MULTI-AGENCY RADIO COMMUNICATIONS SYSTEM

[MARCS]

APRIL 1. 2010

TASK FORCE REPORT

[MARCS] contents

EXECUTIVE SUMMARY

In April 1993, Ohio stood still as inmates in the Southern Ohio Correctional Facility in Lucasville rioted for 11 days, initially taking thirteen correction officers hostage, with five being held for the duration of the riot. Ultimately, inmates murdered ten individuals, including Correction Officer Robert Vallandingham.

At the onset and throughout the course of the riot communication was an issue. SOCF Warden Arthur Tate was near London, Ohio, when he was notified of the uprising. He arrived at the institution approximately three hours later. There was no way to communicate with the institution while he was returning, resulting in delays before control and containment steps could be taken. As the siege continued, the difficulty in being able to communicate between the responding agencies also played a significant role in hampering their ability to manage the situation.

In the final days of the riot, during negotiations for inmate surrender, Ohio State Highway Patrol Colonel Thomas Rice was brought to the table. Col. Rice and two others met in the prison yard with three inmates selected to negotiate on behalf of the rioting inmates. Seeing Warden Tate, or knowing that he was even involved in discussions, could have caused inmates to walk away from the table.

To communicate with leaders on the outside, including Warden Tate, Col. Rice had only a low-band radio whose range was so weak that only a radio located just outside the prison yard could pick up its signal.

The lack of a longer range wireless communication option necessitated that the colonel's executive assistant, Staff Lt. Ken Morkel, stand just outside the prison yard to receive dispatches from the colonel, drive several hundred yards to the site where Warden Tate was located to relay the message and then return with his reply. This process was repeated several times as negotiations continued, eventually resulting in inmate surrender.

During the negotiations, inmates threatened to leave because of the length of time it took for demands to be reviewed by the person Colonel Rice was talking with via radio. They could not believe that there was not a radio system with the ability to communicate outside the prison walls, and assumed the colonel was stalling for time.

On September 11, 2001, as people fled the World Trade Center, fire fighters, police officers and emergency medical service personnel flooded into the building to assist in the evacuation. Throughout the confusion, first responders' communications are reported to have gone down, which caused them to miss directions from coordinating officers and vital cries to leave the collapsing buildings.[1]

As SAFECOM, a program of the federal Department of Homeland Security, states, "The tragic events of 9/11 clarified the critical importance of effective emergency responder communication systems. The lack of emergency response interoperability is a long-standing, complex, and costly problem with many impediments to overcome."[2]

In completing the tasks assigned to it, the MARCS Task Force was guided by the thought that *if public safety officials and first responders can't talk to one another, people's lives are in danger.*

Public safety officers risk their lives daily entering unknown situations, depending upon their radios to call for back-up. If these radios don't work, we are putting their lives, and civilians' lives, at risk.

The MARCS Task Force, created by the Ohio General Assembly in July 2009, was charged to: "...explore and issue recommendations on the organizational structure and operational and capital funding options for the long-term sustainability and more ubiquitous utilization of the MARCS system."

After months of preparing the research and recommendations found in this report, and

1 The 9-11 Commission Report
2 < http://www.safecomprogram.gov/SAFECOM/about/default.htm>

drawing upon decades of experience in public safety, Task Force members strongly believe that Ohio has a tremendous opportunity to move towards an all-encompassing, collaborative and coordinated public safety communication system. This system could eventually service every public safety and first responder entity, from township to city to college to county to state. The Task Force does not believe that this could or should happen overnight. As local systems need to be upgraded, MARCS would offer a cheaper and more efficient alternative, rather than taxpayer dollars being spent to upgrade every jurisdiction's system individually. By moving towards a truly interoperable system, Ohio would see not only a cost savings, but also increased coordination in emergencies which require a response from multiple agencies for multiple jurisdictions.

To increase this collaboration, the Task Force also calls upon the Department of Administrative Services to study ways by which existing state network infrastructure can be utilized to help expand the capabilities and options for public safety communication. This includes the use of the state's fiber optic network to assist in 911 dispatching capabilities.

KEY ISSUES

The key issues identified by the Task Force while exploring the legislative charge are as follows:

- The current organizational structure may not be the optimum structure to support the continued success of MARCS.
- The user community has greatly expanded since MARCS was first launched and may not be appropriately represented in the governance structure of MARCS.
- The system is reaching official product end of life and full supportability in June 2013.[3,4,5]
- The FCC is mandating that mobile radio change to narrowband transmission (12.5 MHz instead of 25.0 MHz) in an attempt to relieve a very crowded section of the spectrum.[3] This change is required by January 1, 2013, and is forcing many public safety agencies to upgrade or replace their current systems.[5]
- The MARCS system must be upgraded to the P25 standard to be eligible for future federal funding.
- The MARCS system must be upgraded to P25 standard[6] to increase interoperability.
- The system is supported exclusively by user fees, which local communities find difficult to afford.
- MARCS is near capacity and can accommodate fewer than 1,000 additional IDs to the current platform.

RECOMMENDATIONS

To overcome these issues, the Task Force recommends the following:

1. MARCS should remain within the Ohio Department of Administrative Services, and the program manager of MARCS, appointed by the director of the Department of Administrative Services, should continue to report to the State Chief Information Officer through the Chief Operating Officer of the Infrastructure Services Division of the Office of Information Technology.
2. The MARCS Steering Committee should be expanded to better represent users.
3. The MARCS Steering Committee and MARCS program should be codified within the Ohio Revised Code as a permanent organization of the Ohio Department of Administrative Services rather than remaining in temporary law. This will give local users increased confidence in the

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3 FCC Order 05-9, WT Docket No. 96-86, January 7, 2005, Federal Communications Commission, 03 March 2010 <http://hraunfoss.fcc.gov/edocs_public/attachmatch/Fcc-05-9A1.pdf>.
4 Lane, Bill, "Narrow Banding Public Safety Communication Channels," Tech Notes, Federal Communications Commission Public Safety and Homeland Security Bureau, 03 March 2010 <http://www.fcc.gov/pshs/techtopics/techtopics16.html>.
5 "Narrowbanding," 2008, RadioReference.com, 03 March 2010 <http://wiki.radioreference.com/index.php/Narrowbanding>.
6 P25 or APCO-25 refers to a suite of standards for digital radio communications for use by federal, state/province and local public safety agencies in North America to enable them to communicate with other agencies and mutual aid response teams in emergencies. The standards were produced through the joint efforts of the Association of Public Safety Communications Officials International (APCO), the National Association of State Telecommunications Directors (NASTD), selected federal agencies and the Naitional Communications System (NCS), and standardized under the Telecommunications Industry Association (TIA). Please see appendix for details.

continued support of the program.

4. MARCS should seek opportunities to maximize the benefits of the tower infrastructure.
5. MARCS should eliminate user fees.
6. MARCS should establish a back-up system.
7. MARCS should fully partner with large cities and counties to establish a statewide system of systems to maximize interoperability and minimize duplicative systems and their subsequent cost.
8. A funding source should be established that is stable and that addresses both the capital needs and the operational needs of the system.
9. Funding should be collected from those who benefit most from the system: the residents of Ohio. Possible funding options were identified, including phone fees on wireline and wireless service, motor vehicle fuel taxes, federal grants, BMV fines and fees, and a "sin" tax.
10. The upgrade to FCC narrowband requirements and P25 standards should be funded through a revenue bond.

The following report explains how and why the Task Force reached these conclusions.

BACKGROUND

A BRIEF HISTORY OF MARCS

Two deadly events spurred the development of Ohio's Multi-Agency Radio Communication System (MARCS) – the Shadyside Flood in 1990 and the Lucasville prison riot in 1993. Following the flood, which took 26 lives and caused numerous injuries, then-Governor Richard F. Celeste issued a directive to design a new, interoperable radio system. Governor George Voinovich took office a few months later and continued to support this initiative.

The 11-day Southern Ohio Correctional Facility riot in Lucasville cost 10 lives, including the life of Correction Officer Robert Vallandingham, and refocused attention on the importance of interoperable communication devices. The MARCS Steering Committee was established in 1994, by HB 790 during the 120th General Assembly,

AUGUST 2004
More than 900 visitors to Put-In-Bay complained of gastrointestinal illness after visiting the island. The Ohio Department of Health and other first responders (ODNR, EPA, local hospitals and health departments, and CDC) arrived on the island to mitigate the incident. The CDC reported, "There has never been an outbreak like this in the history of the country." Through MARCS, all responders were able to communicate in real time. In the end, 15 wells and 12 businesses tested positive for total coliform bacteria or *e. coli* and immediate steps were taken to restrict availability to the public.

to provide assistance to the director of Administrative Services for the effective and efficient implementation of MARCS as well as to develop policies for the ongoing management of the system.

By 1999, MARCS had been designed, bids requested and reviewed, a contract awarded (to TRW of Cleveland[7]), and $272 million in capital funding for real estate purchases and lower build-up secured. Construction commenced the following year. Memorial Day weekend in 2002 marked the first wide-area use. The last tower was finished and county-by-county testing was completed in December 2004.

Thousands of lives and millions of dollars in public and private property depend on maintaining an up-to-date, smoothly functioning, interoperable radio system. The original MARCS concept was to facilitate communication among 10 state agencies, which would bear the costs. The system has evolved into a cross-state, multi-jurisdictional interoperable service, spanning all levels of first responder and law enforcement services.

Today, MARCS is used by more than 700 local and federal first responder agencies, as well as border areas in contiguous states. Users include 213 fire agencies, 128 police agencies, 80 emergency medical service

7 Purchased by Northrop Grumman in 2002.
For information on the TRW acquisition, please see <www.northropgrumman.com/heritage/index.html#2002>.

agencies (EMS), 89 emergency management agencies (EMA), 17 state agencies, the Federal Bureau of Investigation (FBI), the Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF), the U.S. Border Patrol, the U.S. Fish and Wildlife Service, and the High-Intensity Drug Trafficking Area (HIDTA), part of the Drug Enforcement Administration. In all, there are 1,292 subscribing agencies, including health departments, hospitals, fire and police departments, EMS, EMA, sheriffs' offices, the Red Cross and other first responder and public safety agencies throughout Ohio, and in the bordering counties of Michigan, Indiana and West Virginia.

The MARCS infrastructure consists of 130 state-owned towers and 80 leased-space towers, connected through 300 T-1 lines into core computer equipment at the State of Ohio Computer Center. Although only 8,500 mobile radios were envisioned originally, as of February 1, 2010, there were 47,280 radios activated on the MARCS network, as well as 75 computer-aided dispatch consoles and 1,885 mobile data terminals (in-car computers).

THE MARCS MISSION

MARCS is dedicated to providing Ohio's first responders and public safety providers with state-of-the-art wireless digital communications, and to promote interoperability, in order to save lives and maximize effectiveness in both normal operations and emergency situations.

PURPOSE OF THE MARCS TASK FORCE

Proven effective time and again, MARCS has experienced explosive growth in a short period of time. This growth has led to virtually all the capacity of the current system being exhausted. Meanwhile, in order to serve ever increasing numbers of wireless users, the Federal Communications Commission (FCC) is assigning public safety mobile communication to narrowband frequencies and all licensees must be in compliance by January 1, 2013.[8] Similarly, the Public Safety community has developed a set of standards meant to foster interoperability in mission critical communications called Project 25 (P25). To insure this interoperability, the meeting of the P25 standard is increasingly required to secure federal funding.

Recognizing that MARCS is a critical service influenced by a powerful combination of factors, the General Assembly mandated the formationof the Task Force, pursuant to section 755.80 (A) of HB 2, the transportation budget bill. This states:

> There is established a MARCS Task Force to explore and issue recommendations on the organizational structure and operational and capital funding options for the long-term sustainability and more ubiquitous utilization of the MARCS system.

MEMBERS OF THE MARCS TASK FORCE

Membership on the MARCS Task Force is prescribed by HB 2 in the following passage:

> The Task Force shall consist of seventeen members as follows: three members appointed by the Governor; three members appointed by the Speaker of the House of Representatives, not more than two from the same political party; three members appointed by the President of the Senate, not more than two from the same political party; one representative from the Department of Public Safety, appointed by the Director of Public Safety; one representative from the State Highway Patrol, appointed by the Director of Public Safety; one representative from the Buckeye State Sheriffs' Association, appointed by the Governor; one representative from the Ohio Association of Chiefs' of Police, appointed by the Governor; one representative from the Ohio Fire Chiefs Association, appointed by the Governor; one representative from MARCS, appointed by the Director of Administrative Services; one representative of an emergency management agency, appointed by the Governor; and the Director of Administrative Services or the Director's designee. The appointed members shall be appointed not later than forty-five days after the effective date of this section.

8. Ibid.

> The Director of Administrative Services or the Director's designee shall serve as chairperson of the Task Force.

In accordance, the Task Force membership and chair are as follows: Darryl Anderson, administrator, MARCS; Tony Celebrezze, deputy director, Ohio Department of Natural Resources; Adam Coridan, budget analyst, Office of Budget and Management; Col. David Dicken, Ohio State Highway Patrol; Keith Faber, Ohio Senate; Sheriff Mike Heldman, Buckeye State Sheriffs' Association; Cliff Hite, Ohio House of Representatives; Chief Charles Horner, Ohio Association of Chiefs of Police; Eric Kearney, Ohio Senate; Tom Letson, Ohio House of Representatives; Clayton Luckie , Ohio House of Representatives; George Maier, assistant director, Ohio Department of Public Safety; John Parker, director, Jefferson County Emergency Management Association; Tom Patton, Ohio Senate; Chief Scott Skeldon, Ohio Fire Chiefs' Association; and Terry Tibbals, north regional security administrator, Ohio Department of Rehabilitation and Correction. Sam Orth, state chief information officer, serves as the chair of the MARCS Task Force.

TASK FORCE WORK PROCESS

The Task Force met as a whole three times from September 2009 through November 2009 to gather background on MARCS' history, infrastructure, operations, use, funding, future federal requirements and challenges facing both the system and users or potential users. (Research documents reviewed by the Task Force can be found in the appendix of this document.) The Task Force then divided into three work groups: Organizational Structure, Use-Ubiquitous Utilization, and Funding-Operational and Capital Options. The work groups, guided by charters found in the appendix of this report, met several times over two months to make recommendations regarding their subject areas to the entire Task Force. The Task Force as a whole then reconvened in January 2010 to discuss each work group's recommendations. The Task Force reviewed and adopted the recommendations and included them within the MARCS Task Force report. After two additional meetings, the Task Force agreed upon a draft report to be shared with stakeholder organizations. The Task Force discussed and took action on recommendations from stakeholders in a full meeting on March 30, 2010. The final report, including recommendations for the future of MARCS, was accepted by the MARCS Task Force at this meeting.

CURRENT MARCS ORGANIZATION

MARCS is a program area of the Office of Information Technology (OIT), which is a division of the Department of Administrative Services. The MARCS program manager reports to the chief operating officer and deputy director of OIT; supervises two managers; and leads approximately two dozen staff members.

The MARCS Steering Committee exercises strategic oversight. The committee is established in temporary law and must be renewed biannually. This lack of stability creates uncertainty among MARCS' customers as to the support the program will continue to receive. Section 103.80.20 of HB 496, the capital reappropriations bill passed by the 127th General Assembly and signed by the governor (effective June 30, 2008), continued the Steering Committee for the biennium ending June 30, 2010. Section 103.80.20 reads as follows:

> There is hereby continued a Multi-Agency Radio Communications System (MARCS) Steering Committee consisting of the designees of the Directors of the Office of Information Technology, Public Safety, Natural Resources, Transportation, Rehabilitation and Correction, and Budget and Management. The Director of the Office of Information Technology or the Director's designee shall chair the Committee. The Committee shall provide assistance to the Director of the Office of Information Technology for effective and efficient implementation of the MARCS system as well as develop policies for the ongoing management of the system. Upon dates prescribed by the Directors of the Office of Information Technology and Budget and Management, the MARCS Steering

> Committee shall report to the Directors on the progress of MARCS implementation and the development of policies related to the system ...

At this time, the members of the MARCS Steering Committee are: Sam Orth, state CIO, chair; Cathy Collins-Taylor, director, Department of Public Safety; Sean Logan, director, Department of Natural Resources; Ernie L. Moore, director, Department of Rehabilitation & Correction; Jolene M. Molitoris, director, Department of Transportation; and Pari Sabety, director, Office of Budget and Management.

CURRENT MARCS FUNDING

MARCS' annual operating budget is just under $11.1 million. The Ohio Revised Code currently provides funding for MARCS from users' fees collected and distributed by three different intermediaries, each for a specific purpose. Section 4501.16 provides for a MARCS maintenance fund, which "shall consist of moneys received by the state highway patrol from users of the multi-agency radio communications system (MARCS). The fund shall be used to provide maintenance for MARCS-related equipment located at both the MARCS facilities and tower sites."

Section 4501.28 provides for a MARCS operations fund, which "shall consist of moneys received by the emergency management agency established under section 5502.22 of the Revised Code from users of the multi-agency radio communications system (MARCS)."

Added by the 128th General Assembly, section 4501.29 provides an administration fund directing the Department of Administrative Services to "collect user fees from participants in the multi-agency radio communications system (MARCS)" for that purpose.

There presently is no funding source to meet recurring needs to upgrade, extend or expand the system. For instance, currently MARCS must upgrade to P25 standards, convert transmitters and receivers to narrowband capability, and address end-of-life issues for equipment.[9] Upgrades also would support increased MARCS use, which is limited by the fact that the system is near capacity.[10] The current user fee system, which is based on cost recovery, inhibits broader, more ubiquitous use of the system.

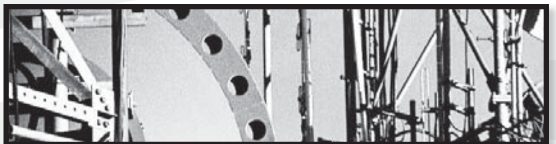
REPORT DEADLINE

The final date for submission of this report is April 1, 2010, as specified by HB 2, section 755.80 (B):

> Not later than nine months after the effective date of this section, the Task Force shall submit a report to the Governor, the President of the Senate, and the Speaker of the House of Representatives. The report shall make recommendations on the matters outlined in the first paragraph of division (A) of this section for the MARCS System.

ORGANIZATION OF THIS REPORT

The following pages detail the research findings and recommendations of the Task Force summarized above. The appendix contains statements of support for MARCS and for the Task Force's recommendations. details on P25 specifications, notification as to equipment end-of-life, data gathered by the Task Force, and the project charters of the three work groups.



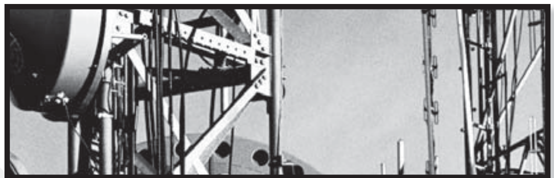
SEPTEMBER 2008
The Clermont County 800MHz radio system suffered a power outage during the September 14 windstorm. Delaware County also experienced outages during the windstorm. The statewide interoperability provided by MARCS to these local agencies allowed them to re-establish communications with their 911 center during this local outage.

9. The manufacturer has announced that support for the system will end as of June 2013. Please see the letter from Motorola in the appendix to this document.
10. Ibid

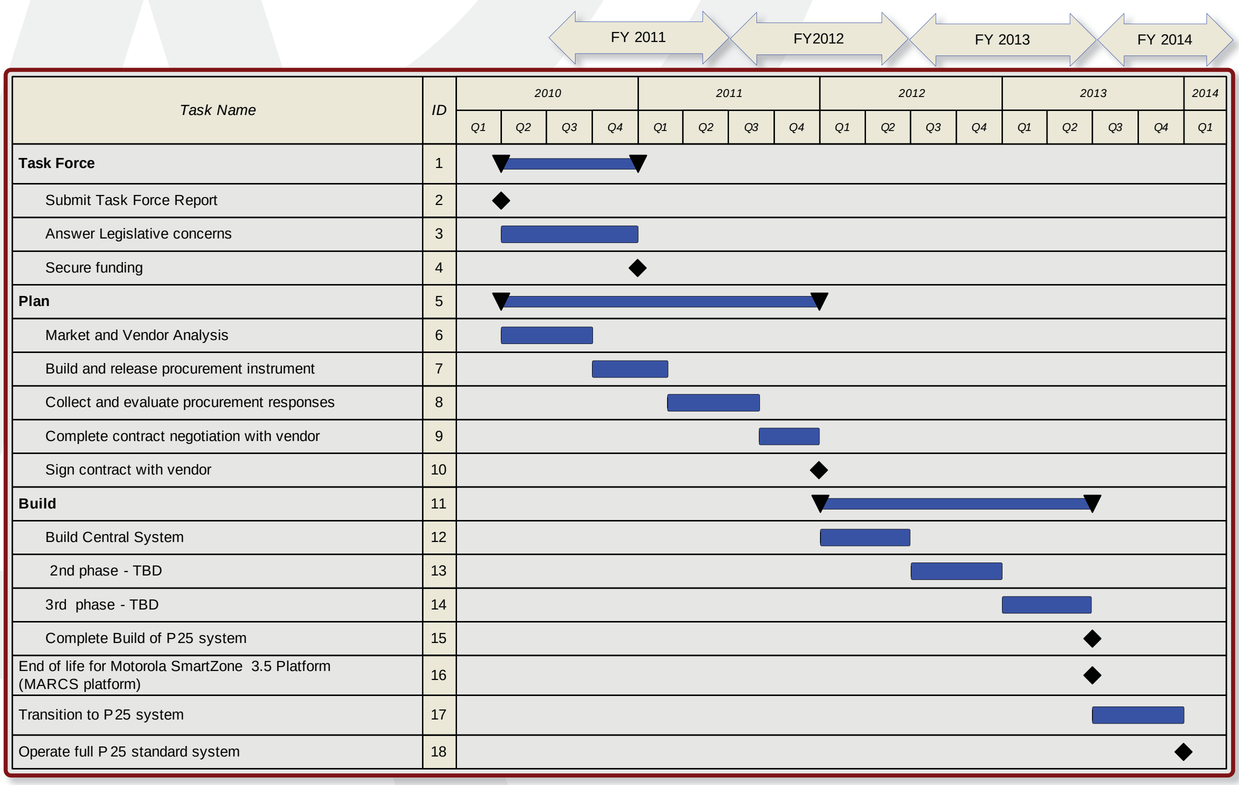
NEXT STEPS

The end-of-life of the current MARCS platform will occur in June 2013. This allows time to secure funding, evaluate products and vendors, decommission the current system, and migrate to a P25 standard system by July 1, 2013.

The following timeline shows the major steps of the process and the time necessary to complete the project. All times are estimated. As the project moves forward, additional details will allow better estimates of project completion. The July 1, 2013, date is a very real constraint. Ohio prides itself on an enterprise first responder system. If these timelines are significantly delayed, the project completion date may slip beyond the July 1, 2013, date. This would jeopardize the system's ability to support first responders.



JULY 2008
A joint initiative of the Cleveland Public Safety Drug Task Force, Ohio Bureau of Criminal Investigation, Franklin County Sheriff, U. S. Marshal Service and Columbus Police Department resulted in the arrest of a known drug trafficker. Officers were able to follow the suspect as he traveled from northeast Ohio to the west side of Columbus. Undercover officers were able to communicate with each other through MARCS, sharing the route the offender was traveling, where he stopped for gas, and switch positions so the offender did not become suspicious. When the offender reached the purchase point in Columbus, officers were able to arrest the offenders on the spot.



ORGANIZATIONAL STRUCTURE

BACKGROUND

The steering committee for the present-day Multi-Agency Radio Communication System (MARCS) was enacted by HB 790 during the 120th General Assembly and has been renewed biannually, most recently by section 103.80.20 of HB 496 during the 127th General Assembly. The director of the Department of Administrative Services was assigned to implement the MARCS system and develop policies for the ongoing management of the system. The director was to be assisted by the following Steering Committee members:

- Chairperson, State Chief Information Officer
- Director of Department of Public Safety
- Director of Department of Natural Resources
- Director of Department of Rehabilitation & Correction
- Director of Department of Transportation
- Director of Office of Budget and Management

TASK FORCE RECOMMENDATIONS

1. **MARCS Management**
   MARCS should remain within the Ohio Department of Administrative Services. The director of the Ohio Department of Administrative Services should continue to appoint a program manager for MARCS. The program manager should continue to report to the state chief information officer through the chief operating and deputy director officer of the Infrastructure Services Division of the Office of Information Technology, Ohio Department of Administrative Services.
2. **Legislation**
   The MARCS Steering Committee and MARCS program should be codified within the Ohio Revised Code as a permanent organization rather than remaining in temporary law. This move to permanent law will provide potential local users with increased confidence as to the continued support of the program.
3. **Steering Committee**
   MARCS should be overseen by a steering committee with a membership that is expanded beyond that of the current steering committee. The expanded, 22-person committee would consist of representatives of today's MARCS user community. This committee will advise the state CIO in the operation of the system and suggest rules, policies and procedures for the effective operation of the system. The state CIO will seek the committee's advice on the efficient management of MARCS, which would include such subjects as expansion of the system, upgrades to the system, and other strategic issues.

Membership of the MARCS Steering Committee

Number of members:	22
Voting:	18
Non-voting:	4

Additional notes on the steering committee and its members:

- Members of the committee shall serve without compensation.
- The State CIO shall act as the chairperson of the steering committee.
- The committee may establish advisory groups as needed to address topics of interest and to provide guidance to the steering committee regarding the needs of state agencies, first responders and public safety.
- Advisory group members need not be members of the steering committee.

PROPOSED STERRING COMMITTEE MEMBERSHIP

	AGENCY	APPOINTMENT	CURRENT	PROPOSED	VOTING
1	Department of Administrative Services	State CIO or designee	Y	Y	Y
2	Department of Natural Resources	Director or designee	Y	Y	Y
3	Department of Rehabilitation & Correction	Director or designee	Y	Y	Y
4	Department of Public Safety	Director or designee	Y	Y	Y
5	Department of Health	Director or designee	Y	Y	Y
6	Office of Budget & Management	Director or designee	Y	Y	Y
7	Department of Transportation	Director or designee	Y	Y	Y
8	Department of Youth Services	Director or designee	N	Y	Y
9	Board of Regents	Director or designee	N	Y	Y
	ASSOCIATION				
10	Buckeye State Sheriffs' Association	Governor selects from association nominations	N	Y	Y
11	Ohio Fire Chiefs' Association	Governor selects from association nominations	N	Y	Y
12	Ohio Association of Chiefs of Police	Governor selects from association nominations	N	Y	Y
13	County Commissioners' Association of Ohio Representative	Governor selects from association nominations	N	Y	Y
14	Ohio Township Association	Governor selects from association nominations	N	Y	Y
15	Ohio Municipal League	Governor selects from association nominations	N	Y	Y
16	Emergency Management Association of Ohio	Governor selects from association nominations	N	Y	Y
17	Large city using MARCS as their primary public-safety radio system	Gubernatorial appointment	N	Y	Y
18	Large city or county fire department using MARCS as their primary public-safety radio system	Gubernatorial appointment	N	Y	Y
	OHIO GENERAL ASSEMBLY				
19	House of Representatives	Appointed by Speaker, Majority Party	N	Y	N
20	House of Representatives	Appointed by Speaker, Minority Party	N	Y	N
21	Senate	Appointed by President, Majority Party	N	Y	N
22	Senate	Appointed by President, Minority Party	N	Y	N

USE - UBIQUITOUS UTILIZATION

BACKGROUND

In considering the challenge of increasing the use of MARCS, the Task Force studied the following data:

Current customer data. Statistics comparing the availability of individual end-user radios (known as IDs) in January 2008, January 2009 and January 2010.

