MissionCriticalPartners
Because the Mission Matters

Radio System Assessment

Final Report

PREPARED OCTOBER 5, 2017
FOR FAYETTE COUNTY, GEORGIA

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Executive Summary

Mission Critical Partners, Inc. (MCP) respectfully submits this Radio System Needs Assessment report to Fayette County, Georgia. Fayette County (County) contracted with MCP to assess its existing proprietary Motorola 4.1 SmartZone radio communications system. The goal is to determine the best approach for replacing the current system, to enhance and improve public safety radio communications within the county.

MCP previously completed an operational needs assessment of the radio system and user requirements. The preliminary findings resulting from that effort were provided separately to the County, but are incorporated into this assessment report, which focuses on the recommended replacement system performance requirements. A budgetary cost estimate for the new system also is provided.

The County was aware of the end-of-life service limitations of its legacy system, which necessitated its replacement. The County did not simply want to replace old for new, but rather desired to enhance and improve the radio system's performance to better support the needs of the public safety users who rely on it for both routine and mission-critical communications needs.

In support of this, MCP developed recommendations related to improving system longevity, reliability, performance and interoperability. Based on the information gathered, MCP identified various issues affecting the current system, which the new system needs to mitigate or eliminate, including the following:

- A lack of coverage and unreliable performance exist in many areas of the county. To enhance coverage, the new system will need to include several additional sites, which will provide a higher level of signal strength across the county.
- Interoperability with external agencies is limited. This can make agency-to-agency communications cumbersome and less than reliable. The technology platform for the new system, Project 25 (P25)–Phase II, will migrate the county to a standards-based system that also is interoperable with the majority of agencies in the Atlanta region. This will allow for enhanced interoperability with external agencies at the user level.
- Reliability will be enhanced through the addition of a redundant public-safety-grade microwave system, which will connect all of the radio sites.
- Channel capacity, while sufficient today, will be increased while allowing for fewer channels and equipment through the transition to the P25 – Phase II technology. This will better support interoperability needs and future growth.

Recommended System Solution

The best new system solution and design for Fayette County was determined by considering the following factors, which impact design options:

- System user load
- County geography and population density
- Frequency availability
- Performance requirements and gaps
- System usability

MCP recommends that the County transition to a P25–Phase II, eight-channel, 13-site, trunked simulcast system design. Key elements of this approach include the following:

- Continues with a trunked simulcast design, which has been meeting the County's needs for capacity, frequency efficiency, and usability
- Through migration to a Time Delay Multiple Access (TDMA) design, the new system provides added capacity, but with a fewer number of channels and related equipment
- Enhances system reliability and coverage by increasing the number of sites to provide greater signal strength
- Adds a new digital microwave network to reliably connect radio sites

Section 6 of this report describes the recommended system design in greater detail.

Cost Estimate Summary

The cost estimates in this report use list pricing for infrastructure equipment. In a competitive procurement process, vendors typically will offer a discount of 35 percent on infrastructure, or even higher in some circumstances. Actual discounts will be bundled and based on a variety of factors such as: discounts off list price, system incentive discounts, customer loyalty discounts, and other creative factors.

Subscriber units also will be discounted by vendors. MCP used the quantities given by the County to determine the mix of radios between sheriff, fire, and general government radios. We then identified the most likely feature set for each radio. For example, sheriff radios included encryption. Fire portable radios included fire-specific features. The estimated pricing is based on other recent similar MCP client procurements. The County Agency Subscriber Cost Table shows the assumptions in quantities and realistic subscriber unit costs after all discounts.

One of the key success factors in meeting cost and performance objectives through negotiations is having participants engaged in that process who are familiar with the marketplace and similar procurements. MCP successfully has served in this role for many other clients and has a high level of confidence that these discount levels are attainable; in fact, we often have been able to attain higher discount levels on behalf of our clients.

Tables 1 – 3 below summarize the estimated costs for the recommended system solution.

Table 1: New Radio System Cost

Infrastructure Budgetary Cost Estimate	
Radio System Infrastructure Equipment	$7,605,000
Microwave	$2,240,940
Towers and Remediation	$3,625,050
Program Management and Engineering Services and Implementation	$4,226,320
Contingency 5% of System Costs	$673,550
Infrastructure Total (List Price)	$18,370,860
With 35% discount	**$11,941,059**

Table 2: County Agency Subscriber Unit Costs

County Agency	Mobile Qty	Portable Qty	Mobile Unit Price	Portable Unit Price	Mobile Extended Price	Portable Extended Price	Totals
Sheriff	141	242	$4,294	$4,260	$605,454	$1,030,920	$1,636,374
Fire	100	225	$4,122	$4,385	$412,200	$986,625	$1,398,825
Other	295	111	$2,185	$1,760	$644,575	$195,360	$839,935
County Totals	536	578			$1,662,229	$2,212,905	$3,875,134

Table 3: Total Costs

System Costs	$11,941,059
Subscriber Unit Costs	$3,875,134
Total Costs	**$15,816,193**

After applying the anticipated discounts, and allowing for a reasonable project contingency, MCP is confident that the overall system costs will fall within the Special-Purpose Local-Option Sales Tax (SPLOST) funding that has been allocated for this project. This includes the implementation of the new system and the purchase of new radios for all County agencies. The cost of new radios for other non-County agencies that are system users is not included in the above budget or in the SPLOST funding.

As final overall pricing will not be determined until later in the procurement process during negotiations, MCP recommends a process that will allow final costs to align with the available budget. During negotiations, selected options and features can be added to enhance value and system performance. Conversely, adjustments could be made to the system design that would reduce overall costs to fit the available budget, while maintaining a high level of system performance. Through this scope adjustment process, the County will be able to maximize the benefits of the new system while also offering protection against exceeding the available budget.

Next Steps

1. Confirm desired new system design parameters and requirements.

2. Develop a request for proposals (RFP) for a new public safety radio system.

3. Support an open and competitive procurement process that will provide high-quality vendor proposals and market-competitive pricing.

4. Provide implementation oversight support to monitor vendor progress and performance, and to advocate on behalf of the County to ensure that all contractual obligations are fulfilled and that the new system will meet all requirements.

1 Background

Fayette County, Georgia, (County) has recognized the need to replace its aging public safety radio system and has been successful in obtaining and allocating Special-Purpose Local-Option Sales Tax (SPLOST) funding for this project. There are three compelling reasons that drove this decision to replace the current system:

- End-of-Life Service Limitations—Elements of the current system have reached end of life for guaranteed system support. Moving forward, support, maintenance and repair of the current system will be on a best-effort basis rather than a service guaranteed by the manufacturer. This circumstance results in added risk of potential service interruptions when system problems occur.

- Desired Interoperability Enhancements—Interoperability with other regional public safety radio systems needs to be improved. Regionally, most neighboring public safety radio systems have migrated to the industry standards-based Association of Public-Safety Communications Officials (APCO) Project 25 (P25) design platform. As the current County system is incompatible with the P25 platform, there are many current obstacles to providing and enhancing regional public safety communications interoperability. By moving to a P25 system, County public safety users will realize significant enhancements to their ability to communicate and interoperate with other regional agencies.

- Improving System Coverage Characteristics—The current system has insufficient coverage, which results in significant areas of the county having less-than-adequate signal strength, and less-than-reliable radio system performance.

