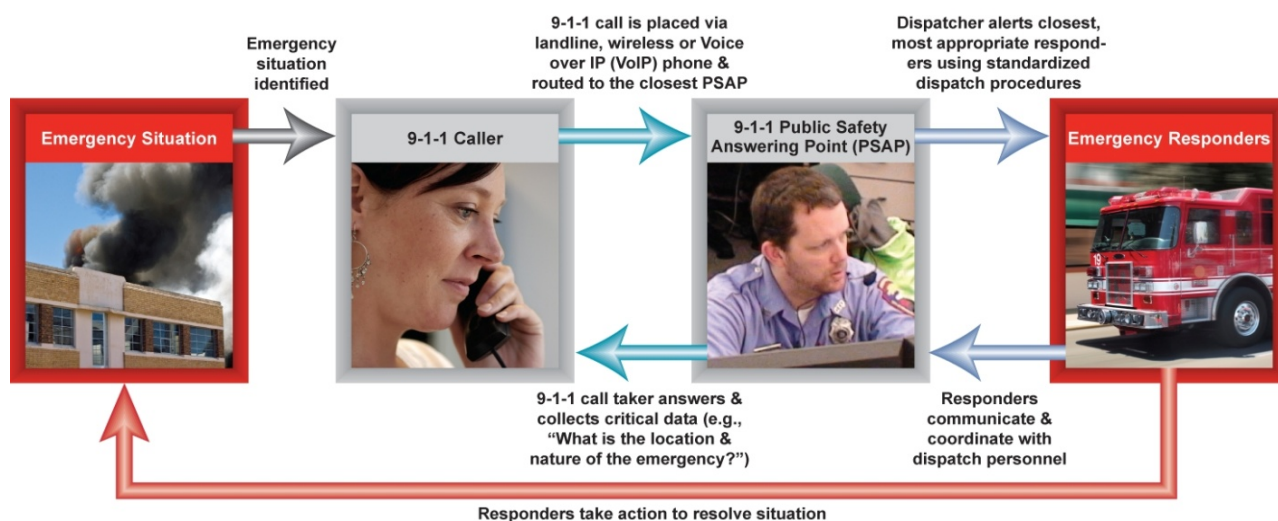


Figure 1. Mission-Critical Communications during Emergency Response

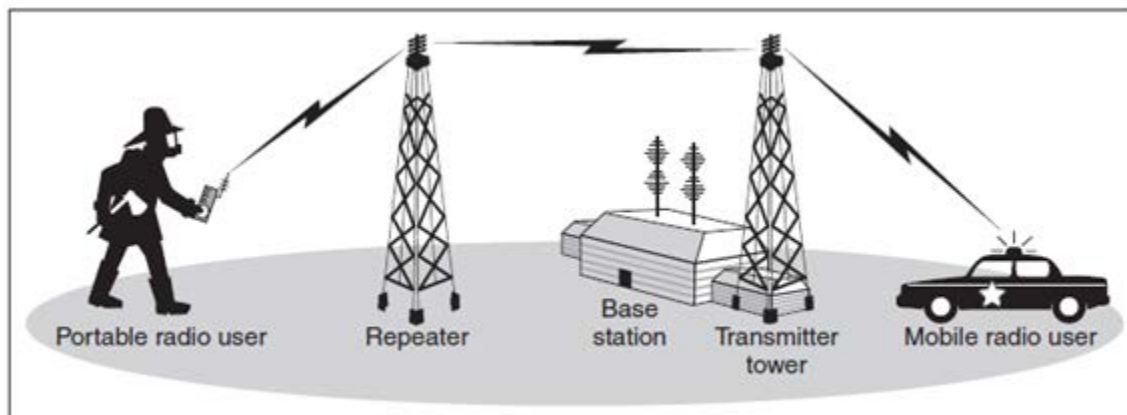
Public safety agencies rely on land mobile radio (LMR) systems as the primary means for transmitting mission-critical voice communications between emergency responders.

WHAT ARE LMR SYSTEMS?

LMR systems are terrestrially-based, wireless communications systems commonly used by federal, state, local, tribal, and territorial emergency responders, public works companies, and even the military to support voice and low-speed data communications. LMR systems typically consist of handheld portable radios, mobile radios, base stations, a network, and repeaters.

