Statewide Needs Assessment and Plan for the Improvement of Public Safety Radio Communications Systems in Wisconsin

Phase III – Operational and Technical Specifications

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1 Executive Summary

This portion of the Phase III Report brings together the operational concepts and technology reviews of Phases I and II in order to propose reasonable alternative interoperability solutions. We briefly restate the types of communications system interoperability, the methods or techniques utilized for improvements, and our definition of interoperability from Phase I.

Four alternative interoperability solutions are developed from the interviews and inputs received. These four alternatives are:

1. No Common Architecture – "Do Nothing" Approach
2. Governance/Standards Guidance-Only Approach
3. Single Statewide System
4. Hybrid Statewide System

These alternatives are evaluated for interoperability improvement impact in the short, medium, and long-term time frames. We have selected some current best practices in Wisconsin to highlight and also illustrated potential solutions.

Finally, ***FE*** recommends an approach for the State to proceed with to address the current interoperability issues. The plan includes a number of elements over a multi-year timeframe such as implementation of a statewide Project 25 digital system combined with build-out of mutual aid channels and computer controlled gateways for the short-term. Also noted are emerging technologies that the State should consider for pilot projects to gain insight for future interoperability applications. The high-level cost estimates for this approach would include the following:

Category	**Estimated Cost**
Statewide Infrastructure	$44M
Subscriber units	$70-80M
Gateways and IP-switching	$1M

This cost estimate would provide service for any units in the coverage area, including both public safety and non-public safety (local departments of transportation, towing services, hospitals, etc.) but since many of these agencies did not report subscriber units in the WEM survey, the costs of those subscriber units are not included.

2 Introduction

The Phase I portion of this Study noted the heavy use of the VHF frequency band by public safety agencies in Wisconsin. The WEM surveys concluded that at least 70% of the radios currently in use are on the VHF band. Phase II reviewed the current public safety communications system configurations in Wisconsin as well as the technology landscape of potential interoperability solutions. Mature applications were included such as console patch along with emerging technologies such as Wi-Fi "Hot-spot" networks. We also outlined the pressures from the FCC to conserve spectrum usage. In this section we will further evaluate this list of solutions and distill out those with a good fit for State and local agencies in Wisconsin.

For reference we restate the three types of communications system interoperability discussed in Phase II of this study.

- *Day-to-day interoperability* covers routine public safety operations, such as responding to a building fire that requires backup for a neighboring fire department, or a vehicle chase that crosses between villages.

- *Mutual aid interoperability* supports a joint and immediate response to catastrophic accidents, large-scale incidents and natural disasters. It supports tactical communications in response to airplane crashes, bombings, forest fires, earthquakes, hurricanes and similar events that occur without warning.

- *Task force interoperability* supports local, state and federal agencies collaborating for an extended period of time to address a particular problem. For example, a task force might lead extended recovery operations, provide security for major events, or respond to prolonged criminal activity. These are activities that are planned in advance.

We also briefly restate the six methods or techniques developed by the Public Safety Wireless Advisory Committee (PSWAC) of the National Telecommunications and Information Administration (NTIA) that can be utilized to achieve radio system interoperability.

1. Swap Radios
2. Talk-around
3. Mutual Aid Channels
4. Gateway/console patch
5. System-specific roaming
6. A standards-based shared system

And finally, our definition of interoperability developed in Phase I is based on the following:

"Interoperability is the ability of public safety and support providers – law enforcement, firefighters, EMS, emergency management, the public utilities, transportation, and others – to communicate with staff from other responding agencies, to exchange voice and/or data communications on demand and in real-time." (AGILE, March 2003, Guide to Radio Communications Interoperability Strategies…)

The requirements of an interoperability plan must support this definition and address the three types of interoperability. Potential solutions can be based on the six methods or techniques above with the ultimate solution being at level six.

FE believes that the plan should also be based upon quick progress, which is supportive of day-to-day interoperability, at the local and county agency level. Therefore, the interoperability plan should contain a mix of short, medium, and long-term elements that address the issues at all levels of government.

3 Alternative Interoperability Solutions

The list of alternatives that ***FE*** has selected was developed from our analysis of the WEM Study and the extensive collaboration that took place through our surveys, meetings, and conversations with Wisconsin public safety personnel. ***FE*** has also factored in the influence/pressure from the key "levers" that will affect the success of a recommended solution. These levers of influence are:

- Governance
    - Wisconsin is a home rule state, and therefore must consider how to facilitate consensus and buy-in from the various public safety agencies across the State, rather than issuing a mandate of participation.

- Technology Demographics
    - While the majority of the State is currently utilizing VHF-band systems, there are a number of 800 MHz systems on-line in areas of higher population. It would not be easy or inexpensive to change out these systems in the short term, especially since several of them have just been recently installed.
    - There is an existing and improving radio network operated by the Wisconsin DOT/SP, which needs to be considered in terms of availability of towers, frequencies, and coverage. This organization also provides data coverage across many parts of the State.
    - There is a preponderance of aging technology across the State that is in desperate need of upgrading.

- Vendor Demographics
    - There is a strong and apparently successful presence of both M/A-Com and Motorola within the State.

- Evolutionary Approach
    - The dominant preference was to "build onto" existing systems wherever technically and economically feasible.

- Sponsorship
    - The desire to "do the right thing" was evident in conversations with public safety personnel at both the State and locals levels.

All of these inputs were evaluated along with ***FE***'s extensive prior experience and we reached a consensus on four alternative interoperability solutions.