Future customer data. A regional Homeland Security survey, deployed to gauge the number of potential future users.

Future capacity. Capacity data for an upgraded system.

Upgrade cost. A breakdown of upgrade costs, including backbone, computer aided dispatch (CAD) and user equipment.

Continuing upgrade information. Overview of upgrade status: what is started, the base plan, and what will need to be in place in 2013.

Upgrade drivers. A list of upgrade drivers as identified in the RCC Consultants, Inc. (RCC), and the U.S. Department of Homeland Security/Interoperable Communications Technical Assistance Program (ICTAP) reports.[11]

In addition, data on current local communication systems will be examined. RCC is currently conducting research on systems across the state and their status.

This data revealed the following:

- The current system is near capacity for system user IDs. Current system capacity is 48,000 IDs. As of February 17, 2010, fewer than 1,000 IDs were available. An upgraded system will support 128,000 IDs.
- The potential exists for an increase in demand for use of the system at the local first responder level due to current system end-of-life issues, narrowbanding, fund availability, and the need for redundancy.
- Upgrade of the current system is required to support increased capacity and address end-of-life issues.
- The system will require ongoing maintenance.
- Greater participation of first responders is dependent on available capacity (upgrade) and the elimination, reduction or subsidization of user fees.

SEPTEMBER 2006
FBI Director Robert S. Mueller, III, in conjunction with the Ross County Sheriff's Department, Chillicothe, Columbus Police Department, Ohio State Highway Patrol, Ohio Bureau of Criminal Identification and Investigation and the U.S. Marshal's Service, added John W. Parsons to the FBI's Ten Most Wanted Fugitives List. Parsons had escaped from the Ross County Jail where he was being held for the 2005 murder of Chillicothe Police Officer Larry Cox. The ability of the FBI, U.S. Marshal Service, U.S. Alcohol, Tobacco, Firearms and Explosives (ATF), and law enforcement agents from all over Ohio to communicate through MARCS was the key to capturing Parsons. Once the FBI, U.S. Marshals and ATF experienced the capabilities of MARCS, they also became MARCS subscribers.

TASK FORCE RECOMMENDATIONS

To enable greater participation statewide in the use of the MARCS system, the Task Force makes the following recommendations:

1. Upgrade MARCS to P25 requirements.

MARCS should upgrade from the current 800 MHz trunked digital system to a 700/800 MHz IP-based system.

The state engaged the RCC and ICTAP for an independent validation of the need to upgrade MARCS from its current platform to a P25 compliant, IP-based platform. These reports offer strong insight and support for an upgrade of the current system, what this system should look like, potential cost, benefits, risks and strategies. The RCC and ICTAP reports are available in the appendix.

11 Please see the appendix for these reports.

The RCC and ICTAP final reports, delivered at the November 19, 2009, Task Force meeting, provided significant detail on the drivers to upgrade the MARCS system to P25 compliance. These drivers include, but are not limited to, the following:

1. Increase system user capacity (IDs) to include all Ohio first responders.
2. Increase traffic capacity (grade of service).
3. Improve portable and in-building coverage.
4. Address narrowbanding requirements (access new public safety spectrum).
5. Implement a standards-based system (P25) to increase interoperability and interconnectivity.
6. Meet DHS grant funding requirements (systems must be P25 compliant).
7. Improve interoperability – this supports the Ohio Statewide Communications Interoperability Plan /Statewide Interoperability Executive Committee (SCIP/SIEC) vision.
8. Avoid costs and risks associated with the end of useful life of the current system.
9. Employ new technology – packet switched (IP-based) vs. circuit switched.
10. Meet Goal 3 of the National Emergency Communications Plan: "By 2013, 75 percent of all jurisdictions are able to demonstrate response-level emergency communication in three hours, in the event of a significant incident as outlined in national planning scenarios."[12]

Greater participation in MARCS is limited by system capacity. As mentioned earlier in this report, the system was originally intended for communication among 10 state agencies with approximately 8,500 radios. This was intended to serve the needs of both state agency first responders and those in need of wireless communication. MARCS has grown to serve 17 state agencies, 700+ federal and local first responders, and approximately 33,000 radios.

12 "National Emergency Communications Plan," Rev. August 2008, U.S. Department of Homeland Security, 03 March 2010 <http://www.dhs.gov/xlibrary/assets/national_emergency_communications_plan.pdf.>

As MARCS talks to additional first responders about joining the system, these potential users need to be assured that the upgrade will occur within a timeframe that meets their needs. Ohio's public safety community includes:

- 37,000 law enforcement personnel
- 53,000 fulltime and volunteer firefighters
- 41,000 EMT/paramedics
- 1,350 emergency squads

According to RCC estimates, the upgrade will cost approximately $205,000,000.[13] This does not take into account infrastructure that has been purchased and installed in a few limited cases.

2. Eliminate MARCS User Fees.

User fees are the barrier to further state and local first responder participation in MARCS. Current user fees are:

- $20/radio/month
- $1,800/Computer Aided Dispatch/month
- $350/Mobile Computer Terminal (MCT)/month[14]
- $40/MCT/month – Law Enforcement Automated Data System (LEADS) only

Customers must make a capital investment for equipment, including radios and in-car computers. Options exist such as federal grants to reduce radio and equipment costs. A similar solution does not exist to address user fees.

MARCS is a rotary funded organization, with operating costs recovered through user fees. If user fees are eliminated, an alternative source of funding would have to be identified to ensure that the recommended MARCS $15,000,000 operating budget is maintained.

3. Establish a MARCS Back-Up System.

Four statewide interoperable high-band frequency systems exist: State Fire, Law Enforcement Radio Network, National Law Enforce-

13 Please see the RCC Report in the appendix.
14 A Mobile Computer Terminal (MCT) is an in-car computer.

ment, and Fire Aid. These systems act as a back up to fire and police systems today.

For an additional investment in the MARCS upgrade of approximately $4 million, 20 towers could be equipped with transmitters and receivers, and a single dispatch could be established per county. This would serve as an initial back-up system for local first responders and those who are primary MARCS users. Participants would be responsible for upgrading vehicle equipment. This would ultimately save taxpayer dollars at the local level and offer true redundancy for MARCS.

A true back-up system that mirrors the current system is a long-term goal and is dependent on other statewide disaster recovery and business continuity strategies.

4. Maximize the Benefits of the MARCS Tower Infrastructure.

There has been increased interest in the tower sites for the purpose of expanding wireless broadband. The American Recovery and Reinvestment Act included funding provisions for grant and loan programs to support the expansion of broadband infrastructure across the country. Applicants have expressed interest in access to the towers across Ohio to support their projects.

Public safety remains a priority for excess capacity on the towers. Currently, 17 entities have lease agreements with MARCS to co-locate on specific towers. It is important to note that private sector tower co-location must be approved by the Ohio Building Authority through their bond counsel for compliance with IRS rules regarding private payment and private use of infrastructure built with tax-exempt bonds. Due to bond-related tax provisions, market rates and the proliferation of towers across the state, revenue generated through co-location is de minimis.

MARCS continues to work with the Ohio Building Authority and other state agencies to leverage the tower infrastructure to enable broadband projects and other tower co-location opportunities to expand services to Ohioans. This includes the Department of Natural

FALL 2003
The I-270 sniper terrified central Ohioans, killing one person during 24 seemingly random shootings. The Columbus Police, Franklin County Sheriff, State Highway Patrol, township police officers, and federal agencies joined forces to identify the perpetrator – Charles A. McCoy -- and prevent further loss of life. They were able to communicate using the Ohio MARCS Radio System.

Resources and their goal for wireless access in state parks to support their employees and provide a benefit to their customers.

MARCS should consider possible public-private partnerships to support aggressive marketing and management of infrastructure opportunities. There are multiple approaches to how other states manage similar infrastructures:

- Motorola responded through a bid process in Illinois to build their tower infrastructure and system.
- South Carolina partners with utilities.
- Montana and Nevada partner with the railroad.
- New York outsources the management of their towers through a competitive bid process but maintains ownership.[15]

5. MARCS should fully partner with large cities and counties that have sophisticated communication systems in place.

There are benefits to local entities that have already invested in system and equipment upgrades to partner with MARCS, such as tower management and support for ongoing and future maintenance and upgrades on systems and equipment.

Case studies were reviewed at the October 22, 2009, Task Force meeting. The Toledo model supports this recommendation. Toledo is implementing a Motorola Version 7.7 system. After the MARCS upgrade, users will

15 See the data on other states in the appendix

be able to roam seamlessly without interruption of service between Toledo's system and MARCS. This option provides redundancy, eliminates duplicate towers, allows the shared use of frequencies, and is more cost effective for taxpayers. This relationship can be duplicated in Butler County, Franklin County, the City of Akron, the City of Cleveland, the City of Columbus and others.

FUNDING–OPERATIONAL & CAPITAL OPTIONS

BACKGROUND

A statewide, interoperable public safety communication system is essential for the public's safety. Echoing the reasoning which first prompted leaders to begin creating the Multi-Agency Radio Communication System, the Task Force believes that a reliable means of communication for first responders to use in day-to-day responses, as well as in major events, is an undisputed necessity.

MARCS is a resource that all local, state and federal public safety agencies communicating within the state should utilize to save taxpayer dollars and increase interoperable communication between agencies. Since the federal government is requiring P25 compliance to qualify for federal funding, the timing is perfect to encourage public safety agencies currently using aging systems to migrate to the MARCS network. Although MARCS does not currently have the capacity to add every first responder in Ohio, it will be able to do so after the narrowband migration and P25 upgrade. This added capacity will mean that local agencies across the state do not have to build and manage their own internal systems, but instead can rely upon the system which the state has already built. The opportunities for savings, reduced duplication of effort, and increased interoperability among agencies are profound.

Local public safety agencies would benefit by using MARCS as their primary communications system, but find it exceedingly difficult to afford user fees. MARCS' current funding structure is to charge a user fee of $20/month/radio. Although the user fees received from local public safety agencies comprise only about 8 percent of MARCS' total budget, MARCS cannot waive fees for any agencies,[16] even those that can show financial distress. Because of federal government rules regarding the use of federal funds in state programs (known as SWICAP, the Statewide Indirect Cost Allocation Plan), MARCS is required to charge all agency, local, state or federal government entities, the same fee. Also, a practice of "waiving" fees would put future funding capacity for MARCS at risk by encouraging new or currently enrolled agencies to plead financial distress.

TASK FORCE RECOMMENDATIONS

1. Any funding source should be stable and cover both the operational and capital needs of the system. Operational and capital funding should be drawn from the same revenue source, with a greater collection in the beginning to support capital expenses, followed by a "steady state" amount of collection to support operations.

A study conducted by state interests in 2005 concluded that, to meet all of its obligations, including maintenance and personnel, MARCS should have an annual operating budget of $15,000,000. Since 2007, MARCS has operated on a flat, $11.07 million annual appropriation budget. Because this recommendation opens the MARCS network to any public safety agency free of charge, the Task Force recommends that any funding source should elevate MARCS' annual operating budget to at least $15,000,000. The Task Force recommends biannual reviews by the MARCS Steering Committee to ensure that this is an appropriate funding level. This recommendation includes presenting a report on revenue and expenses to the governor and leaders of the General Assembly for review.

16 Fees from other users, such as state agencies, provide the balance.

2. Funding should be collected from those who most benefit from a statewide interoperable communication system. All Ohioans benefit from first responders who are able to communicate quickly with back-up and other team members in emergency situations. For this reason, the Task Force believes a fair and manageable fee should provide a dedicated funding stream for this important public resource.

3. A grant program should be set up to help local agencies make the transition to MARCS when their current system becomes obsolete or unusable. The Task Force recognizes that not every local agency will need or want to transition to the MARCS infrastructure immediately after the P25 upgrade. However, as their current communication systems become obsolete, the Task Force recommends that a grant program, using funding from the dedicated revenue source, be established to help local public safety agencies pay for any radios and other equipment necessary to utilize the upgraded system. This grant program, in combination with federal grants, should help to increase the ubiquitous use of the system. The grant program should be administered by the MARCS Steering Committee.

FINANCING OPTIONS

Taking into consideration the fiscal environment as well as the necessity to begin upgrades on MARCS before the expiration of its maintenance schedule in 2013, the Task Force recommends consideration of a revenue bond. In reviewing bond options, the Task Force acknowledged that a $205 million bond backed by the general revenue fund would most likely not be an option in today's budgetary climate.

Although details will be certain only after specific decisions regarding funding source and payback rate are determined, the enactment of the Task Force's preferred financing option would mean:

- The current estimated interest rate for a state of Ohio-issued 20-year revenue bond of this nature is 6 percent. However, this rate could increase or decrease by the time a bond is issued.

SEPTEMBER 2007
MARCS was featured in the September 2007 issue of 9-1-1 Magazine highlighting technology used to enhance mobile data communications through Radio IP.

- A $205,000,000 bond issued at this rate would require a projected $17,872,834 annual debt service payment.
  - Due to rating and revenue coverage requirements for such a bond issuance, the funding source would need to collect at least double the annual debt service payment, plus any amount needed for operating expenses. If a new funding source is chosen, the terms of the bond would require that the source generate annual revenue of $50,745,668 ($17,872,834 x 2, plus $15,000,000 for estimated operating costs).
  - If an existing funding source is chosen, any money collected by the revenue source, even if not intended for the P25 upgrade, would be applicable to the coverage requirement. Thus, a source that collects well over $35 million, such as the "gas tax," would require a minimum of the annual payment plus operating funds in additional revenue to be collected ($32.9 million).
- The bond can be paid off early and, most likely, with no penalty.

Three options for repayment are available:

Option 1: Slow Pay-Off
- Revenues from phone fees would bring in $50 million, with $15 million used for operating expenses and $17 million used for debt service. The remainder each year could be placed towards the principal, allowing the $205 million bond to be paid off in less than ten years.
- Revenues from a motor vehicle fuel tax bring in $32 million each year, with $15 million for operating expenses and $17 million for debt service. The $205 million bond is paid off in twenty years.

Option 2: Quick Pay-off

- For either option, a more aggressive pay-off may be chosen if there is an increased collection of fees or tax.
  - As mentioned earlier, revenues from a non-established funding source would need to bring in at least $50.8 million, with $15 million used for operating and $17.9 million used for debt service. The remainder of the revenue generated each year may be paid toward the principal, allowing an accelerated bond pay-off. Because of the flexibility offered to use the additional $17.9 million in revenue towards paying off the bond faster, or in setting aside part of the sum towards the recommended local grant program, the time in which the bond can be paid off is variable.
- Lower interest would ultimately be paid since the debt would be retired more quickly, which would avoid tens of millions of dollars in interest. (If a $205 million bond is paid off over 20 years, $152,456,684 is paid in interest.)

Option 3: Upfront Payment

- Rather than issuing a bond, there is an option of collecting $205 million from the chosen revenue source before completion of the project.

FUNDING OPTIONS

The Task Force surveyed 43 states and 2 territories to determine how their public safety communication systems are funded. Although most do not have as robust a statewide system as Ohio, many are planning such a system in response to federal requirements. From this survey, found in the appendix of this report, three potential funding mechanisms emerged: user fees; increased citation fines and licensing fees; and phone charges.

- Of the states that currently fund their system via user fees, most are in Ohio's situation, searching for a more flexible, less burdensome revenue source.
- Some states have found success in funding their communication system through increased fines for traffic citations or increased licensing fees, The Task Force notes that Ohio recently enacted these increases to fill a hole in the Ohio State Highway Patrol's budget.

Additionally, the Task Force, in expanding its options, researched federal grants, the motor vehicle fuel tax and 'sin taxes' (alcohol and tobacco).

Following are details of several options reviewed by the Task Force to replace user fees as the revenue source for the MARCS operating budget and to fund the P25 upgrade to the system.

Fee On Phone Bills

This fee would be assessed similar to the way that E 9-1-1 (Enhanced 9-1-1) fees are currently assessed as a means of updating 9-1-1 centers to allow for wireless calls to be tracked. The Task Force proposes considering any fee on phone lines to include both wireless and wireline (landline) phone lines. The charge on both wireless and wireline phone lines would represent a broader-based source of revenue collection than only wireless or only wireline.

Monthly Fee Amount	Anual Revenue
0.01	$1,831,082.40
0.09	$16,479,741.60
0.10	$18,310,824.00
0.24	$43,945,977.00
0.30	$54,932,472.00
0.50	$91,554,120.00
0.65	$119,020,356.00

The Task Force believes that if this funding source is contemplated, it should not affect decisions regarding the E 9-1-1 fee. It is noted by the Task Force's research that Ohio has continually had one of the lowest E 9-1-1 fees in the nation, and therefore currently places a very low burden on citizens for key public safety response tools. The Task Force believes that both services – the Enhanced 9-1-1 capabilities, and a robust, reliable interoperable public safety communications system – are vital to maintaining a responsive public safety system, as well as in complying with federal mandates.

An example of annual revenue which might result from varying levels of monthly fees, based on June 2008 phone usage statistics, is shown below.

Motor Vehicle Fuel Tax

Another option explored by the Task Force was an earmarked increase in the motor vehicle fuel tax.

According to the Legislative Service Commission's FY10-11 Greenbook on HB2, consumption of motor vehicle fuel is expected to remain relatively flat during FY10 and FY11, around 6.5-6.7 billion gallons. If the lower end of this estimate is used:

Increase: Amount/Gallon	Annual Revenue
$ .0025	$16,250,000
$ .005	$32,500,00
$ .0075	$48,750,000
$ .01	$65,000,000

If the P25 upgrade, plus annual operating costs, were to be funded 100 percent by an increase in the motor vehicle fuel tax, depending on preferred financing, a half-cent to one cent increase per gallon would be required.

An advantage to choosing this option would be that transients passing through Ohio, who also benefit from a reliable public safety communication system, would contribute towards its funding.

"Sin" Taxes

The Task Force reviewed the possibility of increasing "sin" taxes to fund the upgrade and operations.

However, according to the Legislative Service Commission, "A declining trend in receipts from the cigarette tax is expected to accelerate somewhat due to an increase in the federal tax on cigarettes."

Further increasing taxes would push sales lower. Because of this declining trend in cigarette and tobacco usage, the Task Force advises against depending upon such a volatile funding source for a public safety system. Current state taxes on cigarettes are 6.25 cents per cigarette and 17 percent of the wholesale value of all other tobacco products.

Alcoholic beverage and liquor gallonage taxes are not associated with an anticipated decline in sales; in fact, modest increases are expected. However, substantial percentage increases would need to be considered to fully fund MARCS' upgrades and operational needs, and this funding source would not meet the Task Force's goal of having those who benefit from the system bear the costs of the system.

Revenue in millions of dollars	FY2005	FY2006	FY2007	FY2008	FY2009	Estimated FY2010	Estimated FY2011
Cigarette	$577.70	$1,084.10	$986.60	$950.90	$924.80	$828.40	$802.50
Alcoholic Beverages	$56.80	$57.50	$56.30	$56.80	$57.10	$58.60	$58.90
Liquor Gallonage	$32.20	$33.40	$34.30	$35.00	$35.80	$36.90	$37.70

Federal Grants

The Task Force explored the possibility of funding the upgrade through federal grants. Because of a distribution process which exists for nearly all federal grants, it was determined that federal grants would not be a viable source of funds for either ongoing operating costs or one-time capital upgrades.

Federal grants, which are earmarked for specific purposes, are allocated according to a distribution formula that requires 80 percent of funds to be appropriated by the state to local entities. For instance, a Public Safety Interoperable Communication grant, meant to help agencies comply with the P25 upgrade standards, awarded $21.6 million to Ohio in 2008. Of this amount, $5.4 million was used by MARCS to upgrade, among other items, a zone controller, a move which is defraying the costs of the statewide upgrade, but which barely begins to cover the costs that are attached to the statewide upgrade.

The Task Force recommends that any new grants made available to the state to help comply with P25 requirements, administered through the Ohio Department of Public Safety, will include criteria for local agencies to upgrade in such a way that MARCS and the local system are completely interoperable.

BMV-Related Fines and Fees

As noted in the state survey found in the appendix, many states use increased fees or fines to fund interoperable communication systems. Although the Task Force explored this option, it is not recommended, largely due to recent, similar fee adjustments made to augment the Ohio State Highway Patrol budget.

Fees recently adjusted, most of which took effect on October 1, 2009, are enumerated in the table below.

A list of fees authorized for collection by the Ohio Revised Code to fund services offered by several divisions of the Ohio Department of Public Safety, including the Ohio State Highway Patrol and the Bureau of Motor Vehicles, is available in the appendix.

New/Increased Fees in FY2010 Budget (enacted through HB 2)			
Transaction Type	Pre-HB 2 Fee Amount	Enacted Amount of Fee Increase	Estimated Annual Revenue Gain
Late Fee (vehicle registration and driver license renewal)	None	$20.00	$34.5 million
Commercial Vehicle Registrations (in-state)	Varies by weight class ($59.50 to $1,354.50)	$19.00 for each weight class	$10.5 million
Temporary License Placard (tags)	$10.50	$8.00	$10.1 million
Special Reserve License Plates	$35.00	$15.00	$4.2 million
Vision Screening	$1.00	$1.75	$3.2 million
Initial Reserve License Plates	$10.00	$15.00	$2.0 million
Duplicate Driver's License	$15.00	$5.00	$1.9 million
International Registration Plan (IRP)	Varies by vehicle type and weight class ($10 to $1,630)	Varies by vehicle type and weight class ($1 to $33.50)	$1.7 million
Replacement License Plates (2 plates)	$2.00	$5.50	$1.4 million
Replacement License Plates (1 plate)	$1.00	$5.50	$1.4 million
Title Abstract	$2.00	$3.00	$10.6 million
County Clerk of Courts Title Fee	$5.00	$15.00	$25.8 million*

*$23.8 million of which is collected will remain with the county clerk of courts
Source: Legislative Service Commission Greenbook on HB 2 (FY 10-11 Transportation Budget)

Comparison of Funding Sources

As noted above, each funding source was found to have both strengths and weaknesses. For ease of comparison, these are presented in the table that follows.

SEPTEMBER 2008
The Clermont County 800MHz radio system suffered a power outage during the September 14 windstorm. Delaware County also experienced outages during the windstorm. The statewide interoperability provided by MARCS to these local agencies allowed them to re-establish communications with their 911 center during this local outage.

Pros and Cons of Funding Sources

Funding Source	Pros	Cons
Fee On Phone Bills	• Spreads the burden among most who would benefit. • Somewhat established way of collecting fees (wireless). • Because of a large revenue base, fee would be small.	• Method to collect wireline fees would need to be established • Wireless users are currently charged 28 cents/ month for E 9-1-1.
Motor Vehicle Fuel Tax	• Spreads the burden among most who would benefit, including out of state travelers. • Easy collection of revenue	• Additional burden on Ohio families.
BMV Fines and Fees	• Allows a variety of small increases in fines/fees and spreads the impact over many different types of transactions.	• Increases in fees recently used to fill holes in the OSHP budget. • Recent public scrutiny on new BMV fines. • Question whether fines are a bondable source of revenue.
Federal Funding	• Good source of funding to help local entities purchase radios and other equipment necessary to use the MARCS system.	• State is eligible to receive only a smaller portiion of federal grants set aside for communication and public safety upgrades. • Even if the state were eligible to apply for all available federal funding, not nearly enough federal funds are allocated to communications to completely fund the necessary upgrades • Federal funds cannot be used for operating budget.
“Sin” Taxes (Cigarette, Alcohol, Liquor Gallonage)	• Less controversial than other taxes	• Burden is on a much smaller population than will actually benefit from the system. • Recent increase in federal cigarette tax has cut sales. Revenue would be uncertain with a further increase.

[MARCS] appendix

County Administration Building
800 Mt. Orab Pike, Suite 101
Georgetown, OH 45121

Phone # (937)378-3956
Fax # (937)378-6324
OH Toll Only (888)454-3956

Brown County Board of Commissioners

Margery Paeltz, President ~ Ralph Jennings, Vice President ~ William R. Geschwind, Member
Jean Rickey, Clerk ~ Lisa Spiller, Asst. Clerk
web site: www.browncountyohio.gov ~ email: commissioners@browncountyohio.gov

March 29, 2010

Samuel Orth
State Chief Information Officer
Ohio Department of Administrative Services
Ohio Office of Information Technology
30 East Broad Street, 39th Floor
Columbus, Ohio 43215

Dear Mr. Orth,

We are writing on behalf of the Brown County Communication Center regarding the MARCS Task Force, which was established by House Bill 2, Section 755.80 of the 128th General Assembly to "explore and make recommendations on the organizational structure, operational, and capital funding for the long-term sustainability and more ubiquitous utilization of the MARCS System."

We fully support the important goal of identifying a long-term funding solution for MARCS and abolishing the burdensome fee structure our first responders currently pay to utilize the MARCS system. In addition, we request that the Task Force make recommendations to the General Assembly that ensures a common sense approach to pay for the maintenance, and technology upgrades needed by MARCS to meet the increasing capacity and technology demands of the first responder community.

We respectfully request that you include our letter of support for the vital MARCS funding with your final report.

Sincerely,
Brown County Board of Commissioners

Margery Paeltz
Margery Paeltz, President

Ralph Jennings
Ralph Jennings, Vice President

William R. Geschwind
William R. Geschwind, Member

BUCKEYE STATE SHERIFFS' ASSOCIATION

6230 Busch Blvd., Suite 260 • Columbus, Ohio 43229 • Tel: (614) 431-5500 • Fax: (614) 431-5665

ROBERT A. CORNWELL
EXECUTIVE DIRECTOR

February 1, 2010

Samuel Orth
State Chief Information Officer
Ohio Department of Administrative Services
Ohio Office of Information Technology
30 East Broad Street, 39th Floor
Columbus, OH 43215

Dear Mr. Orth:

I am writing on behalf of the Buckeye State Sheriffs' Association (BSSA) regarding the MARCS Task Force, which was established by House Bill 2, Section 755.80 (Temporary Law) of the 128th General Assembly, to "explore and issue recommendations on the organizational structure, operational, and capital funding for the long-term sustainability and more ubiquitous utilization of the MARCS System."

