MARIN EMERGENCY RADIO AUTHORITY

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DATE: August 28, 2019

TO: MERA Next Generation Project Oversight Committee

FROM: Ernest Klock, Operations Officer

SUBJECT: AGENDA ITEM G: Update on Motorola Change Order #8 – Multi-Protocol Label Switching (MPLS)

Recommended Action: Provide recommendation to be forwarded to the MERA Governing Board regarding the inclusion of Multi-Protocol Label Switching (MPLS) in-lieu of Layer 2 as part of the microwave system for the MERA Next Gen System project.
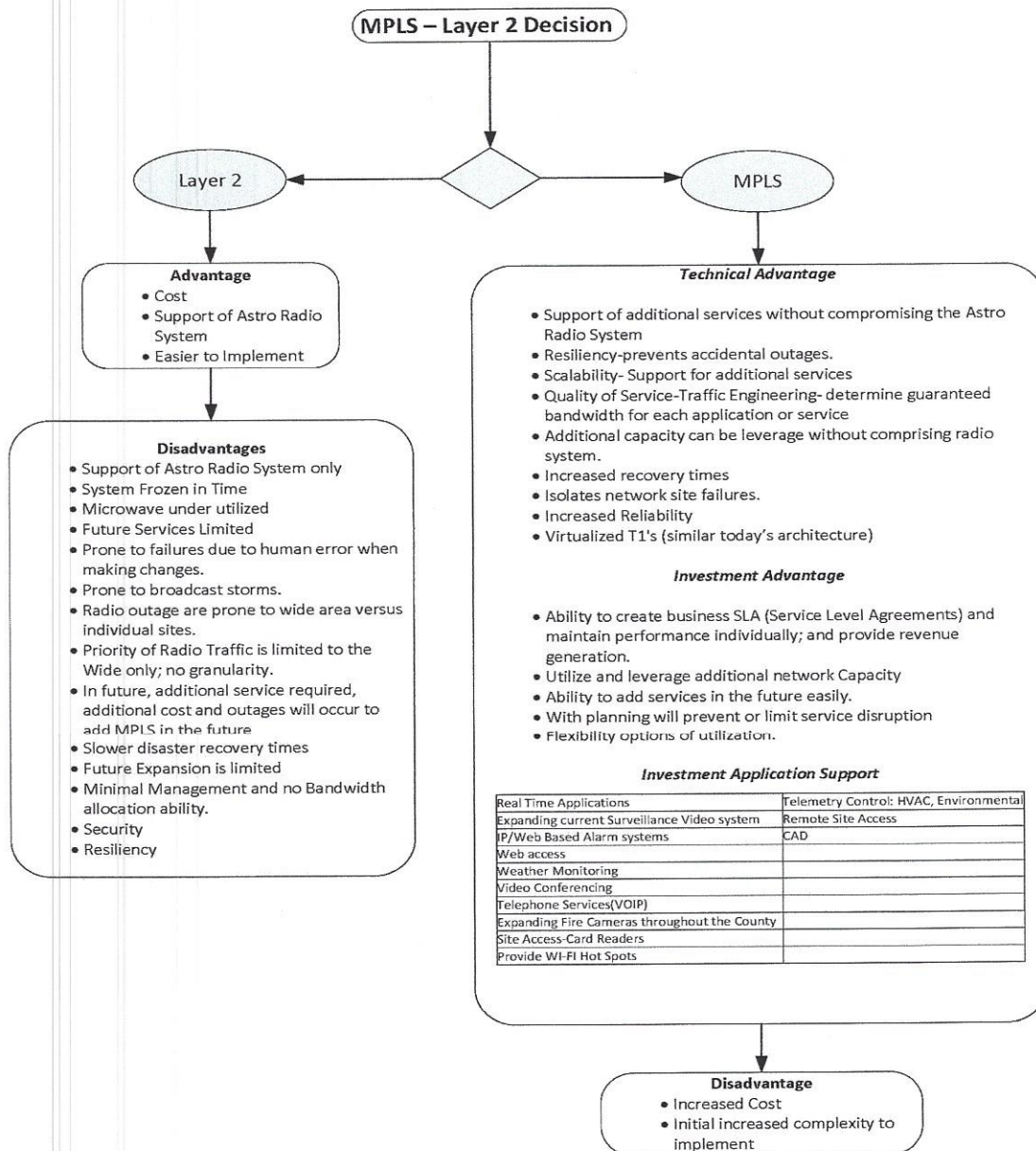
Discussion: The MPLS contract change order #8 (CCO#8) item was presented at various meetings in 2018, as well as the June 26, 2019 Next Gen Project Oversight Committee and the subsequent Governing Board meeting. Since the June 26 meeting, additional research has been performed regarding options for MERA to implement this technology in the Next Gen System.