3.1 No Common Architecture – "Do Nothing" Approach

With this minimal involvement approach, the State continues the rollout of voice and data network improvements with only minor coverage and technology enhancement activities. For example, the WSP adds or upgrades a few strategic sites around the State. County and local agencies continue with their local or regional planning. Improvements in communications interoperability occur predominantly by chance and crisis.

With this alternative the State would base funding allocations on prioritization and incremental improvements in overall interoperability. Prioritization could be tied to the ***FE*** Readiness Assessment by County. However, progress toward interoperability improvements will be similar to today and will be driven by the local agency planning and purchasing requests. Pockets of excellence will exist but overall progress will be relatively slow.

3.2 Governance/Standards Guidance Only Approach

This approach emphasizes the improvements to interoperability that can be obtained if all public safety agencies adhere to common standards, but nothing else is done to drive a specific architecture or design. Funding for equipment purchases and system upgrades would be heavily dependent upon adherence to certain standards. Use of mutual aid channels, currently only at about the 50 percent level for local agencies, would be a critical component of interoperability solutions.

As standards are updated and modified the Governance Committee could consider the impact on the guidelines to be used by agencies. This Committee could also become involved for "special case" funding requests. Interoperability will tend to improve because the number of product and system combinations will be reduced over time to only the standardized types. Local agencies would drive the procurement processes through their local purchasing organizations, but progress will be slow. Improvements in interoperability will happen mostly through the use of mutual aid frequencies and will be solved locally rather than on a statewide basis. It is anticipated that regional consortiums would be created, which would help improve the progress that would be made, absent a single statewide solution design.

Montana is using an approach similar to this, where they have identified a common set of standards (VHF, digital, P25) and are fostering cooperation across multiple "concept demonstration projects" which create interoperability efforts that involve and benefit multiple adjoining counties.

3.3 A Single Statewide System

As we indicated in Phase II the single-vendor, common frequency band, standards-based shared system is the ultimate interoperability solution. This would be useful for any scale of event from small to massive. In this method all radios built to a standard can talk to each other via the infrastructure, or in the case of the Project 25 digital equipment, conventional mutual aid and talk-around also. The single statewide system should be trunked, if sufficient frequencies can be obtained for the timely deployment of new tower sites.

The State would build out the tower sites and interconnecting backbone that provides local agency coverage for voice and integrated data in all regions of the State. The coverage requirement would be on-street portable as a minimum. The funding for subscriber radios would be by agreement between the State and the local agencies. The mutual aid channels included in the Project 25 Standard would be utilized to enhance interoperability where required along with the other devices and technologies evaluated in the Phase II Report. These enhancements may be necessary for interoperability with surrounding states or Federal agencies.

The frequencies to be utilized for this single statewide system could be located in any one of the VHF, UHF, or 700/800 MHz bands. The band selected will be determined by the system design criteria and cost to achieve the design. After the decision is made of which radio band to use, all agencies must relocate to this band to obtain funding.

3.4 Hybrid Statewide System

For this solution the existing VHF statewide voice and data communications systems would be expanded to all local agency mobile and portable coverage needs. As with the previous alternative the State would fund all tower site upgrades and new tower site installations. Site ownership and sharing would be through agreement between the entities involved. The State would also fund the interconnecting site backbone and integrate with IT network planning. Users of current 700/800 MHz systems would stay on their current systems in this band. New systems that are proposed to be in the 700/800 MHz band would be individually reviewed by the SIEC for funding approval.

Roaming interoperability is handled from the perspective of the subscriber radio. When a VHF user roams into an 800 MHz region then they will communicate on the VHF calling and mutual aid channels. When an 800 MHz user roams away from home into coverage of the statewide VHF

system, they must utilize the interoperability methods and devices mentioned in Phase II, such as baseband switching or extra radios in the VHF band. Use of IP-related connectivity to enhance interoperability could be a plus when the higher bandwidth backbone roll-out is completed, but is still dependent on coverage for each band being available by a tower or a baseband switch.

Interoperability with neighboring state agencies and municipalities would be handled by mutual aid or baseband switching capabilities.

3.5 Summary of Alternatives

A summary of the individual impact of these four alternative approaches on interoperability improvements is contained in Table 1. The single statewide trunking system will have the greatest impact upon communications system interoperability in the long-term, but ***FE*** believes that it will be a very difficult architecture to achieve in any reasonable timeframe. The primary reason for this is that the changes necessary to replace those systems with VHF are massive compared to providing a standardized VHF architecture to those agencies that are already using VHF. Further, simply from a political standpoint it will be very difficult to convince many of the municipalities with 800 MHz systems (most of which have been recently installed) that they should now go through another change process to standardize on the statewide VHF system.

Alternative Solution	Day-to-Day Interoperability	Mutual Aid Interoperability	Task Force Interoperability
Do-Nothing	Low	Low	Medium
Standards Only	Low	Medium	High
Single Statewide System	High	High	High
Hybrid Statewide System	Medium	High	High

Table 1- Alternative Solutions Impact Summary

Further, we do need to consider the timeliness of interoperability solutions. Table 2 considers the length of time required to bring a solution on-line. A considerable amount of time will pass before the single statewide system will have a major impact upon improving interoperability.

