Final Report

on

State Radio Assessment

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Architects and Engineers

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TABLE OF CONTENTS

1. EXECUTIVE SUMMARY 1

1.1. SUMMARY OF FINDINGS 1
1.2. SUMMARY OF RECOMMENDATIONS 3
1.3. SUMMARY OF OPINION OF PROBABLE COSTS 5

2. INTRODUCTION 7

2.1. BACKGROUND 7
2.2. CURRENT SCENARIO 9

3. METHODOLOGY 11

4. FINDINGS 13

4.1. OKLAHOMA OFFICE OF HOMELAND SECURITY 13
4.2. OKLAHOMA DEPARTMENT OF PUBLIC SAFETY 14
4.2.1. Oklahoma Department of Public Safety – Commissioner's Office 14
4.2.2. Oklahoma Department of Public Safety -Telecommunications Division 15
4.3. OKLAHOMA STATE BUREAU OF INVESTIGATION 16
4.4. OKLAHOMA BUREAU OF NARCOTICS AND DANGEROUS DRUGS CONTROL 17
4.5. OKLAHOMA DEPARTMENT OF CORRECTIONS 18
4.6. OKLAHOMA DEPARTMENT OF WILDLIFE CONSERVATION 19
4.7. OKLAHOMA DEPARTMENT OF HEALTH 20
4.8. OKLAHOMA DEPARTMENT OF EMERGENCY MANAGEMENT 21
4.9. OKLAHOMA OFFICE OF STATE FIRE MARSHAL 21
4.10. OKLAHOMA DEPARTMENT OF TRANSPORTATION 22
4.11. OKLAHOMA DEPARTMENT OF AGRICULTURE, FOOD AND FORESTRY 24
4.12. OKLAHOMA ATTORNEY GENERAL 26
4.13. OKLAHOMA DEPARTMENT OF TOURISM AND RECREATION, DIVISION OF STATE PARKS AND RESORTS 27
4.14. ONENET 28
4.15. CITY OF TULSA 29

5. ANALYSIS OF FINDINGS 32

5.1. OVERVIEW OF OTHER STATEWIDE RADIO SYSTEMS 32
5.1.1. State of Arkansas 32
5.1.2. State of Colorado 33
5.1.3. State of Florida 35
5.1.4. State of Michigan 37
5.1.5. State of Ohio 39
5.1.6. State of Utah 42
5.1.7. State of New York 43
5.2. BEST PRACTICES AND LESSONS LEARNED 47
5.2.1. System Build-out 47
5.2.2. Governance and Management 47
5.2.3. Funding 48
5.3. TECHNOLOGY REVIEWS 48
5.3.1. Radio over Internet Protocol (RoIP) 49
5.3.2. IP Gateways and Interoperability 52
5.3.3. Mesh Networks 56
5.3.4. Analog vs. Digital 59
5.3.5. Project 25 61

5.3.6. Narrowbanding 67
5.3.7. Motorola SmartZone 4.1 72
5.3.8. PassPort LTR Trunking Systems 75
5.4. ANALYSIS 78

6. RECOMMENDATIONS 80

6.1. OVERALL RECOMMENDATIONS 80
6.2. SPECIFIC RECOMMENDATIONS 81
6.2.1. System Governance and Management 81
6.2.2. Technology and Spectrum 82
6.2.3. System Funding 83
6.2.4. System Coverage Levels 85
6.2.5. System Connectivity 85
6.2.6. Interoperability 87
6.2.7. System Build-Out and Upgrades 90
6.2.8. Opinion of Probable Costs 92

APPENDIX A – EXECUTIVE ORDER 95

APPENDIX B – SURVEY QUESTIONNAIRES 98

APPENDIX C – DPS SYSTEM DOCUMENTATION 105

APPENDIX D – ODOT SYSTEM DOCUMENTATION 131

APPENDIX E – ONENET SYSTEM DOCUMENTATION 136

APPENDIX F – OPINION OF PROBABLE COST WORKSHEETS 139

1. EXECUTIVE SUMMARY

In October of 2007, Oklahoma Governor Brad Henry issued Executive Order 2007-42, which recognized the fact that the lack of interoperable communication between public safety agencies at all levels of government in the State is a persistent problem that has existed for many years. The Order highlights that over $32 million in federal funding has been used to try and address the problem, but it still persists. The Order goes on to authorize the Oklahoma Office of Homeland Security (OKOHS) to conduct a detailed study of the public safety communications situation in the State, as well as directing all State agencies, boards and commissions to fully cooperate with the OKOHS in the study and development of an interoperable communications plan. Late in December, 2007, L. Robert Kimball & Associates (Kimball) was contracted by the State of Oklahoma to begin this effort. Through the efforts of the first phase of this study, this State Radio System Assessment report is presented.

To accurately portray the current situation in the State, interviews were held with more than 15 different State agencies that have a role in public safety or disaster response. To determine what the best practices of the public safety communications industry are in the area of developing statewide communications capabilities, seven states that either already have statewide radio systems or are in the development stages were surveyed. A review of relevant technologies was performed to determine the most appropriate technologies for use in a Statewide environment. And through this, next step recommendations for the State were developed and are presented here.

1.1. SUMMARY OF FINDINGS

From this effort, the following high-level findings are put forth. Detailed discussions of each finding are found later in the report.

- As there has been no coordinated strategy to develop public safety communications capabilities across State agencies, each agency has developed independent systems to meet their own needs, which has created a disjointed number of “silo” systems that cannot interoperate with each other.
- This lack of a coordinated strategy has not only hindered the development of interoperability statewide, it could also put future federal grant funding at risk, which is increasingly requiring long term, strategic plans for communications.
- The Oklahoma Office of Homeland Security (OKOHS) by virtue of being the State Administering Agency (SAA) for federal homeland security funds has taken the lead in interoperable communications planning for the State. OKOHS is focused on tactical and strategic communication planning resulting in expansion of the existing 800 MHz system down the I-44 corridor, allowing public safety agencies at all levels of government the opportunity to participate in the system.
- Tactical solution place holder
- The State has been approached by numerous vendors, all claiming to have the answer to the State’s interoperable communications issues through the use of different devices and technologies (i.e., IP-based routers and gateways), and all at “lower” costs. While all of these “solutions” do have a use,

none of them are a total solution; and none do anything to extend the coverage of a public safety radio system into areas where no infrastructure exists.

- The existing 800 MHz radio system has been expanded to cover more than 70 percent of the State's population, but it only covers about 40 percent of the State's geographic area. Along with state agencies, many local government agencies use this system as their primary communications system for public safety agencies. While in this coverage area it provides reliable, robust coverage for public safety at all levels of government, in the areas that it does not cover communications is provided by legacy equipment that in some cases is more than 20 years old and has no ability to support interoperability at all. In a large part of the State, there is no reliable "operability" for public safety agencies.
- State agencies are almost totally reliant on the City of Tulsa's Communications Division to manage the current 800 MHz radio system. This is a relationship that has evolved over the years but needs to be revisited to meet the State's current and future requirements on a Statewide system.
- While DPS makes a small monetary contribution to the maintenance of the controller in Tulsa, no DPS staff actively participate in the management of the system that is relied upon for a very large portion of public safety operations in the State.
- Overall, the budgets of State agencies in the area of emergency radio communications are either insufficient or non-existent.
- There are over 19,000 individual radios on the existing 800 MHz system, operating on over 1,300 talk-groups. Over half of these radios either belong to local public safety agencies or State agencies other than the City of Tulsa. These radios have full interoperable capabilities in the coverage zone. The City of Tulsa controls the assignment and management of individual radio ID codes and talk groups. Due to the City staff's heavy workload and conflicts in priorities between City needs and State-level needs, delays in the assignment or modification of radio assets are common. Local agencies acquire radios that cannot be used on the system until assignments are made, which is often not in a timely manner.
- Several times it was heard during the data collection of this report that 800 MHz was "old" technology. Spectrum, or the band of frequencies that a radio system operates on, is often mistaken as a technology. Different parts of the 800 MHz spectrum are used by many technologies, including wireless routers, cellular telephones and public safety radio systems.
- The existing analog 800 MHz system uses the Motorola SmartZone 4.1 Operating System. While this operating system has been an extremely reliable product, Motorola has announced that they will not support this operating system after December 2012. However, the lifecycle of the existing infrastructure can be extended by a migration to a digital operating system. This will also allow for the expansion of the infrastructure.
- All agencies have a hodgepodge of radio equipment in use. All agencies are understaffed or have no staff that is dedicated to maintaining and managing these assets. This lack of staffing has caused delays in equipment repairs and coordination of radio development plans. Other than DPS and ODOT, most agencies have no accurate idea of what they are spending on radio communications each year. Based on what is being spent on similar activities around the nation, the amount of funding is insufficient to provide day to day management, maintenance, and life cycle upgrades.
- The Oklahoma Department of Transportation (ODOT) is in the process of building a system that may one day provide a level of Statewide capability that is designed to ODOT's requirements but not public safety's. The new ODOT system does not meet the basic standards for a public safety

trunked radio system. ODOT has also stated that this system was designed to meet their immediate and future requirements and was never intended to be a public safety grade radio system. This system will provide ODOT with an infrastructure that will meet the Federal Communication Commission's first narrowbanding mandate in January, 2013; however, the infrastructure and subscriber radios currently being installed will not be able to meet an expected second narrowbanding mandate that should occur in the next five-to-ten years. Several State agencies with public safety responsibilities have indicated an interest in participating in the ODOT system when it is completely deployed and activated.

- Most agencies indicated a future desire to have features available to them such as mobile data, automatic vehicle locator (AVL), and wireless broadband services to allow their field personnel to be more effective in their delivery of services to the public.

1.2. SUMMARY OF RECOMMENDATIONS

To address the presented findings, Kimball offers the following recommendations to the State:

- Even though there has been no coordinated effort between most state agencies to develop a single interoperable statewide system, interoperability capabilities have improved by using Federal grant dollars to expand the existing 800 MHz system. The 800 MHz system is the best platform for public safety agencies statewide, and Kimball recommends that the State continue to support and enhance this initiative.

- The State must adopt as part of its Statewide Communications Interoperability Plan (SCIP) that a Statewide public safety 800 MHz radio system is the platform that will be used to provide robust, standards based interoperable communications throughout the State. As part of this, the State should continue to expand its policy of allowing local public safety agencies access to the system as their primary means of communications, as well as providing accommodations for local public safety agencies that will not or cannot join as full participants in the system.
- This 800 MHz system must be expanded to cover the areas of the State it currently does not cover, and have additional capacity and upgraded features added to it to be able to support the needs of state and local public safety agencies. The upgrades to the system must be accomplished using accepted public safety standards for radio communications. For this type of system, the P25 Standard is the applicable standard to be used.
- The IP-based "gateway" and router solutions should not be considered a solution to interoperable communications but rather as specific tools that can be used in specific situations. These solutions do nothing to extend the coverage of a radio system into areas if there is no infrastructure in place to support the system. A good example of how this type of solution may be used is in linking the Statewide public safety 800 MHz system and the ODOT radio system. These solutions can also be used to link local and federal agencies to the Statewide system, as long as both systems provide coverage into the area where personnel will be operating.
- The existing 800 MHz system should be upgraded and expanded in phases over a period of seven to ten years as follows:

- Phase I – Install new digital controllers, interface approximately 40 existing sites to new switches, add four additional sites to current 800 MHz service area, replace existing connectivity with new digital microwave system, and upgrade site radio equipment
- Phase II – Expand system to the area north of the Interstate 44 corridor and west of the Interstate 35 corridor, adding 30 additional sites, linked to new digital controllers by new digital microwave system
- Phase III – Expand system to the area south of the Interstate 44 corridor and east of the Interstate 35 corridor, adding 23 additional sites, linked to the new controllers by new digital microwave.

- The State must designate a single state agency to provide the ownership and management of this system, and provide adequate funding to allow this mission to be accomplished. These items are currently not in place. While this may be an agency such as DPS or the Office of State Finance (OSF) in the early stages in order to keep things moving this function should ultimately reside in an independent, third-party State agency. An agency with skills in the area of communications, client management, information technology, or networks, will be most successful in the long term. The current management arrangement with the City of Tulsa for the existing 800 MHz system is not workable for a future Statewide system. The State must take this responsibility.
- An independent entity should be designated to provide planning and policy development guidance on interoperable communications and the continued enhancement of the 800 MHz Statewide system. This entity can take the form of an advisory board or steering committee and must fully represent the participants in a Statewide radio system at all levels of government and disciplines. The existing Governance Working Group established during the Statewide Communications Interoperability Plan (SCIP) planning process could fulfill this role.
- A stable source of State-level funding must be identified and put in place. This funding must be sufficient to cover system expansion, system management and system life-cycle replacements. This funding can come from a mix of sources, such as direct appropriations, bonds and user fees. Grants must not be considered a stable or exclusive source of funding for a new upgraded system.
- State agencies that have developed "silo" radio systems for their own use must be discouraged from making major investments into technology upgrades on those legacy systems. Instead, those systems should be supported only until the 800 MHz system is capable of providing the level of coverage and service to meet that agency's requirements.
- All State agencies that have a public safety function must be strongly encouraged to participate in the 800 MHz system. Agency participation in a shared 800 MHz system may enhance the State's and agency's position in obtaining federal Homeland Security Grants in the future.
- ODOT should continue to develop their Statewide system to meets their needs. Interoperability between the ODOT system and the Statewide public safety 800 MHz system must be attained to support public safety and disaster recovery operations in the State. State agencies with a public safety mission should be discouraged from using this system as it is not a public safety standards based system.
- A complete, detailed inventory of State-owned radio assets (e.g., frequencies, tower sites and condition, infrastructure, mobiles and portables), should be completed to get an accurate picture of the total radio situation. Information collected in this inventory will also help to satisfy federal Homeland Security requirements to accurately catalog all interoperable assets in the State.

- Partnership opportunities with ODOT, OneNet, and the private sector to co-locate on existing towers should be pursued as a way to control costs of deploying the new 800 MHz system statewide.
- The OKOHS has started the planning for some of the recommendations made here, independent of this assessment. That work should be continued and used a basis for all future planning and work.

1.3. SUMMARY OF OPINION OF PROBABLE COSTS

In order to understand the magnitude of a Statewide public safety radio system and be fully prepared as the State moves forward into the planning process, an opinion of probable costs has been developed for the overall build-out of the system, as well as the projected ten-year operating costs.

Based on information collected from various vendors, prior proposals for similar equipment, and industry knowledge, in Table 1.1, Kimball provides the following budgetary estimates for a new, upgraded Public Safety Communications 800 MHz system. A detailed breakdown of this budgetary estimate is found in Section 6.2.8 of this report. It should be noted that these costs show estimates for communications infrastructure only and represent a worst case scenario. A full list of the assumptions used to develop these estimates is found in Section 6.2.8.

Phase	Amount
Phase I	$ 23,100,000
Phase II	$ 63,288,500
Phase III	$ 48,950,000
TOTAL CAPITAL OUTLAY	$ 135,338,500

Table 1.1 - Budgetary Estimate of Total Capital Outlay

To provide for the proper management and maintenance of a complex communications network, the following opinion of probable cost is presented in Table 1.2. Full details of this budgetary estimate are found in Section 6.2.8 of this report.

	Maintenance and Lifecycle Upgrade	Site Utilities	System Management Costs	Total
Year 1	$ 5,000,000	$ 96,000	$ 375,000	**$ 5,471,000**
Year 2	$ 9,516,375	$ 123,600	$ 386,250	**$ 10,026,225**
Year 3	$ 9,706,703	$ 148,320	$ 397,838	**$ 10,252,860**
Year 4	$ 9,900,837	$ 173,040	$ 409,773	**$ 10,483,649**
Year 5	$ 10,098,853	$ 197,760	$ 422,066	**$ 10,718,679**
Year 6	$ 10,300,830	$ 222,480	$ 434,728	**$ 10,958,038**
Year 7	$ 10,506,847	$ 239,784	$ 447,770	**$ 11,194,401**
Year 8	$ 10,716,984	$ 246,978	$ 461,203	**$ 11,425,164**
Year 9	$ 10,931,324	$ 254,387	$ 475,039	**$ 11,660,749**
Year 10	$ 11,149,950	$ 262,018	$ 489,290	**$ 11,901,258**

Table 1.2 - Projected Ten-year System Operating Costs

The State of Oklahoma has taken the first step in improving the interoperable communications situation in the State by moving forward with this assessment. By developing a realistic SCIP that incorporates these recommendations and the best practices learned from other states, Oklahoma will position itself as a leader in the nation in the area of interoperable communications. Sufficient, stable funding must be identified and secured. The State must take the lead role in the planning, deployment, and overall management of the Statewide public safety 800 MHz radio system. And the attitude of individual agencies developing "silo" communication systems cannot be allowed if this problem is ever to be solved.

2. INTRODUCTION

As part of its effort to provide the best possible interoperable communications support to public safety first responders at all levels of government, the State of Oklahoma (the State) is studying the concept of developing a Statewide, interoperable communications network. During the 2007 Legislative Session, the State Legislature provided funding as part of the Public Safety Interoperable Communications (PSIC) Grant Program matching funds to conduct an evaluation, analysis, and develop recommendations for such a system. To further emphasize the critical nature of this issue, Governor Brad Henry issued an Executive Order (#2007-42) on October 16, 2007, which directed the Oklahoma Office of Homeland Security (OKOHS) to:

- Continue to oversee the implementation of any and all initiatives or efforts mandated by the United States Department of Homeland Security (DHS)
- Develop a Statewide Communications Interoperable Plan (SCIP)
- Develop and oversee a study of the current interoperable radio capabilities of State public safety agencies.

Executive Order #2007-42 further directs all State agencies, boards and commissions to fully cooperate with OKOHS on the development of this study. A copy of this Order can be found in the appendices of this report.

As part of this effort, in late December, 2007, the State entered into a contract with L. Robert Kimball & Associates (Kimball) to perform this study for the State. This report is the result of the study; and in this report, the following questions are addressed:

- What is the current state of radio communications at the State agency level?
- If a Statewide radio communications network was available that met the operational needs of State agencies, would State agencies participate?
- What are the next steps the State should consider based on industry best practices and lessons learned?

As the second part of this project, Kimball will be conducting an inventory of State agency radio assets. This inventory should be completed by the summer of 2008 and will paint an accurate picture of the current state of radio communications at the State level.

2.1. BACKGROUND

In November, 1907, Oklahoma became the 46th state in the United States of America. Oklahoma has a rich heritage as a frontier state and is currently a major producer of agricultural products (i.e., cattle, grain, produce). In addition, Oklahoma is also a major supplier of oil and natural gas to the nation. As of 2007, the population of Oklahoma was estimated at 3,617,316 by the United States Census Bureau, covering a total of 69,919 square miles. Oklahoma is also home to 39 Federally recognized Native

American tribal nations, with each being a sovereign nation in the State and estimated to make up over 8 percent of the population of the State.

The State is as diverse in its geographical features as it is in its population. From the open plains of the western regions of the State, to mountain ranges and hilly terrain in the southeastern areas of the State, the State's geography poses challenges to radio communications. This diverse landscape has caused the population to settle along the Interstate Highway transportation corridors, with over 70 percent of the State's citizens living within 50 miles either side of the I-44 corridor. Figure 1.1 shows how the population is located around the State, with some areas having a population of as few as two persons per square mile.

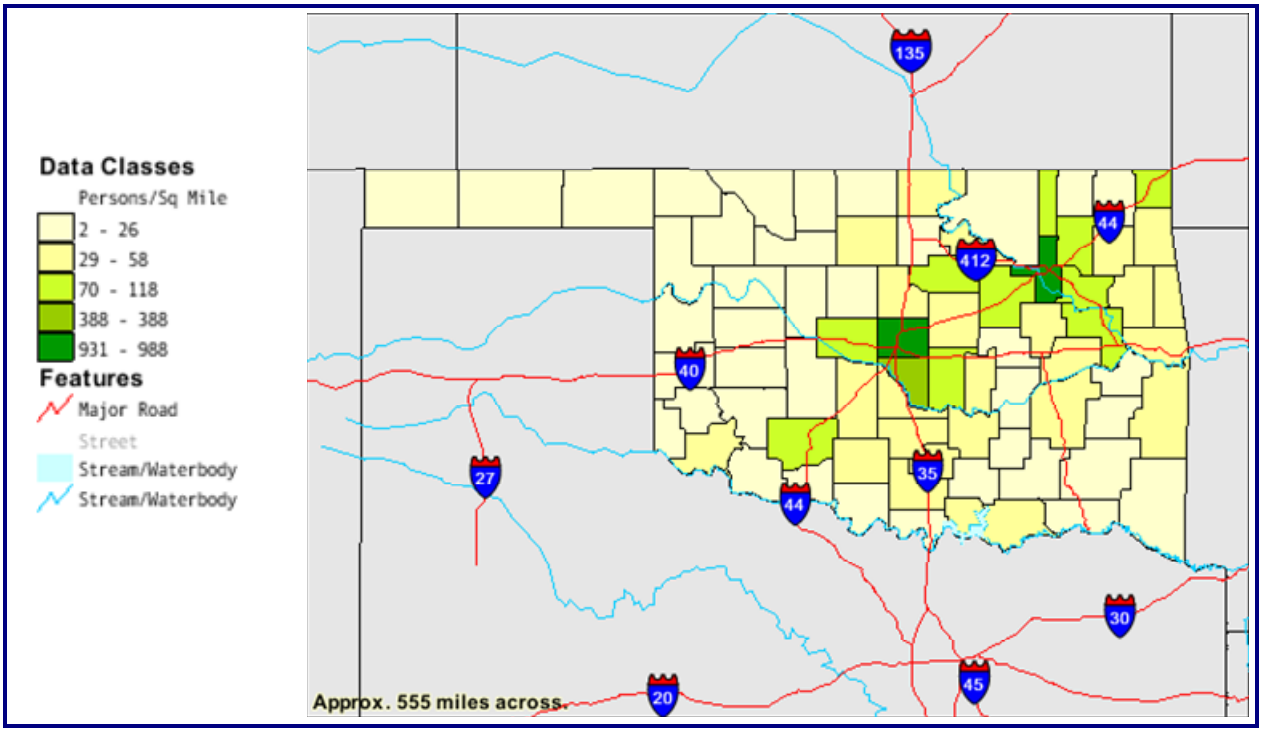


Figure 2.1 - Oklahoma Population per Square Mile by County

Source: United States Census Bureau, 2007 Estimates

Oklahoma also bears the distinction of being home to numerous catastrophes, both natural and manmade. In 2007, the State was declared a Federal Disaster Area numerous times for such instances as tornados, floods, and in January and December of 2007 when a massive ice storms coated large parts of the State with a thick layer of ice, causing electrical power to be out for weeks in large areas and massive destruction of trees. In 1995, the State was site to the worst case of domestic-borne terrorism in the history of the nation with the bombing of the Alfred P. Murrah Federal Building in Oklahoma City. Regardless of the cause of these disasters, each one required the response of multiple public safety and humanitarian agencies, causing the need for interoperable communications. While the needs of the State's first responders continue to grow, no one agency at any level of government has a good picture of what communication systems are currently in use and what plans are being made to improve the capabilities in the future.

As the State moves forward to address this critical issue, the findings and recommendations of this report will act as a roadmap to the development and enhancement of interoperable communications, and to assist in the review and updating of the State's SCIP.

2.2. CURRENT SCENARIO

In the early 1990s, the Oklahoma Department of Public Safety (DPS) was using low-band Very High Frequency (VHF) radios for both dispatch and car-to-car communications. While low-band is a reliable means of communications that is capable of covering large geographic areas, channel congestion as the DPS grew could not be addressed. In approximately 1992, DPS began the development of a trunked radio system using the 800 MHz band of frequencies in the Oklahoma City area to support the higher number of users and the large population in that area. At about the same time, the City of Tulsa began the development of a similar trunked radio system to support its operations. As the two systems developed, the State and the City of Tulsa joined in the development of a joint system that allowed radio coverage from Oklahoma City to Tulsa along the Interstate 44 corridor. The State was allowed to connect to the system controller in Tulsa, which allowed for seamless communications for DPS vehicles equipped with 800 MHz radios along the corridor.

Over the next few years, upgrades were done to the system, including the State providing a new system controller to Tulsa to accommodate the ever-increasing number of State users on the system. As Federal Grant money became available to assist with modernizing communications after the September 11, 2001, terrorist attacks, the State leveraged these funds to expand the coverage and capacity of the system to cover the Interstate 44 corridor from one end of the State to the other, effectively covering the majority of the population of the State but not the geographic area. As geographic areas were covered with the 800 MHz system, local (i.e., county, municipal) public safety agencies were offered the opportunity to join the system with radios purchased by the State with Federal Grant monies. At the time of this report, approximately 20,000 users are on the system from various State and local agencies, with over 40 tower sites in use. In areas that the 800 MHz system does not provide coverage, DPS still uses low-band radios, which is effectively technology that is over 40 years old and does not meet the current or future needs of public safety. A system block drawing indicating radio site locations and detailed information on what type of equipment is at each site can be found in Appendix C of this report.

Currently on the existing 800 MHz system, there are approximately 19,000 active mobile and portable radios. The system is comprised of approximately 1,356 talk groups used by all agencies in the state. A listing of the agencies that have active or reserved talk groups on the system can be found in Appendix C of this report.

One thing has not changed in the system and that is that there is only one system controller, and it is located in and managed by the City of Tulsa. While the State does contribute to the maintenance of the controller, the State plays no part in the management of the system and relies completely on the City of Tulsa radio staff to manage the entire system, even though the vast majority of users on the system are not from City agencies. The City of Tulsa has done a good job of managing the entire system, but as more localities and agencies join, increased pressure and requirements will be placed on City staff to do work that is the responsibility of the State. This situation will be looked at closer in the Findings and Analysis sections of this report.

Along with this, some State agencies have either started development of their own Statewide radio systems or seemingly abandoned the concept of their own system, opting to use commercial wireless providers or no service at all. It does not appear that there is an accurate picture of what efforts are going on in the State at this time. This report will attempt to identify these efforts and provide an analysis of any new systems and how they may relate to public safety in the State.

3. METHODOLOGY

Kimball follows a structured methodology when developing reports of this type. Kimball uses the principles of project management that have been developed and used by the Project Management Institute (PMI), which allows the project to be tracked for success from beginning to end.

For the State of Oklahoma, the following flowchart describes the overall process used in developing the recommendations and report in this project.

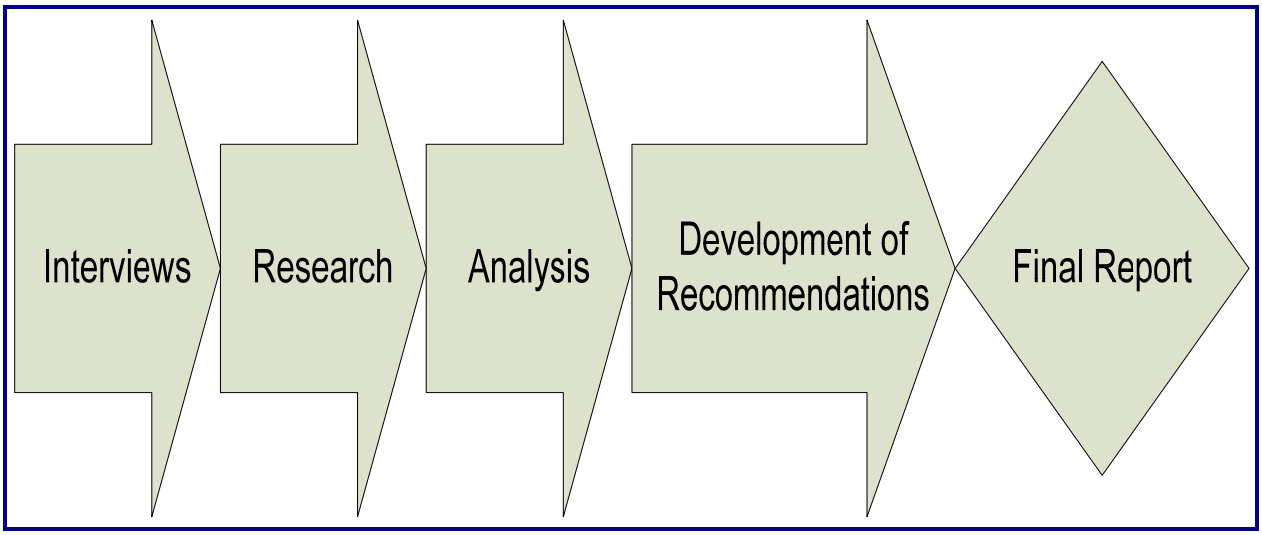


Figure 3.1 - Oklahoma Project Methodology Flow Chart

To facilitate the interviews, a standard survey questionnaire was developed in order to obtain a baseline of information that is consistent across the different agencies. Agencies that were interviewed include:

- Oklahoma State Bureau of Investigation
- Oklahoma Department of Public Safety
- Oklahoma State Bureau of Narcotics and Dangerous Drugs Control
- Oklahoma State Fire Marshal
- Oklahoma Department of Wildlife Conservation
- Oklahoma State Department of Corrections
- Oklahoma Department of Emergency Management
- Oklahoma Office of Homeland Security
- Oklahoma Department of Transportation
- Oklahoma Department of Public Health
- Oklahoma Department of Agriculture
- OneNet
- City of Tulsa

While interviews were being conducted and documented, information on what other states that are either already operating statewide radio systems or are in the planning stages of one was being collected, with the best practices and lessons learned from each state being documented. In addition, research into the

various technologies and standards that will affect a recommendation to the State was conducted. Through this data collection, the findings from the interviews were analyzed, allowing the recommendations of the report to be developed.

Throughout the process, the final report underwent review through Kimball's quality assurance process to assure that data is accurate and that recommendations meet the needs of the State.

4. FINDINGS

In this section, documentation of each agency that was interviewed for this report is presented. A standard survey questionnaire was developed and used for all interviews. A copy of this tool is provided in the appendices of this report. In each case, information on the following topics is presented:

- The agency system, including the number of sites, age and condition of equipment
- An estimate of the number of subscriber units in use
- How the system is currently used
- An assessment of whether the current system meets the needs of the agency
- Whether or not a Statewide shared system would benefit the agency operations
- Other State and local agencies regularly worked with or interoperated with
- The type of system and subscriber maintenance
- The annual cost of maintenance and radio replacement
- Advanced features the agency may want in the future
- Agency plans for the future
- Potentials for interoperability with other UASI regions and states

The analysis of this information is presented in Section 5 of this report.

4.1. OKLAHOMA OFFICE OF HOMELAND SECURITY

Director Kerry Pettingill was representative of the Office of Homeland Security (OKOHS) for purpose of the assessment interview. He indicated that the office acts as the conduit to evaluate the potential of the State to respond to situations that impact the public safety and security. They use the standards as defined by the State and the federal government to evaluate response potential. From these assessments the department designs plans for improvements where needed. Due to the history of natural and manmade disaster circumstances that demand the interoperation of many State and local agencies, the evaluation of communications within the State of Oklahoma is of primary importance. This office is responsible to all State agencies, as well as local agencies and the general public, in its role of trying to ensure that the proper tools and procedures are in place.

A portion of the office's focus has been on communications among response agencies during emergency situations. The frequency and severity of natural disasters in Oklahoma have provided opportunities for observation of wireless inter-agency communications. A complete view of the systems used in the State has, up to this point in time, been difficult to assess. It has been determined that communications between agencies during event responses is not adequate. There is a wide variety of communications systems maintained within the State, but they have no real interoperable system. Some agencies rely on annual budget appropriations for communications funding and others simply use general operating funds as they see fit. Only a few agencies seem to have a plan in place to maintain and improve their communications and those plans are specific to the agency and not the overall communications needs of the State.

With these issues in mind, the OKOHS has determined that the following criteria must be met for true interoperability:

- All agencies should be able to communicate on a single system
- The system must be robust enough to handle all State and local agencies
- The system must cover all regions of the State
- The State must own and manage the system
- The system must be available to local agencies
- Training on system use must be established
- An agency independent of user agencies should manage the system

4.2. OKLAHOMA DEPARTMENT OF PUBLIC SAFETY

4.2.1. Oklahoma Department of Public Safety – Commissioner's Office

Commissioner Kevin Ward was interviewed on behalf of the Department of Public Safety (DPS). He indicated that the department plays a major role in daily law enforcement and public protection and that requires a complete communications system. The Statewide need becomes even more apparent during a time of disaster crisis.

This department operates two communications systems, and the accounting of these systems is included in the stakeholder interview of the department communications division.

The commissioner expressed his opinion that the trunked system that was in use along the Interstate 44 corridor has provided a dependable and interoperable means of communication. He stated that the system was started in the mid 1980s and was supposed to be completed in five years. Now, after over 20 years have passed, there is even a greater need for Oklahoma to find the resources to provide a communications system that can provide interoperability to all State agencies and local agencies if they so desire. He made clear the fact that the Department of Public Safety's mission was not to build and maintain a Statewide communications system, and delays in expansion were likely due to the department's lack of focus in that area.. He suggested that any effort to build any system that served all the State would have to be managed by an agency dedicated to that one mission. Commissioner Ward noted that the concept and use of wireless communications has changed drastically in 20 years as have the needs. He stated that vehicle location, mobile data and mobile video are all technologies that can play an important part in the operation of the department.

The State has made a significant investment in a Smart Zone Trunk system that currently provides communications that meet the accepted APCO-16 standards for interoperability and functionality and meets the current capacity needs. The current system does not provide coverage to the entire State, nor does it have the capacity to expand without hardware and software upgrades. Although this system serves the Oklahoma Department of Public Safety and other State and local agencies satisfactorily, it is managed by the City of Tulsa. The City of Tulsa has to this point in time managed the system in a fashion that benefits all the agencies, but recent disasters have shown that conflicts of priorities can arise due to the State and the City having different primary missions and obligations.

The Commissioner expressed a firm belief that a single, interoperable communications system that was managed by an agency, whose sole mission was to provide that service to all departments in the State, is possible and necessary for the welfare of the citizens of Oklahoma.

4.2.2. Oklahoma Department of Public Safety -Telecommunications Division

Dennis Mitchell and Gene Thaxton were interviewed as part of the Department of Public Safety representative of the Communication Division. The role of the division is to provide communications support to the DPS. This division is responsible for, and is most familiar with, existing radio systems used by the department.

There are two systems currently in use in the department. The Smart Zone Trunk system is in use throughout the I-44 corridor and the I-35 corridor south of Oklahoma City. The original low-band VHF system that was placed into service in the 1950s is still being used throughout the State but is primary in all areas not currently served by the Smart Zone System. This mandates that all highway patrol vehicles have a minimum of two radios installed for communications.

The department originally operated with 11 full-time personnel but is now staffed by four technicians and one individual divided between management and technical duties. This staff is responsible for all the fixed equipment located throughout the State, as well as all mobile and portable equipment in use by the highway patrol. All equipment and personnel resources are located in Oklahoma City. This mandates that all field service time includes travel to the fixed equipment site wherever it is located in the State. It also means that highway patrol units must return to Oklahoma City for service to the electronic equipment in the vehicle. Loss of actual time in the performance of the primary mission of the highway patrol and the communications department is inevitable under these conditions.

The department's annual budget is divided between the operations of these two independent systems.

Low Band System Budget	
-Electricity	$ 26,000.00
-Telephone Circuits	$ 223,200.00
-Low Band Tower Leases	$ 21,000.00
TOTAL LOW BAND COSTS	**$ 270,200.00**

SmartZone System Budget	
-Electricity	$ 71,000.00
-SmartZone Tower Leases	$ 122,000.00
-Generator Maintenance	$ 15,000.00
Motorola System Maintenance Contract	$ 178,000.00
SmartZone Leased Circuits	$ 114,000.00
TOTAL SMARTZONE COSTS	**$ 500,000.00**

The department is currently finding that the maintenance challenges they are facing will require more training in advanced technologies in order to provide adequate service. They are also processing a request to add one more technician to the staff to keep pace with the demands of maintaining the antiquated low-band system and the more advanced Smart Zone system.

The City of Tulsa maintains the Smart Zone controller; therefore, the addition of any new user groups requires that the Tulsa radio group reprogram the system. The data must then be transferred to the State communications department so that they can program the subscriber units. This process has been said to be taking weeks to complete. The Tulsa radio group has found that expansion and changes to the Smart

Zone system made by the State is interfering with the responsibilities that they have to the City. The City of Tulsa is not compensated for the time that they have to invest in the modifications to the system controller. The State has relied on Tulsa for the management of this system, which is primarily used by the State itself. It appears that this partnership has begun to exhibit signs of stress on behalf both parties. The re-organization of this arrangement is inevitable if the Smart Zone system is to continue to perform as expected.

4.3. OKLAHOMA STATE BUREAU OF INVESTIGATION

Alan Salmon represented the department as the individual who manages the radio system. It was determined that although the agency's primary role is to provide investigative assistance to local law enforcement groups; it does play a role in being a resource in disaster situations. Its primary role is in the area of law enforcement and is therefore subject to certain communications needs as they pertain to the safety and wellbeing of department personnel.

The radio system used consists of a single high-band (VHF) repeater that is located in Oklahoma City and approximately 300 personal radios that are used by the department members. The repeater provides communication to the single dispatch center located in Oklahoma City if the investigators are within a 40-to-70-mile radius of the City. Beyond that distance, cell phones are used for communications to the agency. Cell phone coverage through the State is not reliable in all areas and has been found to be practically useless during a disaster or major event. The repeater itself is approximately 20 years old and although it is currently reliable, is beyond its industry accepted life-cycle. The agency vehicles are equipped with a VHF radio and a low-band radio. The VHF radio allows communication with the Bureau and with local agencies using that band. Not all local agencies use the VHF band. At least four counties use the UHF (Ultra High Band) portion of the spectrum, and communications with these agencies is achieved with cellular phones. The low-band radio is used to communicate with the Oklahoma Highway Patrol. All department members carry a portable VHF radio. In total, the department supports approximately 340 radios. The department also has two radios on the Department of Public Safety trunked radio system. These radios are installed in the surveillance and mobile command post vehicles.

The department has no plan to upgrade or improve this system. Attention is given to replacement of radios that are no longer serviceable and the repair of those that can be returned to service. It was estimated that less than $5,000 is used to keep the system operational with no improvements. The department has no internal radio shop and uses OneLink Wireless and Southwest Communications to supply any needed services.

Primary interoperability needs were identified as:

- Local public safety agencies
- Department of Public Safety

It was expressed that a Statewide communication system that provided interoperable communications with the State departments, as well as the local departments, would be beneficial. If it were available and served the needs of the Bureau, they would be interested in participating.

The use of the following enhancements would also be of interest to the department.

- Mobile Data (Agents use laptops in the field)
- Voice Encryption

4.4. OKLAHOMA BUREAU OF NARCOTICS AND DANGEROUS DRUGS CONTROL

Bryan Williams and Paul Robinson were the representatives of the bureau interviewed. This agency is primary in the enforcement of the laws of the State as they apply to illegal narcotics. As an enforcement agency, their primary responsibility is in the investigation, surveillance and apprehension of individuals involved with the illicit manufacture, distribution and use of narcotics. The bureau also has a response function as a supporting State agency in disaster operations because of their unique training and skill set.

The bureau operates a VHF high-band system that consists of eight repeater sites and several smaller receiver sites provide an additional receive source in some difficult areas. Most of these repeaters are collocated on the towers maintained by the Department of Transportation, but at least two are located at leased commercial sites. The repeaters are linked back via leased telephone circuits to the full-time dispatch center in Oklahoma City. Each of the five regional offices also has a dispatch console, and all centers also provide dispatch duties for the State Fire Marshall, the Pharmacy Board and the Veterinarian Board. The coverage in most of the State is described as "pretty good" regarding mobiles, although the panhandle region is classified as having limited mobile coverage. The repeaters are "independent" standalone units and so communication is limited to within the regional coverage of the particular repeater being accessed. A fleet of approximately 60 mobiles and 60 portables is operated Statewide.

A general estimate places operating costs at $40,000. This would include the lease of the telephone circuits and towers, the cost of electricity, and the cost of service provided by Total Radio. Some equipment costs are considered in the general number attributed to annual cost since equipment is being replaced as the budget allows. This equipment is being replaced in order to meet the requirements of narrowbanding and some other considerations that are mentioned below. Total Radio is contracted to perform all service related functions to maintain the system in operating condition. All radio system costs are included in the general operating budget of the bureau. They do not have a separate budget number that is allotted to the purchase of new radios.

The Bureau of Narcotics feels that the radio system they have in place is obsolete and does not meet the overall need of current and future operational situations. They understand that narrowbanding will be mandatory by the year 2013 and are preparing toward migration of the entire system to meet that requirement. They also are working toward a digital platform of operations and possibly toward the P25 platform.

It was expressed that interoperability between agencies within the State is very important and if there were a system in place that provided that feature, as well as Statewide coverage, they would be a willing partner. Specific needs for interoperability included:

- All local law enforcement agencies
- Department of Public Safety
- Department of Wildlife Conservation

The ability to use the following advanced applications would improve field operations.

- Voice encryption to prevent monitoring of communications
- Mobile data to allow laptops to access the network from the field. Currently the department uses air-cards on a commercial system.

4.5. OKLAHOMA DEPARTMENT OF CORRECTIONS

Present for the stakeholders interview were Greg Williams, James Arnett, Steve Moles and Carl Wilkes. The Department of Corrections' primary mission is to safely handle the detention of criminal offenders; but as a State agency they can be called upon to assist the general public in the event of a terrorist act or a natural disaster. They have resources that include k-9 tracking and locating of lost, disabled or escaped individuals. As part of the law enforcement agencies of the State, they are charged with the safety of the inmates under their supervision as well as the general public of the State.

This department uses radios in the 800 MHz frequency band. Some facilities use a repeater and others operate on a simplex system for use within the facilities only. All portable radios used within these systems are programmed with the same template and can be used on the trunked system currently operated by the Department of Public Safety. Only a few facilities can actually use the trunked system at their primary location since that system has been designed to provide coverage in the major population and interstate travel portions of the State. The physical location of most correctional facilities is beyond the operational range of the trunked system. In addition to the 800 MHz radios, some facilities use a VHF high-band system for internal operations and wider area operations. The use of the VHF high-band systems allows some interoperability with local agencies although it was indicated that overall cost is also a driving factor.

There is no single communications plan for the Department of Corrections. Each facility has the latitude to do what they feel best suits the immediate need since there is no Statewide coverage system currently in place. Internal management issues exist with communications systems because a general budget appropriation is made for the entire department and then divided among all the facilities. The cost of operations of communications must then be allocated from within each facilities budget. Since there is no communication system guideline, each facility is left to determine a course of action that fits within the available funding. The entire budget for maintenance of all 800 MHz radios used by the department is reported to be $25,000. The VHF high-band systems in use are maintained internally by DOC personnel band are minimal. An exact count of units in service was not able to be determined and included with this report due to the independent management of communications within all facilities.