2 Fayette County Objective

Fayette County engaged Mission Critical Partners (MCP) to assist and support its objectives regarding implementation of a new public safety radio system that will meet its current and future needs. The following activities support that objective:

1. Completing an operational needs assessment of radio system and requirements.

2. Developing recommendations related to improving system longevity, reliability, performance and interoperability.

3. Developing a request for proposals (RFP) for a new public safety radio system.

4. Supporting an open and competitive procurement process that will provide high-quality vendor proposals and market-competitive pricing.

5. Provisioning of implementation oversight support to monitor vendor progress and performance, and to advocate on behalf of the County to ensure that all contractual obligations are fulfilled and that the new system will meet all requirements.

3 Methodology

The initial phase of this effort is one of fact finding and data analysis to assess how the current system is meeting operational needs and to identify its shortcomings. The purpose is to develop and validate a list of key feature and performance requirements that the new system will need to address to meet the current and future operational needs of the county's public safety agencies. To facilitate information gathering, the following data-gathering activities have occurred.

3.1 Initial Meetings

A project kickoff meeting was held on July 12, 2017, at the Fayette County 911 Center and Emergency Operations Center (EOC). A cross section of agency representatives from public safety and administration were in attendance. Group discussion covered project history and current expectations. A high-level schedule of planned activities was reviewed. SPLOST funding parameters and County project leadership were discussed. Current system performance deficiencies and future needs were identified and validated.

3.2 Public Safety Agency Representative Interviews

Over the course of three days, numerous one-on-one and small group meetings were held with public safety agency representatives across the county. Again, expectations were discussed and system performance deficiencies and requirements were identified and validated.

3.3 Radio Site Surveys

MCP and County staff went to each current radio system site to assess present conditions, gather legacy system design information and assess the suitability of these sites to be used as part of the future system.

3.4 Review of Historical System Configuration and Performance Information

Following the onsite activities; current system design, configuration and performance information was reviewed and analyzed.

The information gathered through the above activities was consolidated and interpreted to develop and validate a set of key performance deficiencies and future requirements, which are detailed in the Preliminary Technical Findings section of this report.

4 Preliminary Technical Findings

The following information summarizes preliminary findings regarding the technical baseline for the current system to include recommendations for enhancements that would be integrated into the features and requirements sections of the RFP for the new radio system.

4.1 Current System Design

The current system is a proprietary Motorola 4.1 SmartZone system, designed as a trunked simulcast system. It was installed in 2002. The system is comprised of seven sites throughout the county. Each site has 10 channels. The system primarily serves the public safety users of the county. However, some public works entities are on the system. This particular system has had no hardware changes since 2005, and an end-of-life software release was issued in 2009. This system has reached the end of its manufacturer guaranteed support window; thus, future maintenance and repair efforts will be on a best-effort basis resulting in increased risk of potential outages and operational disruptions that may take longer to remedy.

4.2 Coverage

System coverage is a reflection of many design elements, but primarily driven by the number, location and configuration of transmit-and-receive sites. The current system design uses seven sites distributed around the county. Information from users who were involved in the current system's design planning indicates that it was intended to provide portable radio coverage outdoors. Beyond that general description, the specifics of the coverage design are unknown.

Modern public safety radio system coverage designs generally will provide a higher level of coverage/signal strength compared with the current system. Radio system user feedback indicates that the current level of coverage is insufficient and often unreliable in many areas of the county.

MCP's recommendation is to significantly enhance the required level of coverage/signal strength in the new system to a level where a portable radio with 20 decibels (dB) of building loss would work reliably on the new system. Doing so would significantly improve coverage and signal strength across the county, resulting in more reliable system performance for public safety users.

To provide the County with an opportunity to ensure that vendor proposal costs will align with available budget, a design requirement of 12-dB of building loss also should be required in the vendor proposals. A 12-dB design would require fewer total sites, and thus also would have a lower overall cost.

4.3 Capacity

Fayette County operates on a trunked radio system technology. Trunked radio systems utilize talkgroups, which are assigned to a talk path on the system when a call is active. Capacity on trunked radio systems is reached when the number of active talkgroups at a particular site exceed the number of available talk paths at that site, resulting in a busy signal for the user initiating the call. The current system has 12

frequencies allowing for 11 talk paths. Currently, users are satisfied with the grade of service (GoS) that the County system is providing. There are no user reports of system-busy events, nor does historical system usage information indicate that there have been any system capacity issues.

The new system's technological platform will utilize a P25 design, which if desired, can provide almost twice the talk path capacity as the current system using the same number of frequencies. The actual number of desired future talk paths will be determined as the details of the new system design are developed. Some additional future capacity would be prudent to include in the design.

4.4 Subscriber Radios

Subscriber units (mobile, portable, and consoles) within the county are owned by each operating agency. The subscriber radios are mostly manufactured by Motorola. The approximate number of radios currently in use on the system includes 925 portables and 802 mobiles.

When the system migrates to the P25 design platform, almost all of the subscriber units in the county will need to be replaced. The SPLOST budget includes funding to replace all County agency subscriber units, and the municipal agencies have been advised that they will need to budget for this cost.

4.5 Radio Sites

Site walks were performed. The equipment shelters are 15-20 years old, but in good condition. The generators, air conditioning, and other civil hardware supporting the system are about the same vintage. Each site uses a circuit-based leased T1 line for radio system connectivity. The sites are as follows:

116 Volunteer Way, Fayetteville (Fayette County prime site)

- FCC Registration 1028391
- Owned by the County
- Guyed tower, medium load
- Transmit antenna height is 248 feet
- Receive antenna height is 350 feet
- Ten-channel zone/voter site

1305 West Highway 54, Fayetteville

- FCC registration 1018956
- Leased site—American Tower L.P.
- Ten-channel simulcast site with two conventional channels
- Self-supporting tower, medium load
- Transmit antenna height is 104.9 feet
- Receive antenna height is 165 feet
- Limited space for additional equipment

431 Porter Road, Fayetteville

- FCC registration 1237611
- Leased site—American Tower L.P.
- Ten-channel simulcast site with two conventional channels
- Guyed tower, medium load
- Transmit antenna height is 241 feet
- Receive antenna height is 293 feet
- Limited space for additional equipment

101 Railroad Road, Brooks

- FCC registration 1236486
- Leased site—Sprintcom, Inc.
- Ten-channel simulcast site with two conventional channels
- Self-supporting tower, medium load
- Transmit antenna height is 174.8 feet
- Receive antenna height is 279.8 feet
- Limited space for additional equipment

153 Willowbend Road, Peachtree City

- FCC registration 1203165
- Ten-channel simulcast site with two conventional channels
- Self-supporting tower, medium load
- Transmit antenna height is 279.8 feet
- Receive antenna height is 305 feet
- Minor site construction occurring at present
- Limited space for additional equipment

365 Swanson Road, Tyrone

- FCC registration 1018915
- Leased site—American Tower, L.P.
- Ten-channel simulcast site with two conventional channels
- Guyed tower, medium load
- Transmit antenna height is 354.9 feet
- Receive antenna height is 375 feet
- Limited space for additional equipment

1479 North Highway 92, Fayetteville

- FCC registration 1237085
- Leased Site—Global Signal Acquisitions
- Ten-channel simulcast site with two conventional channels
- Guyed tower, medium load
- Transmit antenna height is 200.1 feet

- Receive antenna height is 299.8 feet
- Multiple shelters onsite with limited space within the fenced area
- Limited space for additional equipment

4.6 Consolidated Dispatch Center

Fayette County has one public safety answering point (PSAP), which currently has six radio positions and two call-taker positions. Two other console positions exist today but are not fully equipped. To provide for maximum staffing flexibility, and to accommodate large-scale events, MCP's recommendation is to fully equip all ten operator positions so that they can be used for any function.