- **Handheld portable radios** are carried by public safety personnel and tend to have a limited transmission range.
- **Mobile radios** are often located in vehicles and use the vehicle’s power supply and a larger antenna, providing a greater transmission range than handheld portable radios.
- **Base station radios** are located in fixed positions, such as public safety answering points or dispatch centers, and tend to have the most powerful transmitters.
- **A network** is required to connect the different base stations to the same communications system.
- **Repeaters** are used to increase the effective communications range of handheld portable radios, mobile radios, and base station radios by retransmitting received radio signals.

Figure 2 depicts a basic LMR system that shows the flow of communication between emergency responders using portable or mobile radios, which are connected to a network of base stations, towers, and repeaters.¹



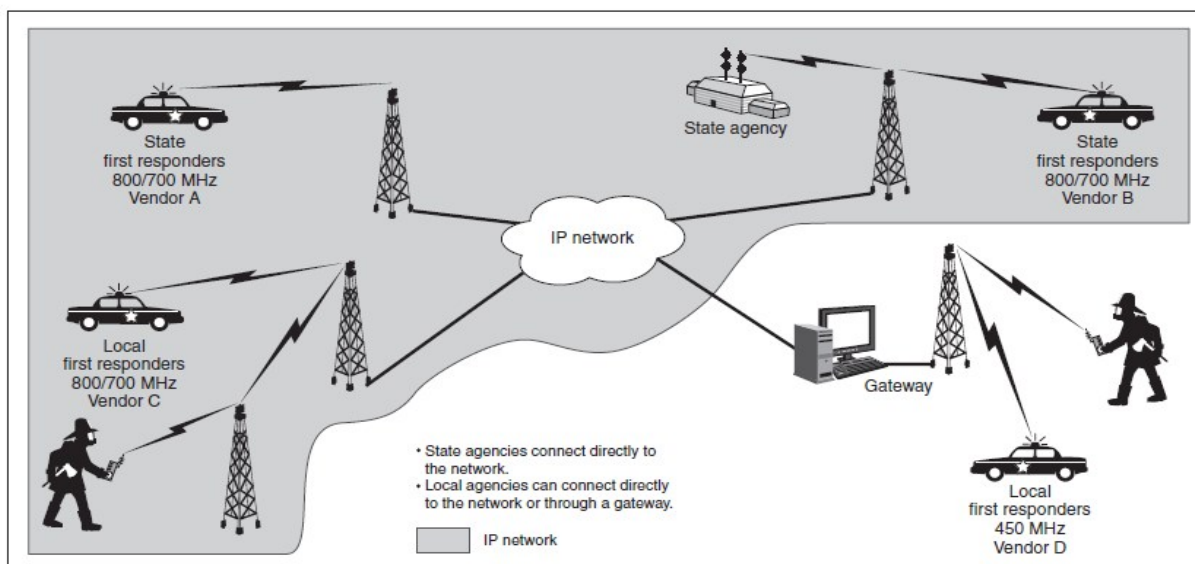
Sources: GAO and DHS.

Figure 2. Basic Components of an LMR System

LMR systems have been deployed since the 1930s to support mission-critical voice communications. Over time, many public safety agencies have migrated from basic LMR systems to more advanced communications systems.

Many agencies have moved from basic, **conventional** systems to more complex **trunked** systems. Conventional radio systems have dedicated frequencies and channels assigned to individual groups of users. When a user makes a call, and selects a channel, other members of the group cannot use the channel until the call is over.² Trunked systems are computer-controlled, and assign a pool of channels for use by multiple individuals. When a call is made by a user on a trunked system, an available channel is automatically selected by the system from the pool of channels, leaving the remaining channels available for others. While trunked systems are more complex and require more infrastructure than conventional systems, they allow for the sharing of channels among a large group of users, increase capacity and interoperability, reduce congestion, and enable the more efficient use of communication channels.³

Some states, regions, and large urban areas have migrated from basic systems to computer-based, or Internet Protocol (IP)-based systems, which has allowed agencies to increase capacity (i.e., the number of users on a system), enhance capabilities, and improve interoperability. Figure 3 provides an example of a regional or statewide IP network.



Source: GAO-07-301

Figure 3. Example of a Regional or Statewide IP Network

¹ "First Responders: Much Work Remains to Improve Communications Interoperability." GAO-07-301: Published: Apr 2, 2007.

² Ibid.

³ Ibid.

