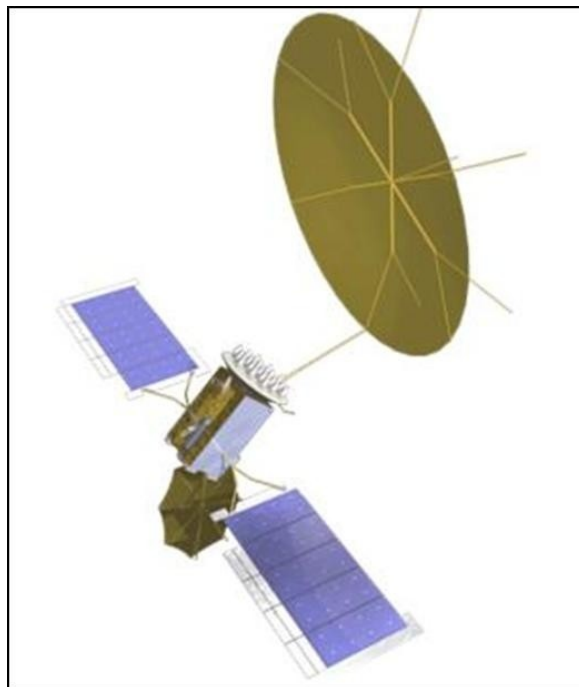




Selected Acquisition Report (SAR)

RCS: DD-A&T(Q&A)823-345



Mobile User Objective System (MUOS)

As of FY 2017 President's Budget

Defense Acquisition Management
Information Retrieval
(DAMIR)

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Common Acronyms and Abbreviations for MDAP Programs

Acq O&M - Acquisition-Related Operations and Maintenance
ACAT - Acquisition Category
ADM - Acquisition Decision Memorandum
APB - Acquisition Program Baseline
APPN - Appropriation
APUC - Average Procurement Unit Cost
\$B - Billions of Dollars
BA - Budget Authority/Budget Activity
Blk - Block
BY - Base Year
CAPE - Cost Assessment and Program Evaluation
CARD - Cost Analysis Requirements Description
CDD - Capability Development Document
CLIN - Contract Line Item Number
CPD - Capability Production Document
CY - Calendar Year
DAB - Defense Acquisition Board
DAE - Defense Acquisition Executive
DAMIR - Defense Acquisition Management Information Retrieval
DoD - Department of Defense
DSN - Defense Switched Network
EMD - Engineering and Manufacturing Development
EVM - Earned Value Management
FOC - Full Operational Capability
FMS - Foreign Military Sales
FRP - Full Rate Production
FY - Fiscal Year
FYDP - Future Years Defense Program
ICE - Independent Cost Estimate
IOC - Initial Operational Capability
Inc - Increment
JROC - Joint Requirements Oversight Council
\$K - Thousands of Dollars
KPP - Key Performance Parameter
LRIP - Low Rate Initial Production
\$M - Millions of Dollars
MDA - Milestone Decision Authority
MDAP - Major Defense Acquisition Program
MILCON - Military Construction
N/A - Not Applicable
O&M - Operations and Maintenance
ORD - Operational Requirements Document
OSD - Office of the Secretary of Defense
O&S - Operating and Support
PAUC - Program Acquisition Unit Cost

PB - President's Budget
PE - Program Element
PEO - Program Executive Officer
PM - Program Manager
POE - Program Office Estimate
RDT&E - Research, Development, Test, and Evaluation
SAR - Selected Acquisition Report
SCP - Service Cost Position
TBD - To Be Determined
TY - Then Year
UCR - Unit Cost Reporting
U.S. - United States
USD(AT&L) - Under Secretary of Defense (Acquisition, Technology and Logistics)

Program Information

Program Name

Mobile User Objective System (MUOS)

DoD Component

Navy

Responsible Office

CAPT Joseph Kan
Program Executive Office (Space Systems)
4301 Pacific Highway
San Diego, CA 92110-3127

joseph.kan@navy.mil

Phone: 619-524-7756
Fax: 619-524-7861
DSN Phone: 524-7756
DSN Fax:
Date Assigned: December 13, 2013

References

SAR Baseline (Production Estimate)

Defense Acquisition Executive (DAE) Approved Acquisition Program Baseline (APB) dated March 15, 2008

Approved APB

Defense Acquisition Executive (DAE) Approved Acquisition Program Baseline (APB) dated July 24, 2012

Mission and Description

The Mobile User Objective System (MUOS) is a narrowband Military Satellite Communications (MILSATCOM) system that supports a worldwide, multi-Service population of mobile and fixed-site terminal users in the Ultra High Frequency (UHF) band, providing increased communications capabilities to smaller terminal users while still supporting interoperability to legacy terminals.