The NextGen System Request for Proposals (RFP) released in 2016 specified a digital microwave network as a replacement for the existing MERA microwave system. In addition to radio voice traffic, the existing microwave system includes other traffic such as FBI and CHP voice circuits, MERA technician troubleshooting tools, and security cameras for several MERA sites. The existing system can accommodate this traffic because of the method that the system uses to route data (called TDM). This technique (created in the 1960's) allows a small number of services to share a common link without interfering with each other. Using TDM, the existing MERA P25 voice radio traffic is transmitted in its own time slot on the microwave network and is therefore isolated from these other services.

At the time of the development of the Next Gen RFP, the presence of the non-Land Mobile Radio (LMR) traffic on the existing MERA microwave system was not clear, so accommodations for it were not required in proposer bids. Since the inclusion of these additional services was not required, Motorola proposed a microwave system that will use simple Layer 2 network protocols to route traffic on the network. After the non-LMR traffic listed above and other features were considered, MPLS was suggested as an alternative to accommodate these services, and CCO#8 was proposed.

The Layer 2 (Ethernet) equipment proposed by Motorola is a series (one per site) of network switches that creates one data "lane" and does not have the capability to "intelligently" manage the non-LMR traffic. A Layer 2 design can carry normal LMR traffic (made up of small bursts of data), but it cannot carry larger data packets such as video traffic, or CHP or FBI circuits without increased system vulnerability (due to feedback loops). In addition, the Layer 2 option is not as scalable when creating larger networks, or "broadcast domains", and the performance degrades if it is configured as such. Motorola cannot guarantee system performance if Layer 2 is configured to carry the non-LMR traffic, so MPLS should be used if accommodation of these services is to continue.

Unlike the Layer 2 switches, the MPLS equipment is a series (one per site) of network routers that create several data "lanes" and can be configured to route each of the non-LMR services independently. Therefore, the LMR voice traffic can be isolated from the other non-LMR services to guarantee mission-critical voice is always available. A design using MPLS will increases the redundancy, reliability, and future flexibility for the NextGen System. The following diagram compares the two technologies.

MPLS – Layer 2 Decision

Layer 2

Advantage
- Cost
- Support of Astro Radio System
- Easier to Implement

Disadvantages
- Support of Astro Radio System only
- System Frozen in Time
- Microwave under utilized
- Future Services Limited
- Prone to failures due to human error when making changes.
- Prone to broadcast storms.
- Radio outage are prone to wide area versus individual sites.
- Priority of Radio Traffic is limited to the Wide only; no granularity.
- In future, additional service required, additional cost and outages will occur to add MPLS in the future
- Slower disaster recovery times
- Future Expansion is limited
- Minimal Management and no Bandwidth allocation ability.
- Security
- Resiliency

MPLS

Technical Advantage
- Support of additional services without compromising the Astro Radio System
- Resiliency-prevents accidental outages.
- Scalability- Support for additional services
- Quality of Service-Traffic Engineering- determine guaranteed bandwidth for each application or service
- Additional capacity can be leverage without comprising radio system.
- Increased recovery times
- Isolates network site failures.
- Increased Reliability
- Virtualized T1's (similar today's architecture)

Investment Advantage
- Ability to create business SLA (Service Level Agreements) and maintain performance individually; and provide revenue generation.
- Utilize and leverage additional network Capacity
- Ability to add services in the future easily.
- With planning will prevent or limit service disruption
- Flexibility options of utilization.