WHY ARE LMR SYSTEMS IMPORTANT?

LMR systems are the primary means of voice communications among public safety personnel. LMR systems are designed to meet the unique needs of public safety, and deliver secure, reliable, mission-critical voice communications in a variety of environments, scenarios, and emergencies. LMR technologies have been used by public safety personnel for many years, and provide the most reliable means of voice communications for public safety at this time.

LMR technologies have been enhanced to provide mission-critical features. LMR technology has progressed over time from conventional, analog voice service (e.g., two-way communications) to complex systems incorporating digital and trunking features that enable such features as rapid voice call-setup, group calling capabilities, high-quality audio, and guaranteed priority access to the end-user. These enhancements have improved the interoperability, spectral efficiency, security, reliability, and functionality of voice and low-speed data communications for public safety personnel.

Public safety agencies are trained and skilled in the use of LMR technologies. LMR technologies and features have been integrated into response protocols and training curriculum, and tested through planned exercises and real-world events. While new technologies are entering the market every day, emergency responders are most familiar with how LMR technologies work. Responders have been trained in their use, and have used LMR technologies in a variety of settings over many years. This familiarity has helped public safety agencies plan for various scenarios and execute effective response operations.

Federal, state, and local agencies have invested billions of dollars in LMR infrastructure. The federal government has provided billions of dollars in grant funding for state, local, tribal, and territorial governments to install, expand, and enhance LMR systems. Individual states, localities, and regions have also devoted public funding to communication systems. Agencies and jurisdictions have worked together to leverage existing infrastructure, connect LMR systems, and create networks of communications systems. State, local, tribal, and territorial governments are continually upgrading these systems to improve interoperability, capabilities, coverage, and capacity. These systems are in place and working.

CURRENT CHALLENGES TO CONSIDER WHEN UPGRADING LMR SYSTEMS

As LMR systems and technologies evolved over many decades, agencies have a variety of communications systems in place today. Some agencies have basic LMR systems in place. Some agencies have more advanced systems in place. Not all of these systems are compatible with each other, inhibiting the ability of public safety responders and officials to talk to each other during emergencies. Below are challenges facing agencies and jurisdictions interested in upgrading public safety communications systems:

- **Agency-specific systems.** Many systems have been designed to meet specific agency missions. Vendors offer customized LMR systems and equipment, designed to serve specific agency missions; vendors build systems to proprietary standards, and offer vendor-specific features that served single agency missions, but may not be compatible with surrounding systems.
- **Spectrum issues.** Agencies and jurisdictions must secure licenses to operate their communication systems on the radio spectrum. The Federal Communications Commission (FCC) assigns spectrum to public safety agencies, according to their needs and use. Public safety communication systems operate on different spectrum frequencies (e.g., very high frequency [VHF], ultra high frequency [UHF], 700 megahertz [MHz], 800 MHz). Systems that operate on different frequencies are not always interoperable. Agencies often invest in bridging devices, and other equipment that connect disparate systems to enable interoperability between systems and responders.⁴
- **Non-standards-based systems** that are vendor-specific or customized, and therefore are not compatible with neighboring public safety LMR systems.
- **Advanced technologies that are not backward compatible** with current systems, including advanced LMR features, Internet Protocol (IP, or computer-based) systems, and broadband technologies that cannot interoperate with older LMR systems.
- **Backup communications solutions** that include commercial cellular voice and data networks as the primary or only source of back-up; these networks may be overwhelmed by congestion and capacity issues during emergencies.
- **Encrypted communications** that are proprietary, or not standardized, prohibiting interoperability with radios that are not encrypted in the same way; if encryption is used, it should be standards-based, and implemented inclusively to ensure existing interoperability is maintained.

⁴ “First Responders: Much Work Remains to Improve Communications Interoperability.” GAO-07-301: Published: Apr 2, 2007.

