

STOKES COUNTY, NORTH CAROLINA

VHF SIMULCAST REPLACEMENT

DECEMBER 13 2019

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12/13/2019

Mr. Del Hall
Stokes County
Emergency Communications Director
1011 Main St.
Danbury, NC 27016

Subject: 3 Site VHF Paging Proposal

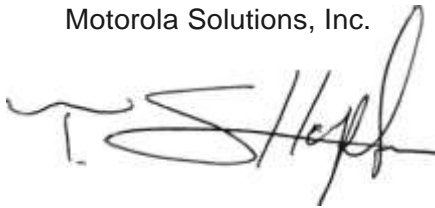
Dear Mr. Hall:

Motorola Solutions, Inc. ("Motorola Solutions") is pleased to have the opportunity to provide Stokes County with quality communications equipment and services. The Motorola Solutions project team has taken great care to propose a solution that will meet your needs for a 3 Site VHF Paging System utilizing equipment from North Carolina State Contract 725G.

We thank you for the opportunity to furnish Stokes County with "best in class" solutions and we hope to strengthen our relationship by implementing this project. Our goal is to provide you with the best products and services available in the communications industry.

Sincerely,

Motorola Solutions, Inc.

A handwritten signature in black ink, appearing to read "S. Hopkins", is written over a horizontal line.

Scott Hopkins
Area Sales Manager North Carolina

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SECTION 1

STATEMENT OF WORK

1.1 OVERVIEW

This Statement of Work (SOW) describes the deliverables to be furnished to Stokes County the tasks described herein will be performed by Motorola, its subcontractors, and Stokes County to implement the solution described in the System Description. It describes the actual work involved in installation, identifies the installation standards to be followed, and clarifies the responsibilities for both Motorola and the customer during the project implementation.

Specifically, this SOW provides:

- A list of the deliverables associated with the project.
- A description of the responsibilities for both Motorola and Customer.
- The qualifications and assumptions taken into consideration during the development of this project.

This SOW provides the most current understanding of the work required by both parties to ensure successful project implementations. It is understood that this SOW is a working document, and that it will be revised as needed to incorporate any changes associated with contract negotiations, Contract Design Review (CDR), and any other change orders that may occur during the execution of the project.

1.2 ASSUMPTIONS

Motorola has based the system design on information provided by Stokes County and an analysis of their system requirements. All assumptions have been listed below for review. Should Motorola's assumptions be deemed incorrect or not agreeable to Stokes County revised proposal with the necessary changes and adjusted costs may be required. Changes to the equipment or scope of the project after contract may require a change order

- All work is to be performed during normal work hours, Monday through Friday 8:00 a.m. to 5:00 p.m.
- Motorola is not responsible for interference caused or received by the Motorola-provided equipment except for interference that is directly caused by the Motorola-provided transmitter(s) to the Motorola-provided receiver(s). Should the Stokes County system experience interference, Motorola can be contracted to investigate the source and recommend solutions to mitigate the issue.
- Any modifications or upgrades required to the existing towers and shelters, to support the installation of the proposed equipment, will also be the responsibility of Stokes County.
- Each site will utilize the County's existing antennas, transmission lines and combiners/multicouplers or duplexers to support the operation of the proposed GTR 8000 radios at that site. The proposed design does not include the replacement of any of this hardware. If any of the existing hardware is found to be insufficient to support the operation of the proposed equipment, it will be the responsibility of the County to upgrade or replace the



components to a state that is capable of supporting the operation of the proposed radio equipment.

1.3 CONTRACT

1.3.1 Contract Award (Milestone)

- The Customer and Motorola execute the contract and both parties receive all the necessary documentation.

1.3.2 Contract Administration

Motorola (MCA) Responsibilities:

- Assign a Project Manager, as the single point of contact with authority to make project decisions.
- Assign resources necessary for project implementation.
- Set up the project in the Motorola information system.
- Schedule the project kickoff meeting with the Customer.

Customer Responsibilities:

- Assign a Project Manager, as the single point of contact responsible for Customer-signed approvals.
- Assign other resources necessary to ensure completion of project tasks for which the Customer is responsible.

Completion Criteria:

- Motorola internal processes are set up for project management.
- Both Motorola and the Customer assign all required resources.
- Project kickoff meeting is scheduled.

1.3.3 Project Kickoff

Motorola (MCA) Responsibilities:

- Conduct a project kickoff meeting during the CDR phase of the project.
- Ensure key project team participants attend the meeting.
- Introduce all project participants attending the meeting.
- Review the roles of the project participants to identify communication flows and decision-making authority between project participants.
- Review the overall project scope and objectives with the Customer.
- Review the resource and scheduling requirements with the Customer.
- Review the teams' interactions (Motorola/MCA and the Customer), meetings, reports, milestone acceptance, and the Customer's participation in particular phases.
- Discuss Cutover Plan

Customer Responsibilities:

- The Customer's key project team participants attend the meeting.
- Review Motorola/MCA and Customer responsibilities.

Completion Criteria:

- Project kickoff meeting completed.
- Meeting notes identify the next action items.