The PSAP is responsible for dispatching all fire/rescue, law enforcement, and EMS agencies within the County. The dispatch center has the capability to communicate with other PSAPs, but generally does not have the ability to communicate via radio directly with most outside agencies.

The PSAP uses Motorola Gold Elite dispatch consoles. This console version has a significant amount of electronics located within the communications equipment room. The backroom infrastructure received an end-of-manufacturer-support notice in 2012.

The dispatch center also has a standalone MOTOBRIDGE™ system, which enables patching through the dispatch consoles. This can provide a basic level of interoperability, but is dependent on specialized programming, radio interfaces, and user familiarity.

The new system should include new radio console equipment for all ten positions and full interoperability capabilities that will be possible through the migration to a P25 system.

4.7 Equipment End of Life

As stated earlier, the Motorola 4.1 SmartZone system is no longer supported and is on the Z software release. There are several components in the system that are in jeopardy of being replaced in a timely manner in the event that they fail. The entire main zone controller and management equipment is based on a system that was released in the 1990s. The boards and support management equipment may or may not be available through Motorola. The following is a list of components that are no longer in production or not currently shipping.

- 4.1 zone controller
- Tensr channel banks
- Comparators
- Motorola Gold Elite Gateway (MGEG)/Embassy switch
- Quantar boards

4.8 Frequency Considerations

The 700/800 megahertz (MHz) band is an advantageous band for semi-urban areas like Fayette County. The 700/800 MHz spectrum offers a good balance of signal penetration and coverage, and generally is licensable. There is no indication that more frequencies are required to support system loading. Using P25 Phase II, there should be plenty of talk paths in the system, as the Phase II technology essentially will allow for a doubling of system talk-path capacity if desired.

4.9 System Resiliency and Single Points of Failure

Several single points of failure and system resilience concerns were observed in the current system design.

- Single zone controller
- Larus loop switch
- Central Electronics Bank (CEB) cards
- The console computers run on Windows XP or NT
- MGEG/Embassy
- Air conditioners at sites are aging
- Generators also are aging

Modern system designs address the above single points of failure and are much more resilient. The replacement of the heating/ventilating/air-conditioning (HVAC) system and generators should be considered, so that the entire infrastructure for the new system will be of the same vintage with the same long-term life expectancy.

4.10 Connectivity/Backhaul

Fiber-optic cable provides the connectivity between the prime site and the PSAP located across the parking lot from the prime site. Media connectors are used in each location to terminate the fiber and provide a T1 interface to the channel banks at each location.

AT&T-leased T1 telephone lines are the current method used for backhaul connectivity between the prime site and each of the six simulcast remote sites. Link failures in leased circuits are the number-one cause of service reduction for public safety communications. The result of a link going down is loss of coverage from that site. Feedback provided by the users suggests that most of the experienced outages on the current system occurred during severe weather events. This is typical of a system that relies on T1 connectivity. Because T1s are bundled with other sites in the network, an outage may occur at multiple sites at the same time.

Because public safety services are in high demand when such events occur and the system is at its most vulnerable, Fayette County should include a public safety-grade, Internet Protocol (IP)-based microwave system for its new system. This would improve system resilience and reliability. Additionally, there would

be a significant long-term cost benefit to the County, as the monthly T1 circuit lease costs would be eliminated.

4.11 Interoperability

Current radio interoperability is provided primarily through a MOTOBRIDGE™ solution located at the County's PSAP. This solution can offer basic interoperability functions, but is highly reliant on specialized configuration, programming, radio interconnects and user familiarity. Many interoperability gaps can occur under this type of design.

A much more desirable, full featured and user-friendly interoperability solution will come through migration to a P25 system design platform, and the provisioning of connectivity between the new Fayette County system and other regional P25 systems.

MCP's recommendation is to incorporate all of these interoperability requirements into the new system design.

4.12 Maintenance

The inclusion of a comprehensive extended maintenance and software services agreement for the new system is recommended. Modern systems are technologically complicated, and require specialized training for proper maintenance. Properly maintained, they are resilient systems with an extended life if selected upgrades are implemented.

5 Preliminary Radio System Operational Findings

The following information summarizes preliminary findings regarding the operational baseline for the current system, to include recommendations for enhancements that would be integrated into the features and requirements sections of the RFP for the new radio system. There is some overlap between selected operational and technical findings and recommendations, which is to be expected, as the technical limitations of a radio system often result in operational performance concerns for the system users.

5.1 System User Observations

System users were surveyed extensively to solicit their inputs and observations regarding how the current system meets their operational communications needs. This information served to identify and validate system and feature performance gaps that will be addressed in the functional and performance requirements for the new system.

The County currently uses a trunked radio system and the new system also will utilize this technology. In layman's terms, the question of "Can you hear me now?" equates to the radio system being available and

reliable to the users when and where they need it to be. System availability and usability is measured by two parameters:

- The availability of a talkgroup and channel to which the radio will be assigned
- System coverage/signal strength where the user is located that allows them to effectively use the system

5.1.1 Availability

There were no user inputs or historical system usage information that would indicate any issues with having an adequate number of talkgroups and channels available to adequately assign radio traffic. The new P25 Phase II system design essentially will double the future system capacity using the same number of frequencies and channels due to enhancements in technology; therefore, the new system should easily serve future needs by easily accommodating any higher radio-user loads.

5.1.2 System Coverage/Signal Strength

There was a clear consensus from the radio system user community that the current system provides less-than-satisfactory coverage across many sections of the County. This means that there are frequent instances where the users cannot be heard clearly, or clearly hear other radio system traffic. When these types of issues and concerns are widespread and frequent—and they are according to user observations— the system often is unreliable for them. In public safety, this unreliability can equate to a safety and operational command-and-control concern for the field personnel, and for the public who depend on radio system users being able to reliably communicate.

While some of this system coverage shortfall might be related to the current older technology platform, it is more related to a historical coverage design that is not typical of how today's public safety radio systems are designed. Additionally, over the past 15 years, the County has continued to increase in population and activity with new roads, businesses and homes being built in areas that previously were undeveloped. System users who were involved in the implementation of the current system 15 years ago indicated that it had been designed to a portable outdoor performance standard. Simply stated, the system was designed to provide reliable use on a portable radio when the user was standing outdoors in the clear. However, this design parameter was not something that MCP was able to confirm through the service provider, and reported system performance appears to be less than the portable outdoor standard in some areas of the county.

Modern public safety radio systems typically are designed to a higher coverage performance standard, one that takes into consideration building density and building types. Public safety field personnel often are required to respond inside of buildings; thus, a system design that will allow for a higher level of signal strength is reasonable and appropriate. The added benefit of such a design is that it also will enhance outdoor radio coverage across the County.