First and foremost, I want to thank you for chairing the MARCS Task Force. BSSA wholeheartedly supports the general goals of the Task Force. BSSA particularly supports the important goal of identifying a long-term funding solution for MARCS and the burdensome fee structure Sheriffs and other local first responders currently pay to utilize the system.

BSSA also requests the Task Force make recommendations to the General Assembly that ensures a common sense approach to both pay and upgrade MARCS to meet the increasing capacity and technology demands of the first responder community. As you are well aware, we are reaching critical capacity limits on the MARCS system due to its success and increase in users, largely added after the September 11th attacks. In addition to the ongoing maintenance and technology upgrades of any communication

BUCKEYE STATE SHERIFFS' ASSOCIATION

6230 Busch Blvd., Suite 260 • Columbus, Ohio 43229 • Tel: (614) 431-5500 • Fax: (614) 431-5665

system, the FCC and others have placed further burdens on MARCS and all public safety communication systems. It is vitally important for the public safety of our communities that a long term plan addressing the needed upgrades and maintenance to the MARCS system be undertaken.

Finally, in addressing the MARCS system organizational structure and governance, BSSA urges the Task Force and thanks them for their consideration of more local involvement in MARCS governance. Because so many of our Sheriffs are dependent on the system for the health, safety and welfare of our officers, Sheriffs and local first responders need to be allowed to play a bigger role in the ongoing governance of MARCS. We look forward to a continued discussion on this matter as the General Assembly considers the Task Force recommendations.

In closing, we respectfully request, that you include our letter of support for the vital MARCS funding, upgrade and governance changes to your final report.

Sincerely,

Robert A. Cornwell

Robert A. Cornwell
Executive Director

CC: MARCS Task Force

Brown County
Communication Center

755 Mount Orab Pike
Georgetown, Ohio 45121
(937) 378-4155
(937) 378-1904

March 24, 2010

Samuel Orth
State Chief Information Officer
Ohio Department of Administrative Services
Ohio Office of Information Technology
30 East Broad Street, 39th Floor
Columbus, Ohio 43215

Dear Mr. Orth,

We are writing on behalf of the Brown County Communication Center regarding the MARCS Task Force, which was established by House Bill 2, Section 755.80 of the 128th General Assembly to "explore and make recommendations on the organizational structure, operational, and capital funding for the long-term sustainability and more ubiquitous utilization of the MARCS System."

We fully support the important goal of identifying a long-term funding solution for MARCS and abolishing the burdensome fee structure our first responders currently pay to utilize the MARCS system. In addition, we request that the Task Force make recommendations to the General Assembly that ensures a common sense approach to pay for the maintenance, and technology upgrades needed by MARCS to meet the increasing capacity and technology demands of the first responder community.

We respectfully request that you include our letter of support for the vital MARCS funding with your final report.

Rob Wilson
Rob Wilson
Director
Brown County Communication Center
(937) 378-4155 office
(937) 378-1904 fax

rwilson_brown911@roadrunner.com

KEITH FABER
Majority Floor Leader

Senate Building
1 Capitol Square
Columbus, Ohio 43215
614-466-7584

OHIO SENATE
12th District

Committees:
- Insurance, Commerce and Labor, Vice Chair
- Judiciary - Civil Justice
- Judiciary - Criminal Justice
- Agriculture
- Finance and Financial Institutions
- Government Oversight
- Rules
- Reference

March 30, 2010

Mr. H. Samuel Orth
State Chief Information Officer
Office of Information Technology
30 E. Broad St., 39th Floor
Columbus, OH 43215

Dear Chairman Orth:

Thank you for allowing me to comment on the final determinations made by the MARCS Task Force.

I commend all of the Task Force's members for their efforts and contributions to this study; however, in reviewing the data and determinations made on behalf of the MARCS Task Force in the draft report, I cannot support the recommended permanent funding sources that place the onus on Ohioans who are already struggling financially.

While I agree that a "stable funding source" is needed in order for MARCS to operate at its optimum capacity, in no way can I endorse any new fees or tax increases on Ohio taxpayers, be it new phone fees, further increases in BMV fines and fees, or an increase to the Motor Vehicle Fuel Tax. When considering the number of unemployed Ohioans and the state of our current economy, I think that the state would be better served by redirecting existing funding sources to support MARCS.

I agree that a reliable and interoperable communications system is an important public safety priority. However, we should exhaust all potential existing sources of revenue before recommending that hard-working Ohioans be burdened with higher taxes or new fees.

Sincerely,

Keith Faber

Keith Faber
Majority Floor Leader
Ohio Senate

THOMAS F. PATTON

Senate Building
Columbus, Ohio 43215
614-466-8056

OHIO SENATE
24th District

March 30, 2010

H. Samuel Orth – Chair
Office of Information Technology
Office of the State CIO
30 E. Broad St., 39th Floor
Columbus, OH 43215

Dear Chairman Orth:

Thank you for the opportunity and privilege to serve on the MARCS Task Force.

Nobody doubts the benefits of the MARCS system; however I think that now is the worst time to consider placing additional financial burdens on Ohioans who are already finding it hard to make ends meet. As such, I am unable to support recommendations of raising phone fees, BMV fines and fees (which have already gone up more than $90 million this year) or gas taxes. Our constituents simply can't afford it.

The Task Force would have a better chance of gaining support for a permanent funding source for the program if it were to consider the use of existing revenue within the state budget. I recognize that funding is limited; however, before we should be willing to ask the taxpayers for another dime, we should be able to demonstrate that we have prioritized public spending programs and explored all funding options already available to us.

While I can't support the funding recommendations, I appreciate the hard work of the members of the Task Force.

Sincerely,

Thomas F. Patton

Thomas F. Patton
Ohio State Senator
24th District

P25 SPECIFICATIONS[17]

"Project 25 (P25) or APCO-25 refers to a suite of standards for digital radio communication for use by federal, state/province and local public safety agencies in North America to enable them to communicate with other agencies and mutual aid response teams in emergencies.

"Introduction

"P25 was established to address the need for common digital public safety radio communication standards for First Responders and Homeland Security/Emergency Response professionals. TIA TR-8 facilitates such work through its role as an ANSI-accredited Standards Development Organization (SDO).

> "**Project 25 (P25)** is a set of standards produced through the joint efforts of the Association of Public Safety Communications Officials International (APCO), the National Association of State Telecommunications Directors (NASTD), selected Federal Agencies and the National Communications System (NCS), and standardized under the Telecommunications Industry Association (TIA)... The P25 suite of standards involves digital Land Mobile Radio (LMR) services for local, state/provincial and national (federal) public safety organizations and agencies...
>
> ''P25 is applicable to LMR equipment authorized or licensed, in the U.S., under the National Telecommunications and Information Administration (NTIA) or Federal Communications Commission (FCC) rules and regulations.
>
> ''Although developed primarily for North American public safety services, P25 technology and products are not limited to public safety alone and have also been selected and deployed in other private system application, worldwide.
>
> ''P25 equipment has also been selected for a railroad system, including rolling stock, personnel, and transportation vehicles.'

"P25-compliant systems are being increasingly adopted and deployed. Radios can communicate in analog mode with legacy radios, and in either digital or analog mode with other P25 radios. Additionally, the deployment of P25-compliant systems will allow for a high degree of equipment interoperability and compatibility.

"P25 standards use the Improved Multiband Excitation (IMBE) vocoders which were designed by DVSI to encode/decode the analog audio signals.

"P25 may be used in "talk around" mode without any intervening equipment between two radios, in conventional mode where two radios communicate through a repeater or base station without trunking or in a trunked mode where traffic is automatically assigned to one or more voice channels by a Repeater or Base Station.

"The protocol supports the use of DES encryption (56 bit), 2-key Triple-DES encryption (112 bits), 3-key Triple-DES encryption (168-bits), AES encryption at up to 256 bits keylength, RC4 (40 bits, sold by Motorola as Advanced Digital Privacy), or no encryption.

"The protocol also supports the ACCORDION 1.3, BATON, FIREFLY, MAYFLY and SAVILLE Type 1 ciphers.

"P25 Open Interfaces

"P25's Suite of Standards specify eight open interfaces between the various components of a land mobile radio system. These interfaces are:

- **Common Air Interface** (CAI) standard specifies the type and content of signals transmitted by compliant radios. One radio using CAI should be able to communicate with any other CAI radio, regardless of manufacturer.
- **Subscriber Data Peripheral Interface** standard specifies the port through which

17 This section is taken directly from the Wikipedia entry on P25. Please see (http://en.wikipedia.org/wiki/Project_25) for additional details.

mobiles and portables can connect to laptops or data networks.

- **Fixed Station Interface** standard specifies a set of mandatory messages supporting digital voice, data, encryption and telephone interconnect necessary for communication between a Fixed Station and P25 RF Subsystem.
- **Console Subsystem Interface** standard specifies the basic messaging to interface a console subsystem to a P25 RF Subsystem.
- **Network Management Interface** standard specifies a single network management scheme which will allow all network elements of the RF subsystem to be managed.
- **Data Network Interface** standard specifies the RF Subsystem's connections to computers, data networks, or external data sources.
- **Telephone Interconnect Interface** standard specifies the interface to Public Switched Telephone Network (PSTN) supporting both analog and ISDN telephone interfaces.
- **Inter RF Subsystem Interface** (ISSI) standard specifies the interface between RF subsystems which will allow them to be connected into wide area networks.

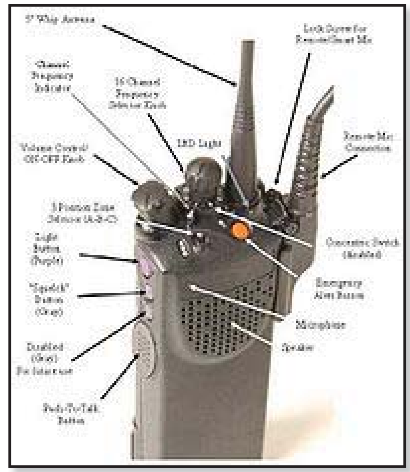
"P25 Phases

"P25-compliant technology is being deployed in several phases:

"Phase 1

"Phase 1 radio systems operate in 12.5 kHz analog, digital or mixed mode. Phase 1 radios use Continuous 4 level FM (C4FM) modulation for digital transmissions at 4800 baud and 2 bits per symbol, yielding 9600 bits per second total channel throughput. Receivers designed for the C4FM standard can also demodulate the "Compatible quadrature phase shift keying" (CQPSK) standard, as the parameters of the CQPSK signal were chosen to yield the same signal deviation at symbol time as C4FM while using only 6.25 kHz of bandwidth.

"Vendors are currently shipping Phase 1 P25-compliant systems. These systems involve standardized service and facility specifications, ensuring that any manufacturers' compliant subscriber radio has access to the services described in such specifications. Abilities include backward compatibility and interoperability with other systems, across system boundaries, and regardless of system infrastructure. In addition, the P25 suite of standards provides an open interface to the radio frequency (RF) subsystem to facilitate interlinking of different vendors' systems.



A hand-held Project 25 radio used in US systems

"Phase 2

"To improve spectrum utilization, Phase 2 is currently under development with concurrent work being done on 2-slot TDMA and FDMA (CQPSK) modulation schemes. Phase II will use the AMBE vocoder to reduce the needed bit rate so that one channel will only require 4800 bits per second.

"Significant attention is also paid to interoperability with legacy equipment, interfacing between repeaters and other subsystems, roaming capacity and spectral efficiency/channel reuse. In addition, Phase 2 work involves console interfacing between repeaters and other subsystems, and man-machine interfaces for console operators that would facilitate centralized training, equipment transitions and personnel movement..."

NOTIFICATION OF EQUIPMENT END-OF-LIFE

02/17/2010 WED 17:27 FAX 8475382289

® *MOTOROLA*

February 17, 2010
Mr. Darryl L. Anderson, Program Director
Ohio MARCS
2323 West 5111 Avenue, Suite 150
Columbus. Ohio 43204

Dear Darryl,
Thank you for your continued leadership in advancing the MARCS system for Ohio Public Safety. With the continued growth MARCS has experienced it is appropriate we communicate the latest information available as to the lifecycle of your current software release and the potential impact that lifecycle could have on MARCS users. The State of Ohio MARCS system was built on the Motorola SmartZone 3.5 system platform. The SmartZone platform was originally introduced back in 1996.

Additionally, as reported at the last Task Force meeting, the current MARCS SmartZone 3.5 system has used in excess of 47,000 of the 48,000 available user IDs on the network.

- The lifecycle dates for the SmartZone 3.5 platform are as follows:
- Add Simulcast/Voting Channels through Dec. 2007
- Add Remote Sites through Dec. 2007
- Add Console Positions through Dec. 2009
- Add IR Channels (Quantars) through Dec. 2009
- Technical Support Contract (SSe) thru Dec. 2009
- Add Subscribers I System End of Life June 2013
- Infrastructure Board Repair through Parts Dependent

Infrastructure board repair is dependent on the parts availability for the individual products that make up the MARCS SrnartZone 3.5 system. Motorola's goal is to provide seven years of parts support for infrastructure products and five years of parts support for subscriber products after cancellation. Motorola will periodically reevaluate these aftermarket parts support dates based upon current inventories and adjust the support dates as necessary.

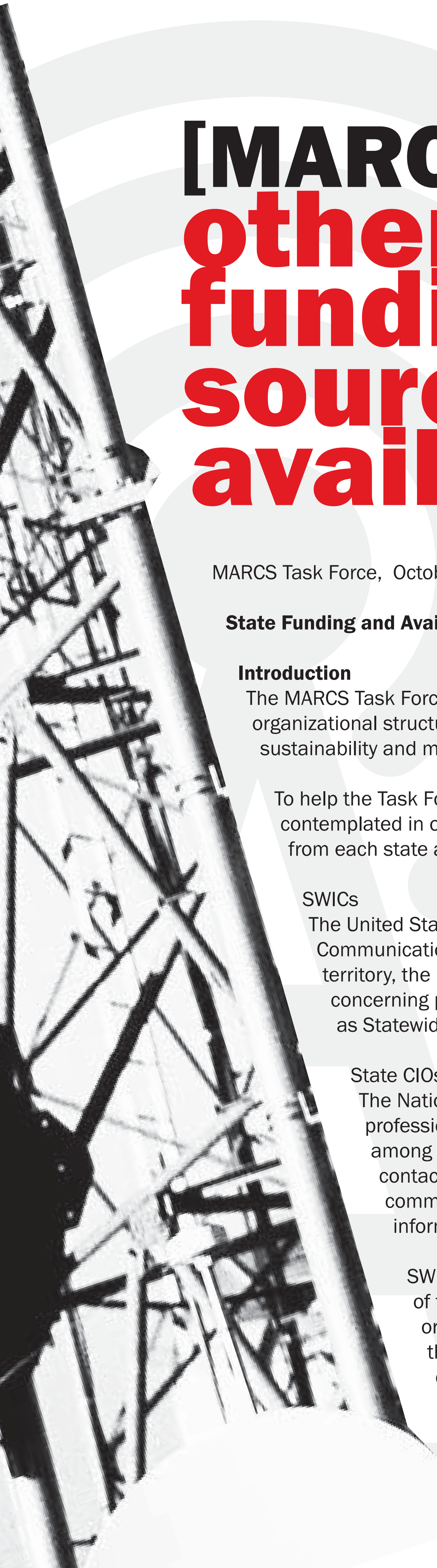
Motorola is dedicated to the support of the State of Ohio MARCS system. We understand the mission critical nature of your communications network and will make our best effort to support the system in the future. Having current software releases insures the optimum in functionality and reliability for MARCS users and is highly recommended in mission critical environments.

Sincerely yours,

MOTOROLA, INC.

Jay Malpass
Strategic Project Team
Government and Public Safety

Michele Shaughnessy
Director of Systems and Infrastructure ~ Operations
Government and Public Safety



[MARCS]
other state's funding sources & availability

MARCS Task Force, October 22, 2009

State Funding and Availability Survey Results

Introduction

The MARCS Task Force has been charged with developing recommendations on the organizational structure and operational and capital funding options for the long-term sustainability and more ubiquitous utilization of the MARCS System.

To help the Task Force review and consider options that are used or being contemplated in other states, DAS requested information from two sets of individuals from each state and territory, SWICs and State CIOs.

SWICs

The United State Department of Homeland Security, Office of Emergency Communications, has designated a single point of contact for each state and territory, the purpose is to centralize by state an information source for all matters concerning public safety radio systems. These points of contact are referenced as Statewide Interoperability Coordinators (SWICs).

State CIOs

The National Association of State Chief Information Officers (NASCIO) is a professional organization which facilitates communication and collaboration among state chief information officers. Their e-mail list was used to contact each state to request information from those whose public safety communication systems are housed within the department charged with information technology.

SWICs and state CIOs were asked to provide information on a variety of topics, including availability or development of a statewide system or "system of systems," use of the system, funding mechanisms for the system and challenges faced in funding both the operational and capital-related expenses of the system.

Following is an executive summary of our findings, and a brief summary of each state's response.

EXECUTIVE SUMMARY

This report contains responses from 45 of the 57 states and territories (generalized as "states" for brevity).

APRIL 2010
An arson set fire fed by high winds burned almost 3,000 acres at the Shawnee Wildlife Area. Numerous private homes on Mackeltree Road, running through part of the forest, were directly in the path of the fire. Local volunteer fire departments helped DNR fight this fire. MARCS' radios were critical to communicating with the fire departments. In the end no private property was damaged by the fire.

A summary of these responses is provided:

- Either prompted by need or prompted by the federal government's requirement for a State Communications Interoperability Plan (SCIP), most states either have a statewide system (or system of systems) or are in the planning, developing or building stages of creating a system.

- A "system of systems" approach is a popular answer to interoperability needs. While agencies at the state and local levels have already existing systems meeting the agency's specific needs, interoperability requires these systems to talk to one another, i.e., allowing the Highway Patrol to talk with a local sheriff. In order to utilize existing infrastructure, and, in most cases maintain local control over day-to-day operation, state and regional systems have begun to be linked in to one another.

- Funding for systems that are funded through a dedicated line item in the state operating budget are contemplating a move to a dedicated source of funding as general funds shrink. The sources being contemplated are user fees, or some form of a citizen-facing fee (e.g. E 9-1-1, BMV fines and fees).

- Systems which are not yet operational seem to have a 'wait and see' approach to funding. They are currently building out the infrastructure while utilizing boards or councils to determine the best way to fund ongoing costs of the system.

- Funding sources which are not GRF-based utilize:
    - traffic citations and fines; and boat and vehicle registration fees (Florida)
    - $1.25 per each BMV transaction (Indiana)
    - fees from property taxes and a 9-1-1 surcharge (Iowa)
    - a monthly charge on each phone bill. To increase revenues, an additional $.10 per month/year is being added to the charge for the next three years. This results in a current monthly charge of $.75 cents/phone. In 2010 the charge will be $.85, and then $.95 in 2011 (Minnesota)
    - $10.00 is collected from each traffic citation for public safety communications, though 90% is given back to local governments. (Mississippi)
    - E 9-1-1 fees (North Dakota).

[MARCS] state sum- maries

ALABAMA

Alabama is putting together an RFP and ITB for a statewide system at this time. They have no solid plan for either system upgrades or maintenance. They are working with the Governor's Public Safety Cabinet to detail future plans. Alabama has pledged no subscriber/user fees, and is hopeful to obtain future DHS/DOJ grants for capital costs. They have no current plan to fund operations.

ALASKA

Alaska has a statewide system covering the normally-traveled portions of the state. Operating costs are covered by a line item in the state legislative budget. The concept of charging subscriber fees was presented to users and shouted down. A quote: "There will be a mutiny if the fee structure is initiated; and many smaller jurisdictions are claiming they don't and won't use it." Consequently, the state is still working on the final solution.

AMERICAN SAMOA

American Samoa is in the process of designing a territory-wide system. Their funding model for ongoing operations is still being developed. They are hopeful of getting ongoing support through federal agencies populating the islands.

ARIZONA

Arizona has a very limited use statewide conventional system used for interoperability as needed. Maintenance of the system is provided by the Arizona DPS, and is part of their overall budget. No cost figures are available. There are also five large regional systems in Arizona, participating agencies pay for their share of use from their budgets.

ARKANSAS

Arkansas has a statewide system, AWIN. Their annual operating cost of approximately $6M is derived from a line item in the state operating budget, general revenue fund. They are seeking a more stable, long-term source of funds.

CALIFORNIA

California has a statewide microwave transport system allowing various radio systems to tie into the statewide backhaul, though each state agency has its own radio communication system (each with its own operating expenses). Funding for the multitude of systems throughout the state comes from general revenue funds, plus a portion of the E 9-1-1 fees collected. While any public safety entity (federal, state or local) is permitted to utilize the system, very few non-state agencies take advantage of the microwave transport system. The centralized yearly cost for the microwave backbone is approximately $4M, but no aggregated cost is known.

COLORADO

Colorado currently maintains a Motorola Astro SR 7.5, P25 700/800 MHz statewide system, consisting of linking largely populated county systems together with an over-arching state system, as well as connecting into smaller systems. The system provides radio coverage to over 90% of Colorado's roadways, and has over 900 user entities (local, state and federal) and almost 50,000 radios. Some non-public safety entities are permitted to use the system, but the state does not permit commercial use of its infrastructure. The state's infrastructure was funded 1/3 by the state, with local and federal budget or grant dollars funding the balance. The statewide system does not have a sustainable funding source (currently a line item in the budget), but is considering a number of options, including user fees, to address on-going costs. The regional systems currently have the option to charge subscriber fees (range $50-$200/year/unit).

DELAWARE

Delaware has a well defined statewide system. The funding comes from a line item in the state budget, utilizing general revenue funds. This method is working well at this time, although they are concerned about future budget cuts. A small amount of additional funding is derived from tower and facility use leases from the private sector.

FLORIDA

Florida has a well developed Statewide Law Enforcement Radio System, utilized by law enforcement and other disciplines. They have leased the system from Harris. Ongoing funding for the system is from a trust fund, fueled by traffic citations and fines, originally set up with boat and vehicle registration fees.

GEORGIA

Georgia has yet to field a consolidated statewide system, although they have invested in a statewide audio gateway system to link legacy systems together when needed. The cost of this linkage is borne by the Georgia Department of Public Safety through the general revenue budget. Georgia is looking into additional fees on vehicle tags and titles to fuel their efforts.

GUAM

This territory has a multi-agency system for its metropolitan area. Funding comes from the Guam Police Department's General Revenue budget. They believe $500,000.00 per year is needed to properly fund their system.

HAWAII

A microwave backbone is available statewide for state, county and federal agencies to utilize, though most counties have largely chosen to operate and fund their own systems. The state has been planning coverage for the entire system for several years, but has not yet completely built out, especially to rural areas. Funding for the infrastructure has been provided by the state (Capital Improvement). Maintenance and operating costs are allocated through the state's yearly budgeting process, or shared by entities utilizing any given site.

ILLINOIS

The state has a statewide system, STARCOM 21, a trunked digital P25 700/800 system leased from Motorola and available to all public safety and public service organizations throughout Illinois. Each user agency pays Motorola monthly, on a fee-per-device basis. The total cost to operate the system (by Motorola) was not known (SWICs and CIOs did not have access to local expenditures). State agencies receive line item budget appropriations through the state operating budget to pay their annual costs. The Illinois State Police received grant funding to purchase their initial equipment.

INDIANA

Indiana has a statewide platform very similar to MARCS, with 130 towers statewide. Their primary service is voice radio, with over 50,000 radios on the system. They face the same end-of-life and capacity issues as MARCS. Build-out and ongoing operations are both funded by a stream of income provided by $1.25 per each BMV transaction. This fee is set to expire in 2019 and has thus far worked extremely well. Indiana has no funding issues with their system. Their current annual operating costs are approximately $8.5M. A quote: "Our biggest problem is that we are too successful – nearing system limitations. The system, however, represents much more than a technological advancement of communications equipment; it represents an unprecedented integration of people working toward a common objective – to protect and save lives."

IOWA

The state does not have a statewide system, but does have at least two large regional systems for the Department of Transportation and Department of Natural Resources (DNR's system is privately owned). Operating costs are basically paid by set fees from property taxes and a 9-1-1 surcharge. This funding method is working well for Iowa, though there is a project underway to examine benefits of building and operating a statewide interoperable radio network for all state and local agencies.

KANSAS

The state is nearing completion of a statewide P25 Smartzone system. All operating costs come from a line item in the KDOT budget. Subscribers are responsible for purchasing their radios, as well as paying for system capacity enhancements, but no user fees for use.

KENTUCKY

Kentucky has several statewide systems for state agencies, a traditional model. They have one statewide data system accessible by all law enforcement and expanding into fire and EMS. General Revenue funds are used to maintain the systems, but not adequately. Kentucky has established a funding subcommittee under their Statewide Interoperability Executive Committee, but progress is slow. The hard costs for their statewide systems are approximately $6.8M.

LOUISIANA

The state's statewide interoperable radio system is a result of the 2005 hurricanes, having been built/rebuilt after the disaster. All operating costs are borne by the state, through general revenue funds. A quote: "Have a catastrophic disaster, then have your radio system fail and that will get the attention of the decision makers." Their current annual budget is $9.5M to run their voice system with 93 sites (expanding to 117 sites). The costs are part of the state operating budget, as a line item.

MAINE

The state is implementing a statewide system due to be completed by 1/1/2013. Operating costs are recovered by charging each state agency on the system. The agencies pay the costs out of their general revenue budgets.

MARYLAND

Maryland is in the RFP stage to build out a 700 MHz system for all state agencies and for interested local jurisdictions. Operating cost funding is not well established at this time.

MICHIGAN

The state's Public Safety Communications System is very similar to MARCS but provides voice services only. The system is currently maxed out in capacity with 64,000 radios on the system. Majority of funding comes from state general fund, but they also charge a yearly per-radio fee. Michigan is seeking a dedicated funding source. Need system sustainability and life cycle replacement funding.

MINNESOTA

Minnesota is in the process of building out their statewide ARMER system – P25, 700/800 system. The expected completion date is 1/1/2013. 9-1-1 fees are utilized for both capital and operating funds. Ten cents per month per year is being added to individual phone bills for the next three years. Current per-month, per phone fee is 75 cents, going to 85, then 95 cents. This funding source is working well in Minnesota, which many point out as being the model for the rest of the nation.

