



Texas Radio

Communications

Interoperability Plan

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Introduction

One of Governor Perry's top 2005 Homeland Security objectives is to achieve Level-4¹ radio interoperability within the first responder community throughout Texas. The Texas Radio Communications Interoperability Plan serves as a high level roadmap to achieve this objective. State wide Level-4 attainment, simply put, is when fire fighters, emergency medical responders, police officers, deputy sheriffs and state troopers can go anywhere in the state and have immediate radio communications with each other using their own equipment on designated channels.

Obstacles to radio communications interoperability have vexed the first responder community for several decades. As the terrorist attacks of 09/11/01 clearly demonstrated, first responders must have real-time radio communications across disciplines and jurisdictions. Radio interoperability in Texas is particularly challenging because of its size and its geographic and demographic diversity. Certainly, radio communications interoperability could be achieved through the acquisition of entire new radio systems. However, this approach would cost too much and take too long and is not necessary with today's integration technology.

The Texas plan employs a network approach using the demonstrated leadership at the regional level through Texas Councils of Governments (COGs) and adherence to the Department of Homeland Security's (DHS) national technical requirements for wireless public safety communications and interoperability. This plan leverages existing radio systems rather than the costly replacement of the existing public safety radio infrastructure in Texas. It was developed with substantial assistance from two industry leaders that possess the technical expertise necessary to validate the efficacy of this plan.

The 24 COGs in Texas will have the responsibility of developing and implementing regional strategies to provide Level-4 radio communications interoperability within their regions in accordance with the technical requirements of this plan. This will result in first responder interoperability within a COG and among other COGs that have also achieved Level-4 interoperability.

Certainly, there are several important Homeland Security initiatives throughout the state that require funding. However, to achieve statewide interoperability, it will be necessary for the COGs to prioritize the expenditure of Office of Domestic Preparedness (ODP) and other grant funds on radio interoperability projects to ensure that each of the 24 COG regions attain Level-4 interoperability.

¹ Texas has adopted the Department of Homeland Security definitions for the six levels of interoperability.

Levels of Interoperability

Interoperability is essential to effective emergency management both during a crisis and on a daily basis. At the most basic level, interoperability allows two or more parties to exchange information directly. First responder personnel at the scene can instantly connect and communicate with each other, make the contacts needed to bring in additional resources, coordinate rescue missions and provide other forms of response to threats and emergencies.

Texas has adopted the DHS definitions to assess the six different levels of interoperability throughout the state which are illustrated in **Figure 1** and defined on page 4 of 17.

<u>Level</u>	<u>Method</u>	<u>Fit</u>
LEVEL 6 Standards-Based Shared Systems	Standards-Based Shared Systems	Most Complete Long-Term Solution
LEVEL 5 System-Specific Roaming	System-Specific Roaming	Full-featured, Wide Area
LEVEL 4 Gateway (Console Patch)	Gateway (Console Patch)	Short-Term System Modification
LEVEL 3 Mutual Aid Channels	Mutual Aid Channels	Well Known With Public Safety Agencies
LEVEL 2 Talkaround	Talkaround	Simple Short-Term Solutions <div style="text-align: right;"> Easily deployed ↑ Time-consuming </div>
LEVEL 1 Swap Radios	Swap Radios	

Figure 1: Six Levels of Interoperability

The SAFECOM Interoperability Continuum which is illustrated in **Figure 2** was designed by DHS to help the public safety community and local, tribal, state, and federal policy makers address the critical elements for success as they plan and implement interoperability solutions. These elements include frequency of use of interoperable communications, governance, standard operating procedures, technology, and training/exercises. This tool was established to depict the core facets of interoperability according to the stated needs and challenges of the public safety community and will aid the COGs and the state with the implementation of this plan.