A new system design that provides higher levels of coverage and signal strength will require the addition of more radio sites into the design.

5.1.3 Interoperability

Interoperability is the ability of radio system users to easily communicate with users on other systems within the region or, if other outside resources are brought into Fayette County under mutual-aid scenarios, for those users to easily communicate with in-county personnel. Interoperability today is very limited. Field users are not able to utilize their mobile or handheld radios to easily communicate with personnel outside the other agencies based within the County. The primary limitation is a technology mismatch. Current County radios cannot operate on the newer technology platforms to which most other regional agencies have migrated, and their radios cannot operate on the legacy Fayette County system.

System users desire enhanced interoperability. When the County transitions to a new P25 system, users will see a significant improvement and enhancement to regional interoperability. Once the new system is implemented, the only limitations will be in implementing operational guidelines and agreements regarding interoperability capabilities and procedures.

5.2 Radio System Performance Findings

Through this fact-finding process and analysis of the information, the three key reasons for the County's decision to replace its current radio system have been validated and reinforced.

- End-of-Life Service Limitations—Elements of the current system have reached end of life for guaranteed system support. Moving forward, support, maintenance and repair of the current system will be on a best-effort basis rather than a service guaranteed by the manufacturer. This circumstance results in added risk of potential service interruptions when system problems occur.

- Desired Interoperability Enhancements—Interoperability with other regional public safety radio systems needs to be improved. Regionally, most neighboring public safety radio systems have migrated to the industry standards-based APCO P25 design platform. As the current County system is incompatible with the P25 platform, there are many current obstacles to providing and enhancing regional public safety communications interoperability. By moving to a P25 system, Fayette County public safety users will realize significant enhancements to their ability to communicate and interoperate with other regional agencies.

- Improving System Coverage Characteristics—The current system has insufficient coverage, which results in significant areas of the county having less-than-adequate signal strength, and less-than-reliable radio system performance.

5.3 Specific Recommendations

Specific recommendations drawn from these findings include:

- Migrate to a P25 System Platform—To address system maintenance and service limitations, the County should migrate to a new system technology platform that is currently supported, will have an extended life, and which aligns with industry standards.

- Migrate to a Platform That Will Enhance Interoperability—Enhance interoperability capabilities by transitioning to a P25 system platform, which is standards-based and the leading technology platform in the country for larger public safety radio systems. As this is the technology platform that is predominantly used in the Fayette County region, it will allow for significant enhancements to interoperability.

- Require a Higher Level of Coverage and Signal Strength—Require the new system to provide better coverage and signal strength within the county borders. The new coverage performance requirement should be set to allow a portable radio within a 20-dB building to reliably operate on the new radio system. This also will significantly enhance outdoor radio performance. A mandatory alternate design that requires a 12-dB in-building loss factor, which also represents a significant improvement in coverage levels from the current system, will ensure flexibility in aligning the design costs to the available budget.

6 New System Design Recommendation

6.1 Best Design

The best new system solution and design for Fayette County was determined by considering the following factors, which impact design options:

- System user load
- County geography and population density
- Frequency availability
- Performance requirements and gaps

MCP recommends that the County transition to a P25–Phase II, eight-channel, 13-site, trunked simulcast system design.

To support the number of system users and to make best use of available frequencies, a trunked system design is needed. The current legacy system is such a system, and has served the users well from a capacity and channel availability perspective. Continuing with a simulcast design is a user-friendly approach in which site and channel selection is completed by the system automatically. The County has sufficient 800 MHz frequencies that should be reusable in the new system design. This is a distinct advantage.

The new system should be a standards-based solution that incorporates all of the design elements and features that will result in optimal flexibility of use, increased interoperability and an extended system life expectancy. A P25–Phase II system is the current standard for public safety trunked system designs. Phase II uses Time Division Multiple Access (TDMA) technology, which significantly can increase the number of talk paths on a system using the same number of channels and frequencies. TDMA allows for systems to be designed with fewer channels and less equipment compared with older technologies, based on system capacity needs. MCP recommends a minimum of eight channels for the new system, which will provide up to 14 TDMA talk paths versus the nine talk paths that are available in the legacy system. Thus, fewer channels will provide a greater number of talk paths, allowing for enhanced interoperability, flexibility and added capacity to support future growth in the number of system users. However, migration to a P25–Phase II system will require the replacement of existing portable and mobile radios.

User feedback indicates that there are numerous areas in the county where system coverage is less than desired, which equates to insufficient radio call reliability. MCP's analysis of current coverage projections validates these reported deficiencies. To provide a higher level of outdoor coverage across the county, and to better provide for in-building coverage, MCP is recommending a 20-dB coverage requirement, which means that a portable radio would be expected to work reliably in a building that equates to 20 dB of signal loss. The vast majority of buildings in the county would fall within this profile. A mandatory alternate design that requires a 12-dB in-building loss factor, but which also represents a significant improvement in coverage levels from the current system, will ensure flexibility in aligning the design costs to the available budget.

To enhance coverage on the new system, additional sites will be required. These new sites likely will be a blend of sites that currently exist today, such as other cell towers, and newly developed sites where no current sites are available to meet design requirements in a certain area. The legacy system was designed to a portable radio outdoor performance standard, which is a signal strength level that is lower than a typical public safety radio system design. To bring the system design up to the 20-dB level, MCP has completed a propagation study and conceptual design that would increase the total number of sites in the system from 7 to 13 to meet the higher coverage requirements. The number and placement of sites in the new design will be determined by the selected vendor, which will base its recommendation on sufficient sites to meet the system performance requirements. Actual site count may vary slightly from the MCP conceptual design.

Fayette County should include a public-safety-grade, IP-based microwave system for its new system to interconnect radio sites. This would improve system resilience and reliability. Additionally, there would be a significant long-term cost benefit to the County, as the monthly T1 circuit lease costs would be eliminated.

6.2 Project 25

The APCO P25 standards for public safety digital radio were established under the guidance of APCO and developed under the governance of the Telecommunications Industry Association (TIA). The development of P25 standards involved representatives from local, state, and federal government agencies, in conjunction with industry representatives, who evaluated basic technologies to develop common standards for advanced digital land mobile radio (LMR) technology for public safety organizations.

P25 is a suite of eight standards intended to help produce equipment that is interoperable and compatible regardless of manufacturer. The P25 standards suite includes the following interfaces:

- Common air interface (CAI)
- Fixed/base station subsystem interface (FSSI)
- Inter-radio frequency (RF) subsystem interface (ISSI)
- Console subsystem interface (CSSI)
- Data network interface
- Network management interface
- Telephone interconnect interface
- Subscriber data peripheral interface

P25 has four key objectives:

- Provide enhanced functionality with equipment and capabilities focused on public safety needs
- Improve spectrum efficiency
- Assure competition among multiple vendors through an open systems architecture
- Allow effective, efficient, and reliable intra-agency and interagency communications

P25 is intended to make informed decisions easier for users when planning to convert an existing system to digital. Using the P25 standards, vendors' systems can be compared more readily because they use an agreed-upon baseline set of specifications. This allows users to more accurately compare the direct features and benefits of both entire systems and individual radio products. It is intended to make bidding processes more competitive among prospective vendors. In addition, users should have the opportunity to mix and match equipment among P25-compliant suppliers because all compliant equipment will use the same standards and work on any P25-compliant system.