Alternative Solution	Short-Term	Medium-Term	Long-Term
Do-Nothing	Low	Low	Medium
Standards Only	Low	Medium	High
Single Statewide System	None	Low	High
Hybrid Statewide System	Medium	High	High

Table – 2 Alternative Solutions Improvement Over Time

Federal Engineering recommends that the State adopt the hybrid approach for building out the overall statewide interoperability network. Figure 1 shows an example of what this would look like. It should be noted that not all interfaces are shown here – it is intended to be a representative ample of the kinds of interoperability approaches that the hybrid solution offers.

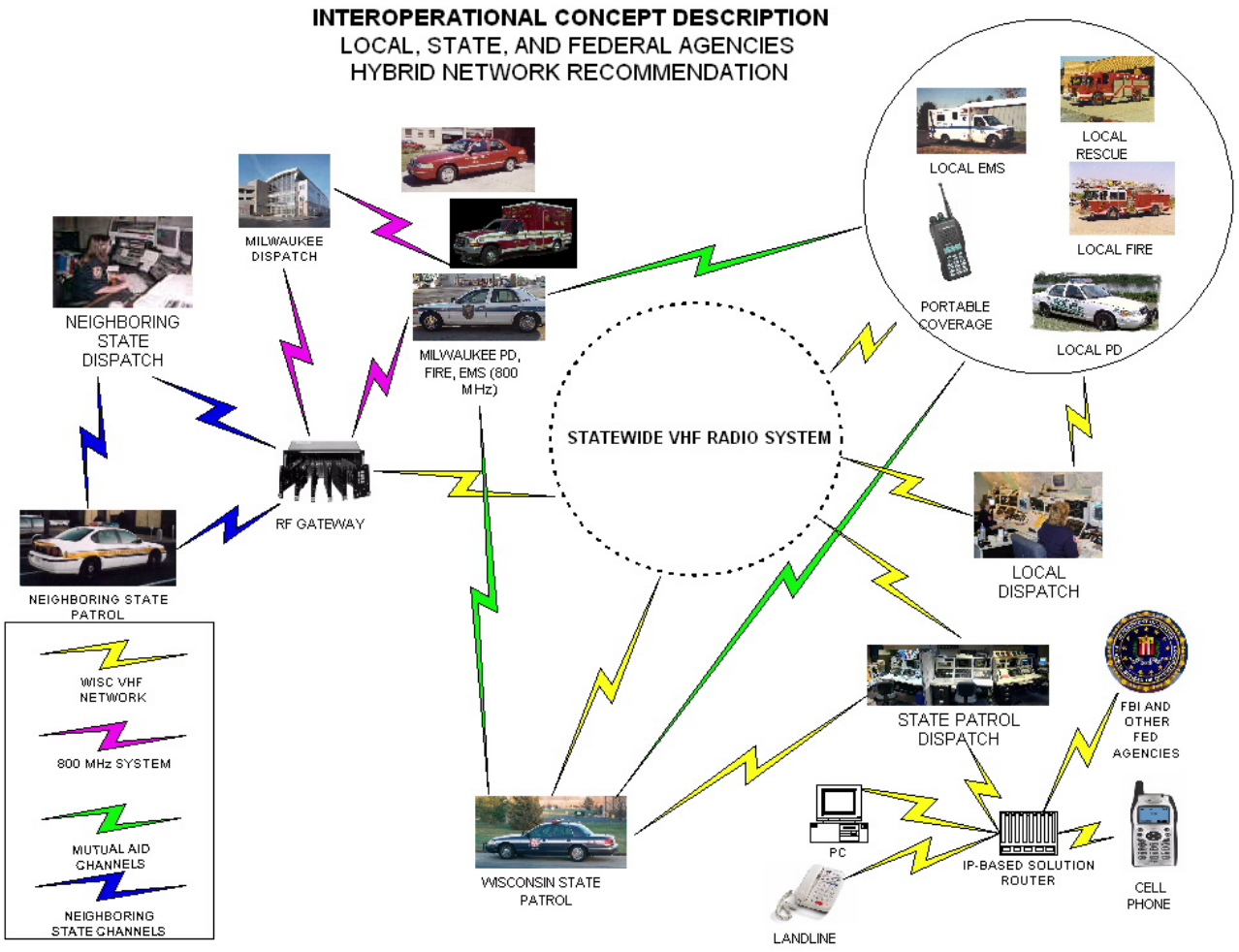

Figure 1 – Hybrid Interoperability Network

4 Potential Interoperability Approaches

Building on the principles and technology discussions in the previous sections of this report, any solutions recommended for a radio system interoperability improvements plan should meet the following criteria.

- Provide a mix of short, medium and long-term elements.
- Create minimum impact on current public safety operations.
- All new equipment should meet the pending FCC and standards constraints, and have maximum reuse capability for the long-term.
- Provide solutions that are cost effective.
- Address improvements in the day-to-day, mutual aid, and task force interoperability needs.

The surveys conducted for this study and the WEM survey last year indicate that serious interoperability issues exist today at all levels of government. Thus, the plan must contain short-term implementation elements that make a positive impact on the problems. A large statewide communications system will address the interoperability concerns, but the State, county, and local public safety agencies should not be required to wait two to five years for full system implementation.

4.1 Short-term Approaches

The most consistent plea from the county and local users was to improve the interoperability at the local and regional levels. Thus, the short-term activities targeted toward interoperability improvements should include a continuation of the build-out of mutual aid channels throughout the State. A listing of the VHF mutual aid frequencies is included in Table 3. Additional mutual aid channels are also available in the UHF and 800 MHz bands. Public safety radios with available frequency capacity should be reprogrammed to add these channels as the infrastructure becomes operational in a local area. A local dispatch center should be designated to monitor these mutual aid channels 24X7, and emergency call processing procedures created to expedite their usefulness.

