# State of Maryland Statewide Public Safety Wireless Communications System (APCO 25 Phase 2 Compliant 700 MHz system)

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**Introduction Summary Statement**

The State of Maryland recognizes the need for and the importance of real time voice and data communications capabilities for public safety agencies, as well as interoperable communications across the various disciplines of public safety, levels of government, and our neighboring States. First-responders must be able to communicate with each other to provide immediate and coordinated assistance in times of emergency, minimizing the loss of life and property.

**Background**

The State of Maryland has contracted to purchase an integrated statewide public safety wireless communication system. The State will use this system as the primary radio communication system for State agencies. Local and municipal first responders may also use the system for primary radio communications. The system will provide voice and data interoperability among its primary users and other public safety agencies to support Day-to-Day, Mutual Aid, and Task Force operations. The system is design to be highly reliable, fault tolerant, spectrally efficient, easily scalable, and meet the operational expectations for public safety first responders.

Traditionally, jurisdictions and agencies have built stand alone systems to meet their individual agency needs. However, the deployment of independent non-integrated systems throughout the State has created situations which prevent cross-jurisdictional, and cross-discipline (police, fire, EMS, transportation, etc.) communications. In Maryland, radio communication interoperability among State agencies and localities is hampered by the use of different operating frequency bands, technologies, and system architectures. These systems are generally voice only and do not support mobile data applications. Many State agency voice systems will need to be replaced within the next five years because they are reaching the end of their useful life and also to meet the FCC narrow banding deadline. The State of Maryland is implementing this enterprise solution for a statewide public safety wireless communication system that supports operable and interoperable public safety voice and low speed data communications as a possible choice for these agencies.

The State and other units of local government own and operate wireless systems employing frequencies ranging from the VHF low band through the 800 MHz band for mobile communications and higher frequencies in the microwave radio frequency bands for point to point and point to multipoint communications. The State also owns, maintains, and operates multiple microwave and fiber optic backhaul transport systems. The contracted system will maximize the use of the existing backhaul network and tower infrastructure to leverage the State's investment in this network and reduce the cost of the Statewide Public Safety Wireless Communications System, but not to the detriment of the performance requirements in the contract.

A variety of conventional and trunked voice radio technologies are used by the agencies, some of which are based on proprietary technology. Operating in mixed bands and utilizing proprietary technology has negative impacts on operability and interoperability at all levels of government. Currently, the radio spectrum usage throughout Maryland is distributed across the various public safety bands with insufficient spectrum in any common band available for a statewide communications network except for the 700 MHz frequency band.

Public safety agencies, as well as the interoperable communications across the various disciplines of public safety, levels of government, and our neighboring States, feel the need to communicate with each other to provide immediate and coordinated assistance in times of emergency, minimizing the loss of life and property.

**Regional Deployment Options under the Statewide Contract**

The system will use a common infrastructure and operate within the 700/800 MHz band of frequencies. There are three possible deployment options for each region that the State may choose from. The choices to be made will be highly dependent on the economic environment in Maryland over the life of this contract.

The first option is "Public Service" defined as designing a system to meet all RFP requirements, and deployed as a subset of that full system exclusively on existing infrastructure. Equipment will only be deployed on towers that are part of the complete communications system; i.e., only the infrastructure that is required to meet the requirements of the RFP. Equipment will not be deployed on an existing tower if that tower will not be used as part of the final design. This path will likely not meet the reliability and coverage requirements of the RFP but will likely be the least expensive alternative in that it requires no new tower construction and uses only the existing infrastructure. This solution can stand alone as a biddable option.

The second option is "Public Safety-Build" defined as building infrastructure and deploying a system to meet all RFP requirements. This path essentially represents the optimum solution regardless of existing infrastructure although the Contractor should maximize existing assets to complete this solution. This solution will meet all RFP requirements including reliability and coverage. This solution can also stand alone as a biddable option.

"Public Safety-Upgrade" is defined as upgrading and constructing infrastructure from "Public Service" levels to "Public Safety" levels, meeting all RFP requirements. This path would meet RFP reliability and coverage requirements and be implemented in conjunction with the "Public Service" path. Accordingly, the "Public Safety-Upgrade" path would never be implemented in isolation since it would not be a complete "system" if it stands alone. This path must be integrated with the "Public Service" path to be a fully capable and deployed system.