MUOS adapts a commercial third generation Wideband Code Division Multiple Access (WCDMA) cellular phone network architecture and combines it with geosynchronous satellites (in place of cell towers) to provide a new and more capable UHF MILSATCOM system. The constellation of four operational satellites and ground network control will provide greater than ten times the system capacity of the current UHF Follow-On (UFO) constellation.

MUOS includes the satellite constellation, a ground control and network management system, and a new waveform for user terminals. The space segment is comprised of a constellation of four geosynchronous satellites, plus one on-orbit spare. The ground system includes the ground transport, network management, satellite control, and associated infrastructure to both fly the satellites and manage the users' communications. MUOS is designed to support users that require greater mobility, higher data rates, and improved operational availability. The new waveform is termed the MUOS Common Air Interface (CAI), a Software Communications Architecture compliant modulation technique for the Joint Tactical Radio System terminals.

The flow of information between users when MUOS is operational will be much different than today's systems. Users will communicate with the satellite via UHF WCDMA links and the satellites will relay this to one of four interconnected ground sites located in Wahiawa (Hawaii), Chesapeake (Virginia), Niscemi (Italy), and Geraldton (Australia) via a Ka-band feeder link. These facilities identify the destination of the communications, and route the information to the appropriate ground site for Ka-band uplink to the satellite and UHF WCDMA downlink to the correct users. A network management facility, located at Wahiawa, will feature a government-controlled, priority-based resource management capability that will be adaptable and responsive to changing operational communications requirements. Additionally, MUOS will provide access to select Defense Information System Network services, providing a voice and data capability that has not been available to UHF MILSATCOM users on prior systems. For satellite telemetry, tracking, and commanding, MUOS will use existing control centers operated by the Naval Satellite Operations Center Headquarters at Point Mugu, California, and their detachment at Schriever Air Force Base, Colorado Springs, Colorado.

When MUOS is fielded, it will serve a mixed terminal population. Some users will have terminals only able to support the legacy waveforms while other users will have newer terminals able to support the MUOS CAI. Each MUOS satellite carries a legacy payload similar to that flown on UFO-11. These legacy payloads will continue to support legacy terminals, allowing for a more gradual transition to the MUOS WCDMA waveform.

Executive Summary

The program office continues to make significant progress toward fielding the complete MUOS constellation and capability. MUOS Information Assurance (IA) accreditations are in place, net-centric capabilities have been validated, and MUOS-1, MUOS-2, and MUOS-3 are providing reliable legacy ultra-high frequency satellite communications capability to the warfighter. MUOS-3 was conditionally accepted by the Navy in June 2015, and legacy operations capability commenced January 2016. MUOS-4 successfully launched in September 2015, completed initial on-orbit testing, and was accepted by the Navy in November 2015. MUOS-4 legacy operations capability is planned to commence by April 2016. Three of four MUOS ground sites are operational. MUOS-5 met the MUOS APB milestone "5th Satellite Ready to Ship", and will support Initial Launch Capability in May 2016. The program continues to work with the State Department and the Secretary of Defense regarding the Italian court-issued Niscemi work sequestration.

The program entered Multi-Service Operational Test and Evaluation which consists of two separate and distinct tests. The first test was completed on November 20, 2015 and evaluated the Wideband Code Division Multiple Access capability. The second test is focused on the cyber security aspects of operational assessment and is on schedule for April 2016. The subsequent operational evaluation report is anticipated by July 2016. Deficiencies discovered during testing are being addressed via incremental software releases.

