STATE OF OHIO

STATEWIDE INTEROPERABLE COMMUNICATIONS PLAN

Recommendations & Long Range Plans for Interoperability

Developed with the advice and consent of the Statewide Interoperability Executive Committee

OCTOBER 26, 2005

October 26, 2005

Darryl Anderson, Ohio MARCS Program Director
Co-Chair, Ohio SIEC

Tim Swanson, Sheriff, Stark County
Co-Chair, Ohio SIEC

Re: State of Ohio Interoperability Plan

Dear Mr. Anderson & Sheriff Swanson;

RCC Consultants, Inc. is pleased to submit this Statewide Interoperable Communications Plan to the Ohio Statewide Interoperability Executive Committee (SIEC). We submit this report to the SIEC for review and approval prior to forwarding final recommendations to the Ohio Department of Public Safety. It is our intent that this task fulfills the objectives set forth in the contract between RCC and the Ohio Department of Public Safety. RCC appreciates the support and guidance the committee has provided throughout this process.

The team has identified a total of ten recommendations designed to greatly improve the communications interoperability throughout the first responder community within the State of Ohio. The recommendations are comprised of five short to intermediate term recommendations designed to provide short term benefit, and five long term recommendations designed to provide a long term vision of enhanced communications interoperability throughout the State.

Please contact me should you have any questions concerning the content of this report. We have enjoyed working with you and the committee and wish you the best in your continued support of the first responder community within the State of Ohio.

Sincerely,

Dominick Arcuri
Sr. Vice-President, Midwest and Mid-Atlantic Regions

Cc. Dean Bolton, Telecommunications Manager
Ohio Emergency Management Agency

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1 EXECUTIVE SUMMARY

1.1 Purpose and objective of the study

RCC Consultants, Inc. has been retained by the Ohio Department of Public Safety, Emergency Management Agency to work in conjunction with the Ohio Statewide Interoperable Executive Committee (SIEC[1]) in the development of a Statewide Interoperable Communications Plan. This Plan will outline the interoperable communications approaches for Ohio's First Responder Community at the State level and within the 88 counties in Ohio.

1.2 Methodology

The responsibilities for this project were divided into three primary tasks:

Task 1: Review and assess current statewide level First Responder Communications connectivity

Task 2: Identify System Level Connectivity, weak points and/or Non Existent Connections. Task 2 has three deliverables as follows:

Report 2A: County Capability Data Base

Report 2B: County Communications Equipment Infrastructure

Report 2C: Present Interoperability Capability

Task 3: Communications Interoperability Recommendations

This report summarizes the work performed and presents the findings and recommendations.

1.3 Summary of Findings

Task 1 focused on the review and assessment of the survey data collected by the OSIEC from Ohio First Responders and the Department of Health (Medical Providers). The initial data (database) was compiled and analyzed by the University of Cincinnati in 2003. The information

[1] In September 2002, the State of Ohio established a Statewide Interoperability Executive Committee (SIEC) in response to FCC directive # DA-02-2142 to oversee the implementation of interoperability channels in the 700 MHz band. The SIEC is comprised of approximately 20 governmental and quasi-governmental agencies, in addition to representation from the FCC Region 33 Planning Committee.

from the survey was analyzed and organized in such a manner such that it could provide a foundation for analyzing the system level connectivity of the First Responder two-way radio systems in the State. The report for this task is included as an Appendix II of this report.

As part of Task 2, RCC developed extensive communications infrastructure and interoperability databases of all 88 counties within the State of Ohio. These databases included a list of infrastructure by agency, the type of communications system(s) in use and the frequencies of operation. The details of this database are included in the report for Task 2B, which is also provided as Appendix IV of this report.

This information was classified by first responder discipline, including Law Enforcement, Fire Protection, Health Provider, as well as a combined multi-discipline response. This information indicates a wide variety of different types of communications systems and frequencies are still in use by first responders throughout Ohio. Nearly one third of the counties, 28 out of 88, do not have a common frequency band of operation among all disciplines. The breakdown of primary frequency band used within the counties is shown in the table below:

Multi-Discipline Frequency Band of Operation

Frequency Band	Number of Counties
VHF Low Band	1
VHF High Band	33
UHF	9
800 MHz	17
Mixed	28

In addition, a full 80% (71 out of 88) of the counties still use at least some older conventional analog communications equipment and have not yet migrated to newer technologies supporting an enhanced feature set and improved efficiency.

Also as part of this task, RCC evaluated and classified the communications infrastructure capability present today both at the county level and between surrounding counties. This information is summarized in the report for Task 2A, which is also provided as Appendix III to this report.

Using common industry-accepted levels of interoperability (Levels 1-6, as defined on page 10), it was determined that only 28% (25 out of 88) of the counties have the capability within the

county to support a level of interoperability higher than Level 2. This number falls to only 25% (22 out of 88), when considering a response with surrounding counties. The highest forms of interoperability (Levels 5 and 6) can be supported by 19% (17 out of 88) of the counties for a response within the county and by 17% (15 out of 88) of the counties when considering a response with surrounding counties. The summary for a multi-discipline response is shown below:

Highest Level of Interoperability	Multi-Entity (Police, Fire, EMS) Response	
	Within County	With Surrounding Counties
	Number of Counties	Number of Counties
Level 2	63 (71.6%)	66 (75%)
Level 3	2 (2.3%)	4 (4.5%)
Level 4	6 (6.8%)	3 (3.4%)
Level 5	16 (18.2%)	15 (17%)
Level 6	1 (1.1%)	0 (0%)

The State of Ohio Office of Information Technology has implemented the Multi-Agency Radio Communications System (MARCS) system, an 800 MHz trunked radio system for use by State agencies, as well as local municipalities who choose to subscribe to the system. The MARCS system provides effective mobile level radio coverage throughout the State of Ohio. Currently, in addition to the State users, all sheriffs' dispatch centers within the state have MARCS radios, as well as all county Emergency Management Agencies, many emergency medical services providers, and all hospitals and health departments. The MARCS system in its current form provides an excellent platform for interoperability among sheriff's offices, local law enforcement, health departments, EMA/Homeland Security, fire/EMS agencies, hospitals and other agencies having the capability of accessing the system. Furthermore, it is recognized MARCS will provide the foundation for an expanded communications network herein after referred to as Ohio's Statewide Interoperable Radio Network (OSIRN).

The State and/or counties have implemented or participate in a number of other initiatives designed to address interoperability challenges affecting most first responder agencies throughout the country – incompatible radio systems and multiple frequency bands of operation. Some of these initiatives include:

- Statewide Mutual Aid Channels
- Predominant Frequency Band Within a County
- OSIRN Radio at Selected Dispatch Centers (including PSAPs)
- OSIRN Radios for Incident Command
- Countywide Trunked Systems
- Interconnection of Neighboring Countywide Systems
- Buckeye State Sheriff's Association (BSSA) Interoperable Communications Vehicles

Detailed information regarding the present interoperability capabilities within the State and the current strengths and weaknesses were addressed in the final report for Task 2, which is also included as Appendix V of this report.

1.4 Recommendations and Long Range Plans

As outlined in an earlier report, the State of Ohio has a number of ongoing projects and initiatives focused on improving interoperability within the State. In many cases, the recommendations and long range plans described here take advantage of the ongoing initiatives and build upon these concepts. These initiatives provide a basis for enhancement and additional development of solutions to improve interoperability throughout the State.

The recommendations and solutions offered here are generally technical in nature. However, technology is only one part of the solution. Without cooperation, management, and the appropriate policies and procedures, no technical solution can be successful.

A total of ten recommendations and potential interoperability improvements for the first responder community within the State of Ohio will be presented. The first five recommendations focus on short to intermediate term solutions that can make a significant improvement in interoperability relatively quickly and inexpensively.

These short/intermediate term recommendations are summarized below, and a goal for the interoperability level is provided. These recommendations are intentionally not provided in any priority order. Each county is left to prioritize these recommendations based on their specific needs and current communications configuration.

TABLE 1.4-1

Short/Intermediate Term Recommendation Summary

Recommendation	Interoperability Level Goal
Dispatch Center Talkgroup	Level 5 at Dispatch Centers
Integrate OSIRN Radios into Console Electronics	Level 5 at Dispatch Centers & Level 4 for patched systems
Extend OSIRN capability to additional Dispatch Centers and Critical Infrastructure Control Centers	Level 5 at Dispatch Centers & Level 4 for patched systems
Equip Incident Command and Key Supervisory vehicles with OSIRN	Level 5 for Incident Command
Encourage Existing Systems to Provide Provisions for interoperability with Neighboring Systems	Level 4 for Neighboring Systems

Additionally, five long-term recommendations are being presented focusing on establishing standard-based solutions at the State and county level, and providing an IP-based network to allow the interconnection of these systems when necessary.

A summary of the long term recommendations, along with the interoperability goal level is provided in the table below. These recommendations are provided in priority order.