The Department of Homeland Security (DHS), in its 2007 Federal Grant Guidance for Emergency Response Communications and Interoperability Grants, indicated a strong preference for P25-compliant radio equipment, stating:

> "When procuring equipment for communication system development and expansion, a standards-based approach should be used to begin migration to multi-jurisdictional and multi-disciplinary interoperability. Specifically, all new digital voice systems should be compliant with the P25 suite of standards. This recommendation is intended for government-owned or -leased digital land mobile public safety radio equipment. Its purpose is to make sure that such equipment or systems are capable of interoperating with other digital emergency response land mobile equipment or systems. It is not intended to apply to commercial services that offer other types of interoperability solutions.
>
> "Further, it does not exclude any application if the application demonstrates that the system or equipment being proposed will lead to enhanced interoperability. With input from the

> user community, these standards have been developed to allow for backward compatibility with existing digital and analog systems and to provide for interoperability in future systems. The FCC has chosen the P25 suite of standards for voice and low-to-moderate-speed data interoperability in the new nationwide 700 MHz frequency band and the integrated wireless network (IWN) of the United States Homeland Security, Justice and Treasury Departments has chosen the P25 suite of standards for their new radio equipment. The United States Department of Defense has also endorsed P25 for new LMR systems."

Only where there are compelling reasons to do so will the federal government fund the procurement of non-P25-compliant radio equipment.

The final documents establishing the P25 standard were approved and signed in August 1995 at the APCO International Conference and Exposition in Detroit, Michigan. These are referred to as the P25–Phase I standards; however, P25 is an ongoing project. The current effort, referred to as P25–Phase II, has developed standards for narrowband operations using 6.25-kilohertz (kHz) channel spacing. Phase II uses TDMA technology. In April 2007, the majority of the P25 steering committee selected what is referred to as the 12-kilobits-per-second (kbps), two-slot TDMA solution for Phase II technology.

According to APCO, this selection not only allows for a graceful migration to Phase II and backward compatibility with Phase I systems, but it also offers advanced capabilities that will result in an even more robust P25 system. This solution was chosen to accommodate ever-increasing needs for spectral efficiency and user capacity in public safety wireless voice and data radio systems, while ensuring full-feature functionality and improved audio quality. The P25–Phase II standard is currently complete and equipment is being sold today that is Phase II-compliant.

6.3 Subscriber Radios

Subscriber radios are one of the most significant components of a communications system. Subscriber radio equipment needs to be compatible with the infrastructure technology implemented by the County and should meet industry standards for durability and reliability for public-safety use.

Subscriber radios utilized within the county today are not capable of basic P25 operation nor are they P25–Phase II capable. Therefore, all subscriber radios will need to be replaced when the County migrates to a new P25–Phase II system. MCP has based system cost estimates on a one-for-one replacement of each existing radio based on the different options, with costing for County-agency radios included in the SPLOST projection.

6.3.1 Subscriber Radio Features

P25-compliant subscriber radios typically are constructed to meet the durability and reliability requirements needed for public safety communications. At a minimum, the following features are recommended for portable radios utilized by public safety users:

- Minimum Mil-Spec F testing
- Model II with liquid crystal display (LCD) and partial keypad
- Emergency call/alert functionality
- Minimum 512 channels
- Minimum three watts (800 MHz) output power
- Motorola Data Communications (MDC) 1200 signaling
- Separate volume and channel adjustment knobs
- AES and DES capable[1]

The following features are recommended for mobile radios utilized by public safety users:

- Minimum Mil-Spec F testing
- Emergency call/alert functionality
- Minimum 512 channels
- Minimum 50 watts (800 MHz) output power
- MDC 1200 signaling
- Separate volume and channel adjustment knobs
- AES and DES capable

6.3.1.1 Encryption

Encryption is often desired by law enforcement agencies. Standards-based AES digital encryption is the most secure encryption available for public safety radios and is the standard encryption per P25 specifications. AES is only available on P25 trunking options. Other lower-cost encryption options may be available depending on the equipment vendor selected.

It is not necessary to purchase the encryption feature for every public safety radio; however, radios capable of encryption should be purchased so that agencies can activate that feature on the radios necessary to support special operations that would benefit from the added security provided by encrypted communications. As there is a cost to adding this feature on a radio, some agencies choose to implement it selectively, while other agencies implement it on all radios. Encryption can be implemented on specific talkgroups for use on an as-needed basis. If law enforcement elects to encrypt primary talkgroups, special considerations must be made for interoperating with agencies that may not have encryption-capable radios, or access to local encryption keys.

6.3.1.2 Proprietary Features

Proprietary features are those features available on P25 systems that do not conform to the P25 standard. When proprietary features are implemented, those features only will work between subscriber radios

[1] Advanced Encryption Standard; Data Encryption Standard.

manufactured by the same vendor. In many cases, the subscriber radio manufacturer must match the system manufacturer for these features to work.

MCP cautions that the adoption of proprietary features may lock agencies within the county into having only one available vendor from which to purchase subscriber radios and to maintain use of the feature. An example of such a proprietary feature is described below.

Over-the Air Programming

Over-the Air Programming (OTAP) is an optional feature that permits the remote programming of subscriber radios utilizing the P25 data network. OTAP significantly can reduce programming time and effort compared with the typical manual programming of radios.

Careful consideration must be given to system capacity when OTAP is implemented. Each radio will require temporary use of a voice channel to receive OTAP data. OTAP requires a large amount of data and, therefore, substantial data usage for each radio to be programmed. Programming of an entire fleet will require a large amount of system resources over an extended period of time. Because voice transmissions take precedence over data, programming times may be further extended.

OTAP-equipped systems and radios are available from multiple manufacturers. However, subscriber radios must match the system vendor, which limits competition for subscriber radios if all radios are to be equipped with OTAP. MCP recommends that the vendor price this as an option.

6.4 Consoles

For P25 systems, the interface between the system and the console remains proprietary for the largest system vendors. Because of this interface, the dispatch console manufacturer will be required to match the radio system vendor. P25 systems permit a direct IP connection between the system and console units, significantly reducing the amount of backroom equipment necessary to provide channel audio to the consoles.

6.5 Logging Recorder

P25 systems provide a significant amount of information along with call audio. This information includes unit identification (ID), affiliated radio sites, talkgroup information, and other data that may be useful in the event that the call needs to be recalled and reviewed in the future. Only certain model logging recorders are able to record this data. Certain model recorders also are capable of directly interfacing with P25 systems, while others only can support four-wire audio through a control station interface. Control station interfaces can be costly if a significant number of channels are to be recorded, as each channel requires a separate mobile radio to provide the four-wire audio.

The current recording system at the PSAP should be replaced to be fully compatible with a new P25 radio system.

6.6 Coverage

Adequate coverage is the most important feature of any radio system. Coverage concerns were noted by almost every agency within the county.

When quantifying coverage in a LMR system, two levels must be considered, as follows:

- Mobile
- Portable

Mobile coverage is defined as the geographic area where a vehicular-mounted radio can communicate reliably with the base station at an associated radio tower. Mobile radios use higher power than portable radios, have higher-mounted antennas, have more efficient antennas, and have antennas mounted free from immediate obstructions. Because mobile radios are able to receive a weaker signal and transmit with more power, they are able to operate reliably over a wider area than portable radios.