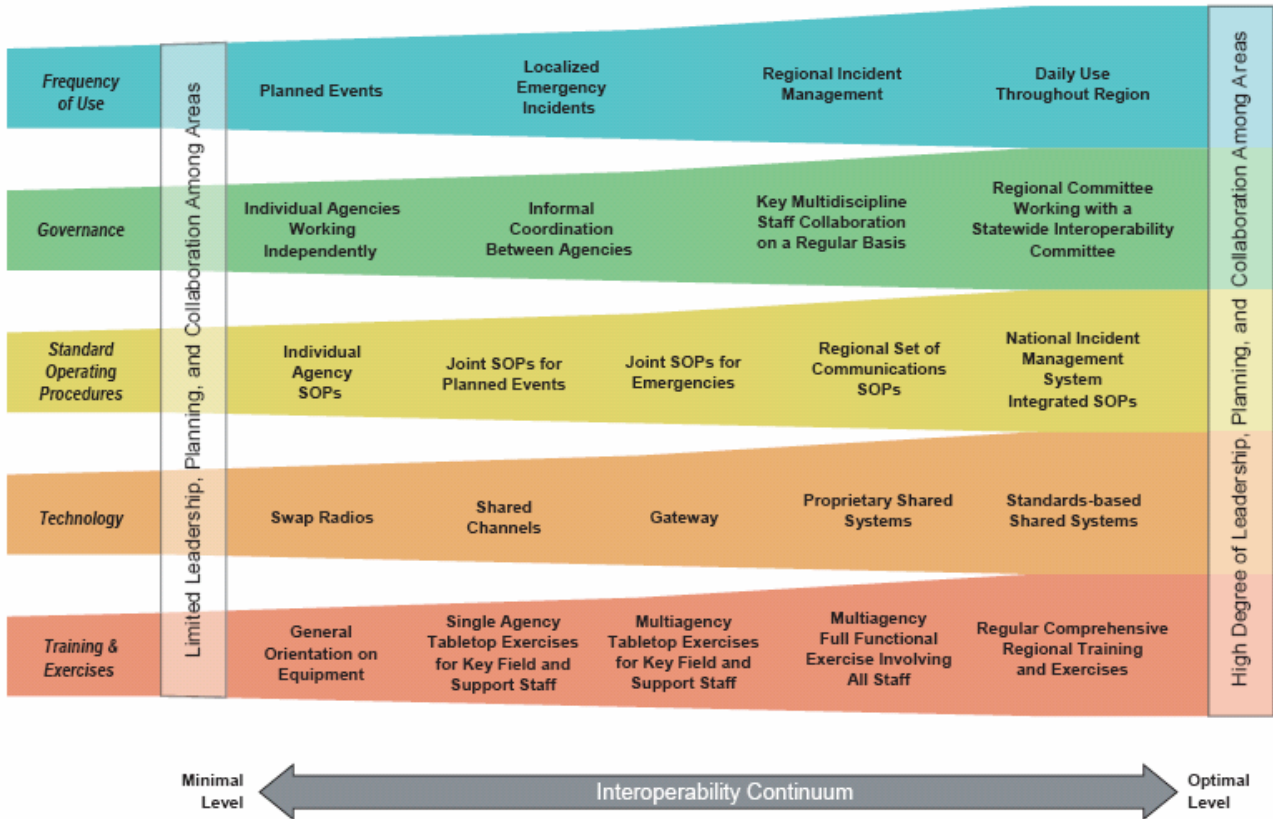


Figure 2: SAFECOM Interoperability Continuum

Progression along the Interoperability Continuum is contingent on the following key drivers:

- Leadership commitment
- Fostering collaboration across disciplines (EMS, Fire, Law Enforcement, and all public safety agencies) through leadership support
- Using interoperability solutions on a regular basis
- Coordinating across all elements (Frequency of Use, Governance, Standard Operating Procedures, Technology, and Training/Exercises)
- Progressing along all the elements of the continuum in parallel