The Department of Corrections representatives believe that the current needs of interoperable communications are not being met. Most facilities can work with each other and with their local agencies but lose communications as they deploy in the field. Communications with other agencies within the State is disjointed. There is no single common system that can be used for inter-agency communications.

It is felt that if a Statewide communications system were in place, the Department of Corrections would find itself able to adapt if that system were based on the 800 MHz systems the department already has in place.

The interoperability needs were defined as:

- Communications between correctional facilities
- Communications with local law enforcement
- Communications with Department of Public Safety

4.6. OKLAHOMA DEPARTMENT OF WILDLIFE CONSERVATION

James Foster was interviewed as the communications manager of the department. The primary mission is to enforce the hunting and conservation laws of the State of Oklahoma. In the role as law officers they can be called into service in the event of a disaster situation. The department field personnel consist of wardens and wildlife managers who have a need for Statewide communications. The duties of the department personnel place them in situations where they must confront illegal poachers and remotely located drug operations. Both of these situations present a danger and the possibility of bodily harm to the department personnel.

The communications system in use operates in the low-band portion of the spectrum. The infrastructure, consisting of around 30 low-band repeaters, was placed into service in the 1980s and is reported as not being in the best shape. These repeaters are located at sites that were once maintained internally by the Wildlife Department but have since been transferred to the Department of Transportation. Financial budgetary issues were sited to be the primary reason. The sites were traded in order to obtain maintenance assistance from the radio department of the Department of Transportation. The lifecycle of these fixed stations appears to be beyond expectation in consideration of the information supplied. James Foster indicated that the fixed radio stations do not have a back-up generator power source and therefore, if commercial power is disrupted, communications within that area is subsequently not available. There are approximately 900 radio units total in operation in this department. These units are divided among the different frequency bands used for intra- and inter-agency communications. There are 120 wardens equipped with the low-band and high-band units in their vehicles. Some wardens also are equipped with UHF radios if they are stationed to patrol areas where local agencies do not have VHF high-band communications systems. There are approximately 350 wildlife managers who have low-band radios installed in their vehicles. The VHF high-band and UHF radios are said to be critical to the operations of the wardens since there is no departmental dispatch center in place. The VHF and UHF units are used to communicate with some other State agencies if they are in the area and to communicate with local agencies if they are available. It was indicated that there is a high use of cell phones when connectivity is available. This compensates for the lack of communications within the department's own system. It was reported that some of the mobile radios in service are 30 years old but that radios are replaced when no longer serviceable.

A complete analysis of the maintenance cost of the system is not available. The primary cost appears to consist of the salary for James Foster, the cost of repair to existing equipment and the cost of replacement units. This cost of operation is wrapped in the overall operational cost of the department.

The department representative indicated safety and general operations would be improved if a Statewide system were in place. It would provide a more seamless means of communications within the department as well as provide an inter-agency path for assistance when needed.

Interoperability needs were defined as follows:

- Local law enforcement agencies
- Department of Public Safety
- Bureau of Narcotics
- Department of Agriculture – Forestry
- National Forest Service

The advantage of using voice encryption would also prove to be valuable since many of the criminal elements that they face use scanner technology to stay aware of the department's activities and evade apprehension.

4.7. OKLAHOMA DEPARTMENT OF HEALTH

Sam Cannella represented the Department of Health for the purpose of the interview. The department does have a first responder obligation as identified by the OKOHS. The department's role is to determine any potential health threat and implement and enforce containment procedures in order to minimize risk.

This department operates radios on the Department of Public Safety current trunked system. They currently use nine portables and have control stations at two emergency operations centers in Oklahoma City. They use one talkgroup for their operation and coordination and have all regional mutual aid talkgroups and the Statewide mutual aid talkgroup programmed into their units to enable communications with any trunk system user group. There are 100 satellite phones used throughout the department as a back-up means of communication. These phones also help to cover regions that are not currently supported by the trunked system. The department also has one VHF radio that operates on a frequency licensed by the State Department of Emergency Management and three mobiles that operate on the Center for Disease Control HF network. Amateur radios in the HF, VHF, and UHF bands are also used for communications during incidents. Non-public safety radios in the Family Radio Service (FRS) frequency band are used for communications at the local inoculations centers since they are very low cost.

Sam Cannella assumes the responsibility of managing the department's communications. There are no service contracts in place to maintain any of the radios that are in use by the department. The trunked radios are serviced with the help of the Department of Public Safety Communications Department and Motorola on a time and material basis. The satellite phone use requires an annual fee of approximately $94,000. Some minor investments are made for battery replacement of the family radios and occasional upgrades to the amateur radio connectivity.

The department holds regular drills to evaluate overall performance and these exercises do include communications capabilities. Currently interoperability needs are being met to a "fair degree".

It is the department's position that they would participate and benefit from a completed Statewide communications system.

They need to have seamless communications with the following agencies:

- Department of Transportation
- Department of Public Safety
- Department of Environmental Quality
- All hospitals and medical response centers

They indicated mobile data would assist in response coordination and information transfer.

4.8. OKLAHOMA DEPARTMENT OF EMERGENCY MANAGEMENT

Jeff Chalmers and Putnam Reiter were interviewed for the Department of Emergency Management. This department serves as the conduit for all management of emergency situations. It plays a primary role in everything from planning and training for response to coordination effort management during an event to post disaster recovery. All of these functions are critical to the well being of the citizens of Oklahoma.

This department uses a variety of methods for communications. They operate a mix of mobile and portable units totaling approximately 77 units. These units are on VHF high-band. They also use the federal HF for interstate communications and national alerting. Satellite phones are also in use. A cost of communications operations was not available. The radio budget is part of the overall operational budget and was not readily available.

Most of the discussion during this interview focused around the need to have a state-wide communications system that had complete coverage and was affordable. It was stated that the budgetary factor would always have the most impact on the use of radio communications. Although the definite need for instant communications was very important to the department's mission, the need to have a solution that fit the budgetary restraints of the State was equally important. The consensus was that most communications needs were being met and improvements would have to fit the budget. It was suggested that the Department of Transportation's proposed system may be the correct fit and that the Department of Public Safety's system was still far from complete and very expensive.

4.9. OKLAHOMA OFFICE OF STATE FIRE MARSHAL

The State Fire Marshall, Robert Doke, provided the information for the State Fire Marshal's Office. The office does play a major role in disaster response and investigation. Special training within the office allows them to provide assistance in procedure to mitigate the chance of further harm being done.

This office does not have a system in operation. It uses other systems throughout the State for communications. The dispatching of field units is done by the Bureau of Narcotics' centers since they are manned around the clock. There are 25 field agents that are equipped with VHF high-band and UHF radios in their vehicles. There are also five supervisors who have an additional low-band VHF radio unit installed. The field officers also carry hand held portable units. Cell phones are used whenever other communications paths are not available. The radio units are maintained by Gateway Communications

and are repaired as needed. The office does not have any personnel dedicated to manage communications and does not have a radio budget. All radios currently in service in the department were funded directly from Department of Homeland Security Grants.

The office finds that it needs to be able to communicate with all government agencies. The need to interoperate with State agencies is foremost but the need to communicate with all local agencies is also important. At this time some of the department's field personnel have the local agencies programmed into their radios to provide some interoperability with local law enforcement and fire departments.

Overall the office feels that their communications needs are not met with the capabilities they currently possess. The Fire Marshal feels that State communications is splintered into many individual groups and that there is no coordination of resources to find a common system that will serve the needs of all agencies. He stated that if a Statewide system was available his office would use it. The office currently has no radios on the 800 MHz system, but he stated he would like to have some. He stated that a strong Statewide communications interoperability plan needs to be in place and that an independent agency needs to oversee the implementation of the plan in order to meet the needs of all agencies.

4.10. OKLAHOMA DEPARTMENT OF TRANSPORTATION

There were two opportunities to meet with this department in the course of two consecutive days. The stakeholders representing the Department of Transportation at the first meeting were Tim Gatz and Kip Smith. The second meeting included Ty Todd to assist in some technical background in his capacity as communication systems manager. It was stated that in its' roles of highway maintenance, the department plays a critical part in disaster recovery. The maintenance and recovery of the highway system is absolutely necessary in order to provide accessibility to areas affected by flood, tornado, or any natural disaster.

This department is in the process of implementing a major upgrade to the communications system so the current and proposed system, were interwoven during the interview. The department currently operates on a VHF high-band system and supports a network of 83 tower sites throughout the State. The department has divided the State into eight operational divisions of responsibility and each of these regions is supported by an operational office. There are 77 maintenance yards in the State with one located in every county. There are also 23 interstate yards and 23 construction residencies. The total number of fixed dispatch points comes to 123. The department operates a fleet of approximately 2,200 mobiles units on the current conventional system There are approximately ten frequencies in use throughout the State in the current configuration. A single frequency pair is used each of the eight regions. Since the regions are geographically separated, some frequency reuse occurs. There are also three simplex frequencies in use throughout the State. These simplex frequencies are repeated in all eight regions.

Other agencies within the State have expressed an interest in partnering with ODOT after the upgrade conversion, in order to gain wider coverage and relieve budgetary constraints associated with maintaining independent systems. A historical relationship between ODOT, the Department of Wildlife Conservation, The Department of Agriculture and the Turnpike Authority have perpetuated a possibility of using the new system as a primary means of communication for all agencies. If these agencies were to become users then the loading would be increased to about 3,000 units. Although coverage advantages may be

gained by these agencies, it may not be in the best long term interest of safety and emergency operations to continue to entertain this option based on the fact that Passport LTR is not compliant with the APCO-16 Public safety Standard for trunked radio systems.

The original configuration consisted of a single repeater at each tower site but when the upgrade is complete, there will be three repeaters at each site. Currently the site repeater provides wide area mobile to mobile coverage and connectivity back to the divisional office. The planned upgrade will provide a much wider area of coverage. All sites will be interconnected through a 4.9 GHz point-to-point microwave system. This microwave system provides a backbone network through which all sites can be centrally controlled. The system could allow a mobile radio in any region of the State to communicate with another mobile anywhere in the state. Division 4 is planned to be in operation during the first half of 2008. The remaining seven divisions would be phased in over a three-year period with an expected completion in 2010. All mobile units for the implementation of the new system have already been purchased and are being fazed into service using the department's regular mobile replacement schedule.

While the ODOT system being developed may be effective to handle their needs, the technology chosen creates serious concerns as to its future. While it will be able to meet the 2013 FCC narrowbanding mandates, it will not support the FCC's intent to narrow channel width even further in the near future. There is a good possibility that the entire system may have to be replaced in the next ten years, depending on what dates the FCC sets for the next phase of narrowbanding.

The Department of Transportation was able to supply operating costs for the communications division from 2002 through 2007. A summary of that report is as follows:

Communications Expenditures
FY 2002 - 2007

		Includes Capital Cost of Ongoing System Build-out				
	FY 2002	****FY 2003**	**FY 2004**	**FY 2005**	**FY 2006**	**FY 2007**
Communications Branch Budgetary Summary						
Branch Salaries & Overhead						
Total	$633,548	$9,706	$486,075	$635,266	$669,048	$729,131
Warehouse						
Total	$14,146	$41,082	$18,236	$9,718	$0	$15,568
Equipment						
Total	$23,716	$18,741	$398,382	$1,804,981	$2,022,871	$2,975,023
Grand Total	$671,410	$69,529	$902,693	$2,449,965	$2,691,919	$3,719,722

** ODOT's Communications Branch transferred from TSD-OS to Maintenance Division in FY 2003. Communications payroll was expended from Maintenance Overhead until FY 2004 when a sub account was created to track Communication costs separately.

The Department of Transportation interoperability needs were stated as follows:

- Department of Public Safety (Highway Patrol)
- Turnpike Authority
- Department of Emergency Management
- State Bureau of Investigation
- Department of Corrections
- County Sheriffs
- Federal Bureau of Investigation
- National Guard

The department indicated the following technologies were currently being considered:

- Automated Vehicle Location
- Advanced Vehicle Monitoring
- Mobile Status and Data

The Department of Transportation is currently taking steps to provide themselves with a Statewide operational communications system and feel it is necessary to have one in place that does serve their needs. A certain level of interoperability is built into the system that is being implemented.

Information on the system can be found in Appendix D.

4.11. OKLAHOMA DEPARTMENT OF AGRICULTURE, FOOD AND FORESTRY

The department was represented by Mark Goeller, who is the Assistant Director of the Eastern Division of the Forestry Division.

The Department of Agriculture is the State Coordinating Agency for fire fighting in the State Emergency Operations Plan (EOP). The Forestry Division frequently plays a primary role in direct response to natural disasters in the State and is called into service for fires, tornados and floods. Agents of the department have responsibilities in the protection and management of the natural forest resources, agriculture products and the food supply. They have response and management capabilities that range from fire control, livestock theft to animal and plant disease control. Officers in this department are certified by the Council on Law Enforcement Education and Training.

The forestry division of the department owns and operates a communications system in the eastern portion of the State. The system is comprised of 17 standalone repeaters that operate on VHF high-band frequencies. There is no direct connectivity to these repeaters through TELCO circuits or any other means. All repeaters are simply accessed through over-the-air transmissions. This system operates in an analog conventional mode but it does appear that all components are ready for the move to narrowband operations as mandated by the FCC. The support structures for these repeaters include two-way antenna towers and, where possible, fire towers since they are a resource already in place. The system is meant to provide increased mobile and portable radio coverage in the areas of Oklahoma that supports the major stands of forests. In areas that are not supported by this system, cellular phones are the only other means of communication. A partnership with the Oklahoma Department of Transportation exists, and Forestry employs the communications staff of the ODOT to maintain the repeaters and tower system. There are no

Forestry staff dedicated to the management of the radio system and responsibility for operations resides at the user level. It was estimated that the entire budget to support the communication system was around $40,000 annually. No actual figures were available since the communications budget comes from the general appropriations of the department. Most of the repeater sites are owned by the department and situated on private land with easement for access and minimal lease cost. Some sites have other State and local agencies equipment co-located but how many or where was not able to be determined.

An estimated number of 100 mobile and 100 portable radios work on the Forestry system. These units are maintained internally to minimize the financial overhead. When units are not serviceable they are boxed and shipped to a manufacturer service representative for repair.

The department operates in three defined regions of eastern Oklahoma. Each region has a dispatch office for a centralized operation base of control. Although the dispatch office is not manned as a 24 x 7 center, the department personnel have radio contact through their personnel radios at all times. Phones to the department are also answered on an around the clock basis by forwarding calls to an on-call employee's home phone number.

The Forestry Division has considered the needs of the future and recognizes that planning is imperative. The relationship with the ODOT has precipitated a phase of planning to become users on the ODOT Passport system as it becomes operational. The needs for wider coverage in addition to fiscal restraints of maintaining the current system are primary drivers of this move. The Passport system is purposing Statewide coverage when it is completed in 2010. In interviews with transportation they said that partnerships and investments of infrastructure in the eastern portion of the state would probably be necessary to allow adequate coverage. Another advantage would appear to be the use of the VHF high-band frequencies which are still in use by local fire and law enforcement agencies in this portion of the state. This would permit the use of a single radio to work on the Passport system and communicate with local agencies.

The division expressed a concern that although some interoperability needs are satisfactory because they share Memorandums of Understanding with local agencies for the mutual use of frequencies, the move of some fire departments to the DPS SmartZone system has caused some disconnects in communications. For example, at this time the use of air support for fire suppression cannot be coordinated without the use of VHF radios and local agencies requesting that support must have VHF communication capability. The air support has no communication capability in the 800 MHz frequency range without the use of a patch between radio systems. These operations must be supported by ground communication for safety and efficiency purposes.

The opinion of the Forestry Division is that interoperability is important with the following agencies:

- All local fire departments
- All emergency management agencies both state and local
- Law enforcement agencies in regard to traffic and crowd control
- The Federal Department of the Interior
- The Nation Forestry Department

The opinion of the division is that an interoperable communications system would contribute to efficiency to their primary mandate and safety for all personnel. At this time, they feel that the build out of the ODOT system appears to be a fit to their immediate needs.

4.12. OKLAHOMA ATTORNEY GENERAL

The Attorney General interview participants were Shelly Berry, Erin Thompson, Doug Brower, Kenny Wynns and Michael Wooldridge.

The primary role of the agency is to provide an investigative service to other State agencies and the general public in regard to fraud and consumer protection. To provide the varied services as mandated, the office is divided into specialized units as follows:

- Consumer Protection Unit
- Criminal Appeals
- Environmental Protection Unit
- General Counsel Section
- Litigation Section
- Multi-county Grand Jury Unit
- Worker's Compensation and Insurance Fraud Unit
- Public Utilities Unit
- Victim's Services Unit
- Tobacco Enforcement Unit

Units that are involved in the protection of the public and the State are called into service in times of disaster. Although not "first responders" to provide physical assistance during events, they must monitor and ensure that during the chaos that follows, the legal interest of the public and State are followed.

This department does not own or operate a wireless communications system. It does have approximately 14 mobile vehicle radio and seven handheld portable radios in service. Most of these units operate in the VHF high-band. The office holds Memorandums of Understanding with the Department of Transportation, the Bureau of Narcotics and Dangerous Drugs Control and the State Bureau of Investigation. This allows them to use the other departments' frequencies for communications. Some units within the office have several 800 MHz radios and although they were not available for this interview, it is assumed that these radios can be used for communications with the Department of Public Safety. Many of the office personnel use cell phones from AT&T with the "Push to Talk" function that allows "one too many" communications similar to dedicated system radios.

The unit representatives interviewed all expressed a concern that communications are not very good and that they often cannot contact the agency they are working with since they don't have common equipment. All stated that a system that covered the State and provided inter-agency communications would improve the department's efficiency and provide a higher level of safety.

The interviewees expressed the need to communicate with:

- Oklahoma Department of Public Safety (Highway Patrol)
- Oklahoma Bureau of Narcotics and Dangerous Drugs Control
- Oklahoma State Bureau of Investigation
- Oklahoma Department of Transportation

- Oklahoma Department of Wildlife Conservation
- Local Law Enforcement Agencies
- Tribal Police Agencies

4.13. OKLAHOMA DEPARTMENT OF TOURISM AND RECREATION, DIVISION OF STATE PARKS AND RESORTS

The Division of State Parks and Resorts was represented by Larry Habegger, Head Law Enforcement Ranger for the State parks. The Division of State Parks has full law enforcement responsibility in all State parks and resorts. The rangers are fully accredited State law enforcement officers and have the authority to respond to and enforce laws Statewide. This law enforcement staff strength varies by season, with up to 120 rangers being in service during peak recreation months. The rangers are all certified in the National Incident Management System (NIMS) and regularly respond to assist with disasters and incidents around the State.

The division does not have its own radio system at the present time. It depends on several different methods of communications. In areas that are under the coverage footprint of the existing 800 MHz system, rangers use it for day-to-day operations and disaster response. In areas of the State where the system does not provide service, rangers rely on low-band, VHF and UHF radios that allow for simplex communications between vehicles and offices and communications with local law enforcement agencies, such as the local sheriff's department. The rangers rely on the local law enforcement agencies for support on warrant and motor vehicle inquiries. There is no central dispatch for the division. The division does not own any repeaters or networks. Not only do the rangers use radios, but different departments such as park maintenance and park managers, use the same radio frequencies. The division owns a mix of approximately 500 mobile and portable radios, in different bands and from different manufacturers. Some law enforcement rangers have as many as four radios in their vehicles, making communications confusing and difficult. Not all radios are programmed alike, which can lead to confusion when units from different parts of the State respond to a common location or event. The division has been working to standardize the way radios are programmed, but due to the number of different manufacturers and models, not much has been accomplished.

No estimate could be provided as to how much the division spends per year on radio services. The division is divided into three regions across the State. Each region is given a total budget, and that region decides on how to spend the money. There is no formal line item for radio equipment or services in the budget. No service contracts with local radio vendors are in place, and repairs to equipment are procured through purchase orders at the time of the needed repairs. At this time there are no plans to upgrade or change any of the radios. The division does not own any radio towers or sites, but would be agreeable to the State locating towers on State park sites if it would bring the coverage of the existing 800 MHz system into the area.

In its operations, the division requires interoperability with the following:

- Local public safety agencies (i.e., law enforcement, fire, EMS, emergency management)
- Department of Public Safety
- Department of Wildlife and Conservation
- Oklahoma Bureau of Narcotics and Dangerous Drugs Control

- State Fire Marshall
- Department of Agriculture – Forestry Division
- National Forest Service
- Numerous Tribal entities

Interoperability currently is very poor. Rangers often carry multiple radios with them, and have resorted to having someone respond to an incident with radio programming software to re-program radios as needed on the site. The division is not satisfied with these arrangements and views them as a risk to the safety of the public and its personnel.

In the future, the division would be interested not only in joining a Statewide radio system, but would look for the following advance applications to help its operations:

- Automatic Vehicle Locator (AVL)
- Mobile Data Services for data base inquiries such as warrants and motor vehicles

4.14. ONENET

OneNet, which is a Statewide telecommunications network, was represented by its Director of Network Operations, Bill Johnson. While OneNet does not own or operate any radios, it is a potential partner in the development of any Statewide radio network. OneNet is a division of the Oklahoma State Regents for Higher Education and is operated in a partnership with the Oklahoma Office of State Finance.

OneNet's origin began in 1992. It was at this time that voters in Oklahoma approved a Statewide capital bond issue that provided $14 million for the implementation of a Statewide telecommunications network. In late 1995, the State Regents approved the OneNet business plan and began implementation in 1996. The system is a hybrid of fiber optics and microwave, depending on the requirements and accessibility in regions of the State.

OneNet was designed and built to provide a carrier class high-speed telecommunication network across the State. OneNet primarily serves as a link between all institutions of education in the State, from levels K-12, all the way to all State university campuses. The network also provides services to the Department of Corrections (DOC) and the Department of the Military for their distance learning programs. The network is connected to all DOC facilities Statewide. Limited connectivity to some of the tribal nations in the State is also provided. OneNet serves many local governments as their primary Internet Service Provider (ISP, and is currently carrying some radio traffic for the Department of Public Safety in some parts of the State. The network is primarily built in a loop configuration, providing a high level of reliability, and hub sites are protected against power losses.

Services that OneNet provides include:

- Distance learning to DOC and the Department of Military
- Distance learning to all educational facilities in the State
- Video conferencing services
- Voice over Internet Protocol (VoIP) telephone services
- Internet Service Provider to local governments and state facilities across the State

OneNet also holds several wireless licenses for a new service that will be able to provide wireless broadband services to large areas of the State. OneNet is currently waiting to enter negotiations with a vendor who is interested in leasing the spectrum from the State and building out a Statewide wireless broadband network. State and local public safety agencies would be eligible to subscribe to this service.

OneNet owns numerous towers throughout the State, many of which are on DOC property. These towers range in height from 20-feet to 460-feet and are all built to support multiple microwave antennas. A listing of these towers can be found in the appendices of this report. OneNet is also co-located on several DPS towers around the State, showing that the network is willing to work with other state agencies.

Mr. Johnson is very agreeable to partnering to enhance the 800 MHz system and sees two specific opportunities:

- Co-location of 800 MHz equipment on existing OneNet towers
- Providing site connectivity between 800 MHz sites through the use of OneNet

OneNet system information can be found in Appendix E.

4.15. CITY OF TULSA

The City of Tulsa, while not a State agency, currently plays a key role in the 800 MHz radio system. The City was represented by Kevin Shoemaker and Susan Austin. Tulsa owns its own two-site Motorola simulcast 800 MHz trunked radio system. This system was originally built in 1984. In 1996, the State joined with the City to form the beginnings of a system that would provide coverage between Tulsa and Oklahoma City along the Interstate 44 corridor. In this upgrade, the State paid for a new system zone controller, and the City paid for the software upgrades, which was able to form a new SmartZone radio system, using operating system 2.0.3. Sites were added along the corridor with the City and State splitting the cost of the sites, usually with the State paying for the tower and site developments, and the City providing the radio hardware for the site. In 2004, the system was again upgraded to the SmartZone 4.1 operating system, with the City paying for that upgrade. The zone controller currently in place manages the entire 800 MHZ Statewide system as it is currently configured. There is no redundant controller available. Currently, the zone controller and the audio switch that control all activity on the 800 MHZ system are at their maximum capacity. Additionally, Motorola does not offer any software updates for the 4.1 operating system as it is being phased out of use. This is of great concern to the City.

The City system currently operates as a mixed analog-digital mode system, with about 80 percent of the voice traffic being analog and 20 percent being digital. The site connectivity of the system is provided by a mix of City-owned microwave and fiber optics cables, and leased T-1 circuits. The system supports encryption, using the non P25 algorithm of DVP-XL on a limited number of talkgroups. There is one primary dispatch center for all public safety agencies in the City and Tulsa County, which also provides dispatch services for several small cities in the area. While the City's system is owned by the City, the zone controller that is located in the City is shared with the State. The City system is currently used by police, fire, EMS, public works, transit system, the Tulsa airport, parks and recreation, as well as several smaller agencies in the City. The City estimates that between all City agencies that use the system, they have 9,445 active user ID numbers. While this includes numbers for lost, stolen, and test radios, they feel

it is fairly accurate as to how many radios they have on the system. Overall, there are approximately 19,000 active user ID numbers on the system, operating on over 1,300 talk groups.

The City also operates a seven-channel, 800 MHz mobile data system that is used by Tulsa public safety agencies. This is a proprietary Motorola RD-LAP system that provides service to about 750 users and has the capability to provide text messaging, CAD dispatch interface, data base inquiries (i.e., warrants, motor vehicle records), and in the field report writing.

The City currently provides staff support to manage the entire 800 MHz radio system. This includes all talkgroup and fleet management, adding new subscriber IDs and sites to the system and taking care of system management issues. Indications from City staff are that this takes a significant amount of their time from their normal City duties and responsibilities and also puts them in a situation of conflicting priorities. The Tulsa staff has to keep the requests of the Tulsa agencies as their number one priority for action. In times of significant incidents (i.e., ice storms, tornados), they must take care of what the City needs done before they can turn their attention to what other users across the State are requiring. This has often led to delays in requests to add new subscribers or address critical infrastructure issues while addressing the City's needs. At this time, the State pays Motorola directly for support in maintaining the zone controller through a service contract but does not reimburse the City for its costs of providing staff support.

Currently, the City has a staff of seven full-time personnel who provide the maintenance and operational management to the system. It was also noted that this staff maintains more than just the 800 MHz system for the City. The current maintenance budget of the City for their system is approximately $500,000 annually. They also budget approximately $1.5 million per year for life cycle replacement of infrastructure and subscriber equipment. The City also leases space on a tower in the city for the system at a cost of approximately $100,000 per year.

The City has several concerns in any plan that the State may have for building out the 800 MHz system across the State.

- The City feels that the State has no plan to deal with expanding both the area and the capacity of the system. At this point in time, the City feels that the State keeps adding units and sites with little concern over what impact that has on the Tulsa City staff's ability to provide management services. This concern was pointed out several times during the interview, that the job of managing the state system conflicts with their responsibilities to the City.
- The City also fears that the State will not put a lifecycle replacement and upgrade plan together for the expanded system. The fear here is that the system will age without a plan to keep it up to date, rendering it obsolete.
- Lastly, the City feels that there should be an outside company that manages the day-to-day operations of the system and that this should not be a duty assumed by a State agency.

In the area of interoperability, the City feels that technically its needs are being met but that the climate of local politics between the City and its neighbors often keeps the technology from being effective. They currently use control station patches to their consoles to meet most of their needs. The City actively trains its staff and routinely uses the National Incident Management System (NIMS) and the Incident Command System (ICS), including in its use of communications.

In the future, the City would like to see its system upgraded to a P25 standards-based system, as well as the availability of mobile broad band services to enhance the ability of getting data out to the personnel in the field.

5. ANALYSIS OF FINDINGS

In this section, several different topics will be presented. Firstly, seven different states that either currently have statewide radio systems operating or are in development were researched. From this research, the best practices and lessons learned from their efforts have been distilled down for presentation. Secondly, different technology issues are presented in the form of white papers prepared by Kimball that will show each technologies pros and cons as they relate to a statewide radio system. Thirdly, an analysis of the current situation in Oklahoma will be presented, based on the findings of the stakeholder interviews and compared to research information in the report.

5.1. OVERVIEW OF OTHER STATEWIDE RADIO SYSTEMS

In order to fully understand what it takes to develop and operate a Statewide radio system, seven states which either have statewide systems in operation or in planning were surveyed to determine what has and has not worked for them. Although survey topics were varied, areas of concentration included system management, system governance and system funding. The survey questions that were asked are found in Appendix C of this report. In the following sections, the responses from each of the states is presented, with a distillation of the best practices and lessons learned following.

5.1.1. State of Arkansas

The Arkansas Wireless Interoperability Network (AWIN) is a Motorola 700 / 800 MHz radio system. AWIN utilizes a digital, trunked backbone to cover the state and provide interoperability. There are 101 sites and 13,000 current users.

5.1.1.1. History

Arkansas had a statewide radio system built in 1985. Proper maintenance did not occur and the system was in need of many upgrades. In 2004, when funding from grants and bonds became available, the state decided to replace the old system. The build-out of AWIN started in June of 2005 and March of 2007 saw the completion.

5.1.1.2. Governance

The establishment of an AWIN Steering Committee in June of 2004 provided oversight for the project. The Steering Committee remains in place to provide guidance and strategic planning. Currently, the state is working with the governor's office to get an Executive Order executed that will more formally establish the responsibilities and authority of the committee.

Standard Operating Plans (SOPs), not yet fully developed, are a goal of the Statewide Communications Interoperability Plan. The steering committee appointed a working group to complete the plans.

5.1.1.3. Funding

The initial cost estimate in 2004, to upgrade the existing system, build-out in five additional counties, and purchase radios for command and control personnel in each of the 75 counties, was $76 million. Grants obtained by the Arkansas State Police (ASP) and Department of Homeland Security grants provided the initial funding. The system cost $71 million upon completion.

Users of the system do not pay any costs. There is no user fee set up at this time. The current annual budget, funded entirely from the State's general revenues, is $9.5 million.

5.1.1.4. Staffing

A program director manages the day-to-day operations and works with the AWIN steering committee. There are five technicians from the state and two on-site maintenance personnel provided via the maintenance contract.

5.1.1.5. Maintenance

Three organizations share the AWIN maintenance. Motorola, as the vendor, is under contract to provide maintenance for the infrastructure. Motorola assigns two technicians on-site, full time. The ASP provides facilities maintenance. The AWIN management and operations staff provide electrical maintenance, as well as oversight of the performance of Motorola and ASP personnel.

5.1.1.6. Users

The ASP and the Arkansas Emergency Management Office use AWIN daily. Other state agencies have some radios deployed to achieve interoperability only.

All counties have AWIN radios distributed at least to the Command and Control level. Some counties share the radios as far as the first responder level. The U. S. Marshals, FBI and National Weather Service have access to the system to achieve federal interoperability.

5.1.1.7. Future Plans

The AWIN steering committee is intent upon making sure the system is current through upgrades. As new technology emerges, the state will perform a cost-benefit analysis to determine how those technologies best fit into the AWIN Strategic Plan. Currently, AWIN is looking at ISSI and Dynamic System Resiliency, both new technologies, for future upgrades.

5.1.2. State of Colorado

The Colorado State Radio System is a 700 / 800 MHz P25 Motorola system. A planned update to the system this year will upgrade both hardware and software to the latest Motorola operating system.

There are 21 interoperability talkgroups, assigned on a regional basis, on the system. Between the statewide P25 system, the six M/A-COM systems, one VHF system, and a federal interoperability channel, the Denver area has 14 intersystem talkgroups alone.

Currently, the system has 154 sites, comprising over 700 federal, state, local and tribal agencies, with 27,000 radios operational. In 2008, funding will build-out an additional 30 sites. When complete, anticipation is the system will have 190 sites, 800 user agencies and 34,000 radios.

5.1.2.1. History

In 1991, the state legislature directed the Colorado State Patrol (CSP) to consolidate the existing 17 communications centers to a smaller number. The direction was also to look at the consolidation of the five major state radio systems into a single system.

The current system started building in 1998 and anticipation is for the infrastructure build-out to be complete at the end of 2008. The decision early on was, where possible, existing towers, buildings and microwave systems would switch over to the new system. This decision reduced the necessary budget by a large amount.

5.1.2.2. Governance

The Consolidated Communications Network of Colorado (CCNC), which sets all policies, procedures and standard operating procedures for the system, was created as a user organization. The establishment of the CCNC served the state by stopping the duplication of systems the state was building, maintaining and funding. It became clear once the new system came online that other agencies were willing to join, rather than build their own new systems, and have automatic interoperability.

5.1.2.3. Funding

The initial cost estimate was $78,970,740. This included radio infrastructure and subscriber units only. The expectation was that towers, buildings and microwave systems would be reused, not replaced. All the original funding came from the Colorado state budget.

Legislation passed by the state in 1998, creating the Public Safety Communications Trust Fund, provided the initial money. A seed fund of $3.3 million, which came from State Capital Construction Funds, piloted the program.

An expectation is the final cost of the system infrastructure will be $68,333,000 or $10 million under the original estimate. $150 million is the expected total cost of the statewide radio system, plus local costs.

The current operating budget for the system is $4 million. Next year's budget anticipates a 3 to 5 percent increase.

The state charges state agencies $260 per year per radio, which funds maintenance and operations of the system. Non-state agencies do not pay a fee at this time. Most federal, local, and tribal agencies do not pay any user fees. Some local owners charge their users a fee, which stays within their organizations.

5.1.2.4. Staffing

The State provides a full-time system manager, system engineer and network operations center.

5.1.2.5. Maintenance

The State, which has 14 shops and 35 technicians throughout the state, performs 90 percent of the maintenance. The remaining 10 percent is a combination of local government maintenance contracts with private Motorola authorized service shops.

5.1.2.6. Users

The statewide system crosses all divisions of government: 15 dispatch centers, six coroners, 13 emergency management agencies, 52 emergency medical services groups, 22 federal agencies, 197 fire organizations, 85 general governments, 72 health, six judicial, 115 police, 18 public works, 11 school organizations, 46 sheriffs, 12 state agencies and three utilities. As of today, 703 different organizations utilize the system. The anticipation is there will be over 800 users when the system is complete.

5.1.2.7. Future Plans

A request for $8 million is in the state budget this year for upgrading the system. The state wants to upgrade the hardware and software to the latest versions of the Motorola operating system. This upgrade will provide the capability for future high-speed data and other applications.

5.1.3. State of Florida

The Florida State Law Enforcement Radio System (SLERS) started as a Motorola P25 Trunked OmniLink v3.5 Frequency Division Multiple Access (FDMA). Cost issues moved the state to issue a Request for Proposal (RFP), which Com-Net Ericsson Critical Radio Systems won. The current system is an EDACS ProVoice FDMA system, using P25 DES-OFB encryption and a P25 common air interface. The vocoder for the system is IMBE full-rate vocoder technology and is compatible with P25 full rate vocoders. (A vocoder is an electronic device that synthesizes speech.

There are 164 radio sites and 36 microwave relay sites. There are approximately 6,500 state agency users and 15,000 radios on the system. An additional 1,000 third-party users are also on the system.

5.1.3.1. History

In the 1980s, discussions started across Florida that led to a five-phase contract in the 1990s with Motorola. Motorola completed Phase 1 in 1994, covering Miami, Fort Lauderdale, Glades and the Florida Keys. In 1998, the completion of Phase 2 covered Daytona Beach, Orlando and West Palm Beach. Because of funding issues, Florida decided to look for other ways of completing the project. Finally, in September, 2000, an RFP was awarded to Com-Net Ericsson Critical Radio Systems, now called M/A-COM Private Radio Systems, to create a public-private partnership that would establish the system and operate it through December, 2021.

M/A-COM started the build-out in the regions not covered by the Motorola system in 2000, with a projected completion date throughout those areas by June of 2004. The state continues to own the Motorola system, but M/A-COM has maintenance responsibility for the entire system and reimburses the state for their maintenance payments to Motorola.

By June of 2006, M/A-COM completed construction of their system in the Phase 1 and 2 locations and cutover from the Motorola system.

5.1.3.2. Governance

Florida statutes established the Department of Management Services (DMS) as the manager of the SLERS. A Joint Task Force (JTF) for State Law Enforcement Communications Services meets quarterly and provides recommendations to DMS regarding the operation of the system, the acceptance of new SLERS (third-party) partners and expenditures of enhancement moneys. A technical and SOP subcommittee, and a security manager, support the JTF. JTF has completed SOPs covering most matters including security, talkgroup structures, all priorities, calling features and use, communications and CAD codes, to name a few.

5.1.3.3. Funding

Initially, the addition of a $1 fee was on both vehicle and vessel registrations for a fixed number of years. In 1999, it became clear that the sunset of the funding mechanism was not going to allow completion of the state build-out. It was then that the issuance of a RFP for a public-private partnership system went out. M/A-COM won that contract which lasts through December 2021.

The initial cost estimate for the Motorola system was valued at $50 million in 2000. In 2000, $40 million went to the M/A-COM system. A construction bond of $36 million was also created. M/A-COM receives the vehicle / vessel fee, $14 to $18 million annually, minus administrative costs, for the life of the contract. The state receives 15 percent of the funds from M/A-COM for other tower users that were not grandfathered public safety users and 5 percent of approved third-party user fees.

The estimated final cost of the system is $340 to $360 million.

The current operating budget consists of the $1 vehicle and vessel registrations fee, a $3 traffic violation surcharge, which was passed in 2007 with a five-year sunset raising $5 to $6 million annually, and any awarded grant funds and revenues from third-party tower lessees and subscribers. The annual budget is over $21 million.

5.1.3.4. Staffing

SLERS has a project manager, system and contract manager, and authorization for six supporting engineers and administrators. Currently, two positions are vacant.

5.1.3.5. Maintenance

M/A-COM and its subcontractors provide all the maintenance for the system.

5.1.3.6. Users

State law enforcement agencies were the primary users. Today federal government organizations, other state agencies, county governments and some system partners (third-party users) utilize SLERS. Recently, the Seminole Tribe inquired about joining the system. New participants are generally

acceptable as long as they do not affect the day-to-day operations of state law enforcement agencies. There are currently more than 16,000 radios on the system.

5.1.3.7. Future Plans

M/A-Com will support and maintain the current EDACS ProVoice for the duration of the contract (2021) including software upgrades. This technology does not support 700 MHz. The state plans to migrate to a 700 / 800MHz P25-capable system that improves survivability and interoperability through an IP-based transport. Using current funding sources, this transition will take several years due to the cost of replacing both the subscriber equipment and the infrastructure.

The plan is to transition the 800 MHz aircraft system to P25 700 MHz capability, which will free up the most 800 MHz frequencies at the lowest cost.

5.1.4. State of Michigan

The Michigan Public Safety Communications System (MPSCS) is a mature statewide system with extensive participation of county and municipal governments in the State of Michigan.

MPSCS' primary use is as a two-way voice system. The system provides 97 percent mobile coverage throughout the state. However, there is extensive portable and in-building coverage in those areas where the system has been built-out by local government to provide enhanced coverage. The system currently utilizes 231 tower sites.

MPSCS is a P25-compliant standards based system. MPSCS operates on Motorola's ASTRO25® Version 6.5 software platform. This version includes capability for Integrated Voice and Data (IV&D). However, this capability is only being tested at present and data capability is limited to 9.6 Kbps.

5.1.4.1. History

The implementation process for MPSCS began in 1984 when the Michigan State Police (MSP) formed a committee to evaluate its 1940's era two-way radio system. The committee consisted of several state agencies and representatives of the State House and Senate fiscal agencies. The committee recommended building a system that would be large enough to support all state and local public safety agencies. In 1992, the request for proposal (RFP) for the system was released. In 1994, the Michigan Legislature approved funding for the system and awarded the contract to Motorola. The construction of MPSCS, done in phases through three regions of the State, was complete in the fall of 2002. In November of 2002, the system upgraded to the ASTRO25® 6.0 software version.

The 1994 contract for MPSCS was for $187 million. By the time of its completion in 2002, the state had spent approximately $221 million and constructed 180 tower sites. Bonds issued by the State Building Authority financed this initiative. In 2003, the state allocated $12 million for infrastructure build-out; the allocation of an additional $13 million in 2005 was for system upgrades. The total state investment in the system to date is approximately $250 million. Local governments have contributed approximately $100 million to upgrade the system infrastructure for additional capacity and coverage.

5.1.4.2. Governance

From 1997 to 2002, the MSP managed and operated the MPSCS. By Executive Orders issued in 2002 and 2005, the responsibility for managing and maintaining the MPSCS transferred to the State of Michigan's Department of Information Technology (DIT).

An advisory board, created by Executive Order, supports the MPSCS. The 19-member panel appointed by the governor represents the state's emergency first responders and state agencies, and provides advice to the MPSCS. The advisory board is responsible for developing and implementing Michigan's interoperability plans.

5.1.4.3. Funding

User fees partially fund the MPSCS. There are four levels of system access, with fees based on varying numbers of push-to-talks (PTT) and minutes of voice talk time during a 12-month period, and number / type of system talkgroups in a radio. An average of the PTTs and minutes of airtime within a subscription level are used to compute an agency's per radio usage. The cost ranges from no charge for a radio with only Emergency Management Division (EMD) and event talkgroups and very limited PTTs and airtime, to $200 per year for full membership that provides unlimited PTTs, airtime, and system talkgroups. There are also fees for building templates, archiving and programming radios. These fees also range from no charge for EMD and interoperability talkgroups only, to $100 per radio to build a master template for an agency. Full membership entitles an agency to a single yearly template / archive re-write.

Inter-Department Grants (IDG), awarded to the MPSCS by state user agencies to help cover operating expenses, also fund the system. These grants come from agencies such as the State Police and the Department of Natural Resources. These grants are not a stable source of funding and the MPSCS advisory board is working with the State Legislature to identify a permanent source of funding for the system.

The 2007 / 2008 operating costs for the MPSCS are estimated at $16 million ($12 million for operating costs and $4 million for infrastructure lifecycle replacement). The MPSCS estimated that the long-term cost to maintain the system, including subscriber equipment based on lifecycle for a radio system, is $32 million per year.

5.1.4.4. Staffing

MPSCS has a full-time staff of 72 who are responsible for system administration and infrastructure maintenance.

5.1.4.5. Users

MPSCS has approximately 40,000 subscribers and records an average of approximately eight million PTTs per month. Of these 40,000 subscribers, only 8,000 are state agency users, with the rest being local government users. MPSCS subscribers purchase and maintain their own equipment. Subscribers may purchase any P25-compatible trunked radios approved for use on the system.

MPSCS provided financial incentives for local agencies to come onto the system through their "Local Credits Policy". This allows the MPSCS to provide financial credits for system use to agencies who contribute local infrastructure - new or existing - that can be integrated with MPSCS and available to all MPSCS members. This allowed numerous local governments to contribute towers, frequencies, and compatible local systems to build-out the MPSCS infrastructure, providing enhanced coverage in these areas. The largest of the local governments to participate in MPSCS is the City of Detroit with over 10,000 radios. Detroit operates as a simulcast zone on the system.