Investment Application Support

Real Time Applications	Telemetry Control: HVAC, Environmental
Expanding current Surveillance Video system	Remote Site Access
IP/Web Based Alarm systems	CAD
Web access	
Weather Monitoring	
Video Conferencing	
Telephone Services(VOIP)	
Expanding Fire Cameras throughout the County	
Site Access-Card Readers	
Provide WI-FI Hot Spots	

Disadvantage
- Increased Cost
- Initial increased complexity to implement

Discussion of Options

Following the June 26, 2019 NGPOC meeting, several options have been further investigated for inclusion of the MPLS design in the Next Gen Project. A description of each option, the pros/cons, and costs associated with each are included in a comparison matrix (Attachment 1). Below is a summary table followed by a discussion on each item:

	OPTION 0	OPTION 1	OPTION 4A	OPTION 4B	OPTION 4C	OPTION 4D
Description	Stay with Motorola Layer 2 per contract	Motorola implements MPLS now, before design complete	Motorola implements MPLS now, no SUA II	Motorola implements MPLS now, SUA II via NASPO – closest to CCO#8	Motorola implements MPLS now, SUA II via NASPO, no Adv. Replace	Motorola implements MPLS now, SUA II via NASPO, no repair SUA II
Cost - No SUA, no hardware refresh	$0	$640,562.86	$502,009	$502,009	$502,009	$502,009
Added Cost - 15 yr. SUAII, Year 6 hardware refresh	$0	$1,140,530	$0	$2,520,020	$2,487,302 + repairs covered, but no Adv. Replacement = downtime	$1,710,079 + repairs via Time and Materials
L2 Network Refresh Credit	N/A	($413,000)	($413,000)	($413,000)	($413,000)	($413,000)
Price after Layer 2 Network Refresh Credit	$0	$1,367,840	$89,009	$2,608,777	$2,576,058	$1,798,835

Option 0 – Keep the Current Layer 2 Motorola Design

This option involves no immediate actions, nor cost impacts to MERA, however, the non-LMR services will need to be terminated at cutover to the Next Gen System as Motorola will not support them on Layer 2. The FBI and CHP voice circuits would be disabled impacting those agency resources in the areas served, MERA technician troubleshooting tools would be disabled potentially increasing service time, and security cameras for several MERA sites would be disabled. APCO International ANSI standards for public safety communication sites (recently revised for 2019) include many recommendations for site and systems monitoring that could be conveyed over MPLS. APCO recommendations for public safety communication sites to include:

APCO Ref	Description
3.6.3.9	The site should be equipped with one or more remote cameras.
3.6.3.10	The site should be equipped with a remote video recording system.
3.6.3.11	The site should be equipped with a local site audible siren.
3.7.3.7	Video surveillance of on-site generator should be installed.
3.7.3.9	Access to on-site generator should have a capability to remotely manage access authentication.
3.7.3.10	Access to site's battery plant should have a capability to remotely manage access authentication.
3.8.2.8	Video monitoring system (Interior/Exterior) shall be implemented with digital-video- recording systems.

3.8.2.9	All alarms and monitoring tools shall be connected and monitored by a NOC or SOC.
3.8.2.14	The site should be equipped with one or more remote cameras.
3.8.2.15	The remote camera(s) video feed should be monitored (or monitor capable) from the NOC/SOC and/or local law enforcement if applicable.
3.8.2.16	The site should be equipped with a remote video recording system.

Option 1 - MPLS for the Microwave Network - $1,781,092.86 less Layer 2 Credit = $1,367,840

CCO#8 includes the replacement of the currently proposed Layer 2 network architecture with MPLS network architecture for the NextGen System microwave network. The cost includes approximately $640k in MPLS equipment and $1.14m in SUA II services including one MPLS network refresh in year 6 after cutover to the Next Gen System. This update represents utilization of $413,000 in L2 credit applied to CCO#8 pricing to result in a $1,367,840 final CCO#8 price. The services provided under this CCO#8 are commensurate with the services as outlined in Attachment 2 – Warranty and Post-Warranty Costs currently provided for MERA's Layer 2 Microwave. This CCO#8 price is contingent upon implementation concurrently with the overall NextGen system design/implementation as well as confirmation from Motorola that the Layer 2 credit can be applied. Decision on this item should be made ahead of the completion of the Customer Design Review (CDR) package to defer additional costs. CDR will be presented for MERA approval following completion of CEQA – anticipated end of 2019.

