Craig County, Virginia

Radio System Assessment Report

Executive Summary

April 2021

Executive Summary

Introduction

Craig County contracted CTA Consultants LLC (CTA) to provide an evaluation/assessment and recommendations for a Public Safety Grade Radio/Paging Communications System to serve Sheriff, Fire and Rescue, EMS, and Craig County Public Schools. Craig County has a land area of 331 square miles and is bordered by Alleghany, Botetourt, Giles, Montgomery and Roanoke Counties in Virginia and Monroe County in West Virginia.

Craig County's agencies operate different radio systems, which include hybrid low-band VHF and UHF analog radio systems. The goal of this project is to design an upgraded radio system which will allow for seamless interoperability for the County's Sheriff, Fire and Rescue, and EMS Departments, Public Safety Dispatch Center and Craig County Schools, with considerations to improve interoperability with agencies in the surrounding counties.

CTA's assessment of the radio system addresses existing coverage and communication problems and provides options and considerations for system alternatives, details the benefits of each, with cost estimates and other considerations for the County's public safety radio communications systems.

CTA interviewed Craig's Emergency Management Services (EMS), Volunteer Rescue Squad, Sheriff's Office, Dispatch Center, County Fire, five Volunteer Fire Departments and the County School Board. CTA surveyed the radio system sites at Potts Mountain, Craig County Emergency Operations Center, Craig County Sheriff's Office and Dispatch Center, and Simmonsville Volunteer Fire Department. CTA also reviewed information on the Sinking Creek site. We use all information gathered to evaluate the existing systems, determine future operational and technical requirements, and develop viable approaches to upgrade or replace the existing radio system.

Assessment

Craig County agencies provide public safety services throughout the County. Craig County agencies primarily use the radio system to communicate with Dispatch, however they also communicate with:

- County Animal Control
- Giles County
- Alleghany County
- Montgomery County
- Monroe County, WV
- Roanoke County and Botetourt County VFD
- Newport Volunteer Fire and Rescue
- National Forest Service
- Virginia State Police (VSP)
- Department of Wildlife Resources (DWR)

There are three different radio systems operating in Craig County:

- Craig County Sheriff's System - hybrid talk-out Low-Band VHF and talk-in UHF system
- Craig County Fire and Rescue System - two channel UHF radio system
- Simmonsville Volunteer Fire and Rescue System - one channel UHF repeater system

All of the Craig County agencies (Rescue, EMS, Sheriff, Dispatch, and Volunteer Fire Departments) share many of the same concerns about the current radio system including:

- Equipment is aging and at the end of their useful life to safely provide communications for the County.
- Interference
- Channel Crowding with Dispatch
- Coverage is lacking or weak in geographic areas. Coverage problems with talk-in from users in the field. Dispatch is unable to hear users. Talk-in coverage is problematic inside buildings and schools. Coverage for pagers is limited throughout the County.
- Many users, especially on the Fire and Rescue system, must often rely on their cell phones for communication.

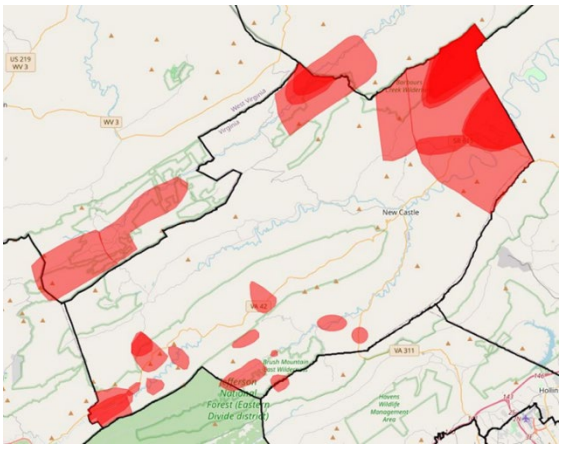

Figure ES-1: Coverage Problem Areas

CTA asked radio system users to identify coverage problem areas on a large map of the County. CTA digitally recreated the map showing the coverage problem areas as shown in Figure ES-1.