TX Freq. - MHz	TX Tone - Hz	RX Freq. - MHz	RX Tone - Hz	Channel Name	FCC License Callsign	Agency Use
155.475	156.7	155.475	CSQ	WISPERN	KA6570	Law Enforcement
155.370	146.2	155.370	CSQ	POINT	KA6570	Law Enforcement
154.295	CSQ	154.295	CSQ	FIRECOM	KO2099	Fire
155.340	CSQ	155.340	CSQ	STATE EMS	KH4762	EMS
156.000	136.5	156.000	136.5	WEM CAR	KGT483	Emergency Management
153.845	136.5	151.280	136.5	MARC1	WNPG812	All Public Safety
151.280	136.5	151.280	136.5	MARC2	WNPG812	All Public Safety
154.265	88.5	154.265	88.5	WISTAC1	KO2099	All Public Safety
154.010	71.9	154.010	71.9	WISTAC2	KO2099	All Public Safety
154.130	82.5	154.130	82.5	WISTAC3	KO2099	All Public Safety

Table – 3 Wisconsin VHF Mutual Aid Channels

The computer controlled RF gateways reviewed in Section 8.2 of Phase II should also be considered to address interoperability improvement opportunities in the short-term. These gateways are manufactured by a number of companies including JPS Communications and Telex/Vega. They can be installed in a dispatch center, as was done by the Alexandria, VA Police Department, or mounted in a communications van as Sauk County Emergency Management has recently completed. The mobile configuration is particularly useful for on-scene coordination of fires or natural disasters, but there is a delay time for vehicle arrival and set-up. A robust planning effort can minimize this delay by anticipating the most likely scenarios in which this technology would be used and establishing the frequency configurations for those scenarios within the gateway.

In Phase I of this Study we discussed the WEM Mobile Command Center, which utilizes the JPS ACU-1000 unit for multi-band interoperability. An application of this technology that could be used as a template is the effort underway in Sauk County. For their implementation Sauk County Emergency Management chose a Telex/Vega channel combiner unit, which is mounted with eight VHF mobile radios in the 38 foot long Mobile Incident Command Center (MICC) (Figure – 1). Public safety voice communications in Sauk County use VHF band frequencies exclusively,

as do the local utility companies. The MICC supports Mutual Aid and Task Force interoperability activities anywhere in the County or adjacent counties. UHF and 800 MHz radios will be purchased soon in order to provide interoperability at an incident scene with resources from Dane County to the south. Three computer dispatch positions mounted in the MICC interface with the gateway to quickly change the mobile radio frequencies and access parameters during an emergency incident. The MICC also contains a broadband RF data link to County Dispatch.