Project 25 and 700 MHz

Before discussing the levels of interoperability, it is important to first discuss Project 25 Digital Radio Standards – Common Air Interface (P25) and the 700 MHz frequency band as they relate to interoperability. The term P25 is a technology standard that was established to provide a common interoperability infrastructure for digital public radio voice communications. P25 capable equipment includes base stations, mobile radios, and portable radios. The P25 committee is working to complete the industry standard for Inter Sub System Interface (ISSI), which will provide the industry with a vehicle to connect multiple P25 systems with an open standard architecture. Once completed, the ISSI will connect any manufacturer's P25 system to any other P25 system. This plan only requires that future purchases of radio equipment be P25 capable which is less costly than P25 ready equipment. Certainly, P25 radio systems will provide users a greater degree of functionality. However, P25 radio systems are not a panacea for interoperability at this time. It does nothing to eliminate the interoperability problems inherent with differing frequency bands. Moreover, no one can afford to replace all existing radio systems to ensure every first responder has a P25 ready radio.

Over the last two decades, there has been continuous growth in the demand for two-way radio service for public safety use. In the 1997 Budget Act, Congress directed the FCC to reallocate 24 megahertz of the spectrum for public safety services which is to be recovered from TV channels 60-69 as a result of digital television implementation. On October 10, 2000, the FCC also dedicated 2.4 megahertz (192 channels) of the 700 MHz public safety spectrum specifically for use by states to develop statewide radio communication systems. Currently, the 700 MHz spectrum is shared by the television industry within Texas. The FCC has mandated that the television industry vacate the 700 MHz by or no later than January 1, 2006. However, the FCC rules provide a loophole that indicates stations will not have to vacate this band until 85 percent of their viewing audience has access to digital television. Certainly, when 700 MHz becomes available it will provide a much needed solution to the limited number of channels available and will facilitate the migration to newer technologies. However, 700 MHz is not a solution to interoperability. Rather it is one more frequency that will need to be linked once it becomes available for public safety use in Texas.

Definitions of Interoperability

Level-1: Interoperability-Swap Radios

The simplest and most basic level of interoperability is the physical exchange of radios with other agencies involved in an event. However, it is impractical for every agency to have extra radios on hand for each member of every other possible agency that could appear on-scene, especially for large scale events.

Level-2: Interoperability-Talkaround or “Directed Net”

Talkaround provides interoperability where multiple radio users talk radio-to-radio on the same transmit and receive frequency in the conventional mode. In this situation, communications are tightly bound by the air interface: the same frequency is required and transmissions are digital-to-digital or analog-to-analog, not analog-to-digital.

Level-3: Interoperability-Mutual Aid

Radio operability allows radio communication by establishing Radio Frequency (RF) coverage. Operability of any radio device is limited to frequency band and coverage, without operability there cannot be interoperability. Mutual Aid channels establish RF coverage areas, which will typically be used exclusively by first responders for RF communication during special events.

Radio interoperability using the Mutual Aid coverage areas is established by ensuring the radios intended to interoperate are programmed with the frequencies of the Mutual Aid channels and by being within coverage of one of these channels. The radio user must know when to manually switch to the Mutual Aid channel and which one to switch to. This allows any VHF or 800 MHz user to travel to other similar VHF or 800 MHz band systems and communicate to other users and dispatchers operating on that system using these mutual aid frequencies in the conventional analog, clear voice mode. The same Level-3 Mutual Aid technology options are available for the UHF band.