**General Requirements Summary**

The system will provide a minimum of 97% reliability across 95% of the defined coverage areas which includes Maryland's entire land area, all jurisdictions and waterways. The only exception to the 97% reliability and 95% coverage standards would be in those regions where the State chooses the "Public Service" path as described above. The system elements will be linked by a backbone network of multi-dimensional redundancy. Because of the sizable State investment in existing infrastructure, backbone and equipment, any new site acquisition, antenna construction, backbone equipment and subscriber equipment will be backward compatible to leverage that investment and reduce the cost of the major new system and network.

The primary land mobile radio frequency infrastructure for new equipment must operate in the 700 MHz band on frequencies available to and licensed by the State of Maryland. The system architecture must allow for multiple band operations or overlay systems where desired by user agencies to accommodate unique coverage requirements within certain geographic areas, or during migration periods from current to new systems.

Implementation of the entire radio system will be provided in five phases corresponding to the regions. Preliminary acceptance will occur after the deployment in each region, followed by the system final acceptance after the last region is completed. Finally, the system, after acceptance by the State, will be operated by the State with contractor system support in the base contract scheduled time and possible subsequent renewal periods.

**Functional Requirements Summary**

1. A multi-agency land mobile radio (LMR) network accessible by state, local, or federal government entities to conduct public safety or public service communications.
2. Operate in the 700/800 MHz band on frequencies available to and licensed by the State of Maryland.
3. Interoperate with existing public safety radio systems.
4. Provide statewide coverage across 95% of the defined implementation region, with a portable radio being operated on the users' hip, inside of a structure.
5. Provide a minimum of 97% reliability with a minimum Delivered Audio Quality (DAQ) of 3.4 when operating in the digital mode.
6. Support at least 100,000 unique subscriber addresses.
7. Support at least 5,000 talk groups.
8. Support individual agency autonomy.
9. Provide integrated voice and data capabilities.
10. Provide secure Over-The-Air Programming (OTAP).
11. Secure encrypted communications with Over-The-Air Re-keying (OTAR) capability.
12. Support direct radio-to-radio operation.
13. Uninterrupted roaming throughout the system when required and authorized.
14. Support the use of U.S. encryption standards.

**Technical Requirements Summary**

The State requires a radio system using emerging open standards and meeting all existing FCC regulations. A summary of the requirements are as follows:

1. Full compatibility with APCO Project 25 Phase 2 standards (ANSI/TIA/EIA-102 series) as required by

FCC Rules in 47 C.F.R. 90.547 and 47 C.F.R. 90.548, with a guaranteed timeframe for completion of a network wide migration to a TDMA solution with an equivalent 6.25 kHz per voice channel spectral efficiency, within four years from the date of the initial NTP.

2. Provide a digital trunked mode of operation.
3. The system design will be modular to permit, enhanced coverage for portable and in-building operation, and increased capacity as a result of increased number of units for currently participating agencies and for additional participating agencies as they come onto the system.
4. End-to-End IP Networking.
5. Provide interoperability by:

a) Enabling interoperable voice communications among all participating agencies,
b) Incorporating mutual-aid channels on frequencies used by the local system,
c) Supporting networking with legacy systems,
   d) Supporting the interlinking of Systems at the Console to Console level, and
   e) Interfacing local government radio systems.
   6. Provide mobile data networking meeting data standards required by FCC 90.548, and APCO Project 25 Phase 2.
   7. Provide a communications backbone that:
   a) Is highly redundant,
   b) Provides a minimum individual Path reliability of 99.9999 %,
   c) Provides a minimum Route reliability of 99.9995 %
   d) Minimizes capital cost to the all users, while providing high redundancy and reliability, through maximum practicable use of existing State backhaul transport networks.

**SYSTEM REQUIREMENTS-General**

The radio system will be an APCO Project 25 Phase 2 digital trunked public safety radio system. All interfaces — including protocols (e.g. message definitions) and physical connections — to any system will be open standard and non-proprietary and comply with the minimum requirements of the APCO Project 25 Phase 2 specifications for subsystem and inter-system communications standards.

The system will be a statewide public safety wireless communication system that allows any participating state, local, or federal government entities to use a state-of-the-art voice and data radio communications system. The system will use a defined backbone to interconnect dispatch centers, base station repeater ("repeater") and other network components to provide high-reliability, interoperable services to its users. Basic benefits of the new system will include:

1. Wide-area portable in building communications throughout the State,
2. Interoperability among all participants — in accordance with their level of authorization,
3. Interoperability with others using specifically-designated interoperability/mutual aid channels as well as specifically designated talk groups, and
4. Networking systems to other systems by means of appropriate inter/intra-system network interfaces.