TABLE 1.4-2

Long-Term Recommendation Summary

Recommendation	Interoperability Level Goal
Expand and Upgrade OSIRN	Level 6 for all OSIRN Users
Encourage Consolidation of Communications Systems at the County Level	Level 6 at county level
Interconnection of Countywide Systems to OSIRN	Level 5/6 for all systems across the State
Implement a Statewide Backbone System	Backbone for Level 4, 5 & 6 throughout the State
Establish and Operate Network based Gateway Switches for Interconnection of Systems	Level 4 for Interconnected Systems

2 INTRODUCTION

2.1 Purpose and objective of the study

The purpose of this study is to develop a State Interoperable Communications Plan under a contract with the Ohio Department of Public Safety (ODPS), Emergency Management Agency (EMA), with the advice and consent of the Statewide Interoperability Executive Committee (SIEC). The Plan will outline the interoperable communications approaches to all of Ohio's eighty-eight (88) counties and jurisdictional entities. The plan will be applied to the First Responder Provider population, which consists of the following:

- Local, County, & State Law Enforcement
- Local & State Fire
- EMS
- County & State EMA
- Hospitals and Local & State Departments of Health
- Ohio National Guard
- Other Federal, State and Local Emergency response communications users

The study will conduct a review of the State's current communications capability. The review will include communications connectivity with hospitals and health care providers.

The objectives of the study are to provide insight and recommendations for the State to meet and/or make significant progress toward the following objectives:

- ✓ Review of the current system architecture connectivity or lack thereof for the aforementioned First Responder community.
- ✓ Address the communications interoperability between entities from a system connectivity level and viewpoint.

- ✓ Emphasize the connectivity capability of the existing system equipment to talk/communicate to the other systems.
- ✓ Develop recommends to improve connectivity cost effectively at the command and operational level while not degrading the current capability of field level communications.
- ✓ Insure open systems architecture when developing the interoperability solutions.
- ✓ Improve spectrum efficiency.
- ✓ Focus initially on mission critical equipment/systems.
- ✓ Develop plans for system level communications between various systems.
- ✓ Develop options for patching together current system gateways.
- ✓ Develop options that create synergism with Ohio's first responder community.
- ✓ Develop an awareness of the 700 MHz national movement and future multi-state interoperability of technology concepts.

2.2 Methodology

The project is divided into three tasks:

Task 1: Review, and assess current statewide level First Responder Communications connectivity. The information analyzed in Task 1 was collected through a survey that was conducted by the SIEC. The survey was distributed to all known Ohio public safety administrators (Sheriffs, Police Chiefs, Fire Chiefs, EMA/Homeland Security Directors and EMS Chiefs). The State received assistance with the compilation and reduction of the raw data from the University of Cincinnati, Division of Criminal Justice. The UC staff made a presentation of their initial findings to the SIEC on April 8, 2003.

Task 2: Identify system level connectivity, weak points and/or non existent connections. Task 2 has the following deliverables:

Task 2A: County Capability Database

Task 2B: County Communications Equipment Infrastructure

Task 2C: Present Interoperability Capability

Task 2 Final Report: Present Interoperability Strengths & Weaknesses

Task 3: Communications Interoperability Recommendations

This report summarizes the work performed and the findings of Task 3 and serves as the deliverable for Recommendations Addressing Deficiencies and Long Range Plan.

2.3 Task 2A Summary

Task 2A focused on determining the present communications interoperability strengths and weaknesses between all law enforcement entities (including State law enforcement), fire protection entities (including State Fire Marshal) and all health providers (including emergency medical services, health care providers, and state and local health departments) within each county and surrounding counties (including adjoining counties of other states). This task also addressed the present communications interoperability strengths and weaknesses between all First Responder entities (law enforcement, fire and EMS) within each county and surrounding counties (including adjoining counties of other states).

To address this objective, data was accumulated from the various sources and presented in a tabulated format on a county-by-county basis. For each county, the interoperability capability is assessed both within the county and with surrounding counties in each of the following categories:

1. Law Enforcement
2. Fire Protection
3. Health Providers
4. Between the above entities in a multi-agency response.

For each county the strengths and weaknesses of the existing interoperability capability was outlined. From the summary of these strengths and weaknesses an interoperability capability assessment was given to each county in the above four categories. The assessments, with some modification, are based on the six levels of interoperability originally defined by APCO. For this report the levels are defined as follows:

Level 0 – Relay Messages through Dispatch Center(s)

Level 1 A – Swap Radios (Radio Exchange)

Level 1 B – Multiple Subscriber Units (Multiple mobile radios installed in the vehicle)

Level 2 – Direct Radio

2A - Talkaround (direct radio to radio simplex communications; i.e., LEERN car-to-car)

2B – Program surrounding agencies frequencies

Level 3 – Mutual Aid Channels (Shared channels) utilizing a dedicated fixed transmitter/receiver system.

Level 4 – Gateway/Console Patch

4A – Crossband Repeater (i.e., VHF LB channel is repeated on a UHF channel)

4B – Console patch

4C – Gateway patch (standalone hardware or network systems)

Level 5 – Proprietary Shared Systems

Level 6 – Standards-based Shared Systems

The data and assessments derived during Task 2A were tabulated on a county-by-county basis and presented in a report presented June 29, 2005 and included here as Appendix III.

2.4 Task 2B Summary

Report 2B focused on providing a county level report of the present communications systems utilized by the first responder entities. The report indicated the band of frequencies (VHF low-band, VHF high-band, UHF and 800 MHz), the system operational platform formats (simplex, duplex repeater, trunk type), tower site facilities, modulation types, and coded squelch types utilized by each entity from each of the 88 counties within the State. This data was provided in a report dated August 31st, 2005 and included here as Appendix IV.

2.5 Task 2C Summary

Task 2C provided a summary of the present interoperability capability. The data was provided as an assessment of Levels 0 through 6 as defined above tabulated and displayed graphically for each individual discipline (Law Enforcement, Fire Protection, Health Provider/EMS) and combined as a multi-entity, multi-discipline response, both within the county and with surrounding counties. The predominant frequency band of each discipline by county was also displayed graphically. This report, delivered September 28th, 2005, and included here as Appendix V, discusses and summarizes present interoperability strengths and weaknesses.

3 GOALS FOR INTEROPERABILITY SOLUTIONS AND IMPROVEMENTS

There are several methods to achieve interoperability. The Department of Homeland Security uses the commonly identified 6 levels of interoperability to illustrate increasing levels of functionality (and cost), as shown in the figure below. For further clarification, Level 0 and additional sub-levels have been added to provide a more complete explanation of the available options.

Level	Method	Comment
Level 0	Relay Messages Through Dispatch	Cumbersome Short-Term Solution
Level 1	Swap Radios	Simple Short-Term Solution
Level 2	Direct Radio: A: Talk-Around B: Program Surrounding Agencies Frequencies	Simple Solution; o Limited Coverage o Requires Same Frequency Band
Level 3	Mutual Aid Channels	Common for Public Safety
Level 4	Gateway/Console Patch: A: Crossband Repeater B: Console Patch C: Gateway Patch	Short or Long-Term System Modification
Level 5	System-Specific Roaming	Wide Area, Full-featured
Level 6	Standard-Base Shared Systems	Most Complete Long-Term Solution

Level 0 describes the situation where no physical or technical connection exists between agencies, and where a person (dispatcher) is required to relay messages from a user of one agency to a user from a different agency. This can obviously become cumbersome if a lot of information must be transferred, and it is possible for some information to be lost during the relay.

Level 1 is the method of simply swapping radios, either in a preplanned manner (before or after arriving at the scene) or after arriving at the scene on an as needed basis. Of course, the swapping of radios is only beneficial if each radio user is within the coverage area of their

respective system infrastructure towers. This method is generally used when radio users are operating in different bands, as radios are commonly programmed with other agencies' frequencies when operating in the same band. If more than 2 radios are needed (for example, VHF, UHF, and 800 MHz radio users desire interoperability at an emergency scene), this method becomes quite cumbersome. There is also a need to relay a message between radio users, resulting in delay and potential errors in the communication. If radio swapping is needed after arriving at the scene, it is often difficult to know who needs to exchange radios and, where they are located. Further, the actual task of providing the radios, such as in the case of a flood, fire, hostage situation, or other natural/man made disaster is cumbersome and detracts from the from the attention that should be paid to the incident.

Level 2 is the next level of interoperability, and involves designating and programming a particular channel to communicate in the "walkie-talkie" mode. In this mode, the communications are conducted directly between radio users, with no amplification of the signal through a repeater. This method works well when the scene is small, such as a house fire. It quickly becomes unworkable in a larger scene scenario, especially when using lower powered portable radios that may have a range of a mile or less, depending upon terrain, building penetration and other signal loss factors. Also, it is a common practice to keep using channels that can communicate with the dispatch center, where practical, as the dispatch center often serves in an oversight and support role to the scene. Level 2 can only be used if the radios operate in the same band. Therefore, Level 2 cannot be used for VHF/800 MHz interoperability.

Level 3 is the extension of Level 2, as mentioned above. In this case, mutual aid channels are provided to allow the radio signals to be repeated at higher power levels, greatly increasing the coverage of the communications. If the infrastructure is in place, this will also allow the dispatch center to stay engaged in the activities at the scene. In the case where the infrastructure tower signals are on the fringe of adequate coverage, a tradeoff decision must be made between the coverage benefits of Level 2 versus the Level 3 involvement of the dispatch center. Level 3 can also only be used with radios in the same operating band and when sufficient channels are available.

Level 4 interoperability overcomes the disadvantages of Levels 2 and 3 with the interconnection of the audio portion of radio communications operating in different bands. Level 4 is commonly performed at the dispatch consoles, but can also be accomplished at the scene with the proper equipment. A major limitation of a gateway patch is that all of the radios being interconnected must be within the adequate signal strength coverage area of their respective system

infrastructure towers. Also, adequate channels must be available to allow both a patch operation and normal operations to take place simultaneously.