The annual MUOS Gate 6 Sufficiency Review/Configuration Steering Board (CSB) was presented to the Principal Military Deputy to the Assistant Secretary of the Navy for Research, Development and Acquisition in August 2015. The PM identified significant growth in the MUOS O&S cost which resulted in an APB breach for which the PM submitted a Program Deviation Report dated November 6, 2015. The principal O&S breach cost driver is hardware/software obsolescence. The program's resource sponsor identified \$188M that was applied across the FYDP for addressing operations and sustainment, obsolescence, and cyber/IA issues. The remaining funding shortfalls are being addressed by the program office via the budget process.

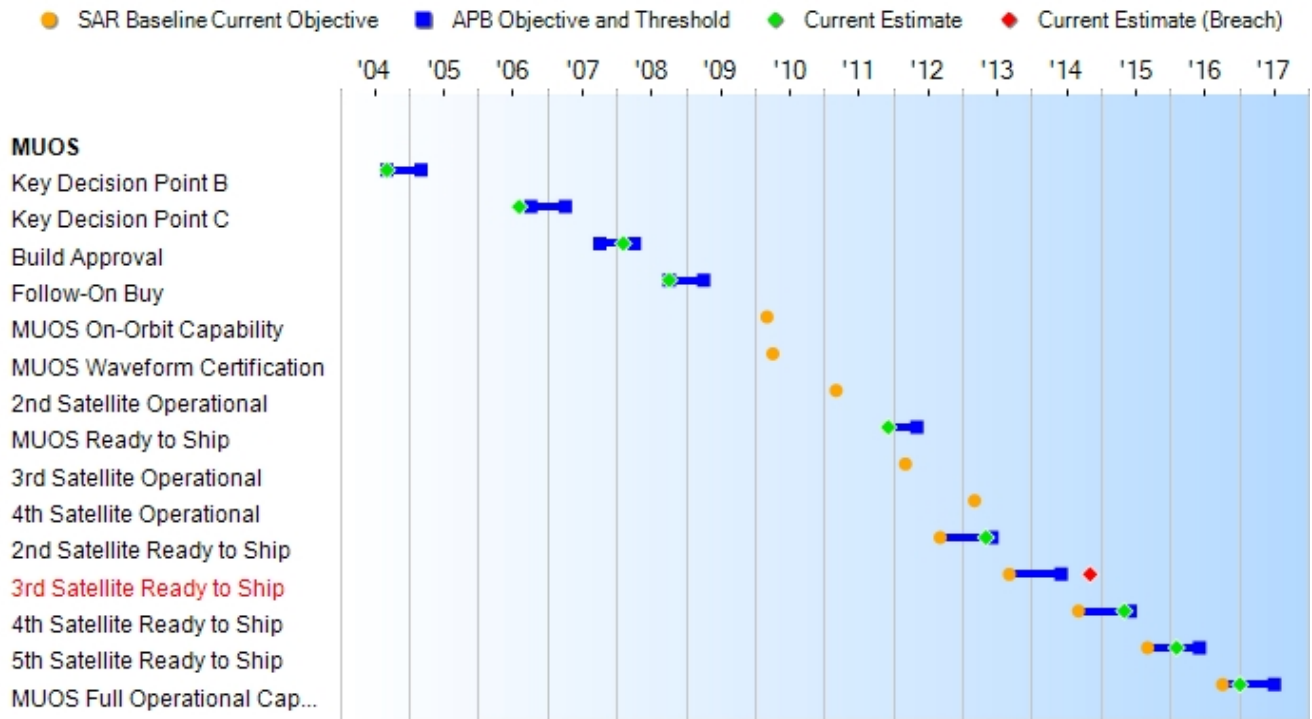
The MUOS constellation consists of five on-orbit satellites, four of which are active, and one that is an on-orbit spare. The MUOS APB reflects a sixth satellite for replenishment. The current estimate for this replenishment satellite is \$1.4B (TY), primarily due to parts obsolescence and the non-recurring engineering cost of re-establishing the satellite production line. Due to the estimated high cost of the sixth satellite and lack of available funding, the CSB determined that the procurement is impractical and unaffordable. The CSB recommended a reduction of the MUOS satellite quantity in the APB from six to five satellites. Pending approval of the revised MUOS cost estimate by the OSD CAPE, the cost/quantity changes will be incorporated into a revised APB and in subsequent SAR submissions.

There are no significant software-related issues with this program at this time.