5.1.4.6. Future Plans

The MPSCS has been criticized for its cost. With the addition of local governments seeking the interoperability and technological benefits of MPSCS, and the infrastructure cost savings offered by membership in MPSCS, the MPSCS witnessed remarkable growth. Supporting the rapid growth of the system and future lifecycle upgrades to the system are probably the two greatest challenges facing MPSCS. It is noteworthy that Oakland County (suburban Detroit) is constructing its own $42 million M/A-COM OpenSky® 800MHz radio system in the belief that OpenSky® utilizes a superior technology. Interoperability efforts in the Detroit metropolitan area have been complicated by this.

Plans are in place to upgrade the system to Motorola's ASTRO25® Version 6.9 software platform sometime in late 2008 with funding from the Public Safety Interoperable Communications (PSIC) Grant Program.

In addition to adding sites and local agencies, the long term development plans for MPSCS include upgrading to ASTRO25® version 7, which will result in the replacement of console central electronics banks and Ambassador Electronics Banks, and will support high performance data (96 Kbps data in a 25 KHz channel) capabilities across the network.

5.1.5. State of Ohio

MARCS (Multi-Agency Radio Communication System) is an 800 MHz wireless communications system operated by the State of Ohio's Office of Information Technology that provides statewide two-way voice and data radio coverage throughout the State of Ohio and a ten-mile radius outside of Ohio.

The MARCS network operates on three system components:

- **Mobile Voice** - operating on 800 MHz digital trunked technology
- **Mobile Data** - allowing data transmissions, Ohio Law Enforcement Automated Data System (LEADS) inquiries, and reformatting of data from Mobile Data Terminals (MDT)
- **Computer Aided Dispatch** - providing GPS-based vehicle location, resource recommendation and mapping display

The MARCS development contract required 97.5 percent mobile voice and data in-street coverage by county. Aggregate voice coverage realized was 99.71 percent and aggregate data coverage achieved was 98.13 percent. Franklin (Columbus), Cuyahoga (Cleveland), Hamilton (Cincinnati) and Montgomery (Dayton) counties also have 97.5 percent portable in-street coverage through enhancements built into those counties. Subscribers may extend coverage by utilizing either UHF or 700/800 MHz vehicular

repeaters. Specified state buildings in Franklin County provide in-building coverage. The system employs 203 towers.

The MARCS voice system is a Motorola ASTRO® version 4.x 800 MHz digital system. The MARCS mobile data system, built upon the Motorola 19.2 RDLAP DataTAC private RF (radio frequency) solution, currently runs at 9.6 Kbps. MARCS offers subscribers a software package that enables connectivity to various internal and external sources, such as LEADS, computer aided dispatch, Bureau of Criminal Identification and Investigation, automatic vehicle location, and field interview database.

5.1.5.1. History

MARCS' development traces back to 1987 when the Ohio State Highway Patrol began a study of its existing radio system, which was primarily low-band. Deficiencies in Ohio's existing communications systems became apparent during several disasters and emergencies, specifically the 1989 Shadyside floods and the 1993 Lucasville prison riot. The establishment of the MARCS Steering Committee was in 1994. The Request for Proposal for the system was issued in 1995. In 1998, the contract award for the system went to TRW, Inc. of Cleveland to develop the system using Motorola as the primary contractor.

The MARCS Program Office was established officially in 1997 with a staff of six full-time employees. The MARCS program officially began on October 2, 1998, with work on establishing the system beginning in 2000. The final communication tower was completed in December of 2004 and the system became fully operational in April of 2006.

Ohio MARCS was designed originally to support ten state agencies. The initial estimate for voice users was approximately 8,500 voice units. The need for expanded interoperability among agencies was recognized following the terrorist attack of September 11 and through a series of Ohio emergencies. In 2002, the state made a decision to allow local emergency responders on the system and to charge subscribers for use of the system.

The original contract in 1998 called for system development to occur in 54 months. The system was not reported as fully operational until 2006. In addition to criticism for being overdue in implementation, allegations of favoritism in vendor selection and tower site acquisition marred the MARCS project.

5.1.5.2. Governance

The State's Department of Administrative Services assumed the role of managing / guiding the procurement process and administering the infrastructure as MARCS became operational. The MARCS Program Office in the Ohio Office of Information Technology (OFT) administers MARCS. The OFT is a division of the Department of Administrative Services that was created in 2004.

5.1.5.3. Funding

Capital appropriations totaling approximately $300 million funded the implementation, construction, and equipment costs of the system. The estimate of initial systems costs was approximately $175 million. The negotiated price for the system with TRW was $272 million. The issuance of bonds by the Ohio Building Authority secured the funding.

Subscription fees fund the system. Annual fees running parallel with the State's fiscal year, July 1 through June 30, are the basis for the subscription rates. The basis of the fees is the type of units activated by the subscriber. Rates are as follows:

- Portable or Mobile Radio: $240.00 per unit / per year
- Control Station: $480.00 per unit / per year

The MARCS data network supports mobile data terminals and computer aided dispatch for state agencies. Rates for data subscriber units are as follows:

- Mobile Data Terminal: $4,200.00 per unit / per year
- Computer Aided Dispatch: $21,000.00 per unit / per year

Subscribers are responsible for purchasing and maintaining their own equipment. Motorola is on state contact and subscribers can receive 20 to 25 percent off Motorola list prices on equipment.

The system is set up to run in a rotary capacity. That is, the subscriber base covers operating expenses (technical support, network operations, and remote communications), estimated at approximately $11 million annually. System upgrades will require additional capital funding.

5.1.5.4. Maintenance

The MARCS Program Office has 23 full-time staff members who are responsible for the oversight, maintenance and repair of the MARCS network. MARCS maintains the system utilizing Motorola for the radio / data / electronics piece and other individual vendors for tower gross site maintenance, generator service, HVAC, switch gear and computer systems.

5.1.5.5. Users

As of December, 2007, MARCS had 24,605 radios, 1,871 mobile computing terminals and 72 computer aided dispatch consoles. Many of the subscribers use MARCS to achieve interoperability, rather than to meet their day-to-day communications needs. MARCS offers local public safety and first responders a Local Emergency Use Only (LEUO) subscription option that provides limited use of radio and airtime for emergencies, special events and periodic testing and training. LEUO requires a $50 initial subscription charge and has no monthly fee. The system logs over four million push-to-talks on an average month.

5.1.5.6. Future Planning

MARCS provides the foundation for an expanded communications network, Ohio's Statewide Interoperable Radio Network (OSIRN), to support statewide interoperability as part of the State's Interoperability Communications Plan. The Interoperability Communications Plan, adopted in 2005, recommended upgrading OSIRN to the current Motorola ASTRO® 7.x platform to support high-speed data, Voice over Internet Protocol (VoIP), P25 trunking compliance, and compatibility with regional systems in Ohio.

The FY 06 / 07 Technology Plan for the OFT set forth a strategic initiative to expand and enhance the existing private wireless data service capabilities for first responders through the use of a 700 MHz data system using the MARCS network infrastructure.

5.1.6. State of Utah

UCAN (Utah Communications Agency Network) is a statewide 800MHz Motorola Mixed Mode 4.1 version Omni-linked with four zones system. It is a basic digital and analog system at 3600 baud.

There are defined interoperable schemes with all agencies using the system. Agencies still on the 150 band are tied through dispatch centers that are networked to the system. Patching is allowed for cross banding.

UCAN currently has 60 sites serving 125 agencies using 19,760 radios. Today the system covers one-third of the state, or about 85 percent of the population.

5.1.6.1. History

The issues that led to the UCAN system were a need for more spectrum and operational capabilities. This was especially true around Salt Lake City, the largest population base in the State. In 1997 a task force was formed by the governor that made recommendations that became legislation. After the award of the Olympic winter games to Salt Lake City it became imperative that a new system be developed to support that effort.

5.1.6.2. Governance

The state system is operated by a quasi state agency owned by the users which consist of state, local, city and county participants and called UCAN. The governance was defined by legislation which includes a board of directors, made up of the users, who oversee the operations. This joint ownership governance should give local participants comfort with the system as they are in fact owners. Since it is a quasi-state organization, UCAN employees can be covered by the state employee benefits and UCAN does not have to engage in the required HR, etc. tasks that take time, money and specialists. This allows them to dip into the programs already engaged and take advantage of the larger group costs which should be cheaper.

5.1.6.3. Funding

Initial funding of $125M came from federal grants, a bond, and one-time Olympic funding provided by the DOD. Total build out is expected to cost $160M.

Annual funding is based on user fees. Currant annual budget is $4.5M

5.1.6.4. Staffing

A Director runs UCAN and is responsible to the Board of Directors. There is also an operations manager, four technicians and three administrative staff.

5.1.6.5. Maintenance

The system is self maintained by four UCAN technicians. The technicians are assisted by contract labor, as necessary, to do the site work. This keeps continuity of the system by having dedicated folks. It also keeps costs down by not having more specialized personnel who are not needed each and every day. Tower workers would be an example of a skill that should be hired when needed.

5.1.6.6. Users

This system is available to state agencies, local (both municipal and county), federal or tribal organizations. Locals are encouraged to join and all participants pay a user fee. The plan of any statewide system should be to build for current need taking into account those who will come once it is built. Remember, the biggest cost to a radio system is neither operations nor maintenance, but rather it is the capital investment. With the mandatory narrowbanding dates approaching, it would seem reasonable that the opportunity for further growth in the local / county market is great if the system is available to the potential customer. Complete statewide build out is imperative and should be a part of the task force bill listed below.

5.1.6.7. Future Plans

UCAN is currently studying the feasibility of further statewide expansion. They are reviewing available options to complete coverage. There is currently a task force bill before the 2008 Utah legislature that is currently in session. Funding will, of course, be an issue to cover the portions of the State with the lesser population. Also given the topography of Utah, the amount of infrastructure required could be very large and expensive.

5.1.7. State of New York

New York's Statewide Wireless Network (SWN) is one of the newest statewide radio systems and certainly the most expensive. It is still in the early stages of construction.

When completed, the SWN will be an integrated voice and data (IV&D) system providing 95 percent mobile coverage throughout the state and 97 percent mobile coverage on roadways. The SWN will employ three technologies to achieve its coverage goal. The primary communications system will be M/A-COM's OpenSky® system using both 700 and 800 MHz frequencies to provided IV&D. In the Catskills and Adirondacks, the SWN will use M/A-COM's P25^{IP}® trunked and conventional system on 150 MHz VHF frequencies to provide IV&D. The two systems will connect using M/A-COM's NetworkFirst IP backbone network. NetworkFirst will be the gateway to provide interoperability among disparate radio systems throughout the state.

OpenSky® is a proprietary technology using the P25 common air interface (CAI). The OpenSky® system uses four-slot Time Division Multiple Access (TDMA) that allows up to four users to talk on the same channel and achieves 6.25 kHz-equivalent channel spacing. OpenSky® also uses Cellular Digital Packet Data (CDPD) standard-based packet technology, voice trunking, optional GPS technology for Automatic Vehicle Location (AVL), and over-the-air provisioning and programming of radios. OpenSky® is capable of providing a data rate of up to 19.2 Kpbs.

The SWN's engineering design calls for over 1,000 sites across the state. To provide the required coverage, OpenSky® uses a combination of high-profile and low-profile sites. Low-profile sites are transmitter sites located on utility poles and other "low-profile" structures. Low-profile sites provide a cost effective way of providing enhanced coverage to an area. However, they do not provide the same fault tolerance and capacity as high-profile sites. M/A-COM's Vehicular Tactical Repeaters (V-TACs) can also extend OpenSky® coverage. The New York State Office of Technology (OFT) expects that new towers will make up a very small percentage of the towers necessary for SWN. The final engineering design, delivered to the state in July of 2007, is still under review.

5.1.7.1. History

The SWN project originally began in 1996 when the New York State Police began research and planning to address their deteriorating radio system. The planning quickly shifted to an all-agency enterprise strategy; in 2000, the SWN Project Office was established within the OFT to move the project forward. In September 2005, the contact award went to M/A-COM. The expectation is the system will be available statewide by September, 2010.

5.1.7.2. Governance

In 2004, law established the Statewide Wireless Network Advisory Council (Council) to assist in the development and implementation of an integrated statewide communications system linking state and local first responders. The 27-member council is comprised of state agency heads, state legislative representatives, representatives of first responder organizations and experts in the field. The Council is charged with assisting in the development and implementation of an integrated statewide communications system linking state and local first responders, consulting and advising the OFT regarding state purchases of information and communications technology, and making recommendations to state elected leaders concerning the availability and reliability of communications to ensure timely assistance.

5.1.7.3. Funding

The contract with M/A-COM is for $2.005 billion over 20 years, to be paid from funds collected through the state's wireless communications service surcharge (surcharge on cellular telephones). At the time of contract approval, the State Comptroller reported that the establishment of a funding stream was necessary for the project for the long-term because proceeds from the wireless 9-1-1 surcharge would be inadequate.

5.1.7.4. Maintenance

M/A-COM is the primary contractor to design, construct and maintain the SWN. M/A-COM's key subcontractors for the project are General Dynamics and Alcatel.

5.1.7.5. Users

The SWN has actively sought local governments to partner with the SWN to provide interoperability, sharing of infrastructure, and local agency use of SWN as their primary voice and data communications system. There are no subscriber costs to local governments and first responders to join the SWN. The SWN offers three level of partnership:

- **Level 1 – Infrastructure**
  Requires sharing infrastructure, such as towers and shelters, collocation to minimize tower proliferation, and sharing some infrastructure costs; this level provides no access to the SWN network and no interoperability through SWN.
- **Level 2 - Gateway**
  Requires the same sharing of infrastructure and collocation of facilities as Level 1, but includes gateway access to the SWN network for interoperability and data sharing
- **Level 3 - Full Integration**
  Requires same sharing of infrastructure and collocation of facilities as Levels 1 and 2, but provides full access to the SWN network and use of the system. Level 3 partners may elect, at their expense, to build-out on the system to provide enhanced in-building and underground coverage where needed. (The SWN has yet to announce the details of the build-out.).

As of December 2007, 33 counties had signed on as either a Gateway / Level 2 or a Full Integration / Level 3 partner; 25 counties were in the process of reviewing or executing a SWN partnership agreement. These agreements commit the parties to explore the particular level of partnership in preparation for a formal contract with the SWN. With the additional agreements signed in 2008, the SWN anticipates that 20 of the state's 62 counties will have signed on as Full Integration / Level 3 partners.

Local agencies must purchase their own subscriber equipment. As discussed above, OpenSky® is a proprietary technology. In its bid proposal, M/A-COM provided commitments from three independent manufacturers to provide compatible subscriber equipment for the SWN. These vendors, reportedly, are in discussions with the SWN office with respect to this commitment. In addition, two Japanese radio equipment manufacturers have expressed interest in producing the SWN radios, but are awaiting the State's decision to proceed to Phase 2 build-out before making a decision to manufacture the radio equipment.

5.1.7.6. Planning

The SWN construction project has two phases. The project is still in Phase 1, which consists of building the system and testing in the Primary Region - Erie and Chautauqua Counties in western New York. The Primary Regional build-out is the "proof-of-concept" for the SWN. It is the first region to be tested for compliance with the SWN functional specifications and must fully conform to all contractual requirements before the OFT will begin payments to M/A-COM and authorize them to proceed with statewide build-out. Currently being undertaken as well is the replacement of the State Police's existing 800 MHz M/A-COM EDACS® trunked radio system in the New York City Region. While considered part of Phase 2, this has been undertaken with agreement between the OFT and M/A-COM. Phase 2 completes the remaining ten regions within five years of the contract sign-off.

Operational testing in the Primary Region, conducted during the fall of 2007, was unsatisfactory and the Acceptance Re-test scheduled for February 2008. The operational testing identified a number of software bugs, network and subscriber equipment configuration problems, and site performance issues. The software code installed for subscriber radios did not reliably support many critical user functions (e.g., emergency button functionality, roaming between sites, and immediate portable radio connectivity with its associated V-TAC). Also identified during the operational testing were deficiencies associated with

M/A-COM's project management processes, configuration management, version control, and technical support to SWN user agencies.

Based on its experience in building-out the system in the Primary Region, the SWN has identified a number of challenges and risks associated with the project including the following:

- **Site Acquisition** - Delays can be caused by:
  - Longer than expected environment reviews due to information that must be provided by entities external to the SWN Project Office
  - Prolonged site lease negotiations with site owners seeking specific terms and conditions
  - Site selection opposition from landowners, local governments and local communities
- **Agency Transition** - Refers to all steps required to migrate a given government entity to SWN:
  - **New technology adoption**
    For many agencies, the SWN system is a new technology platform that requires extensive time and financial commitment to support the technical planning associated with revised business practices, procurement of new radio equipment and user training.
  - **Little, if any tolerance for downtime**
    Most of the agencies transitioning to the SWN provide critical public safety services. In most cases, there will be a requirement for the transition to occur with absolutely no disruption of service. To accomplish this, most transitioning agencies will continue to maintain their legacy radio system as a backup during the transition period. Detailed plans must be developed with each agency that address all aspects of the transition and fully anticipate potential transition problems.
  - **Optimizing agency transition strategies with the SWN build-out order**
    Individual agencies must develop transition strategies that consider both the SWN build-out order and the geographical locations of their organizational structures. For example, some agencies may need multiple SWN regions to be completed before it will be ready to transition any portion of their organization to the new system. Other agencies may only need a single region to be completed for transition to begin. Managing multiple agency transitions, while simultaneously proceeding with the SWN build-out strategy, will be a continual challenge for both the SWN Project Office and involved agencies.

Erie County, one of the largest counties to commit to being a Level 3 partner, has withdrawn from the full partnership agreement, remaining as a Gateway/Level 2 partner. Erie County has decided to pursue other technologies to upgrade their communications system, basing their decision on the cost of building-out the SWN, approximately $39 million, SWN's performance to date in constructing the system in Erie County, and on SWN's and M/A Comms inability to deliver on coverage and performance levels during system testing..

5.2. BEST PRACTICES AND LESSONS LEARNED

From reviewing the past and current efforts of other states as they developed statewide radio systems, key ideas and strategies can be identified that can help the State of Oklahoma as it begins the expansion of its own statewide system. These best practices are presented here and divided into strategic sections.

5.2.1. System Build-out

- Have a valid plan and an accurate estimate of cost. Many of the states had cost overruns and retooling of the plans along the way. Do the required planning up front to meet the users' needs and then stay with the plan. Decide what coverage is going to be right up front in the Request For Proposals and make sure that all users knows what standards the system will be built-out to.
- Site acquisition is typically a more difficult process than is anticipated. Do not underestimate the amount of time and effort that it will actually take.
- Encourage local public safety agencies to join the system. If these users require a higher level of coverage than the plans call for, allow them to enhance coverage in their own areas, at their own cost.
- With narrow banding coming soon to VHF and UHF radio systems, many of the local agencies will need to spend a good deal of money to upgrade their radio systems. Encourage these agencies to join the statewide system as it may be a lower cost to join rather than replace existing systems.
- Identify existing tower sites that may be able to be used for the system, rather than having to build out all new towers. This can save initial construction fees and reduce the amount of time needed for site acquisition.
- Identify potential public-private partnership opportunities, especially in the areas of site development, as they can produce significant cost savings.
- Good project management practices are key to a successful system development.

5.2.2. Governance and Management

- All successful states have strong system governance structures that have been established by Executive Order of the state's Governor
- Successful governance committees consist of members from all state stakeholders and high level representatives from local response organizations. All potential stakeholder groups must be represented.
- Successful governance committees provide guidance and develop effective policies, but do not get involved in the day-to-day operations of a system
- Successful systems have put a dedicated management team in place before development starts that takes care of strategic planning and the day-to-day operation of the system
- While in most states a public safety agency has been key to starting the system development process, once a system is up and running, management has been transferred to an independent

agency, such as Information Technology, to ensure that the system is un-biased in its delivery of services

- Sufficient, qualified staff must be hired to manage a system. This staff must be fully trained on the selected technology and training kept up to date.
- If hiring sufficient staff is not an option, strong contracts must be put in place to provide these capabilities while in-house staff can be developed.

5.2.3. Funding

- Funding is an on-going issue in all systems
- Funding must be provided for initial build-out, on going system management and maintenance, and for system life-cycle upgrades and replacement
- It appears clear that capital funding has been a major issue in all systems. The costs in most cases have ended up higher than planned creating difficulty in completing the projects.
- Capital funding has come primarily from State Capital funding, Bonds, Grants, and dedicated surcharges
    - Florida added $1 to all vessel and vehicle registrations for a fixed period of years which turned out to be not enough. Then they added a $3 surcharge to all traffic violations. All of these are passed with sunset clauses that have to be constantly amended.
    - New York chose to use their wireless 9-1-1 funds, which according to their Comptroller are not going to be enough.
    - Michigan and Ohio provided capital funds from state construction bonds
- Grants cannot be depended on as reliable funding sources for construction or life-cycle updates.
- A dedicated source of funding must be identified and secured if a system is to be successful
- User fees cannot be depended on to provide the total cost of operations.

5.3. TECHNOLOGY REVIEWS

As the State of Oklahoma begins the planning for expanding its statewide radio system, many different technologies may be presented as the "solution" that will take care of all the issues. In this section, the different technologies that may be proposed to the State are presented and examined. In each section, the pros and cons of that technology and how it relates to public safety communications is presented. While this is not an all encompassing list of available technologies, the topics presented are the most applicable to the situation.

5.3.1. Radio over Internet Protocol (RoIP)

5.3.1.1. Introduction

RoIP is the new buzzword thrown around in conversations today. However, what is RoIP; better yet, what is IP? In addition, what are some of the things to consider in developing a RoIP system for public safety applications? These are all questions that deserve answers to understand proposed IP solutions.

5.3.1.2. Circuit Transport vs. IP Packet Transport

Internet Protocol (IP) has become the common terminology associated with the Internet. IP is a data-oriented protocol designed for sending data across a wired network in packets, or discrete blocks. IP provides the addressing and routing information from one user to the next with a unique identification (for example 192.168.100.1). This technology has significantly changed the telecommunications industry accustomed to circuit switching technology which has a limited data capacity. Figure 1 below differentiates between circuit and packet transport.

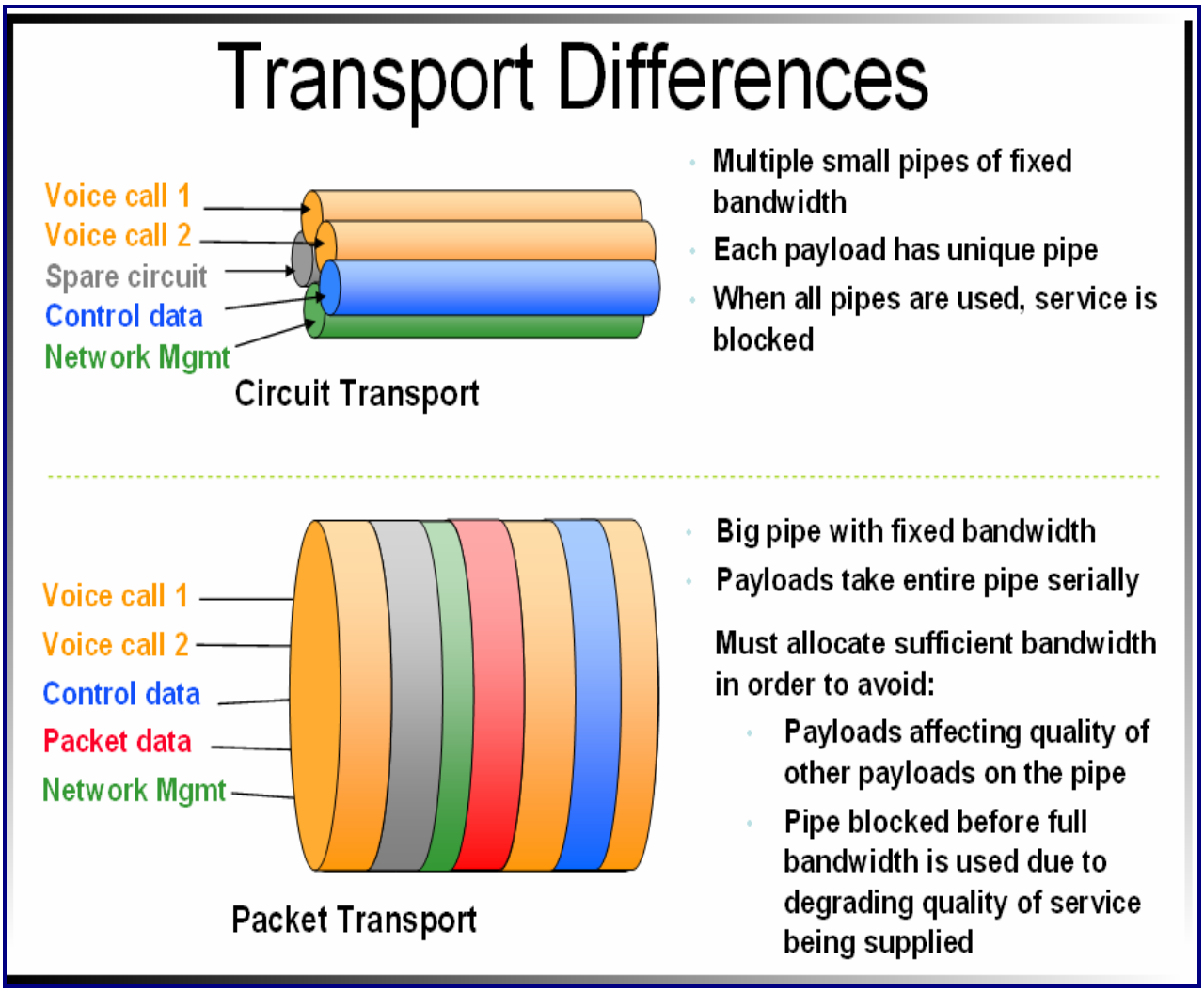


Figure 5.1 – Transport Differences

5.3.1.3. Radio and IP Working Together

One question that presents itself is how IP affects the two-way radio industry. Radio manufacturers have been developing the Radio over IP or Radio control over IP (RoIP) solution that is very similar to Voice over IP (VoIP). VoIP connects a landline telephone to other telephones or devices through an IP network or the Internet. RoIP merely replaces the telephone with a radio to send and receive Radio Frequency (RF) voice traffic. One misconception is that the subscriber unit (mobile radio, portable radio, etc) sends packet data over the air. This is not the case. RoIP is not IP over an RF environment. It is a base station control over an IP-based network.

However, there are also significant distinctions between VoIP and RoIP. In the voice telephone application, only voice is sent over a VoIP application. In a radio control application, additional information, such as push-to-talk, frequency selection, repeater enable or disable and other necessary control and auxiliary control functions for the base station and associated equipment are included in the packet stream, along with voice.

In essence, RoIP acts as the network backbone connection between existing and new land mobile radio systems to computers (or dispatch consoles). Base stations are connected to an IP gateway that codes the voice communications into IP packets. Once packetized, the information is sent through the network, using proprietary protocols offered by each vendor. Many vendors use other vendors' routers and switches to transport the packets through the Ethernet-based IP network until they reach their destination, determined by the media access control (MAC) address. The typical "backroom" console electronics are eliminated and consoles are accessed through the IP routers, switches, hubs, or servers all the way to the base station. Figure 2 is a high-level example of a RoIP network.

Many vendors refer to this design as an end-to-end IP Network. To restate a false impression, although some vendors have unique IP addresses in subscriber units, there are no packets sent over the air, and the IP packet control ends at the base station. There is still a device that converts four-wire audio to an Ethernet connection.

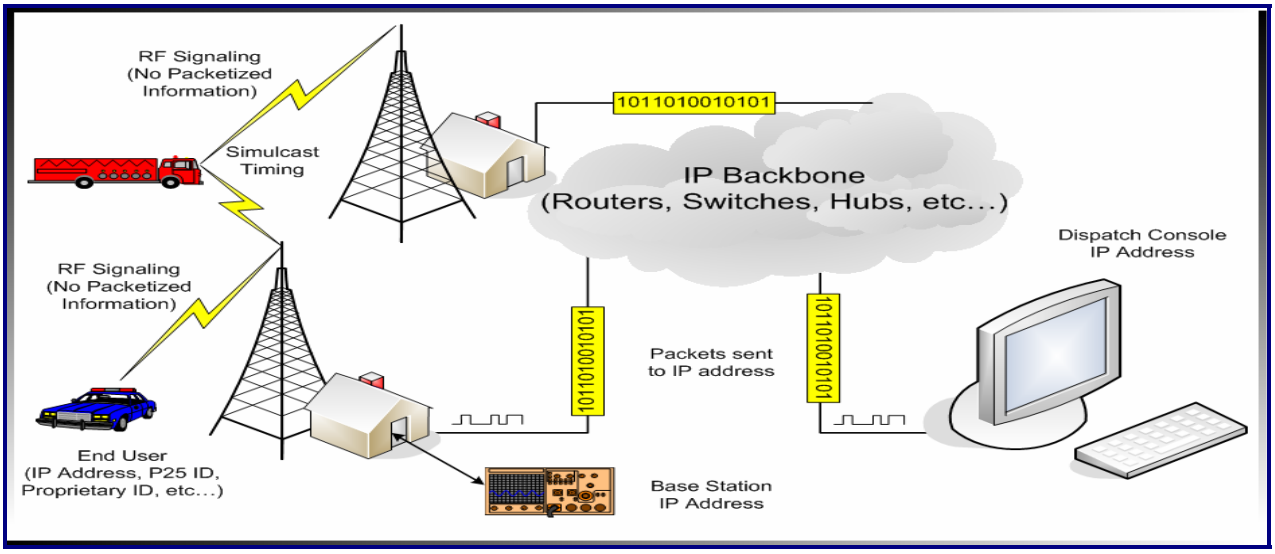


Figure 5.2 – RoIP Network Diagram

5.3.1.4. Private Networks vs. Commercial Networks

An important note is that RoIP does not indicate that the radio audio has to be sent over the Internet. What RoIP utilizes is the transport protocols associated with the Internet such Transmission Control Protocol (TCP /IP) and User Datagram Protocol (UDP) on private networks. Public safety agencies typically operate on their own private network to ensure emergency priorities, total control, and reliability. Any type of IP-based system utilized for public safety applications must contain redundant infrastructure as is inherent in any designed public safety Land Mobile Radio (LMR) communications system. Some vendors provide RoIP solutions through the Internet; however, the emergency responder community relies on a commercial private network to provide the connection. If commercial networks are utilized, the public safety agency is dependent on the commercial provider to maintain and operate their system during high activity events. Similar to leased lines to remote sites, repair time can be inadequate for public safety due to long response times.

A major issue with RoIP and private networks is the lack of standardization. RoIP takes an analog voice and transfers the information into packets the same as VoIP. However, the VoIP signaling that controls the telephone such as Dual-Tone Multi-Frequency (DTMF), dial tones, and busy signals have been standardized for many years. Push-To-Talk (PTT) is equivalent to requesting a dial tone on a system and the functionality behind this request is proprietary. There are critical concerns for large regional networks where multiple vendors are a possibility. Additional planning is necessary to implement RoIP as an interoperability gateway.

5.3.1.5. Design Considerations in Implementing a RoIP

Many of the current vendor solutions are already IP based. If planning on controlling all radio equipment through an existing IP network, there are some important factors that need to be addressed in the network design:

1. Voice information is converted to digital information and sent through the network using UDP (User [*or Universal*] Datagram Protocol) reducing bandwidth requirements.
2. Because the system uses UDP to communicate RoIP, the Quality of Service (QoS) must be understood.
3. The bandwidth for the communications channel must be sufficient in able to guarantee this level of QoS.

These design parameters take into account all applications that may access the network. Some of the major considerations include 9-1-1 Telephony, Computer Aided Dispatch (CAD) and the Records Management System (RMS).

Once a network is in place, whether private or public, there are other issues that need consideration. If implementing a new simulcast radio system, timing and latency issues exist with activating base stations at the correct times. Specific IP routes must be defined on the network to adequately measure launch time compensation. If multiple nodes exist on the network for redundancy, then separate IP routes must be pre-programmed into the network. Using a commercial network or a larger agency Information Technology (IT) network, not a dedicated radio only network, the latency issues become more significant.

Overall, technologies are different, growing, and changing. RoIP systems are proprietary or non-standards based. For all intents and purposes, good planning and designing will be important to successfully implement a RoIP system. If successful, the quality of communications could be greatly improved and many infrastructure or recurring costs may be dramatically reduced. Most importantly, interoperability can be increased with simple implementation of IP gateways interfacing radios, cell phones, landline telephones, IP phones and PCs.

5.3.2. IP Gateways and Interoperability

5.3.2.1. General Overview

The technical foundation of IP Gateways is based on RoIP technologies. This physical design and operating parameters are outlined in Section 5.2.4 (RoIP) of this report. The same technology is used in what are commonly referred to as "interoperability gateways".

5.3.2.2. Background

Radio systems used by different agencies have traditionally been entirely independent of one another. They have a federally authorized and licensed frequency or frequencies that they use to communicate between mobile and fixed units. These frequencies are all different so that an agency can conduct their communication without interference from another agency. In public safety applications this allows a fire department to communicate at a fire scene while a police department communicates at a vehicle accident scene. Both agencies can conduct simultaneous radio communications that are critical to their mission without interference from the other agency.

The advent of the Internet has created improved technologies and advances in hardware that are migrating into the land mobile radio marketplace. As in the use of RoIP, multiple manufacturers have begun to market connectivity solutions. Cisco, Motorola and Tyco are just a few that recognized the potential to offer solutions that can meet new demands in this arena. Most solutions are based on IP router technologies that allow the assignment of IP addresses to traditional legacy and current technology radio equipment. Some solutions are very simple while others offer a range of software applications for controlling the level of interoperability. Large interconnected networks require the use of advanced router technology and strict network management.

5.3.2.3. Application Benefits

The use of the IP Gateway can allow the interconnection between any two different and distinct radio systems. There is no limitation that occurs due the distance between the systems using the gateway. There are no limitations that occur due to different frequencies or frequency band. As in the Internet, as long as there is a path of connectivity existing between the gateways, interoperable communications can exist. A radio system in Miami can be connected to a radio system in Lawton, Woodward, or any or all locations in the State at one time.

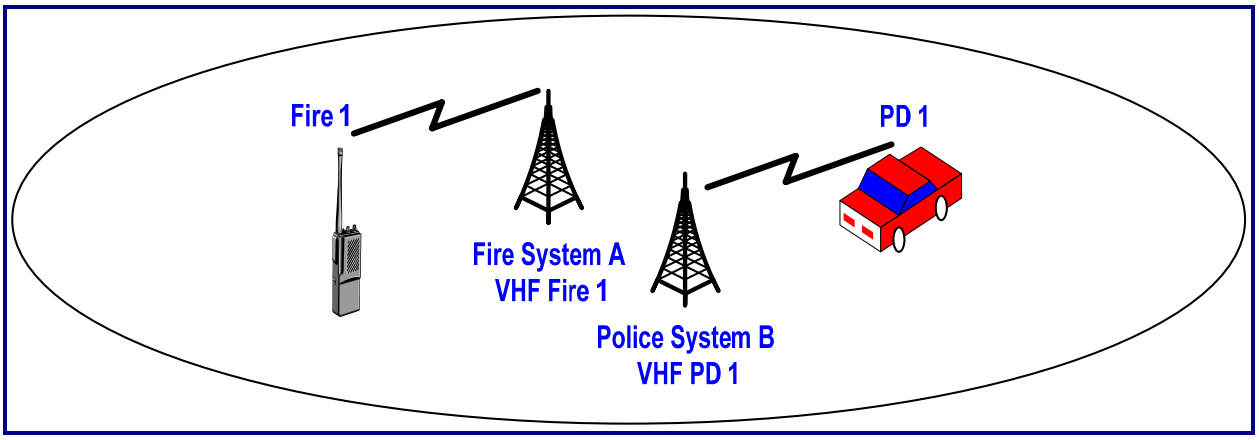
In situations that require a wide area response or wide area interoperations, this can be a beneficial tool. All agencies on the gateways can communicate on their own system and yet be connected to any or all agencies at the same time. If activities need to be coordinated over a large geographical area, communications paths can be established. If an alert needs to be transmitted to many agencies at one time, this also can be done easily.

5.3.2.4. Application Shortfalls

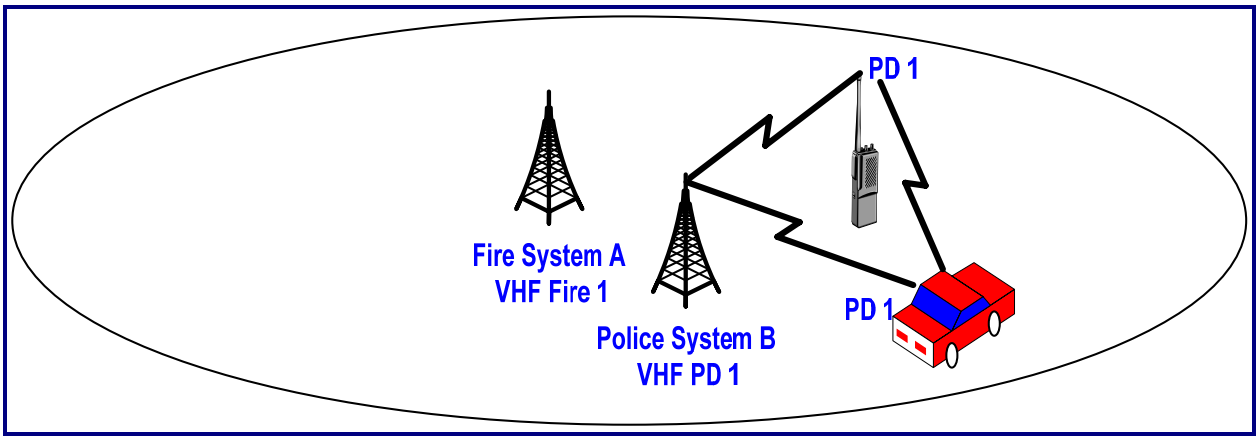
- The interoperability advantage of gateways becomes ineffective if agencies are called to an event that is beyond the range of their system. Once the mobile units are beyond the range of their own system, which is still connected through the gateway, they are once again isolated to operating with mobile units on their own frequency. All connectivity with other agencies at the event is lost.
- If there is a concentrated response, where different agencies that normally operate on there own frequency within the area, are interconnected in a cooperative effort, air traffic congestion can occur. All transmissions are heard on all frequencies and although interoperability is established, usability can be compromised if all agencies do not adhere to a strict incident command structure.
- Strict attention must be given to the connectivity path used between the gateways. Commercial applications commonly rely on the internet. A virtual private network is established as in RoIP and used for the connectivity. In public safety applications, the reliance on commercial providers is still not a standard. Most public safety agencies develop a proprietary connectivity path with a microwave backbone system.

5.3.2.5. Interoperability Situations

Scenario Number 1
If the agencies are within the operational range of each others' system and they are using the same radio frequency band, they may be able to communicate by switching channels on the radio. A policy and procedure would have to be established between the agencies to allow this to function properly. This is common among agencies that provide support and mutual aid to one another.

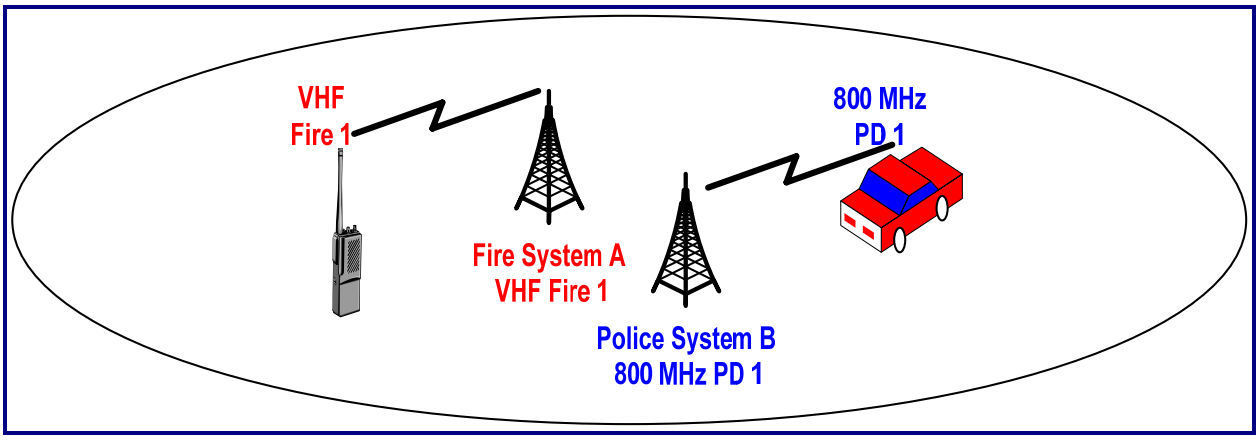


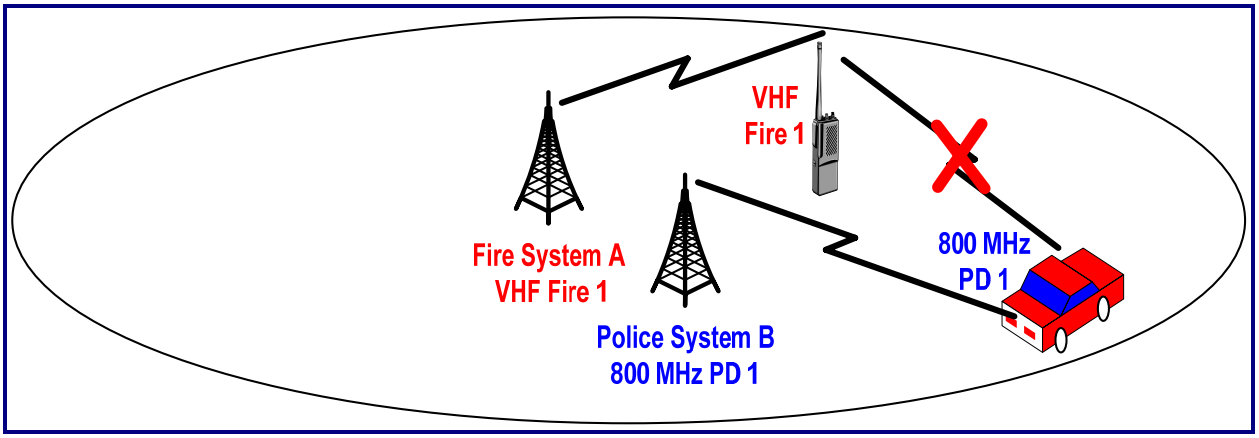
Gateway Solution
There is no need for an IP solution. With proper incident command management, communications can occur to coordinate activities between agencies. The system VHF Fire 1 unit switches to VHF PD 1 and has on over-the-air path. There is a limit to the overall effectiveness since only one radio transmission can occur at any given time on any given frequency. Agencies must adhere to best radio use practices or air traffic increases to a point where some critical communications are lost as more than unit attempts to transmit.