Levels 5 and 6 are essentially the same solution. The major difference is Level 6 uses a standards based system. A shared system, whether standards based or not, overcomes all of the issues present in Levels 1 through 4. For Level 1, the need to swap radios is eliminated. For Level 2, the need to use talk around is diminished, although this may still be the preferred method of communications for specific events. In this case, all radios are operating on the same band, so talk around would be fully enabled. For Level 3, the conventional or trunked Level 5/6 system would also accommodate mutual aid channels.

The standards based solution is commonly referred to as P25, short for APCO Project 25. There are currently advantages and disadvantages to the P25 “standard”. On the down side, only some of the aspects of the P25 solution have been agreed to, the vendor choices are somewhat limited for trunking systems, the standard approval process is slow, and there is no compatibility testing required by the standard. This is not to say there are no merits to P25, but one must be aware of all of the issues prior to making a decision.

In a perfect world, the optimal interoperability solutions would be for each county to implement a standards compliant countywide radio system. This would not only allow any agency within a given county to communicate with any other agency, but would also provide the capability for interoperable communications between different counties in a mutual aid event. However, this “ideal” is at best only a long term solution, and other interim solutions must be considered for agencies and counties with varying levels of requirements and funding.

The key factors to consider when determining where to make “breaks” between Levels 1-4 and Level 5/6 are a combination of cost, channel availability, and the most efficient interoperability pathway. Cost is relative to the user; the same dollar amount that is reasonable to a large agency on a per radio basis may be overwhelming to a smaller agency, such as a volunteer fire department. Also, some bands have fewer channels available. For example, there are not many VHF channels available. In addition, there are technical and regulatory barriers essentially preventing the low quantity of available channels from being used more efficiently by using trunked technology. Normally, different agencies that communicate with each other on a routine basis should be on the same frequency band. This minimizes the need to either carry 2 (or more) radios or make available a channel from each band for interoperability, which is a very inefficient and potentially labor-intensive practice.

4 RECOMMENDATIONS

Currently, the State and/or counties have implemented or participate in a number of initiatives designed to address the communications interoperability deficiencies noted in Appendix V within the First Responder Community. Extensions of these initiatives, along with additional interoperability solutions, provide the basis for ten recommendations to improve interoperability throughout the State. The recommendations are divided into two categories as follows:

- Short/Intermediate Term recommendations addressing the deficiencies
- Long-Term solutions and recommendations for interoperability

The solutions offered here are generally technical in nature. But as noted earlier in this report, technology is only one part of the overall process. Without cooperation, management, and the setting of policies and procedures, no technical solution can be successful.

For the short/intermediate term, the recommendations are listed below. These recommendations are not provided in any specific order. Each county is left to prioritize these recommendations based on their specific needs and current communications configuration.

- Dispatch Center Talkgroup
- Integrate OSIRN Radios into Console Electronics
- Extend OSIRN capability to other Dispatch Centers
- Equip Incident Command and Key Supervisory vehicles with OSIRN
- Encourage Existing Systems to Provide Provisions for interoperability with Neighboring Systems.

The long-term recommendations are listed below. These recommendations are provided in priority order.

- Expand and Upgrade OSIRN
- Encourage Consolidation of Communications Systems at the County Level
- Interconnect Countywide Systems to OSIRN
- Implement a Statewide Backbone System
- Establish and Operate Network based Gateway Switches for Interconnection of Systems.

4.1 Short/Intermediate Term Recommendations

4.1.1 Short-Term Recommendation #1 – Dispatch Center Talkgroup

4.1.1.1 System Description

Currently, each Sheriff's dispatch center is equipped with an 800 MHz control station radio operating on OSIRN. Talkgroups SO 01 through SO 88 are assigned to the 88 Sheriff's in the State. Each sheriff's dispatch center (or a dispatch center that dispatches for the sheriff's office) monitors its assigned SO talkgroup. The OSHP post in a county also monitors that county's SO talkgroup and those SO talkgroups of adjacent counties.

In addition, there are SO Region talkgroups, which correspond with the geographic regions established by the BSSA and OSIRN during the planning for the OSIRN radio installations at each SO. These regions follow established Ohio Department of Natural Resources (ODNR) boundaries. Calling on an SO regional talkgroup will result in all SO's within that region being hailed. ODNR's central dispatch center in Columbus also monitors the SO Region talkgroups.

The Dispatch Center Talkgroup Recommendation proposes creation of a set of new common talkgroups that is shared and monitored by all Dispatch Centers in the State and the appropriate Dispatch Centers in surrounding states. Additionally, 800MHz control stations are proposed for all Dispatch Centers in the State and the Dispatch Centers designated in surrounding areas. Since OSIRN is present statewide, it becomes the backbone for the 800 MHz control stations in the Dispatch Centers. This provides an instant interconnection of all Dispatch Centers in the State and surrounding states. This Recommendation requires the individual Dispatch Centers to monitor a new "Dispatch Center Announcement" talkgroup. The function of the Dispatch Center Announcement talkgroup is to provide enhanced direct emergency communications to and from the State's Dispatch Centers. It is anticipated that an additional group of talk groups would also need to be developed to support inter-Dispatch Center communications both within the SO Regions and statewide.

Note this Recommendation builds on initiatives already in place in at least two of the counties in Ohio (Montgomery and Franklin) and one region (Homeland Security Region 4). In Montgomery County, a common PSAP talkgroup (Inter-PSAP or IPSAP) is shared between all dispatch centers on the county's 800 MHz trunked system. Its intent is to provide dispatch centers with an additional more efficient means of communication with other dispatch centers both in and around Montgomery County. A similar concept is deployed in Franklin County (referred to as

Metro Alert talkgroup). Homeland Security Region 4 has an operational announcement talkgroup in the 15 county central Ohio region.

There are some 340 primary Public Safety PSAPs in the state. There are additional PSAPs in the surrounding states and other secondary PSAPs that could also be added to the total. Therefore, a talkgroup plan will need to be developed that can be assigned to support communications with all of the Dispatch Centers. The talkgroup configuration may follow a similar plan already devised for the SO talkgroups. The talkgroup plan will need to provide the following guidelines as a minimum;

1. A common Dispatch Center Announcement Talkgroup shared among all Ohio and other designated Dispatch Centers. All Dispatch Centers included in this number would monitor this common announcement talkgroup. This announcement talkgroup is used primarily for:
    - Emergency announcements from the State or any member Dispatch Center (i.e., major incidents, mass casualty, hazmat, severe weather warnings and events, etc.)
    - Quick communications to and from Dispatch Centers for sharing of emergency or other important information and then the coordination of other talkgroup or channel assignments. It is anticipated that additional Regional Dispatch Center talkgroups would be established to support regional operational needs and to handle the more routine day to day inter Dispatch Center communications. Provisions might also be made for a conferencing capability among all or selected Dispatch Centers.
2. A capability to switch to additional Dispatch Center talkgroups ("meet me" talkgroups) to keep the main announcement talkgroup clear for other emergency notification of Dispatch Centers.
3. This Recommendation is primarily concerned with the primary Dispatch Centers. Recommendation #3 later in this report suggests extension of this concept to additional Dispatch Centers and control centers. When developing the talkgroup plan for this Recommendation, the configuration should also consider future Short-Term Recommendation #3 additions.

This recommendation will likely add additional radio traffic to OSIRN. It is recommended that a Grade of Service analysis be performed to determine the system's capability to support this.

In addition, installation guidelines to include good engineering practices such as power backup capability to the control station and choice of antenna patterns that allow access to the system from more than one OSIRN site for redundancy purposes must be developed.

Level of Interoperability:

This recommendation provides Level 5 interoperability among the Dispatch Centers. Note the control station radios are capable of operating on P25 Phase I system.

4.1.1.2 Budgetary Cost

The tasks associated with this recommendation are as follows:

- Development of programming templates and the actual programming of the existing Sheriff's control station radios,
- Purchasing, programming and installation of new control station radios to be placed at Dispatch Centers.

The budgetary cost is shown in the table below:

TABLE 4.1.1.2-1

Short-Term Recommendation #1 - Budgetary Cost

Item	Total / Unit
Radio Programming	$100
New Control Station Radio, Antenna	$6,500 to $12,000
Installation (nominal)	$500 to $2,000
Total	$7,100 to $14,100

4.1.1.3 System Management

The current 88 OSIRN control station radios for the Sheriff's offices are owned and maintained by OSIRN. This recommendation assumes that the proposed Dispatch Center radios operate on OSIRN. It is therefore recommended the programming of the units be under control of OSIRN for maintaining uniformity of the system operation. As far as procurement and maintenance of

the new additional radios the state has the option of 1) continue the approach taken for Sheriff's units or 2) the additional units become customer owned and maintained.

A Standard operating procedure (SOP) will need to be developed for use of the Dispatch Center talkgroup(s). The SOP must incorporate the needs of the various regions. A proper training and an on-going monitoring of the operation of this interoperability tool will be needed. A proper forum for exchange of ideas and feedback on the operation of this recommendation may be the SIEC Committee.

4.1.1.4 Advantages and Disadvantages

Advantages:

- Provides an efficient means of providing inter-communications among the Dispatch Centers in the State and surrounding,
- Full conference and enhanced communications capability among the Dispatch Centers,
- A backup capability to other existing means of communications among the Dispatch Centers (i.e., VHF point-to-point and a public switched telephone network),
- Provides an efficient means of coordinating assignment of interoperability talkgroups, mutual aid and tactical channels within a given region.