Level 3: Mutual Aid

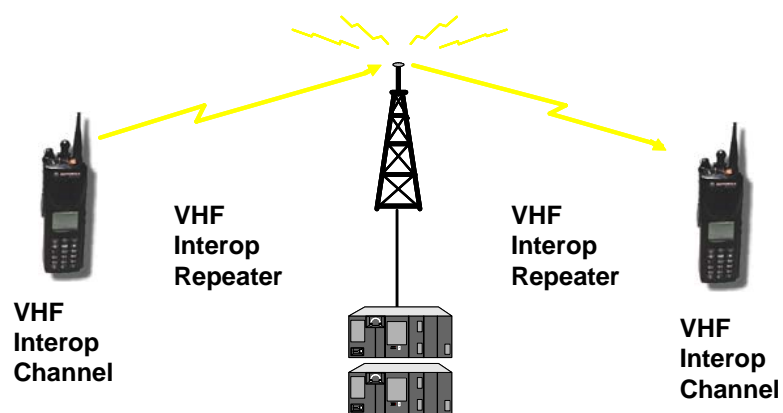


Figure 3: Level-3 Mutual Aid

However, mutual aid channels provide interoperability only between radios within the same frequency band, i.e. VHF users can only talk to (or on) other VHF systems, therefore interoperability is limited.

Level-4: Interoperability – Operability Across Frequency Bands

Level-4 interoperability is achieved by linking all first responder radio systems. The SAFECOM 2004 Federal Grant Guidance describes multiple approaches for linking disparate networks.

Cross band repeaters retransmit signals input from one frequency band to an output in a different frequency band. Cross band repeaters range from simple devices supporting frequency transfers across two bands (e.g., UHF and VHF to more complex devices capable of bridging multiple frequency bands (e.g., UHF, VF Low Band, VHF High Band, and 800 MHz).

Level 4: Cross band Repeaters

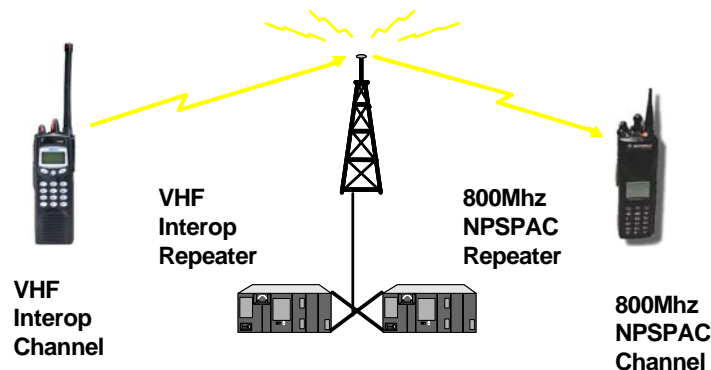


Figure 4: Level-4 Cross Band Repeaters

Fixed or Mobile Deployable Network-to-Network Gateways – provide radio interoperability during missions requiring communications between diverse organizations using different radios and different frequencies. Network-to-Network gateways offer a standard way to link wireless infrastructures. Within minutes after arriving on the scene of an incident, a portable gateway can be quickly programmed to support the frequencies of participating agency radios. Many of these solutions also allow disparate networks to share data and provide a bridge to the public switched telephone network (PSTN).