Scenario Number 2

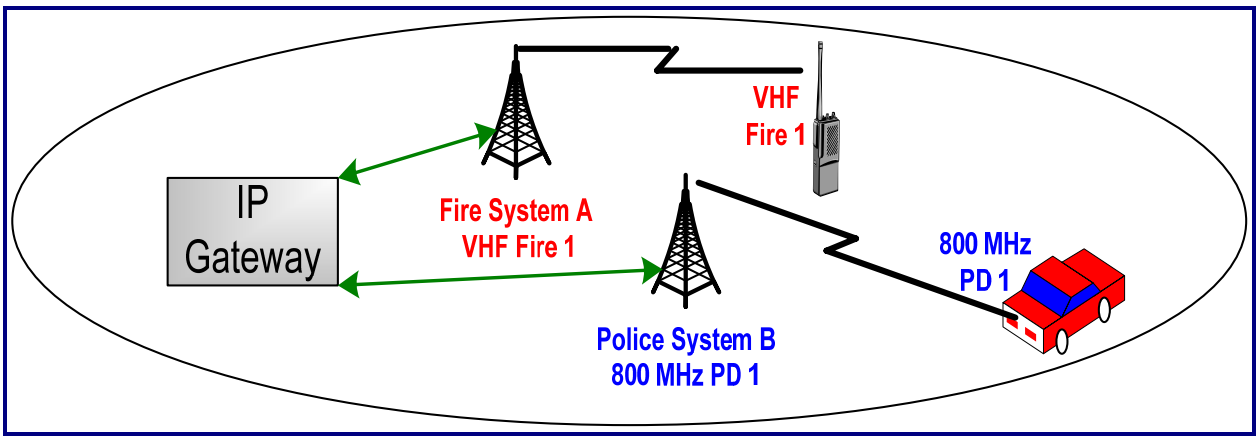
If the agencies are within the operational range of each others system and they are using different radio frequency bands, they will not be able to communicate by switching channels on the radio. There is no "over-the-air" communications between radios on different frequency bands. This situation is also common since interoperations were not an established standard among many agencies.





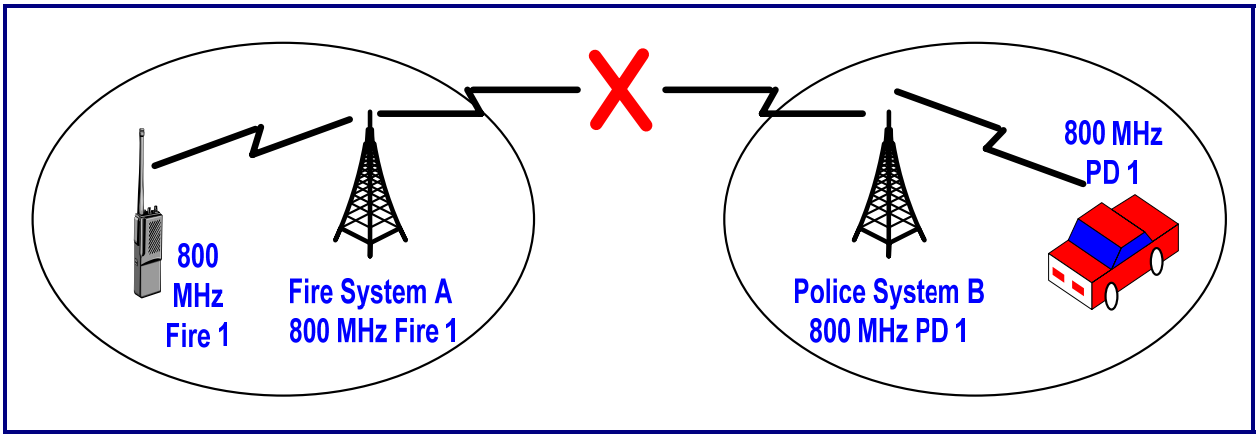
Gateway Solution

The application of an IP Gateway can be used to establish an interconnection between the two systems. The systems can be interoperable. In a basic fashion, all radio traffic that occurs on the system using one frequency band is routed to the system using the other frequency band and is re-transmitted. This reciprocated and is completely bi-directional so that both systems are able to interoperate but still use their own frequency.



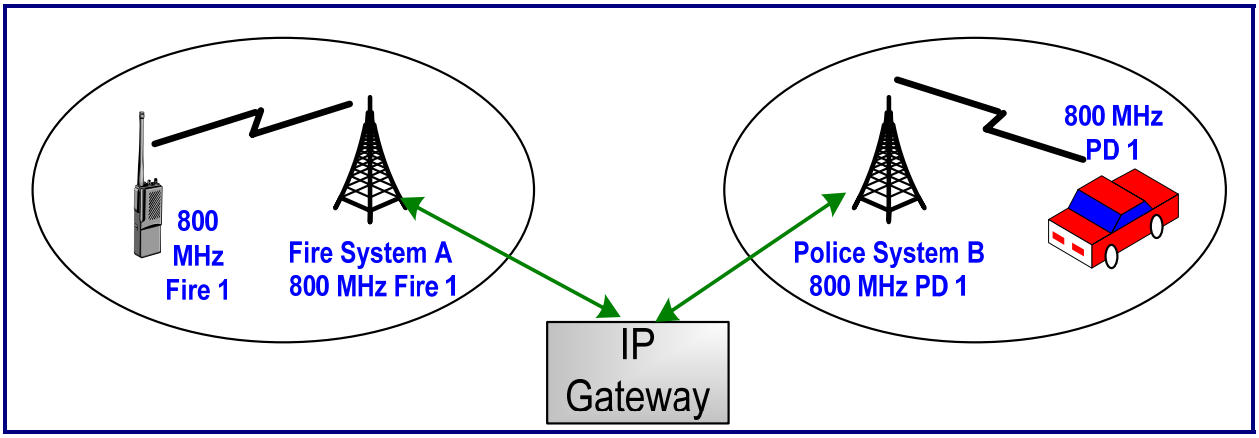
Scenario Number 3

If the agencies are separated geographically, beyond the operation range of their respective systems or units, they cannot communicate under any circumstances. The frequency or band of the radio has no bearing at all. Radio signals can only propagate a certain distance before diminishing to where they become unusable.



Scenario Number 4

The geographical separation between these two systems can be overcome through the use of an IP Gateway. The physical limitations of radio, as described in this scenario, are overcome through the interconnection gateway.



5.3.2.6. Summary

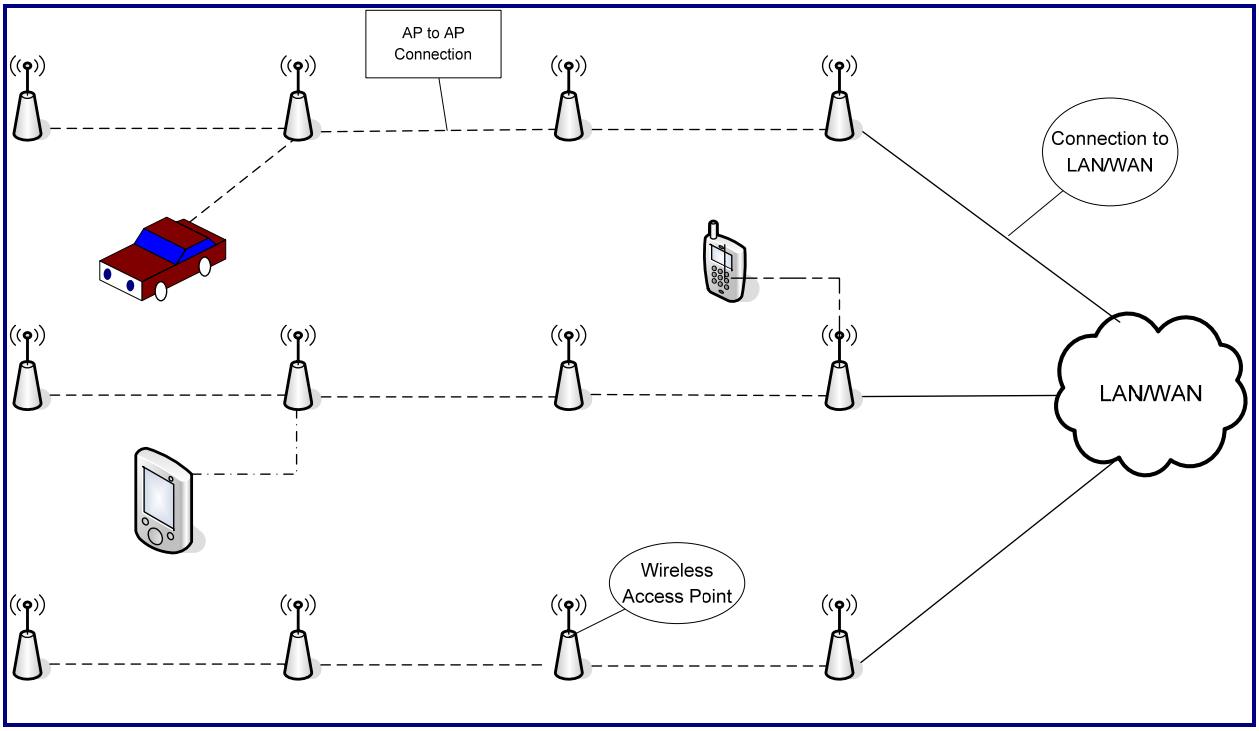
The use of IP Gateways can provide solutions to some communication challenges, if properly implemented in to a total communications plan. It can inter-connect large communications systems where there is only an occasional need to interoperate. It can serve as a temporary migration path when system upgrades or changes extend over a reasonably long period of time.

IP Gateways cannot address the interoperability issues as defined by the APCO-16 standard. The issues of usable range, priority access, and usage control still exist. This type of solution creates a network of multiple systems rather than a networked system. With these issues in mind, we see IP Gateways as a tool that can be used in, but not a solution to, the construction of a state-wide communication system.

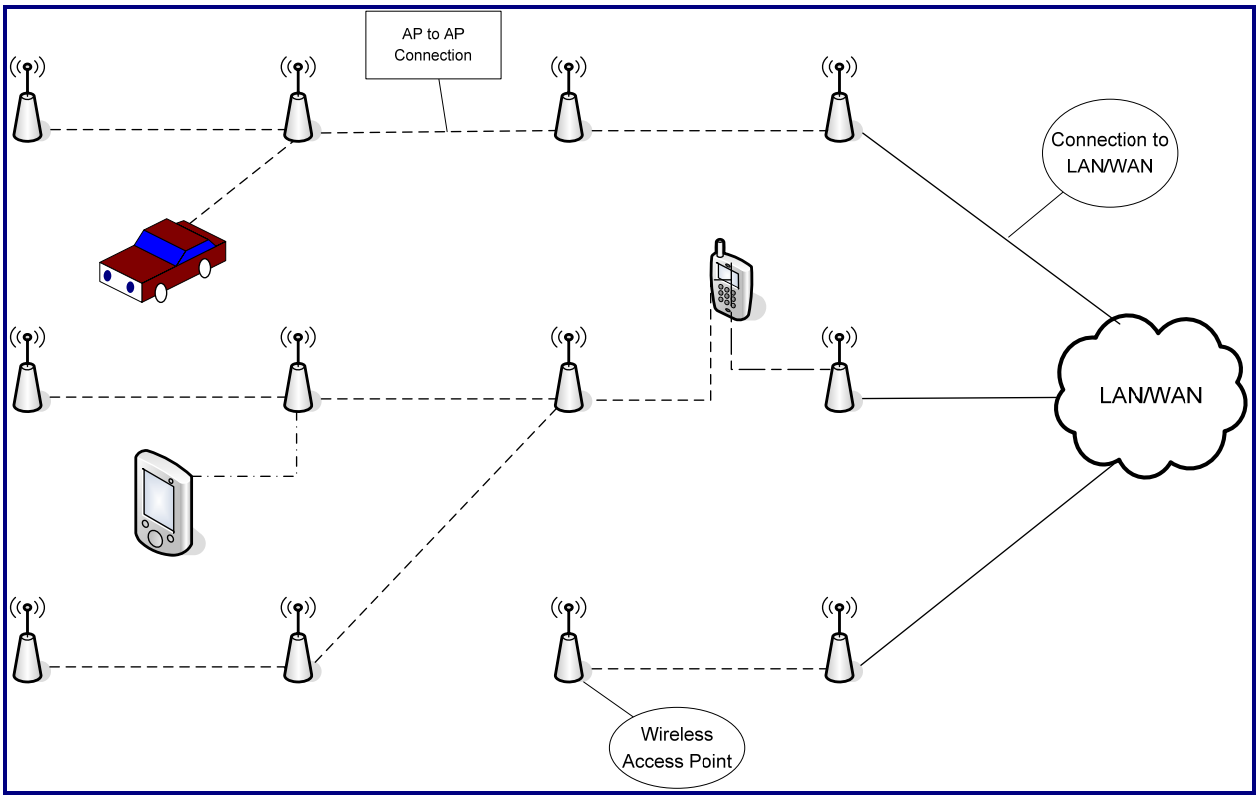
5.3.3. Mesh Networks

Mesh networking is a technology designed to allow mobile wireless access to traditional wired networks and the Internet. In many ways, it is similar to the familiar 802.11 b-g standards for wireless networking that is used in home and office wireless networks; but mesh networks are designed to operate in a mobile environment, which allows mobile devices to move around a service area with greater reliability and connectivity.

Mesh networks are configured to operate in two different modes simultaneously; to connect to fixed Access Points (AP) or to connect directly with other mobile devices in peer-to-peer mode, which is known as ad-hoc mode. While the 802.11 networks can also operate in either of these modes, they cannot do it simultaneously, which gives a mesh network much more flexibility and potential redundancy. The mesh networks for public safety agencies typically operate in the 2.4 Gigahertz (GHz) or 4.9 GHz range. The 2.4 GHz spectrum is unlicensed and is susceptible to interference from other mesh networks. The 4.9 GHz spectrum is licensed exclusively for public safety but is also susceptible to interference from other mesh networks or from microwave systems that operate in that range. The Oklahoma Department of Transportation (ODOT) is planning to use this spectrum for the microwave links in its new radio system and could cause interference problems Statewide to mesh networks. In the following diagrams, these two mesh modes are illustrated.



Fixed Access Point Network



Mesh Network Self-healing Characteristics

By using the fixed AP mode of deployment, a defined geographic area can be covered with APs that are mounted either on traditional radio structures (e.g., towers) or on such non-traditional structures such as utility poles and roof tops. This has resulted in some successful deployments that can provide near carrier class connectivity. While the AP hardware is relatively inexpensive, the limited levels of transmit power that can be used restrict the coverage area of each AP to a distance of approximately 250 meters; however, this distance can be further reduced due to the frequency characteristics of the spectrum used for mesh networks. As noted earlier, mesh networks typically operate in the 4.9 GHz spectrum, which requires a line of sight or near line of sight with mobiles and other APs to be effective.

Typical wide area mesh networks require from 30 to 50 access points per square mile to provide sufficient coverage and bandwidth. While the APs have the ability to connect directly with each other to form the "mesh", experience has shown that as the number of hops from the "wired" connection increases, throughput to the end-user decreases. The first hop carries the data sent and received by the users of mesh node 1, the second "hop" must carry the data sent and received by the users of mesh node 2 AND the data sent and received by the users of node 1. Each hop reduces the available bandwidth by approximately half; therefore, by the third or fourth hop there can be a significant drop in the overall network throughput.

To address this issue, systems are typically engineered to have a dedicated connection to the LAN / WAN by either a hard-line circuit (i.e., T-1) or a high bandwidth point-to-point wireless connection approximately every three to five APs. The ability to connect AP-directly-to-AP does allow for a high level of redundancy, if one AP fails, other APs or mobile devices will automatically seek to "heal" the mesh by looking for the next strongest connection. While the mesh concept is sound for a defined area (i.e., town, small city, campus), the need for sufficient AP infrastructure and backhaul can come with a significant cost, which is one of the reasons that municipal scale mesh networks have had very limited commercial success.

The ad-hoc mode allows for mobile users to form "ad-hoc" networks between each other at the scene of an incident or event. Numerous mobile devices, such as laptop computers, personal digital assistants (PDA) and cell-phone-like devices can be used in this way. This method allows for some ability to expand the coverage area of a fixed AP network. Additionally, other devices can be added to the network if they are programmed to access it. Some interesting devices that provide video and location positioning information are being used in some public safety settings. While the ad-hoc mode allows for maximum flexibility at an event, the ad-hoc mode network has the same limitations as the AP mode, in that each successive hop decreases the available bandwidth to the users. Range of the network may also be a problem as, typically, a vehicle-mounted unit or a handheld unit will have a much smaller coverage range than a fixed AP. Another important note is that in order to have connectivity to the original LAN / WAN, one of the mobile devices has to be connected to a fixed AP or the LAN / WAN in some way, or the ad-hoc network is an isolated island. Infrastructure is still required to make the ad-hoc mode networks effective.

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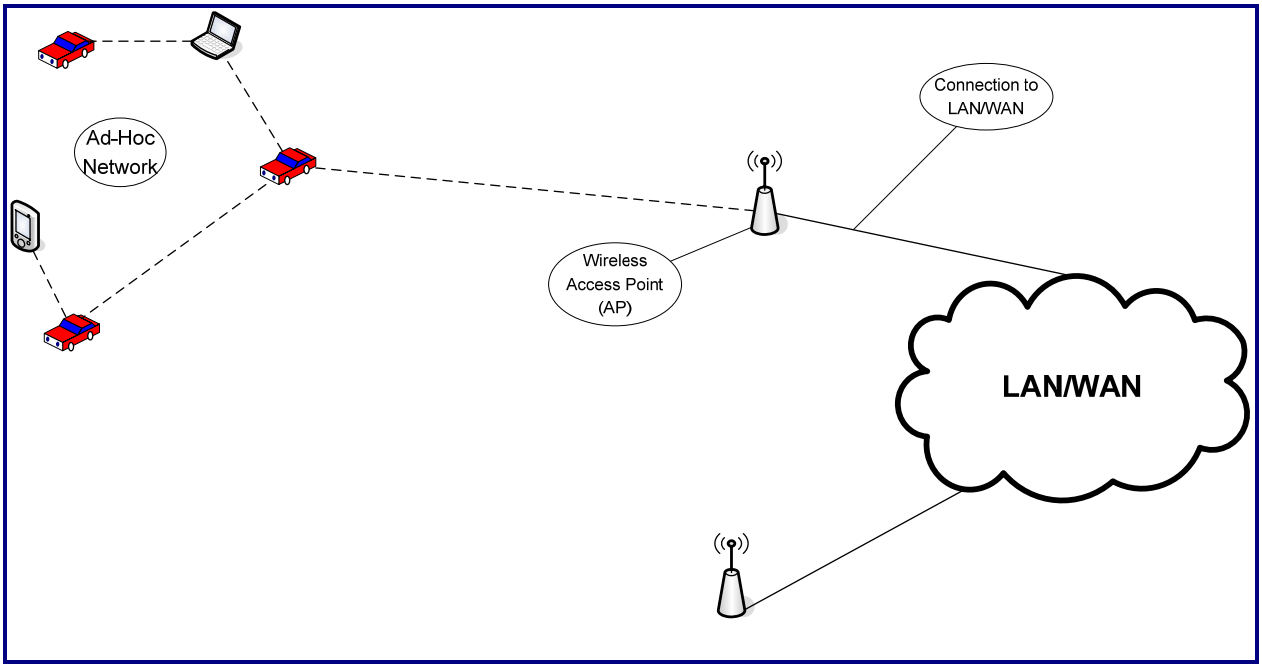

Typical Ad-Hoc Network Configuration

Mesh networks have been successfully deployed in several areas of the nation, where they perform specific functions. Typical successful uses have been:

- Remote video monitoring
- Public safety mobile data applications
- Mobile Internet access
- Incident location monitoring
- Monitoring of industrial processes (i.e., SCADA)

While some deployments have attempted the use of Voice over Internet Protocol (VoIP) technologies, the issues of latency and availability have hindered them. There are no known mesh deployments where a mesh network has replaced land mobile radio technology as the primary means of communications. The use of mesh networks for public safety should be viewed as part of the solution that supplements communications capabilities, but not as a replacement for land mobile radio systems.

5.3.4. Analog vs. Digital

There are two types of voice radio system modulation methods available to the State. These are analog voice and digital voice. As described in the preceding section on P25, the P25 digital standard is the accepted standard for digital voice radio. Either of these modulation methods is available in both conventional and trunked radio systems. Both modulation methods are effective and have their pros and cons.

The best analogy for digital versus analog modulation requires a walk back to the days before compact music discs. Children today have a hard time imagining listening to music on a 45 record or 33 LP album.

For those of us who do remember, we remember the scratches, hiss and pops. The old record was an analog data storage device and the old record player was an analog transmitter of music.

Let's skip a few tracks/years ahead to the compact disc CD, where we now experience a digital format of music. Unless the CD player has a problem, we enjoy crystal clear, hiss-less, pop-less music. The actual CD is digital storage device in which music is stored as a series of (digital) 1's and 0's. The digital data is read by a computer (CD player) which translates and converts the digital data into an analog form and transmits it to our ears in analog format. The CD player is a digital storage device and also an analog transmitter. Until the time when we have computers installed in our body, the human brain is only capable of receiving and decoding analog data.

From the figure 5.1 the mouth is the analog transmitter received by the microphone, data/speech that is received is either kept in a analog format for retransmission from the speaker or it is converted to a digital format. When it is stored digitally, it has to be the reconverted back into analog format for transmission from the speaker to our ears. The human ear is the brain's antenna that receives the analog data and processes the data into either a pleasant or unpleasant experience.

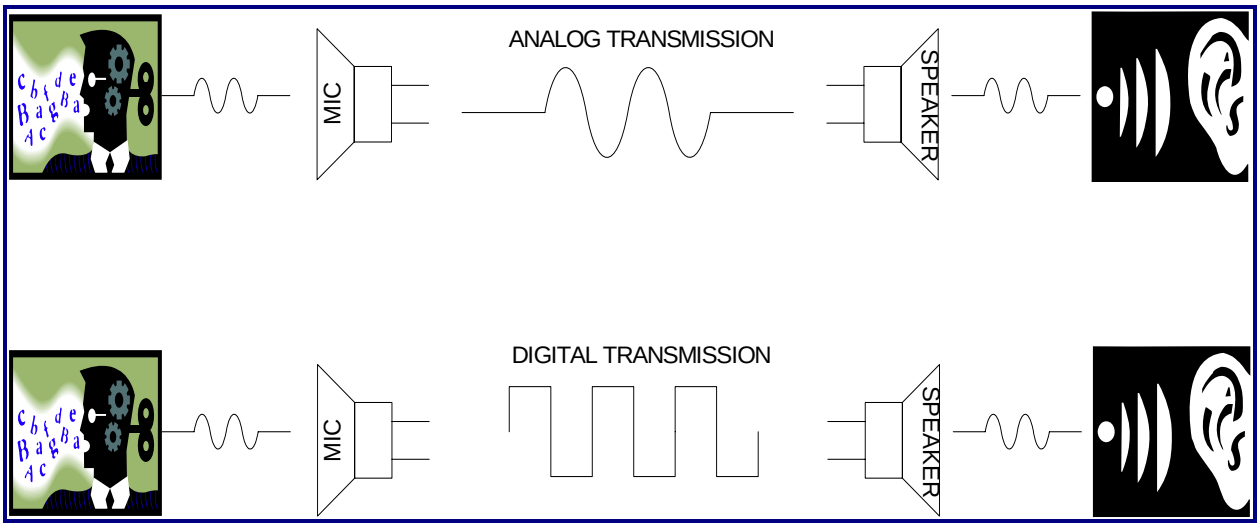

Figure 5.1 - Analog vs Digital

In figure 5.2 the concept of digital radio communications is explained by substituting a portable radio and radio transmission tower.

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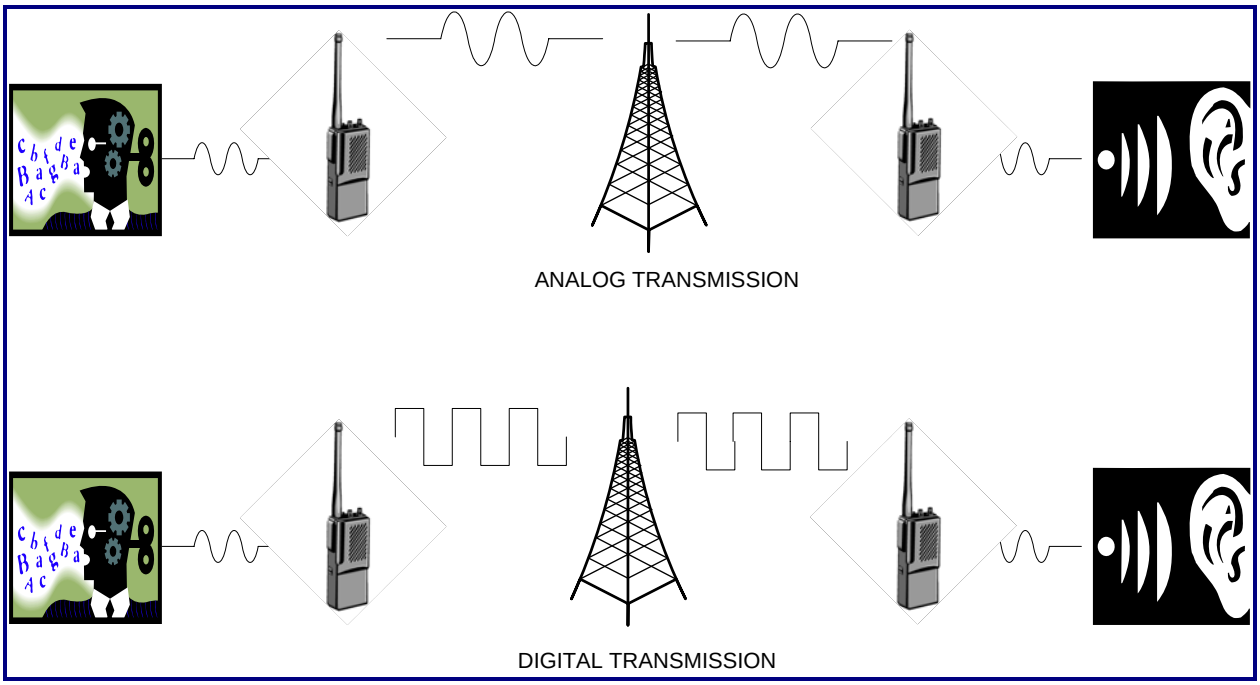

Figure 5.2 - Analog Radio vs Digital Radio

Just like with the music CD, in a digital transmission the experience is a clear, hiss-less, pop-less communication. The trade off comes when you are out of coverage area of the radio tower. Because it is digital the computer has to hear receive precise data. The computer is smart enough to compensate for a few bits of lost data, but is less forgiving than an analog signal. The upside is comes when the radio system is designed and built to provide the proper signal level, the audio presented to the user is perfect.

Because the human brain decodes analog data, it is more forgiving when the signal is less than desirable. The brain can decode around static, hiss and pops, where the digital computer is less discerning.

The downside for both analog and digital transmissions comes when communication system has not been either designed or installed to provide the proper level of signal.

5.3.5. Project 25

5.3.5.1. Introduction

Project 25 (P25) is a partnership between the public safety communications community and industry manufacturers. The partnership goal is the publication of a suite of standards that enable the offering, procurement, and operation of interoperable digital two-way wireless communications products and systems that meet mission-critical needs of public safety practitioners.

The formal standards development process is conducted by the Mobile and Personal Private Radio Standards Committee (TIA TR-8) of the Telecommunications Industry Association's (TIA) Standards and Technology Department. TIA is accredited by the American National Standards Institute (ANSI) to develop voluntary industry standards for a wide variety of telecommunications products.

P25 is unique; it is a user-driven process to develop a family of public safety communications standards for which the requirements have been defined by state, local and federal government users.

The P25 process is directed by a steering committee composed of user representatives from federal agencies, and state and local governments. All activities of the P25 process must be approved by the steering committee and TIA in accordance with the Memorandum of Understanding (MOU) signed in 1993. Members of the public safety community attend regular meetings of the APCO Project 25 Interface Committee (APIC), which was established under the MOU to facilitate TIA's development standards that can be adopted as part of the P25 standards suite.

5.3.5.2. Spectrum Efficiency

P25 represents the public safety community's overall strategy to develop a digital modulation solution and achieve Federal Communications Commission (FCC) spectrum efficiency mandates calling for eventual migration to narrowband channel spacing in the VHF, UHF and 700 MHz bands, which call for an eventual four-to-one reduction in spacing from 25 kHz to 6.25 kHz equivalent per voice channel.

P25 addresses the FCC's mandate with a two-phase plan.

- Phase 1 defines the necessary technologies to provide for channel reduction from 25 kHz to12.5 kHz. Phase 1 refers to P25 requirements and standards for a digital common air interface (CAI) based on frequency division multiple access (FDMA) using a 12.5 kHz channel.
- Phase 2 defines an additional 50 percent reduction in channel size to 6.25 kHz or equivalent. Phase 2 refers to P25 requirements and standards for a digital CAI time division multiple access (TDMA) using a 6.25 kHz equivalent channel, i.e. two slots in a 12.5 kHz channel.

This two-phase approach allows the Phase 2 standard to comply with spectrum use rules and requirements for 6.25 kHz equivalency by 2017 for the 700 MHz band, as well as providing a spectrum efficient technology that may also be employed, though not presently mandated, in the 800 MHz band, effectively doubling, or quadrupling available spectrum capacity.

5.3.5.3. Project 25 Standards – What are they?

A P25 Standard is an agreed upon interface protocol between different elements and subsystems of a Project 25 Land Mobile Radio (LMR) Communications system.

Because constant change is the nature of technology, standards are, in truth, never complete. Standards development is, in fact, a living process. This is a practical result since there will be design improvements in the protocols that will require changes to the protocol specifications (sometimes after products are developed or implemented). Similarly, the development of new technologies or the enactment of new regulations will cause users to modify their requirements, which results in new specification and testing standards. Thus, P25 standards will not remain fixed but will evolve with time and circumstances.

5.3.5.4. Interfaces Described

Dividing the LMR network at defined interfaces allows manufacturers to develop interoperable products specific to their areas of expertise, freeing users to buy products that meet their specific needs.

For example, a manufacturer might build fixed-location radios (identified as base station or fixed station). In this case, the product must meet the requirements of two P25 interfaces - the CAI and the FSSI, which are described below. In addition, this manufacturer might offer non-standardized, value-added features as an extension to their P25 fixed radio offering, such as operation over large temperature spans, ideal for radios on mountaintop locations in isolated areas. Such a feature might be very important to a particular user. In another scenario, a manufacturer might highlight pricing considerations by offering a functionally limited fixed radio that still satisfies all of the mandatory P25 interface requirements. Again, this may be appealing to users for some applications.

The goal is to provide users the ability to build out their P25 systems by choosing from various manufacturers' offerings. P25-compliant equipment offerings must satisfy all mandatory and, as applicable, optional requirements. In this way, users can be confident that their P25 systems will work across the interface with other P25-compliant equipment regardless of manufacturer.

Following is a description of each P25 interface.

- **Common Air Interface (CAI)**
  - Enables wireless communication (voice and data) directly between P25 mobile and portable subscriber units, and between P25 mobile and portable subscriber units via a fixed/base station or repeater, which is a component of the P25 equipment infrastructure.
  - The P25 CAI uses frequency division multiple access (FDMA) methods with two modulations. The first is digital modulation used in the 12.5 kHz voice channel bandwidth and is mandatory for all P25 Phase 1 systems. The second is conventional analog FM modulation used in 25 kHz and 12.5 kHz bandwidths and is mandatory in all P25 Phase 1 subscriber equipment (portable and mobile radios).
  - Operation in a conventional mode is mandatory for P25; operation using trunking is optional based upon local system requirements.
- **Subscriber Data Peripheral Interface**
  - Enables data to be transferred between a P25 radio and an external data device (laptop or mobile data terminal) directly connected to the P25 radio.
- **Fixed/Base Station Subsystem Interface (FSSI)**
  - Enables voice and control information to be transferred between an RF sub-system (RFSS) or console subsystem and a fixed / base station.
- **Console Subsystem Interface (CSSI**)
  - Enables voice and control information to be transferred between an RFSS and a console subsystem. (A console is equipment that a dispatcher or supervisor uses to oversee and control mission critical voice communications among field personnel.)
- **Network Management Interface**
  - Enables administrators to comprehensively control and monitor P25 functional elements via RFSS connectivity.
- **Data Network Interface**
  - Enables data to be communicated to/from external computers, data networks, data sources, etc. via RFSS connectivity.

- **Telephone Interconnect Interface**
  - Enables field personnel to make connections through the public switched telephone network (PSTN) via RFSS connectivity using their radios rather than, for example, using cellular telephones.
- **Inter-RF Subsystem Interface (ISSI)**
  - Enables different manufacturers' RFSS equipment to interoperate, and includes support for roaming of P25 radio subscribers among different jurisdictions, agencies, cities, etc.

Not all interfaces have been fully developed at this time, though work is underway on each. At this time, the CAI, ISSI, and CSSI have been approved and accepted.

The figure below indicates the various interfaces and their place in the typical P25 system.

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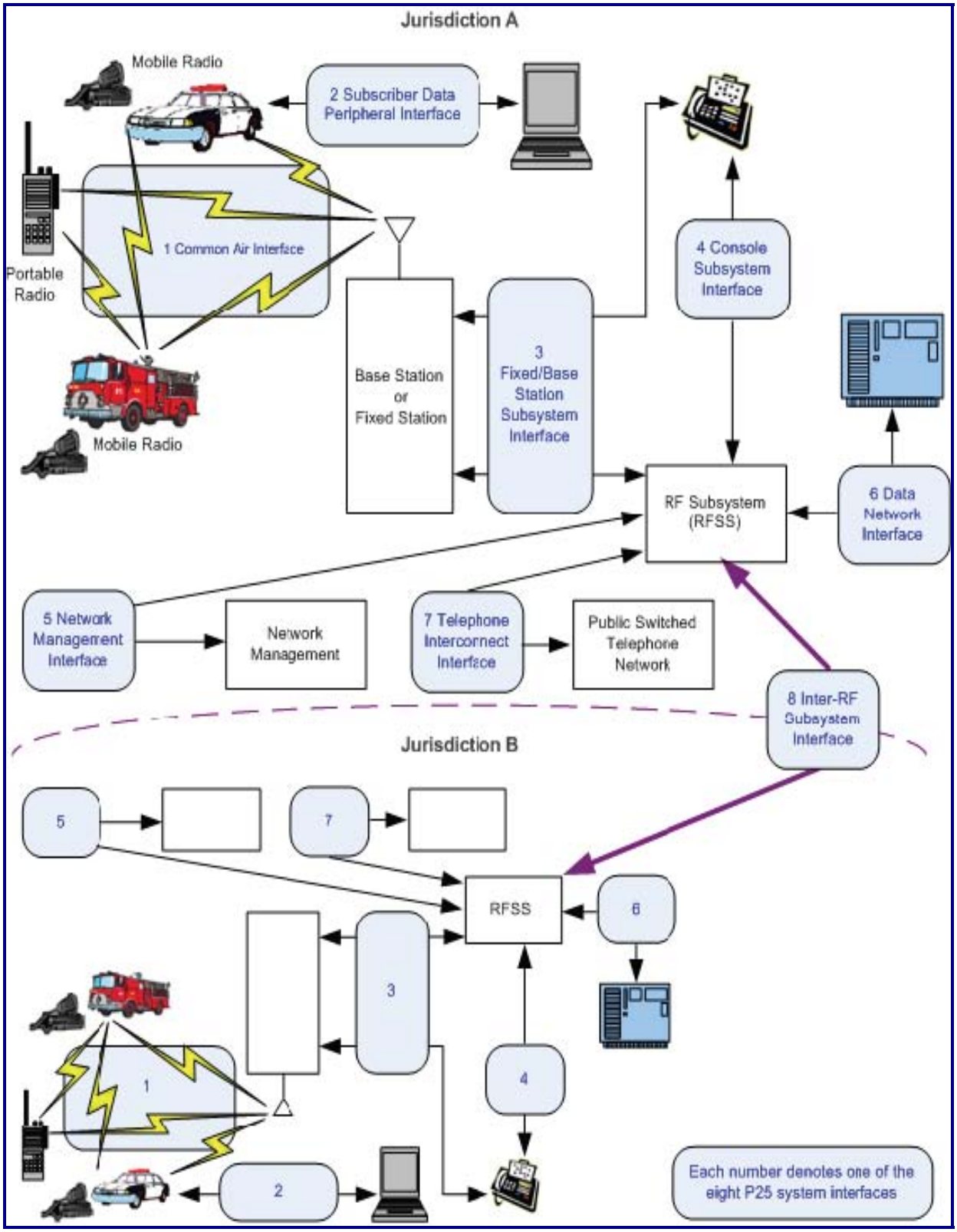

Figure 5.3 - Typical P25 System Interfaces

P25 interfaces enable interoperable voice and data communications between and among different public safety agencies, for example, communications between police and firefighters in a particular jurisdiction. A further example is communications among agencies in different jurisdictions, such as when incidents require the response of agencies from two or more jurisdictions. Standardized P25 interfaces are the "glue" enabling interoperable mission-critical communications between and among radios and infrastructure equipment procured from different manufacturers that compose public safety P25 LMR networks.

5.3.5.5. Encryption

Several encryption algorithms are available for use with P25 systems. The oldest algorithm, for which there are P25 standards documents, is the Data Encryption Standard (DES). As of May 2005, this particular algorithm is no longer endorsed by the Federal Government for secure communications. The most recently endorsed algorithm is Advanced Encryption Standard (AES) and must be used by all Federal agency communications systems beyond May 2007. The recommendation has been that State and local agencies also transition to AES to ensure interoperability.

5.3.5.6. Trunked Services

P25 allows an option to use trunking to increase radio system spectral efficiencies. Two schemes are available; Phase1 and Phase 2 are discussed in the earlier Spectrum Efficiency portion of this paper.

The Phase 1 trunking scheme uses the radio channels in a FDMA mode, utilizing a dedicated control channel operating at 9600 baud, and voice/data channels operating at 9600 baud utilizing the P25 Digital CAI. Phase 1 trunking utilizes a 12.5 kHz bandwidth channel.

The Phase 2 trunking scheme uses the FDMA traffic channels in a TDMA mode to increase further the spectrum efficiencies. The control channel continues to operate at 9600 baud, similar to the Phase 1 control channel that allows backwards compatibility with Phase 1 trunking systems. The TDMA mode used in the voice channels operates at a 12kbps rate, divides the available time into two alternating time slots, intermixed with error correction control and signaling data, allowing two simultaneous conversations to occur on the 12.5 kHz channel.

5.3.5.7. Advantages of Implementing P25 systems

- All P25 systems use the same protocols and are backwards compatible with Phase 1 and analog conventional systems; Allows graceful migration
- The ability to mix subscriber units, consoles and other network elements from different vendors, providing the system owner the ability to pick equipment from the strongest vendor and integrate it into a fully functional system
- The ability to interface neighboring or overlapping P25 systems into a system of systems
- Interoperability between systems at either the network level, which allow automatic system to system roaming, or subscriber level with other systems programmed into the radios; Quick reprogramming and eventually over the air reprogramming for Mutual Aid incidents

- Full public safety features found in APCO 16 analog systems
- The ability of vendors to interface their legacy analog and digital systems to P25 systems - Motorola interfacing analog SmartZone systems through its SMARTX interface to ASTRO25 systems and M/A-COM interfacing EDACS through their VIDA network interface to their P25^{IP} systems

P25 has been adopted by the Land Mobile Industry and the user community as the standard for the next generation of public safety communications equipment with federal, military, state, regional, and large local systems adopting the technology.

5.3.6. Narrowbanding

In many metropolitan, and some rural, areas, the VHF and UHF spectrum is becoming increasingly more crowded as public safety and commercial enterprises implement Land Mobile Radio (LMR) systems, increasing the efficiency of their operations through the use of wireless technology. However, the result is a congested spectrum, which can eventually lead to spectrum saturation and high interference levels, making reliable communications impossible. In the early 1990s, the FCC recognized this trend and began a process, at the time, known as "re-farming". In 1995, the FCC released the first order, giving the Land Mobile industry and user community notice of its intent to increase spectrum availability by reducing channel bandwidth, and provided time to modify systems and obtain narrowband capable equipment.

Many public safety, business and industrial Federal Communications Commission (FCC) licensees currently operate 25 kHz LMR Systems in the 150 MHz to 512 MHz ranges, utilizing VHF, UHF and T-Band. In an effort to increase the availability of frequency spectrum, the FCC mandated that all LMR licensees operating in these frequencies reduce the bandwidth of their systems, creating space for additional systems within the same amount of spectrum - thus the term narrowbanding. Narrowbanding reduces the bandwidth of the now-standard 25 kHz radio channels into 6.25 kHz channel assignments, creating four channels, or talk paths, which allow four simultaneous radio conversations to occur. (Currently, the capability for only one conversation exists on the 25 kHz radio channels.) Multiple operational, logistical and financial considerations exist in the narrowbanding process.

The FCC rewrote Part 90 of the rules governing the operation of LMR systems to reflect these new channel frequencies. Narrowbanding does not apply to Part 90 frequencies below 150 MHz or above 512 MHz. It also does not apply to systems, such as Common Carrier or Marine Service, operating under other than Part 90 rules. (800 MHz rebanding is not to be confused with narrowbanding. 800 MHz rebanding is a separate action affecting 800 MHz system licensees.)

The FCC set deadlines for radio equipment manufacturers to develop equipment capable of operating on these frequencies and set deadlines for licensees to modify their systems in order to operate on them. To operate on these narrower bandwidth channels, current equipment must be modified or older equipment replaced with equipment capable of complying with the new rules.

The purpose of this paper is to present FCC deadline dates, operational considerations, and guidelines for undertaking the narrowbanding process.

5.3.6.1. Important Dates and Deadlines

Over the last 12 years, the FCC has issued multiple orders relating to the narrowbanding effort and multiple revisions. Dates have changed and been modified. Currently only two dates affect all licensees and must be adhered to: January 1, 2011 and January 1, 2013.

January 1, 2011 – New Systems
All applications to implement new systems on Part 90 frequencies between 150 MHz, up to and including, 512 MHz must employ technologies that either operate at 12.5 kHz (11.25 kHz occupied bandwidth) or provide one voice path per 12.5 kHz of occupied bandwidth **OR** provide a data rate of 4800 bps per 6.25 kHz of bandwidth occupied. Kimball recommends that any new system being constructed be designed to operate at 12.5 kHz or less channel spacing.

January 1, 2011 – Modifications to Existing Systems
All applications seeking modifications to existing systems that would increase the station's service area must employ equipment and technologies that either operate at 12.5 kHz (11.25 kHz occupied bandwidth) or employ a technology that provides one voice path per 12.5 kHz of occupied bandwidth **OR** provide a data rate of 4800 bps per 6.25 kHz of bandwidth occupied. These systems may operate 25 kHz bandwidth until January 1, 2013.