1.4 CONTRACT DESIGN REVIEW

1.4.1 Review Contract Design

Motorola (MCA) Responsibilities:

- Meet with the Customer project team.
- Review the operational requirements and the impact of those requirements on various equipment configurations.
- Establish a defined baseline for the system design and identify any special product requirements and their impact on system implementation.
- Review the System Design, Statement of Work and update the contract documents accordingly.
- Provide minimum acceptable performance specifications for microwave, fiber, or copper links. (the Customer is responsible for supplying links)
- Establish demarcation point (supplied by the Motorola/MCA system engineer) to define the connection point between the Motorola-supplied equipment and the Customer-supplied link(s) and external interfaces. (the Customer is responsible for supplying links)

Restrictions:

- Motorola/MCA assumes no liability or responsibility for inadequate frequency availability or frequency licensing issues.
- Motorola/MCA is not responsible for issues outside of its immediate control. Such issues include, but are not restricted to, improper frequency coordination by others and non-compliant operation of other radios.
- Motorola/MCA is not responsible for co-channel interference or adjacent channel interference due to errors in frequency coordination or any other unlisted frequencies, or the improper design, installation, or operation of systems installed or operated by others.
- If, for any reason, any of the proposed sites cannot be utilized due to reasons beyond Motorola/MCA's control, the costs associated with site changes or delays including, but not limited to, re-engineering, frequency re-licensing, site zoning, site permitting, schedule delays, site abnormalities, re-mobilization, etc., will be paid for by the Customer and documented through the change order process.

Customer Responsibilities:

- The Customer's key project team participants attend the meeting.
- Make timely decisions, according to the Project Schedule.
- Frequency Licensing and Interference:
 - As mandated by FCC, the Customer, as the licensee, has the ultimate responsibility for providing all required radio licensing or licensing modifications for the system prior to system staging.
 - Provide the FCC "call sign" station identifier for each site prior to system staging.

Completion Criteria:

- Complete Design Documentation, which may include updated System Description, Equipment List, system drawings, or other documents applicable to the project.
- Incorporate any deviations from the proposed system into the contract documents accordingly.
- The system design is “frozen” in preparation for subsequent project phases such as Order Processing and Manufacturing.
- A Change Order is executed in accordance with all material changes resulting from the Design Review to the contract.

1.4.2 Design Approval (Milestone)

- The Customer executes a Design Approval milestone document.

1.5 ORDER PROCESSING

1.5.1 Process Equipment List

Motorola Responsibilities:

- Validate Equipment List by checking for valid model numbers, versions, compatible options to main equipment, and delivery data.
- Enter order into Motorola's Customer Order Fulfillment (COF) system.
- Create Ship Views, to confirm with the Customer the secure storage location(s) to which the equipment will ship. Ship Views are the mailing labels that carry complete equipment shipping information, which direct the timing, method of shipment, and ship path for ultimate destination receipt.
- Create equipment orders.
- Reconcile the equipment list(s) to the Contract.
- Procure third-party equipment if applicable.

Customer Responsibilities:

- Approve shipping location(s).
- Provide additional storage location if needed.

Completion Criteria:

- Verify that the Equipment List contains the correct model numbers, version, options, and delivery data.
- Trial validation completed.
- Bridge the equipment order to the manufacturing facility.

1.6 MANUFACTURING AND STAGING

1.6.1 Manufacture Motorola Fixed Network Equipment

Motorola Responsibilities:

- Manufacture the Fixed Network Equipment (FNE) necessary for the system based on equipment order.

Customer Responsibilities:

- None.

Completion Criteria:

- FNE shipped the staging facility.

1.6.2 Manufacture Motorola Subscribers (No Subscribers)

Motorola Responsibilities:

Customer Responsibilities:

- None.

Completion Criteria:

- None

1.6.3 Manufacture Non-Motorola Equipment

Motorola Responsibilities:

- Procure non-Motorola equipment necessary for the system based on equipment order.

Customer Responsibilities:

- None.

Completion Criteria:

- Ship non-Motorola manufactured equipment to the staging facility.

1.6.4 Ship to Staging (Milestone)

- Ship all equipment needed for staging to Motorola's factory staging facility Customer Center for Solutions Integration (CCSi).

1.6.5 Stage System

Motorola Responsibilities:

- Set up and rack the system equipment on a site-by-site basis, as it will be configured in the field at each of the transmitter/receiver sites.
- Cut and label cables according to the approved CDR documentation.

- Label the cables with to/from information to specify interconnection for field installation and future servicing needs.
- Complete the cabling/connecting of the subsystems to each other (“connectorization” of the subsystems).
- Assemble required subsystems to assure system functionality.
- Power up, program, and test all staged equipment.
- Confirm system configuration and software compatibility to the existing system.
- Load application parameters on all equipment according to input from Systems Engineering.
- Complete programming of the Fixed Network Equipment.
- Inventory the equipment with serial numbers and installation references.
- Complete system documentation.

Customer Responsibilities:

- Provide information on existing system interfaces as may be required.
- Provide information on room layouts or other information necessary for the assembly to meet field conditions.

Completion Criteria:

- System staging completed and ready for shipping.

1.6.6 Ship Equipment to Field

Motorola Responsibilities:

- Pack system for shipment to final destination.
- Arrange for shipment to the field.

Customer Responsibilities:

- None.

Completion Criteria:

- Equipment ready for shipment to the field. The equipment should be shipped to: **4400-A Indiana Ave , Winston-Salem, North Carolina, 27105**

1.6.7 CCSi Ship Acceptance (Milestone)

- All equipment shipped to the field.

1.7 CIVIL WORK

- Using all existing tower and shelters currently in place.