Disadvantages:

- Radio costs and subscription fees,
- Additional system loading – this should be minimal as the intent of this recommendation is primarily for announcements,
- All Dispatch Centers must monitor the Dispatch Center talkgroup. This may add additional workload at some of the centers, although it is meant to function as an enhanced version of the existing point-to-point VHF channel. Since the "chatter" on an announcement talkgroup must be kept to a minimum, it is anticipated that the talkgroup would remain silent except for emergency announcements and should not therefore place a significant additional burden on any member of the Dispatch Center Announcement Talkgroup.
- The existing OSIRN control station radio is typically installed as a standalone unit, not integrated to an existing dispatch console. Provisions must be made so that the talkgroup can be monitored by all applicable positions within the center.

4.1.2 Short-Term Recommendation #2 – Integrate Existing OSIRN Radios into Console Electronics

4.1.2.1 System Description

This recommendation is similar to Short-Term Recommendation #1 except it integrates the stand-alone OSIRN control station radio into the dispatch console electronics. As described earlier, Short-Term Recommendation #1 requires the Dispatch Centers to monitor a new talkgroup dedicated for Dispatch Center emergency communications (Dispatch Center Announcement Talkgroup). The existing OSIRN control station radios at Sheriff's offices are normally standalone (a desktop control station placed on the dispatcher's console table or somewhere nearby within the center) and are not integrated to the dispatch console electronics. This arrangement should not affect the smaller Dispatch Centers where the dispatchers within the center can monitor and access the control station. For larger Dispatch Centers however, the monitoring of the radio traffic on a single control station by the dispatchers, for the Dispatch Center announcement talkgroup communications, may be a bit more challenging. For this reason, this recommendation suggests for the affected Dispatch Centers to consider provisions to interface the OSIRN control station radio into their console electronics. This will allow monitoring and access of the talkgroup by all dispatchers in the center.

The following are the issues to consider when implementing this recommendation:

- The interface should allow the dispatchers to transmit (push-to-talk) and monitor the talkgroup that the OSIRN control station radio is set on.
- An audio path should also be provided and interfaced to the logging recorder.
- Consider use of Cat 5e or equivalent for the interface cabling to minimize loss. The Dispatch Center should verify with their console electronic vendor on the maximum distances that such an interface can be supported.
- The interface shall provide means of changing the talkgroups on the OSIRN radio. This can be accomplished several ways depending on the radio console capability. The simplest method is to place the OSIRN control station at an appropriate dispatcher position where the talkgroup can be changed from the radio's control head.

Level of Interoperability:

This recommendation provides Level 5 interoperability among the Dispatch Centers and extends Level 4 to systems that can be patched together. Note the control station radios are capable of operating on P25 Phase I system.

4.1.2.2 Budgetary Cost

The cost for this recommendation will vary and it depends on the type, capability and availability of additional channel/module capacity of the Dispatch Center's console electronics. As an example, a typical cost is shown below:

TABLE 4.1.2.2-1

Short-Term Recommendation #2 - Budgetary Cost

Item	Total / Dispatch Center
Radio Console Programming	$100
Interface cable, punch blocks, connectors and misc. hardware	$200 to $3500
Interface Installation	$200 to $500
New Control Station Radio, Antenna (if necessary)	$6,500 to $12,000
Radio Installation (if necessary)	$500 to $2,000
Total (without new radio)	$500 to $4,100
Total (with new radio)	$7,500 to $18,100

4.1.2.3 System Management

The individual Dispatch Center will be responsible to design, implement, operate, and provide field support for the integration the OSIRN radio into their console electronics.

4.1.2.4 Advantages and Disadvantages

Advantages:

- Allows monitoring and control of the Dispatch Center announcement talkgroup by all dispatchers in the Dispatch Center,
- The integration of the OSIRN control station radio into the dispatch electronics may also provide additional capabilities such as patching of the OSIRN talkgroups to the Dispatch Centers other channels or talkgroups. Note, this feature may add additional traffic onto the OSIRN system and will need to be authorized by OSIRN.
- Full conference and enhanced communications capability among the Dispatch Centers,
- A backup capability to other existing means of communications among the Dispatch Centers (i.e., VHF point-to-point and a public switched telephone network),
- Provides an efficient means of coordinating assignment of interoperability talkgroups, mutual aid and tactical channels within a given region.

Disadvantages:

- All Dispatch Centers must monitor the Dispatch Center announcement talkgroup. This may add additional workload at some of the centers, although it is meant to function as an enhanced version of the existing point-to-point VHF channel.
- Cost of interface or integration of the OSIRN control station radio to the console electronics.

4.1.3 Short-Term Recommendation #3 – Extend OSIRN capability to additional Dispatch Centers

4.1.3.1 System Description

This recommendation extends the capability of Short-Term Recommendation #1 to other Dispatch Centers such as secondary PSAPs, and dispatch centers or control centers that support operations of the critical infrastructures such as utilities, nuclear plants, major chemical plants, and transit dispatch centers.

The talkgroup planning for the Dispatch Center Announcement Talkgroup in Short-Term Recommendation #1 can include the planning for secondary PSAPs. The inclusion of the critical infrastructure dispatch and control centers may require a separate or a subset talkgroup

to be used as an announcement and/or coordination talkgroup between the State and the centers.

Level of Interoperability:

This recommendation provides Level 5 interoperability among all the Dispatch Centers. Note the control station radios are capable of operating on P25 Phase I system.

4.1.3.2 Budgetary Cost

The tasks associated with this recommendation are as follows:

- Purchasing and programming of new control station radios to be placed at the Dispatch Centers (if not included when the Dispatch Center Talkgroup recommendation #1above is implemented) and critical infrastructure dispatch/control centers

The budgetary cost, which represents an order of magnitude, is shown in below:

TABLE 4.1.3.2-1

Short-Term Recommendation #3 - Budgetary Cost

Item	Total / Unit
Radio Programming	$100
New Control Station Radio, Antenna	$6,500 to $12,000
Installation (nominal)	$500 to $2,000
Total	$7,100 to $14,100

4.1.3.3 System Management

It is therefore recommended the programming of the units be under control of OSIRN for maintaining uniformity of the system operation. As far as procurement and maintenance of the new additional radios the state has the option of 1) continue the approach taken for Sheriff's units or 2) the additional units become customer owned and maintained.

A Standard operating procedure (SOP) will need to be developed for use of the dispatch/control centers talkgroup(s). The SOP must incorporate the needs of the various centers. A proper training and an on-going monitoring of the operation of this interoperability tool will be needed.

4.1.3.4 Advantages and Disadvantages

Advantages:

- Provides an efficient (streamlines) means of providing inter-communications between the State and the critical infrastructure dispatch and control centers,
- Full conference and enhanced communications capability among the centers,
- A backup capability to other existing means of communications (i.e., telephone).

Disadvantages:

- Radio costs and subscription fees,
- Additional system loading,
- The critical infrastructure dispatch and control centers must monitor the new announcement talkgroup. This may add additional workload at some of the centers.
- Provisions must be made so the talkgroup can be monitored by all applicable positions within the center.

4.1.4 Short-Term Recommendation #4 – Equip Incident Command and Key Supervisory vehicles with OSIRN

4.1.4.1 System Description

This recommendation is intended to address interoperability deficiencies found for areas or regions where different agencies operate on separate and incompatible radio systems. This recommendation equips incident command and key supervisory vehicles from each of these agencies with OSIRN mobile radios. The units equipped with OSIRN radios normally would respond to an incident that will involve response from multiple agencies operating on different radio systems. This recommendation makes use of OSIRN since it provides a uniform and reliable mobile coverage and a common platform, throughout the state.

Some counties in the State have or are in the process of equipping their primary incident vehicles, such as fire captain and police supervisor vehicles with OSIRN radios to provide for access to OSIRN during incident command. This provides these commanders with direct access to State agencies, as well as the other interoperability capabilities OSIRN provides. For example, this recommendation is being implemented in Cuyahoga County for the suburban fire

and police agencies. This initiative will allow a common communications platform or talkgroup among the suburban agencies responding to an incident at their command level.

This recommendation will likely add additional radio traffic to OSIRN. It is recommended that a Grade of Service analysis be performed to determine the system's capability to support this recommendation for a given area.

Level of Interoperability:

This recommendation provides Level 5 or higher interoperability among the incident command units.

4.1.4.2 Budgetary Cost

TABLE 4.1.4.2-1

Short-Term Recommendation #4 - Budgetary Cost

Item	Total / Unit
Radio Programming	$100
New Mobile Radio or Control Station, Antenna	$6,500 to $12,000
Installation (nominal)	$500 to $2,000
Total	$7,100 to $14,100

4.1.4.3 System Management

This recommendation assumes the proposed radios operate on OSIRN. It is therefore recommended the programming of the units be under control of OSIRN for maintaining uniformity of the system operation. The individual agencies will be responsible for procurement and maintenance of the new radios.

4.1.4.4 Advantages and Disadvantages

Advantages:

- Provides an efficient means of inter-communications among the desperate, incompatible radio systems within a region,
- Is a quick solution for interoperability provided: 1) OSIRN has adequate system capacity in that area, and 2) adequate funding for procurement of the new radios.