January 1, 2013 – Narrowbanding Deadline
All incumbent Part 90 systems operating on frequencies between 150 MHz, up to and including, 512 MHz must operate at 12.5 kHz (11.25 kHz occupied bandwidth) or employ a technology that provides one voice path per 12.5 kHz of occupied bandwidth **OR** provide a data rate of 4800 bps per 6.25 kHz of bandwidth occupied .

5.3.6.2. Preparing for the January 1, 2013 Deadline

Funding
If replacement equipment or reprogramming work is needed, decision makers and legislators should get involved in the process quickly. Even if firm costs are unknown, a heads-up as to expectations will allow for budget expense preparations.

Most public safety jurisdictions have only three budgeting cycles remaining until the time to act. Year 2012 is the latest implementation year, so money should be budgeted in 2011, if not sooner.

At this time, there is no grant or other funding available for this mandate. It is a local funding item.

As a reminder, the replacement cost of your volunteer first responder pagers, outlined below, should not be forgotten. This can be a financial and political issue in many communities.

A Plan
Accomplishing the narrowbanding tasks require consideration of the following:

- The logistics of touching every radio
- Does it require more than one touch
- What is the timing
- How will the transition from wide band to narrowband actually take place

- How is quality of service maintained
- Cost and budgeting
- Interoperability considerations with Mutual Aid partners
- Intra-operability within your own jurisdiction departments
- Do opportunities exist to accomplish other things with the system

FCC Licensing
The Land Mobile Communications Council recommended to the FCC that any licenses not showing authorization for narrowband emissions be cancelled automatically on January 1, 2013.

Current FCC license(s) should be reviewed. The license(s) should reflect that the licensee is authorized to use narrowband emissions. Typically, this is emission designator 11K0F3E. This is a good opportunity to update license(s) to reflect changes such as added user radio quantities, as well as address and contact personnel changes. Kimball can assist in this process.

Possible Conflicts with the VHF Interoperability Channels
Channels on or adjacent to any one of the new VHF interoperability frequencies, listed below, may experience interference to and from these frequencies. Consideration should be given to relocating channels.

- 151.130
- 151.1375
- 151.145
- 154.445
- 154.4525
- 154.45625
- 155.745
- 155.7525
- 155.760
- 158.730
- 158.7375
- 158.7450
- 159.465
- 159.4275
- 159.480

Equipment
Equipment needs to be 12.5 kHz capable. Any equipment certified for manufacture or import since February 1, 1997 must have the capabilities of being retuned to 12.5 kHz channel bandwidth. Kimball, your dealer, or equipment supplier can help determine if equipment is capable of 12.5 kHz channel spacing and operation.

Equipment infrastructure should be reviewed, including base stations, repeaters, satellite receivers, and control stations. In many cases, this equipment is not capable of being reprogrammed to narrowband operation and is better replaced with current production equipment. Kimball recommends against field retrofits of this equipment.

Audio and paging tone levels on dispatch consoles will need to be checked and reset.

Many vendors' 12.5 kHz equipment includes a "companding" or compression and expansion software feature, for example Motorola X-Pand. The software is designed to improve the quality of the receive audio in narrowband operation. If companding is desired, all the radios in the fleet need to be companding capable. A mix of companded and non-companded radios means recovered audio will be distorted and often unacceptable. Multiple vendors require companding algorithms be compatible between vendor equipment. Radio testing should occur prior to purchase or distribution to field personnel.

System Coverage
Coverage may be reduced somewhat, especially at the edges, in current weak spots, and in-building. Current tower sites will still need to provide the necessary coverage. Qualified engineering firms can review coverage of 12.5 kHz systems as compared to current 25 kHz systems.

Overlap coverage and system timing should be reviewed in simulcast systems to ensure no new "holes" are created.

Consideration should be given to paging and volunteer alerting systems. Many older 25 kHz pagers will not work in a narrowband system and will need replacing. Pagers often operate at the edge of coverage for the system (in buildings, plants, mobile homes, etc). Transmitter sites may require upgrading, relocation or additions to continue the desired coverage.

Paging
The FCC exempts Part 90 Paging-Only channels from the narrowbanding requirement.

The Public Safety Pool Paging-Only frequencies are, per 90.20(C) Limitations 13 & 30:

- VHF – 152.0075 and 163.250 MHz
- UHF - None

The Industrial/Business Pool Paging-Only frequencies are, per 90.35(B) (3), Limitations 29 & 36:

- VHF – 152.480 MHz, 157.740 MHz, 158.460 MHz.
- UHF – 462.750 MHz, 462.775 MHz, 462.800 MHz, 462.825 MHz, 462.850 MHz
  462.875 MHz, 462.900 MHz, 462.925 MHz, 465.000 MHz

Alerting or paging occurring on any frequency other than those above must be rebanded.

First Responder Paging and Alerting
Fire, Emergency Medical Services (EMS), and Emergency Management Agency (EMA) alerting and paging is normally accomplished on dispatch channels that must be narrowbanded. Kimball recommends planning to replace any wideband monitor receivers, siren and house alerting receivers, and monitor pagers with current production narrowband capable equipment. Kimball recommends investigating digital systems for station alerting and siren activation.

Interference
Coordination with adjacent channel licensees is critical in the rebanding process if interference is to be minimized.

Narrowbanding gives one hundred percent more frequencies at UHF and a few more frequencies at VHF. In the VHF bands, a 15 KHz bandwidth is already in use and the FCC mandated narrower bandwidth would have the tendency to reduce adjacent channel interference. In the UHF bands, the new 12.5 channel spacing has short-term potential to increase adjacent channel interference as additional 12.5 kHz systems are licensed between existing 25 kHz systems.

Due to the wider receiver bandwidth, there will be interference generated to 25 kHz systems by the 12.5 kHz systems. Similarly, the wider modulation emission mask of the 25 kHz system, typically 16 to 20 kHz wide, will bleed over into the 12.5 channel. The only resolution is the current 25 kHz licensees migrating to narrowband 12.5 kHz emission mode.

6.25 kHz Rebanding
The FCC has stated its future intent to mandate splitting the 12.5 kHz bandwidth channels to a bandwidth of 6.25 kHz per talk path, and listed those channels in the Part 90 rules. No date has been set for this transition, primarily because of a lack of 6.25 kHz equipment standards. However, this does not preclude moving to available 6.25 kHz compliant technologies at this time.

In the Third Report and Order released March 26, 2007, the FCC mandated to equipment manufacturers that by January 1, 2011, any equipment submitted to the FCC for certification and sale must incorporate 6.25 kHz technology. The FCC urged that licensees consider migrating directly to technologies that meet the 6.25 kHz requirement.

Systems needing complete replacement in order to meet the narrowbanding criteria would benefit from bypassing 12.5 kHz rebanding and moving directly to 6.25 kHz equivalent equipment, which is soon to be available.

Available 6.25 kHz technologies
Manufacturers have realized the eventual impact of the move to 6.25 kHz and are beginning to offer equipment and systems that meet the requirement: one analog voice channel per 6.25 kHz or a data rate of 4800 bps or greater per 6.25 kHz channel.

The emerging equipment available divides into product groups that serve the public safety market or the Business, Industrial and Land transportation market.

Public Safety Applications
The Project 25 (P25) radio systems on the market today meet the functional and operational requirements of the public safety community. The P25 Phase 1 technology is narrowband compliant, utilizing a 9600 bps data stream in a 12.5 kHz bandwidth channel.

The Project 25 Phase 2 standard, which is close to final approval, employs Time Division Multiple Access (TDMA) technology to create two simultaneous talk paths in a 12.5 kHz channel, thus meeting the 6.25 kHz equivalent requirement. Major vendors, such as Motorola and M/A-COM, committed to this standard, anticipate having complete systems on the market in 2009.

Motorola released a non-P25-compliant two-talk path TDMA system that is currently available.

Business, Industrial and Land Transportation (B/I/LT) Applications
The introduction of several technologies by various manufacturers targets the non-public safety users with 6.25 kHz compliant systems, filling a need within the broad range of non-public safety users. These systems are digital, using both TDMA and Frequency Division Multiple Access (FDMA) to meet the 6.25 kHz requirement.

These systems include competing technologies from the three leading B/I/LT systems manufacturers:

- MOTOTRBO from Motorola, a two-talk path TDMA solution operating on a 12.5 kHz channel
- NXDN Digital from Kenwood and ICOM, a single digital talk path FDMA solution operating on a 6.25 kHz channel.

Both systems are capable of 12.5 analog narrowband operations, as well as respective 6.25 kHz equivalent proprietary digital formats.

5.3.6.3. Conclusion

The narrowbanding process can seriously affect today's VHF and UHF public safety and Business/Industrial licensee. Licensees must begin the process immediately to determine the scope of work required for current systems, to obtain funding, to plan the work and logistics, all the while maintaining service to the user agencies, and to ensure all licensing and operational details are met.

5.3.7. Motorola SmartZone 4.1

Motorola has been manufacturing and installing trunked radio systems for land mobile radio system users for almost 30 years. Trunking systems began with single site, five channel systems, and over the years evolved into simulcast, multi-site and multi-zone regional and statewide systems, each employing hundreds of frequencies. Current technology is now utilizing this system structure and migrating from analog voice-only systems to mixed mode analog and digital voice-only systems, to all-digital integrated voice and data systems. Over the years, Motorola developed the SMARTNET single zone systems, followed by the SmartZone multiple zone and regional systems. SmartZone Release 4.1 is the final release and system configuration of the mixed mode analog and digital voice systems. This section provides an overview of this system and significant timelines for Release 4.1 system owners.

SmartZone 4.1 is the last of the mixed mode systems developed by Motorola. Motorola system technology then migrated to an ASTRO25 platform, which is Project 25 digital only, with integrated voice and data capabilities. The initial ASTRO25 releases were 6.X systems, which have now been replaced by release 7.X systems. Each number release indicates a major change in the system's infrastructure, hardware, network design, and system capabilities. Release 4.1 began shipping in 2001. Since that time, many older SmartZone systems have been upgraded to the 4.1 release. Many statewide and regional Motorola systems in place are release 4.1

SmartZone 4.1 has the following capabilities:

- Up to 48 ports / zones (this includes consoles, simulcast systems, IR sites)
- Up to ten tower sites per zone in Simulcast configuration
- Up to 28 channels per site
- Up to 4,000 talkgroups per system
- Up to 48,000 individual subscriber IDs per SmartZone system
- Supports Centracom Gold Elite Dispatch Consoles
- May be linked to OMNILINK controllers to link up to four SmartZone systems together.

Distinct features available in SmartZone 4.1 include:

- 3600 baud control channel
- 9600 baud ASTRO voice capability
- Mixed mode of transmission, analog or ASTRO Digital; selectable by talkgroup
- Encryption to DES level
- Preformatted "canned" data messages
- Status messages
- Call Alert
- Private calling (one to one)
- Enhanced Network Management tools

5.3.7.1. System and Site Controllers

The Motorola MZC3000 Zone Controller is a redundant system that provides trunking call processing for system operation. The MZC3000 forms the heart of a wide area radio system by providing the central processor for the entire system, using hardware and software to provide call processing and mobility management. The MZC3000 Zone Controller controls radio sub-systems, telephone interconnect devices and CIU/DIU equipment through individual interface ports.

The 4.1 release utilizes the MTC3600 system and site controllers. The MTC3600 site controller replaces the legacy 6809-based system and site controllers. The MTC3600 continues to be a current production item.

5.3.7.2. Network Management Systems

The Network Management System (NMS) can be viewed as a set of software applications or tools used to manage the SmartZone® System 4.1 wide area trunked radio system and its constituent components.

The NMS implementation is based on a client/server architecture that scales to the system by the number of zones. Each zone requires a set of servers to support the management applications for its zone. Typically, the configuration is replicated in every zone. An additional server, supporting from one to seven zones, is required for system-level management applications. Only **one** User Configuration Server (UCS) is required per system and is not required for additional zones in a multi-zone configuration.

The NMS, at a minimum, includes the following servers:

- Zone Database Server (ZDS)
- Fault Server (FULLVISION®)

- Air Traffic Router Server (ATR)
- Zone Statistics Server (ZSS)
- User Configuration Server (UCS)
- System-wide Statistics Server (SSS)

The Network Management Applications in SmartZone 4.1 have been developed with a Graphical User Interface (GUI) based on Microsoft Windows. This GUI has been implemented across all Network Management Applications and is more user friendly than the interface in older systems.

5.3.7.3. Full Vision

The FULLVISION Integrated Network Management application is based on Hewlett-Packard's Open View Network Node Manager software application and a Motorola developed middleware application running under a UNIX operating system on a HP workstation computer. FULLVISION provides a centralized view of the fault condition of the entire communications network using sub-system topology maps. FULLVISION supports auto-discovery of Motorola and approved third party internetworking equipment and supports fault reporting from Motorola Proxy and third party Simple Network Management Protocol (SNMP) based agents.

Optional features include a SNMP trap forwarding capability that passes fault information to a higher level 'manager of managers' and an alphanumeric paging option that can forward faults to a service technician's alphanumeric pager.

5.3.7.4. Radio Infrastructure Networks

While interface of some Network Management System elements are IP based, the overall interconnection of the SmartZone infrastructure elements, such as sites, repeaters, controllers, voting equipment and consoles, remains circuit switched. This requires individual T-1 partitioning within microwave systems and channel banks at all sites to accommodate dedicated circuits to each system element. No provision exists to upgrade this to an IP based solution.

5.3.7.5. Subscriber Radios

At this time, all currently manufactured Motorola Public safety trunking radios, MTS2000, MT1500, XTS series portables and XTL series mobile radios are compatible with the SmartZone Type II signaling protocol. Some industrial market radios (MTX8XX) distributed by Motorola resellers are possibly compatible with SmartZone systems, but may not have the full set of Public safety features and may not operate properly in a multi-zone system.

EF Johnson manufactures and sells a series of its 5100 portable and 5300 mobile radios that are fully compatible with the SmartZone System.

5.3.7.6. System Roadmap

Motorola has created lifecycle roadmaps for each of its system releases. According to the latest Motorola roadmap for the 4.1 release, the following availabilities exist:

- December, 2004 – The last 4.1 systems were shipped; no more orders are being accepted for full systems; systems currently shipping are now ASTRO25 Project 25 systems
- December, 2007 – Last system software releases; current system owners should be receiving or ordering these final "Z" releases at this time
- December, 2007 – Last opportunity to expand Master Site equipment and software
- December, 2009 – No more simulcast and voting equipment orders accepted
- December, 2009 - No more remote radio site equipment orders accepted
- December, 2009 – No more Centracom Gold Elite console position orders accepted
- December, 2011 – No more IntelliRepeater equipment orders accepted
- December, 2012 – End of factory technical support *Contracts*

Many of the above dates are parts-dependent, as Motorola out-sources most of its parts manufacturing and is dependent upon third party vendors.

Does this mean that the 4.1 system will suddenly fail in 2007? No, Motorola will continue to support its customers and provide the technical expertise needed to maintain these systems as parts are available.

At this time, the following major system components are still in production:

- Quantar and Quantro Repeater Stations
- MZC3000 Zone Controllers
- MTC3600 Trunking and Site Controllers
- ASTROTAC and DigiTAC Voting Systems

These major system components have no announced end-of-shipments date, though the above roadmap indicates termination may be by the end of 2009. In any case, parts support will continue, per Motorola policy, for at least seven years after final shipment, and technical support will continue in about the same range. Motorola systems are designed to operate for decades, assuming availability of spare parts and replacement subassemblies.

Motorola account managers continue to promote upgrade of legacy SmartZone systems to Release 4.1 for system owners unable to afford or desiring not to upgrade to ASTRO25 at this time.

5.3.7.7. System Ownership Considerations

Kimball's recommendation to owners of 4.1 systems purchased new is to begin replacement system planning, with a target date for system replacement of 2015 to 2020. Due to the widespread use of the 4.1 release nationwide, Kimball sees no reason that support and parts will not continue to be available in the near future.

5.3.8. PassPort LTR Trunking Systems

PassPort® is a trunking protocol developed by Trident Micro Systems of Arden, North Carolina. It is an enhanced form of Logic Trunked Radio (LTR). LTR is a trunking protocol that uses what is called

distributed control rather than a dedicated control channel. Unlike most trunked radio systems, LTR does not use a dedicated control channel. In LTR, control information can be transmitted on every voice channel. Each repeater determines which channels are idle and transmits this information in a data stream that coexists with voice information on the same frequency. That data stream is transmitted continuously as sub-audible signaling on the voice channel.

In a PassPort® system, each talkgroup has a designated "home" channel (repeater base station) on each site. The user's home frequency is transmitting control information to the radios in the form of an "idle" message that is sent every three-to-five seconds when it is not involved with voice traffic. When the subscriber unit is not transmitting or receiving a call, it is monitoring its home channel. In the idle message, the repeater is telling the subscriber unit which channels are free and if it is being asked to participate in a call. If a radio in a talkgroup initiates a push-to-talk (PTT) and the home channel is free, the members of the talkgroup are assigned to use the home channel for the message. The repeater is communicating with other repeaters at the site and knows what repeaters are available. Other subscribers in talkgroups assigned to that repeater are monitoring the data stream and are told that the repeater is in use and what other repeater is available at the site. These users will be automatically assigned to the designated "free" repeater base station if they initiate a call on their talkgroup. The LTR protocol has the advantage of allowing subscribers to use all of the channels on the system for voice traffic.

PassPort® uses LTR technology in a network configuration to provide wide area trunked radio coverage. Sites are linked with Trident's NTS network controller that will support up to 127 sites. Each site can have up to 30 channels. The system purports to provide seamless roaming to users by measuring Received Signal Strength Indication (RSSI) at sites. When the signal strength from a site falls below the set threshold, the radio will search for another site and automatically register at the site with the best signal strength. This means that a user does not have to manual change zones on the radio when moving from site to site. It does not mean that there is a mid-call hand off from one site to another; the radio must be de-keyed before registering at another site. Also, if a user is engaged in a Selective Call or Call Alert while roaming to a different site, the Selective Call or Call Alert will end.

PassPort® was developed primarily for the business/industry market. It has had very little acceptance for public safety communications because it does not meet the APCO-16 standards for trunked radio systems and it does not provide the robust features found in the standards based public safety trunked systems. A number of vendors are licensed to manufacture PassPort® capable portables and mobiles.[1] These radios are generally less expensive than typical comparable public safety subscriber equipment.

Under the auspices of the Association of Public Safety Communications Officials (APCO), standards have been developed for public safety communications systems. As needs to address technological advancements and procedural changes are identified, APCO International establishes "projects" to investigate the needs and desires of its members. Projects are assigned a number and, working with other entities in the field, protocols or standards are developed.

APCO, in conjunction with radio manufacturers, created the APCO-16 standards for trunked analog radio systems for public safety applications in the late 1970s. APCO Project 16 was an effort to establish the basic requirements for a typical public safety communications system. The result was an

[1] The following companies are licensed to manufacture and supply PassPort® capable equipment: Motorola, Kenwood, ADI, ICOM, Ritron, Topaz, Vertex Standard, Scholer-Johnson, and Aeroflex (IFR Service Monitors). Motorola is the largest distributor of PassPort® systems.

operational/functional (non-technical) *de facto* standard to which many manufacturers have responded. APCO-16 defined system size in terms of the minimum number of sites, channels, dispatch positions, and subscriber units. It also required the capability for future expansion. APCO-16 defined addressing and talk-group structures, call types (individual, group, and interconnect), and the capability for interoperability with conventional systems. Channel access requirements were defined in terms of the minimum access and drop time as well as requiring channel grant notification and queuing. Emergency and subscriber status and data messaging features were also included. The standards also defined system features such as system control of requests and assignment of channels, detection and correction of system failures, and dynamic regrouping. These are industry standards that have served for many years as the minimum feature requirements for trunked radio systems for emergency responders. It was the foundation for the further efforts of Project 25 (P25), which continued beyond Project 16 and has set current standards for public safety digital radio systems.

PassPort® is not minimally compliant with the APCO-16 standards. PassPort® clearly does not provide five levels of priority; it only provides three. Typical public safety trunked radio systems provide eight levels. It does not place a caller in queue when a voice channel is not available, give the caller an indication that the request has been received and queued, and give the caller an automatic notification when a channel has been assigned. PassPort® does not incorporate a minimum of six automatic status reports that can be sent automatically in digital burst format by a mobile unit through activating an appropriate switch on the mobile unit control head.

In recent years, Trident has provided enhanced features to better address the needs of public safety users. These include emergency declaration, channel back-up, and message trunking as a system programming option. Kimball cannot determine if all of these features are fully compliant with the APCO-16 requirements. For example, it appears that emergency declaration does not preempt existing conversations putting in question whether it has the capability of seizing access to the system via an instantaneous emergency switch and permits access to a dispatch position with one-half second as required by APCO-16. Nor will there be any preemption of a call in progress by a high priority user if the system if fully loaded.

Beyond issue of the APCO-16 requirements, PassPort® does not provide many of the features that trunking systems designed for public safety include. PassPort® does not manufacture console equipment. Trident recently began providing cards to interface with consoles including a digital interface with the Orbacom® T5 console. These console interfaces do not provide the type of system control features that a trunked system vendor's console would provide however.

A number of other characteristics limit the desirability of PassPort® as applied to a public safety environment. There is no integrated voice and data offering with PassPort®. The PassPort® system is not capable of simulcast transmission. It is a multicast system. This requires the use of separate frequencies at each site or, at least each site within interference range of another site. For multi-site configurations, more frequencies are required than in a simulcast configuration.

Although PassPort® radios are capable of group scanning; this feature is limited to the "home" site. When affiliated with a "non-home" site, the group scanning feature is lost. In PassPort® mode scanning cannot be prioritized by talkgroup. This is a distinct disadvantage for public safety users who may require constant monitoring of a talkgroup.

PassPort® is available only an analog technology. This will constrain its future development as more users desire digital capable systems. PassPort® also has constraints as a technology by which to provide interoperability. On the Department of Homeland Security's SAFECOM interoperability continuum, it is not a standards-based shared system. Even where it might be deployed for public safety use and shared by multiple disciplines or agencies, it would be a proprietary technology. Any agency desiring direct access to a PassPort® system would be required to purchase PassPort® capable portables and mobiles.

While PassPort® is a cost effective trunking technology for business and industrial users, Kimball does not recommend it for public safety applications.

5.4. ANALYSIS

As the information from the stakeholder interviews has been reviewed and compared what are considered the best practices for establishing a true statewide radio network, several topics have come to the front that accurately reflect the current situation in Oklahoma. These ideas are presented here, with recommendations as to how the State should address these topics in Section 6 of this report.

- IP-based "gateways" and routers, which are being touted to various parts of the State government, should be viewed as a piece of the solution rather than the total solution that their vendors sell them as. These solutions are best used in specific situations to accomplish specific tasks, but they do not extend the range of any radio systems or allow users to communicate once they are out of range of their home systems.
- From talking to the state agency stakeholders, it is clear that there is no real plan in place that guides public safety radio in the State. While a Statewide Communications Interoperability Plan (SCIP) has been developed, it is more of a "plan to make a plan" at this point. While it is understood that the Federal guidelines for development of the SCIP were very restrictive in the amount of time that was available to develop the SCIP, the SCIP must be fleshed out so that it becomes the roadmap to the future for the State.
- Actual "statewide" radio networks do not exist in the State. DPS has a good part of the population covered, ODOT is building out a system to support its operations but it is still several years away from completion, and no other agency has what can be considered an effective network to support even their own activities.
- The amount of funds budgeted annually to emergency radio communications at the State level is entirely insufficient. Many of the interviewees stated that they took radios home on the weekends to work with on them as they have no budget for repairs or modifications. No funds appear to be allocated for anything other than "band-aid" fixes and repairs, and there is little or no actual management at the State level of any of the radio systems that were looked at.
- The State has been able to accomplish significant things with the current 800 MHz radio system even without any dedicated funding. Through the creative use of federal interoperability grants, large parts of the state are now enjoying the enhance coverage and features of the 800 MHz system. However, grants are not a stable source of funding, and are usually only used for specific projects. A stable source of dedicated funding must be found for the new system to be successful.

- With the exception of ODOT, Department of Emergency Management, and the Department of Agriculture – Forestry, all state agencies interviewed stated that they were interested in participating in a statewide radio network as long as it met their operational requirements and was cost effective to join and use.
- ODOT is developing a statewide VHF network that uses the LTR PassPort trunking protocol. According to ODOT, this system was designed to meet their needs only and there was no intention of it ever becoming a public safety radio network to support the state or local responders.
- While the ODOT system being developed may be effective to handle their needs, the technology chosen creates serious concerns as to its future. While it will be able to meet the 2013 FCC narrowbanding mandates, it will not support the FCC's intent to narrow channel width even further in the near future. There is a good possibility that the entire system may have to be replaced in the next ten years, depending on what dates the FCC sets for the next phase of narrowbanding.
- The State has complete reliance on the City of Tulsa to provide management of the State's existing 800 MHz radio system. No personnel from DPS are involved in the day-to-day management of the system. This situation, even if the State does not move forward with any new radio initiatives immediately, must be remedied as the State is responsible for this system, not the City of Tulsa.
- The number of state personnel who are dedicated to radio communications operations is un-satisfactory. DPS is the only state public safety agency that has any personnel dedicated to radio services, and they number only 5 for the entire state. No other state public safety agency has anyone that is completely dedicated to managing or maintaining its radio assets.
- Because of the lack of management personnel who actually manage state radio assets, it was found that most state agencies have little or no idea of what they are actually spending on radio equipment or services. There is no dedicated funding for public safety radio operations anywhere but at DPS.
- Additionally, there are no standards for the type of equipment that is being purchased, which has caused a situation where agencies are not purchasing equipment that is capable of being upgraded in the future and just buying whatever is inexpensive to meet current needs.
- The interoperability needs of state agencies are varied by their specific missions, but all agree that their needs are not currently being met.
- All agencies that are using VHF and UHF radio systems for their operations will be affected by the FCC narrowbanding mandates by January 1, 2013. While all are aware of the mandate, there is no coordinated effort between agencies to address the situation.
- The Low-Band and SmartZone technologies that DPS is currently using for its two radio systems are both facing support deadlines from the equipment manufacturers.
- Additionally, the analog systems being used by most agencies will not support the expected future spectrum efficiency mandates from the FCC; only digital modulation will support these mandates.
- Only P25 offers the standards based communications platform that is required to be eligible for Federal DHS grants and funding.

6. RECOMMENDATIONS

Based on the findings and analysis presented in previous sections, Kimball makes several recommendations to the State as to what should be done in the future to provide communications interoperability to the State's public safety providers. These recommendations are made in an Overall Recommendation, and in Specific Recommendations.

6.1. OVERALL RECOMMENDATIONS

Based on interviews with the key stakeholders in State government, as well as reviewing current and planned activities the need for a statewide, public safety communications system was clearly indicated. Kimball's recommendation is to upgrade and expand the existing 800 MHz radio system into a public safety standards based radio system to provide statewide coverage and interoperability to the State's first responders. All State level agencies with a public safety responsibility, according to DHS guidelines, should be mandated to use this system. Local public safety agencies should be invited to join the system as coverage is expanded.

The State of Oklahoma should immediately begin planning for the expansion and upgrade of the existing 800 MHz trunked radio system to a standards-based Statewide public safety 800 MHz digital trunked, radio system capable of supporting all public safety activities in the State and meeting the requirements of the TIA-102 standards which are described in Section 5 of this report. The existing low-band system used by DPS should be gradually decommissioned as the footprint of the new Statewide public safety 800 MHz system is expanded. The Department of Public Safety has made a considerable investment in the current 800 MHz system. The existing system can be leveraged very well into the expansion and upgrading to a new system. The development of a shared radio system that supports all public safety activities in the State provides the State with the highest level of interoperability recommended by the United States Department of Homeland Security in the SAFECOM Interoperability Continuum. The State should continue down its current path of updating and expanding the 800 MHz system to provide a standards-based platform to enhance interoperability. The use of technologies such as gateways and patching can be part of the migration, but should not be viewed as the solution.

Other than the Oklahoma Department of Transportation, which started investing in its own statewide radio system in 2002 and is not public safety standards based, most agencies that were interviewed expressed an interest in participating in a statewide radio system if it met their operational requirements. While the ODOT radio system will provide coverage throughout the same service area, the technology that ODOT is using is not suitable to support public safety operations. However, there should be interoperability between the two systems to provide support to each other during times of emergencies.

Additional commitments must be made to assume the management of the system, rather than relying on other political entities. A statewide system is the responsibility of the State and the potential for statewide interoperability can only be achieved through dedicated governance of such a system. To achieve these goals, the State must accomplish this project in phases. These phases are outlined in detail in Section 6.2.4. A project of this magnitude will take multiple years to complete, and is more analogous to a marathon race rather than a sprint. Funding sources will be required that will support both the initial

development of the system as well as the continued construction and life cycle upgrades and replacements required.

Before any work on such a system can begin, numerous planning and design activities must take place. These tasks and activities must be carefully coordinated and timed to ensure the success of this new initiative. In the Specific Recommendations of this report, these activities are described in detail.

6.2. SPECIFIC RECOMMENDATIONS

In order for the State to move forward with the long term goal of having a statewide radio system that is capable of supporting all public safety agencies in the State, specific steps need to be taken. These specific steps are each identified in the following pages, with recommendations as to what must be done to succeed.

6.2.1. System Governance and Management

Before any work is attempted to expanding or upgrading the existing 800 MHz radio system, a method of governance and administration must be fully developed. This will include day-to-day operation of the system, as well as the long term strategic goals for the system. Since these two functions are very different, it is advisable to have two separate groups fulfill these roles.

To address the long term strategic goals of the State, a single point of contact for interoperability should be identified. OKOHS has been designated by Executive Order to fill this role. OKOHS should continue and expand its activities and working groups to provide more input, participation and guidance. One of the working groups should be an Advisory Board much like the Governance Working Group already established. This group can consist of representatives from the various stakeholders who will be using the system at all levels of government. If it is truly to be a statewide public safety system, then there must be a balance between state and local agency users. Representatives must be from all public safety disciplines, as well as non-traditional responders such as the Red Cross and Salvation Army. Typically, a group like this will consist of a representative from each state agency that uses the system, and then representatives from each discipline at other levels of government that will use the system. The states of Michigan, Ohio, Florida, and New York use variations of this type of governance at this time.

Organizationally, this board could include the following:

- Chair – Usually the Executive Officer of Public Safety in the State
- Vice-Chair – Selected by the Board on a regular basis (term)
- Director/Manager of the Statewide Radio System
- Representative from each state agency using the system
- Representatives from local law enforcement (1 from County level, 1 from municipal)
- Representatives from local fire departments (1 from County level, 1 from municipal)
- Representative from Emergency Medical Services
- Representative from Local Emergency Management

This group would have the authority to set policy for the system, develop membership criteria for users, as well as the ability to form committees to explore different topics. This group also is the key to long term strategic planning for the system, which includes the development and updates to the Statewide Communications Interoperability Plan (SCIP) and the State's Tactical Interoperability Communications Plan (TICP). In some states, this type of Advisory Board also functions as the State Interoperability Executive Committee (SIEC) to ensure continuity in the strategic plans of the state.

When it comes to the day-to-day operations of the statewide system, the State must take responsibility for this entirely. At the current time, the State relies almost completely on the City of Tulsa for the management of the existing 800 MHz radio system. While this arrangement has worked with differing degrees of success in the past, as the system grows in both coverage and capacity, this arrangement will cease to benefit either party. If this is to be a State system, only the State can manage it. An arrangement to include Tulsa in the system should be developed, but where they are only responsible for their own assets and the agencies that have contracted with Tulsa for radio support.

The State must designate one specific agency in the State government as being responsible for the statewide radio system. Typically the way this has been done in other states is that to get the process started, a public safety agency, such as DPS, takes the initial lead role to establish the system. However, once the system building process is begun, the role of lead agency is transferred elsewhere in the state government, with the most recent trends almost always going to an information technology agency. Managing a large statewide radio network is not that much different than managing a statewide computer network. Many times the initial personnel who worked on developing the system move to this new entity to provide leadership and continuity. And by moving this responsibility to an independent, third party agency, it potentially averts criticism of the system being a "Highway Patrol" network. The executive leader in charge of this network is part of the system working group. And while the working group does develop policy and direction for the statewide system, its role is that of an advisor to the agency that is responsible for managing the system. Independent agencies successfully manage the systems in Ohio and Michigan, with oversight from Advisory Boards or Steering Councils.

The creation of an effective governance and management structure is critical to the success of developing a statewide system. Some initial planning and work can begin before this structure is formally in place; however the long term success of such an endeavor is in peril if this area is not adequately addressed.

6.2.2. Technology and Spectrum

The State uses a variety of different radios and systems across the many agencies that provide public safety first response. The vast majority of these are quickly becoming obsolete and useless. It is critical that all public safety operations move to one common shared communications platform in the State. This will not only improve interoperability capabilities, but may also better position the State for future DHS grants which focus on interoperable communications.

As described earlier in this report, the existing 800 MHz system uses the Motorola SmartZone 4.1 Operating System. While this operating system has been an extremely reliable product, the operating system is no longer in production, and Motorola has announced that they will not support this technology after December 2012. Motorola plans no updates to this system and it is being phased out of use.

Additionally, the Zone Controller, or switch, that is located in Tulsa, is an older analog model that cannot be expanded or upgraded. The switch is currently loaded to the maximum number of radio sites it can

handle. Without the ability to add sites, the system cannot be expanded. The State has a current investment in the technology of over $30 million, and it would make no sense to abandon that investment.

Accordingly, the recommendation is made that the State stays with the Motorola 4.1 technology for now, but begin plans to move to the P25 digital standard in the near future. The current system can be upgraded and expanded in phases to the newer digital technologies using various converter systems, allowing the older sites and radios to be usable during the period of transition for a few more years. In Section 6.2.4, a detailed plan for this build-out is put forth.

Spectrum, or the band of frequencies that a radio system operates on, is often mistaken as a technology. Several times it was heard during the data collection of this report that 800 MHz was "old" technology. With this in mind, the topic of spectrum to operate any new radio system on needs to be discussed.

The current 800 MHz channels being used by the existing system are capable of supporting operations at this point in time. The existing channels will support the newer digital radio technologies with no problems. But as more users join a statewide system, both state and local agencies, additional spectrum will be required to increase the capacity of the system. In most areas of the country, there are few if any frequencies available in any frequency band. To attempt to remedy this situation, the Federal Communications Commission (FCC) reserved a portion of the 700 MHz frequency band for the use of public safety in the type of system that DPS is now using. These new frequencies are spectrally located very close to the current 800 MHz channels and with current radios being sold by most vendors; the systems can operate with a mix of 700 MHz and 800 MHz channels. However, at this point these additional channels are not available to the State to use because the State has not developed and submitted a plan to the FCC for their assignment and use. According to the FCC website, the Region 34 Regional Planning Committee (RPC) held its first meeting on 700 MHz in 2003, but that no plan has been submitted. These additional frequencies will not only be of value to the State, but to local agencies as well who may be looking for additional spectrum. It is strongly recommended that the State work with the Region 34 RPC to complete the development of this plan and submit it to the FCC to make this valuable spectrum available to the public safety providers of the State.

6.2.3. System Funding

In order for a statewide radio system to be successful, a stable stream of funding must be established. Currently, most state agencies have no idea what they are spending on radio communications as the costs are often included in salaries and general operating expenses. Other than DPS and ODOT, no agency could provide a line item description of what level of spending was being done to support communications. In Section 6.2.4, high-level budgetary numbers are presented to gain an idea of what the deployment and operation of a statewide system could be.

To move forward with the development of statewide radio system, funding can be broken down into three distinct phases:

- Initial build-out
- Operating
- Life-cycle updates

The initial build-out is a capital expense to the State. These expenses can include:

- Site construction
- Radio equipment
- Dedicated connectivity (e.g., microwave systems)

In other states that have developed statewide systems, various methods of funding have been employed:

- Capital Project Bonds
- Designated User Fees (i.e., license plates, boat registrations, sales tax)
- Direct Appropriation from State Legislatures
- Grants
- Public – Private Partnerships
- Lease – Purchase arrangements

The day-to-day operating expenses of a statewide system can include:

- Support staff salaries
- Site and utility costs
- System maintenance costs (either in-house or contract)
- System overhead (administrative support, tower leases, leased connectivity circuits)

These costs in other states have been supported by various revenue sources, such as:

- Inter-Department Grants
- User Fees
- Direct Appropriation from the State Legislature
- Public – Private Partnerships
- Lease Fees from other users for tower space

Life-cycle update costs are often the most difficult to justify, but are a critical piece of any system. In the past, most people have always thought that when a radio system has been accepted for use, that the work is done. But in reality, the work is just beginning. As radio systems come to depend on computer-based technology more and more, the need to keep systems and equipment upgraded has become critical. Regular updates, preventive maintenance, and scheduled hardware upgrades have long been understood by the Information Technology sector, and are beginning to take root in the radio sector as well. If the system is not maintained and updated on a planned basis, the life-cycle of the system will decay, causing the same problems that are now being faced by the State. In reality, when one system is successfully installed, an agency needs to begin planning for its replacement almost immediately.

In the case of Oklahoma, the concept of life-cycle planning is doubly important. While the current 800 MHz system is being expanded with new sites, the older sites will need to be replaced and or upgraded. The industry accepted life-cycle for radio system infrastructure is 10-to-15 years. The DPS low-band radio system is in some cases using infrastructure that is better than 20 years old. The existing mixed mode (analog/digital) 800 MHz system is a technology that will have to be upgraded within the next five to seven years due to planned obsolescence of analog technology, and that new advances in radio system technologies have emerged since the current system was started in the early 1990's. With proper planning, an orderly migration to a new P25 standards based system can be accomplished without a major

change out of infrastructure. But funding for life-cycle replacement of equipment will be critical for success. Typically in other states, funds for life-cycle replacement have come from:

- Available budget surpluses
- Grants
- Direct Appropriations from the State Legislature

6.2.4. System Coverage Levels

Up to this point, the existing 800 MHz system has been built out to two different standards of coverage. The bulk of the system has been designed to provide 95 percent outdoor coverage on a portable (e.g., handheld) radio, 95 percent of the time in the designated coverage area. The section of the system being built out along Interstate 35 south of Oklahoma City appears to be designed for 95 percent mobile radio coverage, 95 percent of the time in the designated coverage area. Design parameters of the system must remain consistent throughout the State to ensure that users know what to expect in the performance of any new or upgraded system. While mobile radios used to be the primary means of communications for public safety, more and more the portable radio is the standard now. This allows for first responders to operate in areas of the state that may not be accessible to vehicles. It also allows flexibility to county and municipal agencies that desire to join the system.

Based on interviews with the potential system stakeholders, Kimball's recommendation is to design and build-out the system to achieve the 95 percent outdoor portable coverage, 95 percent of the time on a statewide level, as outlined in the Telecommunications Industry Association (TIA) TSB-88-B standard. If a locality requires a higher level of coverage in their community (i.e., In Building coverage), that locality should be required to pay for any additional equipment that is needed to achieve that level. The State needs to set what the base line level of coverage is and keep that in the design parameters to help control the costs of a new system.

6.2.5. System Connectivity

System Connectivity refers to how the various transmitter sites are connected to the controller switch, each other, and how various dispatch centers connect to the system to provide dispatch services. Currently, on the existing 800 MHz system this is accomplished by a mixture of some microwave radios, and leased circuits from different service providers in the State.

Public safety communication systems require robust, highly reliable networks due to the mission critical nature of the communications they carry. Typically you see the reliability factor of "five 9's", or 99.999 percent reliability, quoted in public safety applications. Very few commercial circuit providers are willing to step up to this level of reliability on leased circuits, as is discussed in the Analysis section of this report (see RoIP discussion).

For the expansion and up-date of the Statewide public safety 800 MHz system, Kimball recommends that as new sites are added, microwave be the choice of connectivity back to the controller switches. As older sites are updated, leased circuits and old microwave units should be replaced with new microwave paths. It is also recommended that this system be built out with sufficient expansion capability, typically 50 percent to 100 percent, that it can be used for other public safety applications in the future if required. While the initial investment in a microwave system is significant, over the anticipated 15-year life-cycle of this type of system, it will cost less than leasing circuits for connectivity. Leased circuits should only

be considered if there is no other way to get a system up and running. While this may reduce the capital outlay, it will increase the annual operating costs.

Depending on the level of redundancy the State wishes to pursue, microwave systems can be configured as either a "star" or a "loop". In the star configuration, the master radio site for the system or a region has a direct connection or path to each site. Redundancy is provided by having a second microwave radio on each loop and at each site in "hot-standby" mode, ready to take over if the primary radio fails. In a loop configuration, the sites are configured as a loop, with connectivity traffic flowing in both directions on the loop. If connectivity is lost between two sites, the traffic reverses flow and goes around the loop the other way to the site. As the State develops its system, it may be that a combination of loop and star configurations proves most efficient, with star set ups in the large rural areas, and loops in the urban areas around Oklahoma City and Tulsa. In Figures 6.1 and 6.2, examples of these configurations are depicted.