MISSISSIPPI

Mississippi is in the process of building out a 700 MHz P25 system. 50 of 150 tower sites completed. Expected operating costs $8M - $10M per year. Mississippi's Wireless Communication Commission (WCC) has formed a Revenue Committee to address the cost concerns generated by local governments. Currently $10.00 is collected from each traffic citation for public safety communication, with 90% of the collection remaining at the local government level.

MISSOURI

Missouri is in the process of completing the design phase for their P25 statewide system. Currently, the concept is for the operating costs for the backbone to be paid out of the state's general revenue fund budget. A very sketchy dialog on the future funding of the system is occurring at this time.

MONTANA

Montana is in the process of constructing a statewide system. One county is on the system at this time, with twelve expected by 1/1/2010. They expect to use a combination of user fees and state appropriations to fund operations, but this is not completely developed at this time. Concepts include developing fees for traffic tickets, ambulance calls, fire services and utilizing a portion of the E 9-1-1 fees.

NEBRASKA

Nebraska is currently installing a statewide system, shared between the state and public power partners. The final phase of implementation will include a system of systems, connected in local entities for interoperability. The infrastructure was funded through a combination of state and federal funds. An operating funding source has not yet been determined, although user fees are being contemplated.

NEVADA

Nevada utilizes a system consisting of a statewide system shared by state-level law enforcement and the Nevada Energy private enterprise. In addition, there are large regional systems that are being tied into the statewide system via bridging devices. A large portion of the operating costs of the statewide system is paid from general revenue funds from the Nevada Department of Transportation. They have a federally-funded initiative underway seeking best solutions for long-term funding.

NEW JERSEY

New Jersey has a statewide system operated by the New Jersey State Patrol and used by 28 other state agencies. Operating costs are borne through the general funds of the NJSP. plus a $25 per radio per month fee. The system is not shared with other governmental units. The projected hard-dollar costs for this fiscal year is $3.5M.

NEW MEXICO

New Mexico does not have a statewide system. At the county level, operating costs are general paid out of county government general funds. One county has a combined council of governments which seems to be the most successful model in New Mexico.

NEW YORK

Currently, each level of government is responsible for its own public safety system. In general, state agencies and local agencies try to utilize other entities' existing infrastructure, if available, to reduce costs and encourage interoperability. Because each system is run in-house, fees are not generally charged. Moving forward, New York is hoping for more interoperability, developing a system of systems, with a few regional systems currently in place. They recognize post-build out operating costs will need to be addressed.

NORTH CAROLINA

North Carolina has a statewide 800 MHz system available for all public safety. Funding is through state general revenue funds, injected into the North Carolina highway Patrol, which is responsible for the maintenance of the system.

NORTH DAKOTA

North Dakota has fielded a statewide radio system. Funding is from E 9-1-1 fees, grants and some general revenue funds. The funding solution is working well at this time.

OKLAHOMA

Oklahoma has a statewide system called OKWIN – Oklahoma Wireless Information Network – an 800 MHz system. They are struggling with bringing an awareness to the state legislature as to the need to maintain the system, currently funded by grants.

OREGON

Oregon is in the process of designing a statewide P25 700 MHz system, the Oregon Wireless Interoperability Network project. The state plans to fund the operational costs for the system via State general funds, and possibly user fees. The first use of radios expected in 2011.

PENNSYLVANIA

The state is completing a statewide 700/800 MHz – STARNet. Currently utilized by 17 state agencies and 70 city/county 9-1-1 centers, costs are covered by a line item in the state general fund budget. There is interest in replacing/augmenting this source with other funding streams. The annual operating budget is $22.8M. The infrastructure was fully funded by the state capital budget.

RHODE ISLAND

The state has a statewide system. Users of the system are funded from line items within the user's budgets. There is a desire for the system to be totally paid by the state government. The operational cost is $2.2M per year.

SOUTH CAROLINA

South Carolina's statewide system – Palmetto 800 – is a partnership system shared by the State and its subdivisions and the State's utility companies. Operating costs are covered by user fees; local agency user fees are off-set by a state subsidy. No annual operational costs given.

SOUTH DAKOTA

South Dakota maintains a statewide, VHF trunked (non P25) system, supported by 54 tower sites and consisting of 16,000 radios. The system is totally funded by the state through a yearly line item in the budget. A quote: "The no-fee (for the end-user) aspect of the system has brought every first responder in the state to a common network, which is invaluable." The annual cost to maintain the system is $1.2M.

TENNESSEE

The state does not have a statewide system, nor do they have any regional systems, although one is being built. They have not determined a logical source for funding the ongoing operational costs due to their development of the system. They are contemplating a $1 periodic fee on all motor vehicle insurance policies.

TEXAS

The state does not have a statewide system; they have broken the state down into 24 regions, and are requiring each region to migrate to a P25 platform no later than 1/1/2015. They will then interconnect each region to establish a system of systems. Funding for the system's operation has not been clearly defined, although some E 9-1-1 funds are believed to be the most likely source.

UTAH

Utah has two statewide systems that in total cover the entire state. The older is a VHS conventional system; the newer is an 800 trunked system covering the highly populated areas. The operating cost is paid via user fees, based on the system used and whether the user is a state or local governmental unit – the state subsidizes local users. The state is contemplating utilizing E 9-1-1 fees to replace a portion of the user fee funding stream. Currently, the operating cost is approximately $7M per year. Utah is planning an upgrade to a statewide 700/800 P25 system with costs estimates in the $100M range.

WASHINGTON
Washington has several large metropolitan regional systems, and is contemplating a more integrated statewide system of systems. Also, each state agency operates its own system for its operational needs. Funding for systems is primarily locally based, through a variety of fees and funding sources.

WEST VIRGINIA
The state is building out a statewide, P25, trunked analog 450 MHz system. Funding for the operations of the system comes from general revenue funds, Wireless 9-1-1 fees, and intergovernmental partnerships.

WISCONSIN
The state is in the process of building out a statewide system. They are expecting a state general revenue appropriation to fund operating costs after the system is built out.

WYOMING
The state has a statewide digital trunked VHF radio system. Current operating costs are paid through a line item in their DOT budget. This may change to a general revenue fund line item in the near future. A quote: "If you want interoperability at all levels of government, you need to have a system that is funded at the state level and allows use by all levels of government, not only for emergencies and/or incidents, but also on a daily basis."

ORC-AUTHORIZED FEES FOR PUBLIC SAFETY

Fees collected in association with motor vehicles.

Transaction Information	FY2007 Volume	Total Fee	FY2007 Revenue	Date Of Last Fee Change
Titles: new	4,508,395	$5.00	$12,398,086.25	FY94
Titles: replacement	353,042	$5.00	$970,865.50	FY94
Titles: duplicate	312,072	$5.00	$78,018.00	FY94
Titles: Liens	1,246,218	$5.00	$934,663.50	FY94
Physical inspection at clerk of courts	531,117	$1.50	$531,117.00	11/28/1988
Physical inspection of motor vehicle previously registered in another state	162,383	$3.50	$568,340.50	1/1/2004
State highway patrol inspection of motor vehicle assembled from component parts by person other than manufacturer	32,843	$50.00	$1,642,150.00	FY99
General reinstatement of driver's license, commercial driver's license, or nonresident operating privilege	57,077	$30.00	$1,712,310.00	10/21/1997
Reinstatement fee for Financial Responsibility Non-Compliance Suspension	19,190	ranges from $125 to $550	$18,710,250.00	4/20/1995
Reinstatement fee for administrative license, driving under influence, and physical control suspension	53,009	$425.00	$2,650,450.00	11/3/2000
Arrest warrant processing fee for blocks on issuance of driver license and vehicle registration	76,662	$15.00	$1,149,930.00	3/3/1998
All driver licenses-additional fee for license, permit, or renewal	3,051,159	$12.00	$36,613,908.00	10/1/2003
Commercial driver's license	111,609	$25.00	$2,790,225.00	7/1/2005
Temporary instruction permit and examination	411,346	$5.00	$2,056,730.00	4/7/2004
Commercial driver's license - temporary instruction permit	32,953		$82,382.50	
Duplicate driver's license or motorized bicycle license	392,529	$2.50	$981,322.50	6/30/1993

Transaction Information	FY2007 Volume	Total Fee	FY2007 Revenue	Date Of Last Fee Change
Driver's license or renewal - driver over 21 years of age	1,921,532	$6.00	$11,529,192.00	6/30/1993
Driver's license or renewal - driver 16-17	80,709	$7.25	$585,140.25	6/30/1993
Driver's license or renewal - driver 17-18	19,457	$6.00	$116,742.00	6/30/1993
Driver's license or renewal - driver 18-19	25,444	$4.75	$120,859.00	6/30/1993
Driver's license or renewal - driver 19-20	10,296	$3.50	$36,036.00	6/30/1993
Driver's license or renewal - driver 20-21	6,423	$2.25	$14,451.75	6/30/1993
Vision Screening Fee	1,840,013	$1.00	$184,001.30	2/11/1982
Identification card	331,479	$8.50	$1,160,176.50	6/30/1993
Temporary motor vehicle license, additional fee	1,262,028	$5.00	$6,310,140.00	10/1/2003
Registration - passenger car	7,781,105	$20.00	$155,622,100.00	6/1/1905
Registration - noncommercial motor vehicle designed to carry no more than three-fourths ton, motor home	1,542,513	$35.00	$53,987,955.00	6/23/92
Registration - noncommercial motor vehicle designed to more than three-fourths ton but less than one ton	43,196	$70.00	$3,023,720.00	6/23/92
Registration - noncommercial trailer	541,587	Based on unladen weight	$4,603,489.50	9/16/2004
Registration - commercial truck	552,874	Based on unladen weight	$151,723,737.00	
Registration - commercial trailer	258,199	$25.00	$6,151,186.00	
Application for registration and renewal, additional fee	10,697,172	$11.00	$123,750,506.00	10/1/2003
Special state reserved license plate numbers	149,489	$10.00	$1,494,890.00	FY79
Special reserved license plate numbers containing more than three numerals or letters	3,694,44	$35.00	$12,930,540.00	FY75

Source: Ohio Department of Public Safety; information was gathered by the Ohio Department of Public Safety in FY08.

ORGANIZATIONAL STRUCTURE WORK GROUP CHARTER

Work Group Information	
Work Group Name	
MARCS Task Force - Organizational Structure Work Group	
Contact Name/Phone	**Date**
Sam Orth, Chair Barbara Edwards, Facilator	November 19, 2009

I. Purpose

This document presents the charter for the MARCS Task Force Organizational Structure Work Group. The work group's primary objective is to identify an organizational structure that would promote the long-term success of MARCS.

The MARCS Task Force was formed in response to section 755.80 of House Bill 2, which reads, in part:

(A) There is established a MARCS Task Force to explore and issue recommendations on the organizational structure and operational and capital funding options for the long-term sustainability and more ubiquitous utilization of the MARCS system ...

(B) Not later than nine months after the date of this section, the Task Force shall submit a report to the Governor, the President of the Senate and the Speaker of the House of Representatives ...

The task force must submit its report on April 1, 2010.

The MARCS Task Force decided to divide its efforts into three work groups to meet the narrow timeline granted under HB 2. The Organizational Structure Work Group will recommend an organization that is efficient and effective and that enables the best service delivery to the citizens of Ohio.

Work group recommendations will be evaluated by the MARCS Task Force. The task force may make modifications in the recommendation. It will be the responsibility of the task force to make a final recommendation on the MARCS organizational structure and incorporate this recommendation into the MARCS Task Force Report.

Final decisions on committing the state to any implementation of the recommendations will be the responsibility of the Governor and/or the General Assembly, as required by law.

II. Scope and Objectives

Key Questions:

- What is the "best" organizational structure to support the continued success of the MARCS program?
- What process shall be followed to determine which organizations will be permitted to access the towers, given the recommendation of the Use Work Group.
- Does the current governance structure provide appropriate representation for the MARCS user community?

If a particular topic aligns with the objectives of more than one work group, each work group will make a recommendation on the topic. The support team will consolidate these recommendations and present them to the task force for vetting and a final recommendation.

III. Out Of Scope

The following concerns are out of scope for this group:

- Capital funding.
- Operational funding.
- Ubiquitous use.
- Additional use of state-owned towers.

IV. Work Group Responsibility and Consensus

The work group will provide agency/organization-specific data, evaluate internal and outside sources, and develop a recommendation on the best organizational structure for MARCS. The work group will present this recommendation to the MARCS Task Force the week of January 25, 2010.

The work group will consider all legitimate views and objections and work to resolve them. Members will strive for consensus on major decision points. Members of the work group are to bring the perspectives of their organizations/agencies to the table, but make recommendations for the good of the enterprise. If consensus cannot be reached, a decision will be attained through majority vote of the work group voting members. Voting members are defined as those members who are appointed or assigned to the work group by the MARCS Task Force.

If consensus is attained by a single vote majority, that fact will be noted in the work group's report. The task force will determine whether or not further evaluation is necessary.

The task force, after validating the recommendation and other critical work products, will submit a recommendation to the Governor, the President of the Senate and the Speaker of the House.

V. Member Responsibilities

Work group members are responsible for providing data, researching outside sources, developing and validating analyses, developing and validating work products, and developing recommendations to assist in establishing the final work group recommendation. Work group members are also responsible for reviewing, providing feedback and applying critical thinking and enterprise-level judgment to work group deliverables.

The work group will expect all members to perform the following duties:

- Participate in work group meetings.
- Review "read-ahead" materials.
- Complete tasks as assigned.
- Develop and validate the resultant recommendation and presentation.
- Develop and support the recommendation throughout the task force review process.

VI. Work Group Structure

Chair: Sam Orth, State CIO
Facilitator: Barbara Edwards
Scribe: Member of Support Team
Members: Michael Heldman, Senator Tom Patton
Support Team: Darryl Anderson, Katrina Flory, Sarah Saccany, Barbara Edwards, Ginny Lagather

FUNDING -- OPERATIONS & CAPITAL OPTIONS WORK GROUP CHARTER

Work Group Information	
Work Group Name	
MARCS Task Force - Funding – Operational & Capital Options Work Group	
Contact Name/Phone	**Date**
Cliff Hite, Chair Sarah Saccany, Facilator	November 6, 2009

I. Purpose

This document presents the charter for the MARCS Task Force Funding Work Group. The work group's primary objective is to define funding mechanisms that will lead to efficient, effective, and more ubiquitous use of MARCS. In addition, the work group will recommend a structure for capital investment to upgrade the system and an on-going operational funding model.

The MARCS Task Force was formed in response to section 755.80 of House Bill 2, which reads, in part:

A. There is established a MARCS Task Force to explore and issue recommendations on the organizational structure and operational and capital funding options for the long-term sustainability and more ubiquitous utilization of the MARCS system ...
B. Not later than nine months after the date of this section, the Task Force shall submit a report to the Governor, the President of the Senate and the Speaker of the House of Representatives ...

The task force must submit its report on April 1, 2010.

The MARCS Task Force decided to divide its efforts into three work groups to meet the narrow timeline granted under HB 2. The Funding Work Group will recommend funding models for on-going operational and capital funding of a system that is efficient and effective and that enables the best service delivery to the citizens of Ohio.

Work group recommendations will be evaluated by the MARCS Task Force. The task force may make modifications in the recommendation. It will be the responsibility of the task force to make a final recommendation on the MARCS funding structure and incorporate this recommendation into the MARCS Task Force Report.

Final decisions on committing the state to any implementation of the recommendations will be the responsibility of the Governor and/or the General Assembly, as required by law.

II. Scope and Objectives

Key Questions:

-
- What funding solution will support the capital upgrade of MARCS to ensure P25 compliance?
- How will the funding solution be in effect in time to meet the 2012 maintenance termination schedule?
- What is the desired permanent funding solution for the on-going operational costs of MARCS, allowing the system to eliminate its reliance on user fees?

If a particular topic aligns with the objectives of more than one work group, each work group will make a recommendation on the topic. The support team will consolidate these recommendations and present them to the task force for vetting and a final recommendation.

III. Out of Scope

The following concerns are out of scope for this group:

- Organizational structure for MARCS operations.
- Organizational structure for the MARCS infrastructure.
- Ubiquitous use.
- Additional use of state-owned towers.

IV. Work Group Responsibility and Consenus

The work group will provide agency/organization-specific data, evaluate internal and outside sources, and develop a recommendation for the best model for capital funding of the MARCS infrastructure and towers. In addition, a funding model to support on-going operation of the system will be recommended. The work group will present this recommendation to the MARCS Task Force the week of January 25, 2010.

The work group will consider all legitimate views and objections and work to resolve them. Members will strive for consensus on major decision points. Members of the work group are to bring their agency/organization's perspectives to the table, but make recommendations for the good of the enterprise. If consensus cannot be reached, a decision will be attained through majority vote of the work group voting members. Voting members are defined as those members who are appointed or assigned to the work group by the MARCS Task Force.

If consensus is attained by a single vote majority, that fact will be noted in the work group's report. The task force will determine whether or not further evaluation is necessary.

The task force, after validating the recommendation and other critical work products, will submit a recommendation to the Governor, the President of the Senate and the Speaker of the House.

V. Member Responsibilities

Work group members are responsible for providing data, researching outside sources, developing and validating analyses, developing and validating work products, and developing recommendations to assist in establishing the final work group recommendation. Work group members are also responsible for reviewing, providing feedback and applying critical thinking and enterprise-level judgment to work group deliverables.

The work group will expect all members to perform the following duties:

- Participate in work group meetings.
- Review "read-ahead" materials.
- Complete tasks as assigned.
- Develop and validate the resultant recommendation and presentation.
- Develop and support the recommendation throughout the task force review process.

V. Member Responsibilities

Work group members are responsible for providing data, researching outside sources, developing and validating analyses, developing and validating work products, and developing recommendations to assist in establishing the final work group recommendation. Work group members are also responsible for reviewing, providing feedback and applying critical thinking and enterprise-level judgment to work group deliverables.

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- Participate in work group meetings.
- Review "read-ahead" materials.
- Complete tasks as assigned.
- Develop and validate the resultant recommendation and presentation.
- Develop and support the recommendation throughout the task force review process.

VI. Work Group Structure

Chair: Representative Cliff Hite
Facilitator: Sarah Saccany
Scribe: Member of Support Team
Members: Anthony Celebrezze, Adam Coridan, Col. Dave Dicken, Senator Keith Faber, Chief Charles Horner, Senator Eric Kearney, Terry Tibbals
Support Team: Darryl Anderson, Katrina Flory, Barbara Edwards, Ginny Lagather

USE WORK GROUP CHARTER

Work Group Information	
Work Group Name	
MARCS Task Force - Use Work Group	
Contact Name/Phone	**Date**
Tony Celebrezze & George Maier, Co-Chairs Katrina Flory, Facilitator	November 19, 2009

I. Purpose

This document presents the charter for the MARCS Task Force Use Work Group. The work group's primary objective is to examine system use, determine upgrade needs, and identify potential other uses to lower costs and maintain efficient, effective use, while improving ubiquitous use of the MARCS system and tower infrastructure. The group will meet this goal by offering recommendations to enable greater participation statewide in the use of the MARCS system.

The MARCS Task Force was formed in response to section 755.80 of House Bill 2, which reads, in part:

A. There is established a MARCS Task Force to explore and issue recommendations on the organizational structure and operational and capital funding options for the long-term sustain ability and more ubiquitous utilization of the MARCS system ...
B. Not later than nine months after the date of this section, the Task Force shall submit a report to the Governor, the President of the Senate and the Speaker of the House of Representatives ...

The task force must submit its report on April 1, 2010.

The MARCS Task Force decided to divide its efforts into three work groups to meet the narrow timeline granted under HB 2. The Use Work Group will recommend a model for enabling and improving participation statewide in the use of the system.

Work group recommendations will be evaluated by the MARCS Task Force. The task force may make modifications in the recommendation. It will be the responsibility of the task force to make a final recommendation on ubiquitous utilization of MARCS and incorporate this recommendation into the MARCS Task Force Report.

Final decisions on committing the state to any implementation of the recommendations will be the responsibility of the Governor and/or the General Assembly, as required by law.

II. Scope and Objectives

Key Questions:

- Which organizations/agencies need to be considered in this solution?
- What are the immediate needs and the longer-term, more strategic needs of the MARCS system and its users?
- Are there legislative restrictions that might be involved? Bond requirements? What are these restrictions and requirements? Can we facilitate changes to either?

If a particular topic aligns with the objectives of more than one work group, each work group will make a recommendation on the topic. The support team will consolidate these recommendations and present them to the task force for vetting and a final recommendation.

III. Out of Scope

The following concerns are out of scope for this group:

- Organizational structure for MARCS operations.
- Organizational structure for the MARCS infrastructure.
- Capital funding.
- Operational funding.

IV. Work Group Responsibility and Consensus

The work group will provide agency/organization-specific data, evaluate internal and outside sources, and develop a recommendation to support ubiquitous utilization of the system and tower infrastructure. The work group will present this recommendation to the MARCS Task Force the week of January 25, 2010.

The work group will consider all legitimate views and objections and work to resolve them. Members will strive for consensus on major decision points. Members of the work group are to bring the perspectives of their organizations/agencies to the table, but make recommendations for the good of the enterprise. If consensus cannot be reached, a decision will be attained through majority vote of the work group voting members. Voting members are defined as those members who are appointed or assigned to the work group by the MARCS Task Force.

If consensus is attained by a single vote majority, that fact will be noted in the work group's report. The task force will determine whether or not further evaluation is necessary.

The task force, after validating the recommendation and other critical work products, will submit a recommendation to the Governor, the President of the Senate and the Speaker of the House.

V. Member Responsibilities

Work group members are responsible for providing data, researching outside sources, developing and validating analyses, developing and validating work products, and developing recommendations to assist in establishing the final work group recommendation. Work group members are also responsible for reviewing, providing feedback, and applying critical thinking and enterprise-level judgment to work group deliverables.

The work group will expect all members to perform the following duties:

- Participate in work group meetings.
- Review "read-ahead" materials.
- Complete tasks as assigned.
- Develop and validate the resultant recommendation and presentation.
- Develop and support the recommendation throughout the task force review process.

VI. Work Group Structure

Co-Chairs: Tony Celebrezze, Deputy Director Department of Natural Resources
George Maier, Assistant Director Department of Public Safety
Facilitator: Katrina Flory
Scribe: Member of Support Team
Members: Representative Tom Letson, Representative Clayton Luckie, John Parker, Chief Scott Skeldon
Support Team: Sam Orth, Darryl Anderson, Sarah Saccany, Barbara Edwards, Ginny Lagather

Ohio Multi-Agency Radio Communications System (MARCS)

MARCS

System Upgrade Strategy

November 19, 2009

Prepared By:

RCC Consultants, Inc.
4900 Cox Road
Suite 235
Glen Allen, Virginia 23060
(804) 353-0300

Contents

I. Executive Summary

The State of Ohio's SIEC (Statewide Interoperability Executive Committee), during its recent meetings on October 10^{th} & 11^{th} 2009, refined and affirmed its long term vision (stated below) of creating a "system of systems" enabling seamless communications across the state for all of its Public Safety users.

> ***Ohio's interoperability vision is to have all of its first responders operating on a single, integrated, standards-based platform that offers seamless communications across the state. This "system of systems" is to be built on the base of MARCS and other existing local networks.***[1]

This is a laudable and ambitious objective, requiring careful planning and broad-based support. The SIEC's concept for such as system relies heavily on the existing statewide system ("MARCS") and other major trunked 800 MHz systems throughout the State.

This document presents a high level overview of the:

- Long term vision
- Current situation
- Major challenges to be overcome to realize the long term vision
- Major steps leading to improvement of the current situation and to fulfilling the long-term vision
- Expected costs of fulfilling the long-term vision

The state of Ohio has enjoyed and benefited greatly from the MARCS state-wide Public Safety radio communications system over the last several years. The system currently serves over 33,000 subscribers, as it has gained wide acceptance around the state. It is used for primary communications by almost 20,000 users, with the additional 13,000 using it to provide critical inter-agency interoperability.

The current MARCS equipment is nearing the end of its technological life, facing potentially increasing maintenance costs and unacceptable repair risks. Additionally, MARCS faces other serious challenges in terms of capacity, interoperability and portable coverage in certain areas. As a result, MARCS requires an upgrade in the near to mid-term future to continue to provide industry-leading service and to realize the SIEC's long-term vision.

[1] Throughout this report, the consultants have emphasized important points in a "boxed" format.

The essential aspects of a MARCS upgrade, in order to realize Ohio's long-term communications vision, include the following:

- Migration to a state-of-the-art platform to address obsolescence issues,
- Migration to a Standards-Based (P25) platform,
- Implementation of a packet-switched (IP-based) interconnection network,
- Implementation of a robust Standards-Based inter-system interoperability protocol such as the P25 Inter SubSystem Interface (ISSI),
- Obtaining sufficient User Identification Number (ID) capacity for all of Ohio's first responder community plus additional potential users,
- Obtaining the capability to access new Public Safety spectrum allocations at 700 MHz for improved capacity and level of service,
- Improving portable and in-building coverage in certain areas,
- Upgrading existing radios to be interoperable with new local systems based on P25 technology,
- Obtaining broader State-wide acceptance by reducing or eliminating the monthly user fees.

RCC supports the work of the SIEC and its long term vision, and believes it is an achievable, albeit ambitious, goal. RCC supports the essential high-level characteristics of the next generation system as described above, and recommends MARCS management proceed to develop the detailed implementation plans necessary to achieve the SIEC's vision.

RCC also recommends throughout this upgrade to the next generation system, MARCS management work with its chosen vendor to develop a clear and complete description of all aspects of the migration, in order to provide a smooth transition, and to avoid any reduction in features or capabilities during the process. MARCS should insist on a commitment from the vendor that full functionality will be maintained across the entire network throughout the transition period. There must be a clear understanding between MARCS and any vendor before work proceeds.

The total estimated costs for the upgraded network, based on the assumptions described in this report, is $205M. This total includes approximately $25M for a recommended, although optional, microwave network.

Once realized, Ohio's "system of systems" will again be an example to follow for communications leadership in other states. It will allow Ohio residents to take advantage of all of the benefits of a seamlessly interoperable Public Safety communications system throughout the State, as well as the technical advancements and improved competition resulting from the use of established industry standards.

II. Introduction

The State of Ohio owns and operates the Multi-Agency Radio Communications System (MARCS) – a Version 3.5 800 MHz Motorola trunked radio system designed to support public safety communications for state agencies, local agencies and mutual aid partners. Certain major components of the network are nearing end of life. Several communities in the State facing a similar situation are in various stages of upgrading their networks with later generation products that is likely to introduce incompatibility into the present environment. Other challenges for MARCS include, but are not limited to, limitations in user (unit ID) capacity, lack of available frequencies in the 800 MHz band, and traffic handling capability.