The radio network will provide public-safety and public-service agencies with communications solutions to serve the residents of the State of Maryland well into the foreseeable future.

**Digital Modulation and Common Air Interface**

The system must provide a Radio Frequency (RF) infrastructure that supports spectrally efficient digital modulation and is capable of operating with open standards-based common air interfaces.

**APCO Project 25 Phase 2**

The system will be compatible with all APCO Project 25 Phase 2 requirements and standards, including but not limited to a digital common air interface that is TDMA based using a 6.25 kHz channel or equivalent bandwidth and for the supporting system (i.e., radios and infrastructure).

**APCO Project 25 Phase 2 Migration**

If the technology solution is not compliant with APCO Project 25 Phase 2, the technology solution must include a guaranteed timeframe for completion of a network wide migration to a TDMA solution with an equivalent 6.25 kHz per voice channel spectral efficiency, in no event longer than four years from the date of contract award.

The migration plan must include, but not be limited to, guaranteed timelines for: (a) completion of a network wide migration, (b) user transition plans, (c) recovery plans should a failure occur during the migration, and (d) system impact analysis to include but not limited to system channel capacity and subscriber equipment upgrade logistics.

**System Availability**

The system will have a fault-tolerant architecture that permits the radio system to continue operation in the event of a hardware or software malfunction.

All system sites will be capable of maintaining trunking operation in the event of a failure of a site controller, control channel, and/or a single backbone (microwave or fiber) path failure.

**Transport System Expansion Capability**

System throughput, grade of service, circuit congestion, or packet loss must not be further degraded by the transport system due to expansion of the system to the limits of its capacity.

**Expansion Capability**

The system must be scalable and have the ability to expand and upgrade all system components including, but not limiting to, software and firmware to maintain compatibility with future product offerings and enhancements.

**Support Agencies As They Exist**

The system must support the operations of user agencies as they currently exist, without requiring material changes in agency structure, service area boundaries, operational protocols, or function in order to provide the desired communications.

**Provide Multipoint Voice Communications**

The system must provide multipoint voice communications directly between registered users of mobile and portable radios, RF control stations, console operator positions, or other dispatch point(s) throughout the State's service area. This communication must be simultaneous to all users of a group, and must not require operator intervention other than a user's selection of their own desired talk group.

**End to End IP with Ethernet Interface**

Connectivity for all offered infrastructure equipment (repeaters, dispatch consoles, message switching and routing, and transport equipment) must be accomplished using Internet Protocol (IP) from end to end, with Ethernet interface for local site equipment. It is required that any equipment, including mobiles, portables, RF control stations and vehicular repeaters be individually addressable and accessible from the management and administration sub-system described elsewhere.

**PSTN Interconnection**

The system infrastructure must be capable of providing interconnection of authorized users with the Public Switched Telephone Network (PSTN).

**System Level Latency and Delays**

Total access delay time plus latency time between two subscriber radios in any two or more cells of the system must be less than 700 milliseconds from Push-To-Talk (PTT) to reception and passage of voice information.

**Voice Latency**

Delay of voice information (speech delay or latency) must be less than 500 milliseconds total when communicating directly from unit to unit. This includes vocoder delay, digital encoding, and digital encryption time. During the delay period, voice information will be buffered.

**Intra-Cell Latency and Delays**

Total access delay time plus latency time between two subscriber radios in the same cell of the system must be less than 500 milliseconds from PTT to reception and passage of voice information.

**Grade of Service**

The system must be designed to provide a Grade of Service (GOS) such that less than one percent of the offered traffic will be expected to be queued during the busiest period of the day, with a waiting time of no more than three seconds for queued calls.

1. A delayed call will be considered to be any communication attempt not immediately establishing a talk-path. In this definition, "immediate" refers to time not exceeding the specified system access time limit.
2. The delay time of a call will be considered to be the length of time, beyond the specified system access time limit, that any communication attempt requires to establish a talk-path.
3. A blocked call will be considered to be any communication attempt that fails to establish a Talk-path within a delay time of 3.0 seconds.
4. The daily busy hour for each site location will be considered to be the busiest one-hour traffic period experienced over the course of a day.
5. The Grade of Service for communications at each site location is defined as the daily busy-hour ratio of blocked calls to number of communication attempts.