The north end of the County has been designated as having poor coverage, while the southeast part of the County has spotty coverage, with the differing terrain being a major factor. The map above was recreated to show where users reported coverage issues on the County's current radio system. Areas of darker red shading indicate that multiple user agencies described coverage issues in those areas.

System Alternatives

CTA identified potential alternatives that will allow the County to implement a unified radio system. Below are the alternatives evaluated for a County-wide public safety grade radio system that will provide reliable communications for Craig County:

- Do Nothing
- Upgrade Existing Radio Systems
- UHF DMR Radio System
- UHF Conventional Analog Radio System
- UHF Hybrid Analog/P25 Conventional Radio System
- UHF P25 Conventional Radio System
- 700/800 MHz P25 Phase 2 Trunked Simulcast Radio System
- Join a Neighboring P25 Trunked Radio System
- Join Virginia State Police VHF STARS System

CTA used the following overarching system considerations when developing our System Alternatives: ***coverage, capacity, and interoperability***. The ability of a public safety communications system to meet the requirements of the users will rely heavily upon meeting these system considerations.

Coverage:

Based upon preliminary coverage estimations: 3 sites may provide public safety grade (95%) mobile coverage for the Craig County service area in the VHF band, 4-5 sites may provide public safety grade (95%) portable outdoor coverage for the Craig County service area in the UHF band; and 6 sites may provide public safety grade (95%) portable outdoor coverage for the Craig County service area in the 700/800 MHz band.

Capacity – the number of channels necessary to meet your needs:

Based upon preliminary capacity estimations, a conventional analog simulcast system may require 4 channels, with several added channels for tactical operations; a trunked DMR system will need 3 channels for each of the 4-5 sites, requiring a total of 12-15 channels; and a P25 Phase 1 Conventional or P25 Phase 2 Trunked Simulcast system will require 4 channels.

Interoperability:

Interoperability for the local jurisdictions operating around Craig County is critically important and must be considered as we look at potential system alternatives. CTA developed an interoperability chart as part of the interview process, which clearly shows the need for law enforcement, fire, and EMS to be able to communicate directly with each other in emergency situations. It also reflects the need for users to communicate with other agencies outside of the local jurisdictions, and the ability to use dedicated channels to communicate directly with each other without overloading the primary dispatch channels. The interoperability chart is included in Section 4 of the report.

Based upon our analyses and these considerations, we evaluated the viability of each potential alternative:

- ***Do Nothing Alternative***
  Craig County may consider staying the course and continue to communicate using the existing radio systems when they are operational. Under this course of action, significant costs will be incurred just to maintain today's communications with no improvements. Coverage will continue to be severely inadequate. Capacity will continue to be limited. Interoperability will remain fragmented both within and outside of Craig County. Overall communications will not improve, and Craig County will be no closer to its goal of safe and reliable communications for its public safety users.

- ***Upgrade Existing Radio Systems***
  Craig County can upgrade their existing radio systems, keeping the same general technical system configuration used today. This alternative keeps the County's public safety agencies on different frequency bands, as they are configured today. Upgrading the existing radio systems will require replacement of equipment which will not be supported by the vendor past 2021. Additional coverage is needed to provide reliable communications County-wide for mobile and portable radios. If Craig County decides to upgrade their existing radio systems, there will be very few operational changes, and the overall functionality of the radio systems will not be improved.

- ***UHF DMR Radio System***
  A new UHF DMR Radio System can provide mobile and portable outdoor coverage for reliable public safety communications in Craig County. Implementing a DMR radio system will have many obstacles to overcome, not the least of which is the difficulty in achieving the desired level of interoperability with neighboring

jurisdictions. This alternative also does not provide Craig County a ***sustainable*** public safety grade system that will provide reliable mission critical communications for the next 15-20 years.