Threshold Breaches

APB Breaches		Explanation of Breach	
Schedule	<input checked="" type="checkbox"/>	The schedule breach was previously reported in the December 2013 SAR. The "3rd Satellite Ready to Ship" milestone was met when the satellite was shipped in November 2014 and subsequently launched in January 2015.	
Performance	<input type="checkbox"/>		
Cost	RDT&E	Increases due to hardware and software obsolescence, Information Assurance/cybersecurity existing/emerging vulnerabilities, and new scope attribute to waveform support, End-to-End implementation and Electro-Magnetic Interference mitigation were incorporated into the MUOS O&S cost estimate, which resulted in an APB O&S threshold cost breach.	
	Procurement		
	MILCON		
	Acq O&M		
O&S Cost	<input checked="" type="checkbox"/>		
Unit Cost	PAUC		
	APUC		
Nunn-McCurdy Breaches		A Program Deviation Report was submitted November 6, 2015 to the Navy. The MUOS PM will continue to work with the Navy Resource Sponsor via the budget process to fund the total program sustainment requirements. The MUOS PM will incorporate a revised cost estimate into the APB.	
Current UCR Baseline			
	PAUC		None
	APUC		None
Original UCR Baseline			
	PAUC		None
	APUC	None	

Schedule



Schedule Events				
Events	SAR Baseline Production Estimate	Current APB Production Objective/Threshold		Current Estimate
Key Decision Point B	Sep 2004	Sep 2004	Mar 2005	Sep 2004
Key Decision Point C	Oct 2006	Oct 2006	Apr 2007	Aug 2006
Build Approval	Oct 2007	Oct 2007	Apr 2008	Feb 2008
Follow-On Buy	Oct 2008	Oct 2008	Apr 2009	Oct 2008
MUOS On-Orbit Capability	Mar 2010	N/A	N/A	N/A
MUOS Waveform Certification	Apr 2010	N/A	N/A	N/A
2nd Satellite Operational	Mar 2011	N/A	N/A	N/A
MUOS Ready to Ship	N/A	Dec 2011	May 2012	Dec 2011
3rd Satellite Operational	Mar 2012	N/A	N/A	N/A
4th Satellite Operational	Mar 2013	N/A	N/A	N/A
2nd Satellite Ready to Ship	N/A	Sep 2012	Jun 2013	May 2013
3rd Satellite Ready to Ship	N/A	Sep 2013	Jun 2014	Nov 2014¹
4th Satellite Ready to Ship	N/A	Sep 2014	Jun 2015	May 2015
5th Satellite Ready to Ship	N/A	Sep 2015	Jun 2016	Feb 2016
MUOS Full Operational Capability	Mar 2014	Oct 2016	Jul 2017	Jan 2017

(Ch-1)

¹ APB Breach

Change Explanations

(Ch-1) The current estimate for "5th Satellite Ready to Ship" is updated from August 2015 to February 2016 and reflects the actual satellite availability to support the Initial Launch Capability assigned by the Air Force's Current Launch Schedule Review Board.

Performance

Performance Characteristics				
SAR Baseline Production Estimate	Current APB Production Objective/Threshold	Demonstrated Performance	Current Estimate	
Coverage				
24 hours/day communications services at all latitudes and longitudes	24 hours/day communications services at all latitudes and longitudes	24 hours/day communications services from 65 degrees North to 65 degrees South latitude at all longitudes	Coverage threshold requirement verified by analyses using the Satellite Tool Kit (a performance model). Recent exercises demonstrated coverage to 75 degrees North with limited coverage above 75 degrees North	24 hours/day communications services from 65 degrees North to 65 degrees South latitude at all longitudes
Capacity				
300% worldwide simultaneous accesses (5,991 at 117.6 Mbps) associated with the CMTW scenario	300% worldwide simultaneous accesses (5,991 at 117.6 Mbps) associated with the CMTW scenario	1,997 worldwide simultaneous accesses (39.2 Mbps) with 502 simultaneous theater accesses (3 Mbps)	Capacity threshold requirement verified by analyses using the MPM	1,997 worldwide simultaneous accesses (39.2 Mbps) with 502 simultaneous theater accesses (3 Mbps)
Access and Control				
Resources planned, allocated, prioritized, and dynamically configured or reconfigured in less than 5 minutes for all networks; and priority-based access is provided or the request is queued and feedback provided to the user within 3 seconds 90% of the time and 6 seconds 99% of the time	Resources planned, allocated, prioritized, and dynamically configured or reconfigured in less than 5 minutes for all networks; and priority-based access is provided or the request is queued and feedback provided to the user within 3 seconds 90% of the time and 6 seconds 99% of the time	Resources planned, allocated, prioritized, and dynamically configured or reconfigured within 15 minutes and for selected high priority networks within 5 minutes; and priority-based access is provided or the request is queued and feedback provided to the user within 6 seconds 90% of the time and 10 seconds 99% of the time	Automated functionality for resource planning, allocation and prioritization were demonstrated via test; network configuration/reconfiguration was demonstrated via PM's capabilities assessment. Priority-based access was demonstrated via PM's capabilities assessment and	Resources planned, allocated, prioritized, and dynamically configured or reconfigured in less than 5 minutes for all networks; and priority-based access is provided or the request is queued and feedback provided to the user within 6 seconds 90% of the time and 10 seconds 99% of the time