**Subscriber Roaming**

The system must ensure that subscriber roaming (system switching, handoff, or cell changes) will not result in any delay, interruption, or loss of communications to any traffic in progress for any user. The system must ensure that if such situations of delay or interruption are possible, that the conditions and duration be identified. Examples would be where a subscriber unit is transmitting, receiving or in standby while crossing any site cell, or regional architectural boundary.

**Vocoder Performance**

The system must ensure that voice coder (vocoder) intelligibility, reliability, and efficiency meet or exceed the performance specified by TIA TSB 88 standards in terms of mean opinion scores and required data rates. The use of IMBE, AMBE, or equivalent vocoders will be considered.

**Simultaneous Voice and Data Support**

Any integrated or mixed voice and data system offering must support simultaneous voice and data operations from end to end. In a voice and data contention condition, voice transmission will be given the priority over data transmissions.

**Low-Speed Wireless Data**

The system must provide low-speed wireless data access and service to users. The low-speed wireless data system must provide a minimum "payload" data throughput as required by the APCO Project 25 standard.

**System Unit Capacity**

The system must be capable of, but not limited to, supporting at least 100,000 unique addresses and 5,000 talk groups. Addresses are used to identify any individual unit of subscriber equipment or managed infrastructure equipment. The system architecture will be scalable, without replacement, such that additional system loading (talk groups and subscriber equipment within an area) can be accommodated. Frequency planning must allow for additional trunked channels to be added to transmitter sites in order to accommodate additional system loading.

**Subscriber Mobility**

The system must ensure that a radio unit's local area of operation be defined as the user's home area and all adjoining areas. The system must ensure that the radio units automatically select the best radio site or "cell" for two-way operation in this local area. The Contractor will provide the infrastructure or subscriber radios to support mobility and manage automatic access outside of this local area, in order to minimize spectrum resource demands.

**Interoperability**

There are three general categories of subscriber interoperability. The system ensures that radio subscriber units and system unit interoperability. Any dispatch point can communicate on the interoperability portion of the network infrastructure.

1. Unit-to-unit/talk group, direct and through the system.
2. Unit-to-unit between one system and another systems units operating in the same frequency band, direct and through the network.
3. Unit-to-unit between one system and another systems units operating in frequency different bands using the network infrastructure.

**APCO Project 25 Phase 1**

The system will be backwards compatible with existing APCO Project 25 Phase 1 700/800 MHz trunked radio systems.

**System Network Interface**

The system must include, identify and reserve at least 50 interfaces for interoperability with local or regional groups. This is in addition to providing operation on the designated 700 MHz interoperability frequencies.

**Analog Interface**

At least twenty-five full-duplex 600 Ohm 4-wire E & M signaling, 0 dBm Transmit level and -10 dBm Receiver level audio interfaces will be included. These interfaces will be deployed in groups of five in each of the new system regions.

The system will be fully capable of providing gateways for full-featured (to the extent practicable) inter-connecting with other standardized systems and with the following manufacturers' proprietary (non-standards based) systems.

1. MA/COM
2. Motorola
3. Transcrypt-EF Johnson
4. Any other public-safety radio system operating in or adjacent to the State

The system will be fully capable of providing gateways for full-featured (to the extent practicable) inter-connecting with the following types of systems available from the manufacturers listed above.

1. Digital
2. Analog
3. Trunked
4. Conventional

**Priority Access**

The system must accommodate a minimum of five levels of priority access for first responders and associated entities, and allow for automatic ruthless preemption of other users, if needed, to accommodate high priority user demand and emergencies.

**Dynamic and Ad Hoc Groups**

Radio units and system infrastructure must support the establishment and activation of dynamic groups, which allow operation of ad hoc talk groups as established by system managers.

**User Registration/De-Registration**

The system must allow the users to select from among an available pool of talk groups, and must recognize that the individual user is now part of that talk group (user registration/de-registration). System management may restrict or allow access by talk group and site for any individual user or group.

**Single Unit Required for Access**

System users must be able to access the system using a single portable or mobile unit regardless of their location in the service area.

**Emergency Call and Man Down**

The system must be supplied with an emergency call feature, and an emergency call button must be present on each subscriber unit. Emergency calls may be configured as audible or silent to the user.

**Selective Calling to Individuals**

The infrastructure and subscriber units must be designed to allow selective calling to and from individual users, without interrupting operations on the selected talk group.