Disadvantages:

- Radio costs and subscription fees,
- Additional system loading,
- This recommendation addresses only intercommunications among command levels from different responding agencies at or on-route to the scene. Each responding agency will still be relying on their own systems, for communications between their command level, responding units at the scene and their corresponding dispatch center.
- The command will need to monitor their individual agency radio system channel (for coordination with their units) as well as the OSIRN talkgroup (for coordination with other agencies responding to the incident).
- This recommendation requires a command or supervisory level vehicle equipped with an OSIRN radio be available for incident command, from each of the responding agencies.
- This recommendation does not support portable coverage for interoperability between the responding agencies. The OSIRN interoperability talkgroup is provided for mobile coverage.
- This recommendation assumes the individual agencies will be required to fund the purchasing of the new radios. The agencies in the region may also try to locate grants toward funding of the radios.

4.1.5 Short-Term Recommendation #5 – Encourage Existing Systems to Provide Provisions for interoperability with Neighboring Systems

4.1.5.1 System Description

Natural and man caused disasters and other emergencies do not respect operational, political or jurisdictional boundaries. More often than not, an emergency incident requires a multi-disciplinary response (police, fire, etc.) and when the incident affects a wide geographic area, requires the multi-disciplinary responses (police, fire, etc.) from more than one jurisdiction. The extent to which these multi-disciplinary emergency responses are coordinated and utilized promptly and efficiently during an incident relies, in great part, on the ability of responding and on scene units to communicate and to coordinate the operations. Interoperable radio communications at such an incident is essential.

The data collected for this project indicates a wide variety of communications system capability and communications system interoperability levels exist within Ohio Counties. Nearly one third of the counties, 28 out of 88 do not have a common frequency band of operation among all disciplines. In addition, a full 80% (71 out of 88) of the counties still use at least some older conventional analog communications equipment and have not yet migrated to newer technologies supporting an enhanced feature set, improved efficiency and an increased capability for interoperability.

Using common industry-accepted levels of interoperability (Levels 1-6) it was determined that only 28% (25 out of 88) of the counties have the capability within the county to support a level of interoperability higher than Level 2. This number falls to only 25% (22 out of 88), when considering a response with surrounding counties. The highest forms of interoperability (Levels 5 and 6) can be supported by 19% (17 out of 88) of the counties for a response within the county and by 17% (15 out of 88) of the counties when considering a response with surrounding counties.

Improving interoperability is a process that involves planning, operations and equipment. Significant improvements in basic interoperability can be accomplished through planning and use of current technologies and equipment. The higher levels of interoperability will require the acquisition of new technologies and equipment. The following continuum is offered:

- Inventory – Distribute an inventory of First Responder agencies both within the county <u>and</u> in contiguous counties. For each agency listed include critical information on its communications system such as type (i.e. analog, digital, trunked, conventional, single site,

simulcast, etc.), frequencies utilized, coverage area, manufacture type and version, and so forth. An initial inventory of this information has been developed for the State as part of this project.

- Plan – Develop an interoperability plan. Set as a goal: ***To achieve at least basic interoperability (Level 2 or above) with all First Responder agencies on the inventory.***

  A) For each agency on the inventory, where interoperability at any level does not exist, develop a short strategy statement for achieving interoperability. Examples of subjects for these strategy statements are: 1) Swap Radios. 2) Create a new talk group. 3) Use NPSPAC or other mutual aid frequencies. **Section 4** of this document contains a list and description of system technologies and tools that might be used to create interoperable inter-agency communications. The current interoperability capability database developed for this project identifies the existing capabilities throughout the State.

  B) For each agency on the inventory, where a basic level of interoperability does exist, develop a short strategy statement for improving the level of interoperable communications. Where interoperability does exist, the goal should be to improve the level of interoperability to at least Level 4 interoperability. **Section 4** of this document contains a list and description of system technologies and tools that might be used to improve interoperable inter-agency communications.

  C) Once the assessment of the level of interoperability with neighboring agencies is completed, a Tactical Interoperability Communication Plan (TICP) should be developed. This TICP should address the manner in which communications with neighboring agencies will be handled during times of area wide emergencies or other multiple agency responses and should include the standard operational procedures/guidelines that govern such interoperable communications. (Note: The Miami Valley public safety agencies have developed a Standard Operating Guideline for interoperable communications that is an excellent reference for anyone interested in how to draft such a document.)

  D) Exercise - Once the TICP is adopted, agencies should conduct regular operational exercises utilizing the plan. These exercises will help agencies determine the viability of the plan, will point out areas where revisions might be required and will prepare the

agencies to implement the plan during times of emergencies or other multi-jurisdictional responses.

Interoperability Level:

While the overall objective of this recommendation is to achieve Level 4 interoperability, in reality, the improvement in the interoperability level could vary from Level 1 to Level 6 depending upon the existing level of interoperability between the implementing agency and its neighbor agencies and the strategy employed.

4.1.5.2 Budgetary Cost

The costs of the above recommendations would vary from the staff time required to develop the interoperable inventory and TICP, to the acquisition of minimal amounts of equipment needed for basic interoperable communications, and up to the major investment require for the acquisition of a P25 system. The minimal investment required for an interoperability inventory and TICP is expected to vary between $10,000 and $25,000 per system/agency.

4.1.5.3 System Management

The lead for the implementation of this recommendation must come from the State if a coherent improvement in statewide interoperability is to be realized.

- The State of Ohio should adopt radio communications interoperability at **Level 4** as the minimum communications standard for all state recognized/certified first responder agencies.
- The State should promulgate guidelines for achieving statewide interoperability at **Level 4**. These guidelines should include requirements for the development and adoption of 1) Interoperability Inventories/Plans, 2) Tactical Interoperability Communication Plan (TICP), and 3) A requirement for annual first responder radio communications training and exercises.
    - The State should develop a communications inventory template and inventory guidelines
    - The State should develop a TICP template and guidelines
    - The State should develop guidelines for annual interoperable communications exercises

- The State should adopt grant and other funding strategies that support the goal of statewide interoperability at **Level 4**.
- The State should manage frequencies in all bands in a manner that supports the steps to achieve the interoperability goal.

4.1.5.4 Advantages and Disadvantages

Advantages:

- Increased radio communications interoperability for county level traditional and non-traditional (public works, etc.) first responders,
- Increased operational readiness at the local level,
- Increased opportunities for local jurisdictions to communicate with State Agencies,
- Increased opportunity for a coherent statewide approach to interoperability.

Disadvantages:

- Improvements in interoperability can be expensive,
- Increased need for frequency coordination,
- Development of inventories and plans is labor intensive,
- Increased need for State monitoring of interoperability training/exercises and plan updates.

4.2 Long-Term Recommendations for Interoperability

4.2.1 Long-Term Recommendation #1 – Expand and Upgrade OSIRN

4.2.1.1 System Description

The State of Ohio Office of Information Technology has implemented the Multi-Agency Radio Communications System (MARCS) system, an 800 MHz trunked radio system for use by State agencies, as well as local municipalities who choose to subscribe to the system. The MARCS system provides effective mobile level radio coverage throughout the State of Ohio. Currently, in addition to the State users, all sheriffs' dispatch centers within the state have MARCS radios, as well as all county Emergency Management Agencies, many emergency medical services, and all hospitals and health departments. The MARCS system in its current form provides an excellent platform for interoperability among sheriff's offices, local law enforcement, health departments, EMA/Homeland Security, fire/EMS agencies, hospitals and other agencies that have the capability of accessing the system. Furthermore, it is recognized that MARCS will provide the foundation for an expanded network herein after referred to as Ohio's Statewide Interoperable Radio Network (OSIRN). Several of the recommendations described in this report utilize OSIRN as the platform for improved interoperability. As a result, in order to realize these interoperability improvements, and to maintain a platform for continuing interoperability enhancements, it is recommended OSIRN be upgraded for additional capacity.

The current OSIRN system architecture is primarily a multicast design[2], where each transmit/receive site uses a different set of frequencies. In order to increase the capacity of this system, additional frequencies (channels) and base station repeaters must be added at each individual site that requires a capacity increase. Prior to adding additional services or user traffic on to OSIRN, it is recommended that a traffic or Grade Of Service (GOS) study is performed at each participating site to determine how much additional traffic can be supported, and to determine if additional channels are required. As an alternative, if a significant traffic increase is anticipated in a concentrated geographical area, a simulcast cell may be utilized to address this need. In this case, all of the channels available at a given number of sites can be pooled together for the simulcast cell to significantly increase capacity in that area.

Currently OSIRN supports 800 MHz frequencies only. This frequency band is quite congested in most areas of the country and also in the State of Ohio. As a result, the ability to increase the capacity of OSIRN significantly in any particular area is likely to be limited. However, the

[2] A single 5-site simulcast cell is part of OSIRN.

current version of Motorola equipment (Version 7.x), compatible with current OSIRN technology, supports 700 MHz frequencies in addition to 800 MHz frequencies. An upgrade of OSIRN to this technology will provide the capability necessary to provide significant increases in capacity.

Upgrading OSIRN to system to Version 7.x also has additional benefits. Some of these additional benefits are:

- Support for High-Speed Data: With this upgrade, the data channels operating on OSIRN will be capable of supporting up to 96 kbps of data on a single channel, compared with the current 19.2 kbps data rate.
- Support for Voice over Internet Protocol (VoIP): Compliance to this standards-based network protocol will allow for reduced operational costs for system interconnection and also provide the capability to interface all types of Public Safety information systems to OSIRN.
- Compliance with P25 Trunking: The Motorola Version 7.x system complies with the P25 trunking protocol, which will provide the option of purchasing compatible subscriber radios from multiple manufacturers.
- Compatibility with Regional Systems: Upgrading to the current version system will make OSIRN compatible with several regional systems in the State that are either currently implemented or in the process of being implemented. This will allow further interoperability and potentially sharing of resources where appropriate. Compatible regional systems include:
    - City of Cincinnati,
    - Hamilton County,
    - Lucas County (In process),
    - Delaware County (In process).