Options 2 and 3 from NGPOC June 26, 2019 MPLS Staff Report Removed

After feedback at the last NGPOC, Option 2 (Motorola Implement MPLS after Next Gen Live) and Option 3 (Outside Vendor Implement MPLS after Next Gen Live) have been removed from consideration. Option 2 was significantly more expensive ($2.3M) and Option 3 did not provide commensurate SUA II services while introducing risk associated with pricing that would not hold for the next three to four years.

Option 4A, 4B, 4C, 4D - MPLS by Motorola Now via Layer 2 SUAII Network Refresh Credit – Range of SUA II Services

As presented at the June 26, 2019 NGPOC, Option 4 included implementing MPLS now with Motorola (equipment, configuration, and training only – NO SUAII Services) – this is now Option 4A and remains unchanged. By eliminating the service agreement for one of the two included network refreshes and receiving SUA and layer 2 credits, the cost would be lowered to approximately $89,000 for this item. Attachment 2 highlights where this credit would come from and preserves one network refresh for MERA under the existing SUA II services. It is important to note that MERA may not necessarily need to use either Layer 2 network refreshes during the 15-year SUA II period (determined by Motorola product releases and need to upgrade) and the contract structure does not allow for credits after the fact.

The risk introduced by eliminating one refresh is an increase in long-term support as the system gets older, since there is a greater chance of running the equipment past its manufacturer-support life cycle. It should be noted that MERA has not refreshed its existing microwave system since the original installation, partly because of how TDM was able to support additional services. The flexibility of MPLS reduces the need to refresh the network as often because MPLS is able to support more configurations, similar to the existing TDM system. A Layer 2 solution is more likely to encounter limitations within its lifecycle, especially considering modern network design migrating away from

larger layer 2 networks, thereby requiring more maintenance. This is likely why two network refreshes were included in the existing SUAII services.

The Layer 2 credit approach provides the advantages of upgrading the microwave network at a lower cost while delivering the benefits of MPLS mentioned above with the risk of no SUA II services. In response, three additional options (4B, 4C, and 4D) have been developed with varying degrees of SUA II services provided through contracts negotiated by National Association of State Procurement Officials (NASPO). NASPO SUA II-type services are used by communications partners in the region to maintain their microwave networks. Nokia (Motorola's subcontractor and MERA's microwave network provider for Next Gen) has pricing under NASPO and details are provided in Attachment 1.

Option 4B – MPLS by Motorola Now via Layer 2 Credit – SUA II by NASPO - $2,608,777
This is the most comparable service scenario to Motorola's CCO#8 at a significantly higher cost. It includes NASPO pricing for services commensurate with MERA's Layer 2 SUA II including – 24-hour telephone support, software subscription, part repair with advance replacement for 12 years (starts in year 4), and one hardware refresh. Pricing is 2019 and will likely change in 2023 and beyond.

Option 4C – MPLS by Motorola Now via Layer 2 Credit – Reduced SUA II by NASPO - $2,162,805
This is the same option as 4B service scenario with a reduction to remove the advance replacement cost. Advance replacement allows for faster service restoration on faulty equipment and costs approximately $450,000 over 12 years. Option 4C NASPO pricing for services includes – 24-hour telephone support, software subscription, part repair (no advance replacement) for 12 years (starts in year 4), and one hardware refresh. Pricing is 2019 and will likely change in 2023 and beyond.

Option 4D – MPLS by Motorola Now via Layer 2 Credit – Reduced SUA II by NASPO - $1,798,835
This is the same option as 4C service scenario with a reduction to remove all part repair and replacement costs with the intent of utilizing time and materials to address failures as they arise. Option 4D NASPO pricing for services includes – 24-hour telephone support, software subscription, and one hardware refresh. Pricing is 2019 and will likely change in 2023 and beyond.