1.8 SYSTEM INSTALLATION

1.8.1 Install Fixed Network Equipment

Motorola (MCA) Responsibilities:

- Motorola will be responsible for the installation of all fixed equipment contained in the equipment list and outlined in the System Description the site is ready for installation. All equipment will be properly secured to the floor and installed in a neat and professional manner, employing a standard of workmanship consistent with its own R-56 installation standards and in compliance with applicable National Electrical Code (NEC), EIA, Federal Aviation Administration (FAA) and FCC standards. (Note: R56 Standards as much as existing site condition will allow.)
- For installation of the fixed equipment at the various sites, Motorola/MCA will furnish all cables for power, audio, control, and radio transmission to connect the Motorola /MCA supplied equipment to the power panels or receptacles and the audio/control line connection point.
- Receive and inventory all equipment.
- Bond the supplied equipment to the existing site ground system in accordance with Motorola's R56 standards or as close as existing site conditions allows.

Customer Responsibilities:

- Provide secure storage for the Motorola/MCA-provided equipment, at a location central to the sites.
- Motorola/MCA coordinates the receipt of the equipment with the Customer's designated contact, and inventory all equipment.
- Dispose of existing equipment that has been removed that is not being relocated
- Provide access to the sites, as necessary.

Completion Criteria:

- Fixed Network Equipment installation completed and ready for optimization.

1.8.2 Fixed Network Equipment Installation Complete

- All fixed network equipment installed.

1.8.3 Console Installation

- Customer's existing MCC5500 will be used.
- Connection from prime site to console will be wireless using existing xpr8400 control stations currently interfaced to console.

Motorola (MCA) Responsibilities:

- None.

Customer Responsibilities:

- None

Assumption

- None

Completion Criteria:

- None

1.8.4 Microwave Installation

Utilize customers existing microwave links for transport.

Motorola (MCA) Responsibilities:

- None.

Customer Responsibilities:

- None

Assumption

- None

Completion Criteria:

- None

1.8.5 System Installation Acceptance (Milestone)

- All equipment installations are completed.

1.9 SYSTEM OPTIMIZATION

1.9.1 Optimize System FNE

Motorola (MCA) Responsibilities:

- Motorola and its subcontractors optimize the new simulcast system.
- Verify that all equipment is operating properly and that all electrical and signal levels are set accurately.
- Verify that all audio and data levels are at factory settings.
- Check forward and reflected power for all radio equipment, after connection to the antenna systems, to verify that power is within tolerances.
- Check audio and data levels to verify factory settings.
- Verify communication interfaces between devices for proper operation.
- Test features and functionality are in accordance with manufacturers' specifications and that they comply with the final configuration.

Customer Responsibilities:

- Provide access/escort to the sites.

Completion Criteria:

- System FNE optimization is complete.

1.9.2 Link Verification

Motorola (MCA) Responsibilities:

- Perform test to verify site link performance, prior to the interconnection of the Motorola-supplied equipment to the link equipment.

Customer Responsibilities:

- Make available the required links which meet the specifications supplied by Motorola/MCA at the CDR.

1.9.3 Completion Criteria:

- Link verification successfully completed.

1.9.4 Optimization Complete

- System optimization is completed. Motorola and the Customer agree that the equipment is ready for acceptance testing.

1.10 TRAINING

1.10.1 Perform Training

- No Training Included at this time.

Motorola (MCA) Responsibilities:

- None

Customer Responsibilities:

- None

Completion Criteria:

- None

1.11 ACCEPTANCE TESTING

1.11.1 Perform Functional Testing

Motorola (MCA) Responsibilities:

- Verify the operational functionality and features of the individual subsystems and the system supplied by Motorola, as contracted.
- If any major task as contractually described fails, repeat that particular task after Motorola determines that corrective action has been taken.
- Document all issues that arise during the acceptance tests.
- Document the results of the acceptance tests and present to the Customer for review.
- Resolve any minor task failures before Final System Acceptance.

Customer Responsibilities:

- Witness the functional testing.

Completion Criteria:

- Successful completion of the functional testing.
- Customer approval of the functional testing.(System Acceptance Warranty begins)

1.11.2 **Perform Coverage Testing**

No Coverage Testing Guarantee.

Motorola (MCA) Responsibilities:

- None

Customer Responsibilities:

- None

Completion Criteria:

- None

1.11.3 **System Acceptance Test Procedures (Milestone)**

- Customer approves the completion of all the required tests.

1.12 **FINALIZE**

1.12.1 **Resolve Punchlist**

Motorola (MCA) Responsibilities:

- Work with the Customer to resolve punchlist items associated with this project, documented during the Functional Testing, in order to meet all the criteria for final system acceptance.

Customer Responsibilities:

- Assist Motorola with resolution of identified punchlist items for this project by providing support, such as access to the sites, equipment and system, and approval of the resolved punchlist item(s).

Completion Criteria:

- All punchlist items resolved and approved by the Customer.

1.12.2 **Transition to Service/Project Transition Certificate**

Motorola (MCA) Responsibilities:

- Review the items necessary for transitioning the project to warranty support and service.

- Provide a Customer Support Plan detailing the warranty and post-warranty support, if applicable, associated with the Contract equipment.

Customer Responsibilities:

- Participate in the Transition Service/Project Transition Certificate (PTC) process.

Completion Criteria:

- All service information has been delivered and approved by the Customer.

1.12.3 Finalize Documentation

Motorola (MCA) Responsibilities:

- Equipment Inventory List

Customer Responsibilities:

- Receive and approve all documentation provided by Motorola (MCA).

Completion Criteria:

- All required documentation is provided and approved by the Customer.

1.12.4 Final Acceptance (Milestone)

- All deliverables completed, as contractually required.
- Final System Acceptance received from the Customer.

1.13 PROJECT ADMINISTRATION

1.13.1 Project Status Meetings

Motorola (MCA) Responsibilities:

- MCA Project Manager, or designee, will attend all project status meetings with the Customer, as determined during the CDR.
- Record the meeting minutes and supply the report.
- The agenda will include the following:

Customer Responsibilities:

- Attend meetings.
- Respond to issues in a timely manner.