Level of Interoperability:

Currently, OSIRN is capable of providing Interoperability Level 5 among agencies that have access to the system. Therefore, a capacity enhancement of the system would maintain this level. An upgrade to P25 compliance would increase the interoperability to Level 6.

4.2.1.2 Budgetary Cost

The cost associated with a system enhancement or upgrade will vary based on the enhancement implemented either at a site or across the system. The most straightforward enhancement would be a capacity increase at a particular site. Budgetary estimates on a per site basis are estimated as follows:

TABLE 4.2.5.2-1

Long-Term Recommendation #1 - Budgetary Cost – Addition of Channels to OSIRN

Item	Total / Unit
Single Channel Upgrade	$ 80,000
Two Channel Upgrade	$120,000
Three Channel Upgrade	$160,000

These estimates include the necessary combiners, antennas and base stations.

The upgrade of OSIRN to a newer version platform in the Motorola product line is a significant undertaking, and a detailed estimate of the budgetary cost for that project is beyond the scope of this report. However, this significant an upgrade to a system the size of OSIRN is estimated to be between $110 and $130M.

In addition to the equipment and installation costs, the maintenance costs of the system must be considered as well. Currently, the State‘s 800 MHz interoperability platform is totally funded through a rotary (charge-back) system. The summation of the fees paid by all users pays for the yearly operating costs. A hand-held, or in-car, radio, for example, costs $20 per month per radio.

While the individual radio monthly fee does not seem onerous, consideration must be given to the fact that many potential public safety users do not have flexibility in their operating budgets and simply cannot afford additional user fees.

The recommendation to place additional interoperable radios in communications centers, and in the hands of command level personnel statewide, should be supported by funding from other than the local source.

Strong consideration should be given to seek operating funding for part or all of the annual operating costs for the system through a line item in the State's annual operating budget, thereby spreading out the costs over the largest possible tax base.

4.2.1.3 System Management

The OSIRN system infrastructure is currently managed by a central office under the State of Ohio Department of Information Technology. With the completion of the initial build out and the considerable broadening of the scope of the radio network it is logical to review the permanent placement of OSIRN within state government.

4.2.1.4 Advantages and Disadvantages

Advantages:

- Significant capacity increase (access to 700 MHz channels),
- Support for High-Speed Data,
- Support for Voice over Internet Protocol (VoIP),
- Compliance with P25 Trunking,
- Compatibility with Regional Systems,

Disadvantages:

- Identifying and licensing additional frequencies as necessary,
- Funding any proposed upgrades (via capital improvement funds), initial establishment of the state operating budget to support ongoing system costs,
- The logistical concerns associated with upgrading a system of this magnitude,
- The reprogramming of all of the radios currently operating on the system.

4.2.2 Long-Term Recommendation #2 – Encourage Consolidation of Communications Systems at the County Level

4.2.2.1 System Description

What is suggested by this recommendation is the establishment of a consolidated radio communications system within each Ohio County with the coverage and the channel/frequency capacity to address the radio communications needs of the county when faced with an

emergency or other extraordinary event. This consolidated communications system should meet, at a minimum, the radio communications needs of the First Responders identified in **Section 2.1** (local, county and state law enforcement, local and state fire, EMS, county and State EMA. hospital and local and State departments of health, Ohio National Guard, and other Federal, State, and local first responder communications users). Additionally, the consolidated communications system should support those government agencies and other local agencies that provide support during emergency incidents. These agencies vary by locality but might include public works, water, sewer, highways, public health, mental health, Red Cross, etc.

For purposes of this recommendation, "consolidated communications system" is defined as one radio infrastructure within the county, not a system of separate, though interoperable, radio systems. The consolidated system should provide radio communications for the First Responders listed above and the consolidated system should be designed to meet the coverage standards of the most demanding users. Generally, this would mean that the portable in-building coverage standard required to support the fire and law enforcement operation would be the uniform coverage requirement. Channel/frequency capacity would be determined through radio traffic studies and the number of subscriber units estimated to be utilized on the system.

Particularly in the less populous counties that support a small First Responder and support contingent, a variety of system technologies are available for this consolidated system. It is conceivable that a conventional VHF, UHF or 800MHz system could adequately support the needs where communications needs are light. However, probably the best approach to consolidation would be to employ the latest in P25 digital trunked radio communications to provide the coverage and channels required by all agencies in the county. The use of "talk groups" in a trunked radio system greatly increases the ability of the user to respond to emergencies.

The notion of a consolidated radio system within a county could fail for a variety of reasons ranging from costs to the "politics" of jurisdictions, PSAPS or dispatch centers. Trunked radio systems with IP based infrastructure can be designed in such a way that separate dispatch centers and talk groups can be maintained by the jurisdictions within a County. For example with its some 47 PSAPS, Cuyahoga County could support the need for separate independent dispatch centers and talk groups. Further, the IP based infrastructure could be modified in the future should there be a need to increase or decrease the number of dispatch centers. Any new 800 MHz P25 radio system purchase should require that the entirety of the infrastructure equipment and the subscriber units be capable of handling traffic in the 700MHz spectrum.

Consolidated, trunked, digital IP based radio infrastructures need not be confined to a single county but could be put up on a multi-county basis or regionally with a potential cost savings over separate county systems.

Data collected for this project indicates that although some “consolidated systems” as defined above exist within the State today (i.e. Hamilton County/Cincinnati system and Lucas and Delaware Counties under development), all first responders must have access to and utilize the system in order to fully realize its benefits. Additionally, nearly one third of the 88 counties in Ohio or 28 counties do not have a common frequency band that might be used in such a consolidated system.

Level of Interoperability:

The recommendation for consolidated radio communications systems would provide an Interoperability Level 5 or 6 depending on how it is implemented.

4.2.2.2 Budgetary Cost

The cost for consolidated county wide systems would vary greatly depending on the size and complexity of the system required by the environment. The costs for such systems is also a function of the frequency band used as coverage requirements and thus the number of tower sites required varies with the frequency band utilized. For example, 800MHz generally requires more towers than the same coverage in the VHF or the UHF spectrum. This recommendation for a consolidated county radio system does not preclude the adoption of consolidated multi-county or regional systems. Savings could be realized in the construction and maintenance of those wider area systems over the construction and maintenance of multiple, separate county systems. Savings could be realized, for example, through the reduction in need for separate zone controllers, through the joint use of tower sites and the economies of large scale purchases particularly of subscriber units and related equipment.

Finally, the State should consider, on a case by case basis, proposing to counties, multi-county or regional communications consolidation efforts the use where feasible of compatible State infrastructure equipment such as zone controllers, towers, gateways, microwave and other networks, etc. Such an effort would have a number of benefits including; improved utilization of the State communications infrastructure, reduction in the costs for consolidating systems and increased assurances of the interoperability of the consolidated systems with the State and other consolidated systems in the State.

Funding a consolidated county or regional system will be a daunting task. Thought should be given to innovative funding strategies such as is being used in Butler County. Butler County is utilizing a sales tax increase with a sunset provision to secure the funds to build a county wide 800MHz trunked radio system.

4.2.2.3 System Management

The State should promulgate a standard that encourages Ohio Counties to consider consolidated county, multi-county or regional radio communications systems as new systems are purchased or as systems are substantially updated. This standard should include a set of minimal requirements for a consolidated system. The State should provide incentives to counties to assist in the achievement of this recommendation. Incentives might include:

- Technical Assistance in system design and acquisition.
- Publishing generic specifications and performance criteria for consolidated systems
- Technical assistance and other assistance in frequency coordination
- Grants and preference in grant awards for communications equipment and services related to achieving a consolidated communications system.

4.2.2.4 Advantages and Disadvantages

The major advantage to a consolidated system will be an increase in the interoperability of agencies previously employing disparate communications systems. If the consolidated system is a P25 system it would be interoperable with and could become a part of OSIRN when upgraded to P25, which will improve operational efficiencies across a much broader area and provide unprecedented levels of interoperability. Consolidated systems at the P25 level could also allow the State and local consolidated systems an opportunity to utilize 700MHz frequencies as they become available.

The major disadvantage to a consolidated communications system will be the cost of implementation. As pointed out above, innovative funding strategies maybe a necessity. Additionally, consolidation at a multi-county or regional system level may do a great deal to reduce construction costs and costs of maintenance in the future. Another disadvantage of a consolidated system would be the need for system management/governance. Consolidated systems may require a new system management structure.

4.2.3 Long-Term Recommendation #3 – Interconnection of Countywide Systems to OSIRN

4.2.3.1 System Description

As a long-range goal toward broad interoperability and efficient use of various system resources, a goal of interconnecting countywide systems with OSIRN should be pursued. As Long-Term Recommendation #5 suggests, individual systems can be interconnected using smart switches or "gateway switches" such as the Network First, or Motobridge switches as described in Appendix I. In general, these switches enable the interconnection of audio from different systems, but are limited in feature set. In addition, these types of interconnections require resources (including channels) from both systems in order to communicate.

This Recommendation would go beyond this type of interconnection, by using a higher form of system interface. Interconnecting systems of a common protocol, or standards-based systems, will enable interconnection and interoperability with full-feature functionality, including capability for emergency, user ID display, and a full-trunked feature set. This will also allow the sharing of resources among systems that can be used to increase capacity where necessary across the State.