Portable coverage is more limited than mobile coverage. Portable radios typically are limited to transmitter power output (TPO) of three to five watts, compared with mobile radios, which typically have a TPO of 35 to 50 watts. Due to a less-effective antenna system, a portable radio needs significantly more received signal power compared with a mobile radio to clearly receive a signal.

Indoor coverage is the most limited radio coverage level. Public safety radio users often need to communicate within buildings. Buildings further impede the radio wave, making it more difficult for the portable radio inside the building to interpret the signal. A plethora of building factors—such as the type of construction, number of floors, number of windows, location of the building relative to tower sites, placement of fire walls, location of electrical wiring, and the location of the user within the building—impact the path of the radio wave and the ability of the radio to interpret a received signal. When designing a radio system, buildings typically are quantified as to how much they degrade a radio signal. Because there are so many factors associated with in-building coverage losses, there is no perfect way to quantify such coverage. Typical building losses range from 6 dB of signal reduction to 24 dB. Losses within a building may differ dramatically from one location within a single building to another. Radio systems are designed to meet categories of average building-loss specifications. Coverage within individual buildings may be enhanced through bidirectional amplifiers (BDAs) that reradiate received signals from outside the building to inside the building.

The greater the coverage requirement that a system has, the greater the number of radio sites that are necessary. The number of radio sites increases significantly as the coverage requirement increases, also increasing costs. When a vendor is contracted to install a radio system, a coverage requirement typically is defined in the contract. The typical coverage requirement is 95 percent mobile coverage throughout a defined area with required portable coverage varying from system to system. Once the system is installed, the vendor must demonstrate proof of performance by testing the system using a combination of automated and manual coverage testing tools.

6.7 Coverage Propagation Maps

MCP performed propagation modeling for a new conceptual design, a system with 13 sites. Maps for two levels of portable coverage, 12 dB and 20 dB, can be found in Appendix A.

A third graphic showing areas of unreliable coverage on the current system also is provided to demonstrate the significant improvement that would come from either a 12-dB or a 20-dB design.

6.8 Conceptual System Design Details and Cost Estimate

MCP developed cost estimates for the conceptual system design. This section identifies the cost summary for the system as well as the high-level design assumptions.

The cost estimates in this report use list pricing for infrastructure equipment. In a competitive procurement process, vendors typically will offer a discount of 35 percent on infrastructure, or even higher in some circumstances. Actual discounts will be bundled and based on a variety of factors such as: discounts off list price, system incentive discounts, customer loyalty discounts, and other creative factors.

Subscriber units also will be discounted by vendors. MCP used the quantities given by the County to determine the mix of radios between sheriff, fire, and general government radios. We then identified the most likely feature set for each radio. For example, sheriff radios included encryption. Fire portable radios included fire-specific features. The estimated pricing is based on other recent similar MCP client procurements. The County Agency Subscriber Cost Table shows the assumptions in quantities and realistic subscriber costs after all discounts.

One of the key success factors in meeting cost and performance objectives through negotiations is having participants engaged in that process who are familiar with the marketplace and similar procurements. MCP successfully has served in this role for many other clients and has a high level of confidence that these discount levels are attainable; in fact, we often have been able to attained higher discount levels on behalf of our clients

Our budgetary estimates also include a project contingency of 5 percent of the anticipated infrastructure and site upgrade costs. This contingency is intended to cover items such as: unexpected/unusual site foundation costs, land or lease acquisition costs, unusual existing tower structural enhancement costs, possible intermediate microwave site costs, and other items that may not be identified until a design has been finalized and preliminary engineering work completed.

For portable radio pricing, MCP includes all necessary software, antenna, single-unit charger, and remote speaker microphone. For mobile radio pricing, MCP includes all necessary software, control head, antenna, palm microphone, and installation. Spare batteries were not included in pricing, but are estimated to cost $140 each.

Figure 1 and Tables 4 - 6 below summarize the anticipated costs for the new system and radios.

Assumptions include the following:

- Total of 13 RF sites with eight P25–Phase II channels at each site
- Simulcast transmit and voted receive signal at all sites
- Structural analysis performed on existing sites
- Loop-configured microwave network connecting all radio sites and dispatch
- Six new sites
  - Three would be newly built 200-foot towers
- New shelter, generator, and site upgrades at the new locations
- Replacement of 536 mobile radios and 578 portable radios
  - County-agency radios funded within the project budget
- A new P25-compatible logging recorder
- Vendor project management, engineering, and training
- Vender recommended spares
- Mobile radio pricing includes:
  - Remote radio control head
  - P25 software
  - OTAP
  - 3-dB antenna
  - Palm microphone
- Portable radio pricing includes:
  - P25 software
  - OTAP
  - ¼-wave antenna
  - Single-unit charger
  - Remote speaker microphone
  - Encryption (400 units)
- Ten new P25-compatible radio consoles and workstations

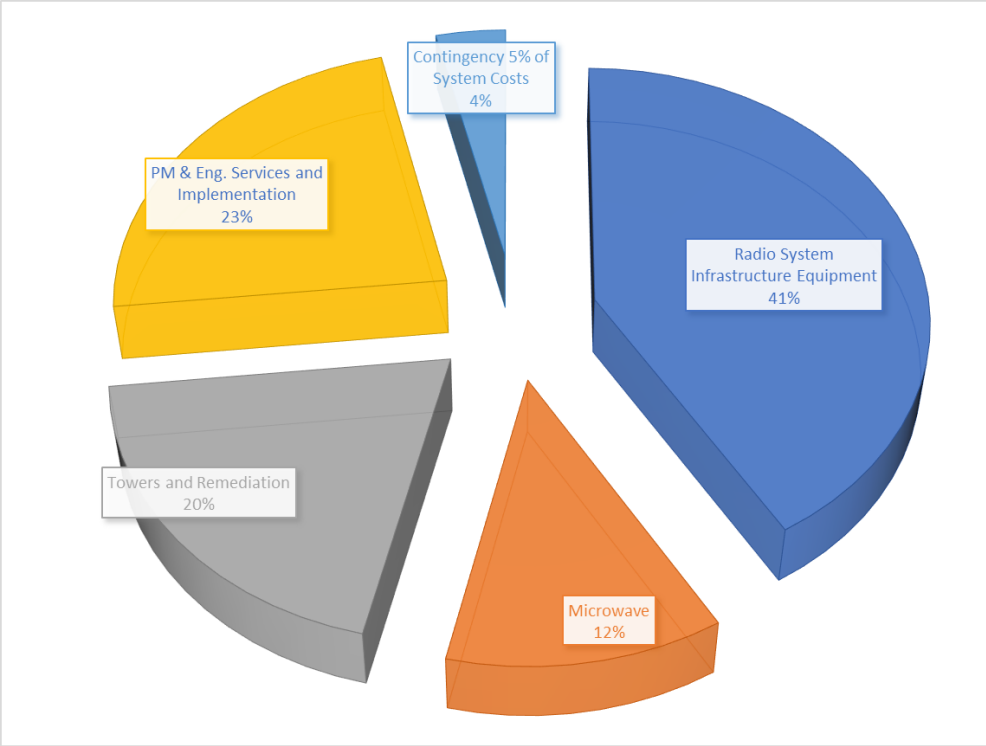

Figure 1: New Radio System Proportional Costs

Table 4: New Radio System Cost

Infrastructure Budgetary Cost Estimate	
Radio System Infrastructure Equipment	$7,605,000
Microwave	$2,240,940
Towers and Remediation	$3,625,050
Program Management and Engineering Services and Implementation	$4,226,320
Contingency 5% of System Costs	$673,550
Infrastructure Total (List Price)	$18,370,860
With 35% discount	**$11,941,059**