Within Ohio there are many jurisdictions, such as cities, counties, and others who operate their own independent systems. The FCC's Narrowbanding mandate requires systems operating in lower radio frequency bands[2] to convert their operations to narrowband by January 1, 2013, or otherwise abandon their existing systems and licenses. No new operations in these lower bands will be authorized after January, 2011 unless they are narrowband. It may become very attractive, especially for smaller agencies, to convert their operations to the MARCS system and abandon their old systems. In order for MARCS to accommodate these users, at least the capacity issues of the current system must be addressed and overcome.

RCC Consultants, Inc. has been engaged to augment the effort undertaken by MARCS staff to develop a strategy and tactics for an upgraded system, along the lines of the "system of systems" approach. This consultation has as its purpose: to collect and analyze data that will assist MARCS in choosing from technology related alternatives; to investigate the feasibility of merging MARCS with other systems in the State of Ohio, to consider enhanced voice and data functionality and platforms, to provide a timetable/phased approach to implementation, and to provide an estimated cost for the proposed upgrades.

In the short term MARCS must address the end of life for its current trunked radio system architecture and take steps to maintain public safety communications interoperability throughout Ohio.

Telecommunications and information technology are rapidly converging to provide access to video, data, and voice communications in a digital format in the mobile environment. Such convergence provides opportunities in the future for improved public safety services, and it is essential MARCS be prepared in the long term to exploit or augment that trend.

[2] Generally, below 470 MHz, and above 150 MHz

In today's environments most public safety agencies recognize the necessity of communicating with their neighbors with minimal intervention by dispatchers or technicians. Budgetary and economic conditions mandate the highest possible degree of sharing of facilities and of missions. Technology developments provide a means for the sharing of facilities and equipment. Within Ohio, the MARCS system offers an opportunity to share systems and infrastructure, making operations more economical.

III.Future Vision and Strategies

Ohio's State Communications Interoperability Plan (SCIP)

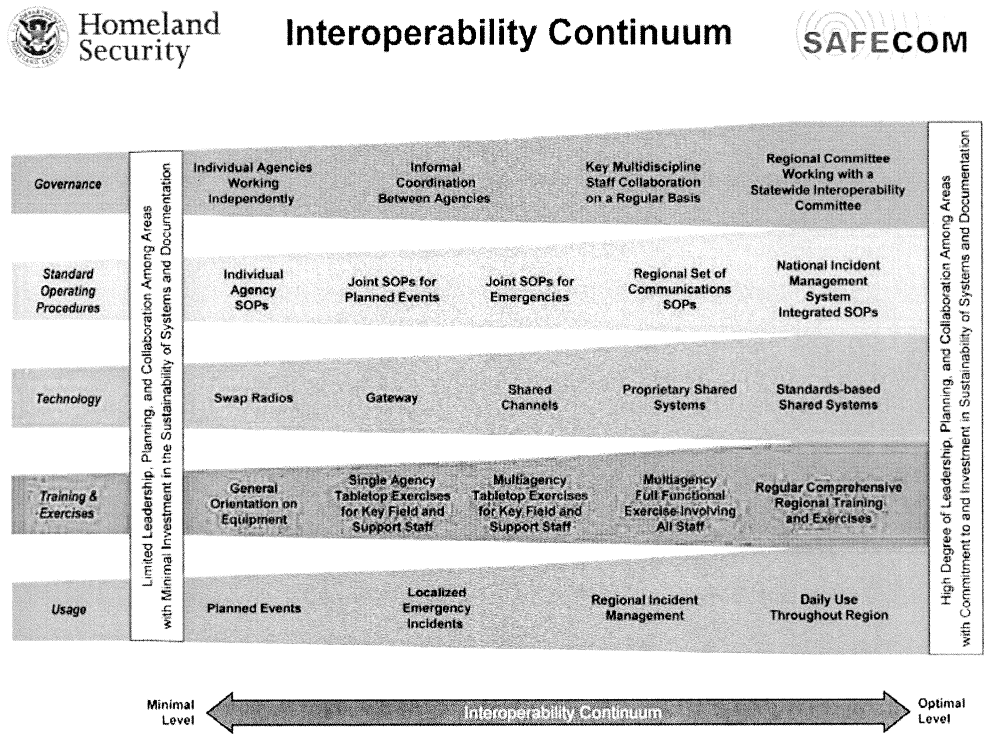
Ohio's SCIP was created under the auspices of the Statewide Interoperability Executive Committee (SIEC), and crafted to be a living document with revisions on an annual basis as needed. The SIEC is organized to represent the interoperability interests of first responders serving at the state and local government levels.

Ohio's interoperability vision is to have all of its first responders operating on a single, integrated, standards-based platform that offers seamless communications across the state. This "system of systems" is to be built on the base of MARCS and other existing local networks.

The State's strategy encourages local agencies to consolidate communications at the county level where appropriate, and to use these county systems to augment the state-wide coverage currently provided by MARCS. The State of Ohio is at the beginning of the procurement process for 700 MHz equipment to expand and upgrade the statewide MARCS system, and convert to an open, standards-based system.

The SCIP thoroughly supports the important theme of public safety communications interoperability across the state, not just in isolated or metropolitan areas of Ohio. MARCS already enjoys a high level of interoperability around the state with a number of partners. The SCIP challenges state and local governments in Ohio to advance their systems to a higher level of interoperability thereby permitting first responders to interoperate with others, while assisting or being assisted, regardless of where they are located.

Ultimately, attainment of a "Level 6" on the Department of Homeland Security (DHS)-defined Interoperability Continuum will achieve seamless interoperability statewide by using standards-based shared-systems technologies. In the chart below, the descriptions in the right column of the continuum represent "Level 6."



DHS public safety interoperability continuum

The goal of Level 6 interoperability relates to the adoption of a standard that permits users that have purchased radio equipment from different manufacturers to interoperate seamlessly. The P25 standard was adopted by the Association of Public Safety Communications Officials ("APCO") several years ago, and is only recently becoming available competitively through multiple manufacturers. The purpose of P25 is to overcome the lack of interoperability inherent with the proprietary radio systems that permeate the country, including Ohio.

The strategy focuses on promoting regional interoperability, sharing of interoperability concepts, procedures and best practices and facilitating inter-regional and intra-regional interoperability where possible using the Statewide MARCS system.

The members of the SIEC and authors of the SCIP recognize such bold visions take time to accomplish initially, and require constant attention.

As outlined in the Ohio SCIP, several short and long-term objectives were developed to address weaknesses and gaps identified in 2005, including:

- Different frequency bands in use within the same county,
- Different frequency bands in use in neighboring counties,
- Incompatible legacy systems in use (i.e. conventional/trunking, different trunking protocol, etc.),
- Lack of interconnection of disparate systems,
- Insufficient capacity to implement system interconnections.

Ohio SCIP Long Term Objectives

The long term Objectives are far-reaching and strategic, requiring statewide commitments and coordination. They seek to move toward standards, and encourage the sharing of resources and promoting and supporting networks that improve the effectiveness and/or reduce the cost of those services.

Long-Term Objective #1	Expand and Upgrade MARCS
Long-Term Objective #2	Encourage Consolidation of Communications Systems at the County Level
Long-Term Objective#3	Interconnection of Countywide Systems together and to MARCS
Long-Term Objective#4	Implement a Statewide IP-Based Backbone System.
Long-Term Objective#5	Establish and Operate Network based Gateway Switches for Interconnection of Systems

MARCS management and the Office of Information Technology are interested in expanding the current statewide backbone network to one which can provide increased bandwidth and connectivity and improved reliability while potentially reducing cost through the use of more efficient packet switched Internet Protocol technologies and alternate routes. The Office of Information Technology has the responsible role in an objective to develop a statewide "IP-Based" backbone system to interconnect strategic locations throughout the State. Such a system could be used, and would be required in some cases, to interconnect primary dispatch centers, interconnect sites within a system, interconnect systems through interoperability gateways, and interconnect P-25 based systems using the Inter SubSystem Interface (ISSI) as described in the P25 suite of standards.

MARCS management is considering a proposal to replace the four existing zone controllers with three 'next generation" units. The later technology does not require the current OmniLink equipment, but provides connection (to the extent of its capabilities) directly between zone controllers. The new zone controllers also have greater capacity in the number of sites (100 vs. 64) and unit IDs (128,000 vs. 48,000). Additionally, new zone controllers do not have to be physically collocated, which reduces vulnerability to catastrophic failure of supporting infrastructure or connectivity, and they can provide backup capabilities for each other through the use of Dynamic System Resiliency[3] (DSR), which is a new feature designed to improve reliability.

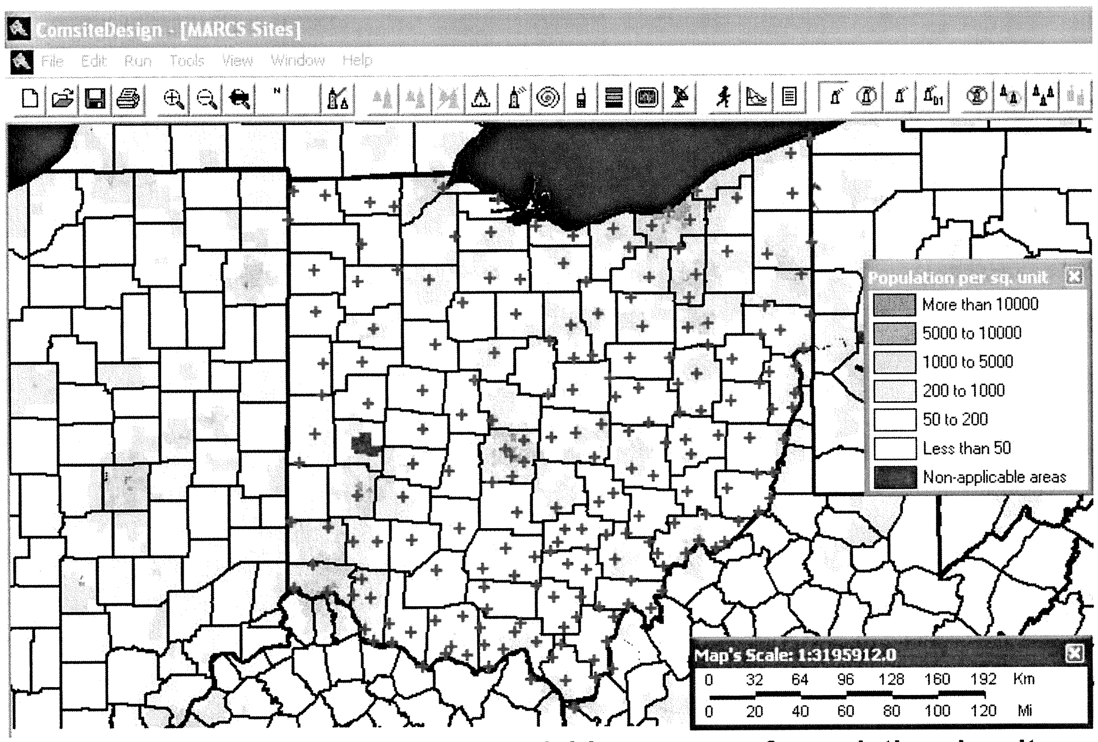
In order to provide the capability to connect with several other similar and compatible regional systems, some additional capability must be added. In a configuration with DSR, zone controllers can be configured to provide redundancy to other controllers. With DSR, this configuration can support up to six zones with redundancy (zone controllers, while fully capable of handling 100 sites within their own zone, and 100 sites in the alternate zone, can be paired with another, similarly configured and connected controller).

Within the Ohio SCIP, there is also the stated objective to improve data performance to support higher speeds in support of the Ohio Law Enforcement Management Information Sharing (OLEMIS) initiative. The current 9600 bps capability is expected to be the limit for integrated voice and data. Higher speed technologies, apart from being interconnected via the new zone controller, would not be part of the integrated network.

[3] Dynamic System Resiliency is a new feature to allow remote sites to connect to more than one zone controller, allowing zone controllers to be paired with another (up to three pairs) to provide back up (one for one protection with another zone controller for up to a total of six networked controllers).

IV. MARCS System Overview

The current MARCS voice system is organized into four geographic areas (zones), and these zones are interconnected using a Motorola OmniLink system. The four zones are generally located in the West Central (Zone 1), Northern (Zone 2), Southern (Zone 3) and East Central (Zone 4) areas. Zone 1 serves 22 counties, including two metropolitan areas around Columbus and Dayton. Zone 2 serves 35 counties and the areas surrounding Akron, Cleveland, and Youngstown. Zone 3 serves 17 counties including the area surrounding Cincinnati. Zone 4 serves 14 counties including the Appalachian region. Each site contains between three and 13 channels to serve voice users.



Existing antenna site resources overlaid on a map of population density

State Office Computing Center (SOCC) Equipment

The SOCC site is the Master Site for the entire MARCS system. Housed at this location are the SmartZone and Omni-Link controllers, which are UNIX based "IMP" computers. There is one computer for each of the four zones in the MARCS system, and one computer to connect the four zones. Each operates in a hot-standby redundant configuration. Also included are the Ambassador Electronics Banks ("Embassy Switches") which serve to process and cross connect the trunked system conversations.

The SOCC also includes other "prime site" equipment for the Columbus simulcast cell. It includes the main and standby trunking controllers, voting receiver comparators, and other control equipment.

The Central Electronics Bank (CEB) for the MARCS system is located at the SOCC, which serves 77 Computer Aided Dispatch (CAD) operator positions. Console operation in this vintage of Motorola trunked system is dependent on connection to and proper operation of the Embassy Switch.

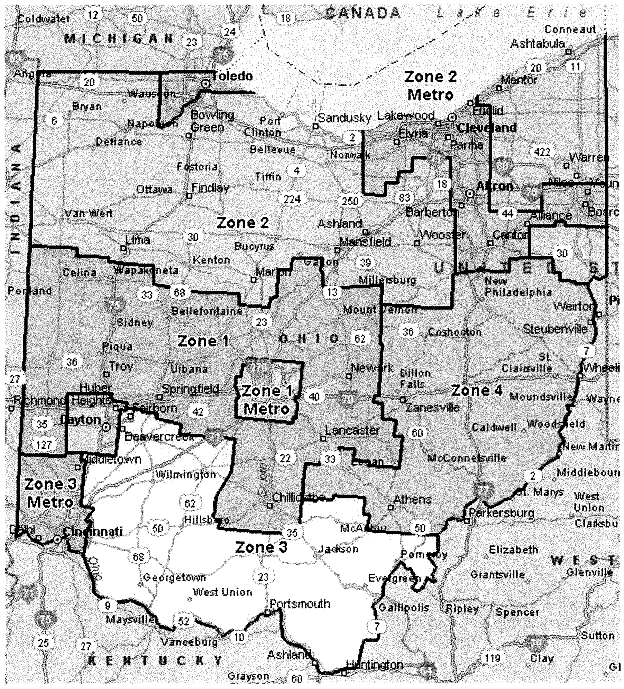
Finally, the SOCC houses the four Radio Node Controllers (RNCs) for the mobile data system, which is described later.

Trunked Radio System Antenna Site Components

A total of 164 trunked antenna sites are employed in the radio communications system. The equipment configuration varies by site, depending on its location and traffic demand. The method of interconnection to the Master Site from each of the intellirepeater stations is via subrate serial ports in a TENsR channel bank, which is served by a leased T-1 circuit, described later.

Mobile Data Radio System Antenna Site Components

The mobile data system is independent of, but mostly collocated with the trunked voice radio system. Data base stations are located at virtually every voice capable site. There are also 38 "data only" sites. The data base stations are connected to the RNC equipment using the same leased lines used for the voice transport where collocated.



Existing MARCS Zones

MARCS Zone	Region	Metropolitan Areas
1	West Central	Columbus, Dayton
2	Northern	Akron, Canton, Cleveland, Toledo, Youngstown
3	Southern	Cincinnati
4	East Central	

Sites are distributed throughout the State, and operate in a multi-cast mode except in the Columbus area, which is implemented as a five site simulcast cell. Simulcast mode transmits the same audio and control information simultaneously from all sites within the cell on radios operating at the same frequency for greater coverage over a wide area. This simultaneous transmission requires extremely precise control of the transmitter carrier frequency, as well as the audio amplitude and phase of the modulating signal. Multicast radios operate with a different frequency set at each site. Simulcast is more difficult and costly to implement and maintain, but is more frequency efficient (uses one common set of channels for the entire area covered). Multicast is less costly to implement and maintain, but less frequency efficient. It is typically used to provide service over larger geographic areas with lower traffic volume demands.

Each site providing voice services is connected to the zone controller for its respective zone. The simulcast cell in Zone 1 which serves the Columbus area has an intervening "prime site" which includes an additional level of controller responsibilities, voting, and simulcast distribution.

Six base station sites are also equipped with two National Public Safety Planning and Advisory Committee ("NPSPAC") Mutual Aid channel repeaters that operate in the conventional analog mode. There are two sites in Zone 1, three sites in Zone 2, and one site in Zone 3. There are no sites in Zone 4 equipped with these channels. These repeaters are used for voice communications with itinerant units from other jurisdictions that may not be equipped with access to the trunked radio system. Because of their limited implementation and small number of channels, the conventional NPSPAC capability would not be useful as a backup to the trunked radio system in the event of system failure.

Virtually each base station site for the trunked voice is also equipped with a Motorola RD-LAP mobile data base station is used in a multi-frequency reuse system. The RD-LAP system is used by State-level law enforcement agencies. Since the majority of channels are NPSPAC, they all operate with 12.5 KHz channels, which results in a maximum data rate of 9.6 Kbps.

A summary of the current MARCS fixed network equipment system below shows a variety of configurations based on location and user demands. There are a total of approximately 930 base stations serving voice and data needs at 205 sites across the four zones in the system. Further breakdowns are reflected in the table below (CD is collocated data stations, MA reflects collocated mutual aid stations, and DO denotes data only sites):

Zone	#Sites	Number of Channels Implemented									
		13	8	7	6	5	4	3	CD	MA	DO
1	35	5			4	12	13	1	33	2	38
2	43		2	1	5	11	22	3	43	3	
3	41					4	25	12	41	1	
4	44					8	23	13	44	0	

Radio Subscribers

Subscriber units currently in use on the system are reported to be primarily of the XTS5000/XTS2500/XTS1500 family of portable (hand-held) radios and primarily XTL5000/XTL2500 family of mobile radios. These constitute the overwhelming bulk of radios (approximately 30,000) in current operation. Other radios in the system in smaller numbers include the XTS3000 family portables (approximately 3,400), and Spectra mobiles (approximately 1,650).

V. Current Situation – Main Challenges

The existing Motorola ASTRO Smart Zone trunked radio system is serving Ohio well, eliminating many deficiencies that existed in the previous conventional radio systems used by public safety agencies including State Highway Patrol, Natural Resources, Health Departments, and Corrections. The Sheriff's departments in each of the 88 Counties in Ohio are also equipped with a control station to provide access to the MARCS system, if not otherwise equipped and capable by other means. Local emergency management and health departments across the state also have access to the system.

However, MARCS is currently faced with many challenges and limitations that must be addressed.

A. Technology Life Cycle

The chart below shows the normal life expectancy by equipment type and class. However, these are affected by the interrelationship of different system elements. Many other factors affect these expectations as well: how well the equipment is cared for and maintained; the amount of direct user interaction/contact; protective accessories or installation practices; policies and procedures regarding equipment issuance and accountability; normal expected damage and wear; the cost and operational impact of installation efforts; and exposure to harsh environments (lightning vulnerability; exposure to chemicals, moisture or corrosive substances, dust, etc.)

Equipment	Approximate Life Expectancy		Replacement
	Years	Average (months)	Plan/Bid/Install (months)
Building Structure	20 – 30	300	24
Towers	25 – 30	330	12
Transport/Microwave Equipment	10 – 15	150	18
Base Station	7 – 10	108	9
Mobile Radio	5 – 7	72	12
Computer Hardware	4 – 6	60	9
Portable Radio	3 – 5	48	6
Software	2 – 3	30	12

One driving force behind shorter life cycles of some equipment, and the requirement for the early replacement of communications equipment in recent years is the rapid advancement of technology. Equipment becomes obsolete not because of its condition or age, but because its manufacture has discontinued, the technology has advanced, and often the parts are no longer available in their previous physical packages and form factors. As manufacturing processes are becoming more complex, serviceability is diminishing. As replacement units or assemblies become more specialized and unique, their availability diminishes quickly once production of the equipment ends.

An aging communications infrastructure increases the risk that a maintenance problem could result in an extended outage. Aside from the importance of repair parts in the expected life, service expertise and availability of reference materials are also factors.

MARCS employs the OmniLink-SmartZone Version 3.5 in its network. Motorola has a schedule for phasing out technical support for systems after they have reached the end of their life cycle. The scheduled date for the end of formal technical support for SmartZone V3.5 systems is December 31, 2009. Most importantly, Motorola has notified all SmartZone V3.5 customers it can no longer guarantee repair of certain critical portions of the system's infrastructure at Motorola's factory depot. Motorola will attempt to repair or replace these parts only on a "best effort" basis. MARCS is expected to have amassed a considerable inventory of these critical infrastructure pieces, but should be working to transition its infrastructure, as soon after that date as is economically possible, with a new system, for which guaranteed support can be obtained.

The chart shown on page 14 depicts the system life-cycle for the Version 3.5 system. This chart is based on information provided to RCC by Motorola in support of network upgrade strategies for various clients.

Newer generations of trunked radio systems are under constant development, and require many years of research and development, prior to being ready to serve agencies with life safety responsibilities.

SmartZone 3.5 System Life Cycle

Software (SER) Releases through	Q4 2003
Expand Master Site through	Dec. 2003
Rebanding Release	Jan. 2006

- Add Simulcast/Voting Channels through — Dec. 2007
- Add Remote Sites through — Dec. 2007
- Add Console Positions through — Dec. 2007 → Dec 2009
- Add IR Channels (Quantars) through — Dec. 2009
- Technical Support Contract (SSC) thru — Dec. 2009
- Board Repair through — Box/Parts Dependent

The existing MARCS system has passed the last stage of software revisions for Version 3.5 systems. System warranty, maintenance and expansion of the subscriber fleet is still provided. The current date for the end of the lowest level of support, radio parts and warranty, is 2016.

As systems of the size, scope, complexity and cost of MARCS take several years to implement or upgrade, the final product often is not the latest technology offered at the time of its completion. Currently, Motorola is offering various version of its 7.x platform, which is compatible with and can support the P-25 Phase II standard and has an IP-based backbone.

In summary, the MARCS ASTRO 3.5 system is in the twilight of its useful and fully-supported life cycle. Given the expected long time needed for implementation of a new system or system upgrades, planning for the required transition needs to be undertaken immediately.

There are no intermediate levels of beneficial upgrades available for MARCS' current network due to obsolescence of certain network subsystems, particularly the IMP Computers, Embassy audio switch components, Gold Elite consoles, and other similar elements.

An additional challenge is posed on the subscriber equipment side. Even if new 700 MHz interoperability channels were implemented in Ohio over the short term, there remains the practical problem that not all of its existing public safety mobile and portable radios can operate on those frequencies. Only newer radios are capable of operating on P25 trunked systems, or in the 700 MHz band.

Proprietary System – Single Vendor Dependency

The current platform (V3.5) of MARCS SmartZone system is a proprietary Motorola technology. With the exception of some subscriber units offered by EF Johnson based on Motorola's license, no significant elements of the system can be purchased in competitive process with multiple vendors.

Reliance on a single supplier is reflected in relatively high pricing, but it has other negative consequences, such as lack of competitive alternatives for system improvement or maintenance. MARCS and its users are at the mercy of its virtually sole supplier.

Standards for digital public safety communications systems, intended to improve interoperability and to stimulate competition among multiple suppliers have evolved since Ohio embarked on its system implementation. Vendor efforts to implement competitive features also tend to shorten support and system life cycles, and that can hasten the obsolescence of existing systems.

The P-25 suite of public safety digital trunked and conventional radio standards has been standardized by the American National Standards Institute (ANSI), but is also under constant review and improvement.

Motorola, the dominant supplier of public safety communications systems in North America, has enjoyed considerable success in Ohio and across the nation with the sale of trunked radio systems. Prior to ANSI recognition of the APCO 25 standard for digital public safety communications systems, Motorola had established a strong foothold with its Astro systems. Digital trunked radio systems deployed in the timeframe of the MARCS system contain some Motorola proprietary functions and architecture that limit compatibility with the digital radio systems produced by others during the same period. Such functions and features, while based on state of the art processors and communications protocols of the time, had the effect of creating a barrier to entry by competitors. This barrier was surmountable at the trunked radio level only at the cost of compatibility and interoperability amongst public safety agencies. While there was open competition for most of the trunked radio systems, to provide full compatibility and interoperability Motorola was often the logical choice. To this date, full interoperability within the MARCS system requires a subscriber unit radio that supports Motorola trunking functions, the source of which is limited to a very few providers.

B. Connectivity to Sites and Other Systems

Network connectivity between the MARCS master site and each of the remote radio sites is provided by telecommunications facilities and circuits leased from

AT&T. The system is presently served by dedicated point to point circuits based on time division multiplexing technology.

The present radio system is dependent on circuit switched technology, which is supported by time division multiplexing (dedicated bandwidth). Current and future systems technologies can usually be supported by packet switched network systems with much lower bandwidth requirements, as long as latency, jitter, and peak data rates are well defined and stable.