**Unit ID and Alias Display**

Subscriber units must be offered which support the display of unique unit identification (ID) and text alias conversion with a minimum of 12 alphanumeric characters**.**

**Talk Group Scanning**

The radio system must allow selection of alternate talk groups of interest, and automatically monitor them in a sequential manner, while optionally monitoring the currently selected talk group with priority (priority and non-priority scan of talk groups).

**Over-The-Air Programming**

The system must provide the capability to program or update subscriber equipment using Over-The-Air Programming (OTAP) methods. The system must provide the inclusion of methods or mechanisms to authenticate user equipment ensure the integrity of reprogramming commands, and to provide "fall-back" capability for incomplete, aborted, or unsuccessful programming attempts.

**End-to-End Encryption**

Communications carried by the interoperability system may contain sensitive information regarding critical infrastructure and vulnerabilities, protected patient information, ongoing criminal investigations, protective services, surveillance, or similar activities. As such, the system must ensure that encrypted communications not be decoded at intermediate points within the infrastructure.

**Access Limitations**

Access to the system must be limited to authorized users, and provided only within the geographic regions where communications are necessary and appropriate.

**Subscriber Unit Authentication**

The network management system must authenticate all users by an Electronic Serial Number (ESN) or equivalent unique identifier for validation of services and access. It must be possible to immediately disable any individual radio from the network management system so that it may not access the system, initiate a call, or receive traffic. Any radio so disabled will continue to broadcast its position data at intervals and will be capable of being polled without alerting the subscriber operator. A radio so disabled must be physically reset by an authorized system manager.

**Management of Dynamic Groups**

Radio units and system infrastructure must support the establishment and activation of dynamic groups, which allows operation on special talk groups as established on an "as-needed" basis by system managers.

**Advanced Encryption Services**

Voice and data radio systems must support digital encryption using Advanced Encryption Standard (AES) or an equivalent method approved by the State.

**Over-The-Air Re-keying**

The system must provide the ability to use Over-The-Air Re-keying (OTAR) for the management of encryption keys, and to allow their change without need to recall or physically connect to subscriber radios. The system also must provide the use of a key management facility to store keys and track re-keying progress. The system must provide the ability to partition the management of keys, and to allow distributed "self-management" by individual agencies, if desired. The system also must provide the capability to include two keys, one for the network infrastructure (Network Operations Center), and one for the agency subscriber equipment (Agency Operations Center).

**Data Requirements**

This section includes requirements specific to the communication of data throughout the network.

**Data Types**

The system will be capable of supporting applications that transmit and receive various forms of data content, including but not limited to:

1. Short Messaging (e.g. up to 254 bytes),
2. Text and American Standard Code for Information Interchange (ASCII) data,
3. Image and Graphics (e.g. JPEG files),
4. Binary files (e.g. MP-3 files), and

**Interfacing to Peripheral Devices**

1. To provide the highest degree of functionality, portable and mobile terminal equipment will have the capability to interface with independent peripheral devices through use of the standard interfaces available on their radios.

2. Examples of peripheral devices are: Mobile Computer Terminals, Printers, Facsimile, Image Scanner, Finger Print Scanner, Bar Code Reader, Card Reading Device, and Digital Camera.

**Automatic Vehicle/Vessel Location (AVL)**

The system must provide two way communication supporting subscriber location position reporting. This is to include providing an open standard data interface to AVL equipment and applications provided by third party manufacturers. The interface will provide an automated exchange of digital information between the system and the external Computer Aided Dispatch/ Record Management System in accordance with standards published by the Association of Public-Safety Communications Officials (APCO) International and the National Emergency Number Association (NENA).

**Automatic Vehicle Location (AVL) Requirements**

1. AVL will be offered as an option for Tier II and Tier III portables and mobiles.
2. The AVL option will be powered from its associated subscriber unit.
3. The AVL system will have the capability to track and locate individual units to within a 15-meter radius.
4. The AVL system will be integrated within the terminal equipment.
5. Subscriber units will transmit AVL data upon direct command or at programmable intervals,

consistent with not causing excessive loading of the system.

6. The AVL must be capable of simultaneously transmitting location data and an alert message when the emergency "man down" feature is activated.

**Computer Aided Dispatch/Record Management System**

The system must provide two way communication supporting subscriber reporting and messaging. This includes providing an open standard data interface to equipment and applications provided by third party manufacturers. The interface will provide an automated exchange of digital information between the system and the external Computer Aided Dispatch/ Record Management System in accordance with standards published by APCO and the NENA.