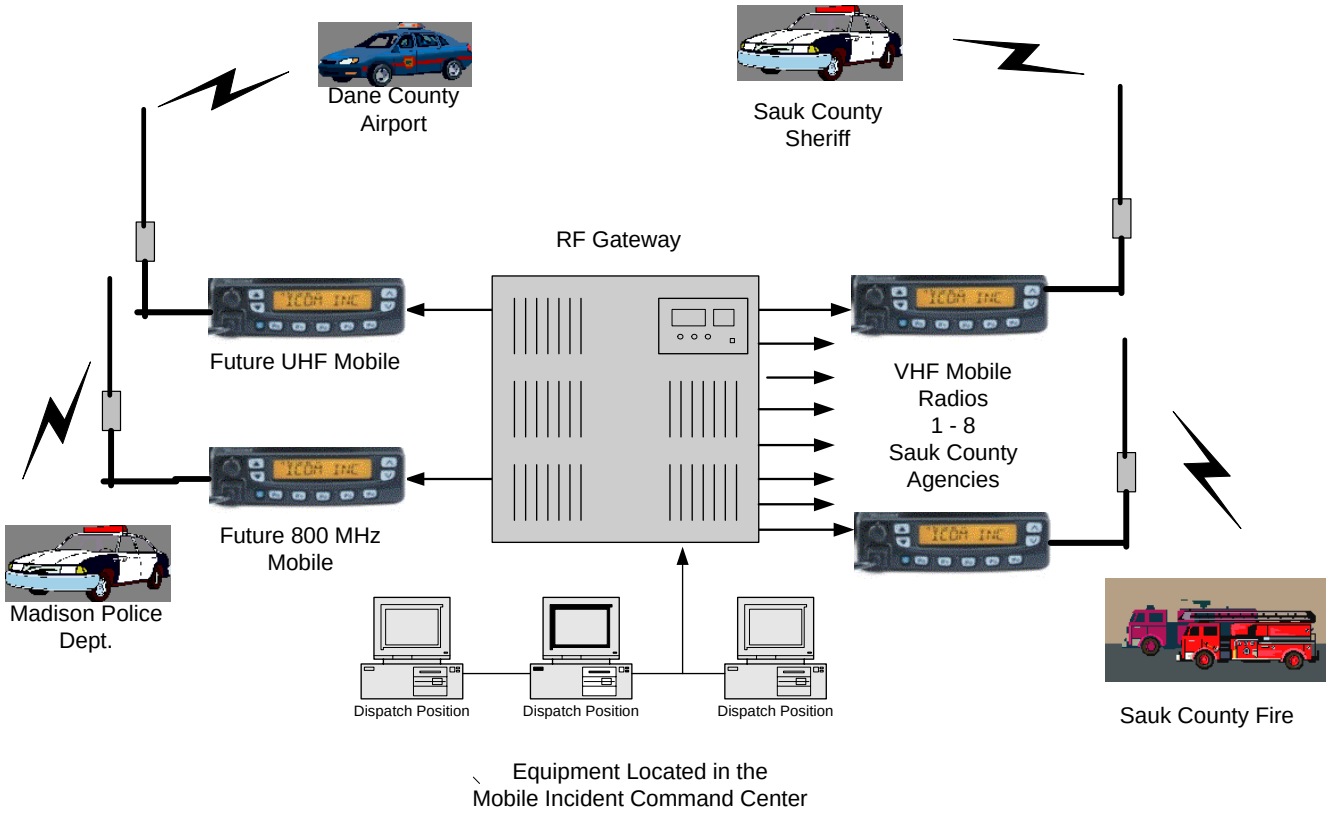

Figure 2 - Sauk County RF Gateway Mobile Interoperability System

4.2 Short to Medium-term Approaches

In parallel with the mutual aid channel build-out and increased use of RF gateways, consideration should be given to enhancement of interoperability capabilities in the public safety dispatch centers. Our recommendation is the use of expanded console patch and the Mutual Aid base stations or repeaters as part of an interoperability sub-system for county public safety operations. This approach is illustrated in Figure 3 below.

As we know most agencies in Wisconsin operate in the VHF radio band. Therefore, theoretically, most radio users could interoperate today if only they knew what frequency the person they were calling was on and if radio coverage was available. Identifying the frequency is a difficult task with hundreds of channels involved. To address this issue the public safety community along with the FCC set aside national emergency calling frequencies. Agencies, which need to communicate, gather on a mutual aid emergency frequency to communicate with a dispatcher or incident commander for coordination.

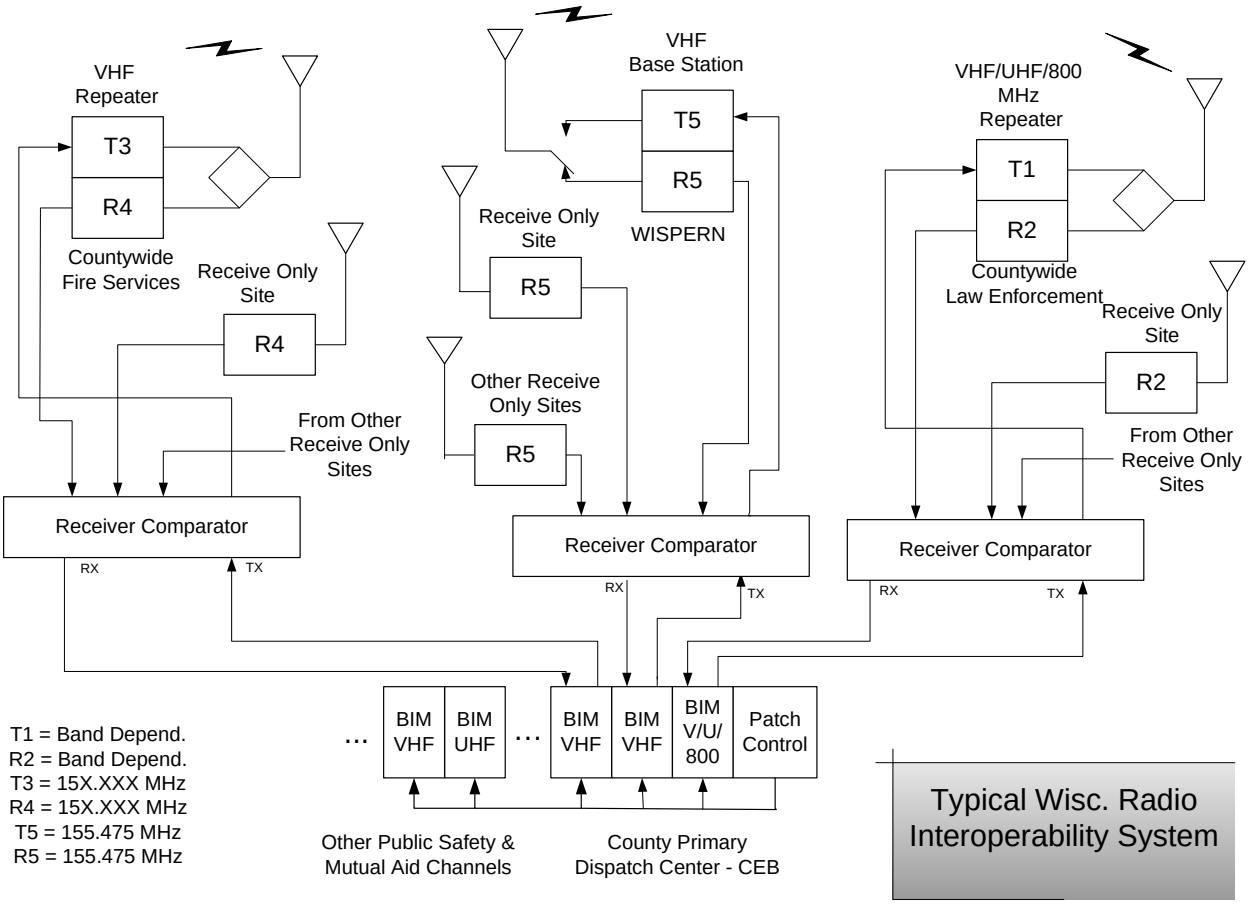

Figure 3 - Wisconsin Countywide Interoperability System

There are three different radio transmitters highlighted in this interoperability system: Fire Services, Law Enforcement, and a mutual aid base station. We have chosen to illustrate the VHF band because of the popularity in Wisconsin, but this sub-system can be applied to solutions for any band combination. The agency frequencies utilized should normally have light traffic loading in order to not interfere with regular operations. The mutual aid channel can be WISPERN or MARC or even one of the

newer FCC assigned interoperability frequencies mentioned in Phase II. Operationally, a mutual aid channel that is a repeater should be used if the other channels to be patched together are also repeaters.