GUIDANCE FOR AGENCIES INTERESTED IN UPGRADING LMR SYSTEMS

To overcome these challenges, the federal government provides grant funding and guidance to states and localities. The Department of Homeland Security (DHS), Office of Emergency Communications collaborates with SAFECOM and the National Council of Statewide Interoperability Coordinators (NCSWIC) to develop the annual [SAFECOM Guidance on Emergency Communications Grants](#) (*SAFECOM Guidance*). The *SAFECOM Guidance* provides recommendations, best practices, and resources to public safety agencies investing federal funds in emergency communications. **DHS encourages grantees to:**

- **Review the [National Emergency Communications Plan \(NECP\)](#) and [Statewide Communication Interoperability Plans \(SCIP\)](#)**, to ensure that grant proposals support broader plans to improve communications across all systems and users.
- **Coordinate with Statewide Interoperability Coordinators (SWICs)**, to serve as a single point of contact to implement statewide plans and coordinate regional projects.
- **Develop Standard Operating Procedures (SOPs)** that provide mutually-approved processes to coordinate public safety agencies' resources during response operations.
- **Invest in training, exercises, and activities that enhance operational coordination** that prepare emergency responders to communicate across agencies.
- **Purchase standards-based equipment** (e.g., Project 25 for LMR, Long-Term Evolution [LTE] for broadband technologies) to ensure public safety systems can interoperate.

State, local, tribal, and territorial governments are encouraged to reference the *SAFECOM Guidance* when developing emergency communications projects and target federal funding toward the priorities above.

CONCLUSION

LMR technologies provide mission-critical voice communications that are tailored to public safety needs. While the community considers new and emerging technologies to supplement communications, current LMR capabilities must be sustained until other technologies provide the reliability that LMR offers. Decision-makers should consider the impact of funding decisions on their agencies' ability to communicate during day-to-day incidents, emergencies, and natural and man-made disasters. The federal government and public safety agencies have spent billions building a vast LMR infrastructure and training users. Without continued investment to operate and maintain LMR systems, emergency communications could be compromised.

ABOUT SAFECOM/NCSWIC

SAFECOM is comprised of more than 70 members representing federal, state, local, and tribal emergency responders, and major intergovernmental and national public safety associations, who aim to improve multi-jurisdictional and intergovernmental communications interoperability through collaboration with emergency responders and policymakers across Federal, State, local, tribal, territorial, and international partners. SAFECOM members bring years of experience with emergency communications during day-to-day operations, and natural and man-made disasters. SAFECOM members offer insight and lessons learned on governance, planning, training, exercises, and technologies, including knowledge of equipment standards, requirements, and use. SAFECOM members also provide input on the challenges, needs, and best practices of emergency communications, and work in coordination with OEC to share best practices and lessons learned with others.

The National Council of Statewide Interoperability Coordinators (NCSWIC) is comprised of Statewide Interoperability Coordinators (SWIC) and their staff from the 56 states and territories. NCSWIC assists states and territories with promoting the critical importance of interoperable communications and sharing best practices to ensure the highest level of interoperable communications across the Nation.

This document was developed by the [SAFECOM/NCSWIC](#) Funding and Sustainment Committee, with support from the Department of Homeland Security (DHS) Office of Emergency Communications (OEC). This document reflects the expertise and knowledge of SAFECOM and NCSWIC members, and coordination efforts of OEC in bringing stakeholders together to share technical information, best practices, and lessons learned in funding and deploying public safety communications systems.

For more information on SAFECOM, see: <http://www.dhs.gov/SAFECOM>

For more information on NCSWIC, see: <http://www.dhs.gov/SAFECOM/NCSWIC>

Resources for Public Safety Agencies Investing in LMR

[SAFECOM Guidance on Emergency Communications Grants](#)

The SAFECOM Guidance provides information for grantees developing emergency communications projects for federal funding. Decision makers and grantees should read the SAFECOM Guidance, coordinate proposals with the Statewide Interoperability Coordinator, and encourage compliance with the recommendations contained therein. For Department of Homeland Security (DHS) grants, grantees must comply with the SAFECOM Guidance as a condition of funding.

[P25 Technology Interest Group \(PTIG\)](#)

The PTIG website provides information on all topics concerning P25 standards. Free registration is required to view content.

[P25 Suite of Standards](#)

The Telecommunications Industry Association's website contains P25 standards development activities that address all technical matters for private radio communications systems and services, including definitions, interoperability, compatibility, and compliance requirements. P25 standards documents are available for purchase. Qualified government entities may obtain copies of P25 standards via the PTIG website.

[P25 Compliance Assessment Program \(CAP\)](#)

The P25 CAP establishes a process for ensuring that equipment complies with P25 standards and is capable of interoperating across manufacturers. P25 CAP is helping emergency response officials make informed purchasing decisions by providing manufacturers with a method for testing their equipment for compliance with P25 standards.