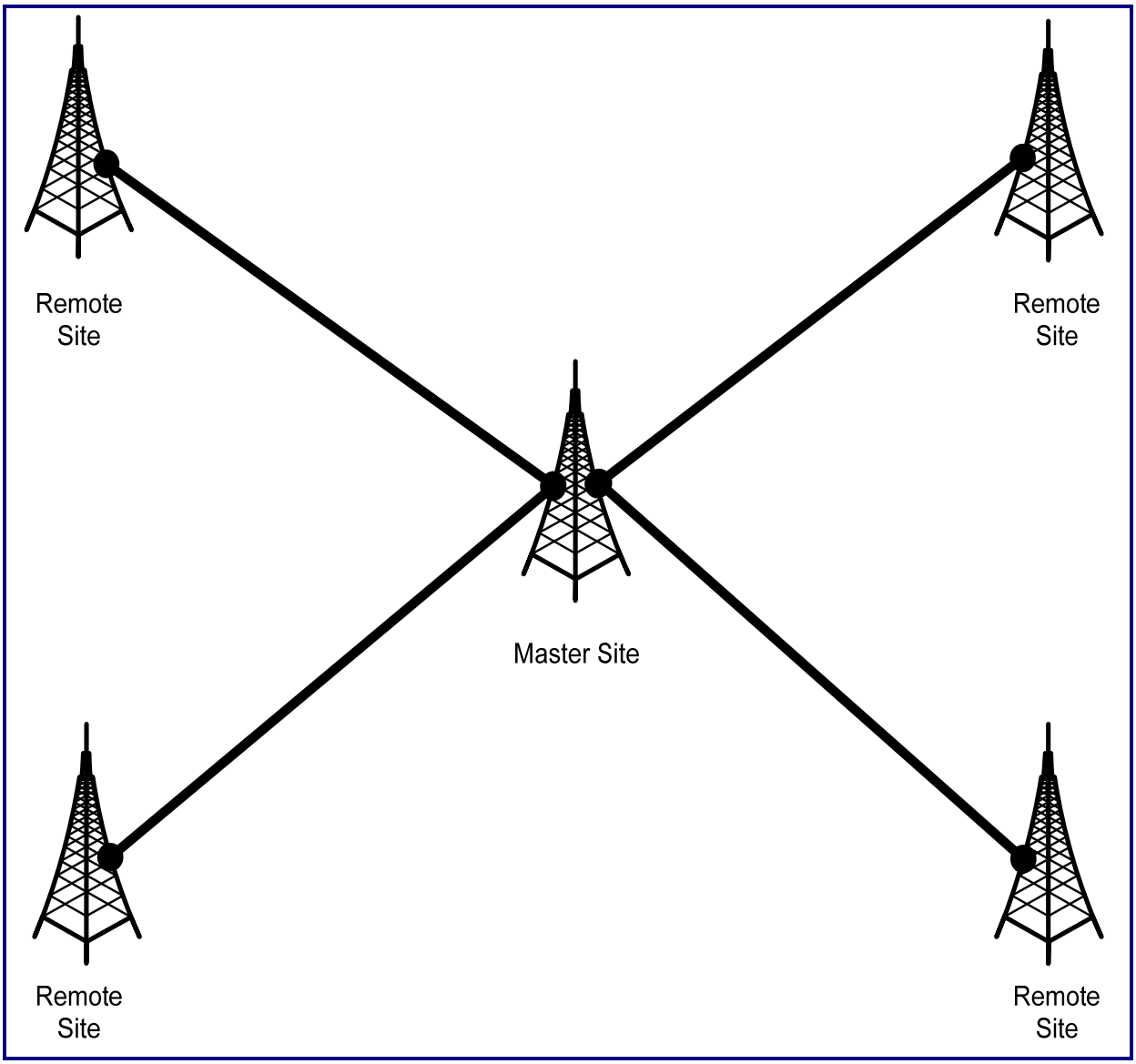

Figure 6.1 - Microwave System Star Configuration

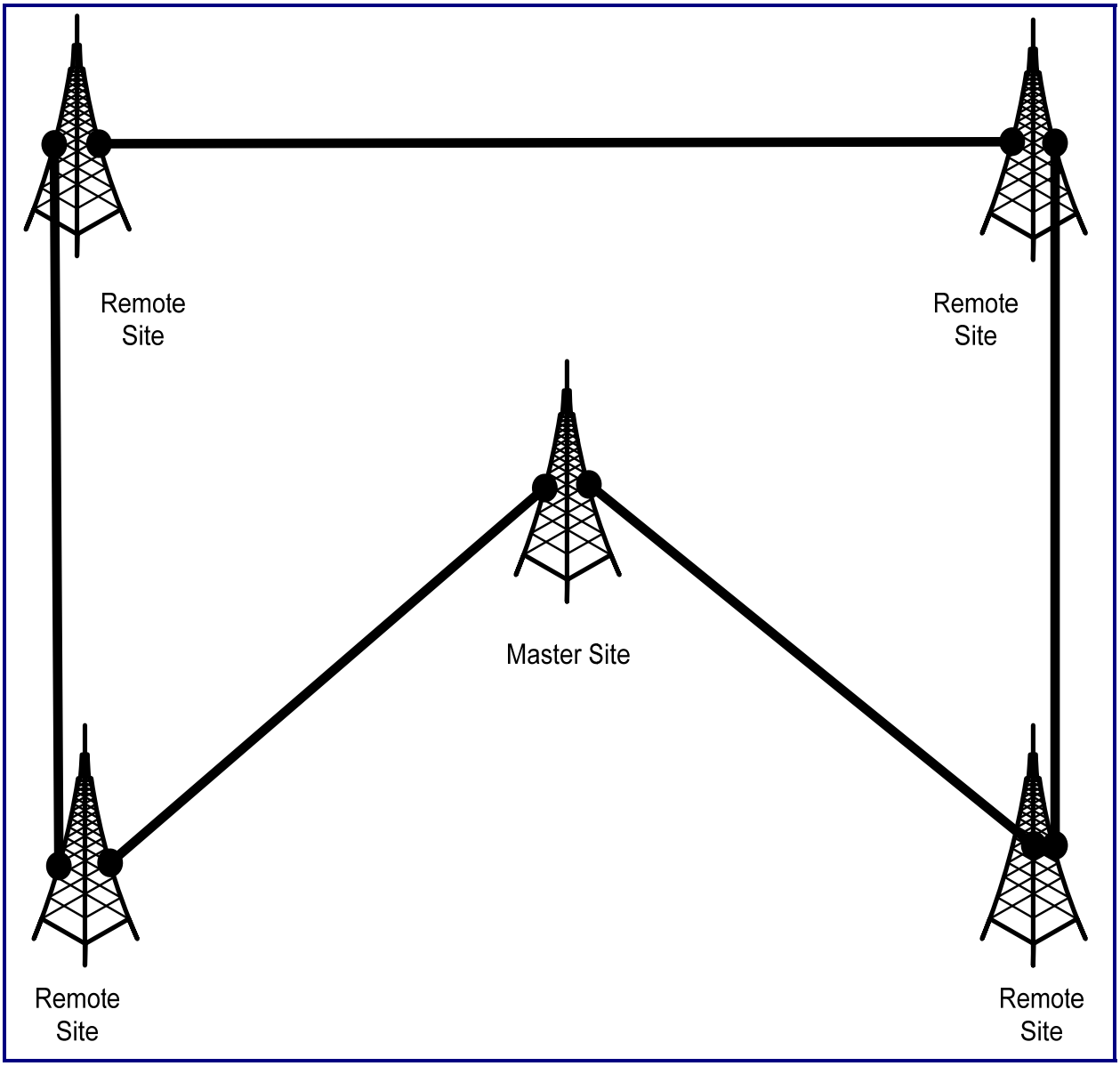

Figure 6.2 - Microwave System Loop Configuration

6.2.6. Interoperability

Currently, the level of interoperability in the State of Oklahoma is dictated by if a user is in the coverage footprint of the existing 800 MHz system or not. In areas that the system covers, the OKOHS has done a good job of bringing local public safety agencies onto the system to use it as their primary means of communications. This has mainly been done through the use of Federal Homeland Security Grants at no or minimal costs to the State or local agencies.

The current 800 MHz system not only allows direct interoperability with the Highway Patrol and the other state agencies that use the system, but it also allows regional and statewide interoperability through the use of Statewide Mutual Aid (SMA) and Regional Mutual Aid (RMA) talkgroups that are in every

radio on the system. All 800 MHz radios on the existing system also have the National I-Call and I-Tac mutual aid channels available.

If a user is outside the coverage of the existing 800 MHz system, interoperability is much more limited, with most parts of the state only having each others radios or channels available to them. There is no known use of regional or federal conventional VHF and UHF mutual aid channels at this time. Arrangements will also need to be made for local agencies that decide not to join the statewide system and remain with their legacy systems. Interoperability can be achieved with these locations through the use of gateway devices, console patches, or the federal mutual aid channels identified for different frequency bands.

By developing a standards-based, shared system, the State of Oklahoma has set its goal for public safety interoperability to the highest level. Based on the United States Department of Homeland Security's SAFECOM Program Interoperability Continuum, this method of interoperability is considered the most effective that can be developed. In Figure 6.3, the DHS SAFECOM Interoperability Continuum is provided. The further to the right side of the continuum that a state's operations are, the more efficient these operations are considered. While this not only makes interoperability a day-to-day function of communications, it may position the State in favorable place for future interoperability grants from the DHS.

The new shared system should be incorporated into the Statewide Communication Interoperability Plan (SCIP) as the cornerstone for interoperability in the State. But plans must also be made to accommodate users who either will not or can not join the statewide system for economic, political, or operational reasons. The SCIP can develop strategies that allow these non-system users to access the system when needed and leverage the coverage and capabilities of the system.

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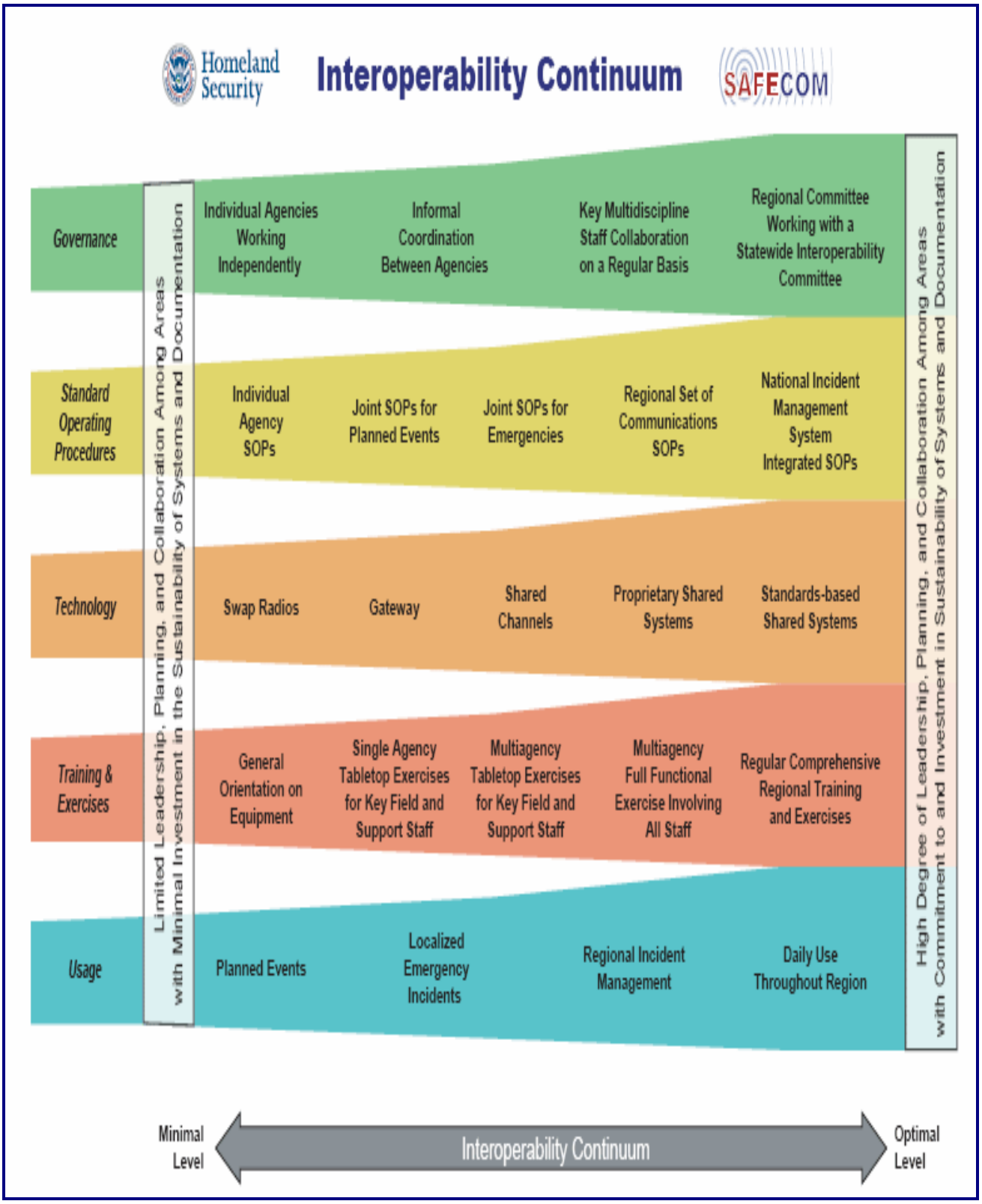

Figure 6.3 - DHS SAFECOM Interoperability Continuum

6.2.7. System Build-Out and Upgrades

The challenge that the State of Oklahoma needs to address is twofold:

- First, coverage of the existing 800 MHz radio system needs to be extended into parts of the State that it currently does not serve.
- Secondly, the existing sites on the system need to be upgraded to a newer operating system to be able to fully use capabilities that are built into the new Statewide Public Safety 800 MHz system

As stated earlier in this section, before a new system can be fully operational, the State needs to address the issues of system governance and day-to-day management. A dedicated system manager needs to be put in place, with the appropriate support staff. Depending on whether the State opts to try and maintain the system itself, contract system maintenance out, or a hybrid of these two, a dedicated system manager is a critical priority to have in place. The responsibility of management of the system must become the State's responsibility, taking this over from the City of Tulsa. Tulsa can still manage its own system and that of the agencies that pay a user fee to it, but everything else must become the responsibility of the State.

The development of an expanded system should be handled in phases, both to ensure success, but also to effectively manage the budget of such a project to ensure that the State receives the maximum value for the investment. As was stated earlier in this report, the build-out of a Statewide public safety 800 MHz system will take multiple years to accomplish, and should be viewed as a marathon race, not a sprint. Detailed planning must be developed to ensure that the project is successful. Budgetary estimates and the amount of time needed to complete each phase are included in the phase description. Bear in mind that the time to complete each phase is dependent on the ability to secure adequate funding. Accomodations will also need to be made during the system buildout to allow radios in other frequency bands or other proprietary systems to interoperate with the 800 MHz system.

As stated in the Introduction to this report, OKOHS and DPS have done a good job of expanding the 800 MHz radio system along Interstate 44, and on Interstate 35 south of Oklahoma City. It is estimated that 75 percent of the population of the State lives within 50 miles of either side of these corridors. These areas appear to be well covered, but further study should be performed to determine what the exact levels of coverage and capacity are.

6.2.7.1. Phase I - Build-out

The first phase to expanding the capacity and coverage of the system will be to add a new digital system controller, probably in the Oklahoma City area, and replace the existing controller in Tulsa. These controllers will be the first step in upgrading the system from the soon-to-be obsolete 4.1 SmartZone Controller to the Internet Protocol (IP) based P25 system. The new controllers have to be added as the current controller in Tulsa is not capable of being expanded or upgraded to digital operations. Any new digital sites will be connected to the new controllers, but they will also be able to manage the older analog and mixed analog-digital sites through the use of what is known as a Smart X converter that Motorola manufactures. At some point, these older sites will have to have their radio repeaters replaced with newer digital radios; however, the converter boxes will allow that to be a gradual transition. Funding for this replacement is not included in the estimate for this phase. There will have to be a division of sites

between the two controllers that allows for an equitable distribution. The replacement of the current Tulsa controller is recommended as there is a question as to whether the older analog controller can be interfaced directly with the newer digital controller. This is an unknown at this time.

Kimball recommends that the sites be divided initially as follows.

- The new controller in Oklahoma City will control all new sites added to the system, as well as take over the control of the DPS sites to the north and east of Oklahoma City
- The new Tulsa controller will continue to control sites owned by the City of Tulsa, as well as the sites that serve agencies that are paying a user fee to the City. The Tulsa controller will also control any sites to the north and east of the City that are DPS sites.

In Phase I of the project, additions will also be made to the coverage and capacity of the regions that already have 800 MHz coverage. This should add approximately 4 more sites to the system. This phase can actually be run concurrently with other phases to expedite work.

New microwave paths will be installed at all new sites to provide connectivity back to the controller(s). As the older sites are addressed, the existing leased circuits will be replaced by new microwave paths. The goal of this is to develop a robust, highly reliable system that is dedicated to the public safety responders of the State.

This phase is anticipated to take approximately 24 months to complete, with a budgetary estimate of $23,100,000. Approximately $7M is being provided by the 2007 Public Safety Interoperable Communications (PSIC) grant to help pay for this phase. The State Legislature also approved approximately $5M to replace some of the older radios in this phase. Work on this phase can begin as soon as funding is secured.

Of course, the deployment of a State-owned controller in Oklahoma City will require that a system management structure and a funding source is in place that can take over the responsibilities that Tulsa staff are currently doing for the State with no or little assistance.

6.2.7.2. Phase II - Western Build-Out

Work on Phase II can begin simultaneously with Phase I. Site acquisition will need to be done before any new sites can be added and is typically one of the bigger risks in any project. Once the new controllers are in place and the existing sites are interfaced, work can begin on expanding the actual coverage of the system.

In Phase II, coverage will be extended into the areas to the north of the Interstate 44 corridor and west of the Interstate 35 corridor all the way through the Panhandle. The terrain in this area is less rugged than in the area southeast of the corridor, and should work out as an easier deployment. With the existing coverage along the Interstate 44 corridor, this phase will provide coverage to better than half the State's geographic area. From initial reviews of planning that has been done for expanding the system, it should take approximately 30 new radio sites. Detailed site surveys will need to be completed to determine if there are existing towers in these areas that may be able to be co-located on rather than having to build all new towers, which may help lower the cost of expansion. These sites will initially be able to work with both analog and digital radios, which will help keep the initial cost of replacing subscriber units down. However, in the future, these sites will need to be converted to all digital operations through a

programming update. It is anticipated that this phase will take three-to-five years to complete at a budgetary cost of $63,288.500.

6.2.7.3. Phase III - Eastern Build-Out

In Phase III, coverage will be extended into the eastern portion of the State, east of Interstates 35 and south of Interstate 44. Terrain in this area is more rugged and will present more challenges to coverage. Reviews of initial planning for this expansion indicate that it will take approximately 23 sites to cover this area, which is primarily due to the rugged terrain. Detailed site surveys will need to be completed to determine if there are existing towers in these areas that may be able to be co-located on rather than having to build all new towers, which may help lower the cost of expansion. These sites will initially be able to work with both analog and digital radios, which will help keep the initial cost of replacing subscriber units down. However, in the future, these sites will need to be converted to all digital operations. This phase should take approximately four-to-five years to complete, mainly because of terrain issues. The budgetary estimate of this phase is $48,950.000.

6.2.8. Opinion of Probable Costs

As part of the recommendations of this report, budgetary estimates for both the expansion of the Statewide Public Safety 800 MHz Radio System and the ten-year operating costs have been developed. These estimates are based on current trends in the industry, as well as research with vendors and review of recent proposals for similar equipment and systems. The budgetary estimate also has a contingency amount, based on 10 percent of the total infrastructure to account for variables or unknowns that have not been forecasted. In Table 6.2.8.1, the overall budgetary project estimate for Phases I – III is presented. Following the table are the assumptions that were made when developing the estimate.

Phase	Amount
Phase I	$ 23,100,000
Phase II	$ 63,288,500
Phase III	$ 48,950,000
Total Capital Outlay	$ 135,338,500

Table 6.2.8.1 - Estimate of Project Capital Outlay

The following assumptions have been made in the development of these estimates:

- The existing 800 MHz system will be upgraded and expanded into a new P25 digital, trunked radio system.
- The new Statewide Public Safety 800 MHz Radio System will be built to provide street level portable radio coverage to cover 95 percent of the State
- There are 57 new tower sites that will have to be built. All new tower sites are considered undeveloped land and will need all work done, to include; tower, shelters, utilities, compounds, all radio equipment. If suitable existing structures can be found for use, rather than building new towers, this cost may be reduced.
- There will be two digital controllers on the system; one in Oklahoma City and one in Tulsa

- The 40 existing sites / simulcast cells will all require Smart X converters to operate with the new digital controllers
- All 97 sites on the system will be linked by a new digital microwave system. If alternate means of existing connectivity (i.e., OneNet, leased T-1 circuits) can be used, it may lower the capital cost of the project, but it will also raise the yearly operating costs.
- A 10 percent contingency amount has been built into the total estimate to account for any unknowns.
- As a final system design is prepared, the actual costs will be better defined.
- This amount only accounts for system infrastructure; no mobile, portables, or dispatch consoles are included in the amount.

While the total capital outlay is a significant amount, the current best practices in the industry may help the State be able to develop a funding plan that is manageable. Many of these practices would not require the total outlay amount all at once, but allow for paying back over time. Trends that have been identified include:

- Using capital construction bonds or special bonds to finance the system development
- Entering into lease-purchase agreements with vendors that allow payments to be spread out over the life of the system, usually 10-to-15 years. While there is usually a finance charge involved in this type of arrangement, vendors typically can arrange for below-market interest rates to help a client with the purchase. In this scenario, the State would know exactly how much it would need to budget each year for the duration of the lease.
- Combining grant funds with direct appropriations
- Dedicated funding sources, such as fees that are part of motor vehicle or boat registrations
- Entering into public-private partnerships with a vendor to provide equipment, sites, or services. This would be considered the riskiest to the State as vendors will not usually enter into this type of agreement unless there is little risk to them.

To obtain a true picture of the ongoing operating costs of a complex communications system, research was done to look at what other states and local governments are doing, and what the approximate costs are. Included in this area is the life-cycle replacement funding of equipment and software, which will allow the new system to remain up-to-date and of value to the State. In Table 6.2.8.2, the ten-year projected operating costs are presented, followed by the assumptions that were used to develop them. It is important to note that these costs include those of a full-time system management team of three full-time employees. These employees would take over the duties that are now being done by the City of Tulsa staff, as well as the management of the system and any vendors that are used to manage and maintain it.

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	Maintenance & Lifecycle Upgrade	Site Utilities	System Management Costs	TOTAL
Year 1	$ 5,000,000	$ 96,000	$ 375,000	**$ 5,471,000**
Year 2	$ 9,516,375	$ 123,600	$ 386,250	**$ 10,026,225**
Year 3	$ 9,706,703	$ 148,320	$ 397,838	**$ 10,252,860**
Year 4	$ 9,900,837	$ 173,040	$ 409,773	**$ 10,483,649**
Year 5	$ 10,098,853	$ 197,760	$ 422,066	**$ 10,718,679**
Year 6	$ 10,300,830	$ 222,480	$ 434,728	**$ 10,958,038**
Year 7	$ 10,506,847	$ 239,784	$ 447,770	**$ 11,194,401**
Year 8	$ 10,716,984	$ 246,978	$ 461,203	**$ 11,425,164**
Year 9	$ 10,931,324	$ 254,387	$ 475,039	**$ 11,660,749**
Year 10	$ 11,149,950	$ 262,018	$ 489,290	**$ 11,901,258**

Table 6.2.8.2 - Projected Ten-year System Operating Costs

The assumptions that were used to develop these operating costs include:

- All system maintenance during this period is provided by a commercial provider under contract to the State
- The first-year maintenance is lower due to only covering the original 40 sites. Sites are added at a rate of ten per year until all 97 sites are included. Annual per site fee raises at a rate of 3 percent per year
- Site utility rates are based at $200 / site / month. Sites are added in the first seven years until all 97 sites are on line. Utility rates increase 3 percent annually.
- System management costs are based on three full-time employees, plus benefits, with an increase of 3 percent annually.
- All sites are owned by the State, with no lease fees paid to private landlords.

The operating costs of the new system can be made up of several different sources. While grants can help in this area, especially with system lifecycle upgrades, grants should not be viewed as stable source of funding for everyday operations, but more for special projects and upgrades. The trends that most statewide systems seem to follow are:

- Direct appropriation of funds
- User fees, preferably on an annual basis
- Direct fund transfers from user agencies
- Dedicated funding sources, such as fees added on to motor vehicle or boat registrations
- Grants for specific projects and upgrades

APPENDIX A – EXECUTIVE ORDER

Brad Henry
Governor

FILED
OCT 16 2007
OKLAHOMA SECRETARY
OF STATE

EXECUTIVE DEPARTMENT

EXECUTIVE ORDER 2007-42

I, Brad Henry, Governor of the State of Oklahoma, pursuant to the authority vested in me by Sections 1 and 2 of Article VI of the Oklahoma Constitution and the Oklahoma Homeland Security Act, 74 O.S. §§ 51, *et seq.*, hereby direct and order as follows:

The lack of adequate interoperable communications for first responders at all levels has been a problem for many years. Significant advances have been made in interoperable communications over the past five years. Under my authority, the Oklahoma Office of Homeland Security (OKOHS) has made a number of investments in improving interoperable communications through funding from the United States Department of Homeland Security. To date over $32 million in federal funds have been dedicated to increasing interoperable communications.

OKOHS is directed to continue their efforts to improve interoperable communications in the state of Oklahoma. The Oklahoma Homeland Security Director and OKOHS shall continue to oversee the implementation of any and all initiatives or efforts mandated by the United States Department of Homeland Security and its subdivisions. OKOHS shall remain the State Administering Agency for all federal funds related to homeland security, including the Public Safety Interoperable Communications grant program. OKOHS is further directed to oversee the development and implementation of a Statewide Interoperable Communications Plan pursuant to federal requirements.

Recognizing the need for a state level strategy for communications, the Oklahoma Legislature appropriated funding to the Department of Public Safety for a study of state level communications capabilities and needs. OKOHS, in consultation with the Oklahoma Department of Public Safety, is directed to develop and oversee the state study. All state agencies, boards and commissions are directed to cooperate with the OKOHS in the study and development of state interoperable communications

042452

STATE CAPITOL BUILDING • 2300 N. LINCOLN BOULEVARD, SUITE 212 • OKLAHOMA CITY, OKLAHOMA 73105 • (405) 521-2342 • FAX: (405) 521-3353

This Executive Order shall be distributed to all Cabinet and the Oklahoma Homeland Security Director for immediate implementation.

IN WITNESS WHEREOF, I have hereunto set my hand and caused the Great Seal of the State of Oklahoma to be affixed at Oklahoma City, Oklahoma, this 16th day of October, 2007.

BY THE GOVERNOR OF THE STATE OF OKLAHOMA

BRAD HENRY

ATTEST:

SECRETARY OF STATE Acting Assistant

APPENDIX B – SURVEY QUESTIONNAIRES

Oklahoma Statewide Communications System
State Agency Survey

Questions v5 – Initial Report Only

Interviewer:_____ **DATE:** _____

1. Agency Name

2. Does your agency play a role in the response to disasters in the State, or does any part of your agency's duties require enforcement of laws or regulations?

3. Does your agency have a dedicated wireless communications system for its use?
   - If so, who owns the system?
   - If not, do you use wireless communications for day to day or incident operations?

4. System Manufacturer :

5. If a common statewide system could meet your coverage and operational requirements, would your agency be interested in participating? Why or Why Not?

6. What is the Total Annual Cost to maintain and support the system? (Include e.g. system maintenance, vendors, contractors, employees, tower maintenance, lease fees, utilities, etc.)

7. How are the costs to own, operate and maintain the system funded? (E.g. annual legislative appropriation, revolving fund, fees generated, etc.)

8. Who maintains your system or radio equipment (i.e., contractor, self maintained)?
If contracted out, who is your provider?

9. What is the number of personnel dedicated to the operation and maintenance of the system? (E.g. Administrators, radio technicians, tower technicians, etc.)
- How many Personnel?
- What is the average annual cost of personnel?

10. Tower Sites
- If your agency has a dedicated system, how many tower sites are used to provide service coverage?
- Who owns the sites?
- Do you co-locate with other governmental agencies or private groups?

11. System Users:
Primary users (including local, state, tribal, and federal agencies)
(1) Entity
a) Total number of handheld radios
b) Total number of mobile radios
c) Dispatch radios
d) Tower radios

Secondary users (Including local, state, tribal and federal agencies

(1) Entity
   a) Total number of handheld radios
   b) Total number of mobile radios
   c) Dispatch radios
   d) Tower radios

12. Frequency Band

13. Technology overview of each radio system:
    - Simplex or Repeated?
    - Trunked or Conventional?
      - If trunked, how many channels per site?
    - Analog, Mix-Mode or Digital?
    - Voted?
    - Simulcasted?
    - Capable of Encryption?
    - System connectivity (i.e., microwave, leased circuits, etc)?

14. Total number of dispatch facilities

15. What is the planned obsolescence of each system?

16. Are there any planned upgrades to the system?
    - What is the upgrade plan?
    - What are the costs of the planned upgrade?
    - How are the upgrade costs being funded?

17. What is the coverage area of the system (i.e., regions, statewide)?
- What percentage of the population is covered by each radio system?
- Are there any plans to expand the coverage area of this system?

18. What are your agency's interoperability needs?
- Other state agencies
- Local agencies
- National Guard
- Federal, Tribal agencies
- Non-public safety entities (i.e., utilities, Red Cross, etc)

19. Are your interoperability requirements currently being met?
If yes, how (i.e., patches, radio swapping, channel sharing, interoperability devices)

20. What features would your agency be looking for in the future for wireless communications (i.e., mobile data, broadband services, etc)?

21. Is your agency familiar with and in compliance with the National Incident Management System (NIMS) and the Incident Command System (ICS)?

NOTES:

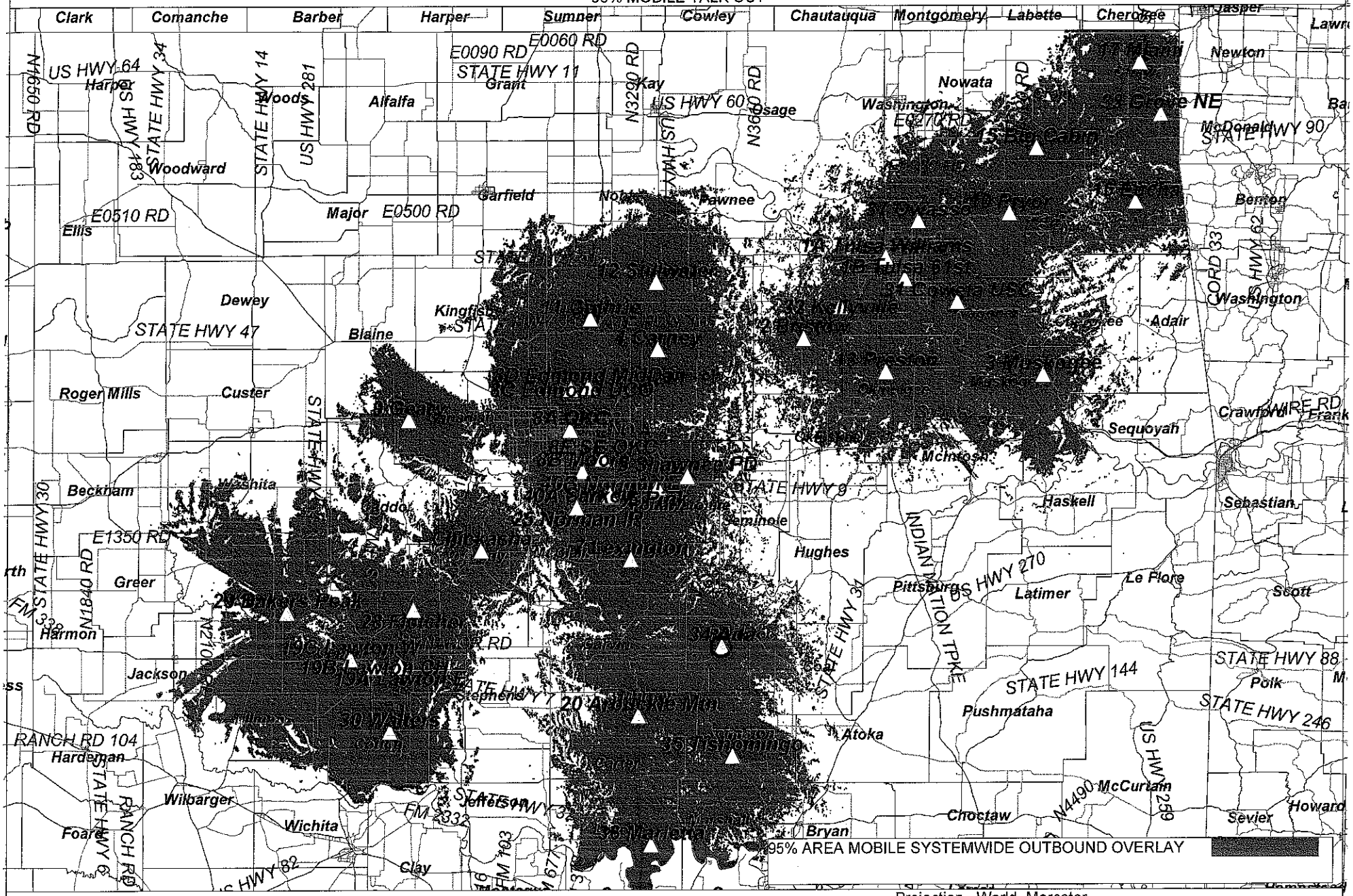
Oklahoma Radio Assessment
State System Survey Questions

Information that needs to be captured on each system includes:

1. What was the impetus for starting a statewide radio system
2. Start and Complete dates (or planned)
3. Initial cost estimate
4. Final cost
5. What was initial funding source, how were funds secured
6. What technology used, what frequency band
7. How many sites, how many users
8. What is current operating budget, anticipated budget in the future?
9. Who uses the system (i.e., State only, shared with locals, federal, tribal, etc)
10. Status of governance, SOPs
11. Is there a full time system manager/management team?
12. Who maintains the system? (i.e., self maintained, contract, etc)
13. If self maintained, how many staff?
14. Interoperability with local agencies, other states, federal and tribal agencies
15. Current funding model
16. Current business model (i.e., user fees, private ownership, state supported)
17. Future plans for technology, funding

APPENDIX C – DPS SYSTEM DOCUMENTATION

OK DPS
95% MOBILE TALK OUT



0 32.46 64.92 mi
1 inch = 32.46 miles @ 1/2056737

MOTOROLA

Projection World_Mercator
Center Point 35:19:50 N 96:58:20.41 W

Wednesday, June 13 2007 3.10 Build 3121

Job Id : 287014430.39.000.2.5

Portion(s) Of GIS Source Data Provided By ESRI, Inc.

			STATE CONTRACTS REGULAR				
CONTRACT NO.	PERIOD		LOCATION	DIVISION NUMBER	AMOUNT	RENEWAL DATE	CONTRACT AMT
SW70011	02/01/07	01/31/08	BATTERY CONTRACT	DCS			
5859007732	06/01/07	05/31/08	SBC/AT&T	TRPK/211 - LB	$1,281.00		$15,372.00
			DB-1 PERRY - PAWNEE				
			PTCI - GUYMON	DPS - LB	$460.00		$460.00
5859008856	02/01/08	01/31/09	SBA/AAT - ENID TOWER LEASE	C&ES/422 - LB	$396.31		$4,755.72
5859008726	02/01/07	01/31/08	VICI	C&ES/422	$200.00		$200.00
5859004756	11/04/07	11/03/08	CLIFFORD POWER SYSTEMS	?????			$15,000.00
			STANDBY GENERSTORS				
REVISED	01/25/08						$35,787.72

Electric Companies for LB Relay Sites					
Company	**Location**	**Acount Numbers**	**Phone Numbers**		**Amount per Year**
Caddo Electric Coop.	Binger X	48503	1-405-656-2322		**$360.00**
	Cherokee X	48502			**$450.00**
	Geary	48501		**800MHz**	**$360.00**
Choctaw Electric Coop.	Cloudy X	144600	1-580-596-3575		**$380.00**
Cookson Hills Electric Coop.	Porum X	879900	1-800-328-2368		**$240.00**
			1-918-967-4614		
Crec	Carney	1469400	1-800-375-2884	**800MHz**	**$520.00**
	Carney	748901	1-405-372-2884	**800MHz**	**$3,000.00**
	Guthrie	2200100		**800MHz**	**$2,200.00**
	Stillwater	2679000		**800MHz**	**$3,600.00**
Kiamichi Electric	McAlester	8006101	1-800-888-2731		**$590.00**
	Poteau X	8006102	1-918-465-2338		**$360.00**
Northwestern Electric	Vici X	26201	1-580-256-7425		**$300.00**
	Woodward X	26202			**$590.00**
Okla. Electric Coop.	Lexington X	6510100101	1-405-321-2024	**800MHz**	**$3,400.00**
OG&E	Bristow X	153676	1-405-272-9595	**800MHz**	**$3,800.00**
	Bethal Acres	4645784		**800MHz**	**$1,800.00**
	Wewoka X	3846011			**$240.00**
Poeples Electric Coop.	Stratford X	540700900	1-877-456-3031		**$400.00**
			1-580-332-3031		
Public Service of OK	Atoka/Stringtown	95995709201	1-888-218-3919		**$350.00**
	Hobart X	95581909207			**$420.00**
	Turley	95439759010			**$450.00**
Tri County Electric	Guymon	2732100	1-800-522-3315		**$1,700.00**
Verdigris Valley Electric	Bartlesville X	471400400	1-800-870-5948		**$260.00**
	Claremore X	911701900	1-918-371-2584		**$250.00**
					$25,770.00
REVISED 01/24/08					

Oklahoma SmartZone Trunking Sites

Site #	Site Name	In Service Status	Site Type	Operational Mode	Control Channels	Total Channels w/Telephone and Voice Capable Channels	Coverage Region	Notes
1	Tulsa	In Service	Simulcast 2 Sites	14 Analog/14 Mixed	4	28 w/14 TI and 27 Voice	NE	BOK & 61st
2	Bristow	In Service	IR	Analog	2	5 w/3 TI	NE	
3	Muskogee	In Service	IR	Analog	2	5 w/3 TI	NE	
4	Carney	In Service	IR	Analog	2	5 w/3 TI	CN	
5	Shawnee	In Service	CSC	Mixed	2	7 w/5 TI and 7 Voice	CN	
6	Pink	In Service	CSC	Analog	2	6 w/4 TI and 4 Voice	CN	
7	Lexington	In Service	CSC	Analog	2	6 w/4 TI and 4 Voice	CN	
8	OKC	In Service	Simulcast 5 Sites	7 Analog/10 Mixed	4	17 w/10 TI	CN	OKC (at Troop-A), Moore (Moore Water Tower), Edmond UCO, Edmond Mid-Dan, & OKC-SE
9	Geary	In Service	CSC	Analog	2	6 w/3 TI and 3 Voice	CN	No T1 Time Slot for Audio on Channel 5
10	Pryor	In Service	IR	Mixed	2	5 w/3 TI	NE	
11	Guthrie	In Service	CSC	Analog	2	6 w/4 TI and 4 Voice	CN	
12	Stillwater	In Service	IR	Mixed	2	5 w/3 TI	CN/NE	
13	Preston	In Service	IR	Mixed	2	6 w/3 TI	NE	
14	Prue	**Future**					NE	
15	Big Cabin	In Service	IR	Mixed	2	5 w/3 TI	NE	Use to be Vinita
16	Jay	**Future**					NE	aka Eucha
17	Miami	In Service	IR	Mixed	2	6 w/4 TI	NE	
18	Chickasha	In Service	IR	Mixed	2	6 w/3 TI	SW	

Oklahoma SmartZone Trunking Sites

Site #	Site Name	In Service Status	Site Type	Operational Mode	Control Channels	Total Channels w/Telephone and Voice Capable Channels	Coverage Region	Notes
19	Lawton	In Service	Simulcast 3 Sites	Mixed	2	8 w/6 TI	SW	Lawton East, Lawton City Hall & Lawton West
20	Arbuckle	**Future**	IR				SW/SE	
21	Velma	**Future**					SW/SE	
22	Enid	**Future**					NW	
23	Ponca City	**Future**					NE/NW	
24	Ochelata	**Future**					NE	
25		**Out of Service**						Use to be Norman-IR
26		**Out of Service**						Use to be OKC-IR
27	ECHO-1	SOW	IR				ANY	Tulsa Site on Wheels
28	Fletcher	In Service	IR	Mixed	2	5 w/3 TI	SW	
29	Baker Peak	In Service	IR	Mixed	2	5 w/3 TI	SW	
30	Walters	In Service	IR	Mixed	2	5 w/3 TI	SW	
31	Coweta	**Future**	IR				NE	
32	Kellyville	In Service	IR	Mixed	2	7 w/5 TI	NE	
33	Grove	In Service	IR	Mixed	2	5 w/3 TI	NE	
34	Ada	**Future**	IR				SW	
35	Tishomingo	**Future**	IR				SW	
36	Marietta	**Future**	IR				SE/SW	
37	Owasso	**Future**	IR				NE	
40	Norman-S	In Service	Simulcast 2 Sites	10 Analog/4 Mixed	4	14 w/10 TI	NE	

Revised 01-16-2008

NEW ELECTRIC COMPANIES 800 MHZ SITES

CONTRACT #	PERIOD		COMPANY	LOCATION	DIVISION #	ACCOUNT NO	PHONE NO	P.O. AMOUNT
5859007759	07/01/07	06/30/08	AEP/PSO	CHICKASHA	800 MHZ/091	951-869-899-0-1	1-888-218-3919	$5,264.00
				LAWTON CITY HALL		956-858-764-0-1		
				LAWTON EAST		958-680-689-0-9		
				LAWTON WEST		950-707-566-0-6		
5859007766	05/12/07	05/11/08	CADDO ELECTRIC COOP	BAKERS PEAK	800MHz/091	111980-01	1-405-656-2322	$4,800.00
5859007260	02/01/078	01/31/09	CADDO ELECTRIC COOP	FLETCHER	800 MHz/091	48504	1-405-656-2322	$3,600.00
5859007796	04/01/07	03/31/08	COTTON ELEC. COOP	WALTERS	800 MHz/091	3443602500	1-800-522-3520	$3,600.00
5859009310	10/01/07	09/30/08	CREC	STILLWATER	800 MHz/091	2679000	1-405-372-2884	$3,600.00
(Replaces 6702)								
5859007744	07/01/07	06/30/08	NE OK ELECTRIC COOP	GROVE	800 MHZ/091	952131	1-800-256-6405	$10,800.00
				MIAMI		952132		
				PRYOR		951242		
5859007801	04/07/07	04/06/08	OG&E	MOORE	800 MHz/091	127638727-9	1-405-272-9595	$4,800.00
5859007660	04/01/07	03/31/08	OG&E	KELLYVILLE	800 MHz/091	127944419-2	1-405-272-9595	$3,600.00
5859008640	09/01/07	08/31/08	OG&E	SE OKC	800 MHz/091	128078882-7	1-405-272-9595	$4,800.00
5859009371	12/15/07	12/14/08	PEOPLES ELEC.COOP	TISHOMINGO	800 MHz/091		1-580-436-0229	$21,600.00
5859009368	12/15/07	12/14/08		ADA	800 MHz/091			$4,200.00
								$70,664.00
REVISED	01/25/08							