While the current backbone is generally reliable, there is an interest in investigating replacement options, which might include microwave radios and/or fiber optic networks. Current radio technologies can be supported by more advanced networking techniques, such as Asynchronous Transfer Mode (ATM) or Multiple Protocol Label Switching (MPLS). These networks, while running at much higher rates in their core, are packet switched, and provide higher efficiency by not requiring the dedicated end-to-end bandwidth of time division multiplex systems. Properly engineered and implemented networks using these technologies can provide reliable service at a lower cost. Currently, the annual recurring cost of the backbone network is reported to be approximately $1.1M

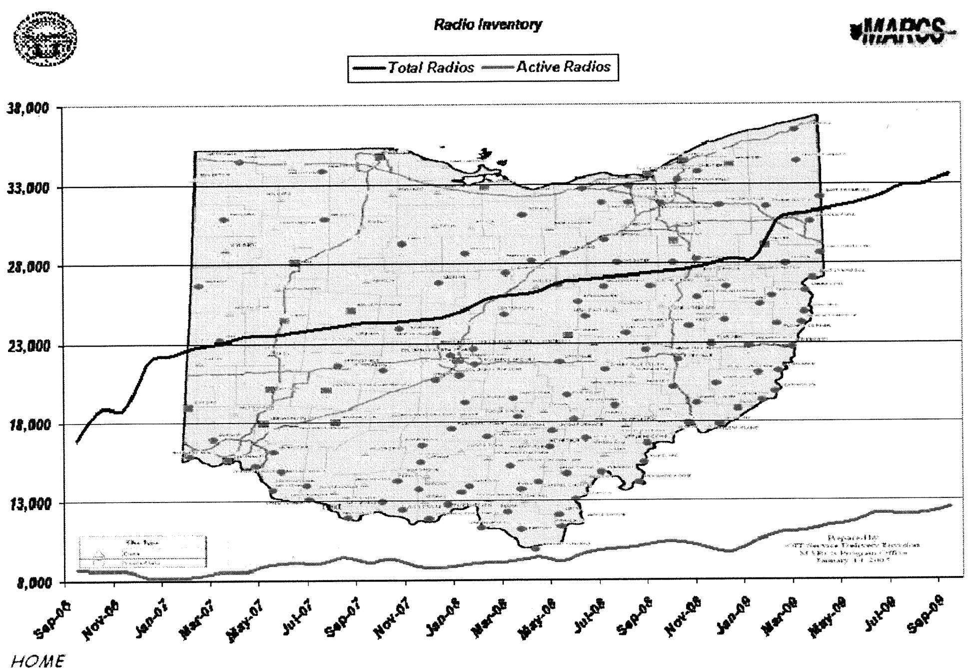
There were a few "high profile" circuit outages during recent hurricanes. In one report, eight T-1 circuits were reported to be out. While non-simulcast sites can continue to operate independently on loss of network connectivity, the ability for users to communicate over wide areas or to console operators is lost.

C. Capacity – User Identification Numbers

The SmartZone/OmniLink 3.5 architecture, upon which the MARCS system was designed and implemented, is limited to a maximum of 48,000 user Identification numbers (UIDs). Each subscriber radio (mobile/portable/control station) requires a unique UID. In addition, each operator position of each console in the system requires one UID for each talk group that they are programmed to have accessible. For instance, 10 operator positions with access to 70 talk groups will consume a total of 700 UIDs.

Currently, there are approximately 33,000 subscriber radios in the MARCS system, there are also approximately 10,000 UIDs consumed by the 77 operator positions (an average of about 130 talk groups per operator position). There are approximately 5,000 UIDs available for assignment with the current architecture.

Given the historical rate of MARCS user growth of approximately 1.2% per month, the number of UIDs will be theoretically exhausted within the next ten months absent some corrective action.



The responsibility for some of the short term objectives identified in the Ohio SCIP rests primarily with localities, but heavily involves and includes MARCS and its resources. Objectives include developing a dispatch center talk group and extending MARCS capability to additional dispatch and critical infrastructure control Centers to provide "Level 5" capabilities, or "Level 4" for systems patched through them. Incident Commanders and vehicles of key supervisory personnel are also to be equipped with MARCS equipment. All of these local objectives will consume scarce unit ID resources; an issue that was mentioned earlier. Depending on implementation (direct console, or control station based), that objective could have a significant impact on available IDs.

D. Capacity – Traffic Handling

Typically it is accepted that the Grade Of Service (GOS) for Public Safety systems should be a maximum of 1% during busy hours. In plain terms, it means that no more than 1 in 100 requests to talk by a subscriber during the "busy hour" should be denied access because all channels are busy. Additionally; the denied call should be queued and allocated access to a working channel in no more than 2 seconds after the initial denial.

MARCS administration defines traffic handling capacity of the network in terms that are somewhat different than industry standards. GOS is defined for MARCS as an "availability of all MARCS towers as a percentage of total tower availability (with 100% being the maximum availability)". In simplistic terms, 1% GOS in standard terms is equivalent to 99% GOS in MARCS terms.

The statistical data provided to RCC by MARCS Administration indicates that MARCS' traffic handling capacity in some areas, does not meet industry standards. For example, for the first nine months of 2009 the worst GOS varies between 66.6% and 84.8% at some sites, although the average does exceed 99.9%. It is important to note that Public Safety systems are designed for critical situations, not for average throughput.

MARCS management monitors this performance regularly, and takes appropriate action, such as adding channels whenever possible. However, their ability to add channels is becoming limited in many areas, due to the lack of available 800 MHz frequencies.

Independently of the system capacity limitations in the terms of the number of user ID's, MARCS is facing some serious traffic capacity limitations in some locations.

E. Spectrum Limitations

It is desired to operate the core MARCS system and provide coverage by continuing to focus on the 800 MHz frequency band, or adjacent spectrum. However, there are spectrum availability limitations that require alternate strategies, as explained and outlined in this section.

1. 800 MHz Spectrum

Urban growth in areas of the State with increased use of the 800 MHz spectrum has caused depletion in the availability of suitable channels, both for new systems as well as the expansion of existing systems. Interference and increased noise levels from this growth is compounded by similar growth and incompatible uses of the spectrum by commercial providers. The MARCS system is currently undergoing a "rebanding" process, which is intended to segregate public safety communications from incompatible commercial carrier operations, presently operating on adjacent spectrum in most areas of the country.

The rebanding process exacerbates the spectrum issues. It requires certain portions of the 800 MHz band first be "cleared" in order to make room for relocation of the NPSPAC channels as a group. System-wide, the MARCS usage is entwined in several ways. First, channels must be cleared from the band of 851-854 MHz at the bottom of the band (lower 120 channels). Operations in the expansion band (860-861 MHz) may be relocated at the option of the licensee.

Once space is cleared for the new Public Safety spectrum, channels may be exchanged. MARCS frequency use by these "sub-bands" is listed below.

	System	Pct	Zone 1	Zone 2	Zone 3	Zone 4
L120	15	2.1%	5	3	3	4
Non-SMR	63	8.7%	7	3	34	19
Ex Band	4	0.5%	1	0	1	2
NPSPAC	643	88.7%	195	196	115	137

The listing shows that 91% of the radios in MARCS have been or will be impacted by rebanding. The license application freeze periods for various portions of the band which have been enacted to minimize confusion during reorganization of the band have hindered activities to modify licenses and address system needs. It is apparent the rebanding activities have already delayed or prevented the licensing of channels to enhance of expand the current system to address localized needs.

The situation is further complicated by proximity to Canada and related limitation in the use of 800 MHz channels.

With very few localized exceptions, acquisition of additional 800 MHz channels in the state of Ohio is not a viable option for solving capacity or coverage problems.

2. 700 MHz and the Digital Television Transition

In June 2009, the digital television transition occurred wherein most analog television broadcasting ceased and broadcasters in the upper part of the 700 MHz frequency band relocated to lower frequency channels. When these broadcast operations finally cease, 24 MHz of that spectrum will be made available by the FCC for public safety operations. Of the spectrum allocated, approximately 10 per cent was set aside for licensing directly to State Governments. The remaining spectrum is set aside to interoperability and general use on a regional basis in accordance with approved regional plans. A number of public safety providers have been granted licenses to operate in these newly available bands, and others have applied for such licenses.

In the 700 MHz band, the FCC established thirty-five frequencies for nationwide interoperability. Thirty-two of the frequencies are for conventional operation (non-trunked systems or the use of trunking on a secondary basis) and three frequencies are for nationwide itinerant low-power use. The TDMA (P25 Phase II) standard does not apply to the thirty-two (32) 700 MHz nationwide interoperability channels.

Also set aside in the nationwide plan, was 2.4 MHz of spectrum, which is the equivalent of 96 duplex channels with a bandwidth of 12.5 KHz. Although licensed only to State Governments, there is coordination required with adjacent states. In other words, the same spectrum was allocated to each state, and coordination near state borders is necessary to minimize interference. This will reduce the overall availability and use of the channels. The fixed (base station) portion of this band will be in the range of 769 to 775 MHz, and the mobile portion is higher by 30 MHz. The process of coordination of this spectrum for the state of Ohio has already been concluded.

As the current MARCS system uses over 300 distinct 800 MHz channels, any significant growth is expected to depend on the statewide allocation of the 700 MHz spectrum, and may also require contributions of local government channels, as those local entities join the system.

F. Interoperability

Interoperability is the ability of first response agencies, whether fire, police, or emergency medical services, to work together and to communicate with each other during an incident, emergency, or disaster. Radio communications is integral and essential to this ability. During these events radios of personnel of all involved jurisdictions must be able to talk to each other. Operating procedures for communication and clear lines of authority must be pre-established and practiced.

Interoperability is commonly considered to be one of the most serious problems to be overcome by Public Safety, both in Ohio and nationwide.

In preparation of this study, RCC Consultants interviewed a number of primary and secondary MARCS users; interoperability has been by far the most common concern expressed by the state agencies and local authorities.

MARCS currently employs a variety of techniques to enable its subscribers to communicate with other systems. The situation varies depending on location and on the locally implemented technologies. In a few places the local systems are directly compatible with MARCS. Quite too often, however, there is no easy, quick and dependable method of interoperability. For example, all of Ohio's Department of Natural Resource's law enforcement officers operate alone and depend on the local Public Safety as their back-up. In several locations they carry two or more radios for interoperability's sake. In the most drastic cases, a cellular phone is the best method to call local law enforcement for back-up.

On the other hand, many county public safety agencies are now on a common radio platform, if not on a common system. Because of that, they can and do communicate with one another on a routine basis, have better coverage than in the past, and have interoperability with most public safety agencies.

On January 3, 2007, Homeland Defense Secretary Michael Chertoff gave a press conference discussing the *Nationwide Interoperable Communications Assessment*. This assessment was a scorecard of 75 urban and metropolitan areas all across the nation. Of the 75 areas scored, only 6 received the highest score in all three rating categories. The Columbus, Ohio area was one of those six. The scorecard assessed jurisdictions in three areas: governance, standard operating procedures (SOP's), and usage. The governance area assessed shared systems and solutions, the equipment and the technical matters. The SOP area assessed planning and preparations. The usage area assessed the actual implementation of interoperable communications; "how well did they do it in the field under live conditions?"

Key to the continued success of MARCS and its ability to interoperate with its various partners is the cooperation among the various jurisdictions with regard to radio system technologies. With the availability of newer technologies than those of SmartZone 3.5 and with the advent of national interoperability protocols, such as APCO P25, it remains vitally important that MARCS continue to move forward in collaboration with its partners. Butler, Lucas and Hamilton counties, as well as the city of Cleveland, are or will soon be on the air with P25 systems. MARCS must start upgrades in the very near future regarding its technology direction for the next decade.

The Counties which abut, encompass, or are in proximity to metropolitan areas include the Counties of Cuyahoga (Cleveland), Franklin (Columbus), Butler, Warren, Clermont and Hamilton (Cincinnati), Lucas (Toledo), Mahoning (Youngstown), Montgomery (Dayton), Stark (Canton), and Summit (Akron) in Ohio, as well as neighboring localities in Northern Kentucky and Southeastern Michigan. These areas are of primary importance and priority for provision of advanced interoperability capabilities in the state of Ohio.

G. Coverage

The MARCS system presently boasts mobile "on-street" coverage to an aggregate 99.71% of the State, including a 10 mile radius "buffer" outside of the state. For mobile data users, coverage is reported to be 98.13% over this same area. While it is widely accepted no radio system will ever have perfect coverage in 100 percent of the areas desired, as new local users join the MARCS system, their coverage needs and expectations may vary somewhat, typically being more intense and focused on portable and indoor operations.

With some localized exceptions, the majority of the State is not covered adequately for portable radios; hence the extensive (several thousands of units) use of vehicular repeaters among MARCS users. Providing adequate coverage for portable radios will likely require a significant number of additional sites.

VI. Gap Analysis & Recommendations to transition from Current Status to the Long Term Vision

#	Current Status	Desired Status
1	Obsolete platform	State of the art platform
2	Proprietary system	Standard-based system
3	Circuit-switched backbone	IP-based network
4	Incompatible system throughout the State	Support of ISSI interconnectivity
5	33,000 users	Sufficient capacity for all of OH first responders + other users
6	GOS failing PS standards in some areas	GOS meeting/exceeding PS standards
7	Very good mobile coverage	Very good portable coverage
8	Level of interoperability varying based on location/agency	Very high level of interoperability throughout the State
9	Acceptance varying by location/agency	Uniform acceptance throughout the state

1. *Obtaining State-of-the-Art Platform*

It is clear that in order to avoid the limitations of the current platform and impending service/maintenance issues, MARCS must plan to migrate to a state-of-the-art platform.

It must be taken into consideration that implementation of the new statewide network will take at least three years from the date of the project being awarded. All seriously considered vendors must be required to provide official and contractually binding roadmaps for their technologies to ensure the system that will commence implementation will still be state-of-the-art when the implementation is finalized and it can benefit from new technological developments for several years after.

2. *Implementing a Standards-Based System*

For many reasons (details of which are beyond the scope of this report), the only standard to be seriously considered for a MARCS upgrade is P25. The obvious next question is should MARCS pursue a Phase I or Phase II platform? The major advantage of P25 Phase II is increased capacity (two voice paths per one radio channel). The major advantage of P25 Phase I is that it shows very promising signs of commercial maturity – several interoperability tests have been successfully held and it can be expected that, in addition to enjoying multiple sources of the subscriber equipment, we can expect the benefit from competition among the network providers.

Given the state of Ohio has several hundred 700 MHz channels that can be used for the future network, the trade-offs between the benefits of higher level of competition (Phase I) and higher capacity (Phase II) point to Phase I as the desired technology for the initial deployment. However, any vendor providing equipment for the future network needs to contractually commit to the supplied technologies upgradeability to Phase II.

MARCS and several local entities already use radios that either already operate using the P25 PH I air interface or can be software-upgraded. The policy of buying P25 compatible radios will bring substantial savings when the system is upgraded.

3. Implementing an IP-based Network

The current MARCS system is supported by a large, leased network of dedicated T-1 circuits that support a relatively low volume of traffic.

Each of the more than 200 sites is reported to presently have a dedicated T-1 back to the master site at the SOCC. The average number of radios at all sites is less than five, and the intellirepeater sites are connected by low speed RS-232 links, served by the dedicated T-1. Fractional T-1 circuits were said not to be used. While the last mile transport would be framed as a T-1 circuit with a fractional T-1, the information and data content could be restricted and the bandwidth demands reduced in the core network, potentially resulting in an immediate savings for most circuits that traverse the state.

RCC recommends the next generation of MARCS be based on a packet switched network. The current system offerings from nearly all of the major two-way radio manufacturers are IP-based, in order to take advantage of this industry's equipment availability and extensive product development. This will allow MARCS to eliminate the requirement for dedicated T-1 circuits from end to end, and in most cases even reduce the amount of bandwidth necessary from what is currently in place. The State's OARnet could potentially serve the core backhaul needs for MARCS, from its regional points of presence back to the Columbus area. Additionally, there would still be requirements for the "last mile" connectivity to the sites.

An alternative approach for the next generation system could be to develop network connectivity by a combination of fiber or leased lines, and microwave systems for diverse routing. Where practical, such a configuration raises system reliability as the two media are entirely separate and protected from vulnerability to some of the failures resulting from a single action or condition. By implementing microwave links, the transition from leased circuits could be effected with minimal outages or disruption. Current trends in microwave technology also allow a mixture in payload between traditional time division and packet switched traffic.

Once the future network needs can be properly sized, it is highly advisable to run a feasibility study to compare all available options, including procurement of a dedicated backbone network.

4. Implementing the InterSubSystem Interface (ISSI)

The current MARCS system is an older vintage proprietary system that has limited capability for connection to newer Motorola systems or systems of other manufacturers. A system level interconnection between MARCS and local or regional 800 MHz systems throughout the State is critical to "system-of-systems" approach envisioned by the SIEC. This type of interconnection must be in place to allow seamless roaming of users across the State and the efficient sharing of resources.

The emerging P25 Inter SubSystem Interface (ISSI) standard is designed to address these issues and to allow interconnection of "P25-Compliant" systems of different manufacturers. A number of successful demonstrations of systems from different manufacturers interoperating have taken place recently and several manufacturers are now offering the ISSI as an available interface. These positive developments mean that, at least in theory, all but one[4] current 800MHz PS systems in Ohio can be upgraded to P25 and interconnected using ISSI.

RCC recommends MARCS include the requirement for ISSI interconnectivity as part of its next generation system.

5. Obtaining sufficient capacity for all of Ohio's first responders plus other users

The current MARCS system is limited to 48,000 individual ID's. The City of Cleveland, a strong candidate to participate in the future system of systems, is planning to procure a system for 12,000 users; other large local systems (Cincinnati, Butler County, Lucas County, etc.) are also interested in/open for additional users, both from adjacent PS entities and from their local non-PS organizations. Therefore, procuring a network with a relatively small, incremental improvement in capacity (such as 64,000 users offered currently by Motorola[5]) is not recommended.

[4] An LTR system used by Sheriff's Office in Brown County

[5] Motorola will release a network capable of handling 128,000 users in the near future.

To accommodate all of Ohio's first responders and some additional subscribers (administration, Public Works, Transportation, School Districts, etc.), the future network must be capable of accommodating at least three-fold the current limit.

In the near term, an immediate step that could provide some interim relief is to review and revise current console talk group capabilities. One unit ID is consumed for each possible talk group appearance on each console operator position within the system. Removal of unnecessary talk groups from the consoles, or limiting their appearance to supervisory or key positions could provide some immediate and much needed relief. Based on information provided, each console operator position presently consumes an average of 130 IDs for trunked talkgroups (more than could be reasonably managed at one time by a single operator). Removal of 10 talk groups from 77 console operator positions could free up almost 800 IDs in the system.

6. *Maintaining Public Safety GOS standards*

Providing Public Safety GOS standards in the future network which is expected to accommodate many additional users will require additional channels at a large number of the sites, and quite likely, additional sites at some areas of high density of users. Given the supply of 800 MHz channels is, for practical reasons, exhausted, it will be necessary to integrate 700 MHz channels into the future network.

Such integration will require careful and detailed planning for the transition period. In the ultimate network, the channels need to be fully integrated and the subscriber units must be able to operate indiscriminately between the two bands as if they were one. Any half-way measures, such as manual switching between the networks operating on different bands, will add cost and complexity to the system and should only be tolerated during a transitional period, if at all.

MARCS should continue in the short term to monitor the grade of service on their current voice system, and act upon the worst case, peak performance issues as they are doing now. As channels potentially become available (unutilized equipment at some sites and/or newly available frequencies at others), MARCS personnel should seek to make these minor adjustments to the system in an effort to reduce access delays and further improve service on the current system.

7. *Achieving Excellent Portable Coverage*

As the long term vision includes merging the state system with the local networks, portable coverage will be provided by the existing local networks where it is most needed – large urban areas. This is one of the great benefits of the long term vision of the "system of systems".

However, it must be expected the demand for portable coverage will eventually become ubiquitous throughout the state, including less populated areas. To achieve portable coverage in the entire state, additional sites will have to be built.

Composite coverage provided by MARCS and the local systems currently expected to be integrated with MARCS into the future network needs to be carefully analyzed so that additional sites can be proposed, as necessary.

8. Achieving very high level of interoperability throughout the State

In the short term, existing subscriber units (mobile and portable radios used by first responders) are beginning to lose interoperability with other systems as those other systems upgrade to the P25 standard (Lucas County, Butler County, etc.) or 700 MHz operations. MARCS should commence the replacement or upgrade of these subscriber units. The upgraded or replaced units should be capable of operating on both legacy Motorola trunking technology and P25 Phase I and II systems, support roaming technology, be able to operable on the 700 MHz frequency band and compatible with conventional analog operation.

These upgrades will involve the replacement of approximately 5,000 radios, and “flash” firmware upgrades to approximately 30,000 more, which will allow all radios to communicate with a 3600 or 9600 bps control channel, and operate over the entire 700 and 800 MHz radio bands. This work should start as soon as possible, and could take as much as two years to accomplish at a rate of 50-75 units per day.

MARCS should first consider the replacement of older or obsolete subscribers (Spectra mobile and XTS3000 portable). These radios are nearing the end of their expected life, and will be unable to operate at 700 MHz or with P25 control channels unless very extensive factory upgrades are performed. Even with those upgrades, they still would be aged radios with a very limited future. This entails the following:

Radios to replace	Spectra Mobiles	~3,400
	XTS3000 Portables	~1,700

The current XTS5000/2500/1500 portable and XTL5000/2500 mobile radios which are capable of 700 MHz operation and can be optioned for P25 (9600 bps control channel) should be flash upgraded to do so. This will allow reprogramming as needed to provide immediate interoperability with other systems that are currently at or quickly moving toward P25 systems. They will also then be ready for operation on either the present or upgraded MARCS system.

Radios to upgrade ~30,000

The long term vision of the "system of systems" provides the desired level of interoperability. If and when all of the Ohio's first responders operate on a combined 700/800MHz P25 system(s), all of them will be able to talk to any other user in the state without an intervention from a dispatcher, simply by moving the selector switch or typing in the ID/alias of the desired party.

9. Achieving uniform acceptance throughout the state

While significant progress has been made (the system was designed for 8,500 units and already has 33,000 subscribers) and the interest in joining a state-wide system appears to be growing, achieving a true statewide acceptance for a single "system of systems" may be the biggest challenge of all.

US Public Safety is known for turf wars and varying political and regional agendas in some areas. Unfortunately, the state of Ohio is not free of that malaise; while many of the most progressive leaders have been actively participating in and are eagerly anticipating the realization of the SIEC vision, such an attitude is not universal and a major initiative will be necessary to convince great majority of the local leaders to join. There are some valid arguments that will be made and that must be successfully countered.

For example, a new financial model for the network subscribers must be implemented. For many current potential users, the idea of replacing their relatively inexpensive conventional radios with equipment many times more expensive AND then paying monthly user fees is very difficult to swallow. The State of Ohio should strive to make the new system free to use for qualified participants (at least all first responders). Moving to a P25 platform with the expected high level of competition among the radio suppliers should make the equipment somewhat more affordable than today.

Additional incentives may be necessary to convince the current users of various vintages of Motorola and Harris technologies. There are approximately 70 800 MHz trunked networks used by Pubic Safety agencies in Ohio. While improved interoperability is the obvious advantage of moving to P25 technology, other functional advantages are less obvious. From the perspective of an average PS user, the functionalities delivered by even the oldest SmartNet, SmartZone or EDACS systems do not vary that much from the functionality of P25 system.

There will also be issues of loss of jobs by local maintenance personnel, loss of control by the local administrators, fears of centralized bureaucracy, lack of trust in robustness of the one network and, undoubtedly, many other challenges.

An effective marketing/educational program will be necessary to successfully convince the great majority of Ohio PS users to undertake the necessary financial and logistical efforts to switch to one state-wide network.

10. Other Considerations

The MARCS system upgrade is expected to entail implementing standard-based P-25 technologies while refreshing infrastructure hardware. The expansion of MARCS is expected to improve the coverage at local levels and to improve the grade of service by adding additional channels, and offering services to more local agencies.

Equipment Shelters

Most MARCS equipment is located in and protected by pre-fabricated shelters. Shelter size varies by site from 8' x 8' up to 12' x 30'. These shelters were provided and installed by Northrop Grumman as part of the initial system implementation. The shelters are in good condition and have been maintained since the system was installed. However, space is limited and will be insufficient in some of the smaller shelters to accommodate a full set of replacement equipment associated with a parallel system upgrade.

UPS Systems

Uninterruptible Power Supply (UPS) systems are present at all radio system sites to ensure that, should commercial power be lost at a site, the load will be carried by a UPS until such time as the site's generator can come up to full voltage and proper frequency before connecting to the load. Without a healthy UPS at each site, the site would go down until the generator comes on-line, and for a significant period thereafter, while computer equipment re-boots and re-synchronizes. Even a momentary loss of power at a radio site can cause severe degradation of radio service for the geographical area that it serves. Even when operating within its rated capacity, the run time of a UPS (before shutdown) depends on the connected load. Run times of up to 30 minutes are a common expectation (in the case where generators fail to crank). As more equipment is added to those existing UPS systems, their run time will be diminished.

Mobile Data

The current trunked voice radio system is separate and distinct from the mobile data system. Virtually every MARCS voice site also includes at least one mobile data channel. A small number of sites have a second data channel to support increased demands in those areas. While the overall data rate is somewhat limited, it was state-of-the-art for private mobile data systems at the time of procurement, and through the use of other external compression techniques and programs, MARCS users continue to share advanced information such as mug shots over the system. As with the voice system, there have been several technological advances that support the implementation of integrated (voice and) data over the same network, wideband data that offers higher speeds and adaptive rates, or broadband equipment that offers speeds comparable to commercial offerings.

For a variety of reasons the current mobile data system should be considered for replacement in conjunction with the voice radio system. One of those reasons is that other functions depend on the data capability to provide services such as over the air programming and rekeying for encryption. While an integrated data system is desirable for that purpose and allows shared use of those channels to improve service to both voice and data users, it is not likely to be able to serve the growing mobile data needs of all users.

It has been shown that although integrated voice and data systems can allow infrastructure to be shared for multiple purposes, any traditional data use (mobile computing terminals, driver license checks, messaging, silent dispatch, etc.) should operate over a separate subscriber radio, similar to the current configuration. Attempting to use the same subscriber equipment for multiple purposes may well lead to very unsatisfactory performance of the data services provided.

Geographical Separation of Control Equipment

While the SOCC facilities offer a very secure and resilient location, connectivity between zone equipment and ease of administration were likely two of the primary reasons for their initial collocation. More modern technologies, advancement in network connectivity, and transport efficiencies would allow the zone controllers to be physically separated, while providing backup to each other (which is not currently possible) and allowing centralized administration. Any catastrophic failure to the physical plant or telecommunications serving this one location could have a devastating impact on the operation of the system. Some previous incidents with uninterruptible power supplies have demonstrated that alternate backup sites can be beneficial.

MARCS should consider taking advantage of the current capabilities to disperse the master site equipment to more than one physical location. If other similar "hardened" sites are available nearby, that may provide the protection of an alternate site while maintaining the proximity, repair response times, and convenience for the support team. This dispersion of equipment and use of dynamic system resilience (or similar feature) could also facilitate future upgrades of master sites (renovations, power or network upgrades, forklift replacement of equipment, etc.), allowing them to be done with little or no interruption in service.

Antenna Systems

Any use of an expanded frequency set into adjacent bands must also consider the antenna systems, including any "in-building" enhancements, which would also have to be upgraded in order to ensure similar service and coverage. Some consideration will need to be given to these devices with the decision to employ 700 MHz channels. For instance, the first generation antenna systems will not serve the 700 MHz band. The current systems must either be modified to operate over the wider bandwidth, or additional antenna systems need to be acquired and installed. It is likely that dual antenna systems may be needed for the transmit band, which will span almost 100 MHz.