- ***UHF Hybrid Analog/P25 Conventional Radio System***
  Craig County can replace their existing systems with a new UHF Hybrid Analog/P25 Phase 1 Trunked Simulcast Radio System, which may improve radio communications for all users in Craig County. This alternative allows the Sheriff's Office to add newer features such as encryption and mobile data. This will also allow the Fire and Rescue agencies to purchase cheaper subscriber units, because they will only operate in analog mode. Implementing a UHF Hybrid Analog/ P25 Conventional Radio System will provide some improvement for users in Craig County. However, interoperability and operability will be challenging due to Craig County Fire and Rescue, and Sheriff's Office operating on a different radio mode (analog vs digital).

- ***UHF Simulcast P25 Conventional Radio System***
  The P25 standards facilitate interoperability by allowing any P25 certified radio subscriber to operate on any P25 Conventional system infrastructure regardless of the system vendor. This system alternative will allow Craig County to have dedicated channels for specific groups and users, and the user manually selects the channels they will use. If Craig County procures a UHF P25 Phase 1 Conventional Simulcast Radio System, interoperability will be seamless with Alleghany County. Interoperability will improve with Montgomery and Botetourt Counties, if they decide to implement UHF P25 Conventional systems. Implementing a UHF Simulcast P25 Conventional Radio System will provide the needed public safety grade coverage and provide capacity for all users in Craig County that desire to participate in the system.

- ***700/800 MHz P25 Phase 2 Trunked Radio System***
  The P25 standards facilitate interoperability by allowing any P25 certified radio subscriber to operate on any P25 system infrastructure regardless of the system vendor. This system alternative will allow Craig County to significantly increase capacity using the same number of frequency pairs as a P25 Conventional or Phase 1 Trunked system. Implementing a 700/800 MHz P25 Phase 2 Trunked Simulcast Radio System will provide the needed public safety grade coverage and capacity for users in Craig County that desire to participate in the system. However, interoperability will be challenging due to Craig County operating on a different frequency band than the surrounding agencies they interoperate with.

- ***Join a Neighboring County's P25 Trunked Radio System***
  Craig County could potentially use one of the neighboring jurisdiction's tower sites if the location is close to the border of both Counties. This could provide useful coverage for Craig County without requiring new tower sites to be constructed, and it could also extend Craig County's coverage into a neighboring jurisdiction for use during mutual aid events. Craig County will be required to sign a Memorandum of understanding (MOU) with the neighboring jurisdiction they are connecting to and pay a percentage of the maintenance costs for any shared equipment. This alternative will require a good working relationship with the neighboring jurisdiction(s) Craig County will join. However, the governance and level of control Craig County has over the radio system could be a challenging factor for joining a neighboring radio system.

- ***Join Virginia State Police STARS VHF P25 Trunked Radio System***
  The Commonwealth of Virginia's Statewide Agencies Radio System (STARS) is a P25 Phase 1, multi-site VHF radio system designed for mobile only radio coverage for the entire state of Virginia. If using the STARS network, a DVR is required on all law enforcement vehicles, ambulances, and fire apparatus. The DVR will add significant costs; however, it will provide the needed coverage and interoperability with surrounding

700/800 MHz systems. This alternative will have many obstacles to overcome, not the least of which could be the difficulty in obtaining the necessary VHF frequencies and the requirement to purchase only the prescribed subscriber units/ DVRs currently operating on STARS, which can be cost prohibitive for a locality.

CTA uses an impact analysis process to help evaluate the system alternatives in combination with of all the information gathered during this needs assessment. The results help narrow down the alternative(s) that best fit your needs by reflecting how well each alternative meets the needs and requirements of Craig County's users. Part of this process is evaluating the rough order of magnitude (ROM) costs for each alternative.