Level 4: Deployable RF Gateways

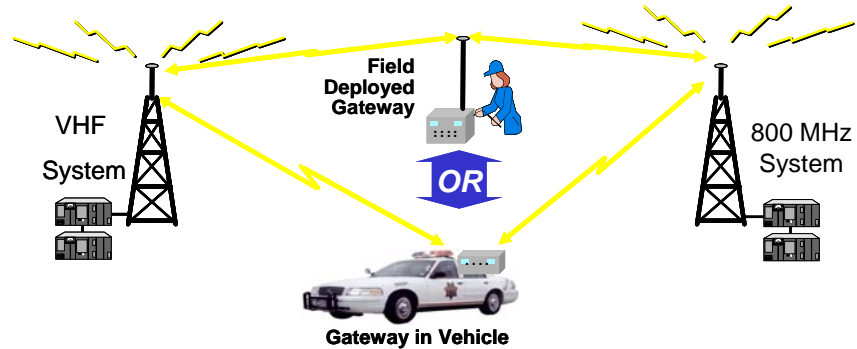


Figure 5: Level-4 Deployable Gateways

Level 4: Fixed Gateway -- Interface Box

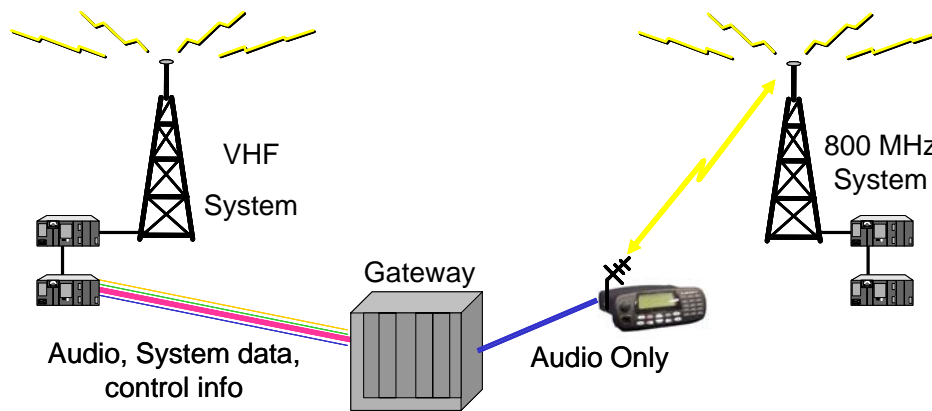


Figure 6: Level-4 Fixed Gateways

IP (Internet Protocol) Network-to-Network Gateways – An IP packet-switched network gateway links legacy radio sites, systems and dispatch consoles over an IP standard transport. In addition to Level-4 capabilities, IP Gateways provide additional functionality through software and data services. An IP Network-to-Network gateway can leverage Commercial Off The Shelf (COTS) backbone equipment and can be scalable to a large number of users. An IP network gateway should provide high availability and redundancy in its design.

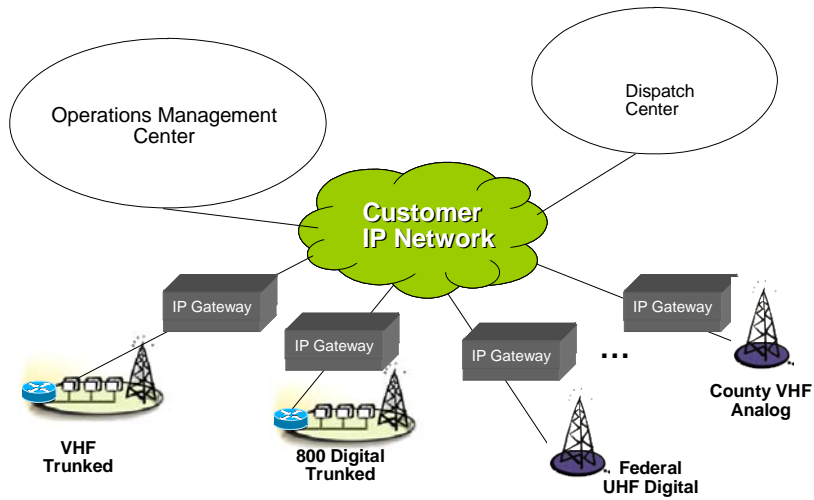


Figure 7: IP Gateway

Level-5: Interoperability – System Specific Roaming

Sharing systems for first responder interoperability during special instances provides greater capacity and functionality than relying on dedicated Mutual Aid channels. When the radios or systems intended to interoperate are from the same manufacturer, full functionality is available radio to radio. When the radios and/or systems are from different manufacturers, interoperability is limited to a common capability (i.e. voice) for either radio to radio or system to system operation. Gateways can also be used to supplement system to system interoperability. Another option at this level could be the standards based system-to-system P25 Inter Sub System Interface (ISSI) standard when it becomes available.