developmental
scenario-based
testing

Net Ready

<p>Fully support execution of all operational activities identified in the applicable joint and system integrated architectures and the system must satisfy the technical requirements for Net-Centric military operations to include 1) DISR mandated GIG IT standards and profiles identified in the TV-1, 2) DISR mandated GIG KIPs identified in the KIP declaration table, 3) NCOW RM Enterprise Services 4) Information assurance requirements including availability, integrity, authentication, confidentiality, and nonrepudiation, and issuance of an ATO by the DAA, and 5) Operationally effective information exchanges; and mission critical performance and information assurance attributes, data correctness, data availability, and consistent data processing specified in the applicable joint and system integrated architecture views</p>	<p>Fully support execution of all operational activities identified in the applicable joint and system integrated architectures and the system must satisfy the technical requirements for Net-Centric military operations to include 1) DISR mandated GIG IT standards and profiles identified in the TV-1, 2) DISR mandated GIG KIPs identified in the KIP declaration table, 3) NCOW RM Enterprise Services 4) Information assurance requirements including availability, integrity, authentication, confidentiality, and nonrepudiation, and issuance of an ATO by the DAA, and 5) Operationally effective information exchanges; and mission critical performance and information assurance attributes, data correctness, data availability, and consistent data processing specified in the applicable joint and system integrated architecture views</p>	<p>Fully support execution of joint critical operational activities identified in the applicable joint and system integrated architectures and the system must satisfy the technical requirements for transition to Net-Centric military operations to include 1) DISR mandated GIG IT standards and profiles identified in the TV-1, 2) DISR mandated GIG KIPs identified in the KIP declaration table, 3) NCOW RM Enterprise Services 4) Information assurance requirements including availability, integrity, authentication, confidentiality, and nonrepudiation, and issuance of an IATO by the DAA, and 5) Operationally effective information exchanges; and mission critical performance and information assurance attributes, data correctness, data availability, and consistent data processing specified in the applicable joint and system integrated architecture views</p>	<p>JITC Memorandum "Mobile User Objective System (MUOS) Net Ready Key Performance Parameter (NR KPP) Interim Status Letter" of May 2, 2013 summarized the interim evaluation of MUOS NR KPP compliance. For the final assessment, JITC will use Information Exchange performance data from both the MUOS second Technical Evaluation and second Multi-service Operational Test and Evaluation events</p>	<p>Fully support execution of joint critical operational activities identified in the applicable joint and system integrated architectures and the system must satisfy the technical requirements for transition to Net-Centric military operations to include 1) DISR mandated GIG IT standards and profiles identified in the TV-1; 2) DISR mandated GIG KIPs identified in the KIP declaration table; 3) NCOW RM Enterprise Services; 4) Information assurance requirements including availability, integrity, authentication, confidentiality, and nonrepudiation, and issuance of an IATO by the DAA; and 5) Operationally effective information exchanges; and mission critical performance and information assurance attributes, data correctness, data availability, and consistent data processing specified in the applicable joint and system integrated architecture views</p>
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Types of Service