Table ES-1 provides the results of the alternatives analysis, summarized below:

ALTERNATIVES SUMMARY									
	Do Nothing	Upgrade Existing Radio System	UHF DMR Radio System	UHF Conventional Analog System	UHF Hybrid Analog P25 Conventional System	UHF P25 Conventional System	700/800 P25 Phase 2 Trunked System	Joining a neighboring P25 Trunked System	Join VSP VHF STARS System
System Functionality/ System Reliability	Not Public Safety Grade	Not Public Safety Grade	Not Public Safety Grade	Not Public Safety Grade	Public Safety Grade	Public Safety P25	Public Safety P25	Public Safety P25	Public Safety P25
Coverage / Sites	Existing Coverage 3 sites	Existing Coverage 3 sites	Improved Mobile/Portable Coverage 4-5 Sites	Improved Mobile/Portable Coverage 4-5 Sites	Improved Mobile/Portable Coverage 4-5 Sites	Improved Mobile/Portable Coverage 4-5 Sites	Improved Mobile/Portable Coverage 6 Sites	Improved Mobile/Portable Coverage 4-5 Sites UHF) or 6 Sites (700/800)	Improved Mobile Coverage using existing STARS Sites
Capacity / Channels	3 Channels	3 Channels	12-15 Channels	4 Channels	4 Channels	4 Channels	4 Channels	4 Channels	4 Channels
Operability	Separate Systems/Frequency Bands	Separate Systems/Frequency Bands	One System/Frequency Band	One System/Frequency Band	Separate Systems / Same Frequency Band	One System/Frequency Band	One System/Frequency Band	One System/Frequency Band	One System/Frequency Band
Interoperability	**Gateways / Manual Patch** Alleghany, Botetourt, Roanoke, Montgomery, Giles, Monroe	**Gateways / Manual Patch** Alleghany, Botetourt, Roanoke, Montgomery, Giles, Monroe	**Gateways / Manual Patch** Alleghany, Botetourt, Roanoke, Montgomery, Giles, Monroe	**Gateways / Manual Patch** Alleghany, Botetourt, Roanoke, Montgomery, Giles, Monroe	**Seamless for Sheriff's Office** Any user on Neighboring System or P25 Capable in the same frequency band	**Seamless** P25 Capable in the same frequency band **Gateways / Manual Patch** Non-P25 surrounding	**Seamless** Roanoke **Gateways / Manual Patch** Alleghany, Botetourt, Montgomery, Giles, Monroe	**Seamless** Any user on Neighboring System or P25 Capable in the same frequency band **Gateways / Manual Patch** Non-P25 surrounding	**Seamless** VSP **Gateways / Manual Patch** Alleghany, Botetourt, Roanoke, Montgomery, Giles, Monroe
Costs		$2,000,000 - $2,300,000	$3,000,000 - $3,500,000	$3,500,000 - $4,000,000	$4,250,000 - $4,750,000	$4,250,000 - $4,850,000	$6,500,000 - $7,000,000	$5,500,000 - $6,000,000	$3,500,000 - $4,000,000
Alternatives Score	104.43	171.86	376.57	334.00	357.29	394.71	373.00	355.00	392.21
Alternatives Ranking	9	8	3	7	5	1	4	6	2

Table ES-1 Alternative Summary

When comparing the results of each alternative, it is clear that the options related to remaining in the UHF Band are the highest ranked alternatives for Craig County. The overall highest ranked alternative is a ***UHF Simulcast P25 Conventional Radio System.***

This alternative stands out, primarily in the areas of:

- System Functionality / System Reliability
- Capacity / Frequency Availability
- Interoperability
- Costs

Upgrading the existing systems within Craig County will provide the needed public safety grade coverage, capacity, and interoperability for all current public safety and non-public safety radio users within the County for the next 15+ years. ***In CTA's opinion, a UHF Simulcast P25 Conventional Radio System is the BEST FIT for Craig County.***

Conceptual Design

The new system configuration will operate in the UHF public safety band and reuse some of the County's existing licensed frequencies. The design includes updates for important auxiliary systems, such as the existing paging system, consoles, and fixed control stations, and will provide adequate radio coverage for Craig County. This new

system will provide reliable public safety grade service for the next 15-20 years. This architecture may be procured turn-key, or via separate procurements using an open and competitive Request for Proposals (RFP) from a variety of system vendors.