Table 5: County Agency Subscriber Costs

County Agency	Mobile Qty	Portable Qty	Mobile Unit Price	Portable Unit Price	Mobile Extended Price	Portable Extended Price	Totals
Sheriff	141	242	$4,294	$4,260	$605,454	$1,030,920	$1,636,374
Fire	100	225	$4,122	$4,385	$412,200	$986,625	$1,398,825
Other	295	111	$2,185	$1,760	$644,575	$195,360	$839,935
County Totals	536	578			$1,662,229	$2,212,905	$3,875,134

Table 6: Total Costs

System Costs	$11,941,059
Subscriber Unit Costs	$3,875,134
Total Costs	**$15,816,193**

6.9 Conclusion

The public safety radio system users in Fayette County have identified radio system deficiencies that exist today, which can and do adversely impact their ability to reliably communicate in both routine and mission-critical circumstances.

Local elected officials and senior staff wisely have requested a needs assessment to better understand the situation and to receive information regarding recommendations that would improve public safety communications capabilities in the county.

With the completion of this report, decisions can be made based on a much better understanding of the needs and potential solutions. The procurement process for a new system will take approximately six months. The typical implementation period for a radio system is 18–24 months following vendor selection, when additional sites are being added or developed.

MCP has been selected to assist the County through the implementation of the new system. We look forward to this opportunity to advocate on the County's behalf, so that your goal of implementing a new radio system that will meet the present and future needs of the public safety user community within Fayette County is realized.

Appendix A: New P25 – Phase II Conceptual Design System Coverage Maps

Three maps are shown in this appendix:

- The first map shows areas where system performance deficiencies are experienced on a regular basis, as reported by users of the current system.
- The second map shows predicted coverage using a 20-dB performance design, which is a significant enhancement to the design requirements of the current system.
- The third map shows predicted coverage using a 12-dB performance design, which also is a higher design criteria than the current system, but lower than the 20-dB design.

Both the 20-dB and 12-dB designs assume approximately 13 tower locations distributed across the county. The current system is a seven-site design. Within the 20-dB and 12-dB maps, areas shown as red or black, within the county boundary, would be areas where predicted system performance would fall below the desired performance threshold.

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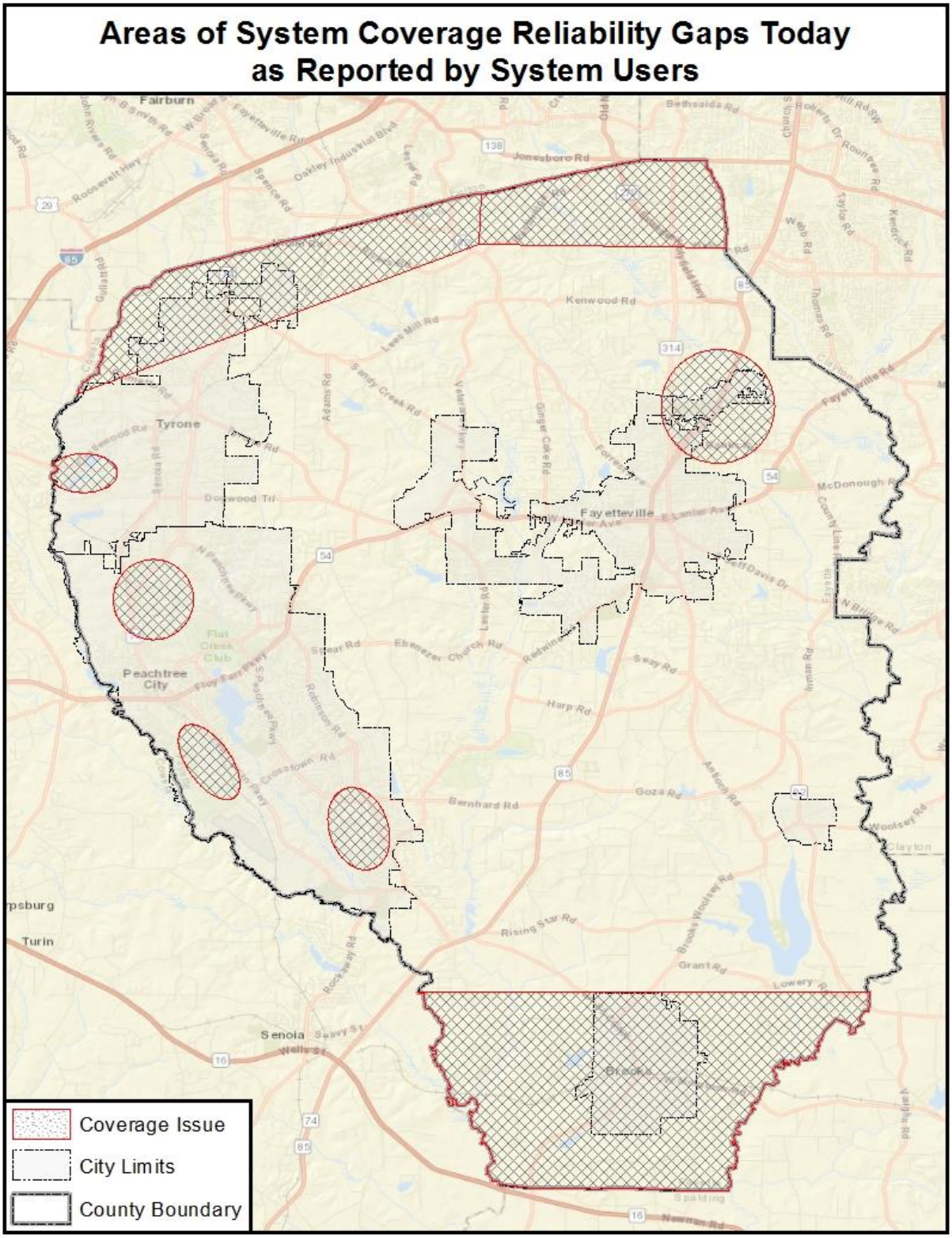

Figure 2: Areas of System Coverage Reliability Gaps Today as Reported by System Users