Level 5: System Specific Roaming

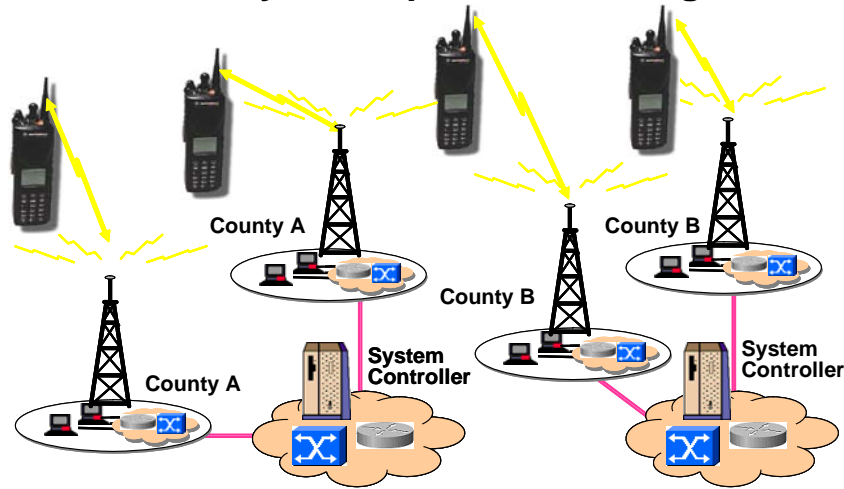


Figure 8: Level-5 System Specific Roaming

Level-6: Interoperability - Standards Based Shared Systems

Level-6: Interoperability uses shared systems that rely on open standard functionality for both over the air and wireless. In North America, there are two sets of open air interface standards for public safety radio communications, analog voice (TIA-603) and Project 25 digital radio standards defined as ANSI / ITA / EIA-102. The standards set the capabilities that are expected to be interoperable. A standardized ISSI insures that the set of air interface capabilities as well as wireline capabilities interoperate between systems regardless of the systems manufacturer or frequency band. However, these standards have not yet been determined.

Level 6: Standards-Based Shared Systems

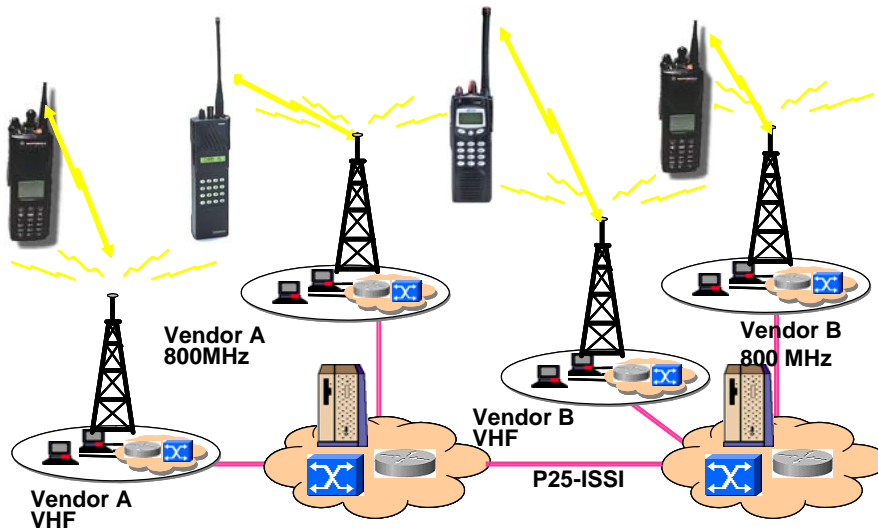


Figure 9: Level-6 Standards Based Shared Systems

Challenges to Interoperability in Texas

The need for and challenges to communications interoperability in Texas are as large as the state. The states' diverse geography and demography presents unique challenges. Texas spans over 267,338 square miles with 254 counties, over 1,400 jurisdictions and 21 million residents. In addition it has some of the nations most populous urban areas and sparsely populated rural areas. Geographical features include a 1,200 mile border with Mexico, a 367 mile coastline, coastal plains in the east, hills in central Texas, and mountains in the west. In addition, there are over 5,206 first responder agencies in Texas using various local and regional radio systems throughout the state. **Figure 10** illustrates the number of different systems currently in use in Texas.