Another configuration for this sub-system consists of all the base stations or repeaters programmed on mutual aid frequencies in different bands. This approach is applicable for a county adjacent to a city or county with 800 MHz usage, for instance.

An important design parameter to be considered is that all units involved in an emergency must have radio coverage on their licensed frequency. Thus, the wide-area interoperability sub-system diagramed should have wide-area coverage on all channels involved. If the desired coverage area is as large as a typical county, voting receivers and comparators will be required to achieve on-street portable coverage on the talk-in side throughout the county. If the terrain is high rolling hills and valleys, multiple transmitter sites may be needed.

Any new equipment purchased for interoperability sub-systems should be at least equipped for narrowband analog operation initially and be capable of upgrade to Project 25 digital in the future. This requirement will ensure that equipment purchased for the short-term can be migrated into the longer-term statewide system. If sufficient funds are available equipment should be purchased initially with Project 25 options installed.

A dispatch console is utilized for the audio patching function of the interoperability system in Figure 3. Base station interface modules are added to the console electronics for each new frequency to be combined. This implementation is the fastest path to interoperability, if a console is available for upgrade. However, as mentioned in Phase II, the console operation can become quite complicated for the dispatcher. Other alternatives include the use of RF gateways such as the ACU-1000 or the Telex/Vega IP-223 channel combiner. As noted previously, these units can be controlled with a computer workstation separate from the dispatcher operator position.

This interoperability sub-system can be considered medium-term because design and installation in some locations may require up to 18 months duration. The key issue is the availability of tower sites if a new centrally located transmitter site or voting receiver sites are required to achieve acceptable user coverage.

4.3 Long-Term Approaches

The solutions available for inclusion into an interoperability plan in the long term are either system specific roaming or a standards based statewide system. The tradeoffs of these two alternatives are discussed briefly in Phase II of this study. In this section we will continue the analysis further before making a recommendation.

System specific roaming implies that a radio user is able to communicate on a number of different systems by changing a selector knob position. If these systems are conventional analog and in the same band, then roaming between them is only a matter of programming in the correct frequencies and creating an Interlocal operating agreement. These conventional systems are actually standards based, which will support roaming interoperability in the same band.

However, if the systems are a mixture of conventional and trunked from different vendors, roaming communications will be available only with the conventional system. This situation is created because the current analog trunking systems are proprietary to the vendors. But, the radio vendors design products with conventional transmission capabilities for operation on mutual aid channels.

In the future, as these systems are upgraded, they should migrate to a standards based configuration, which will support radio interoperability. Currently this standard is known as Project 25 – Phase I (P25). As mentioned earlier Project 25 is a digital modulation based standard that efficiently utilizes the frequency spectrum. System configurations can be of the conventional or trunking type. If trunking is considered, spectrum utilization is further improved. Systems implemented using the P25 standard support roaming for any radio from any vendor that also meets the same standard.

We have discussed individual systems, which should migrate to a standards based configuration. However, if these systems aren't linked together by some method it is the user's responsibility to determine the radio selector switch position to set. To overcome this drawback a common interconnected statewide system should be implemented. This approach will yield the highest level of interoperability. As ***FE*** suggested in Phase II the ultimate solution for statewide interoperability is to implement a Project 25 digital VHF trunking system in Wisconsin, if sufficient frequencies are available. While a detailed VHF frequency plan is beyond the scope of this phase of the project, it is an important effort for the State to accomplish as part of the next steps to be taken. Similar efforts in other states have had good results, but it should be noted that a strong central planning effort, including the potential reassignment of

frequencies among existing users, is an important aspect of the governance process.

4.4 Cost Analysis of Statewide Conventional Vs. Trunked System

Another key determinant of whether the interoperability plan should include a statewide conventional or trunked system, in addition to available frequencies, is the infrastructure cost of each. We have developed high level cost estimates for both conventional and trunked system, as shown in Table 4, using the same coverage assumption of 95% mobile for both.

Generally speaking the existing conventional sites to be upgraded are from State agencies such as the WSP. While one SmartZone Master Site could manage an entire statewide trunking system we have included two for redundancy and reliability reasons.

In addition to the costs shown in Table 4, there are costs for subscriber units and interoperability gateway devices that must be planned. For both of these categories, the costs would be generally the same for either a conventional or trunked system.

- ***FE*** developed a "worst-case" estimate of $70-80M for subscriber unit costs, assuming that all existing VHF units would have to be replaced over a 3-5 year timeframe.
- The interoperability devices would cost approximately $75K each, which would cover 8 frequencies. ***FE*** estimates that up to 13 of these might be required – 11 to cover the existing 800 MHz systems and two portables that would be deployed on an incident-specific basis.