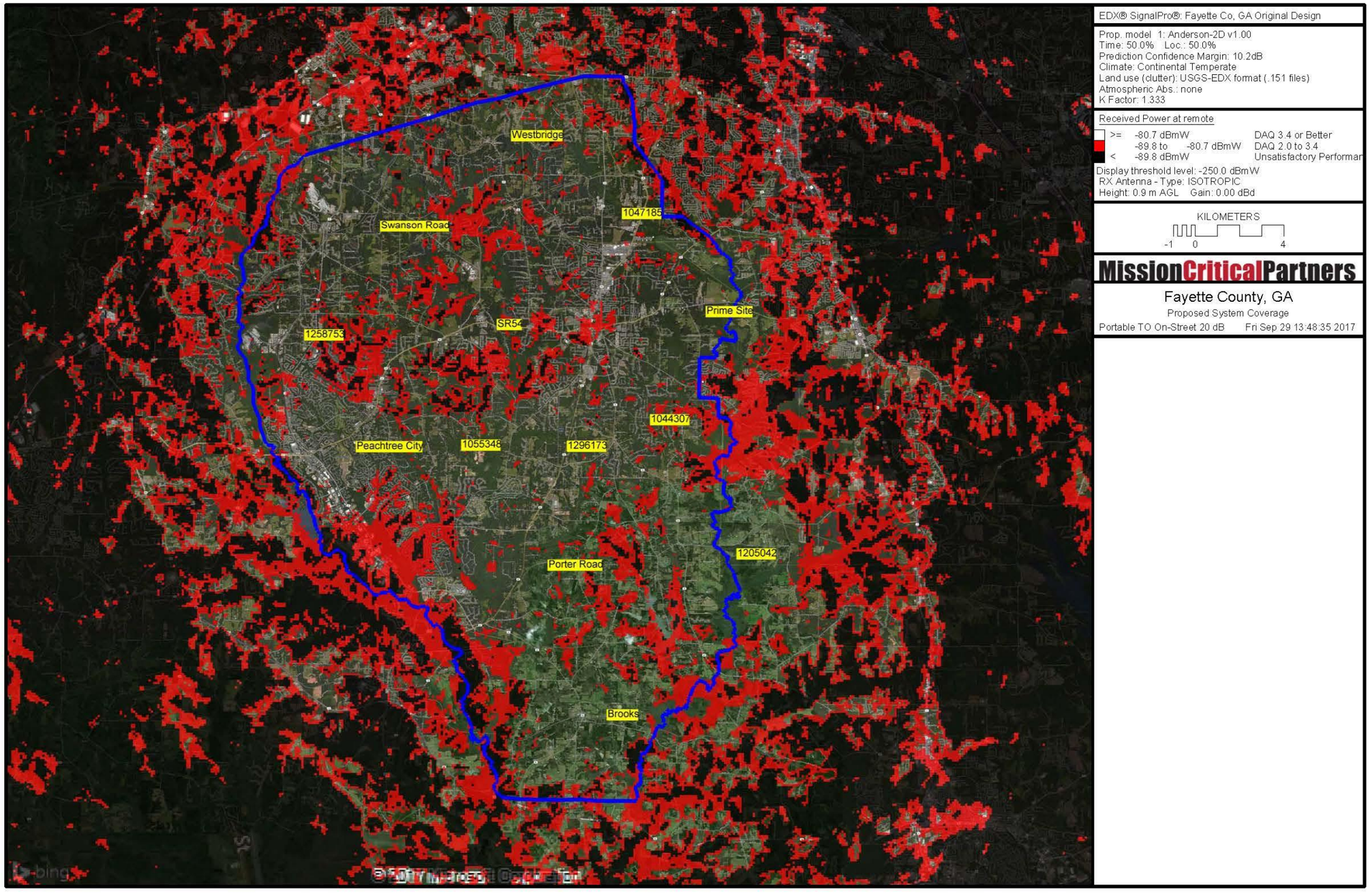

Figure 3: Predicted Coverage Map for Portable Radios in a 20-dB Building Design Criterion

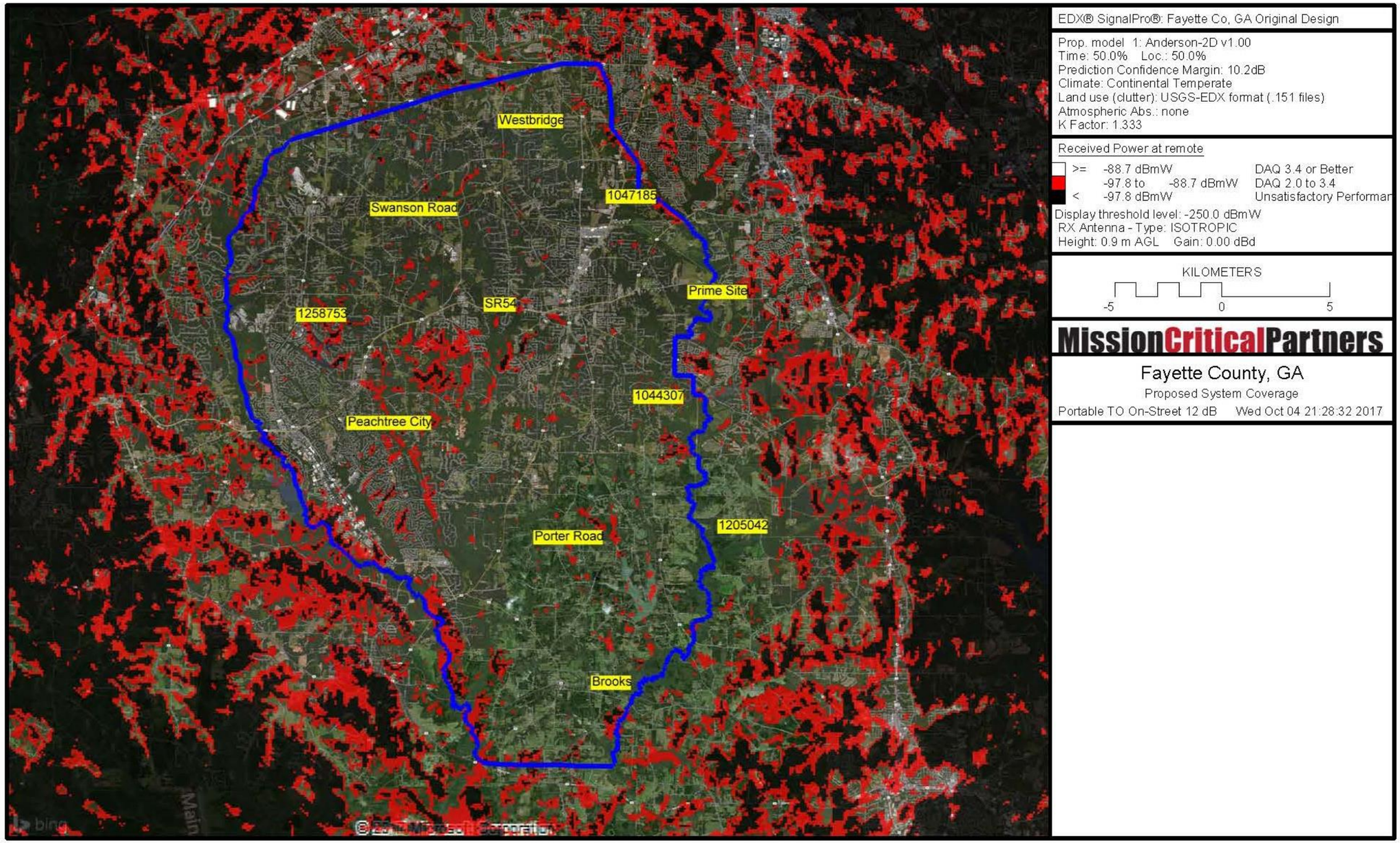

Figure 4: Predicted Coverage Map for Portable Radios in a 12-dB Building Design Criterion