Agency	800	VHF	UHF	900	Other
Local Police Agencies	X	X	X	X	X
Local Fire Departments	X	X	X	X	X
Local EMS	X	X	X		X
State Agencies		X			X
FBI		X			
FEMA		X			
National Guard		X			

Figure 10: Texas Radio Systems

The frequencies most in use within Texas for public safety are VHF and 800 MHz. VHF frequencies have been in use for over 30 years and provide coverage to approximately 80 percent of the geography in the state of Texas. However, because of the lack of available spectrum and other technical limitations associated with the VHF band, several of the urban areas in Texas have moved to the newer 800 MHz band. In fact, approximately 80 percent of the population in Texas is covered by 800 MHz systems. UHF frequencies are also still in use by some police departments, fire departments, and emergency medical services in urban areas and a few local agencies are using 900 MHz systems. Additionally, state and local agencies use varying system architectures (i.e., conventional and trunked) and proprietary technologies (e.g. Motorola and M/A-COM).

The most common approach now used in Texas during incidents to achieve interoperability is radio swapping. However, this is contingent on available portable radios and has other serious limitations. Some public safety officials in Texas have even resorted to using cellular phones to communicate with other agencies during incidents requiring first responder cross jurisdictional communication.

Several regions in Texas have made substantial progress toward interoperability. For example, the Houston-Galveston Area Council of Government has substantial interoperability in the urban areas and is in the process of upgrading radio system capabilities in the outlying counties. In addition, the regional leadership in South Texas has developed a plan that will provide Level-4 interoperability from Brownsville to El Paso providing coverage along the entire Texas / Mexico border. This project leverages the existing public safety radio communications infrastructure, and will use 800 MHz systems in some of the urban areas along the border to address the long standing problems of VHF radio interference from Mexico. The Panhandle COG has completed a study that recommends the development of an IP-based network using commercial data circuits. This plan takes into account the existing communications infrastructure and the Panhandle topography. The South Texas solution is different from the Panhandle solution, yet they both achieve Level-4 interoperability within their regions taking into account their existing infrastructures, regional needs and differences.

Interoperability Solutions

There are three general solutions to achieve Level-4 or higher interoperability:

- 1) Acquire the same P25 compliant radio system for each first responder agency.
- 2) Provide all first responders with additional radio systems used within the region.
- 3) Link existing radio systems together.

The first solution is ideal only if everyone in the state acquires a new P25 ready radio system which is not feasible. Also, until standards are established there is no guarantee that P25 systems from different manufacturers will communicate with each other. The costs would be enormous and it would take too long to migrate each agency to the new system. This approach would also impact on the number of frequencies available to each agency. As more users join a common system, the number of channels available would be constrained. Obviously, this solution should not be considered by the COGs.

The second solution would be to provide first responders with multiple radios to facilitate communications. This approach has been used in different areas in Texas for years, but it is not a viable solution to interoperability. It is currently being used on a limited basis to provide interoperability between local police agencies. However, the first responder community includes EMS, Fire Departments and the Department of Public Safety Highway Patrol. Furthermore, installing multiple radio systems is cumbersome and does not enable communication with first responders in other regions in Texas.

The only practical solution is to link radio systems together within each COG. The manner in which radio systems are linked within the COGs will depend on the unique variables within the regions such as existing communication infrastructures, population density, and geographic features. The goal is to find the most cost effective means to link first responder radio systems within the region.

As previously discussed, one method of linking systems together is through the use of cross band repeaters which can connect an 800 MHz site with a VHF or UHF radio site. This would enable a radio on a 800 MHz system to be heard on the VHF or UHF repeater or a radio on a UHF system to be heard on the 800MHz on UHF repeater.