Systems complying with P25 may someday support a standard system interconnection protocol. The Inter Sub-System Interface (ISSI) is a standards-based protocol currently under development within the P25 process. It is possible that within two to three years this interface will be defined and manufacturers will incorporate it into their product offerings.

It is envisioned the statewide backbone system described in Long-Term Recommendation #4 would provide the interconnection medium necessary to interconnect the different systems as described above.

Level of Interoperability:

The recommendation for consolidated radio communications systems would provide an Interoperability Level 5 or 6 depending on whether the implementation involves standards-based systems.

4.2.3.2 Cost Factors

The cost factors associated with the interconnection of systems via a standards-based protocol such as the ISSI are difficult to define at this time. This technology is still under development, and therefore not well defined. If interoperability gateways are used, there is generally a base

cost for the "switch", typically $500,000 to $1M, with additional costs per interconnected talkpath. Further discussion of these costs appears in the description of Long-Term Recommendation #5. Interconnection via the ISSI interface, when available, is expected to be significantly less.

In addition to these equipment costs, labor costs associated with developing radio templates to allow roaming of radios between interconnected systems and programming of radios must be considered.

4.2.3.3 System Management

The management of each system interconnection will require some level of operational effort to establish the interoperability talkgroups, develop and implement the radio templates, and reprogram radios as appropriate.

4.2.3.4 Advantages and Disadvantages

Advantages:

- Interconnecting systems in this manner essentially creates a single larger system. It allows users from each interconnected system to roam from one system to the other and to utilize resources from each system as appropriate. Therefore, a user of the state system could roam onto a smaller city/county system which would likely provide better portable in-building coverage, if support of an incident required that level of coverage. In this scenario, the state user could still maintain contact with all other state users and dispatchers if these systems were interconnected in this manner. In addition, interconnected systems that enjoy overlapping coverage could be used as spare capacity resources for each other's systems as necessary.

Disadvantages:

- The cost of the interconnecting hardware/firmware,
- The technology is still under development and standards such as the ISSI are still undefined,
- The cost and complexity of developing and maintaining radio templates to allow roaming between interconnected systems,
- The additional complexity of management of "guest" radios that will be allowed to roam onto interconnected systems.

4.2.4 Long-Term Recommendation #4 – Implement a Statewide Backbone System

4.2.4.1 System Description

This recommendation focuses on development of a statewide "IP-Based" backbone system that would interconnect State's strategic locations. Availability of such a network is integral to many of the long-term recommendations presented in this report. This system is envisioned to be used as an interconnection medium that can be used to connect various systems or system components such as the following:

- Interconnection of primary Dispatch Centers in the state,
- Interconnection of different sites of a single system,
- Interconnection of different systems using "Interoperability Gateways" to allow interoperability across different systems,
- Interconnection of different systems using a standards-based Inter-SubSystem Interface (ISSI) as it becomes available.
- Other Public Safety and public service applications.

The applicability of the various technologies described in Appendix I and the technology solutions provided by the various vendors can best be described within the context of commonly accepted telecommunications standards. The basic standard is the Open Systems Interconnection [OSI] model that is comprised of several technology layers. Each of these layers performs a specific range of telecommunications functions and services. Figure 4.2.4.1-1 graphically describes these layers and the fit of the various technologies cited in the Appendix within this model.

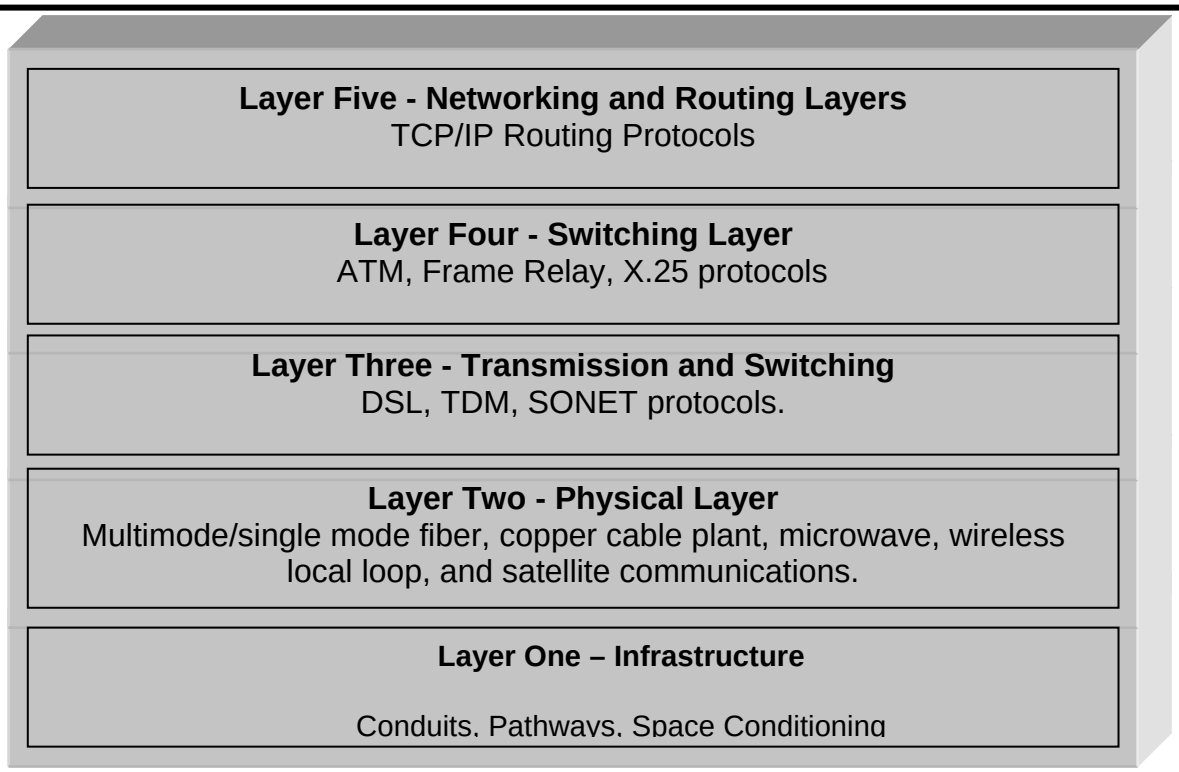

Figure 4.2.4.1-1 – Description of Various Network Layers

Appendix I provides a tutorial on the potential backbone network solutions including optical fiber networks, microwave radio, satellite services, carrier-based networks, or a combination of these or other technologies. The State has the right-of-way along the highway system that may allow implementation of a fiber optic system. The final decision in the technology selection is based on the evaluation of network reliability, system performance, and total cost-of-ownership.

Microwave radio could be a good backbone solution for many areas including areas where the sites are continually subjected to environmentally harsh conditions, such as high winds and icing. Consequently, cable based medium would contribute to lower network reliability.

To be most effective, the backbone network should also consider use of an appropriate switching and routing protocol that would most efficiently use a given quantity of network capacity. Appropriate technologies and protocols that should be considered include the use of traditional TDM, Asynchronous Transfer Mode (ATM), packet over SONET protocol, and routing protocols. A statewide backbone network will require multiple drops throughout the state to interconnect various sites. An ATM solution for bandwidth management allows the ATM network to map any circuit anywhere, independently of each other. A TDM solution can also work by

routing the circuits to a hub location where they are bridged, and re-routed to the appropriate sites.

An ATM solution, as compared to TDM, provides greater efficiencies and flexibility and its ability to configure virtual circuits. Furthermore, an ATM platform can support a multitude of interfaces, which include IP, frame relay, voice, video, Ethernet, etc. However, an ATM platform is significantly higher in cost than a TDM platform. For example, TDM multiplexing equipment at a site may cost $5,000 where an equivalently equipped ATM switch may cost $20,000. An ATM platform can also be used to support the Public Safety radio system provided it can provide the performance guarantees that will be required by the radio vendor.

Additional considerations will include the technical and operational requirements for network management. The network infrastructure should be cost effective to manage as well as require a network management system that is relatively easy to operate. Some additional considerations are listed below:

The requirement for a highly reliable and survivable network – Typical of most Public Safety networks, the statewide network has to have a higher level of reliability than is currently the case with most commercial carrier provided network services. This is in many respects different from the issues of fiber optic and digital based technology because of the technology itself is inherently more reliable. This additional level of reliability is referred to here as survivability. A highly survivable network must meet the following criteria:

- Physical alternate routing capability to the end user premise,
- Redundancy on a hot-standby basis of all common components,
- Use of hardened facilities for housing equipment, complete with UPS systems and emergency power generators,
- Physical loop or mesh backbone infrastructure,
- Inclusion of a network management capability,
- Use of technologies that are relatively easy to operate and maintain,
- Geographic routing of facilities along “safe zones” not usually affected or prone to extended outages or disaster situations.

The need for providing a uniform level of service – Regardless of the physical end user location, all end users will use common telecommunications infrastructure technology and capabilities.

The need for a long-term, flexible solution – The backbone network architecture that will be developed should have the capacity and flexibility that will be needed to support the long- term requirements of various Ohio Public Safety departments and agencies. The effective service life of the infrastructure architecture should be in the range of at least 10 years or more.

The need to support a wide range of current and projected applications – The backbone network architecture may provide opportunity to support a wide range of public safety applications. This will include short bursts of email message traffic and mobile data applications, up through video conferencing and imaging applications.