Summary
Research on SUA II pricing has yielded varying results depending on the level of service MERA wishes to fund. At a minimum, 24-hour telephone support and software subscription will ensure that the microwave network can be diagnosed by technicians and is updated with the latest software releases - $1,350,000 for 12 years. Combined with Option 4A, this results in an MPLS solution costing approximately $1,440,000 – which is slightly higher than CCO#8 with a severe reduction in SUA II services. Given that some existing diagnostic and security services will not be available in the Layer 2 microwave design that is currently planned, there will be increased maintenance costs and higher risk of system busy or temporary outages as technicians would have to drive to remote sites to diagnose certain system performance that currently is monitored remotely via the microwave network. Another significant benefit of MPLS is that the vast amount of unused bandwidth on the new microwave network could be utilized for MERA to support applications (as recommended via APCO) and transmission of third-party traffic that could generate revenues for MERA.

Attachment 1 – Options Comparison Matrix
Attachment 2 – Warranty and Post-Warranty Costs

Attachment 1 - MPLS Comparison Matrix

	OPTION 0	OPTION 1	OPTION 4A	OPTION 4B	OPTION 4C	OPTION 4D
Description	Take no action. Configuration in the original contract. Maintains Layer 2 architecture. Non-LMR services are not permitted on network.	Motorola implements MPLS now as part of current design of Next Gen System.	Motorola implements MPLS now as part of current design of Next Gen System, paid for by reduction in Layer 2 SUAII services.	Motorola implements MPLS now as part of current design of Next Gen System, paid for by reduction in Layer 2 SUAII services.	Motorola implements MPLS now as part of current design of Next Gen System, paid for by reduction in Layer 2 SUAII services.	Motorola implements MPLS now as part of current design of Next Gen System, paid for by reduction in Layer 2 SUAII services.
Data Transfer	Layer 2 - used predominantly in single-use networks.	MPLS - commonly used in high performance networks.	MPLS - commonly used in high performance networks.	MPLS - commonly used in high performance networks.	MPLS - commonly used in high performance networks.	MPLS - commonly used in high performance networks.
Traffic	Conventional voice channels, interoperability voice channels, 700 MHz trunked voice channels, and basic system management data.	Conventional voice channels, interoperability voice channels, 700 MHz trunked voice channels, and system management data, plus data traffic from other applications (cameras, site security, radio system diagnostics, etc.)	Conventional voice channels, interoperability voice channels, 700 MHz trunked voice channels, and system management data, plus data traffic from other applications (cameras, site security, radio system diagnostics, etc.)	Conventional voice channels, interoperability voice channels, 700 MHz trunked voice channels, and system management data, plus data traffic from other applications (cameras, site security, radio system diagnostics, etc.)	Conventional voice channels, interoperability voice channels, 700 MHz trunked voice channels, and system management data, plus data traffic from other applications (cameras, site security, radio system diagnostics, etc.)	Conventional voice channels, interoperability voice channels, 700 MHz trunked voice channels, and system management data, plus data traffic from other applications (cameras, site security, radio system diagnostics, etc.)
Pros	- According to Motorola, it can robustly and reliably support single-use traffic at no additional cost to current project.	- MPLS is specifically designed to carry many kinds of traffic simultaneously. - More reliable network. - More flexible and more future oriented. - Motorola alone is responsible for correcting all implementation issues. - Various diagnostic and security tools for the P25 radio system can be added.	- MPLS is specifically designed to carry many kinds of traffic simultaneously. - More reliable network. - More flexible and more future oriented. - Motorola alone is responsible for correcting all implementation issues. - Various diagnostic and security tools for the P25 radio system can be added.	