<p>Support synchronous and asynchronous broadcast, point-to-</p>	<p>Threshold plus support an asymmetrical multicast</p>	<p>Support synchronous and asynchronous broadcast, point-to-</p>	<p>Transmission of both voice and data via</p>	<p>Support synchronous and asynchronous broadcast, point-to-</p>
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point, and netted communications topologies plus support an asymmetrical multicast communications topology	communications topology	point, and netted communications topologies	broadcast, point-to-point and netted topologies. Services were tested during the PM's capabilities assessment and developmental scenario-based testing	point, and netted communications topologies
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Communications on the Move

Support communications on the move when and where needed in all environments while engaged in combat operations	Support communications on the move when and where needed in all environments while engaged in combat operations	Support communications on the move when and where needed in all environments while engaged in combat operations	Analysis that service requirements can be met in all required environments based on expected user radio performance. Developmental testing during terminal integration phase demonstrated Handheld, Manpack, and Small Form Fit terminals with various antennas in urban and forested environments	Support communications on the move when and where needed in all environments while engaged in combat operations
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Availability

Provide an operational link availability of at least 99% averaged over any year of operation and a constellation availability over the required length of service of at least 90%	Provide an operational link availability of at least 99% averaged over any year of operation and a constellation availability over the required length of service of at least 90%	Provide an operational link availability of at least 97% averaged over any year of operation and a constellation availability over the required length of service of at least 70%	Link availability analysis predicted that all MUOS users will have at least 97% link availability averaged over a year. Constellation availability analysis predicted that the probability of 4 operational satellites on orbit over the required length of service is 87%	Provide an operational link availability of at least 97% averaged over any year of operation and a constellation availability over the required length of service of at least 70%
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Requirements Reference

Capability Production Document (CPD) dated January 15, 2008

Change Explanations

None

Acronyms and Abbreviations

ATO - Approval to Operate
CMTW - Combined Major Theater War
DAA - Designated Approval Authority
DISR - DOD Informational Technology Standards Region
GIG - Global Information Grid
IATO - Interim Approval to Operate
IT - Information Technology
JITC - Joint Interoperability Test Command
KIPs - Key Interface Profiles
Mbps - megabits per second
MPM - MUOS Performance Model
NCOW RM - Net-Centric Operations and Warfare Reference Model
NR - Net Ready
TV-1 - Technical View 1

Track to Budget

RDT&E

Appn	BA	PE
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Navy 1319 07 0303109N

Project	Name
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2472 Mobile User Objective System (MUOS)

Procurement

Appn	BA	PE
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Navy 1507 02 0303109N

Line Item	Name
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2433 Fleet Satellite Communications Follow-On

MILCON

Appn	BA	PE
------	----	----

Navy 1205 01 0301376N

Project	Name
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P131 Facilities Restoration & Mod - Communication (Shared) (Sunk)

Acq O&M

Appn	BA	PE
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Navy 1804 04 0303109N

Project	Name
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4A6M Servicewide Communications (Shared) (Sunk)

Cost and Funding

Cost Summary

Total Acquisition Cost							
Appropriation	BY 2004 \$M			BY 2004 \$M	TY \$M		
	SAR Baseline Production Estimate	Current APB Production Objective/Threshold		Current Estimate	SAR Baseline Production Estimate	Current APB Production Objective	Current Estimate
RDT&E	3245.2	3684.0	4052.4	3604.9	3636.2	4138.2	4057.9
Procurement	2460.3	2354.2	2589.6	2165.4	3104.1	2896.3	2719.9
Flyaway	--	--	--	2165.4	--	--	2719.9
Recurring	--	--	--	2165.4	--	--	2719.9
Non Recurring	--	--	--	0.0	--	--	0.0
Support	--	--	--	0.0	--	--	0.0
Other Support	--	--	--	0.0	--	--	0.0
Initial Spares	--	--	--	0.0	--	--	0.0
MILCON	30.7	30.8	33.9	30.8	34.5	34.6	34.6
Acq O&M	32.7	25.2	27.7	25.2	35.8	26.8	26.8
Total	5768.9	6094.2	N/A	5826.3	6810.6	7095.9	6839.2

Confidence Level

Confidence Level of cost estimate for current APB: 50%

This cost estimate incorporates the 2011 Director, Cost Assessment and Program Evaluation (D,CAPE) Research, Development, Test and Evaluation (RDT&E) estimate (April 2011) which, like all CAPE estimates, carries a confidence level of 50%. The development estimate presented by the CAPE in April 2011, as a result of Acquisition Decision Memorandum (ADM) direction January 2011, like all life-cycle cost estimates previously performed by the CAPE, is built upon a product-oriented work breakdown structure, based on historical actual cost information to the maximum extent possible, and, most importantly, based on conservative assumptions that are consistent with actual demonstrated contractor and government performance for a series of acquisition programs in which the Department has been successful.