Completion Criteria:

- Completion of the meetings and submission of meeting minutes.

1.13.2 Progress Milestone Submittal

Motorola (MCA) Responsibilities:

- Submit progress (non-payment) milestone completion certificate/documentation.

Customer Responsibilities:

- Approve milestone, which will signify confirmation of completion of the work associated with the scheduled task.

Completion Criteria:

- The Customer approval of the Milestone Completion document(s).

1.13.3 Change Order Process

- Either Party may request changes within the general scope of this Agreement. If a requested change causes an increase or decrease in the cost, change in system configuration or adds time to the project's timeline required to perform this Agreement, the Parties will agree to an equitable adjustment of the Contract Price, Performance Schedule, or both, and will reflect the adjustment in a change order. Neither Party is obligated to perform requested changes unless both Parties execute a written change order.

SYSTEM DESCRIPTION

2.1 INTRODUCTION

At Stokes County's (the County) request, Motorola Solutions, Inc. (Motorola) is pleased to provide the following proposal for a radio equipment refresh of the County's three site, single channel VHF paging system. This will provide the County with a replacement of their existing simulcast radio equipment with something that is current and within support. The proposed equipment refresh will consist of a replacement of the County's existing VHF radios and simulcast equipment (comparators, GPS timing and site LAN/WAN devices with Motorola equipment. The County's existing equipment shelters, towers, antennas and transmission lines, dispatch consoles and microwave transport equipment will continue to be utilized in the system and will not be replaced.

2.2 DESIGN OVERVIEW

The proposed radio equipment refresh will provide Stokes County with an IP-based, 3-site, single channel VHF analog conventional simulcast radio system. The design includes simulcast transmit and voted receive from the Booth Mountain, Sandy Ridge and Sauratown sites, which will be connected back to the County's radio dispatch center and will be interfaced with the existing MCC 5500 radio dispatch consoles over the air through a control station. The radio sites will be connected back to the prime site at Booth Mountain over the County's existing Ethernet based microwave links between the sites.

The radio equipment at these sites will be installed within existing shelters and transmitters and receivers at each site will be interfaced to the existing antennas, lines and RFDS hardware at each site. The County will be responsible for providing space within the shelters for the installation of the proposed equipment, as well as for providing the electrical power (both primary and backup power), adequate grounding, and HVAC requirements of the proposed equipment. Any modifications or upgrades required to the existing towers and shelters, to support the installation of the proposed equipment, will also be the responsibility of Stokes County.

2.3 SYSTEM DESIGN

Motorola is the recognized industry leader in analog simulcast infrastructure solutions. For the past 20 years, Motorola's circuit based solution employed a GPS synchronized channel bank and audio distribution equipment to deliver optimal audio quality in the "overlap" zones within a simulcast coverage area. The audio voting was provided by our Spectra-TAC and DIGITAC comparator products, and the precise transmit audio synchronization was provided by a Motorola designed DSM channel bank card.

Given the cost savings of IP technology compared to circuit leased lines, the MLC 8000 analog gateway will exclusively support IP connectivity for analog simulcast systems. The MLC 8000's IP analog simulcast configuration greatly simplifies the audio distribution and synchronization technology formerly provided by circuit based solutions. The MLC 8000 is equipped with a 5MHz/1PPS combined frequency/timing reference interface to achieve the precise audio timing required by analog simulcast.

2.3.1 Architecture

Direct radio frequency (RF) communication – relying solely on the transmitter output power of a portable or mobile radio – is not always enough to successfully network a fleet of field radios throughout a system coverage area. When coverage is required over a large area or in a building, an infrastructure must be added to complete the network.

Conventional systems vary in both size and sophistication. Systems are often configured as single-site or multi-site depending on the coverage or "talk range" that is desired. A basic conventional system consists of a GTR 8000 repeater or base station. The system can be expanded to increase system wide coverage by adding equipment to make it a simulcast system.

2.3.1.1 Multi-Site

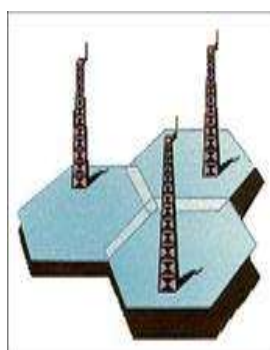


Figure 2-1: A multi-site system coverage footprint

When a single site transmitter does not provide the coverage needed in a conventional system, a multi-site solution is the answer. A multi-site system contains multiple sites throughout the user's service area, extending radio coverage beyond that of a single-site system.

The basic multi-site configuration is simply standalone base stations or repeaters located at different sites throughout the user's coverage area, shown in Figure 2-1. As users move through the expanded coverage area of a standalone configuration, they need to know the coverage footprint of each station, and manually select their channel. In a standalone configuration, only the receiving base station retransmits the signal. Thus, only the subscribers listening to this channel will hear the communication.

Standalone multi-site works well in systems where specific user groups have specific coverage areas, and do not typically roam throughout the system.

Different system designs and methods such as voting, simulcast, and multi-cast can be applied to the multi-site system to extend radio range and ease subscriber radio operations.

Voting

Receiver voting system topologies are used when a single transmitter provides sufficient outbound coverage, but a single receiver does not provide sufficient inbound coverage for subscriber transmissions. To provide balanced coverage, multiple satellite receivers are added to cover "dead spots" created by buildings, foliage, valleys, or hills.