Support New Public Safety Users – The infrastructure should have the capability to support new Public-Safety users and applications that are supportive of Public Safety and emergency management functions.

Support Non-Public Safety Users – The backbone network may provide the opportunity to support other organizations, such as state colleges, and applications such as distance learning, related video applications and non-emergency administrative video conferencing.

Inclusion of each segment of users on the backbone network will result in an incremental increase in the capacity, complexity, and purchase cost of the system. However, it will also increase the overall utility and value of the network to State and other users and will effectively reduce the cumulative operating costs.

Network Capacity – An additional consideration is the importance of network capacity, or bandwidth. The backbone network will need to provide sufficient capacity or throughput to support current and future applications including data intensive and video applications.

The backbone network will also need to support in the long term a larger proportion of data communications traffic than has traditionally been the case. Such a network will need to go beyond providing basic transmission of analog voice channels to support complex switching and routing functions. These capabilities will need to be included in the backbone network that will eventually be implemented.

The backbone network will also need to include adequate network management systems and procedures in order to provide a high level of reliability and performance, and minimal mean-time-to-repair for network problems. Features such as a graphical user interface and graphic display of location and equipment status should be included as an important part of the overall backbone network. The management system should also have the ability to monitor the

performance of the network, as well as include a trouble ticket program feature for tracking and managing network problems.

From an architectural standpoint, the network can be segmented into the following two major components:

The backbone network segment - this segment consists of the high capacity technologies and services that will interconnect the major network nodes. The network nodes will serve as concentration points for local access to the statewide network.

The local access segment - this segment consists of lower capacity technologies and services that will interconnect major concentration nodes to local sites such as radio system locations.

4.2.4.2 Budgetary Cost

It is beyond the scope of this report to estimate the implementation cost of a statewide IP backbone system. This cost will vary greatly depending on various factors including:

- The system capacity and topography
- Type of transmission medium used
- Type of switching technology utilized
- Will it be implemented by the State as part of a State-owned and managed fiber optic network or leased from commercial vendors or a combination of

The State can also consider feasibility of utilizing or incorporating current and future networks that are being developed by the counties and municipal public safety and service agencies into the State's backbone network. This strategy will provide opportunity to leverage the assets and potentially reduce the overall costs.

In addition to the implementation costs associated with this recommendation, the State must also consider the potential for ongoing service fees when leased circuits are used. Leased lines, such as T1s, may form an integral part of this backbone network. A typical monthly cost for a T1 is generally between $600 and $800. If it is assumed that as a minimum, a single T1 per county is leased as part of this backbone network, a monthly fee of between $52,800 and $70,400 will be incurred. This equates to annual cost to the State of $633,600 to $844,800.

Level of Interoperability:

This recommendation would provide the basis for extension of Interoperability Level 4, 5 & 6 throughout the State.

4.2.4.3 System Management

The proposed network will need to be managed by the State. An important consideration is that the department responsible for engineering, design and operation be intimately familiar with public safety applications. The reason for this is that the proposed network supports important public safety radio systems. Although these systems in general will use common networking equipment such as Cisco routers, the familiarity with radio system technology is an absolute requirement. For example, changes or upgrades to the network that have not been cleared with the radio system vendors (or the radio system is not ready to interface with the latest release of the network software) may result in detrimental effects to the radio system.

4.2.4.4 Advantages and Disadvantages

Advantages:

- Provides a statewide IP backbone network. The network is integral to long-term interoperability solutions. Many of the public safety applications are moving toward IP based systems.
- Efficient management of Bandwidth
- Suitable for all types of applications, IP, frame relay, voice, video, Ethernet
- Virtual circuits
- Alternate routing and mesh

Disadvantages:

- Implementation cost
- Recurring monthly fees for T1 or other interconnection circuits
- System complexity

4.2.5 Long-Term Recommendation #5 – Establish and Operate Network based Gateway Switches for Interconnection of Systems

4.2.5.1 System Description

This recommendation uses an infrastructure network interoperability system to interconnect responding agencies on disparate radio systems. Examples of these interoperability systems include Network First or Motobridge, and are discussed in detail in Appendix I. In general, these

switches enable the interconnection of audio from different systems, but are limited in feature set. In addition, these types of interconnections require resources (including channels) from both systems in order to communicate.

Networked systems depend upon some form of connectivity to support their interconnection. Some are circuit based, while some make use of packet data technology such as Voice over Internet Protocol (VoIP). Many system suppliers strongly recommend private or dedicated methods of connectivity instead of an interconnection that is shared, such as the Internet. When considering a network solution, an important aspect is the survivability of the circuits that provide the connectivity. Certain events can compromise these services, unless alternate routing or some other form of redundancy is employed. Recommendation #6 describes development of a statewide backbone IP system that would support a network based VoIP interoperability switch(s) concept. Recommendation #6 further suggested that an application of the statewide backbone system would be an interconnection of the primary Dispatch Centers in the state. Since the majority of the Public Safety systems in the state are accessed through the Dispatch Centers, this will allow the proposed VoIP interoperability switch(s) to interconnect the various systems on demand. There are various approaches to the design of such a system and they vary by vendor from a central switching platform with appropriate backup redundancy to a distributed configuration, or a combination of these two approaches.

This recommendation is similar in functionality to the BSSA Communications/Command Vehicle concept, except that it links the systems remotely through a network, instead of on-site via an RF link.

Level of Interoperability:

This recommendation would provide Interoperability at Level 4.

4.2.5.2 Budgetary Cost

From the Report for Task 2B, there are approximately 1,171 conventional systems or channels and 45 trunked systems. Therefore, if the goal were to interconnect all of the existing systems within the State, the interconnection network would need to support one talkpath for each conventional system and one or more for each trunked system. As a result, an estimated 1360 talkpaths will be required to interconnect every system within the State. The budgetary, order of magnitude costs shown below reflect a base cost for a VoIP switch, and a cumulative cost for the total of 1360 talkpaths.

TABLE 4.2.5.2-1

Long-Term Recommendation #5 - Budgetary Cost – Statewide System Interconnection

Item	Total / Unit
VoIP Switch, Engineering Services	$1,000,000
1360 Talkpaths	$ 17,000,000
Total	$ 18,000,000

Optionally, this recommendation could be implemented in a regional or incremental approach to allow for a phased implementation and budget expenditure.

In addition, monthly service fees for interconnection circuits such as T1 lines (as identified in the previous recommendation) must also be considered when evaluating this recommendation.

4.2.5.3 System Management

The management of each system interconnection will require an active level of operational effort to establish and knock-down the interoperability links, develop, implement and maintain the radio interfaces. In addition to the operational effort, policy level groups or committee(s) will be needed to develop and maintain the appropriate operating procedures.

4.2.5.4 Advantages and Disadvantages

Advantages:

- Allows on-demand interconnection of disparate radio systems,
- The operation is conducted remotely from either a central location, regional center, dispatch center, or a combination of one or more of these,
- Allows limited remote dispatching of systems and provides some level of backup dispatch capability.

Disadvantages:

- This method of interoperability works as long as the individual radio units are within their respective radio system coverage. Note this recommendation does not improve or enhance the coverage of the individual radio systems,

- Linking or patching of the channels will utilize channels and resources from each interconnected system,
- Requires personnel in a real-time operation for performing interconnection of the systems and subsequent knock-down of the connections. The operators must also monitor the quality of the linked output,
- Must establish a process or procedure to avoid a conflict when other interoperability switches, which may be operated independently by other entities, are in use,
- Requires cooperation of various agencies for linking of the systems.

4.3 Summary of Recommendations

The development of Ohio's State Interoperable Communications Plan has identified a number of existing communications strengths and ongoing interoperability initiatives within the State. While much progress has been made, further enhancement is recommended to more fully equip the first responder community with the communications tools they deserve to protect life and property most effectively.

Since no single all-encompassing solution exists, the team has identified a total of ten recommendations designed to greatly improve the communications interoperability throughout the first responder community within the State of Ohio. The recommendations are comprised of five short to intermediate term recommendations designed to provide short term benefit, and five long term recommendations designed to provide a long term vision of enhanced communications interoperability throughout the State. These recommendations, which have been described in detail in the previous sections, are summarized again in the tables below.

TABLE 4.3-1

Short-Term Recommendation Summary

Recommendation	Interoperability Level Goal
Dispatch Center Talkgroup	Level 5 at Dispatch Centers
Integrate OSIRN Radios into Console Electronics	Level 5 at Dispatch Centers & Level 4 for patched systems
Extend OSIRN capability to other Dispatch Centers and Critical Infrastructure Dispatch/Control Centers	Level 5 at Dispatch Centers & Level 4 for patched systems
Equip Incident Command and Key Supervisory vehicles with OSIRN Capability	Level 5 for Incident Command
Encourage Existing Systems to Provide Provisions for interoperability with Neighboring Systems	Level 4 for Neighboring Systems

TABLE 4.3-2

Long-Term Recommendation Summary (In order of priority)

Recommendation	Interoperability Level Goal
Expand and Upgrade OSIRN	Level 6 for all OSIRN users
Encourage Consolidation of Communications Systems at the County Level	Level 6 at county level
Interconnection of Countywide Systems to OSIRN	Level 5/6 for all systems across the State
Implement a Statewide Backbone System	Backbone for Level 4, 5 & 6 throughout the State
Establish and Operate Network based Gateway Switches for Interconnection of Systems	Level 4 for Interconnected Systems