Equipment	Approximate Unit Price	Conventional System Quantity	Conventional System Total	Trunked System Quantity	Trunked System Total
New Conventional Sites	$316K	13	**$4.1M**		
New Trunking Sites	$348K			13	**$4.5M**
Upgrade Existing Sites - Conventional	$135K	69	**$9.3M**		
Upgrade Existing Sites - Trunked	$166K			69	**$11.5M**
Master Site Trunking Controller	$1.750M			2	**$3.5M**
Upgrade Current uWave System			**$9.6M**		**$9.6M**
Receiver Voting Sub-system			**$1.7M**		
Equipment Cost			**$24.7M**		**$29.0M**
Stage, Inst., Opt., ATP, PM, Etc.			**$10.3M**		**$12.2M**
Contingency (10%)			**$2.5M**		**$2.9M**
Total System Cost =			***$37.4M***		***$44.1M***

Table 4 - High Level Cost Estimates - Statewide Project 25 Systems

These high level estimates are based on pricing that has been proposed to other States, and also includes the following assumptions:

- A sufficient number of sites are available between WSP, WEM, DNR, and the Counties. Therefore, no new towers are required.

- No new site buildings or site improvements required.

- The Statewide System will be organized into Interoperability regions similar in size to the current WSP districts.

- Enough frequencies can be found in the VHF band for either the conventional or trunking approach. FE estimates that about 30 frequency pairs in each region would be required. Frequency reuse in the State will be coordinated by region and may require additional frequencies at region and State boundaries. No simulcast transmit sites are assumed to be needed.

- Frequencies are P25 digital narrowband 12.5 KHz. Some will be on 7.5 KHz centers.

- Bandwidth of current WSP microwave system will be upgraded to OC3. Possible reuse of some current equipment for spurs.

- Some trunking sites can be four voice/control channels, but the average is five. Conventional system sites average eight transmit/receive and two or more receive-only frequencies per site.

- A typical Conventional site will have six base stations & two repeaters.

- The P25 Dispatch Center/console upgrades required are the same for either approach and are not included in this cost analysis.

- List prices were used for all equipment cost estimates.

- A minimum of six frequencies in each region will require most receivers voted by a P25 capable comparator for 95% mobile coverage with the conventional system.

The cost of a statewide trunking system is somewhat higher (41%) than a conventional system because of the additional site controllers and the two Master Site Zone Controllers and equipment. However, as was discussed in Phase II, digital trunking systems offer significant operational advantages to the users as well as improved spectrum efficiencies

As pointed out in Section 3.2, an appropriate interoperability solution should support on-street portable coverage in the cities and towns of Wisconsin. The long-term statewide system should also support this level of performance. However, to estimate the number of sites and towers needed would require ***FE*** to perform a significant statewide RF coverage study, which is beyond the scope of this report. Local portable coverage

is dependent on the topology of each locality as well as their specific requirements. These should be determined through additional communications with the local municipalities in the next phase of this project. It is possible that the costs to provide this level of coverage would be higher than for providing mobile coverage.

4.5 Other Interoperability Considerations

The current 800 MHz systems, which are located in the higher population density areas of Wisconsin, should remain operational in this band. Many of them are simulcast transmit trunking systems, which have been optimized for in-building portable coverage in these larger cities. Interoperability between these systems and the proposed statewide system can be achieved by utilizing the short and medium-term implementations discussed earlier in this Report.

The packetized IP sub-system approach for interoperability, reviewed in Phase II, could also be applied in the multi-band regions of the State. A prime example is the City of Milwaukee communications system. The City has recently purchased a M/A-COM Open Sky 800 MHz digital trunking system. The Open Sky infrastructure, called NetworkFirst, is based on IP technology. Thus, the City's NetworkFirst system Network Switching Server (NSS) could be utilized to interconnect many other agency systems for interoperability in the southeast region. Communications between the City and the County can be accomplished using the 800 MHz band mutual aid channels. Agencies on VHF and UHF frequencies such as Fire Services and Public Works could interoperate with the City and County through the NetworkFirst NSS. Other IP-based solutions are also available from suppliers that are independent of the radio equipment, such as the Wide Area Voice Environment (WAVE) from Twisted Pair Solutions. These IP-based solutions could offer connectivity and multicast capabilities to virtually any communications device or computer, and should be considered as an important tool as the need to extend the reach of communications to other municipalities, states, and federal agencies.

5 Summary of Recommendations

5.1 Statewide Interoperability

A key decision to make before a statewide interoperability solution is selected is to determine in which frequency band the system will operate. Public safety agencies in Wisconsin utilize all of the radio bands, but a majority use High-Band VHF. The propagation characteristics of the public safety radio bands are well known. In general, the range and building penetration capabilities degrade as the frequency of use increases. The worst-case situation occurs when coverage is required over terrain that is rolling hills covered in pine forest. For this case the difference in range between mobile radios operating on 150 MHz and 800 MHz is nearly two to one. Thus, if the current VHF band users moved to a statewide system at 800 MHz, three to four times as many tower sites may be required to obtain the same coverage as today. Site acquisition and construction will make a statewide system at 800 MHz cost prohibitive. Therefore, ***FE recommends that a new statewide interoperability system be located in the VHF High-Band frequency spectrum for existing VHF users and for new systems, unless there is a clear and compelling reason to consider 700/800 MHz. The existing 800 MHz systems should remain intact.***