STATE CONTRACTS 800MHz

CONTRACT NO.	PERIOD		LOCATION	DIVISION NUMBER	AMOUNT	RENEWAL DATE	CONTRACT AMT.
			TOWER SITE LEASES				
5859007733	**12/15/07**	**12/14/08**	AMERICAN TOWER - ADA	**800 MHz/091**	$1,500.00		**$18,000.00**
			MUSKOGEE COMMUNICATIONS				
			BIG CABIN				
5859007023	**12/15/07**	**12/14/08**	AMERICAN TOWER - FLETCHER		$1,500.00		**$18,000.00**
	This is the only one that should be on ATC Invoices!						
5859008177	**05/01/07**	**04/30/08**	AMERICAN TOWER/SPECTRASITE	**800 MHz/091**	$1,000.00		**$12,000.00**
			GUTHRIE				
5859007734	**12/15/07**	**12/14/08**	AMERICAN TOWER - TISHOMINGO	**800 MHz/091**	$1,500.00		**$18,000.00**
5859005692	**03/01/07**	**02/28/08**	CAPITOL TOWER - CHICKASHA	**800 MHz/091**	$867.00		**$10,404.00**
5859007765	**05/01/07**	**04/30/08**	COTTON ELECTRIC COOP	**800 MHz/091**	$580.00		**$6,960.00**
			WALTERS				
5859005840	**02/01/08**	**01/31/09**	LAWTON COMMUNICATIONS	**800 MHz/091**	$800.00		**$9,600.00**
			LAWTON EAST				
5859008979	**11/01/07**	**10/31/08**	MOTOROLA 800 MHZ SERVICE	**800 MHz/091**	$14,793.42		**$177,521.04**
5859008241	**10/01/07**	**09/30/08**	MUSKOGEE COMMUNICATIONS	**800 MHz/091**	$800.00		**$9,600.00**
			MUSKOGEE				
5859009169	**01/01/08**	**12/31/08**	PAT TOWERS	**800 MHz/091**	$850.00		**$10,200.00**
			LAWTON WEST				
5859005782	**07/01/07**	**06/30/08**	WYNN COMMUNICATIONS	**800 MHz/091**	$800.00		**$9,600.00**
			OKMULGEE				
			TELEPHONES LINES				
58589007778	**07/01/07**	**06/30/08**	ONENET - MUSKOGEE - GUTHRIE	**800 MHz/091**			**$55,512.00**
			OKMULGEE/PRESTON				
5859001769	**08/21/07**	**08/20/08**	SBC/AT&T	**TELECOM - 800MHz**			

			TULSA - 911		$13,233.30		**$13,233.30**
5859005360	**04/01/06**	**03/31'07**	SBC/AT&T	**TELECOM - 800MHz**			
			GUTHRIE POTS		$430.85		**$430.85**
			MUSKOGEE		$21,763.00		**$21,763.00**
5859007781	**07/10/07**	**06/30/08**	SBC/AT&T	**TELECOM - 800MHz**			
			GEARY		$22,895.00		**$22,895.00**
							$29,374,062.49
REVISED	**01/25/08**		**karyn.loper@americantower.com**				

2

413-718

COX BUISNESS SERVICES 1-405-654-2322 Mary Elder 607-4875 - Doug Manning 601-8375

CONTRACT NO.	PERIOD		LOCATION	CIRCUIT NUMBER	AMOUNT	RENEWAL DATE	CONTRACT AMT
5859007817	05/01/07	04/30/08	TISHOMINGO - PSRC - TULSA	28/DHXX/053173/000/COXC	$2,594.20		$31,130.40
			ADA - PSRC - TULSA				
5859007879	09/01/07	08/31/08	BIG CABIN - PSRC - TULSA	28/DHXX/049786/000/COXC	$870.00		$30,911.76
			COWETA - PSRC - TULSA	29/DHXX/048409/000/COXC	$362.50		
			N. CHOWNING - EDMOND - OKC	28/DHXX/048509/000/COXC	$671.74		
				28/DHXX/048510/000/COXC			
			N MIDWEST BLVD. - OKC	28/DHXX/048460/000/COXC	$671.74		
				28/DHXX/048461/000/COXC			
5859009233	06/01/07	05/31/08	CHICKASHA - PSRC - TULSA	28/DHXX/046107/000/COXC	$568.22		$101,154.12
(Replaced 7732)							
			LAWTON - PSRC - TULSA	28/DHXX/046106/000/COXC	$636.29		
			NE 12TH MOORE - OKC	28/DHXX/047321/000/COXC	$481.28		
				28/DHXX/047322/000/COXC			
			I-240/ANDERSON ROAD - CITY OF MOORE	28/DHXX/056484/000/COXC	$481.28		
				28/DHXX/056483/000/COXC			
			OKC - PSRC - TULSA	28/DHXX/046280/000/COXC	$624.13		
			SHAWNEE - STILLWATER - PSRC - TULSA	28/DHXX/046100/000/COXC	$4,861.95		
				28/DHXX/046101/000/COXC			
				28/DHXX/046102/000/COXC			
				28/DHXX/046103/000/COXC			
				28/DHXX/046104/000/COXC			
				28/DHXX/046105/000/COXC			
				28/DHXX/046224/000/COXC			
			WALTERS - PSRC – TULSA	28/DHXX/046108/000/COXC	$776.36		
5859007238	02/01/08	01/31/09	FLETCHER - PSRC - TULSA	29/DHXX/051760/000/COXC	$778.70		$10,200.00
5859008343	09/01/07	08/31/08	GROVE	28/DHXX/048851/000/COXC	$797.70		$9,768.00
5859007768	05/01/07	04/30/08	KELLYVILLE - PSRC - TULSA	29/DHXX/053104/000/COXC	$516.00		$7,450.00

5859008991	01/01/08	12/31/08	MIAMI - PSRC - TULSA	29/DHXX/051340/000/COXC	$983.04		**$11,796.48**
5859008430	07/01/07	06/30/08	W. GRAY NORMAN - PSRC - TULLSA	28/DHXX/048741/000/COXC	$1,363.70		**$16,440.00**
				28/DHXX/048746/000/COXC			
5859008647	09/01/07	08/31/08	OWASSO - PSRC - TULSA	29/HCGS/056183/000/COXC	$361.46		**$4,337.52**
							$223,188.28
Revised	01/25/08						
5859006642	09/01/06	06/30/07	EDMOND - PSRC - TULSA	28/DHXX/048507/000/COXC	$617.50		
			DISPATCH-CITY OF EDMOND RENEWS	28/DHXX/048508/000/COXC	$617.50		
			AS OF JULY 01, 2007 PER WILL BORDEN	28/DHXX/048602/000/COXC	$617.50		
5859005949	06/01/06	05/31/07	N BRDWY MOORE - PSRC - TULSA	28/DHXX/046221/000/COXC	$669.50		
			DISPATCH-CITY OF MOORE RENEWS	28/DHXX/046222/000/COXC	$669.50		
			AS OF JUNE 01, 2007 PER WILL BORDEN	28/DHXX/046223/000/COXC	$669.50		
5859006640	09/01/06	08/31/08	W GRAY NORMAN - PSRC - TULSA			**DPS Renews 2**	
5859006641	09/01/06	08/31/07	W GRAY NORMAN - PSRC - TULSA	28/DHXX/048746/000/COXC	$667.50	**07/18/07**	
			DISPATCH-CITY OF NORMAN RENEWS	28/DHXX/048743/000/COXC	$667.50		
			AS OF SEPT. 01, 2007 PER WILL BORDEN	28/DHXX/048744/000/COXC	$667.50		
				28/DHXX/048745/000/COXC	$667.50		

Oklahoma Public Safety SmartZone Sites

Site Numbers

Created: Jan-01
Updated: Apr-07

No	SITE NUMBER	SITE NAME	COUNTY	REGION	NOTES
1	1	Tulsa Simulcast	Tulsa	NE	
2	2	Bristow	Creek	NE	
3	3	Muskogee	Muskogee	NE	
4	4	Carney	Lincoln	CN, NE	
5	5	Shawnee	Pottawatomie	CN	
6	6	Pink	Pottawatomie	CN	
7	7	Lexington	Cleveland	CN	
8	8	OKC Metro Simulcast	Oklahoma, Cleveland	CN	
9	9	Geary	Canadian	CN	
10	10	Pryor	Mayes	NE	
11	11	Guthrie	Logan	CN	
12	12	Stillwater	Payne	NE, CN	
13	13	Preston	Okmulgee	NE	
14	15	Big Cabin	Craig	NE	was Vinita
15	17	Miami	Ottawa	NE	
16	18	Chickasha	Grady	SW	
17	19	Lawton Simulcast	Comanche	SW	
18	20	Arbuckle Mtn.	Murray	SW, SE	future Troop F
19	25	Norman IR	Cleveland	CN	
20	26	OKC IR	Oklahoma	CN	No longer operational
21	27	ECHO-1	SOW	n/a	Transportable Site
22	28	Fletcher	Comanche	SW	
23	29	Baker's Peak	Comanche	SW	
24	30	Walters	Cotton	SW	
25	31	Coweta	Wagoner	NE	
26	32	Kellyville	Creek	NE	
27	33	Grove NE	Ottawa	NE	
28	34	Ada SW	Pontotoc	SE	
29	35	Tishomingo	Johnston	SE	future Troop F
30	36	Marietta	Love	SE	future Troop F

Oklahoma Public Safety SmartZone Sites

Site Numbers

Created: Jan-01
Updated: Apr-07

No	SITE NUMBER	SITE NAME	COUNTY	REGION	NOTES
31	40	Norman Simulcast	Cleveland	CN	City of Norman 2 site
32	41	Edmond Backup	Oklahoma	CN	City of Edmond 2 site

Agency Name	User Type	RMA	Interest	Paying
Afton Fire Department	Primary	NE		
Afton Police Department	Primary	NE		
American Airlines	IO	NE	Tulsa	
American Red Cross	IO	NE	Tulsa	Yes
Apache Emergency Medical Services	IO	SW		
Army (WMD)	IO	NE	Tulsa	
Bailey Medical Center - Owasso	IO	NE	Tulsa	
Baptist Medical Center - OKC	IO	CN		
Beggs Fire Department	IO	NE	Tulsa	
Bernice Fire Department	Primary	NE		
Bernice Police Department	Primary	NE		
Berryhill Fire Department	Primary	NE	Tulsa	Yes
Bethel Acres Fire Department	Primary	CN		
Bethel Road Fire Department	Primary	SW		
Big Cabin Emergency Medical Services	Primary	NE		
Big Cabin Fire Department	Primary	NE		
Big Cabin Police Department	Primary	NE		
Bixby Police Department	IO	NE	Tulsa	
Black Dog Fire Department	IO	NE	Tulsa	
Boeing	IO	NE	Tulsa	
Bone and Joint Hospital	IO	CN		
Broken Arrow	IO	NE	Tulsa	
Brooksville Fire Department	Primary	CN		
Bureau of Alcohol, Tobacco, and Firearms	Task/IO	NE	Tulsa	
Bureau of Indian Affairs - Miami	Primary	NE		
Burlington Northern Santa Fe Railroad	IO	NE	Tulsa	Yes
Cache Emergency Medical Services	IO	SW		
Cache Fire Department	Primary	SW		
Cache Police Department	Primary	SW		
Cache Road Fire Department	Primary	SW		
Cameron University Police Department	Primary	SW		
Canadian Valley Regional Hospital	IO	CN		
Catoosa Fire Department	Primary	NE	Tulsa	Yes
Catoosa Police Department	Primary	NE	Tulsa	Yes
Chattanooga Fire Department	Primary	SW		
Chattanooga Police Department	Primary	SW		
Chickasha Animal Control	Primary	SW		
Chickasha Emergency Management	Primary	SW		
Chickasha Fire Department	Primary	SW		
Chickasha Police Department	Primary	SW		
Chickasha Public Works Department	Primary	SW		
Cleora Emergency Medical Services	Primary	NE		
Cleveland County Sheriff's Office	Primary	CN		
Collinsville Police Department	IO	NE	Tulsa	
Collinsville Rural Fire Department	IO	NE	Tulsa	
Comanche County Detention Center	Primary	SW		
Comanche County Emergency Management	Primary	SW		
Comanche County Juvenile Bureau	Primary	SW		
Comanche County Sheriff's Office	Primary	SW		
Comanche Memorial Emergency Medical Services	IO	SW		
Comanche Memorial-Elgin	IO	SW		

Comanche Tribe	Primary	SW		
Commerce Emergency Management	Primary	NE		
Commerce Fire Department	Primary	NE		
Commerce Police Department	Primary	NE		
Country Corner Fire Department	IO	NE	Tulsa	
Cove Acres Fire Department	Primary	SW		
Coweta Fire Department	Primary	NE		
Coweta Police Department	Primary	NE		
Coweta Public Schools	Primary	NE		
Coxs Store Volunteer Fire Department	Primary	SW		
Craig County Sheriff's Office	Primary	NE		
Creek County District Attorney	IO	NE	Tulsa	
Creek County Emergency Medical Services	Primary	NE	Tulsa	
Creek County Sheriff's Office	Primary	NE	Tulsa	Yes
Cyril Emergency Medical Services	IO	SW		
Deaconess Hospital - OKC	IO	CN		
Delaware County Sheriff's Office	IO	NE		
Department of Public Safety Air Support	Primary	ALL		
Department of Public Safety Bomb Squad	Primary	CN		
Department of Public Safety Troop Headquarters	Primary	ALL		
Department of Public Safety Troopers	Primary	ALL		
Eastern Shawnee Tribal Police	Primary	NE		
Edgewater Park Fire Department	Primary	SW		
Edmond Arcadia	Primary	CN		
Edmond Cemetary Department	Primary	CN		
Edmond Electric Department	Primary	CN		
Edmond Emergency Management	Primary	CN		
Edmond Engineering Department	Primary	CN		
Edmond Fire Department	Primary	CN		
Edmond Hospital	IO	CN		
Edmond Police Department	Primary	CN		
Edmond Public Schools	Primary	CN		
Edmond Street Department	Primary	CN		
Edmond Traffic Department	Primary	CN		
Edmond Utility Department	Primary	CN		
Edmond Water Department	Primary	CN		
Elgin Police Department	Primary	SW		
Elgin Volunteer Fire Department	Primary	SW		
EMSA East Division	Primary	NE	Tulsa	
EMSA West Division	Primary	CN	Tulsa	
Fairland Fire Department	Primary	NE		
Fairland Police Department	Primary	NE		
Federal Bureau of Investigation	IO	CN		
Fletcher Fire Department	Primary	SW		
Fletcher Police Department	Primary	SW		
Flower Mound Fire Department	Primary	SW		
Ft. Sill Emergency Medical Services	IO	SW		
Geronimo Police Department	Primary	SW		
Geronimo Volunteer Fire Department	Primary	SW		
Glenpool Fire Department	IO	NE	Tulsa	
Glenpool Police Department	IO	NE	Tulsa	
Grady County Hospital ER	IO	SW		

Grady County Sheriff's Office	Primary	SW		
Green Country Fire Department	IO	NE	Tulsa	
Grove Emergency Medical Services	Primary	NE		
Grove Hospital	IO	NE		
Hall Park Police Department	Primary	CN		
Hillcrest Medical Center	IO	NE	Tulsa	
Hulen Volunteer Fire Department	Primary	SW		
Indiahoma Fire Department	Primary	SW		
Jenks Police Department	IO	NE	Tulsa	
Kellyville Fire Department	Primary	NE	Tulsa	
Kellyville Police Department	Primary	NE	Tulsa	
Keystone State Park Rangers	IO	NE	Tulsa	
Keystone Volunteer Fire Department	Primary	NE	Tulsa	
Kickapoo Tribal Police	Primary	CN		
Kiefer Fire Department	IO	NE	Tulsa	
Kiowa Emergency Medical Services	IO	SW		
Kirks Emergency Medial Services - 315 H Street	IO	SW		
Kirks Emergency Medical Services - 322 G STREET	IO	SW		
KJRH Channel 2	IO	NE	Tulsa	
KOTV Channel 6	IO	NE	Tulsa	
KRMG Radio	IO	NE	Tulsa	
KTUL Channel 8	IO	NE	Tulsa	
KVOO Radio	IO	NE	Tulsa	
Lake Thunderbird State Park Rangers	Primary	CN		
Lawton Emergency Medical Services	Primary	SW		
Lawton Fire Department	Primary	SW		
Lawton Medical Emergency Repsonse Center	IO	SW		
Lawton Police Department	Primary	SW		
Liberty Fire Department	IO	NE	Tulsa	
LifeFlight Air Ambulance Service	IO	NE	Tulsa	Yes
Limestone Fire Department	IO	NE	Tulsa	
Little Axe Fire Department	Primary	CN		
Mannford Police Department	IO	NE	Tulsa	
McLoud City Administration	Primary	CN		
McLoud Emergency Management	Primary	CN		
McLoud Fire Department	Primary	CN		
McLoud Police Department	Primary	CN		
Medicine Park Police Department	Primary	SW		
Medicine Park Volunteer Fire Department	Primary	SW		
MediFlight	IO	CN		
Meeker Fire Department	Primary	CN		
Meers Volunteer Fire Department	Primary	SW		
Memorial Hospital ER	IO	SW		
Mercy Health Center	IO	CN		
Metropolitan Tulsa Transit Authority	Primary	NE	Tulsa	Yes
Miami Emergency Management	Primary	NE		
Miami Emergency Medical Services	Primary	NE		
Miami Fire Department	Primary	NE		
Miami Hospital ER	IO	NE		
Miami Nation Tribal Police	Primary	NE		
Miami Police Department	Primary	NE		
Midwest City Fire Department	Primary	CN		

Midwest City Hospital	IO	CN		
Midwest City Police Department	Primary	CN		
Monkey Island Fire Department	Primary	NE		
Moore Emergency Management	Primary	CN		
Moore Emergency Medical Services	Primary	CN		
Moore Fire Department	Primary	CN		
Moore Medical Center / ER	IO	CN		
Moore Police Department	Primary	CN		
Mounds Fire Department	IO	NE	Tulsa	
Mustang Fire Department	Primary	CN		
National Weather Service Norman	IO	CN		
National Weather Service Tulsa	IO	NE	Tulsa	
NEO A&M Police	Primary	NE		
Nichols Hills Fire Department	Primary	CN		
Nichols Hills Police Department	Primary	CN		
Noble Emergency Medical Services	Primary	CN		
Noble Fire Department	Primary	CN		
Noble Police Department	Primary	CN		
Norman City Administration	Primary	CN		
Norman Emergency Management	Primary	CN		
Norman Emergency Medical Services	Primary	CN		
Norman EMSTAT	IO	CN		
Norman Fire Department	Primary	CN		
Norman Max Westheimer Airport	IO	CN		
Norman Police Department	Primary	CN		
Norman Public Works Department	Primary	CN		
Norman Regional Hospital	Primary	CN		
North Miami Police Department	Primary	NE		
Northwest Rogers Fire Department	IO	NE	Tulsa	
Oak Cliff Fire Department	Primary	CN		
Oak Grove Fire Department	Primary	NE	Tulsa	Yes
Oakhurst Fire Department	IO	NE	Tulsa	
OK Rapic Response Trailer - ADA	IO	SE		
OK Rapid Response Trailer - ALTUS	IO	SW		
OK Rapid Response Trailer - ARDMORE	IO	SE		
OK Rapid Response Trailer - BLACKWELL	IO	NE		
OK Rapid Response Trailer - BROKEN ARROW	IO	NE	Tulsa	
OK Rapid Response Trailer - CHICKASHA	IO	SW		
OK Rapid Response Trailer - CLAREMORE	IO	NE	Tulsa	
OK Rapid Response Trailer - CUSHING	IO	NE		
OK Rapid Response Trailer - DURANT	IO	SE		
OK Rapid Response Trailer - EDMOND	IO	CN		
OK Rapid Response Trailer - ENID	IO	NW		
OK Rapid Response Trailer - GUYMON	IO	NW		
OK Rapid Response Trailer - LAWTON	IO	SW		
OK Rapid Response Trailer - McALESTER	IO	SE		
OK Rapid Response Trailer - MOORE / NORMAN	IO	CN		
OK Rapid Response Trailer - MUSKOGEE	IO	NE		
OK Rapid Response Trailer - OKLAHOMA CITY	IO	CN		
OK Rapid Response Trailer - SAPULPA / SAND SPRINGS	IO	NE	Tulsa	
OK Rapid Response Trailer - SEMINOLE	IO	CN		
OK Rapid Response Trailer - SHAWNEE	IO	CN		

OK Rapid Response Trailer - STILLWATER	IO	NE		
OK Rapid Response Trailer - TAHLEQUAH/CHEROKEE COUNTY	IO	NE		
OK Rapid Response Trailer - TULSA	IO	NE	Tulsa	
OK Rapid Response Trailer - WEATHERFORD / CLINTON	IO	NW		
OK Rapid Response Trailer - WOODWARD	IO	NW		
Oklahoma Air National Guard	IO	NE	Tulsa	
Oklahoma Bureau of Narcotics	IO	CN		
Oklahoma City Dispatch Center	IO	CN		
Oklahoma City Emergency Management	IO	CN		
Oklahoma City Police Department	IO	CN		
Oklahoma County Fire District	IO	CN		
Oklahoma County Sheriff's Office	IO	CN		
Oklahoma Department of Corrections - Alva	Primary	NW		
Oklahoma Department of Corrections - Atoka	Primary	SE		
Oklahoma Department of Corrections - Carter County	Primary	SW		
Oklahoma Department of Corrections - Cleveland County	Primary	CN		
Oklahoma Department of Corrections - Comanche County	Primary	SW		
Oklahoma Department of Corrections - Delaware County	Primary	NE		
Oklahoma Department of Corrections - Enid	Primary	NW		
Oklahoma Department of Corrections - Ft. Supply	Primary	NW		
Oklahoma Department of Corrections - Grady County	Primary	SW		
Oklahoma Department of Corrections - Granite	Primary	SW		
Oklahoma Department of Corrections - Headquarters	Primary			
Oklahoma Department of Corrections - Helena	Primary			
Oklahoma Department of Corrections - Howard McLeod	Primary			
Oklahoma Department of Corrections - J Brannon	Primary	NE		
Oklahoma Department of Corrections - J Crabtree	Primary			
Oklahoma Department of Corrections - Lexington	Primary	CN		
Oklahoma Department of Corrections - Lilly	Primary			
Oklahoma Department of Corrections - Lincoln County	Primary	CN		
Oklahoma Department of Corrections - Mabel Bassett	Primary			
Oklahoma Department of Corrections - Mayes County	Primary	NE		
Oklahoma Department of Corrections - McAlester	Primary	SE		
Oklahoma Department of Corrections - Muskogee	Primary	NE		
Oklahoma Department of Corrections - Muskogee County	Primary	NE		
Oklahoma Department of Corrections - Oklahoma City	Primary	CN		
Oklahoma Department of Corrections - Pottawatomie County	Primary	CN		
Oklahoma Department of Corrections - Shawnee	Primary	CN		
Oklahoma Department of Transportation - Tulsa	IO	NE		
Oklahoma Heart Hospital	IO	CN		
Oklahoma Museum of Natural History	Primary	CN		
Oklahoma State Attorney General	IO	CN		
Oklahoma State Bureau of Investigation	IO	CN		
Oklahoma State Emergency Management Agency	IO	CN		
Oklahoma State Health Department	Primary	CN		
Oklahoma State Medical Examiners	IO	ALL		
Oklahoma State University - Tulsa	Primary	NE	Tulsa	Yes
Oklahoma State University Fire Training - Stillwater	IO	NE		
Oklahoma Turnpike Authority	Primary	ALL		
Oklahoma University Medical Center - Everett	IO	CN		
Oklahoma University Medical Center - Presbyterian	IO	CN		
Oklhoma University Medical Center - Childrens	IO	CN		

Osage Hills Fire Department	IO	NE	Tulsa	
Ottawa County Sheriff's Office	Primary	NE		
Owasso Emergency Management	Primary	NE	Tulsa	
Owasso Emergency Medical Services	Primary	NE	Tulsa	
Owasso Fire Department	Primary	NE	Tulsa	
Owasso Police Department	Primary	NE	Tulsa	
Owasso Public Works Department	Primary	NE	Tulsa	
Paradise Valley Fire Department	Primary	SW		
Peoria Fire Department	Primary	NE		
Picher Emergency Medical Services	Primary	NE		
Picher Fire Department	Primary	NE		
Picher Police Department	Primary	NE		
Porter Hill Volunteer Fire Department	Primary	SW		
Pottawatomie County District Attorney	IO	CN		
Pottawatomie County Health Department	IO	CN		
Pottawatomie County Public Safety Center (Jail)	Primary	CN		
Pottawatomie County Sheriff's Office	Primary	CN		
Pottawatomie Tribal Police	Primary	CN		
Purcell Fire Department	Primary	CN		
Quapaw Fire Department	Primary	NE		
Quapaw Police Department	Primary	NE		
REACT Ambulance Service - Shawnee	Primary	CN		
Remo Emergency Medical Services	Primary	NE		
Reynolds Hospital ER	IO	SW		
Rock Fire Department	IO	NE	Tulsa	
Rolling Hills Fire Department	IO	NE	Tulsa	
Sac and Fox Tribal Police	Primary	CN		
Saint Anthony Hospital	IO	CN		
Sand Springs Fire Department	Primary	NE	Tulsa	Yes
Sand Springs Leader Newspaper	Primary	NE	Tulsa	Yes
Sand Springs Police Department	Primary	NE	Tulsa	Yes
Sand Springs Police Department SOT	Primary	NE	Tulsa	Yes
Sand Springs Public Works Department	Primary	NE	Tulsa	Yes
Sapulpa Fire Department	Primary	NE	Tulsa	Yes
Sapulpa Police Department	Primary	NE	Tulsa	Yes
Shawnee City Administration	Primary	CN		
Shawnee District Attorney	Primary	CN		
Shawnee Emergency Management	Primary	CN		
Shawnee Expo Center	Primary	CN		
Shawnee Fire Department	Primary	CN		
Shawnee Housing Department	Primary	CN		
Shawnee Lake Patrol	Primary	CN		
Shawnee Park Department	Primary	CN		
Shawnee Police Department	Primary	CN		
Shawnee Street Department	Primary	CN		
Shawnee Traffic Department	Primary	CN		
Shawnee Utility Department	Primary	CN		
Shawnee Waste Water Treatment	Primary	CN		
Shawnee Water Department	Primary	CN		
Sinclair Oil Refinery	IO	NE	Tulsa	
Slaughterville Fire Department	Primary	CN		
Southcrest Hospital	IO	NE	Tulsa	

Southwest Medical Center	IO	CN		
Southwest Medical Center ER	IO	SW		
Southwest Medical Emergency Repsonse Center	IO	SW		
Sperry Fire Department	Primary	NE	Tulsa	Yes
Sperry Police Department	Primary	NE	Tulsa	Yes
St. Francis -Broken Arrow	IO	NE	Tulsa	
St. Francis Heart Hospital	IO	NE	Tulsa	
St. Francis Hospital	IO	NE	Tulsa	
St. John's Hospital - Owasso	IO	NE	Tulsa	
St. John's Medical Center	IO	NE	Tulsa	
Stephens County Hospital ER	IO	SW		
Sterling Police Department	Primary	SW		
Stillwater Police Dept	IO	CN		
Stone Bluff Volunteer Fire Department	IO	NE	Tulsa	
Sun Oil Refinery	IO	NE	Tulsa	
Tecumseh Emergency Management Department	Primary	CN		
Tecumseh Fire Department	Primary	CN		
Tecumseh Police Department	Primary	CN		
The Village Fire Department	Primary	CN		
The Village Police Department	Primary	CN		
Tulsa Airport Authority	Primary	NE	Tulsa	
Tulsa Animal Control	Primary	NE	Tulsa	
Tulsa Area Emergency Management Agency	Primary	NE	Tulsa	
Tulsa City/County Health Department	Primary	NE	Tulsa	Yes
Tulsa Community College	Primary	NE	Tulsa	Yes
Tulsa County District Attorney	IO	NE	Tulsa	Yes
Tulsa County Engineering Department	Primary	NE	Tulsa	Yes
Tulsa County Highway Department	Primary	NE	Tulsa	Yes
Tulsa County Jail	Primary	NE	Tulsa	Yes
Tulsa County Sheriff's Office	Primary	NE	Tulsa	Yes
Tulsa County Sheriff's Office SID	Primary	NE	Tulsa	Yes
Tulsa County Sheriff's Office SOT	Primary	NE	Tulsa	Yes
Tulsa Department of Public Works - Facilities Maintenance	Primary	NE	Tulsa	
Tulsa Department of Public Works - Field Customer Service	Primary	NE	Tulsa	
Tulsa Department of Public Works - Field Engineering	Primary	NE	Tulsa	
Tulsa Department of Public Works - Inspections	Primary	NE	Tulsa	
Tulsa Department of Public Works - Inventory Control	Primary	NE	Tulsa	
Tulsa Department of Public Works - SCADA - Distribution Systems	Primary	NE	Tulsa	
Tulsa Department of Public Works - SCADA - Underground Collections	Primary	NE	Tulsa	
Tulsa Department of Public Works - Security	Primary	NE	Tulsa	
Tulsa Department of Public Works - Street Maintenance	Primary	NE	Tulsa	
Tulsa Department of Public Works - Surface Drainage	Primary	NE	Tulsa	
Tulsa Department of Public Works - Underground Collections	Primary	NE	Tulsa	
Tulsa Department of Public Works - Vegetative Maintenance	Primary	NE	Tulsa	
Tulsa Department of Public Works - Water Distribution	Primary	NE	Tulsa	
Tulsa Department of Public Works - Water Maintenance	Primary	NE	Tulsa	
Tulsa Department of Public Works - Environmental Operations	Primary	NE	Tulsa	
Tulsa Department of Public Works - Quality Assurance	Primary	NE	Tulsa	
Tulsa Department of Public Works - Raw Water Supply	Primary	NE	Tulsa	
Tulsa Department of Public Works - Refuse	Primary	NE	Tulsa	
Tulsa Equipment Management Department	Primary	NE	Tulsa	
Tulsa Fire Department	Primary	NE	Tulsa	

Tulsa Gilcrease Museum	Primary	NE	Tulsa
Tulsa Municipal Cpurts	IO	NE	Tulsa
Tulsa Parks Department	Primary	NE	Tulsa
Tulsa Performing Arts Center	Primary	NE	Tulsa
Tulsa Police Department	Primary	NE	Tulsa
Tulsa Police Department Air Support	Primary	NE	Tulsa
Tulsa Police Department Bomb Squad	Primary	NE	Tulsa
Tulsa Police Department Reserves	Primary	NE	Tulsa
Tulsa Police Department SID	Primary	NE	Tulsa
Tulsa Police Department SOT	Primary	NE	Tulsa
Tulsa Public Events Department	Primary	NE	Tulsa
Tulsa Public Safety Response Center	Primary	NE	Tulsa
Tulsa Public Schools Security	IO	NE	Tulsa
Tulsa Radio Services	Primary	NE	Tulsa
Tulsa Regional Medical Center	IO	NE	Tulsa
Tulsa River Parks Authority	Primary	NE	Tulsa
Tulsa World Newspaper	Primary	NE	Tulsa
Tulsa Zoo	Primary	NE	Tulsa
Turley Fire Department	IO	NE	Tulsa
Tuttle Police Department	IO	CN	
Twin Bridges State Park Rangers	Primary	NE	
Twin Hills Fire Department	IO	NE	Tulsa
United States Attorney General	IO	CN	
United States Marshal	IO	CN	
United States Secret Service	IO	CN	
University of Oklahoma Parking and Transportation	Primary	CN	
University of Oklahoma Police	Primary	CN	
USHPS Indian Hospital	IO	SW	
Vera Fire Department	IO	NE	Tulsa
Veteran's Hosptial	IO	CN	
Vinita Emergency Management	Primary	NE	
Vinita Emergency Medical Services	Primary	NE	
Vinita Fire Department	Primary	NE	
Vinita Hospital ER	Primary	NE	
Vinita Police Department	Primary	NE	
Wichita Mountain Estates	Primary	SW	
Wichita Mountain Estates Fire Department	Primary	SW	
Wildlife Fire Department	Primary	SW	
Wildlife Lake Ellsworth	Primary	SW	
Wildlife Refuge	Primary	SW	
Wyandotte Fire Department	Primary	NE	
Wyandotte Police Department	Primary	NE	

City of Tulsa / State of Oklahoma SmartZone System
Trunked System ID SZ092C
Default Network ID: 2C0

ITEM	SITE No.	NAME	LOCATION / COUNTY	LATITUDE (DMS)			LONGITUDE (DMS)			LATITUDE (DD)	LONGITUDE (DD)	SITE TYPE	SHELTER SIZE	BU POWER	NUMBER of CHANNELS	TOWER OWNER	FCC ASR	GROUND ELEV (AMSL)	TOWER HEIGHT (AGL)	TX ANT HEIGHT	TX ANT PATTERN	TX ANT GAIN	RX ANT HEIGHT	RX ANT PATTERN	RX ANT GAIN	ANT. AZIMUTH	CHAN	CONNECT TONE	CALL SIGN	821 Y/N
1	1	City of Tulsa Simulcast	Downtown Tul							0.0000	0.0000	6809 Siml	Building top	D Gen	28	Williams	n/a											0	KNJH431	N
2	a	Downtown - Williams Ctr	Downtown Tul	36	9	18.9	95	59	27	36.1553	95.9908	Quantar and Qu	Building top	D Gen	28	Williams	n/a	710	645	645	omni	10	645	omni	10			0	KNJH431	N
3	b	Tulsa 61st + Sheridan	South Tulsa	36	4	29.9	95	54	1.9	36.0750	95.9005	Quantar and Quantro		D Gen	28	City of Tulsa	1047282	835	350	340	omni	10	320	omni	12			0	KNJH431	N
4	2	Bristow	Creek	35	51	4.8	96	22	39.2	35.8513	96.3776	Quantro IR	12 x 12	LP Gen	5	OK DPS	1007483	850	480	480	omni	12	460	omni	12		220	0	WPIP618	N
5	3	Muskogee	Muskogee	35	42	46	95	15	8	35.7128	95.2522	Quantro IR		none	5	Musk Comm	1047054	810	310	310	omni	10	270	omni	10		210	4	WPIP618	N
6	4	Carney	Lincoln	35	48	37	97	3	53	35.8103	97.0647	Quantro IR	8 x 12	none	5	OK DPS	1204651	1118	430	430	omni	12	410	omni	12		229	0	WPIP618	N
7	5	City of Shawnee	Pottawatomie	35	19	45.3	96	55	36.1	35.3293	96.9267	6809 Quantar	Eqp Closet	unknown	7	City Shawnee	1226992	1055	160	170	omni	9	160	omni	9		219,230	1	WNWV280	N
8	6	Pink	Bethel Acres	35	17	12	97	3	48	35.2867	97.0633	6809 Micor	8 x 12	none	6	OSRHE	1200970	1214	350	350	omni	10	330	omni	10		211	0	KNBU457	N
9	7	Lexington	SE Cleveland	35	0	52	97	11	16	35.0144	97.1878	6809 Micor	8 x 12	none	6	OK DPS	1065490	1166	440	440	omni	10	420	omni	10		218	0	KNBU457	N
10	8	OKC Simulcast	Oklahoma City							0.0000	0.0000	MTC Siml		D Gen	17	OK DPS												4	KNBU457	Y
11	a	OKC DPS	Oklahoma City	35	30	22.8	97	28	21	35.5063	97.4725	MTC Quantar		D Gen	17	OK DPS	1007481		400	400	Omni	10	380	omni	10			4	KNBU457	Y
12	b	Moore N. Water Tank	Moore	35	20	57.6	97	27	50.4	35.3493	97.4640	MTC Quantar	12 x 34	LP Gen	17	City Moore			170	170	Omni	10	170	omni	10			4	KNBU457	Y
13	c	Edmond UCO	Edmond	35	39	37	97	28	12	35.6603	97.4700	MTC Quantar		none	17	UCO FM	1012602				220 degree	14		omni	12	270		4	WQHG780	Y
14	d	Edmond Mid Dan	Edmond	35	40	7	97	23	14.5	35.6686	97.3874	MTC Quantar		LP Gen	17	Global	1065472		360		220 degree	14		omni	12	90		4	WQHG780	Y
15	e	I-240 and Anderson Rd.	SE OKC	35	23	44.5	97	19	17	35.3957	97.3214	MTC Quantar	12 x 26	LP Gen	17	City of OKC	1235587		240	170	220 degree	13	240	220 degree	13	0		4	WQHG780	Y
16	f	NW Expressway + Kilpatri	NW OKC							0.0000	0.0000	MTC Quantar			17	City of OKC												4		Y
17	g	OKC Airport	SW OKC							0.0000	0.0000	MTC Quantar			17	FAA												4		Y
18	9	Geary	W Canadian	35	32	43	98	14	13	35.5453	98.2369	6809 Micor		none	5	OSRHE		1610	160	160	220 degree	13	170	220 degree	13	90	220	0	KNBU457	N
19	10	Pryor	Mayes	36	19	13	95	24	43.8	36.3203	95.4122	Quantro IR	12 x 26	LP Gen	5	GRDA	1009699		300	300	omni	10	280	omni	10		229	4	WQCQ878	N
20	11	Guthrie	Logan	35	55	31.4	97	22	46.2	35.9254	97.3795	6809 Micor	8 x 12	LP Gen	6	Spectrasite	1055475		400	360	omni	10	340	omni	10		210	0		N
21	12	Stillwater	Payne	36	3	44.7	97	4	28.7	36.0624	97.0746	Quantar IR	12 x 26	LP Gen	5	GRDA	1009703		300	300	220 degree	13	280	220 degree	13	10	209	0	WQDS599	Y
22	13	Preston	Okmulgee	35	43	29	95	59	17	35.7247	95.9881	Quantar IR		LP Gen	6	Wynn Comm	1202657	990	300	300	omni	10	280	omni	10		218	4	WPiP618	N
23	14	RESERVED Prue	Osage							0.0000	0.0000																			
24	15	Big Cabin	Craig	36	33	56.9	95	17	13.9	36.5658	95.2872	Quantar IR	12 x 16	LP Gen	5	Muskogee Comm	1040125		280	280	omni	12	250	omni	12			4	WQEN879	Y
25	16	Jay - Eucha	Delaware	36	21	48.5	94	49	7.3	36.3635	94.8187	IR		LP Gen	5	City of Tulsa	1047281		400	400	omni	10	380	omni	10			4		N
26	17	Miami	Ottawa	36	53	2.3	94	48	3.5	36.8840	94.8010	Quantar IR	12 x 26	LP Gen	6	City of Miami	1206503		640	500	omni	12	480	omni	12			1	WQGF211	N
27	18	Chickasha	Grady	35	2	53	97	53	25	35.0481	97.8903	Quantro IR	12 x 26	LP Gen	6	Capitol Tower	1011123		480	480	omni	12	460	omni	12			0	WQFR618	N
28	19	Lawton Simulcast	Comanche	34	36	25.5	98	16	27.2	34.6071	98.2742	MTC Siml	12 x 34	LP Gen	8	Lawton Comm	1011804	1300	260	260								1	WQFN465	Y
29	a	Lawton East	Comanche	36	36	25.5	98	16	27.2	36.6071	98.2742	MTC Quantar	12 x 34	LP Gen	8	Lawton Comm	1011804	1300	260	260	omni	12	230	omni	12			1	WQFN465	Y
30	b	Lawton PD	Comanche	34	36	26.7	98	23	41	34.6074	98.3947	MTC Quantar	12 x 26	D Gen	8	City of Lawton	1202692		180	180	omni	10	160	omni	10			1	WQEN871	Y
31	c	Lawton West	Comanche	34	38	12.3	98	30	28.2	34.6368	98.5078	MTC Quantar	12 x 26	D Gen	8	Lawton Comm	1229460	1290	500	500	omni	10	480	omni	10			1	WQFN465	Y
32	20	Ardmore / Arbuckle Mtn.	Murray	34	25	4	97	9	0	34.4178	97.1500	Quantar IR	12 x 26	LP Gen	5	TBD												1		N
33	21	RESERVED Velma	Stephens							0.0000	0.0000					OSRHE														
34	22	RESERVED Enid	Garfield							0.0000	0.0000																			
35	23	RESERVED Ponca City	Kay							0.0000	0.0000																			
36	24	RESERVED Ochelata	Washington							0.0000	0.0000																			
37	25	Norman IR	OU Campus	35	12	38.4	97	26	25.5	35.2107	97.4404	Quantro IR	Building top	OU Gen	5	OU			180	180	omni	10	180	omni	10		240	4		N
38	26	OKC IR (decomissioned)	OKC	35	30	22.8	97	28	21	35.5063	97.4725	Quantro IR		D Gen	6	OK DPS			400	400	omni	10	380	omni	10			0		
39	27	Tulsa SOW - ECHO 1	Tulsa							0.0000	0.0000	Quantro IR		D Gen	10	City of Tulsa			100	100	omni	10	100	omni	10			0		Y
40	28	Fletcher	Comanche	34	49	26.1	98	12	42.2	34.8239	98.2117	Quantar IR	12 x 20	LP Gen	5	American	1064076		400	315	omni	10	315	omni	10			1	WQEN873	Y
41	29	Baker Peak - Wichita Mtn.	Comanche	34	48	52.4	98	48	10	34.8146	98.8028	Quantar IR	12 x 20	D Gen	5	FBI / NWLR	n/a		20	20	omni	8	5	omni	8			1	WQFN467	N
42	30	Walters	Cotton	94	21	28.8	98	19	15.6	94.3580	98.3210	Quantar IR	12 x 20	LP Gen	5	Cotton Electric	1009382				220 degree	13		220 degree	13	225		1	WQFN466	N
43	31	Coweta	Wagoner	35	59	14.9	95	39	16.4	35.9875	95.6546	Quantar IR	12 x 26	LP Gen	6	US Cellular	1010803		280	250	omni	10	230	omni	10			0	WQEN870	Y
44	32	Kellyville	Creek	35	58	14.1	96	12	17.4	35.9706	96.2048	Quantar IR	12 x 26	LP Gen	7	OneOK ONG	1025988				omni	10		omni	10			0	WQEN877	Y