It is difficult to calculate mathematically the precise confidence levels associated with life-cycle cost estimates prepared for Major Defense Acquisition Programs (MDAPs). Based on the rigor in methods used in building estimates, the strong adherence to the collection and use of historical cost information, and the review of applied assumptions, we project that it is about equally likely that the estimate will prove too low or too high for execution of the program described. The program office's estimate for Procurement and Sustainment activities (December 2011), like the RDT&E estimate, was completed with a 50% confidence level.

Total Quantity			
Quantity	SAR Baseline Production Estimate	Current APB Production	Current Estimate
RDT&E	2	2	2
Procurement	4	4	4
Total	6	6	6

Quantity Notes

The units of measure for the MUOS program consist of six satellites, six launch vehicles, the entire ground system, and the associated support.

Cost and Funding

Funding Summary

Appropriation Summary									
FY 2017 President's Budget / December 2015 SAR (TY\$ M)									
Appropriation	Prior	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	To Complete	Total
RDT&E	3971.6	3.1	0.0	0.0	0.0	0.0	0.0	83.2	4057.9
Procurement	2009.4	2.6	0.0	0.0	0.0	0.0	0.0	707.9	2719.9
MILCON	34.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	34.6
Acq O&M	26.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	26.8
PB 2017 Total	6042.4	5.7	0.0	0.0	0.0	0.0	0.0	791.1	6839.2
PB 2016 Total	6064.4	56.1	21.7	22.6	23.3	23.8	58.3	1012.6	7282.8
Delta	-22.0	-50.4	-21.7	-22.6	-23.3	-23.8	-58.3	-221.5	-443.6

Funding Notes

Funds for sustainment were identified within acquisition costs in prior SAR submissions. The funding profile within this SAR submission accurately categorizes O&S costs. The total amount moved from acquisition to O&S costs is \$562.4M (TY) (RDT&E: \$218.4M TY, Weapons Procurement, Navy (WPN): \$344M TY). However, the Total Appropriation Summary Delta of \$443.6M (TY) does not match the O&S cost of \$562.4M (TY) because total WPN increased by \$118.8M (TY) in FY 2017 PB, all of which is O&S costs.

Quantity Summary										
FY 2017 President's Budget / December 2015 SAR (TY\$ M)										
Quantity	Undistributed	Prior	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	To Complete	Total
Development	2	0	0	0	0	0	0	0	0	2
Production	0	3	0	0	0	0	0	0	1	4
PB 2017 Total	2	3	0	0	0	0	0	0	1	6
PB 2016 Total	2	3	0	0	0	0	0	0	1	6
Delta	0	0	0	0	0	0	0	0	0	0

Cost and Funding

Annual Funding By Appropriation

Annual Funding							
1319 RDT&E Research, Development, Test, and Evaluation, Navy							
Fiscal Year	Quantity	TY \$M					
		End Item Recurring Flyaway	Non End Item Recurring Flyaway	Non Recurring Flyaway	Total Flyaway	Total Support	Total Program
2000	--	--	--	--	--	--	8.6
2001	--	--	--	--	--	--	27.1
2002	--	--	--	--	--	--	32.5
2003	--	--	--	--	--	--	67.0
2004	--	--	--	--	--	--	84.4
2005	--	--	--	--	--	--	375.2
2006	--	--	--	--	--	--	449.5
2007	--	--	--	--	--	--	637.2
2008	--	--	--	--	--	--	591.3
2009	--	--	--	--	--	--	497.0
2010	--	--	--	--	--	--	398.3
2011	--	--	--	--	--	--	391.4
2012	--	--	--	--	--	--	224.2
2013	--	--	--	--	--	--	141.2
2014	--	--	--	--	--	--	34.9
2015	--	--	--	--	--	--	11.8
2016	--	--	--	--	--	--	3.1
2017	--	--	--	--	--	--	--
2018	--	--	--	--	--	--	--
2019	--	--	--	--	--	--	--
2020	--	--	--	--	--	--	--
2021	--	--	--	--	--	--	--
2022	--	--	--	--	--	--	13.5
2023	--	--	--	--	--	--	69.7
Subtotal	2	--	--	--	--	--	4057.9