This conceptual design addresses the following overarching technical concerns:

- Aging, support-limited radio system, subscriber units, and dispatch consoles
- Lack of capacity causing interference from users talking over each other
- Countywide coverage issues
- Portable outdoor coverage issues
- Portable in-building coverage issues

Figure ES-2 shows a diagram of the conceptual system design.

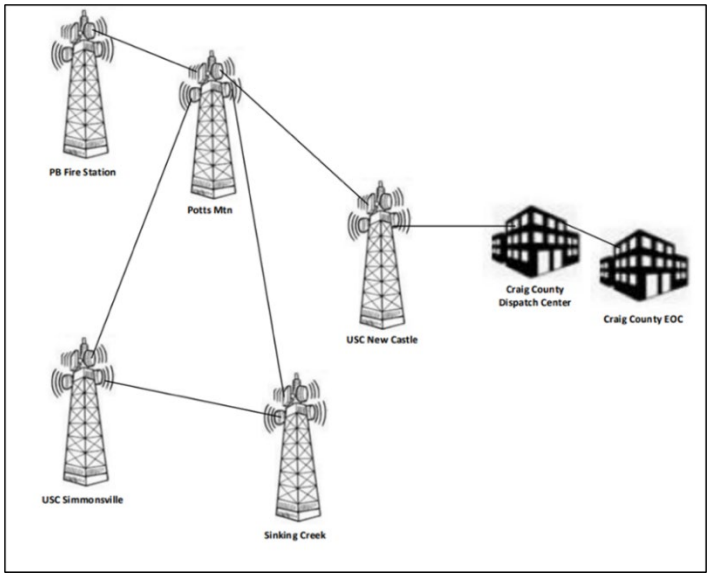

Figure ES-2 Conceptual Design Block Diagram

We performed an analysis of the potential coverage a UHF P25 conventional system could provide. Our goal is to evaluate the total coverage that can be delivered by using existing tower sites which are locality owned, existing state-owned sites, or existing commercial sites.

After analyzing the coverage advantages and disadvantages of various tower sites, we concluded that the base configuration that best meets the County's stakeholder needs is 4 RF sites in a P25 conventional simulcast site design. The 5th site shown in Figure ES-2 is for microwave only to connect all the radio sites. Figures ES-3 thru ES-5 illustrate the performance of this configuration at the two coverage levels needed by County agencies: mobile, and portable outdoor.