- MPLS is specifically designed to carry many kinds of traffic simultaneously. - More reliable network. - More flexible and more future oriented. - Motorola alone is responsible for correcting all implementation issues. - Various diagnostic and security tools for the P25 radio system can be added.	- MPLS is specifically designed to carry many kinds of traffic simultaneously. - More reliable network. - More flexible and more future oriented. - Motorola alone is responsible for correcting all implementation issues. - Various diagnostic and security tools for the P25 radio system can be added.	- MPLS is specifically designed to carry many kinds of traffic simultaneously. - More reliable network. - More flexible and more future oriented. - Motorola alone is responsible for correcting all implementation issues. - Various diagnostic and security tools for the P25 radio system can be added.
Cons	- Low-level protocols may not have the logic built in that would be required to compensate for a broadcast storm or other sudden network event. - May not support future upgrades to the P25 radio system. - Uses only a fraction of the available bandwidth of the Next Gen microwave network. - Existing troubleshooting services will be removed. - Current non-MERA users (CHP, FBI) will be required to find another path. - Provides less functionality than today's microwave system. - Not industry best practice.	- Significant additional cost to project. - Requires additional hardware. - Adds some complexity to the network. - Hardware refresh is only for hardware that is not compatible with updated Motorola software. - Reduces contingency funds in current project.	- Additional cost to project. - Requires additional hardware. - Adds some complexity to the network. - Hardware refresh is only for hardware that is not compatible with updated Motorola software. - Reduces contingency funds in current project. - Reduces Layer 2 network hardware refresh from two instances to one. - SUA II services for microwave network reduced from existing contract.	- Additional cost to project. - Requires additional hardware. - Adds some complexity to the network. - Hardware refresh is only for hardware that is not compatible with updated Motorola software. - Reduces contingency funds in current project. - Reduces Layer 2 network hardware refresh from two instances to one. - SUA II services for microwave network reduced from existing contract.	- Additional cost to project. - Requires additional hardware. - Adds some complexity to the network. - Hardware refresh is only for hardware that is not compatible with updated Motorola software. - Reduces contingency funds in current project. - Reduces Layer 2 network hardware refresh from two instances to one. - SUA II services for microwave network reduced from existing contract.	- Additional cost to project. - Requires additional hardware. - Adds some complexity to the network. - Hardware refresh is only for hardware that is not compatible with updated Motorola software. - Reduces contingency funds in current project. - Reduces Layer 2 network hardware refresh from two instances to one. - SUA II services for microwave network reduced from existing contract.
MPLS Hardware Cost - No SUA, no Refresh	$0	$640,562.86	$502,009.08	$502,009.08	$502,009.08	$502,009.08
Addt Cost - 15-Yr SUAII. Yr-6 MPLS Hdwr Rfsh	$0	$1,104,930	N/A	N/A	N/A	N/A
Estimate - manufacturer's support for 12 yrs purchased in year three - 24 hour telephone support	N/A	Included	N/A	$1,223,194.36 - Nokia via NASPO	$1,223,194.36 - Nokia via NASPO	$1,223,194.36 - Nokia via NASPO
Estimate - software subscription plan for 12 yrs purchased in year three	N/A	Included	N/A	$124,095.75 - Nokia via NASPO	$124,095.75 - Nokia via NASPO	$124,095.75 - Nokia via NASPO
Estimate - Part repair/replacement for 12 yrs purchased in year three	N/A	Included	N/A	$1,223,194.36 - Nokia via NASPO (Advanced Replacement)	$733,965.96 - Nokia via NASPO (no Advanced Replacement) plus $43,257 - spares	?? - Repair via time and materials plus $43,257 - spares
Estimate - one hardware refresh in year six	N/A	Included	N/A	$362,789 - Nokia via NASPO	$362,789 - Nokia via NASPO	$362,789 - Nokia via NASPO
Subtotal		$1,781,092.86	$502,009.08	$3,022,029.55	$2,576,058.15	$2,212,088.00 + repairs
Apply Layer 2 Network Refresh Credit		$413,253.00	$413,253.00	$413,253.00	$413,253.00	$413,253.00
Total		$1,367,839.86	$88,756.08	$2,608,776.55	$2,162,805.15	$1,798,835.19