Since the receivers operate on the same frequency, it is possible that a field radio may simultaneously hit multiple sites when transmitting. To ensure that the best audio from these satellite receivers is processed, a voting comparator compares and selects the best signal. This signal is then forwarded to the transmitter for rebroadcast to the subscriber units, as well as the console for dispatcher monitoring.

Simulcast

When a wide geographical area requires communications throughout the system, a simulcast solution may be implemented. Simulcast is the simultaneous broadcast of the

same voice or message from multiple transmitter sites on the same frequency. Simulcast was developed by Motorola to meet the needs of users who were outgrowing their single-site radio systems. These systems provide consistent communications throughout a large city, metropolitan area, county, or even country.

Simulcast systems are a frequency efficient and user-friendly technique of providing wide-area coverage. Simulcast offers the following advantages:

- **Larger Coverage Area** – One radio site may not provide the coverage necessary for the application in question. Simulcast expands the coverage area by expanding the number of radio sites and delivering continuous coverage throughout a large geographic area.
- **Efficient Use of Frequencies** — Adding sites typically requires more frequencies. In a simulcast system, the same frequencies are reused at every site in the system. This makes very efficient use of the available spectrum.
- **Simple Radio Operation** — Field units must be easy to use. Unlike multi-site configurations where users must manually select their channel, the simulcast architecture operates like a single-site system. The subscribers seamlessly roam throughout the coverage area simplifying operations.

2.3.2 Mode

Analog voice is the basis of the conventional system proposed for Stokes County. The base system will consist of Booth, Sandy Ridge, and Sauratown. The transmit sites will simultaneously broadcast on the same frequency and the receive sites will be voted for the best audio, which will enhance the coverage throughout the County.

2.3.3 System Overview

The analog simulcast system is comprised of a simulcast prime site and remote simulcast RF sites. The prime site is the location of the comparators which are used to vote the best received audio from each site for retransmission. Additionally, the prime site aggregates all of the RF remote site links.

2.3.3.1 Simulcast Prime Site

The prime site will be located at the Booth Mountain site. The equipment will be located within the equipment shelter at that location. Space for the equipment, along with capacity for it on the building generator and HVAC will be supplied by Stokes County. The County will be responsible for providing space, power (primary and backup), HVAC and adequate grounding for the equipment installed at this location. Any modifications or upgrades required to the building, to support the installation of this equipment, will also be the responsibility of Stokes County. The major equipment, which will be located at this site is:

- One (1) MLC 8000 analog comparator
- One (1) Prime Site LAN Switch
- One (1) Prime Site Gateway
- One (1) TRAK 8835 Frequency Standard
- One (1) 7.5' equipment rack

2.3.3.2 TX/RX Sites (Base Design)

The Booth, Sandy Ridge and Sauratown sites are remote RF sub-sites. The equipment at each of these sites will be located within the existing buildings and on the existing towers at those locations. The County will be responsible for providing space within the shelters and on the towers for the installation of the proposed equipment, as well as for providing the electrical power (both primary and backup power), adequate grounding, and HVAC requirements of the proposed equipment. Any modifications or upgrades required to the existing towers and shelters, to support the installation of the proposed equipment, will also be the responsibility of Stokes County. The major equipment, which will be located at each of these sites is:

- One (1) GTR 8000 station with analog conventional software
- One (1) MLC 8000 analog gateway
- One (1) Site LAN Switch
- One (1) Site Gateway
- One (1) TRAK 8835 Frequency Standard
- One (1) 7.5' equipment rack

2.4 CONVENTIONAL SYSTEM COMPONENTS

The analog conventional radio system designed for Stokes County consists of the following major components:

- GTR 8000 Base Station/Repeater
- MLC8000 Voter/Comparator
- Frequency Standard

This section of the system description contains descriptions of these components.

2.4.1 GTR 8000

The Motorola GTR 8000 Base Radio is designed to meet Stokes County's current and future requirements for both analog and Project 25 solutions. The GTR 8000 Base Radio transmits using configurable Compatible 4-level Frequency Modulation (C4FM) or Linear Simulcast Modulation (LSM) and receives Compatible 4-level Frequency Modulation (C4FM) for traffic channel communications. The GTR 8000 Base/Repeater station is designed to maximize channel up-time, simplify system migrations, and enable smaller, more efficient site design while minimizing the cost of ownership to the customer. GTR 8000 stations are designed so that upgrades, migrations and conversions can be completed with only software installations. Information Assurance/Network Security updates, migrations to new system releases, and system migrations from analog to digital, conventional to trunking, and from 25 kHz Analog to 6.25 kHz TDMA Digital can be completed with a software download.

The GTR 8000 is shown in Figure 2-2.



Figure 2-2: G Series Equipment

Motorola is the industry leader in simulcast system solutions with more mission critical systems fielded and fully operational than any other LMR vendor systems provider. The GTR 8000 Base Radios feature a linear simulcast modulation (LSM) that provides industry leading P25 compliant coverage in 700/800 MHz, UHF & VHF.

The conventional GTR 8000 Base Radio hardware consists of four major Field Replacement Units (FRUs): the transceiver, the power amplifier, the power supply and the fan module. When the GTR 8000 is used in a simulcast topology an external time reference is used to generate the signal for launch time determination. The time reference signal is obtained from the external frequency reference or a separate time reference input obtained from a device such as the TRAK 8835.

G-series site equipment products are very flexible and designed to support today's robust site designs. G-series site equipment products provide the flexibility to upgrade to future functionality through software downloads.