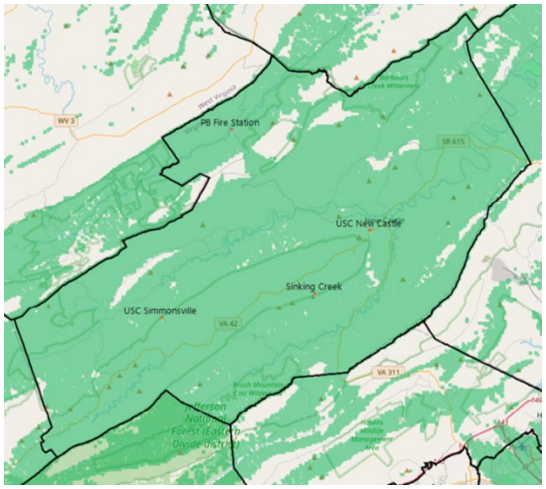

Figure ES-3 P25 Mobile Talk-out Conceptual Coverage

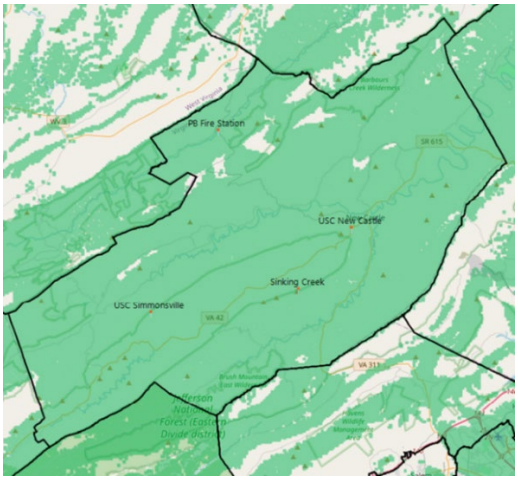

Figure ES-4 P25 Mobile Talk-in Conceptual Coverage

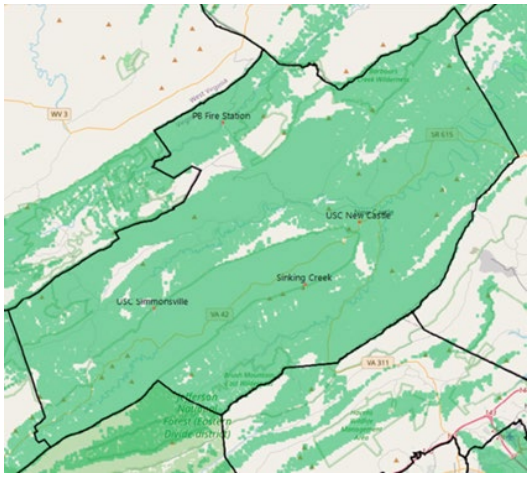

Figure ES-5 Portable Outdoors Balanced Conceptual Coverage

Utilizing a microwave network is a common way to ensure highly reliable radio system connectivity. To function reliably, the radio system requires a highly reliable telecommunications backbone to connect the radio system tower sites and the Craig County EOC to the Dispatch Center. Reliability is a function of equipment and path redundancy, as well as path dependability. This reliability is most often provided by a dedicated digital microwave system. For the Craig County radio system, there should be a public safety grade microwave network configured in a ring topology with Monitored Hot Stand-By (MHSB) equipment for all microwave spur links. A microwave ring topology provides redundancy and reroutes data traffic in the opposite direction around the ring in case of microwave equipment failure, or link outages.

The new UHF P25 conventional simulcast radio system will fundamentally operate similar to the radio systems currently in use. The major operational difference is the improved operability between different agencies in the County, the interoperability between Craig County and other neighboring systems operating UHF P25 conventional systems, and simulcast system operation.

This opinion of probable cost represents the conceptual system design, uses mostly existing sites and operates in the UHF frequency band. The system includes the radio infrastructure, any upgrades to the physical facilities, upgrades to the paging system, a microwave system, dispatch consoles, subscriber equipment, vendor services, consulting, and contingency funds.

Craig County, VA
UHF P25 Conventional Simulcast Radio System

Cost Elements	List Estimate	Negotiated Estimate	Competitive Estimate	MULTI-VENDOR ESTIMATE
RADIO INFRASTRUCTURE	$ 1,155,700	$ 1,155,700	$ 1,155,700	$ 1,155,700
COMMUNICATIONS CENTER	$ 334,500	$ 334,500	$ 334,500	$ 334,500
MICROWAVE SYSTEM	$ 604,900	$ 604,900	$ 604,900	$ 502,100
PHYSICAL FACILITIES	$ 1,443,800	$ 1,443,800	$ 1,443,800	$ 816,700
SUBSCRIBERS	$ 1,342,700	$ 1,033,900	$ 966,700	$ 939,900
VENDOR SERVICES	$ 707,800	$ 707,800	$ 707,800	$ 545,800
DISCOUNT	$ -	$ (867,000)	$ (1,300,400)	$ *(1,063,200)*
SPARES - SUBSCRIBERS	$ 25,600	$ 19,700	$ 18,400	$ 11,800
SPARES - FIXED NETWORK	$ 88,100	$ 88,100	$ 88,100	$ 66,100
CONSULTING	$ 225,000	$ 225,000	$ 225,000	$ 337,500
CONTINGENCY (5%)	$ 285,200	$ 226,100	$ 201,000	$ 165,500
RADIO SYSTEM TOTAL	***$ 6,213,300***	***$ 4,972,500***	***$ 4,445,500***	***$ 3,812,400***
MAINTENANCE (After 1 year warrenty)	$ 185,000	$ 185,000	$ 185,000	$ 138,800

Table ES-2 UHF P25 Phase 1 Conventional Simulcast Radio System

Recommendations

Now is the time for Craig County to upgrade your public safety communications to protect your public safety users. Your current systems have reached the end of their usable life and their ability to be supported. Spare parts are becoming scarce which will lead to potentially dangerous system issues.