Zone Boundaries

The current voice system was developed as four interconnected zones to overcome the site capacity limitations of a single zone controller in the architecture under which it was originally implemented (and currently operates). Those original zones are assumed to have been selected with consideration to other user defined regions, service areas, districts, or relationships with local partners in an effort to minimize inter-zone communications, and the need for the subscriber OmniLink software required for statewide operations. In other words, the zones represent the best fit of customer needs and architectural constraints.

Currently available information seems to suggest that MARCS might operate under three zones, or that the fourth zone might be under the control of a shared resource (zone controller) owned by a local partner at another location. If four zones are intended (one by a local government entity), then the participation, governance, administration, and commitment that formalize the relationship are the responsibility of MARCS and should be carefully crafted to protect the interest of their user base.

If three controllers are envisioned, then there will necessarily be some realignment of zone boundaries and areas. If two of the zone controllers are intended to serve the MARCS system (and the third primarily for interconnection with localities), then the two controllers will be at or near their 100 site per zone capacity, and may have little chance to expand further by adding more sites.

For these reasons, a comprehensive review of the existing zone areas and boundaries would be in order, as well as a clear vision of the "service area" for each of the controllers and the responsibility for maintenance and administration in future enhancements. Any plan to implement dynamic system resilience (zone controllers that back each other up) must equally pair one controller with other. These issues are also expected to affect upgrade decisions (system upgrades must be made in lock-step).

VII. Migration Recommendations and Strategy

An overall system upgrade that involves replacement of the existing system must be performed without significant interruption of service and continued interoperability and access to sites and/or talk groups during interim periods. The connection and capabilities (if any) between the current and enhanced system cannot be clearly defined at this moment.

There are a number of issues to consider and several areas to investigate further as the MARCS upgrade planning and implementation progresses. RCC recognizes some of these items will, out of necessity, be handled in a phased approach because of the magnitude and complexity of the project, as well as emerging technologies and routine enhancements.

However, from the information currently available, it is not clear that Motorola has developed what we would consider a smooth migration path for Multi-Zone or OmniLink (non-P25) systems to transition to current state-of-the-art systems in a phased fashion. While there are solutions to use the SmartX box between a current P25 zone controller and its remote sites or simulcast cells, it does not appear there are any offerings (for the old or new equipment) that would interconnect a new zone controller and legacy zone controllers or OmniLink systems.

It is also not clear how some operations would continue at their current statewide capability during any interim period. Examples are the use of consoles to dispatch agencies in various locations throughout Ohio. The present consoles require connection to the radio system through an audio switch. Current technology consoles are capable of connection directly to current technology controllers, but cannot connect directly to the present MARCS controllers. If the existing consoles are replaced with newer units with the latest technology, it appears that they would connect to the new master site equipment. But if the new master site equipment is not interconnected with the old, it appears that there also is no capability to allow new consoles to connect to old master site equipment (directly or indirectly). It is essential that console operation during interim periods be fully explained and that operations do not require duplicate operator positions, or cumbersome interfaces and operation.

MARCS should insist on a clear and complete description of all aspects of the transition, including any reduction in features or capabilities during interim periods and the expected duration of any such reductions or loss in service. For any situation where there are compromises or selections to be made (old or new system, lost services, loss of interoperability, reduction in grade of service, etc.) MARCS should insist on full disclosure prior to any further work. For such lapses or setbacks in capability that would occur in the interim, proposals for work-around solutions should be required. That would include development of detailed information to support recommendations, or a commitment that full functionality will be maintained across the entire network throughout the interim periods. There must be a clear understanding between MARCS and any vendor before work proceeds. Absent a clear and committed migration path without loss of capability from Motorola, MARCS should consider an open procurement of the standards-based open system, and seek alternative views on overcoming or minimizing the identified problems during the transition.

CORE Equipment Procurement Considerations

Much of the computing and networking equipment in state-of–the–art systems is moving toward commercial-off-the-shelf (COTS) products. Such equipment can be less expensive and more familiar, but also can have very short life cycles, and undergo dramatic changes in architecture and capability over relatively short periods of time. While this is often advantageous to pricing and sourcing over short terms, it subjects large systems such as MARCS that might be implemented over multiple years to unavailability of some private-labeled, third party equipment. Some of these situations may be beyond the control of the systems integrators, but others occur while being clearly preventable (by having failed to secure such long-term commitments from original equipment manufacturers, or sometimes strictly the result of business decisions, new partnerships and strategic alliances).

The core equipment should be procured and implemented in as few steps as is practical, over as short a period as possible, even if full migration cannot be completed for some time. Spreading such equipment over multiple phases or years could result in equipment differences, which could affect maintenance, sparing, or require hardware and software updates.

Procurement of such equipment could be accelerated to early stages of the project, if funding allows. If immediate funding is not possible, then deferral until later phases of all procurement for similar equipment that will be tightly integrated might be desirable. Due to the circumstances of MARCS in the areas of capacity and support, and depending on interim capabilities offered, MARCS should push for an accelerated procurement if it facilitates migration.

Alternatively, MARCS could secure a commitment to the implementation and support of specific equipment and software to avoid these situations. Such commitments are very difficult for smaller customers and markets, but should be achievable with reasonable levels of effort by MARCS, given the size of the system and attractiveness of their business in the marketplace. There are from time to time, commitments made outside of the published roadmaps in order to meet procurement and contractual requirements. These should be carefully crafted and thoroughly studied by MARCS before commitment.

Again, procurement should not be finalized and implementation should not commence until there is a clear understanding by both parties of all aspects, and a commitment from the vendor for the features and services which meet or exceed current capabilities, both in the interim phases and for the final system.

VIII. Cost Estimate

This section provides a budgetary cost estimate for the suggested upgrades assuming MARCS upgrades its existing hardware while maintaining the current system vendor. This assumption is done for convenience purposes and is not an endorsement of any particular vendor.

Costs are provided for equipment, as well as installation or integration. With few exceptions, the installation and integration costs are based on an assumed percentage of the equipment cost, with the cost of construction and integration of some elements reflecting additional effort. There are also some reductions where the effort reflects bolt in, or plug and play operation, or where there are economies of scale, or efforts that do not scale linearly with the quantity of equipment.

System Level Equipment

This section includes major hardware and system level equipment and software.

Master Site Equipment reflects trunked controllers, traffic handling and administrative/management servers, and connecting equipment necessary for its operation.

Interoperability (ISSI) reflects the cost of interconnecting hardware that is expected to allow connectivity with similar, standards-based systems.

Integrated Voice and Data represents the routers, gateways, firewalls, and connectivity to support data services over the new network.

Supplemental Administrative Servers are those special computers and software/tracking systems that would enhance administration of equipment, or manage inventory and configuration information. Examples are the encryption Key Management Facilities, Over The Air Rekeying, Over The Air Provisioning, and system documentation/inventory systems.

Network Operations Equipment represents the computers, servers, terminal server and data collection/distribution, monitoring and alarm, and similar equipment installed and expected to be operated by network specialists or help desk assistants staffing the support centers which ensure system availability and reliability across the entire system, as well as preventive maintenance duties.

Supplemental Routers and networking equipment reflects some of the related "customer side" hardware needed to connect to or support the system, but not part of the core system, or necessary for basic operation. They support "external enterprise" operations. Examples would be the routing of security equipment to allow the connection to Bureau of Motor Vehicles data or other similar systems to allow online access from computers connected to data capable radios.

Interoperability Gateways and Radios are the specialized routers, VOIP interfaces, control station or gateway radios or other interface equipment necessary to connect to other specialized, proprietary, or conventional radio resources that are not otherwise compatible with the standards-based system (non-ISSI connections). Although not directly tied to the master sites or trunked infrastructure, they are shown at the "zone" level to represent geographic distribution.

Existing Site Information

This section provides an overview of the number of sites in the current system for use in estimates and calculations for the expansion or distribution of remote sites.

Site additions or replacements

This section contains two lines. The first is the anticipated costs associated with renovating an existing site, or constructing a new one to house an alternated Master Site location, for dispersion of redundant system equipment. The second line reflects the final estimate of an expected target of new sites across the system (from discussions with MARCS), distributed across zones (the next whole number of sites relating to the distribution of five sites in accordance with the current distribution). The costs reflect an estimate for a new tower (current towers average 330ft – 350 ft is assumed), and a 12X20 foot shelter.

Site Equipment Upgrades

The quantities in these lines are for the upgrade of existing sites or outfitting of additional sites, based on the current number of voice sites and data sites plus the anticipated expansion mentioned above. The antenna system and 700 MHz station quantities reflect expansion to also support four 700 MHz channels. The quantities of 800 MHz radios are based on an average of five stations per site (current average is 4.55 800 MHz radios per site).

Site support costs were also estimated assuming that during the course of system upgrades approximately 25% of the existing sites will require some combination of equipment rearrangement, substantial expansion of electrical circuits, replacement of UPS equipment, an upgrade or replacement of HVAC equipment, or some other significant shelter repair. An additional, smaller estimate was assumed across the entire system.

Simulcast Voice Support equipment

It is assumed that over the course of system expansion or enhancement, the existing simulcast equipment will be replaced, and additional existing sites may be converted to simulcast operation in metropolitan areas. It reflects the expected voting, timing, and distribution equipment (in addition to base station equipment).

Microwave Radio Network (Optional)

The cost of the microwave network is provided as optional. MARCS currently uses lease T1 lines to interconnect sites and may continue to do this in an upgraded network. However, RCC recommends implementing a microwave network to reduce reoccurring costs and improving reliability.

The Microwave radio equipment is a high level estimate of the quantity and types of microwave radios that would be needed to interconnect sites. The regional microwave would represent OC3 (155 Mbps) capacity radios in a loop configuration for each of the four zones back to the Columbus area. The cost reflects the estimate for the equipment necessary to connect a site into the loop configuration (two radios and associated equipment for one site are reflected), with path distances of about 15 miles. The local loop systems are similar in nature and configuration, but serving a group of sites more localized in nature and limited in capacity to approximately one third of the regional loops (DS3 – 45 Mbps). The spur microwave equipment is estimated based on the anticipated number of sites that might not be along a higher level route, or are located in an isolated site, and requiring a lower capacity. The assumed configuration is a hot standby approach for these sites, since they would not be loop protected. The capacity for these sites would be approximately 12 Mbps. As these spurs would have lower capacity and less protection than loop sites, they would be expected to be on routes and serve sites not separated by more than one additional "hop" from a higher capacity loop. The total number of microwave stations is a gross estimate based on overall area, approximate route miles, and maximum expected average path length. It does not reflect a developed network, or an exact arrangement of sites. A small number of additional sites are included, which are anticipated to be located at other intervening sites if necessary in order to ensure terrain clearances, path distance, and allow for available siting. An estimate is also included for the basic monitoring and management system for such a network. It is based on an assumption of two percent of the cost of the microwave radio equipment being monitored.

Communications Center Costs

The costs for communications centers assume the replacement of existing equipment with a similarly sized arrangement, but using the new technology.

Costs such as those for telephone equipment, emergency power, computers unrelated to the radio system (CAD terminals, etc.), or console furniture are not included, as this equipment is expected to occupy the same physical space as existing consoles, with no new centers being implemented. The quantity and type of recorder shown is expected to be capable of recording the activity of approximately 500 talk groups. Playback on such systems is typically performed by application software on existing computers with network attachment, so no costs are reflected for playback equipment or software.

Additional Costs

Additional costs are assumed as a percentage of the gross cost of the system in specific areas. For instance, engineering costs assume a level of effort based on the amount of hardware as well as some oversight and activity related to its installation and integration. Costs for spare equipment do not include the cost of the initial installation of the equipment being "spared."

Subscriber Costs

Subscriber costs reflect system-wide quantities of "user radios" affected by or included in the upgrade. They include the replacement of older or incompatible radios, as well as firmware "flash" upgrades where they are available and advisable.

Also included in this list are a number of "data only" radios. Although an integrated voice and data infrastructure is recommended, data subscribers (distinct from and in addition to voice radios) are recommended for use where traditional mobile computing services are being supported.

Spares for subscribers reflect five percent of the total equipment cost. This can be viewed as one spare radio for every 20, or as $150 worth of accessories for a $3,000 radio. Similarly, it could reflect one spare for every 40 radios and half the amount on average for accessories as previously mentioned. As this is a gross estimate, the actual expenditure could be any mixture amounting to the same estimated cost.

Control station quantities reflect an estimate based on the assumption of: an average of three control stations per agency for 80 agencies; one control station for each of the Counties (88); and one control station for each console operator position (77), with the sum of these rounded up to the next hundred.

Total Costs

The total estimated costs for the upgraded network, based on the assumptions provided above, is $205M. This total includes approximately $25M for a recommended although optional microwave network. The details of the cost estimate are provided below.

System Enhancement and Refreshment Cost Estimate									
		Zone				Total	Unit	Inst/Integ	Extended
	System	1	2	3	4				
System Level Equipment									
Master Site Equipment		1	1	1	1	4	$3,500,000	$30,000	$14,120,000
Interoperability (ISSI)		1	1	1	1	4	$100,000	$10,000	$440,000
Integrated Voice and Data Support		1	1	1	1	4	$75,000	$18,750	$375,000
Supplemental Administration Servers (KMF/PC	3					2	$100,000	$25,000	$250,000
Network Operations Center Equipment	2					2	$300,000	$30,000	$660,000
Supplemental Routers/Networking Equipment		4	4	4	4	16	$20,000	$2,000	$352,000
Interoperability Gateways and Radios		8	8	8	8	32	$50,000	$5,000	$1,760,000
Existing Sites (for Overview only related equipment distribution guides)									
Num of Twrs		38	60	57	49	204			
Not MARCS Owned		15	27	20	13	75			
Percent Leased		39%	45%	35%	27%	37%			
Site Additions or Replacements									
Renovations or Upgrade for Alt Master	1					1	$1,500,000	$225,000	$1,725,000
Remote/RF		1	2	2	2	7	$400,000	$60,000	$3,220,000
Site Equipment Upgrades or Additions									
Networking/Control		39	62	59	51	211	$25,000	$2,500	$5,802,500
Antenna Systems		39	62	59	51	211	$31,000	$6,000	$7,807,000
700 MHz Base Stations		156	248	236	204	844	$25,000	$500	$21,522,000
800 MHz Replacement Base Stations		190	300	285	245	1,020	$25,000	$500	$26,010,000
Site Support Systems Expansion or Upgrade	21	10	15	15	13	74	$25,000	$2,500	$2,035,000
Simulcast Voice Support Equipment									
Prime Site Equipment		2	2	1		5	$60,000	$6,000	$330,000
Sub Site Equipment		8	20	10		38	$40,000	$4,000	$1,672,000
Microwave Radio Equipment (Optional)									
Regional (OC3 loop site locations)	3	24	28	24	23	102	$120,000	$30,000	$15,300,000
Local (DS3 loop site locations)	2	6	12	20	10	50	$80,000	$20,000	$5,000,000
Spur (8 T-1 MHSB Links)	2	8	20	13	16	59	$60,000	$15,000	$4,425,000
Monitoring/SCADA/Net Management	2					2	$395,600	$59,340	$909,880
Communications Centers									
Console Operator Equipment	77					77	$50,000	$5,000	$4,235,000
Support Networking	8					8	$12,000	$1,200	$105,600
Recorders	2					2	$150,000	$10,000	$320,000
Sparing	7%	(Of Fixed Equipment Only)							7603624
System Engineering	10%	(Of Equipment and Services)							$11,837,598
Contingency	20%								$23,675,196
Internal Project Management/Oversight	5%								$5,918,799
Subscribers									
Portable Radios						3,400	$2,600		$8,840,000
Mobile Radios						1,650	$2,800	$500	$5,445,000
Mobile Repeaters						500	$12,000	$500	$6,250,000
Data (only) Subscribers						500	$3,200	$500	$1,850,000
Control Stations						500	$5,000	$1,500	$3,250,000
Flash Upgrades						30,000	$300	$50	$10,500,000
Subscriber Accessories and Spares	5%	(Of Subscriber Equipment Only)							$1,178,000

$204,724,197

GLOSSARY OF TERMINOLOGY

APCO P25	See P25
ASTRO SmartZone	A digital trunked radio system designed by Motorola in the 1990s and acquired by MARCS that permits the establishment of centrally connected "zones" of coverage
ASTRO Spectra	Motorola's first generation 800 MHz trunked mobile radio compatible with ASTRO digital systems
ATM	Asynchronous transfer mode
Backhaul transmission	A transport layer designed to provide communications between the radio system's prime and remote sites
Base station	A radio transmitter and receiver permanently installed at a fixed geographical location
Cache	A supply of radios that can be distributed to jurisdictions in the event of an emergency or other extraordinary event
Console	A personal computer based system that permits a user to manage a trunked or conventional radio system (operator console) or to send or receive radio transmissions (communications officer console)
Conventional radio	A non-intelligent system that transmits and receives radio messages on specific radio frequencies
Coverage	The geographical area in which a radio system provides reliable transmission and reception of user voice communications or data
DHS	United States Department of Homeland Security

Interoperability	An essential communications link within public safety and public service communications systems which permits units from two or more different entities to interact with one another by radio or data networks and to exchange information according to a prescribed method in order to achieve predictable results
IP	Internet Protocol, a suite of protocols designed to provide connectivity between disparate networked equipment
Latency	The amount of time delay associated with the processing of a transmission in a network
Mutual aid	An agreement between two or more governmental units to provide first responder resources when required
Network availability	A radio trunk available to transmit or receive a user's message
Noise levels	Electrical impulses generated by natural and manmade sources that may affect radio communications
NPSPAC Mutual Aid	Five 800 MHz radio frequencies identified by the National Public Safety Planning and Advisory Committee designed for nationwide interoperability (one calling and four tactical channels)
OmniLink	Motorola's architecture to interconnect multiple Smart Zone systems into one larger network, which overcomes the capacity limitations of a single Smartzone network
OLEMIS	Ohio Law Enforcement Mobile Information Sharing
PSIC	Public Safety Interoperable Communications (program authorized by the Deficit Reduction Act of 2005, Title III of Digital Television Transition and Public Safety Act)

P25	An open architecture set of technical standards developed under the supervision of the Association of Public Safety Communications Officials, Inc. for the manufacture and operation of base stations, mobile, and portable radios as adopted by the Telecommunications Industry Association and recognized by the American National Standards Institute and encouraged by the United States Department of Homeland Security
P25 Phase I	The first generation of P25 operating on a 12.5 KHz radio frequency and producing one talkpath through the use of the Frequency Division Multiple Access ("FDMA") architecture
P25 Phase II	A developing generation of P25 operating on a 12.5 KHz radio frequency and producing two talkpaths through the use of low bit-rate vocoders and Time Division Multiple Access ("TDMA") architecture
Quality of service	A measure of the reliability of a voice or data network
Radio trunk	A pair of transmit and receive radio frequencies organized as a channel and assigned to users in a shared fashion
Rebanding	Retuning all public safety land mobile radio systems from the 821-824 and 866-869 MHz frequency bands to 806-809 and 854-857 MHz to avoid radio interference from common carrier systems
Roaming	The ability of a mobile or portable radio to roam from one radio system to another radio system through programming of the mobile or portable device as well as the host radio management software

Satellite timing receiver	A receiver used at a trunked base station site to manage the frequency and launch times of simulcast radio transmissions
SCIP	Statewide Communications Interoperability Plan
SIEC	Statewide Interoperability Executive Committee
Simulcast transmissions	A system that permits the same radio transmission to be broadcast simultaneously from multiple transmitting sites without the generation of interference
SmartZone 3.5	A software release developed to manage the digital trunked radio system introduced by Motorola in the 1990s and acquired by MARCS, which provides for multiple coverage areas to be networked together over wide areas
System key	The software code that permits subscriber mobile and portable radios to be programmed to operate on systems managed by other jurisdictions
TDMA	Time Division Multiple Access: An available radio frequency channel bandwidth is divided by equal time intervals, synchronized by a time source, thus permitting the channel to be shared by more than one user simultaneously
Trunked radio system	An intelligent computer controlled radio system that manages radio communications traffic by assigning system messages to available radio channels (trunks)
Software defined radio	A mobile or portable radio that contains digital signal processing under software control that permits various frequencies, modulation types and digital protocols to be programmed
Subscriber radio	A mobile or portable radio assigned to a user of the radio system

Wireless broadband	An advanced wireless technology that provides high speed data communications through private or commercial radio networks
Wireless network operator	A radio common carrier such as Verizon Wireless, Sprint, T-Mobile, AT&T, etc.
XTL5000	Motorola's digital mobile radio capable of P25 operation in the 700/800 MHz frequency band
XTS3000	Motorola's digital portable radio capable of P25 operation in the 800 MHz frequency band, but not 700 MHz
XTS5000	Motorola's digital portable radio capable of P25 operation in the 700/800 MHz frequency band
6809 Controller	The trunking central controller used in Motorola trunked radio systems, including many SmartZone 3.5 systems, especially in simulcast configurations. Its name comes from a Motorola microprocessor series used in the controllers.
700 MHz (data)	A group of frequencies in which base stations transmit between 763 to 768 MHz and receive subscriber device transmissions on frequencies between 793-798 MHz
700 MHz (voice)	A group of frequencies in which base stations transmit between 769 to 775 MHz and receive subscriber device transmissions on frequencies between 799-805 MHz
800 MHz	A group of frequencies from 806 to 817 MHz in which mobile and portable radios and control stations transmit and base stations transmit from 851 to 862 MHz

U.S. Department of Homeland Security
Homeland Security

Prepared for the State of Ohio

OEC/ICTAP

Office of Emergency Communications / Interoperable Communications Technical Assistance Program

OEC/ICTAP-OH-PROPREV-001-R0

MARCS P25 Plan
November 2009

Review of Ohio's Plan for a Project 25 Build-Out and Migration of MARCS

Executive Overview

The State of Ohio's MARCS (Multi-Agency Radio Communications System) Program Administrator requested DHS OEC ICTAP[1] technical assistance to review a proposed plan for an upgrade of their statewide radio system. The present MARCS system uses a proprietary protocol that limits interoperability. In addition, MARCS uses obsolete infrastructure hardware and software and is close to its maximum system capacity, thus preventing it from meeting an increase in demand. The system also has insufficient RF capacity at some of its sites and cannot expand due to insufficient availability of 800 MHz frequencies.

This report provides a review of a proposed high-level plan to upgrade the MARCS system. The proposed plan appears to address these problems with the present MARCS system. It utilizes the only standards-based public safety radio communications protocol, Project 25, that is already used today by many agencies and is expanding to many others. Due to the use of P25, the technical path to the highest level of interoperability will exist after implementation of the plan. The equipment that is proposed will be state-of-the art and will be upgradable as technology and the P25 standard is enhanced. The capacity of the proposed system will address current issues while providing room for growth to accommodate many more public safety users in the state. The plan makes use of new 700 MHz frequencies as well as the presently used 800 MHz frequencies to provide capacity for the future demand.

The proposed plan is to implement the new P25 system in four phases. The first phase adds the central core hardware and software, the system master site and a simulcast cell in Cuyahoga County. This equipment has been ordered from Motorola and is now being implemented. Since the P25 standard is not currently designed to provide for interoperability amongst infrastructure components, that part of the system must be purchased from the same manufacturer, in this case Motorola. When new agencies are added to the system or when existing subscriber radios are replaced, the purchase of these subscriber radios can be competitively bid among several manufacturers. The plan is to build a parallel 700 MHz P25 system in the first three phases while retaining the full functionality of the existing MARCS 800 MHz system. In the final phase, the 800 MHz system will be decommissioned, and the 800 MHz frequencies will be used to provide additional channels in the new P25 system. Thus, the final system will use both 700 and 800 MHz frequencies as one system. The user will not be able to tell any difference since these bands behave similarly.

A future FCC mandate for the 700 MHz band that will impact the new system is one that requires double the voice capacity of the planned P25 Phase 1 system; that is *two* voice channels in a 12.5 kHz bandwidth (6.25 kHz equivalency). This requirement for increased voice capacity will go into effect December 31, 2016. Recently the FCC requested comments by November 19, 2009 on a Petition for Rulemaking by the State of Louisiana that would delay this requirement to December 31, 2024.[2] The

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[1] OEC Interoperable Communications Technical Assistance Program (ICTAP) provides cost-free technical assistance requested through Statewide Interoperability Coordinators (SWIC). This technical assistance was requested by the MARCS Program Director, Mr. Darryl Anderson, in September of 2009.

[2] See FCC Public Notice, Report No. 2902, dated October 19, 2009, DOC-294017A1. This is an FCC public notice calling for comment about a petitioned FCC rule change. This public notice should not be the basis to delay planning for 700 MHz narrowbanding.

infrastructure in the proposed plan can be upgraded to Project 25 Phase 2 which meets the FCC requirement. However, the cost for this upgrade was not included in any of the proposed phases. Also, none of the present subscriber radios (35,000+) will be upgradeable to meet the FCC requirement. The 800 MHz spectrum has no current FCC mandate and thus equipment not capable of supporting the 700 MHz requirement could be isolated to 800 MHz operations after 2016. Ohio should plan to upgrade both the hardware and software of the new P25 system regularly in order to avoid obsolescence and ensure MARCS can employ new features and capabilities as they become available, such as P25 Phase 2.

The plan will improve the RF coverage by expanding the number of RF sites from 167 to 217. The system capacity will increase from a maximum of 48,000 IDs to 128,000. The talkpath capacity will also increase significantly from 540 to 1,324 talkpaths. However, this increase in talkpaths only occurs after completion of the fourth phase; that is, after the existing MARCS is decommissioned and the legacy frequencies are reassigned and implemented in the P25 system. Prior to that, the capacity of the 700 MHz system may be marginal at certain sites. The migration from the existing MARCS to the new P25 system will be complicated and should be carefully planned.

The highest level of interoperability is a shared, standards-based system. Since P25 is standards-based, the highest degree of interoperability can be attained by sharing. MARCS is already used by more than 700 agencies. However, for the upgrade, MARCS is actively working with additional local agencies to enable them to use MARCS for their day-to-day activities. These efforts include sharing towers, sharing frequencies and sharing equipment purchases to affect a common set of radio sites that are used by both state and local agencies tied into the MARCS infrastructure. If sharing MARCS is not attainable with an agency or area of the state, MARCS has made provision for the equivalent in interoperability. This will be accomplished by connecting independent systems such that they operate as one from the user perspective, but maintain their independence. This can be accomplished in two ways. If the systems to be connected are both upgraded Motorola P25 systems then they can be connected using the Multi-system Interzone capability. MARCS's plan includes implementing the Multi-system Interzone for MARCS and encouraging other Motorola P25 systems to implement it also as the interface has to be enabled on all participating systems. The other method of connecting systems as though they are one is by use of the standards-based P25 Inter-RF Subsystem Interface (ISSI). MARCS has stated that they will implement the ISSI when it becomes available and if it is needed. If the systems cannot be interconnected to appear as one, MARCS is committed to using gateways and patches (many of which already exist) to attain interoperability.