$1.35M for 12 YEARS - MINIMUM LEVEL OF SUPPORT RECOMMENDED

Attachment 2 - NEXT GEN RADIO SYSTEM - Warranty and Post-Warranty Support Costs

Item Description		Total Cost	Years 1-3	Years 4-15
			2023 2024 2025	2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037
BASE CONTRACT WARRANTY				
Radio System, Microwave, Dispatch Consoles				
Latest Software Versions	Motorola to install latest versions of all Motorola and third-party software at commencement of system final testing.	$0.00	Available	Services Covered by Post Warranty
Infrastructure Repair	Motorola to repair or replace all Motorola and third-party infrastructure equipment for covered issues. Advanced replacement applies. County to remove and ship.	$0.00		
Technical Support Services by Phone	Telephone support 24 x 7 x 365 from Motorola Solution Support Center.	$0.00		
System Update Agreement (SUA I)		$2,156,874.00	Average $719,000/year	
Minor Software Release	Motorola to provide (and the County installs) OS and application security updates, patches and service pack updates for Motorola equipment, Windows, Server OS, Red Hat Linux, and Sun Solaris.	$0.00	Quarterly	
Major System Release	Motorola to provide Motorola system software release and third-party OS and application software releases. Motorola establishes the release schedule.	$0.00	TBD	
Implementation Services	Motorola to provide all in-house and on-site resources to implement and test a major system release update.	$0.00		
Hardware Refresh	Motorola to provide hardware version updates and/or replacements for Motorola field replaceable units and third-party networking and computing hardware, but only if the existing hardware is not compatible with a particular major system release. Maximum one per year.	$0.00	Available	
Motorola System Manager Services	Motorola employee that assists the County in the support, monitoring, and maintenance of the system. Will make scheduled visits to Marin County. Total of 100 days per year to be provided.	$428,571.43	Average $143,000/year	
Mobile and Portable Radios, Consolettes				
Repair / Replacement	Motorola to repair or replace subscriber units for covered issues. County to ship failed units to Motorola. Warranty for the radios will restart at System Acceptance if radios are purchased within two years prior to cutover.	$0.00		
POST-WARRANTY OPTION (Purchased with the Contract)				
Radio System and Dispatch Consoles				
Infrastructure Repair and Technical Support by Phone	Motorola to repair or replace all Motorola and third-party infrastructure equipment for covered issues. Advanced replacement applies. County to remove and ship. Telephone support 24 x 7 x 365 from Motorola Solution Support Center.	$4,143,378.10	Services Covered by Base Warranty	Average $350,000/year
System Update Agreement (SUA II)		$5,932,942.00		Average $500,000/year
Minor Software Release	Motorola to provide (and the County installs) OS and application security updates, patches and service pack updates for Motorola equipment, Windows, Server OS, Red Hat Linux, and Sun Solaris.	$0.00		Quarterly
Major System Release	Motorola to provide Motorola system software release and third-party OS and application software releases. Motorola establishes the release schedule.	$0.00		TBD by Motorola
Implementation Services	Motorola to provide all in-house and on-site resources to implement and test a major system release update.	$0.00		
Hardware Refresh	Motorola to provide hardware version updates and/or replacements for Motorola field replaceable units and third-party networking and computing hardware, but only if the existing hardware is not compatible with a particular major system release. Maximum once within two years.	$0.00		Available if Necessary by Motorola
Microwave System (Includes L2 Hardware)		$919,454.55		Average $56,000/year
Gold Technical Support	Telephone support for troubleshooting. Product-specific technical content through Nokia's online technical support portal.	$0.00		Included Services
On-site Response	On-site trouble shooting of failures by Day Wireless Systems in Benicia.	$0.00		
Advance Replacement	Motorola to provide a replacement component for the microwave network within one day of identification that it has failed. The failed component is then shipped to Nokia for repair and return.	$0.00		
Software Subscription Plan	Software patches or maintenance releases.	$0.00		Years 4-10 / Years 11-15
Local Spares Pool	To be identified.	$0.00		
Up to 2 Network Refreshes	Motorola to provide a complete replacement of all 9500 MPR microwave radios. (Dishes, lines, dehydrators are excluded.)	$826,000.00		$413,000 for one Network Refresh in Year 4-10 / $413,000 for one Network Refresh in Years 11-15
CONTRACT CHANGE ORDER #1 - Fire Station Alerting				
Servers, AIC, Modules				
Standard Equipment Warranty	Motorola to provide complete in-house testing and repair of all failed equipment. Technical support available by phone.	$0.00		
Extended Equipment Warranty	Motorola to provide complete in-house testing and repair of all failed equipment. Technical support available by phone.	$447,562.00		Average $37,000/year
Hardware/Software Update	Motorola to update or replace certain fire station alerting equipment if found to be incompatible with a Motorola major system release. Motorola to update fire station alerting software if needed whenever a Motorola major system release occurs.	$441,084.00		Average $37,000/year
Base Cost		$15,295,866.08	Total of services taken from Motorola Price Sheets in Contract - Numbers Approximate	
MERA Cost After Discounts		$9,000,000.00	Approximate SUA/SUAII Cost to MERA after Applied Discounts	

12 July 2019