**Data Throughput**

The system must provide the data rate as specified in the APCO Project 25 standard. As a combined voice and data trunked radio communications network that is able to accommodate variable traffic conditions, dynamic bandwidth allocation is the preferred method for achieving the data throughput goal.

**Consoles Utilizing IP**

A console systems interface to control the radio and data systems must be created. Consoles must use Internet Protocol (IP) connectivity for all voice, data, activity, and parallel console status information.

**Regional Dispatch Organization and Functions**

The supporting network and console subsystem architecture must accommodate regional dispatch organizations and functions.

**Dispatch Console System**

The console system must be scalable supporting between one and 20 operator positions.

**Regional Dispatch Groups**

The supporting network and console subsystem architecture must accommodate both collocated and non collocated consoles to be configured into a regional dispatch facility with all functions of each console.
The system will accommodate the establishment of 20 regional dispatch groups. Each dispatch group must support a minimum of 200 operator positions.

**Console Indication of Emergency**

Console operator positions must provide an indication of the activation of an emergency switch by any user, and have the ability to acknowledge the emergency alarm. The Unit ID for an unacknowledged emergency alarm must not scroll from the Unit ID display.

**Computer Aided Dispatch and Record Management Systems Interface**

Each console will provide a standard interface allowing the automated exchange of digital information related to the radio system unit operations and alarms with Computer Aided Dispatch and Records Management Systems. The digital information will be accomplished in the accordance with the standards published by the National Emergency Number Association (NENA) and the Association of Public-Safety Communications Officials (APCO) International.

**Logging Recorder**

Each dispatch system must provide a logging recording capability with an interface to provide connection to, and operation with the new system, having a capacity to simultaneously record 510 talk groups.

**Instant Recall Recorder**

Each dispatch system must provide an instant recall recording capability for each operator position. It will provide an interface to provide connection to the console operators' microphone/telephone audio and the selected radio channel receiver and telephone audio.

**Wireless Data Interfaces**

The system must supply a wireless data subsystem(s) interface to at least six host computer systems or local area networks operated by the State. The system will provide fire walls and an intrusion detection system to meet the State's security standards. The State's Information Technology Security Policy and Standards are located at: www.doit.maryland.gov - keyword Security Policy.

**Legacy Console Interface**

The system architecture must provide an interface to allow connection of existing or planned legacy, connection based or circuit switched (non-IP) consoles to the new system.

**System Status and Alarm Monitoring**

The system must provide the ability to continuously monitor system status and alarms in order to be aware of isolated or widespread system failures.

1. The status and alarm monitoring system will provide a custom GUI that has been formatted per the State's direction. This interface will provide a pictorial representation of the State of Maryland showing the location of all active system elements and allow easy access to a specific system element's operating status.
2. The operator interface will have multiple levels of access and be web based allowing both local and remote operation.
3. The status and alarm monitoring system will have a means to provide alarm condition notification to designated personnel using assigned radio pagers, telephone text messages,

and email notifications in addition to local audio and visual alarm indicators.

4. The status and alarm monitoring system will maintain a database of all alarm events, such as, but not limited to the following: event type, device identification, time, date, major or minor, personnel notified and event resolution.
5. In addition to the event database, the status and alarm monitoring system will have the ability to create custom reports as configured by the State in both electronic and hardcopy formats.

**Graceful Degradation of System**

In addition to the basic reliability and redundancy features, the design of infrastructure must ensure that fault tolerance is an integral part of the Statewide Public Safety Wireless Communications System. In the event of one or more total failures in transport or key system components, the system must ensure that operations slowly degrade from a full featured system with centralized control and management, to limited management and features, and allow for some level of basic communications and coverage from implemented sites, even in the event of a total loss of system management and local control.

**Specialized Resources**

In the event of the total loss of a site, or specialized coverage needs for intense operations, the system must allow for the deployment of specialized equipment and resources within four hours of arrival on site to provide service to users.

**Redundancy**

System reliability will be accomplished by utilizing redundant configurations, alternate locations and interconnections.

**Single Points of Failure**

System architecture and implementation must be designed to preclude all single point(s) of failure in the system infrastructure that will result in the loss of communications with any user.

**Loss of Capacity**

No failure in the system will result in the loss of more than 15% of the system's peak capacity. The system design must ensure that the loss of a single site does not cause widespread outages or transport congestion at adjacent sites. No single site loss will result in the loss of more than 5% of the system's peak traffic capacity.