Overall, the plan appears to provide a reasonable approach that addresses the State's need to replace obsolete equipment, expand capacity and advance to a new standards-based technology that will further enable interoperability throughout the State of Ohio.

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List of Tables

1 Introduction

The Department of Homeland Security (DHS), Office of Emergency Communications (OEC) implements programs designed to enhance the preparedness of state and local governments and agencies to effectively prevent, respond to, and recover from major terrorist incidents. The Interoperable Communications Technical Assistance Program (ICTAP) is funded by OEC to provide technical assistance to states and urban areas. The goal of ICTAP is to help public safety agencies to communicate during incidents. ICTAP interacts with other federal, state, and local interoperability efforts to enhance the ability of agencies and individuals to communicate with one another.

ICTAP assistance was made available by the Department of Homeland Security/ Office of Emergency Communications to provide interoperable communications planning support to the State of Ohio.

2 Scope of Review

This report provides the results of a high level review of the technical aspects of the State's plan to build a Project 25 (P25) frequency division multiple access (FDMA) (Phase 1) statewide radio system (herein called the P25 system) in parallel to the existing MARCS Smartzone v3.5, radio system (herein referred to as the legacy system). The legacy system operates in the 800 MHz band. Initially the P25 system will be constructed in the 700 MHz band. When the P25 system is functional statewide in the 700 MHz band, the present users of the legacy system will be migrated to the P25 system. The 800 MHz frequencies of the legacy system will then be converted to P25 to increase the capacity of the resulting, unified, 700/800 MHz P25 system.

The report is based on:

- Memo dated September 22, 2009 from Motorola (Debora Courtright) to MARCS (Darryl Anderson) with the subject "Budgetary Estimate for ASTRO 25 System Phased Upgrade & Overlay System"
- PowerPoint dated September 23, 2009 and entitled "Multi-Agency Radio Communication System MARCS Task Force Meeting 1"
- Conversations and written questions and answers with MARCS (Darryl Anderson, Ohio SWIC and some of his staff)
- Conversations and written questions and answers with the Motorola project team assigned to the MARCS P25 project
- Reports and email from Gary Swart (MARCS) regarding the traffic statistics of MARCS
- A conversation with Paul Mayer, the Local Frequency Advisor for the Association of Public Safety Communications Officials, Inc. (APCO) in Ohio.
- Use Case Studies from file "MARCSTFmtg 102209 FINAL.pdf"

This technical assistance effort did not review the cost, schedule, management or governance issues of this proposed project. Copies of these references are available through Darryl Anderson upon request.

3 Summary of the Plan

The plan is to build a 700 MHz, FDMA, P25 system in phases while retaining the full functionality, capacity and availability of the present 800 MHz, legacy system. After Phase III, the 700 MHz P25 will be fully functional statewide and operating in parallel with the 800 MHz legacy system. Subscriber radios will be programmed to operate on either system. Users could be assigned to normally operate on one of the systems but could retune to the other system by manually selecting that system on the portable or mobile radio. In phase IV the legacy system will be decommissioned. The 800 MHz frequencies of the legacy system will be reused and programmed into new base stations that will be added to the P25 system. These 800 MHz frequency stations will provide additional capacity for the P25 system to allow it to greatly expand the user base. The P25 system will treat all P25 channels, whether 700 MHz or 800 MHz. the same. The subscriber units have the capability to use channels in either band equally. A short description of each phase follows.

3.1 Phase I

This phase provides one master site that controls and connects the various components of the system such as the subscriber units, the base stations and the dispatch consoles. The master site will be located in the State of Ohio Computer Center (SOCC) in Columbus. This phase also adds one console position for demonstration and testing purposes. In addition this phase provides an 8-site, 15 channel simulcast cell in Cuyahoga County. At the completion of this phase local agencies in Cuyahoga County will be able to use the State system for their day-to-day communications activities. When the master site in Lake County is constructed and interfaced to the Lake County RF sites and connected to the master site in Columbus, Lake County and Cuyahoga County, agencies will be able to roam into each other's area and communicate with their home agencies using the resources in the other county. They will also be able to interoperate on talkgroups assigned for that purpose. All of the equipment for Phase I has recently been delivered to MARCS.

3.2 Phase II

This phase adds a third master site augmenting the two existing master sites, one in Columbus and one in Lake County. The plan is to place this new master site in the same Columbus facility as the phase 1 master site. This phase also adds 77 dispatch consoles and adds 408 new 700 MHz base radios to 102 existing state tower sites. In addition 15,000 (nearly 50%) of the State's existing portable and mobile radios are reprogrammed to allow them to operate on the 700 MHz P25 system while still maintaining the ability of the subscriber radios to operate on the legacy 800 MHz system. At the end of this phase a subsection of state users could operate in a subsection of the state on the 700 MHz P25 system as well as operate statewide on the 800 MHz legacy system. Those users would have to manually choose which system to use.

3.3 Phase III

This phase adds a fourth master site to the P25 system which is also planned to be placed in Columbus. An additional 408 new 700 MHz base radios are added to 102 existing MARCS sites (not the same sites as in Phase II) to provide improved and complete statewide coverage for the P25 system. 15,000 more state radios are programmed for operation on the P25 system. The legacy system has one simulcast cell that services the state users in the Franklin County area.[3] The 'Budgetary Estimate' doesn't list the construction of a P25 700 MHz simulcast cell during Phase II or III to parallel the legacy cell. However MARCS assures us that the construction of the Franklin County 700 MHz simulcast cell will be constructed prior to Phase IV. Therefore at the end of this phase, the P25 system is a fully functional system capable of providing statewide coverage to 30,000 of the existing subscriber units and dispatched by 78 consoles.

3.4 Phase IV

In Phase IV the 690 non-simulcast repeaters and 65 simulcast repeaters that are used in the existing MARCS system are replaced by P25 compatible repeaters. After Phase III, MARCS will have two functional statewide radio systems: the legacy system and the new P25 system. This phase decommissions the legacy system and uses its 800 MHz frequencies for additional capacity on the P25 system. Although it is not mentioned in the budgetary estimate, we have been told by Motorola that the console subsystem of the new P25 system will interface to the same 176 conventional channels to which the legacy system presently interfaces. Thus the P25 system will provide interoperability with these existing conventional channels.

3.5 Subscriber Radio Option

In addition to the proposed four phases of the plan, there is also an option included to replace Motorola radios that are not P25 capable. There are 5,022 subscriber radios owned by MARCS's users that cannot be programmed to operate on a P25 system. These radios will have to be replaced when MARCS migrates to the P25 protocol. This option identifies mid-tier, P25 Phase 1 capable radios as the replacement radios.

3.6 Non-Motorola Subscriber Radios

There are approximately 3,000 EF Johnson subscriber radios in use within the MARCS system. It is believed that these radios are capable of P25 and 700 MHz operation but this has to be confirmed. If so, the cost to reprogram these radios must be factored into the budget for the migration. The total number of subscriber radios in this report may be higher than the actual total radios in use. The total number of radios listed above is 38,022 whereas reports from MARCS list the number of radios in use in September 2009 as 33,575.

[3] All references to the Franklin County system and Franklin County simulcast cell refers to the sites in Franklin County that are part of MARCS. It does not refer to the sites and systems that are locally owned by Franklin County and the City of Columbus.

4 Comments on the Plan

This section provides comments on the various technical aspects of the plan.

4.1 Over-the-Air (RF) Protocol Selection

At the present time there is only one radio protocol that meets public safety requirements and provides the highest level of interoperability; namely, Project 25. Therefore we agree with the State's choice of P25 for the upgraded MARCS. The only other potential competing technology that some have considered is the Long Term Evolution (LTE) which is a high speed data protocol. Lately there has been an initiative for public safety to adopt the use of LTE and a few areas in the country are investigating this potential. However, voice communication using this protocol has not been developed, especially for talkgroup (one-to-many) operation and direct (subscriber radio to subscriber radio) operation. Furthermore, P25 is the next generation of trunked, land mobile radio systems, hundreds of which have been deployed across the country. In addition, the State owns approximately 30,000 subscriber radios that are capable of operating in a P25 system after their software has been reprogrammed. All of these radios would have to be replaced if LTE were the choice. The two protocols are compared below.

Table 1: Comparison of P25 and LTE

Figure of Merit	P25	LTE
Public Safety Proven	Yes	No
Standardized PTT Voice Operation to Talkgroups	Yes	No
Infrastructure Independent Communications (direct radio to radio)	Yes	No
High Speed Data	No	Yes
Compatible with existing State owned subscriber radios	Yes	No
Subscriber radios can interoperate with other existing radio systems	Yes	No

4.2 P25 Equipment Compatibility

Since the P25 protocol is defined by a set of standards documents, equipment for a P25 system can be purchased from multiple vendors and can be expected to interoperate within certain limits. This is discussed in the following two subsections, one section for subscriber equipment (portables, mobiles and control stations) and one section for the fixed infrastructure (trunked repeaters, site controllers, zone controllers, switches, configuration databases and consoles, etc.).

4.2.1 P25 Subscriber Equipment Compatibility

P25 subscriber equipment from one manufacturer will function on another manufacturer's infrastructure as long as the frequency band is compatible. For example, P25 portable radios from Harris will function on a Motorola provided trunked system. Subscriber equipment from multiple vendors is being used on many P25 trunked systems today. Subscriber equipment should not be purchased that has not been delivered with a Supplier's Declaration of Compliance (SDoC) that has been issued in conformance with the P25 Compliance Assessment Program (P25 CAP[4]). Federal grant programs require the existence of an SDoC for P25 equipment. The P25 CAP program is relatively new. As the equipment is tested a list of equipment that has been issued an SDoC can be found at www.rkb.us. Motorola should provide an SDoC for the XTS5000 and XTL5000 when they are reprogrammed in Phases II and III. MARCS's users own approximately 5,000 portable and mobile radios that are not capable of P25 operation. When new radios are purchased, they could be replaced from any vendor that can provide an SDoC.

Compatibility between vendors is only true for those features and functions that have been defined by the standards. Some manufacturers offer features that have not been defined and are therefore often proprietary to their subscriber radios and only function with that vendor's infrastructure equipment. A list of features that have been defined in the standards can be found at www.ptig.org. Use of undefined features can be an impediment to interoperability. If a system uses a proprietary feature and help is required from an outside agency that uses P25 equipment that does not support the proprietary feature, interoperability with the visiting agency can be compromised.

4.2.2 P25 Infrastructure Equipment Compatibility

P25 trunked infrastructure from one vendor is generally not compatible with another vendor with the exception of consoles. For example a master site and a simulcast cell have been purchased from Motorola in Phase I. This commits MARCS to purchase all the rest of the infrastructure equipment from Motorola. That is, the other master sites, the switching equipment and routers, the software and all the trunked repeaters and the site controllers for the entire system must be purchased from Motorola since like equipment from another manufacturer is not compatible with the Motorola master site. The P25 standards do not define the interfaces within the infrastructure that would allow multiple vendor procurements as can and is done for the subscriber equipment. Because P25 do not define all the interfaces within the infrastructure, purchasers have to buy many of the infrastructure components from the same vendor. The P25 standard development committees are in the process of defining a Console Subsystem Interface (CSSI) that would provide for multiple vendor compatibility. Use of consoles from another manufacturer will become an exception to this in the near future.

4.3 System Obsolescence

Since P25 is a standard and is widely used it should be in existence for many years. However the standard is still being enhanced and new features and functions and definition of interfaces are being defined. In addition manufacturers are continuously renewing their designs not only to add the new features defined in the standards but also to make the hardware and software more efficient, and to make use of better components that come onto the market. A system that is not updated on a regular basis can become obsolete in that it may be difficult or disruptive to expand the system, and it may be impossible to incorporate new features that are required. For these reasons, MARCS should require vendors to specify their recommendations for maintaining and upgrading the software and hardware.

[4] More information on the P25 Compliance Assessment Program (CAP) can be found at the following website: http://www.safecomprogram.gov/SAFECOM/currentprojects/project25cap/.

Another issue that MARCS must consider is the FCC mandate that all systems using the narrowband portion of the 700 MHz public safety band must convert their systems to one voice channel in 6.25 kHz of bandwidth by December 31, 2016. The MARCS upgrade plan is to use the narrowband 700 MHz frequencies for Phase I through Phase III and thus will be affected by this requirement. However, the present P25 version that MARCS plans to implement uses FDMA, which provides one voice channel in 12.5 kHz of bandwidth. The next version of P25 (P25 phase 2) will use time division multiple access (TDMA) to achieve one voice channel in 6.25 kHz. The infrastructure that MARCS is planning to purchase should be capable of this second phase of P25 and thus meeting the FCC mandate after some software changes. However MARCS should receive assurances that any equipment (hardware and software) it purchases has a smooth and defined upgrade path to P25 Phase 2.

The 33,000 portable and mobile radios that MARCS's users own and that are being reprogrammed for P25 Phase 1 operation cannot be upgraded to P25 Phase 2 according to current Motorola and EF Johnson literature. Thus, they will not be able to be used on the 700 MHz frequencies after December 31, 2016. Recently the FCC requested comments by November 19, 2009 on a Petition for Rulemaking by the State of Louisiana that would delay this requirement to December 31, 2024.[5] The MARCS system could continue to use the P25 phase 1 modulation (one voice per 12.5 kHz) in the 800 MHz band. Thus the system would operate in both P25 modes (FDMA and TDMA) dependent on the frequency band. Thus, some of the existing subscriber radios could continue to be used, but they would be confined to the 800 MHz band. New subscriber radios should be purchased with P25 phase 2 compatibility. According to the 'Budgetary Estimate' the 5,022 radios that cannot be upgraded and are being replaced (see section 3.5) are being replaced with radios that are not P25 Phase 2 capable and thus would not be able to operate in the 700 MHz band after December 31, 2016. Some of the radios presently owned by MARCS's users will be replaced due to end of useful life issues. These could be replaced with radios that are capable of P25 Phase 2 in accordance with plans of MARCS and the FCC mandate for Phase 2 operation.

4.4 RF Coverage for Voice Communications

For voice communications the RF coverage of the upgraded system will exceed the coverage of the present system by a substantial amount. The geographic area that is covered by any one site is approximately equal for the legacy system and the P25 system. However, the P25 system will have more voice sites. The P25 will use the existing 167 voice RF sites in the legacy system and will add voice to 50 additional MARCS's sites that are presently data only. This brings the total number of RF sites in the proposed P25 system to 217. Therefore, the RF coverage will be significantly improved on a statewide basis. Some areas may have the same coverage if one of the new sites does not add coverage in that area. A coverage study was not performed for this report so the details of where the coverage will improve are unknown, but it should not degrade in any location.

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[5] See FCC Public Notice, Report No. 2902, dated October 19, 2009, DOC-294017A1. This is an FCC public notice calling for comment about a petitioned FCC rule change. This public notice should not be the basis to delay planning for 700 MHz narrowbanding.

4.5 Voice Capacity and Grade of Service

After all four phases are completed, the voice capacity of the P25 system will exceed that of the legacy system due to an increased number of talkpaths in the system. In the interim before phase IV is completed there could be some low capacity conditions as discussed below. The present legacy system has 540 talkpaths; that is, a maximum of 540 simultaneous conversations can be accommodated as long as each conversation uses only one RF site. Calls which use more than one site, such as a talkgroup call with group members at more than one RF site, will occupy one talkpath at each site and thus reduce the maximum number of simultaneous conversations. Table 2 summarizes the size of the legacy system. Note: Table 2 does not include two new sites that MARCS is planning to add at Van Wert and Holgate. The number of talkpaths is less than the number of channels since one control channel is required at each site and the control channel cannot transmit voice conversations.

Table 2: Legacy System Voice Capacity Summary

Description	Voice Sites	Channels	Talk Paths	Stations
Existing Multisite (non-simulcast)	162	690	528	690
Existing Franklin County Simulcast Cell	5	13	12	65
Existing Legacy System Total	167	703	540	755

The multisite average talkpaths per site is 3.25 (528/162); some sites have more than the average and some have less. The small number of talkpaths at some sites causes them to experience frequent excessive busy conditions (a low grade of service). For example, the sites at Fremont and Findlay[6] experienced a grade of service (GOS) averaged over 24 hours of less than 98% during several days of each of the recent months. An average over 24 hours of 98% would indicate that some hours of that day were substantially lower GOS. Public safety systems are typically required to provide a GOS of 95% or higher at each site in the system when averaged over the busiest hour of the day. From the Voice Monthly Summary provided by MARCS, the site with the lowest GOS averaged over the busiest hour ranged from 66.7% to 84.8% for the months of January through September of 2009. This indicates that at least one site in the MARCS system has a very poor grade of service every month this year. Clearly MARCS needs more voice capacity.

Table 3 indicates the number of talkpaths planned for the P25 system. In phases I, II and III the P25 system is constructed over the entire state using 700 MHz channels. After phase III the number of talkpaths (refer to the 'Total 700' row in Table 3) in the P25 system are 632. This is a 17% increase in voice capacity system wide over the 540 talkpaths of the legacy system. Thus, when users are migrated to the P25 system after phase III, they will experience a system with a higher GOS on a system wide basis. Since the budgetary estimate does not specify how many channels will exist at each site for the P25 system, the improvement in GOS on a site basis can't be determined at this time. The average number of talkpaths per site for the multisite (non-simulcast) portion of the P25 700 MHz only system is 612/204 = 3. This is a decrease from the multisite average of 3.25 talkpaths per site in the legacy system, so a decrease in capacity at

[6] Darryl Anderson has informed us that MARCS is in the process of adding capacity to both the Fremont and Findley sites.

some sites can be expected prior to the next step in the plan; namely, the conversion of the 800 MHz frequencies to P25 protocol.

Also it is not clear in the plan how the MARCS 700 MHz P25 simulcast cell in Franklin County will be constructed. If it is constructed with only 7 channels and 6 talkpaths as shown in Table 3 then it will have significantly less capacity as a stand alone 700 MHz cell than the existing Franklin simulcast cell that has with 13 channels and 12 talkpaths. This simulcast cell is one of the most utilized sites in the MARCS system. MARCS needs to carefully plan the migration of users from the legacy Franklin site to the P25 Franklin site to ensure that neither site receives an excess demand for traffic during the transition period.

Table 3: P25 System Voice Capacity Summary

Phase	Description	Sites	Channels	Talk Paths	Stations
I	Cuyahoga Simulcast Cell	8	15	14	120
II	First Half of Multisite	102	408	306	408
III	Second Half of Multisite	102	408	306	408
III or IV	Franklin Simulcast Cell – 700 MHz	5	7	6	35
700 Total	Completed 700 MHz P25 System	217	851	632	971
IV	Franklin Simulcast Cell – 800 MHz	0	13	13	65
IV	800 MHz Multisite Conversion	0	690	690	690
Total	Completed 700/800 P25 System	217	1,541	1,335	1,726

The lower three rows of Table 3 show the results of the conversion of the 800 MHz frequencies from the legacy system to the P25 protocol. Phase IV decommissions the legacy system. After the conversion the 700/800 MHz P25 system will have a total of 1,335 talkpaths; an increase of 2.5 times over the 540 of the legacy system. The multisite average talkpaths per site will increase to 6.4 (1,302 talkpaths / 204 sites) from the 3.25 average of the legacy system. Therefore, the capacity of the system at all sites should increase substantially after phase IV.

4.6 System Capacity

The present legacy system has a maximum capacity of 48,000 subscriber radio and console IDs. Approximately 34,000 of these have been assigned to subscriber radios and approximately 10,000 to consoles. This leaves approximately 4,000 remaining for expansion before the system reaches maximum capacity. The MARCS system has been adding an average of 235 radios IDs per month during 2009. At this rate the system will reach maximum capacity in less than 2 years. The P25 system will be licensed (after all phases) for 36,500 radio IDs and can be upgraded to 64,000 as more users are added. According to Motorola, in 2011 their equipment may be upgraded to 128,000 radio IDs. Note that in Motorola's new P25 system architecture, the consoles do not need a multitude of IDs as was required in the legacy system. The proposed Motorola plan includes licenses for 110 console positions of which 95 will be used (17 in Lake County and 78 for the State).

The plan is to purchase four master sites. Each master site can control a maximum of 100 RF sites. Thus, the system will have a capacity for 400 RF sites with 217 used in the plan. Three master sites would be more than sufficient to control 217 RF sites with the capability to expand to 300 sites; however, 4 master sites are required to achieve the ability for one master site to back up another master site. The plan is to place three of the four master sites in the same facility in Columbus. Placing two of these three master sites in different parts of the State would provide geographic isolation in case a disaster struck the facility in Columbus. In addition, the overall distance between the RF sites and the master sites would decrease if the master sites were dispersed. The shorter distance for the connections would also increase the already reliable T1 connections as typical call processing would be more localized and wouldn't require traversing as many links. Dispersing the master sites would also provide for better system redundancy as physical separation ensures equipment is less likely to fail if damaged is sustained in one area.

4.7 Cutover Logistics

At the present we aren't aware of any detailed plans for the migration of the users from the legacy system to the P25 system, so only general comments can be made. The migration plan will have to be meticulously planned to avoid disruption of communications. Based on OEC/ICTAP's experience with large radio system migrations, the State should conduct detailed, long range planning for the cutover to the new P25 system.

4.7.1 Gateway

The plan does not mention connecting the legacy system with the P25 system during the migration. For example, a gateway or audio bridge (ACU-1000, MotoBridge, etc) between the two systems that allow talkgroups in one system to communicate with talkgroups in the other may be beneficial.

4.7.2 Consoles

When both the legacy and the P25 systems are functional, MARCS will have two sets of dispatch consoles: 78 connected to the legacy system, and 78 connected to the P25 system. We have not seen a plan as to where these consoles will be placed. We have not seen a plan as to which system the dispatchers will be assigned during the migration. The plan does not supply computer aided dispatch (CAD) software or hardware. The plan provides for an interface between each master site and a CAD system that is provided by MARCS. The plan also provides for 40 hours of support to interface a CAD to the P25 system. The plan does not make any mention of supplying a new, or interfacing to an old, records management system (RMS). There may be additional costs to add this function to the P25 system.

4.7.3 Subscriber Radios

The subscriber radios will be programmed for both systems during the migration period so that entire agencies can switch to the new system at the flick of a switch or switches. The subscriber radios will not be able to automatically scan or automatically roam between the legacy system and P25 system. The user of the radio will have to manually switch between systems. If a user homed on one system needs to communicate with an agency on the other system during the migration period, the user will have to manually switch to the other system, and thus will lose the capability to monitor the user's dispatch talkgroup on the home system. The migration plan will require careful planning, especially since the 700 MHz P25 system will have somewhat less capacity prior to conversion of the 800 MHz frequencies. The subscriber radios may have to be reprogrammed a second time to add the capability to support automatic inter-system roaming. Whether or not a second programming is required depends on when the radios are reprogrammed to add the P25 system relative to when Motorola releases the software for inter-system roaming. The budgetary estimate does not include the cost to reprogram the subscriber radios (a possible third time) to remove the legacy system after it has been decommissioned.

4.8 Interoperability with Other Systems

The Ohio SCIP states "The overarching goal for the State is to provide full standards-based interoperability throughout the State by July of 2012." This goal will be achieved by every agency using MARCS. For those agencies that don't adopt MARCS as their primary system, MARCS should find a way to interoperate with all the other pertinent agencies using the highest level of interoperability possible. At the second meeting of the MARCS Task Force on October 22, 2009 Darryl Anderson presented six use cases that demonstrated either interfacing to or incorporating other systems into MARCS. All of these use cases assumed the other system used Motorola equipment or would be converted to Motorola equipment. An additional use case could be added that demonstrated how MARCS would connect to non-Motorola systems.

4.8.1 Other Motorola P25 Systems

The only part of the budgetary estimate that takes into account interoperability with other systems is purchase of Multi-system Interzone. This capability will allow MARCS to interoperate only with other Motorola P25 systems that have updated their systems to a relatively current version and have purchased Multi-system Interzone as well. The subscriber units in the other systems must also be upgraded to allow inter-system roaming. If all of this is done, the two systems will behave almost as though they are one system from the perspective of the user, and thus the highest level of interoperability can be achieved.

4.8.2 Other Non-Motorola P25 Systems

For other, non-Motorola, P25 systems, MARCS could choose to acquire a P25 Inter-RF Subsystem Interface (ISSI). A Multi-system Interzone capability is required prior to adding ISSI.2 to Motorola systems. The ISSI would allow MARCS to connect to P25 systems from other P25 manufacturers that also have an ISSI capability. An ISSI that adheres to all of the requirements of the P25 standard will provide the highest level of interoperability between systems, so that from the perspective of the user, they will seem to be almost one system. Note that the ISSI.1 that Motorola plans to release at the end of 2009 does not meet all the requirements of the P25 ISSI standard. The ISSI.1 is a very limited version of ISSI and will not provide the highest level of interoperability without user intervention. For example, the user is required to manually switch between systems connected by ISSI.1. MARCS should carefully review the limitations of any interoperability solution.

4.8.3 Non P25 Systems or P25 Systems without ISSI or Multi-System Interzone

MARCS already has the ability to connect through their console system to 176 conventional repeaters at various locations in the state to interoperate with conventional subscriber units. In addition a gateway could be used for MARCS to connect to non P25 trunked systems, or to P25 systems without ISSI, or to Motorola P25 systems without Multi-system Interzone, or even if they have Multi-system Interzone but don't have a software/hardware version upgrade that is within two years of the MARCS current version of software. There wasn't any mention of a gateway in the plan. We would recommend consideration of one of the many gateways on the market to improve the interoperability with the many disparate systems in Ohio.

Appendix A Acronyms

Acronym	Definition
CAD	Computer Aided Dispatch
CSSI	Console Subsystem Interface
DHS	Department of Homeland Security
FCC	Federal Communications Commission
FDMA	Frequency Division Multiple Access
GOS	Grade of Service
ICTAP	Interoperable Communications Technical Assistance Program
ISSI	Inter-RF Subsystem Interface
LTE	Long Term Evolution
MARCS	Multi-Agency Radio Communications System
OEC	Office of Emergency Communications
P25 CAP	P25 Compliance Assessment Program
RF	Radio Frequency
RMS	Records Management System
SDoC	Supplier's Declaration Of Compliance
SOCC	State of Ohio Computer Center
TDMA	Time Division Multiple Access