An alternative linking solution is the use of a switching mechanism that connects the different radio systems within the region using telephone lines or the internet. Switching technology can link VHF, 800 MHz, 900 MHz and UHF. It can also accommodate the future migration of some agencies to new frequencies, such as 700 MHz. **Figure 11** illustrates the three different interoperability solutions. The total system replacement solution is not a cost effective solution and should not be considered. Each COG will need to decide whether to use a cross band repeaters solution or a switching solution

based upon what is the most cost effective means that meets the needs of the region. Whatever solution is chosen it must provide Level-4 interoperability as defined in this plan to ensure interoperability between COGs and throughout the state.

Interoperability Solutions	Functionality	Cost	Time
Total System / Network Replacement	Highest	Highest	Longest
Cross Band Repeaters	Medium	Low	Medium
Network Connectivity via Switching	Medium	Medium	Medium

Figure 11: Interoperability Solutions

Implementation Steps

The success of this plan is contingent on the demonstrated leadership within the 24 COGs and their ability to address the requirements in this plan. There are also requirements in this plan for the state agencies, the Texas Office of Homeland Security and a newly established Technical Advisory Group (TAG). Several of the COGs are already implementing interoperability projects within their region that are consistent with this plan. It is recognized that several public safety agencies in Texas need funding support to upgrade their existing systems. However, the goal of this plan is to achieve statewide interoperability among the first responder community using the most cost effective solutions. Certainly upgrades to existing agency radio systems using Office of Domestic Preparedness (ODP) grant funds is acceptable; however, the first funding priority must be the attainment of regional interoperability between all COGs and throughout Texas. The following are implementation requirements for the COGs, the TAG, state agencies and the Governor’s Office of Homeland Security.

Councils of Governments

- 1) Assess the level of interoperability within the region using the SAFECOM definitions for interoperability.
- 2) Develop project proposals that achieve Level-4 regional interoperability and meet the technical requirements of this plan and submit same to the TAG.
- 3) COGs that have achieved Level-4 interoperability and have met the technical requirements of this plan should submit the appropriate documentation to the TAG for verification.
- 4) Ensure that future acquisitions or upgrades to agency radio systems within the COGs, regardless of the source of funding (grants or general revenue) is P25 capable. (Not P25 ready)

Technical Advisory Group

The success of any interoperable communications solution is dependent upon the design and implementation of the various communication components and their reaction when connected to each other. Because of the complex nature of public safety communication technologies, it is vital that the COGs and the Texas Office of Homeland Security have detailed input from an independent technical advisory group comprised of representatives from the COGs and the state who have a high degree of technical knowledge in radio systems and the application of interoperability communication solutions. The TAG will have the following responsibilities:

- 1) Establish uniform technical requirements to be used by the COGs to ensure statewide interoperability between the different bands on the designated mutual aid frequencies, regardless of the disparate manufacturers system's architecture.
- 2) Provide technical advice to the COGs on cost effective interoperability solutions.
- 3) Evaluate all interoperability projects within the state and make recommendations for funding.
- 4) Certify when a COG achieves Level-4 interoperability and meets the technical requirements of this plan.

State Agencies

- 1) Make available their existing towers for use in the regional interoperability projects.
- 2) Ensure that future radio communication acquisitions are P25 capable (not ready).
- 3) State agencies who serve as first responders such as the Texas Department of Public Safety Highway Patrol will work with each COG to achieve communications interoperability.
- 4) Other state agencies who provide a vital support role in major incidents will work with each COG to ensure communications interoperability.

Governor's Office of Homeland Security

- 1) Establish system to track the progress of regional interoperability projects and provide periodic updates to the Governor and the state legislature.
- 2) Through the Governor's Division of Emergency Management, establish statewide communications standard operating procedures for multi-agency, multi-jurisdiction responders, coordinated numbering schemes and develop dedicated Mutual Aid talk group nomenclature consistent with the National Incident Management System (NIMS).

- 3) Acquire for statewide use a deployable gateway capable of supporting interoperable communications at an incident site.