The GTR 8000 Base Radio includes features such as:

- Multisite Linear Simulcast offers industry-leading radio coverage with fewer sites
- IP based simulcast operation
- Compact and integrated hardware utilizing 3 rack unit chassis enables efficient use of site space
- Software Defined Radio allows for upgrades to future functionality through software update
- Modular software design coupled with the Software Download Manager simplifies future upgrades and routine servicing
- Functionally separate modules - Field Replacement Units (FRU) - are hot-swappable allowing servicing and replacement without system down-time while minimizing channel down-time
- Designed for ease of service including significantly reduced alignment servicing
- No initial field alignment or servicing required for Multisite (simulcast) systems

2.4.2 MLC 8000

The MLC 8000 is a versatile, powerful and compact hardware platform that can be configured as either an analog comparator or an analog simulcast station gateway.

2.4.2.1 Simulcast Solution

The MLC 8000 analog simulcast solution provides a tone remote control (TRC) analog comparator that supports IP site links to its associated base station and receiver sub-sites.

2.4.2.2 Voting Solution

The MLC 8000 voting solution provides a tone remote control (TRC) analog comparator that can support any combination of circuit and IP site links to its associated base station and receiver sub-sites. This is an enormous value proposition for customers who want to avoid the risks associated with “knife-switch” network transport upgrades, and minimize their installation and equipment costs. The MLC 8000 provides turn-key integrated voice over IP networking capability with a direct 4-wire 600 Ohm wire-line interface to existing base station and receiver equipment.

The MLC 8000 uses a Motorola enhanced G.711 voice codec technology to provide transparent operation for several analog signaling standards including MDC1200 and DTMF. The G.711 voice codec was selected because it employs the same pulse code modulation audio sampling techniques used in most circuit and leased line equipment today. The Motorola designed audio sampling hardware and digital signal processing provide superior audio fidelity and low latency, minimizing the impact to the audio quality experienced by the subscribers and console operator positions.

Each MLC 8000 is equipped with the following interfaces:

- 4 V.24 ports
- 4 600 Ohm 4-wire analog ports
- A PoE Ethernet port
- An auxiliary Ethernet port
- A GPS frequency/timing reference input

The MLC 8000 offers standard status tone and TRC signaling capabilities on each of its four analog interfaces. The MLC 8000 supports voting and simulcast system configurations, and is certified to be fully compatible with GTR 8000 and several of Motorola’s other analog base station and receiver products, including QUANTAR, ASTRO-TAC Receiver, and MTR2000.

2.4.3 GPS/Frequency Standard

The TRAK 8835, used to synchronize the simulcast system, is a Global Positioning Satellite (GPS)-based frequency and time reference unit. Its purpose is to provide a stable and accurate network time.

The TRAK 8835 provides:

- 1 pulse-per-second (pps) signal to the MLC 8000 for simulcast transmission synchronization
- 5 MHz frequency stability signals to the GTR 8000 repeaters.

The TRAK 8835 is GPS disciplined, which provides time stamp information that is critical to setting precise transmission launch times in Simulcast.

2.4.4 Antenna Network

Each site will utilize the County's existing antennas, transmission lines and combiners/multicouplers or duplexers to support the operation of the proposed GTR 8000 radios at that site. The proposed design does not include the replacement of any of this hardware. If any of the existing hardware is found to be insufficient to support the operation of the proposed equipment, it will be the responsibility of the County to upgrade or replace the components to a state that is capable of supporting the operation of the proposed radio equipment.

2.5 VHF BAND CONSIDERATIONS

The proposed system has been designed to operate in the VHF bands. This section describes some of the difficulties associated with operation within these bands and defines some of the steps that Motorola takes to try to mitigate them.

2.5.1.1 Licensing

There are no proposed changes to the mode of operation, location of transmit antennas or transmit power at any of the sites, so new frequency licensing or modifications to existing licenses should be required. If the need to make any modifications to existing licenses or file for new licenses become necessary, this will be the responsibility of Stokes County. The ability to obtain licensing on a particular frequency in UHF and VHF can be an uncertain prospect and will require the consent of any other users in the region. If Stokes County is unable to obtain licensing for these transmitters, it will be necessary for Stokes County to obtain licensing for different frequencies which can be licensed at all of the sites in the proposed design. If a different set of frequencies is ultimately utilized by the system, Motorola will need to determine if they are compatible with the design. If they are not compatible, Motorola will need to alter the design to accommodate them and provide updated pricing to Stokes County for the additional costs.

2.5.1.2 Intermodulation

This section is provided to inform Stokes County of the risk of interference on its VHF channels due to intermodulation.

Intermodulation can be broken down into active and passive intermodulation. Active intermodulation is where the mixing is occurring in an active stage such as a transmitter's final amplifier or the receiver's front end. In these situations the mixing efficiency is high, which results in higher-level products. Passive intermodulation occurs in non-active locations such as antennas and combiners or in external locations such antenna mounting structures or towers.

Intermodulation occurs when two or more signals mix. The results of the mixing will be the various sum and difference products as well as the original frequencies. Any number of frequencies can mix in various combinations. If two frequencies, A and B, are mixed together (a "second order" product), the following products can result: A+B, A-B, 2A+B, 2A-B, 2B+A, 2B-A, 3A+B, 3A-B, 3B+A, 3B-A, 3B+2A, 3B-2A and so on. If three frequencies A, B & C are mixed (a "third order" product), the following products can result: A+B+C, A+B-C, A+C-B, B+C-A and so on.