The next decision is whether to implement conventional or trunking technology. This decision is a little tougher to make with systems that meet the Project 25 digital standard. Many of the traditional trunking system features such as user ID, talk-group affiliation, and emergency alarm are included in conventional Project 25 compliant operation. Integrated voice and data operation (4.8 Kbps) is available with either approach. Also, the spectral efficiencies of trunking systems become more obvious with sites of four or more frequency pairs. Our cost analysis in section 4.4 showed that a trunking system is about 41% more expensive than a conventional system. However, a key feature of subscriber radios operating in the trunked mode is automatic site select. The radio will monitor all trunking sites within range and operate on the site with the strongest signal. For radios operating in the conventional mode the user must select the frequency of the correct site. Thus, ***FE recommends that the statewide system utilize VHF Project 25 trunking if enough frequencies are available for the transition and enough funding is identified.***

This recommendation will lead to the implementation of a Hybrid Statewide System as previously outlined in section 3.4. Those city and county agencies operating on a 800 MHz trunking system today will want to continue to do so. According to the WEM surveys, about 21% of the radios are in the 800 MHz

band. Interoperability with these units will occur through the use of baseband switches and gateways as discussed earlier in sections 4.1 and 4.2.

On the horizon in the three to five-year timeframe is PSMR system vendor compliance to the Project 25 inter sub-system interoperability (ISSI) set of standards, which may be released yet this year. If the VHF and 800 MHz trunking systems in Wisconsin continue to migrate along the Project 25 standards continuum they will eventually be able to be interconnected directly for interoperability. This migration process will be accomplished through the purchase of yearly system software updates from the equipment vendors involved.

Data communications interoperability poses much more complex issues in the short term than voice. It is clear that as new applications utilizing data communications emerge, that the end users will want and need additional bandwidth. There are many emerging alternatives in addition to the existing capabilities that are offered by the current systems vendors. It is anticipated that the bandwidth available through all of these alternatives will be increasing over the next few years. In the short term, ***FE*** understands that the State Patrol will be providing increased bandwidth on the existing MDCN system. The need to interoperate at the data level is being assessed in another study, and the results of that study should be available before any detailed recommendations are made on the infrastructure to support it. Directionally, however, ***FE*** would recommend that the State provide some common, standards-based capability in conjunction with the voice interoperability solutions described in this report. It should be noted that the recommended VHF solution cost estimates would support a P25-based VHF data capability, but that additional towers, transmitters, or other equipment may be necessary to support other alternatives, such as a 700 MHz-based system or a broadband system that would include mesh technology or 802.11-type systems.

5.2 Operations and Maintenance Plan

Management and maintenance of the proposed statewide Project 25 digital system can be accomplished by one of three different methods. The system can be self maintained by the State, serviced by a private in-state service organization, or managed and serviced by the system vendor. If the State chooses to do their own maintenance, it appears from the results of the Skills & Leadership Survey that there are sufficient skilled resources to support this decision. However, the staffing levels were not universally provided and should be reassessed once the specific technology and configuration are known. The final decision on the maintenance should be based on detailed system cost estimates that would be generated through an RFI or RFP process.

The survey contained a solid cross section of the PSMR universe and indicated well-seasoned levels of experience across the respondents. We must remember though that current technical strength is mostly in analog systems with some digital technology knowledge gained through the Project 25 trunking system pilot in western Wisconsin. Thus, a training plan will be needed to strengthen State support personnel in digital and trunking technologies as well as in creating and managing agency talk-group organization. Training in high-level system management and alarm analysis with troubleshooting will also be key.

As indicated in the Governance recommendations, the organizational responsibility for the operation of the system should be placed within the Division of Enterprise Technology, with a short-term partnership between DOT/State Patrol, OJA, and DET to address transition issues.

5.3 Investment in Emerging Technologies

As was mentioned in the Phase II Report the State should consider implementing trial systems in two areas of emerging technologies: Broadband wireless data and wide-area IP based network solutions.

- Directionally, we see the need for a broadband-type data capability for public safety agencies, but it is premature to make a recommendation for a specific technology at this time. The implementation of 802.11 - type emerging technologies that currently rely on the use of unlicensed frequencies, cannot offer service level performance or availability guarantees. A better recommendation could be made in 12 months, as the 4.9 GHz public safety band standards should stabilized by then. In the meantime the State could invest in a pilot program using equipment in the 4.9 GHz unlicensed band to develop an initial understanding of the data exchange capabilities and coverage characteristics of “hot-spot” networks.

- Also, directionally we see a migration to IP-based services offered by both the current radio vendors as well as emerging vendors such as Twisted Pair Solutions. These solutions should be considered in situations where there is a need for inter-agency interoperability that doesn’t require roaming capabilities until the statewide system is built out. The State should invest in further study that would result in a pilot program to test this type of a tool and then consider deploying beyond the pilot based on the results.

6 Next Steps

The State of Wisconsin has taken the initiative to develop a planning process for improving public safety radio interoperability across the state. The next steps in this process are critical in terms of further engaging stakeholder involvement and support for the plan, as well as fine tuning it based on that involvement. ***FE*** recommends that the State develop a program to communicate the results of the analysis to the stakeholders, as well as moving ahead with the establishment of the Governance and Funding processes recommended in this study. In the near term, it is also possible to start development of a Request for Information or Request for Proposals in order to be ready to start the procurement process as the funding and design issues are finalized. Once this is done, a detailed transition plan can be developed, including the prioritization results from the funding process described in the Phase III – Funding Priorities section.