**Use of Existing Transport Systems**

The system must maximize use of existing transport systems used by the State, either digital microwave or fiber, where they exist for voice and data system interconnection. The design will assume that adequate capacity and performance is available on the State backhaul transport system. Where existing transport systems used by the State are not available, the Contractor must provide new transport networks.

**Site Connectivity and Interface Levels**

The system must include all equipment necessary for connection of the voice and data systems to the fixed transport infrastructure, and must interface with the digital microwave or other transport system at a DS1 level, allowing DS0 level grooming on channel bank equipment where necessary or appropriate. If direct interface to digital transport is not possible, then the system must provide the necessary interface to affect that connection.

**Prediction Modeling**

Radio system coverage will be predicted through use of a radio wave propagation model that has been developed on the basis of theoretical and empirical data, and will consider terrain irregularity, foliage, urban clutter, noise and long and short term signal variations.

**Coverage**

The system design will be based on APCO Project 25 Phase 2 performance as required to provide the specified reliability throughout the coverage area as defined above. Portable radios will be configured using a hip-worn radio in a belt loop case and speaker-microphone without antenna. The maximum output transmit power of a portable radio is limited to 3 Watts for determining the system coverage.

The basic network coverage design will be applicable to vehicles, aircrafts, railroad trains, and vessels traveling at speeds up to 150 MPH. At least 95% of all test locations within the State will meet or exceed the coverage threshold for both voice and data.

The requirement for supplemental in-building portable coverage is defined for specific locations required by agencies. Supplemental coverage requirements must be equal to or better than the statewide requirements.

Wireless Voice Requirement:

All coverage requirements described in this section require a round trip (transmit and receive) delivered audio quality (DAQ) rating of 3.4 as defined in current edition of TIA/EIA/TSB88 *(Wireless Communications Systems -Performance in Noise and Interference - Limited Situations – Recommended Methods for Technology – Independent Modeling, Simulation, and Verifications*).

Low Speed Wireless Data Requirement:

The system will provide portable data coverage across 95% of each region while being operated on the hip inside of a structure providing a minimum "payload" data throughput as required by the APCO Project 25 standard. Mobile data coverage applicable to vehicles, aircrafts, railroad trains, and vessels can be measured using a mobile antenna.

All coverage predictions will provide a minimum of 97% reliability across 95% of each Region.

The coverage area includes Maryland's land area, all jurisdictions, and all waterways up to 10 miles offshore in the Atlantic Ocean along the entire coastline of the State. Coverage prediction will use a minimum of 30-meter terrain data overlay and a minimum of 100-meter land use classification overlay for performance modeling of the coverage area. Coverage performance prediction will be calculated and illustrated via maps and tables to reflect level of performance using portable radios. The system development must include a measurement and verification methodology to ensure and demonstrate compliance.

**Operational Coverage Conditions**

The system will be designed to provide the specified coverage under the following conditions:

On a statewide basis, outside of the areas defined below as urban areas, critical building and special locations, with coverage inside of buildings allowing for 12 dB building wall loss. The margin will be in addition to diffraction and shadowing losses of operating portable radios in land use classification environments and terrain database overlays.

1. Provide for coverage inside of urban areas allowing for 24 dB building wall loss. The margin will be in addition to diffraction and shadowing losses of operating portable radios in land use classification environments and terrain database overlays.

2. Critical Buildings are hopefully have coverage with the 24 dB provided from the radio infrastructure. A list of buildings that may use supplemental radiating system (SRS) only if the wall loss of the building exceeds that of the defined coverage area loss has been provided to the Contractor.

3. Provide for on-street coverage throughout the areas. Assume this is portable coverage with the portable radio worn on the hip.

**700 MHz Channel Plan**

The Contractor will develop a 700MHz Channel Plan using the 700 MHz State License channels. The Contractor's plan will only use General Use pool channels after demonstrating the coverage requirements cannot be met with the State License channels. Due to the uncertainty of the obtaining General Use pool channels, it is not permissible under the contract for any site to consist entirely of General Pool channels.

**Conformance to Spectrum Agreements**

All 700 MHz frequencies employed in the system design must conform to FCC Rules & Regulations, interstate spectrum agreements and NPSPAC Regional plans as defined by inter-regional and intra-regional agreements of Region 20, Region 28, Region 36, Region 42, and Region 44.