Intermodulation products are generally grouped by their order. The order is simply the sum of the coefficients of the frequencies that make up a particular mix. For example, A+B represents second order intermodulation. In this case, the coefficients of both A and B are 1 and $1 + 1$ equals 2. The example A+B-C is a “third order” product. The coefficients of A, B and C are all one, so $1 + 1 + 1$ equals 3, a 3rd order mix. The product 2A-B is also a “third order” mix. The coefficient of A is 2 and the coefficient of B is 1; therefore, $2 + 1$ equals 3, which indicates a 3rd order mix. 3A-2B would be a 5th order mix and 5A-4B would be a 9th order mix.

Motorola is unable at this time to conduct proper Intermodulation studies for Stokes County, as information regarding any other radio resources that may be operating at the same locations is currently not available to Motorola. Once these have been identified, the Intermodulation Study will need to be performed to determine if there are any potential intermodulation risks. If it is determined that potential intermodulation risks are present, Stokes County will then need to make a determination on whether they would like to attempt to obtain licensing for different frequencies or accept the potential risk of IM interference. If different frequencies are selected, the Combiner/Multicoupler design may need to be revised to accommodate the frequency changes and Motorola will need to provide updated pricing for these changes to the County.

2.5.1.3 Interference

VHF is also prone to interference from other outside radio sources and other environmental sources. The organization of channels in this band is not as structured as that for the 800 MHz band and in many cases very close spacing of transmitters and receivers can be encountered. Having a transmitter operating in close proximity, both in terms of physical distance and frequency, to a receiver can result in a reduction in the sensitivity of that receiver which will reduce the performance. In addition to receiver performance issues that may be caused by Stokes County's own transmitters, interference from other radio resources can potentially exist as well.

2.6 SYSTEM BACKHAUL

The radio sites will be connected to each other over the County's existing Ethernet based microwave links. The proposed design includes no changes to this equipment and assumes sufficient capacity to support the proposed radio equipment.

2.7 SUBSCRIBERS

Motorola is including no new subscribers and no modifications to the existing fleet of subscribers that Stokes County currently operates. Stokes County will continue to utilize the current subscribers on the new system. Any programming or configuration changes required in the existing pagers or portable radios will be the responsibility of Stokes County.

2.8 COVERAGE

There are critical unknown/undefined design parameters at each site which inhibits Motorola's ability to develop an RF Coverage guarantee. Among the missing information is the degree of detrimental ambient RF energy (intermodulation and RF noise floor levels) at each location and the allowable transmit power. Although Motorola stands behind the quality

of its products and workmanship, for the reasons previously listed we cannot provide a guarantee of system coverage and no Coverage Acceptance Testing (CATP) will be performed. As part of system implementation and optimization Motorola will perform testing on performance of the system, but this will not include a formal CATP.



EQUIPMENT LIST

QTY	NOMENCLATURE	DESCRIPTION
1	DSTRAK88358M	GPS CLOCK, 10MHZ, DOCXO, 48VDC INCL ANT,100' COAX W/DONGLE SNMPV3
1	DSTRAK4008245101	MOUNTING SHELF FOR 8835 GPS CLOCK
1	DSTRAKP001134	AC POWER SUPPLY FOR 8835 GPS CLOCK
1	DSTRAK4702354	Lightning/Surge Arrestor for Trak 8835
2	CLN1868	2930F 24-PORT SWITCH
1	T8492	SITE AND HUB ROUTER AND FIREWALL-AC
1	CA03445AA	ADD: MISSION CRITICAL HARDENING
1	CA03448AA	ADD: STATEFUL FIREWALL
1	TRN7343	SEVEN AND A HALF FOOT RACK
1	DS1101990	SPD, SHIELDED RJ-45 JACK, SINGLE LINE GBE (1000MBPS) R56 COMPLIANT
1	DSTSJADP	RACK MOUNT GROUND BAR, 19 IN FOR TSJ AND WPH SERIES DATA SPDS
1	F2979	MLC 8000
1	VA00783AA	ADD: ANALOG CONVENTIONAL SIMULCAST COMPARATOR/GATEWAY
1	VA00011AA	19INCH RACK MOUNT HARDWARE KIT CABINET OR RACK
1	VA00012AA	ADD: 120/240VAC TO +12VDC POWER ADAPTER
1	F2979	MLC 8000
1	VA00783AA	ADD: ANALOG CONVENTIONAL SIMULCAST COMPARATOR/GATEWAY
1	VA00011AA	19INCH RACK MOUNT HARDWARE KIT CABINET OR RACK
1	VA00012AA	ADD: 120/240VAC TO +12VDC POWER ADAPTER
1	T7039	GTR 8000 Base Radio
1	X530BG	ADD: VHF (136-174 MHZ)
1	CA01949AA	ADD: ANALOG ONLY CONV SW
1	CA01952AA	ADD: ANALOG CONVENTIONAL SIMULCAST SOFTWARE
1	X153AW	ADD: RACK MOUNT HARDWARE
1	X265AM	ADD: BR PRESELECTOR 150-174 MHZ
1	CA01503AA	ADD: FALL BACK IN SIMULCAST CABINET REPEAT
1	DSTRAK88358M	GPS CLOCK, 10MHZ, DOCXO, 48VDC INCL ANT,100' COAX W/DONGLE SNMPV3
1	DSTRAK4008245101	MOUNTING SHELF FOR 8835 GPS CLOCK
1	DSTRAKP001134	AC POWER SUPPLY FOR 8835 GPS CLOCK
1	DSTRAK4702354	Lightning/Surge Arrestor for Trak 8835