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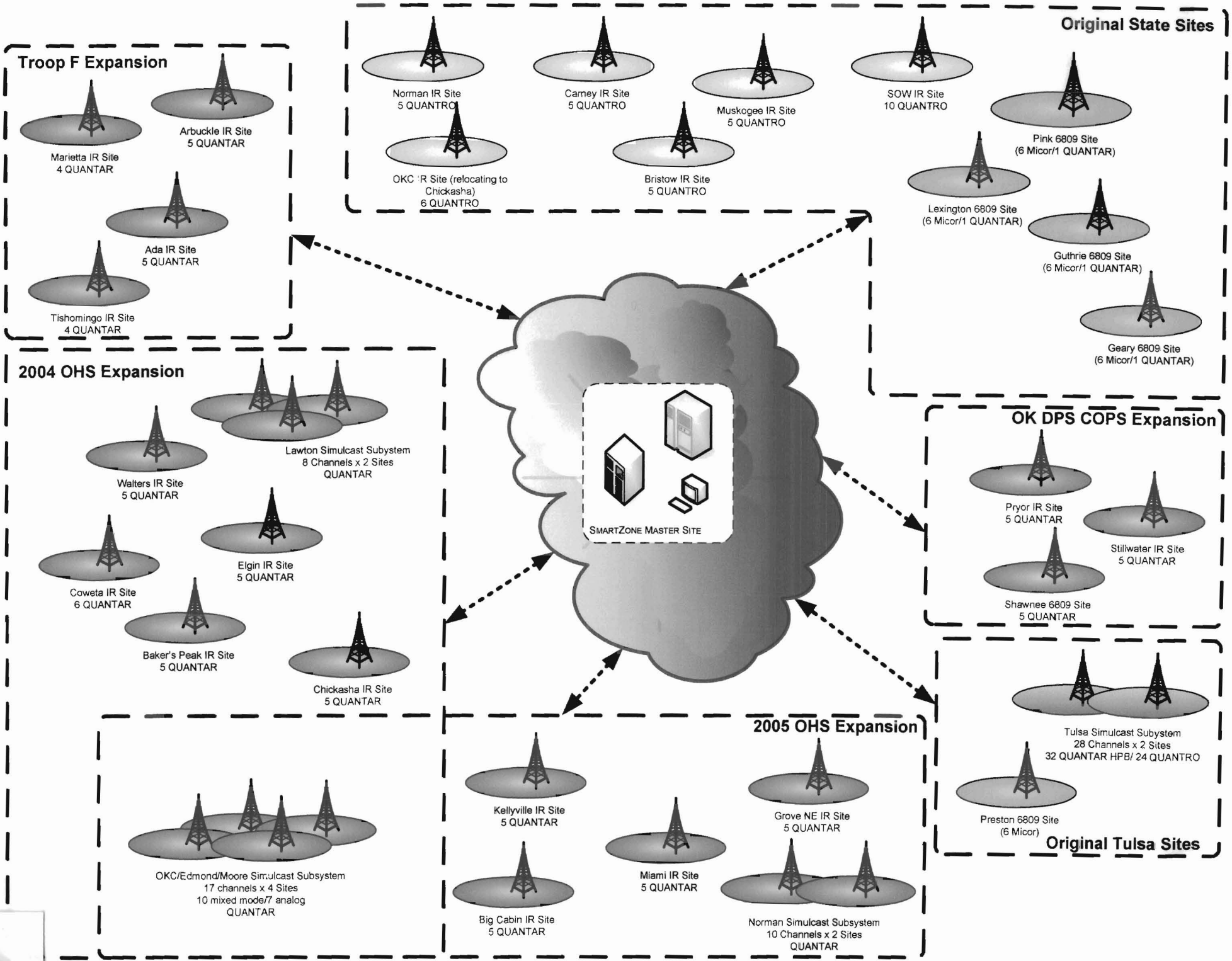
ITEM	SITE No.	NAME	LOCATION / COUNTY	LATITUDE (DMS)			LONGITUDE (DMS)			LATITUDE (DD)	LONGITUDE (DD)	SITE TYPE	SHELTER SIZE	BU POWER	NUMBER of CHANNELS	TOWER OWNER	FCC ASR	GROUND ELEV (AMSL)	TOWER HEIGHT (AGL)	TX ANT HEIGHT	TX ANT PATTERN	TX ANT GAIN	RX ANT HEIGHT	RX ANT PATTERN	RX ANT GAIN	ANT. AZIMUTH	CHAN	CONNECT TONE	CALL SIGN	821 Y/N
45	33	Grove NE	Ottawa	36	41	29.3	94	42	10.1	36.6915	94.7028	Quantar IR	12 x 26	LP Gen	5	GRDA			180	180	220 degree	13	160	220 degree	13	210		1	WQEN878	Y
46	34	Ada SW	Pontotoc	34	40	59	96	45	43.7	34.6831	96.7621	Quantar IR	12 x 26	LP Gen	5	American	1018511				omni	12		omni	12			4		N
47	35	Tishomingo	Johnston	34	15	44	96	42	37	34.2622	96.7103	Quantar IR	12 x 20	LP Gen	4	American	1003721		400	380	omni	10	360	omni	10			1		N
48	36	Marietta	Love	33	55	18.1	97	5	18	33.9217	97.0883	Quantar IR	12 x 20	LP Gen	4	TBD			420	420	omni	10	400	omni	10			1	WQFR887	N
49	37	Owasso	Tulsa	36	17	28.2	95	50	18.5	36.2912	95.8385	Quantar IR	12 x 26	D Gen	7	Global Twr	1218556		260	260	omni	8	240	omni	8			4	WPPA313	Y
50	38	reserved								0.0000	0.0000																			
51	39	reserved								0.0000	0.0000																			
52	40	Norman Simulcast	Cleveland							0.0000	0.0000	MTC Siml	EOC		14	City of Norman												4		Y
53	40a	Sarkey Center	OU Campus	35	12	38.4	97	26	25.5	35.2107	97.4404	MTC Quantar	Building top	OU Gen	14	OU												4		Y
54	40b	Norman East	T-Bird Lake	35	15	26.5	97	17	7.5	35.2574	97.2854	MTC Quantar		LP Gen	14	City of Norman	1212795		280									4		Y
55	41	Edmond Simulcast Bu	Edmond									6809 Quantar	EOC	unknown	7	City of Edmond												4		Y
56	42	Army Ammo Depot	Pittsburg	34	50	32	95	55	46	34.8422	95.9294	MTC Quantar		unknown	5	Ammo Depot			180										WQFZ462	N
57	43	reserved - Lucien	Garfield	36	14	21	97	28	45	36.2392	97.4792					OSRHE	1209820	1270	450											
58	44	reserved - Silver City	Creek													GRDA														

Revised: 12-07-2007

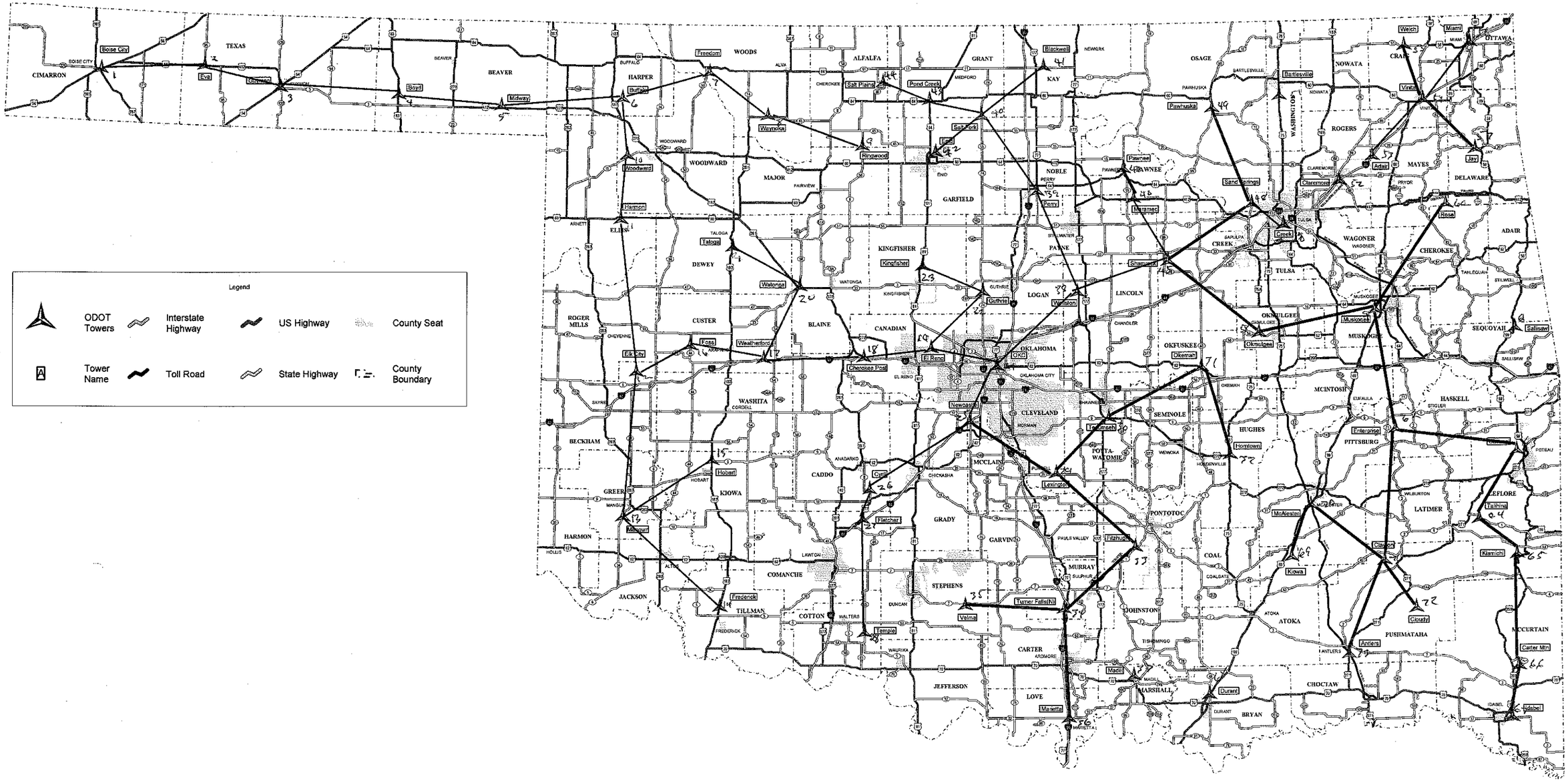
NOTES	CH 1	CH 2	CH 3	CH 4	CH 5	CH 6	CH 7	CH 8	CH 9	CH 10	CH 11	CH 12	CH 13	CH 14	CH 15	CH 16	CH 17	CH 18	CH 19	CH 20	CH 21	CH 22	CH 23	CH 24	CH 25	CH 26	CH 27	CH 28	CH 29	CH 30
	860.9375	859.9375	858.9375	857.9375	856.9375	860.7625	859.7625	858.7625	857.7625	856.7625	860.9625	859.9625	858.9625	857.9625	856.9625	860.9875	859.9875	858.9875	857.9875	856.9875	860.4625	859.4625	858.4625	857.4625	856.4625	860.7375	859.7375	858.7375	857.7375	856.7375
	860.9375	859.9375	858.9375	857.9375	856.9375	860.7625	859.7625	858.7625	857.7625	856.7625	860.9625	859.9625	858.9625	857.9625	856.9625	860.9875	859.9875	858.9875	857.9875	856.9875	860.4625	859.4625	858.4625	857.4625	856.4625	860.7375	859.7375	858.7375	857.7375	856.7375
	860.9375	859.9375	858.9375	857.9375	856.9375	860.7625	859.7625	858.7625	857.7625	856.7625	860.9625	859.9625	858.9625	857.9625	856.9625	860.9875	859.9875	858.9875	857.9875	856.9875	860.4625	859.4625	858.4625	857.4625	856.4625	860.7375	859.7375	858.7375	857.7375	856.7375
	860.4875	859.4875	858.4875	857.4875	856.4875																									
	860.2375	859.2375	858.2375	857.2375	856.2375																									
	860.7125	859.7125	858.7125	857.7125	856.7125																									
	860.4625	859.4625	858.4625	857.4625	856.4625	856.7375	857.7375																							
	860.2625	860.2625	859.2625	858.2625	857.2625	856.2625																								
	860.4375	860.4375	859.4375	858.4375	857.4375	856.4375																								
	860.9375	859.9375	858.9375	857.9375	856.9375	868.7250	868.3750	867.7500	866.9250	867.4000	868.5500	868.1750	866.5375	867.1625	866.2375	866.7625	866.0375	868.9875												
	860.9375	859.9375	858.9375	857.9375	856.9375	868.7250	868.3750	867.7500	866.9250	867.4000	868.5500	868.1750	866.5375	867.1625	866.2375	866.7625	866.0375	868.9875												
	860.9375	859.9375	858.9375	857.9375	856.9375	868.7250	868.3750	867.7500	866.9250	867.4000	868.5500	868.1750	866.5375	867.1625	866.2375	866.7625	866.0375	868.9875												
	860.9375	859.9375	858.9375	857.9375	856.9375	868.7250	868.3750	867.7500	866.9250	867.4000	868.5500	868.1750	866.5375	867.1625	866.2375	866.7625	866.0375	868.9875												
	860.9375	859.9375	858.9375	857.9375	856.9375	868.7250	868.3750	867.7500	866.9250	867.4000	868.5500	868.1750	866.5375	867.1625	866.2375	866.7625	866.0375	868.9875												
	860.9375	859.9375	858.9375	857.9375	856.9375	868.7250	868.3750	867.7500	866.9250	867.4000	868.5500	868.1750	866.5375	867.1625	866.2375	866.7625	866.0375	868.9875												
	860.9375	859.9375	858.9375	857.9375	856.9375	868.7250	868.3750	867.7500	866.9250	867.4000	868.5500	868.1750	866.5375	867.1625	866.2375	866.7625	866.0375	868.9875												
	860.4875	860.4875	859.4875	858.4875	857.4875	856.4875																								
	860.7125	859.7125	858.7125	857.7125	856.7125																									
	860.2375	860.2375	859.2375	858.2375	857.2375	856.2375																								
	867.5875	867.0875	868.7750	868.2625	866.4500																									
	860.4375	859.4375	858.4375	857.4375	856.4375	855.4625																								
	867.0875	867.5875	868.7125	868.2250	866.5500																									
	860.2125	859.2125	858.2125	857.2125	856.2125																									
	860.4375	859.4375	858.4375	857.4375	856.4375	855.4625																								
	860.2125	859.2125	858.2125	857.2125	856.2125	tbd																								
	860.7125	859.7125	858.7125	857.7125	856.7125	868.5125	868.2875	866.4875																						
	860.7125	859.7125	858.7125	857.7125	856.7125	868.5125	868.2875	866.4875																						
	860.7125	859.7125	858.7125	857.7125	856.7125	868.5125	868.2875	866.4875																						
	860.7125	859.7125	858.7125	857.7125	856.7125	868.5125	868.2875	866.4875																						
	860.4875	859.4875	858.4875	857.4875	856.4875																									
	860.9875	859.9875	858.9875	857.9875	856.9875																									
	867.7125	867.5875	868.9500	868.6250	868.2125	867.9375	867.3500	867.3125	867.0500	866.8000																				
	867.5875	867.0875	868.7500	868.2375	866.1750																									
	860.2625	859.2625	858.2625	857.2625	856.2625																									
	860.7375	859.7375	858.7375	857.7375	856.7375																									
	866.9250	867.7500	868.6750	866.5750	866.3000	866.0500																								
	867.7125	867.1625	868.9625	868.4875	866.8875	866.5375	866.1750																							

Revised: 12-07-2007

NOTES	CH 1	CH 2	CH 3	CH 4	CH 5	CH 6	CH 7	CH 8	CH 9	CH 10	CH 11	CH 12	CH 13	CH 14	CH 15	CH 16	CH 17	CH 18	CH 19	CH 20	CH 21	CH 22	CH 23	CH 24	CH 25	CH 26	CH 27	CH 28	CH 29	CH 30
	867.1625	867.7125	868.3375	866.4500	866.2000																									
	860.2375	859.2375	858.2375	857.2375	856.2375																									
	860.9375	859.9375	858.9375	857.9375	856.9375																									
	860.7625	859.7625	858.7625	857.7625	856.7625																									
	868.8875	868.3875	867.8875	866.9625	866.4375	867.4250	~~868.1875~~	868.6375																						
	860.9625	860.7625	859.9625	859.7625	858.9625	858.7625	857.9625	857.7625	856.9625	856.7625	868.9000	866.3125	855.2125	854.7875																
	860.9625	860.7625	859.9625	859.7625	858.9625	858.7625	857.9625	857.7625	856.9625	856.7625	868.9000	866.3125	855.2125	854.7875																
	860.9625	860.7625	859.9625	859.7625	858.9625	858.7625	857.9625	857.7625	856.9625	856.7625	868.9000	866.3125	855.2125	854.7875																
Edmond prime - EOC	860.9375	859.9375	858.9375	857.9375	856.9375	868.7250	868.3750																							
near Savanna	860.7125	859.7125	858.7125	857.7125	856.7125																									
alternate Pioneer Telephone Mannford																														


Original State Sites
Norman IR Site
5 QUANTRO
Carney IR Site
5 QUANTRO
Muskogee IR Site
5 QUANTRO
SOW IR Site
10 QUANTRO
Pink 6809 Site
(6 Micor/1 QUANTAR)
OKC IR Site (relocating to Chickasha)
6 QUANTRO
Bristow IR Site
5 QUANTRO
Lexington 6809 Site
(6 Micor/1 QUANTAR)
Guthrie 6809 Site
(6 Micor/1 QUANTAR)
Geary 6809 Site
(6 Micor/1 QUANTAR)
Troop F Expansion
Marietta IR Site
4 QUANTAR
Arbuckle IR Site
5 QUANTAR
Ada IR Site
5 QUANTAR
Tishomingo IR Site
4 QUANTAR
SMARTZONE MASTER SITE
2004 OHS Expansion
Lawton Simulcast Subystem
8 Channels x 2 Sites
QUANTAR
Walters IR Site
5 QUANTAR
Elgin IR Site
5 QUANTAR
Coweta IR Site
6 QUANTAR
Baker's Peak IR Site
5 QUANTAR
Chickasha IR Site
5 QUANTAR
OK DPS COPS Expansion
Pryor IR Site
5 QUANTAR
Stillwater IR Site
5 QUANTAR
Shawnee 6809 Site
5 QUANTAR
Tulsa Simulcast Subystem
28 Channels x 2 Sites
32 QUANTAR HPB/ 24 QUANTRO
Preston 6809 Site
(6 Micor)
Original Tulsa Sites
OKC/Edmond/Moore Simulcast Subsystem
17 channels x 4 Sites
10 mixed mode/7 analog
QUANTAR
2005 OHS Expansion
Kellyville IR Site
5 QUANTAR
Grove NE IR Site
5 QUANTAR
Miami IR Site
5 QUANTAR
Big Cabin IR Site
5 QUANTAR
Norman Simulcast Subsystem
10 Channels x 2 Sites
QUANTAR

APPENDIX D – ODOT SYSTEM DOCUMENTATION



COMMUNICATION TOWER LOCATIONS

OKLAHOMA DEPARTMENT OF TRANSPORTATION
PLANNING & RESEARCH DIVISION
GIS MANAGEMENT BRANCH
200 N.E. 21ST. STREET
OKLAHOMA CITY, OKLAHOMA 73105

N
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February 06, 2007
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Department of Transportation Sites

Region / City	Lat	Lon	AGL [ft]
1 Enterprise	35-10-59.6 N	95-20-19.0 W	150
1 Muskogee	35-42-41.7 N	95-26-00.4 W	190
1 Okmulgee	35-37-37.3 N	96-03-40.0 W	195
1 Rose	36-10-04.0 N	95-01-36.0 W	85
1 Sallisaw	35-36-43.3 N	94-40-02.1 W	150
1 Tahlequah	35-51-08.5 N	94-57-51.1 W	150
2 Antlers	34-11-43.3 N	95-37-14.4 W	110
2 Carter Mtn.	34-07-13.3 N	94-42-23.5 W	90
2 Cavanal	35-04-14.4 N	94-40-45.4 W	150
2 Clayton	34-36-07.9 N	95-24-54.4 W	100
2 Cloudy	34-23-23.5 N	95-14-58.6 W	150
2 Durant	34-01-41.4 N	96-22-24.6 W	150
2 Idabel	33-53-38.0 N	94-45-00.0 W	150
2 Kiamichi	34-36-48.8 N	94-41-42.8 W	150
2 Kiowa	34-37-47.3 N	95-55-07.0 W	150
2 Madill	34-07-01.0 N	96-46-34.7 W	70
2 McAlester	34-51-20.3 N	95-48-31.0 W	150
2 Talihina	34-46-28.6 N	94-53-46.9 W	150
3 Fitzhugh	34-41-05.1 N	96-45-37.6 W	150
3 Horntown	35-05-08.2 N	96-14-26.5 W	70
3 Lexington	35-00-50.9 N	97-11-16.1 W	150
3 Norman	35-11-57.2 N	97-29-02.1 W	150
3 Okemah	35-28-28.6 N	96-23-21.4 W	150
3 Tecumseh	35-15-28.4 N	96-53-50.7 W	190
3 Wellston	35-40-45.0 N	97-03-17.0 W	150
4 Blackwell	36-48-39.0 N	97-14-25.5 W	120
4 Carney	35-48-46.0 N	97-03-50.0 W	250
4 El Reno	35-34-07.0 N	97-52-04.0 W	150
4 Enid	36-26-02.0 N	97-50-35.0 W	100
4 Guthrie	35-49-01.0 N	97-35-01.8 W	100
4 Kingfisher	35-55-54.0 N	97-54-54.7 W	190
4 OKC	35-29-20.0 N	97-30-28.0 W	150
4 Perry	36-15-36.0 N	97-16-53.0 W	200
4 Pond Creek	36-39-56.5 N	97-52-33.2 W	70
4 Salt Fork	36-35-35.5 N	97-35-11.7 W	120

5 Cherokee Post	35-31-44.8 N	98-14-08.7 W	200
5 Elk City	35-27-34.0 N	99-28-46.1 W	300
5 Foss	35-34-31.0 N	99-11-15.0 W	220
5 Frederick	34-25-27.9 N	99-00-27.3 W	150
5 Hobart	35-04-21.5 N	99-03-36.4 W	120
5 Mangum	34-49-08.0 N	99-32-26.0 W	300
5 Taloga	36-00-48.7 N	98-57-31.7 W	190
5 Watonga	35-50-30.6 N	98-35-19.9 W	150
5 Weatherford	35-31-18.6 N	98-47-06.1 W	160
6 Boise City	36-43-29.0 N	102-28-47.0 W	300
6 Boyd	36-39-32.0 N	100-49-29.0 W	300
6 Bufallo	36-49-49.0 N	99-38-33.0 W	300
6 Buffalo New	36-39-57.2 N	99-38-29.9 W	300
6 Eva	36-45-35.0 N	101-54-15.0 W	300
6 Freedom	36-47-01.0 N	99-05-43.0 W	300
6 Guymon	36-40-28.0 N	101-28-47.0 W	200
6 Harmon	36-07-51.5 N	99-34-44.7 W	300
6 Ringwood	36-27-45.7 N	98-14-53.6 W	110
6 Salt Plains	36-44-34.9 N	98-07-59.0 W	130
6 Slapout	36-37-13.0 N	100-15-14.9 W	350
6 Waynoka	36-35-43.6 N	98-46-22.5 W	160
6 Woodward	36-24-51.7 N	99-32-52.8 W	150
7 Chickasha	35-05-06.2 N	97-53-16.8 W	100
7 Cyril	34-56-50.2 N	98-12-06.2 W	150
7 Fletcher	34-48-53.0 N	98-14-24.0 W	150
7 Lawton	34-33-04.3 N	98-24-18.2 W	150
7 Marietta	33-55-02.4 N	97-07-36.0 W	150
7 Newcastle	35-14-46.0 N	97-39-31.0 W	150
7 Temple	34-18-48.6 N	98-13-38.7 W	150
7 Turner Falls	34-24-58.6 N	97-09-00.3 W	200
7 Velma	34-25-58.4 N	97-41-02.8 W	150
8 Adair	36-25-50.6 N	95-23-11.9 W	150
8 Bartlesville	36-40-00.3 N	95-56-00.9 W	100
8 Claremore	36-17-00.0 N	95-36-50.0 W	180
8 Jay	36-24-24.2 N	94-51-12.6 W	120
8 Maramec	36-13-28.0 N	96-44-50.0 W	120
8 Miami	36-52-38.0 N	94-51-58.0 W	150
8 Nowata	36-42-15.3 N	95-38-00.9 W	150

8 Pawhuska	36-37-04.0 N	96-18-29.5 W	120
8 Pawnee	36-21-23.9 N	96-48-06.4 W	150
8 Sand Springs	36-11-27.3 N	96-05-49.0 W	120
8 Shamrock	35-56-42.0 N	96-33-46.0 W	150
8 Test	36-29-50.1 N	95-55-11.9 W	100
8 Tulsa	36-01-14.3 N	95-56-53.7 W	150
8 Tulsa HQ	36-12-38.3 N	95-51-14.0 W	70
8 Turley	36-15-12.4 N	95-59-18.1 W	150
8 Vinita	36-38-50.0 N	95-08-15.0 W	300
8 Welch	36-52-20.8 N	95-13-55.8 W	120

APPENDIX E – ONENET SYSTEM DOCUMENTATION

Tower Site Name	Call Sign		County	Structur Height Feet	Structur Height meters	Ground AMSL Feet	Ground AMSL meters	Total AMSL meters	NAD83 FCC Website LATITUDE DEG	MIN	SEC	LAT DD.DDDDD	LONGITUDE DEG	MIN	SEC	LONG DD.DDDDD	NAD83 FAA Study LATITUDE DEG	MIN	SEC	LAT DD.DDDDD	LONGITUDE DEG	MIN	SEC	LONG DD.DDDDD	El Verified with Topo	FCC ASR#
Lucien	WDQ37 Check FRN	Repeater	Garfield	450	137.16	1269			36	14	21.0	36.23917	97	28	45.0	-97.47917	36	14	21.00	36.23917	97	28	45.00	-97.47917		1209820
Carney	WDQ36	Repeater	Lincoln	430	131.06				35	48	37.0	35.81028	97	3	53.0	-97.06472	35	48	37.00	35.81028	97	3	53.00	-97.06472	10/19/04	1204651
Tulsa	WDQ41 WGM92	Repeat	Tulsa	404					36	10	18.0	36.17167	95	57	21.0	-95.95583	36	10	18.00	36.17167	95	57	21.00	-95.95583		1204647
Langston Univ.	WAM274	Fiber Sha	Logan						35	56	36.1	35.94336	97	15	33.1	-97.25919	35	56	36.00	35.94333	97	15	32.00	-97.25889		1204649
McAlester	WPP85 - KGF21	Repeater	Pittsburg						34	58	37.0	34.97694	95	43	1.0	-95.71694	34	58	37.00	34.97694	95	43	1.00	-95.71694		1208431
Snyder	WIQ42	Repeater	Tillman						34	35	12.0	34.58667	98	57	54.0	-98.96500	34	35	12.00	34.58667	98	57	54.00	-98.96500		1234626
Velma	WDQ42	Repeater	Stephens						34	26	1.0	34.43361	97	41	6.0	-97.68500	34	26	1.00	34.43361	97	41	6.00	-97.68500		1217598
Lawton	WIQ43 - WAH862	Repeater	Commanche						34	37	26.0	34.62389	98	16	15.0	-98.27083	34	37	26.00	34.62389	98	16	15.00	-98.27083	7/27/05	1204648
Lawton OLD	Adjacent to NEW Tower		Commanche									0.00000				0.00000				0.00000				0.00000		
Bethel Acres	WPP88	Repeater	Pottawottomie						35	17	12.0	35.28667	97	3	53.0	-97.06472	35	17	12.00	35.28667	97	3	53.00	-97.06472	10/19/04	1200970
Stringtown	WED425	Terminal	Atoka						34	32	36.0	34.54333	96	2	13.0	-96.03694	34	32	36.00	34.54333	96	2	13.00	-96.03694		1234644
Wilburton	WPP84	Repeater	Latimer						34	55	1.0	34.91694	95	19	47.0	-95.32972	34	55	1.00	34.91694	95	19	47.00	-95.32972		1208424
Newcastle	WDQ38	Repeater	McLain						35	11	48.0	35.19667	97	36	2.0	-97.60056	35	11	48.00	35.19667	97	36	2.00	-97.60056		1209823
Bartlesville	WEE355 WGM91	Repeater	Washington						36	45	22.3	36.75619	95	50	51.9	-95.84775	36	45	22.30	36.75619	95	50	51.90	-95.84775	10/19/04	1204646
Hodgen	NEVER LICENSED\	Terminal	Leflore						34	45	9.0	34.75250	94	38	7.0	-94.63528	34	45	9.00	34.75250	94	38	7.00	-94.63528		1209830
Rush Springs	WDQ45	Repeater	Grady						34	48	46.0	34.81278	97	55	50.0	-97.93056	34	48	46.20	34.81283	97	55	51.10	-97.93086		1204650
ElReno	WEE547	Repeater	Canadian						35	34	7.1	35.56864	97	52	2.0	-97.86722	35	34	7.00	35.56861	97	52	2.00	-97.86722		1208432
Ardmore	WNES257 - WAH871	Fiber Sha	Carter						34	12	10.0	34.20278	97	9	12.0	-97.15333	34	12	10.00	34.20278	97	9	12.00	-97.15333	10/19/04	1019112
Hollow	WEE353	Repeater	Craig						36	52	30.0	36.87500	95	15	11.0	-95.25306	36	52	30.00	36.87500	95	15	11.00	-95.25306		1234624
Tahlequah Tm	WLT48	Terminal	Cherokee						35	55	22.0	35.92278	94	58	18.0	-94.97167	35	55	22.00	35.92278	94	58	18.00	-94.97167		1234633
Fittstown	WEE843	Repeater	Ponotoc						34	32	2.0	34.53389	96	36	58.0	-96.61611	34	32	2.00	34.53389	96	36	58.00	-96.61611		1234631
Stone Bluff	WDQ40	Repeater	Waggoner						35	52	46.0	35.87944	95	46	3.0	-95.76750	35	52	46.00	35.87944	95	46	3.00	-95.76750		1236233
Geary	WEE546	Repeater	Blain						35	32	43.0	35.54528	98	14	13.0	-98.23694										FAA Study
Alva NWOSU		Terminal	Woods						36	47	48.0	36.79667	98	40	0.0	-98.66667	36	47	48.00	36.79667	98	40	0.00	-98.66667	10/19/04	1234618
Durant	WEE842	Terminal	Bryan						34	0	26.0	34.00722	96	22	35.0	-96.37639	34	0	26.00	34.00722	96	22	35.00	-96.37639		1236229
Kiamichi Mtn.	WEG497	Repeater	Leflore						34	36	48.0	34.61333	94	41	38.0	-94.69389	34	36	48.00	34.61333	94	41	38.00	-94.69389		1234638
Miami	WEE352	Terminal	Ottawa						36	52	38.0	36.87722	94	51	58.0	-94.86611	36	52	38.00	36.87722	94	51	58.00	-94.86611		1234641
Emet	WEE841	Repeater	Johnson						34	12	30.0	34.20833	96	32	31.0	-96.54194	34	12	30.00	34.20833	96	32	31.00	-96.54194		1234617
Poteau Mtn.	WED424 - KGF24	Repeater	LeFlore						34	56	35.0	34.94306	94	33	9.0	-94.55250	34	56	35.00	34.94306	94	33	9.00	-94.55250		1234620
Ramona	WEE354	Repeater	Washington						36	29	48.0	36.49667	95	55	7.0	-95.91861	36	29	48.00	36.49667	95	55	7.00			1234621
Warner	NEVER LICENSED\	Termaina	McIntosh						35	28	54.5	35.48180	95	18	54.4	-95.31511										
Norman	WDQ43	Terminal	Cleveland						35	12	38.0	35.21056	97	26	35.0	-97.44306	35	12	38.00	35.21056	97	26	35.00			1236235
Jet	WHC763	Repeater	Alfalfa						36	48	37.0	36.81028	98	7	24.0	-98.12333	36	48	37.00	36.81028	98	7	24.00			1236820
Ada	WAM273	Repeater	Ponotoc						34	46	24.0	34.77333	96	39	52.0	-96.66444	34	46	24.00	34.77333	96	39	52.00			1236228
Altus	WNES258 - KGF23	Terminal	Jackson						34	40	14.0	34.67056	99	20	13.0	-99.33694	34	40	14.00	34.67056	99	20	13.00			1206232
Stuart	WPP86	Repeater	Hughes						34	53	34.0	34.89278	96	9	15.0	-96.15417	34	53	34.00	34.89278	96	9	15.00			1234629
Tate Mtn.	WPP87	Repeater	Seminole						35	4	52.0	35.08111	96	32	25.0	-96.54028	35	4	52.00	35.08111	96	32	25.00			1234619
Enid Phillips	NEVER LICENSED\	Terminal	Garfield						36	23	46.0	36.39611	97	50	35.0	-97.84306	36	23	46.00	36.39611	97	50	35.00			1236225
Enid		Repeater	Garfield						36	28	41.0	36.47806	97	50	10.0	-97.83611	36	28	41.00	36.47806	97	50	10.00			1234640
Tahlequah Rp	WIQ44	Repeater	Cherokee						35	56	40.0	35.94444	95	3	14.0	-95.05389	35	56	40.00	35.94444	95	3	14.00			1234625
Sycamore Mtn.	WGX746	Repeater	LeFlore						34	46	29.0	34.77472	94	53	47.0	-94.89639	34	46	29.00	34.77472	94	53	47.00			1234634
Weatherford	WEE548	Terminal	Custer						35	32	7.0	35.53528	98	42	32.2	-98.70894	35	32	7.19	35.53533	98	42	32.24			1206229
Chickasha USAO	WNES256	Terminal	Grady																							1236232
Carter Mtn.	WEG498	Repeater	McCurtain						34	15	1.0		94	46	32.0		34	15	1.00		94	46	32.00			1234636
Idabel	WEG499	Terminal	McCurtain						33	55	17.0		94	46	48.0		33	55	17.00		94	46	48.00			1234637
Lexington		Terminal	Cleveland						35	0	59.0	35.01639	97	12	52.0	-97.21444	35	0	59.00	35.01639	97	12	52.00	-97.21444		1234642
Cyril	NEVER LICENSED\	Terminal		50	15.24	1416	431.5967993	1466	446.8367993	34	52	25.9	34.87387	98	15	5.3	-98.25146										
Cameron Univ	WNES259	Terminal	Commanche	48	14.63	1150	350.5199995	1198	365.1503994	34	36	25.0	34.60694	98	26	5.0	-98.43472	34	36	25.00	34.60694	98	26	5.00	-98.43472	10/19/04	1206231
CASC		Terminal	LeFlore	40	12.192	1565	477.0119993	1605	489.2039993	35	2	23.0	35.03972	94	38	5.0	-94.63472	35	2	23.00	35.03972	94	38	5.00	-94.63472		1234635

Good

Small Error

Major Error

FAA Study	Landowner	USGS Map Name	Vegetation Abatement Contract	Beacon Contract	Notes
1970-FTW-358-OE	Private			X	
1984-ASW-0645-OE	Private			X	
1985-ASW-1766-OE	Tulsa University			X	
1974-SW-1198-OE	Langston University			X	
NONE	Private				
2002-ASW-0283-OE	Private	Manitou		X	
1987-ASW-0685-OE	Private			X	
1978-ASW-1873-OE	Oklahoma Land Office			X	
	Oklahoma Land Office				
1984-ASW-0580-OE	Private			X	
2002-ASW-0295-OE	DOC	Colgate SE		X	
1985-ASW-0829-OE	OESC			X	
1970-FW-0555-OE	Private			X	
1974-SW-163-OE	Private			X	
1974-SW-439-OE	USDA			X	
1970-FTW-356-OE	Private			X	
1973-SW-882-OE	Private			X	
1987-ASW-1950-OE	Noble Foundation				
2002-ASW-0284-OE	Private	Hollow		X	`
2002-ASW-0289-OE	NSU	Tahlequah			
2002-ASW-0288-OE	Private	Harden City			
2002-ASW-3019-OE	Private				
NONE	Private				
2002-ASW-0279-OE	NWOSU				
2002-ASW-3139-OE	SOSU				
2002-ASW-0299-OE	USDA	Octavia			
2002-ASW-0297-OE	NEOA&M	Picher			
2002-ASW-0278-OE	Private	Milburn			
2002-ASW-0281-OE	Kerr Foundat	Heavener			
2002-ASW-0282-OE	Private	Vera			
NONE	Connors Co	Warner			
2002-ASW-3142-OE	OU				
2002-ASW-3021-OE	Private				
2002-ASW-3023-OE	ECU				
1975-SW-1032-OE	WOSU	Altus			
2002-ASW-0287-OE	Private				
2002-ASW-0280-OE	Private	Tate Mountain			
2002-ASW-3488-OE	NOC				
2002-ASW-0293-OE	Private	Enid East			34.9436 -94.5491 Actual tower is 430yards east of FCC license
2002-ASW-0285-OE	Private	Thompson Corner			
2002-ASW-0290-OE	USDA	Blackjack Ridge			
1993-ASW-1914-OE	SWOSU				
2002-ASW-3041-OE	USAO				
2002-ASW-0292-OE	USDA	Bethel			
2002-ASW-0294-OE	SOSU	Idabel			
2002-ASW-0298-OE	DOC	Eason			
	Private				
1987-ASW-0686-OE	CU	Lawton			
2002-ASW-0291-OE	CASC	Poteau West			

APPENDIX F – OPINION OF PROBABLE COST WORKSHEETS

Opinion of Probable Cost
10 Year Projection

State of Oklahoma

Statewide Public Safety Trunked Radio System

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Infrastructure Maintenance, Warranty, Life Cycle Upgrades	$5,000,000	$9,516,375	$9,706,703	$9,900,837	$10,098,853	$10,300,830	$10,506,847	$10,716,984	$10,931,324	$11,149,950
Site Utilities	$96,000	$123,600	$148,320	$173,040	$197,760	$222,480	$239,784	$246,978	$254,387	$262,018
System Management Personnel Costs	$375,000	$386,250	$397,838	$409,773	$422,066	$434,728	$447,770	$461,203	$475,039	$489,290
Estimated Annual Cost	$5,471,000	$10,026,225	$10,252,860	$10,483,649	$10,718,679	$10,958,038	$11,194,401	$11,425,164	$11,660,749	$11,901,258

Assumptions

System maintenance provided by commerical service provider

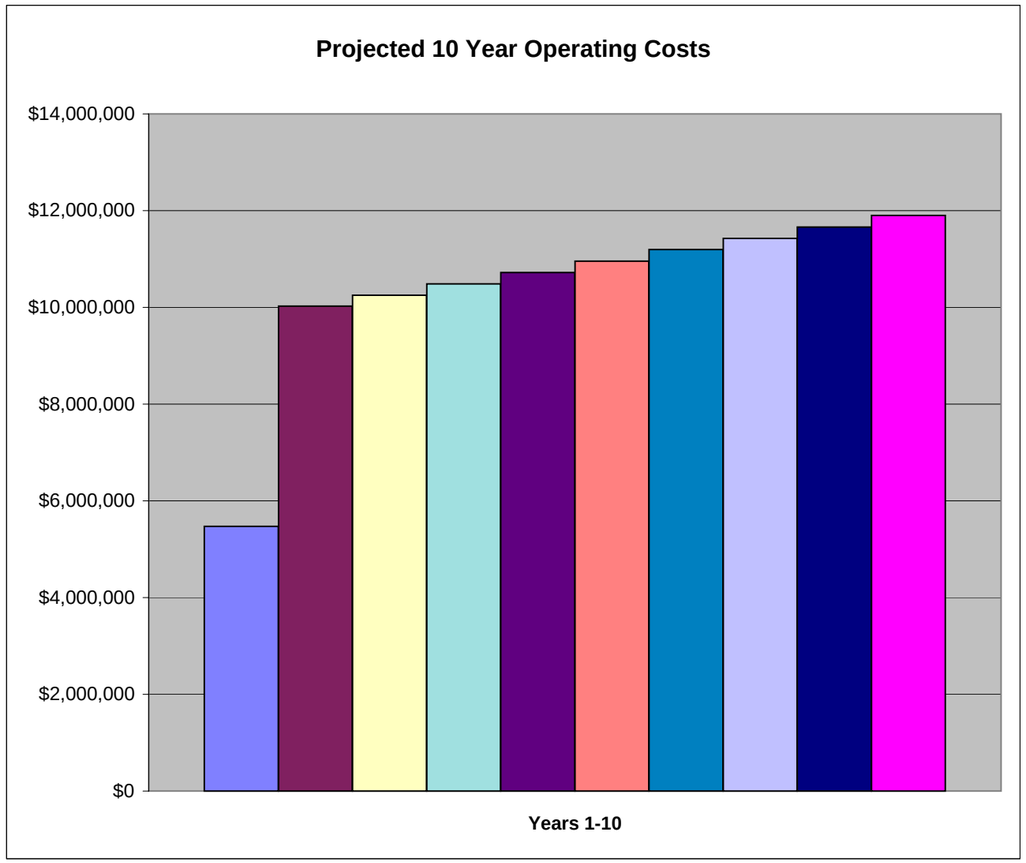
Maintenence costs will increase at 2% Annually and is based on 97 operational sites; Initial cost for first few years may be lower as new sites are added.

Initial remote site utilities estimated at $200/site/month with 40 sites and increase annual 3%. 10 sites are added per year through Year 7 to reach total of 97 sites.

All sites are owned by the State of Oklahoma, no known leases

System management personnel costs are based on 3 full time employees plus benefits, increased at an annual rate of 3%

First year maintenance costs are based on full contract maintenance of existing sites. Year 2 is the first year new equipment is included in. These costs may vary due to warranty on equipment



Kimball
L. Robert Kimball & Associates

02/27/08

Opinion of Probable Cost

Phases I - IV

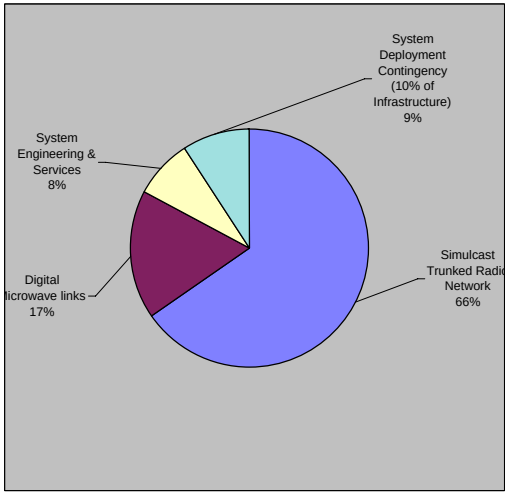
State of Oklahoma

Statewide Public Safety Trunked Radio System

OPINION OF PROBABLE COST

Simulcast Trunked Radio Network	$91,100,000
Digital Microwave links	$24,250,000
System Engineering & Services	$11,535,000
SUBTOTAL -Infrastructure	$126,885,000

TOTAL Infrastructure	$126,885,000
System Deployment Contingency (10% of Infrastructure)	$12,688,500
TOTAL	**$139,573,500**



BASIS OF ESTIMATE

This Opinion of Probable Costs for the multiple phases of the project is based on a total of fifty-seven new remote tower sites, and upgrades to approximately 40 existing sites. These phases will take 7-10 years to complete, with ongoing life cycle upgrades after that. The actual number of sites required will depend largely upon specific locations selected and specific heights available for use at each site. Co-location or reuse of existing sites may help bring the cost down, but cannot be determined without a detailed system design.

New Trunked P25 IP Digital Voice Radio Network
New Digital Microwave Connectivity at all sites.

Included are 40 Smart X Converters to allow old system sites to work with new controllers
Includes 2 new digitial system controllers

ASSUMPTIONS

TOWER SITES

All new tower sites are assumed to be bare, undeveloped land.
All new sites will require installation of tower, shelter, utilities

All sites are connected by new digital microwave
This cost may be affected by the ability to use existing tower sites, which may lower the overall construction cost.

A 10% overall contingency is estimated into the TOTAL cost of the system.

EXCLUSIONS

User equipment not included in this estimate (i.e., mobiles, portables)
No new dispatch consoles are included in this estimate.

L. Robert Kimball & Associates

02/27/08