**EQUIPMENT REQUIREMENTS- General**

All equipment, materials and related services supplied including but not limited to electronics, hardware, software, and etc. will be brand new from the manufacturer, commercially available, and suitably designed and installed in accordance with FCC, FAA, building code and appropriate specifications and standards.

For the duration of the contract, the State requires direct access to the manufacturers' web sites containing each manufacturer's entire current equipment offering for the product lines in the delivered system. The manufacturers' web sites will be used by the State to validate the commercial availability and current MSRP for products.

**APCO PROJECT 25 Trunked Repeaters**

All repeaters will be capable of providing APCO Project 25 digital trunked voice and data services to user radios. All repeaters will be capable of being configured as either an APCO Project 25 control channel and/or working channel and any working channel repeater will be capable of automatically assuming the role of the control channel in the case of a failure of the control channel repeater. Repeaters will provide automatic call sign identification that meets the FCC requirements for identifying APCO Project 25 trunked repeater sites. The system will provide the ability to reconfigure individual repeaters through the network backhaul interface.

**Initial Maryland Agencies to be part of the 700 MHZ Public Safety System**

The following agencies are the initial agencies that are part of the base contract.

Maryland Transportation Authority (MdTA)
Maryland State Highway Administration
Maryland State Police
Maryland Department of Natural Resources

By agreement, the MdTA will be the first to be built. The others will follow according to a negotiated schedule.

**Maryland Transit Administration (MTA)**

The MTA operates a multi-modal network of buses, trains, and paratransit vehicles either through direct operation or contractual arrangement. This network serves a population of over two million people living in an area of about 1,800 square miles. The main components of MTA's transit service are described below:

**Core Bus** - The MTA bus fleet is currently comprised of 755 buses in the active fleet, of which 680 are equipped with a wheelchair lift. MTA operates 55 "core" bus lines serving Baltimore Area. The core bus routes carry an average of 282,315 unlinked passengers

**Commuter Bus** - Washington – The MTA provides fourteen privately-contracted commuter bus services which offer long-haul service from points throughout Maryland to Washington, D.C. and its inner-ring suburbs.

**Metro** - The Metro heavy-rail service operates on a single line from Owings Mills to Johns Hopkins Hospital, linking downtown Baltimore, the northwest part of the city, and the northwestern suburbs. The line is now 15.5 miles long and serves 14 stations. Average daily boarding on a typical weekday is approximately 42,634 passengers.

**Light Rail** - The Central Light Rail Line is presently 30 miles long, serving 33 stops between Hunt Valley and Penn Station to the north, and BWI Airport and Cromwell Station to the south. The Light Rail fleet consists of 53 articulated cars. Service throughout the day requires 17 trains, configured with one, two, or three cars. Daily ridership is 28,830.

**MARC** - The MTA operates MARC commuter rail service, a 187 mile, 42 station system serving Washington, D.C., Baltimore City, seven Maryland counties, and parts of northeastern West Virginia. Average weekday ridership on all three lines combined is about 26,500.

The base radio contract requires uniform radio coverage across the entire State of Maryland. The contractor will meet this requirement by using a combination of existing State towers and newly built towers designed supplied and constructed under this contract. These towers will be linked together in a network with a fiber and microwave backbone system to provide all of the necessary interconnection to all of the equipment on the system. The backbone network will also provide the necessary interconnection to existing radio systems that want to join the State system using their existing equipment and interfacing through gateway translators. Once completed, this infrastructure will be available for use by other state agencies.

The Maryland Transit Administration (MTA) will be the first agency to be built out that is not part of the original contract. This will require the first of many change orders to the base contract as other agencies come on board the system. The change order will include nearly all of the elements of the base contract. Included are engineering, consoles, subscriber units, training for operators and maintainers, spare parts plus all the pertinent requirements of the base contract.

In pursuit of this goal the (MTA) has directed that a study be done showing the service area in Geographic Information Systems (GIS) coordinates of each separate mode of operation. In addition a composite of the entire service area will also be part of this study. Using the coordinate information of the towers discussed above, the MTA will identify all of the towers that are located within the MTA service area. The MTA will purchase all of the consoles and subscriber units to meet their needs. The towers in the MTA service area will be programmed to work with these MTA units.

This initial effort to bring a new agency onto the base system will be a valuable training exercise for both the Contractor and the State. In the future, as additional agencies gravitate towards the State-wide system there will be the experiences of this first effort, good and bad, to guide the State as it expands across Maryland to provide a fully interoperable radio system.