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QTY	NOMENCLATURE	DESCRIPTION
1	CLN1868	2930F 24-PORT SWITCH
1	T8492	SITE AND HUB ROUTER AND FIREWALL-AC
1	CA03445AA	ADD: MISSION CRITICAL HARDENING
1	CA03448AA	ADD: STATEFUL FIREWALL
1	TRN7343	SEVEN AND A HALF FOOT RACK
1	DS1101990	SPD, SHIELDED RJ-45 JACK, SINGLE LINE GBE (1000MBPS) R56 COMPLIANT
1	DSTSJADP	RACK MOUNT GROUND BAR, 19 IN FOR TSJ AND WPH SERIES DATA SPDS
1	F2979	MLC 8000
1	VA00783AA	ADD: ANALOG CONVENTIONAL SIMULCAST COMPARATOR/GATEWAY
1	VA00011AA	19INCH RACK MOUNT HARDWARE KIT CABINET OR RACK
1	VA00012AA	ADD: 120/240VAC TO +12VDC POWER ADAPTER
1	T7039	GTR 8000 Base Radio
1	X530BG	ADD: VHF (136-174 MHZ)
1	CA01949AA	ADD: ANALOG ONLY CONV SW
1	CA01952AA	ADD: ANALOG CONVENTIONAL SIMULCAST SOFTWARE
1	X153AW	ADD: RACK MOUNT HARDWARE
1	X265AM	ADD: BR PRESELECTOR 150-174 MHZ
1	CA01503AA	ADD: FALL BACK IN SIMULCAST CABINET REPEAT
1	DSTRAK88358M	GPS CLOCK, 10MHZ, DOCXO, 48VDC INCL ANT,100' COAX W/DONGLE SNMPV3
1	DSTRAK4008245101	MOUNTING SHELF FOR 8835 GPS CLOCK
1	DSTRAKP001134	AC POWER SUPPLY FOR 8835 GPS CLOCK
1	DSTRAK4702354	Lightning/Surge Arrestor for Trak 8835
1	CLN1868	2930F 24-PORT SWITCH
1	T8492	SITE AND HUB ROUTER AND FIREWALL-AC
1	CA03445AA	ADD: MISSION CRITICAL HARDENING
1	CA03448AA	ADD: STATEFUL FIREWALL
1	TRN7343	SEVEN AND A HALF FOOT RACK
1	DS1101990	SPD, SHIELDED RJ-45 JACK, SINGLE LINE GBE (1000MBPS) R56 COMPLIANT
1	DSTSJADP	RACK MOUNT GROUND BAR, 19 IN FOR TSJ AND WPH SERIES DATA SPDS
1	F2979	MLC 8000
1	VA00783AA	ADD: ANALOG CONVENTIONAL SIMULCAST COMPARATOR/GATEWAY
1	VA00011AA	19INCH RACK MOUNT HARDWARE KIT CABINET OR RACK
1	VA00012AA	ADD: 120/240VAC TO +12VDC POWER ADAPTER
1	T7039	GTR 8000 Base Radio

QTY	NOMENCLATURE	DESCRIPTION
1	X530BG	ADD: VHF (136-174 MHZ)
1	CA01949AA	ADD: ANALOG ONLY CONV SW
1	CA01952AA	ADD: ANALOG CONVENTIONAL SIMULCAST SOFTWARE
1	X153AW	ADD: RACK MOUNT HARDWARE
1	X265AM	ADD: BR PRESELECTOR 150-174 MHZ
1	CA01503AA	ADD: FALL BACK IN SIMULCAST CABINET REPEAT
1	DLN6897	FRU: PA VHF
1	DLN6893	FRU: XCVR VHF V2 W/OPTION CARD
1	DLN6781	FRU: POWER SUPPLY
1	DLN6898	FRU: FAN MODULE
1	DLN6821	FRU: GTR ANALOG 4W E&M SIMULCST KIT
1	CLN1868	2930F 24-PORT SWITCH
1	T8492	SITE AND HUB ROUTER AND FIREWALL-AC
1	CA03445AA	ADD: MISSION CRITICAL HARDENING
1	CA03448AA	ADD: STATEFUL FIREWALL
1	FLN0001	FRU KIT, MLC8000
1	DSTRAK88358M	GPS CLOCK, 10MHZ, DOCXO, 48VDC INCL ANT,100' COAX W/DONGLE SNMPV3
1	DSTRAKP001134	AC POWER SUPPLY FOR 8835 GPS CLOCK

SECTION 4

SERVICE/WARRANTY

Our standard commercial warranty covers on-site response during normal business hours per the equipment list contained in this proposal

Use or disclosure of this proposal is subject to the restrictions on the cover page.



SECTION 5

PRICING SUMMARY

Motorola is pleased to provide equipment and services to Stokes County, North Carolina:

Description	Price
Total	\$297,000.00

PAYMENT SCHEDULE

Except for a payment that is due on the Effective Date, Customer will make payments to Motorola within thirty (30) days after the date of each invoice. Customer will make payments when due in the form of a check, cashier's check, or wire transfer drawn on a U.S. financial institution. Payment for the System purchase will be in accordance with the following milestones.

1. 25% of the Contract Price due upon contract execution (due upon effective date);
2. 60% of the Contract Price due upon shipment of equipment;
3. 5% of the Contract Price due upon installation of equipment; and
4. 10% of the Contract Price due upon Final Acceptance.



SECTION 6

CONTRACTUAL DOCUMENTATION

To accept Motorola's proposal, the County will issue a Purchase Order that includes the following statement on its face:

The pricing, terms and conditions of the NC State Contract #725G will control this purchase. All details of the purchase and payment terms are per the Stokes County Proposal dated December 13, 2019.