Public Safety radio communications within the County are characterized by poor portable coverage in some areas, both in-buildings and outdoors, as well as aging equipment. These major deficiencies, plus other operational and technical concerns, currently inhibit public safety personnel from operating at full capacity and efficiency. Mutual aid between the surrounding Counties and Craig County routinely occurs, and without the ability to communicate with all public safety personnel in these jurisdictions, users will find themselves in potentially dangerous conditions.

The public safety personnel in the County have made valiant efforts to provide necessary services to your citizens using the communications resources made available to them. We believe the County recognizes the potential advantages of designing and implementing a Public Safety Radio System that will address the needs of the Sheriff's Office, Emergency Management, Fire, EMS, and Schools.

CTA recommends Craig County procure and install a UHF P25 Conventional Simulcast Radio System consisting of 4 RF sites, 5 MW sites, and 5 channels.

By doing so, the County will provide a public safety grade communications network for all users within Craig County. A well designed, implemented, and tested radio system will provide the public safety users in Craig County:

- *Simplified communications* – removing the dispatch communications relay barriers and differences in equipment and capabilities from agency to agency.

- *The ability to communicate as needed* – within the guidelines of organizational structure, users can push to talk with those they need to. Equipment is no longer a barrier, and with cooperative agreements, political boundaries are less of a barrier. The tools are in place for true interoperable communications.

- *Consistently dependable system* – uniform design, deployment, operation, and maintenance of the system means that robust equipment is designed for the task, placed where it is needed, and users can depend on reliable service every day.

Go Forward Plan of Action:

1. Initiate planning and budgeting for a new UHF P25 Conventional System.

2. Identify and submit grants to support the cost of the system.

3. Review and approve the upgraded radio communications conceptual design contained in this report. Work with CTA to complete any adjustments in preparation for specifications development.

4. Adopt Project 25 (P25) technology as the interoperability standard for Craig County. This will help maintain interoperability with some surrounding jurisdictions that have already migrated to P25 systems.

5. Prepare a set of functional specifications, scope of work, and terms and conditions in preparation for issuance of Request for Proposals. Construct the RFP package targeting a competitive multi-vendor procurement. We recommend the specifications allow the following to be examined and evaluated for each proposal:
   - Overall viability of the configuration
   - Communications throughput and performance, matched to consider present and future voice needs
   - Guaranteed (95%) coverage over the Craig County service area
   - Redundancy and Backup Failure Modes
   - Fifteen-year life cycle costs, including keeping the number of tower sites as low as possible, while retaining the requisite coverage – mobile, and portable outdoors and inside buildings
   - Degree to which the system requirements are addressed

6. License additional UHF frequencies and modify existing UHF licenses for use on the new P25 radio system, to ensure sufficient spectrum is under Craig County license to build the systems.

7. Implement a digital microwave network as a stand-alone, fault tolerant, dedicated emergency system to provide long-term cost savings and improved reliability.

8. Any new replacement subscriber radios, whose lifecycle is anticipated to span into new upgraded P25 infrastructure, should be P25 capable.

9. Retain CTA to provide implementation oversight for the following items:
   - Project Kickoff Meeting
   - System Design
   - Physical Facilities Site Upgrades
   - Detailed Design Review
   - Radio System Staging Test
   - Microwave System Staging Test
   - Radio System Installation
   - Microwave System Installation
   - Site Inspections
     - Physical Facilities Completion
     - Equipment Installation Completion
     - Final Acceptance
   - Field Acceptance Testing
     - Radio System Testing
     - Subscriber Radio Testing
     - Microwave Network Testing
     - Coverage Testing
   - Fleet Mapping Workshop
   - Training
     - Radio User Training
     - System Administrator TrainingConsole User Training
     - Maintenance Training
   - System Cutover
   - Final Documentation/ System As-builts Review

Final Acceptance