Annual Funding							
1319 RDT&E Research, Development, Test, and Evaluation, Navy							
Fiscal Year	Quantity	BY 2004 \$M					
		End Item Recurring Flyaway	Non End Item Recurring Flyaway	Non Recurring Flyaway	Total Flyaway	Total Support	Total Program
2000	--	--	--	--	--	--	9.0
2001	--	--	--	--	--	--	28.0
2002	--	--	--	--	--	--	33.2
2003	--	--	--	--	--	--	67.5
2004	--	--	--	--	--	--	82.7
2005	--	--	--	--	--	--	358.3
2006	--	--	--	--	--	--	416.3
2007	--	--	--	--	--	--	576.0
2008	--	--	--	--	--	--	524.9
2009	--	--	--	--	--	--	435.6
2010	--	--	--	--	--	--	344.0
2011	--	--	--	--	--	--	330.1
2012	--	--	--	--	--	--	186.0
2013	--	--	--	--	--	--	115.9
2014	--	--	--	--	--	--	28.3
2015	--	--	--	--	--	--	9.4
2016	--	--	--	--	--	--	2.4
2017	--	--	--	--	--	--	--
2018	--	--	--	--	--	--	--
2019	--	--	--	--	--	--	--
2020	--	--	--	--	--	--	--
2021	--	--	--	--	--	--	--
2022	--	--	--	--	--	--	9.5
2023	--	--	--	--	--	--	47.8
Subtotal	2	--	--	--	--	--	3604.9

FY 2017 PB RDT&E Controls (TY): \$4276.3M
Total RDT&E Acquisition (TY): \$4,057.9M

RDT&E O&S (TY):

FY 2016 - \$13.0M

FY 2017 - \$13.9M

FY 2018 - \$13.9M

FY 2019 - \$13.2M

FY 2020 - \$13.0M

FY 2021 - \$13.2M

FY 2022 - \$33.9M

FY 2023 - \$32.6M

FY 2024 - \$21.0M

FY 2025 - \$21.4M

FY 2026 - \$21.8M

FY 2027 - \$7.5M

Total RDT&E O&S (TY): \$218.4M

Total RDT&E O&S (BY 2004): \$153.5M

Annual Funding 1507 Procurement Weapons Procurement, Navy								
Fiscal Year	Quantity	TY \$M						
		End Item Recurring Flyaway	Non End Item Recurring Flyaway	Non Recurring Flyaway	Total Flyaway	Total Support	Total Program	
2008	--	203.7	--	--	203.7	--	203.7	
2009	1	339.5	--	--	339.5	--	339.5	
2010	1	509.9	--	--	509.9	--	509.9	
2011	1	494.7	--	--	494.7	--	494.7	
2012	--	238.2	--	--	238.2	--	238.2	
2013	--	21.4	--	--	21.4	--	21.4	
2014	--	13.8	--	--	13.8	--	13.8	
2015	--	188.2	--	--	188.2	--	188.2	
2016	--	2.6	--	--	2.6	--	2.6	
2017	--	--	--	--	--	--	--	
2018	--	--	--	--	--	--	--	
2019	--	--	--	--	--	--	--	
2020	--	--	--	--	--	--	--	
2021	--	--	--	--	--	--	--	
2022	--	--	--	--	--	--	--	
2023	--	49.0	--	--	49.0	--	49.0	
2024	1	658.9	--	--	658.9	--	658.9	
Subtotal	4	2719.9	--	--	2719.9	--	2719.9	

Annual Funding 1507 Procurement Weapons Procurement, Navy								
Fiscal Year	Quantity	BY 2004 \$M						
		End Item Recurring Flyaway	Non End Item Recurring Flyaway	Non Recurring Flyaway	Total Flyaway	Total Support	Total Program	
2008	--	179.0	--	--	179.0	--	179.0	
2009	1	294.1	--	--	294.1	--	294.1	
2010	1	434.3	--	--	434.3	--	434.3	
2011	1	413.4	--	--	413.4	--	413.4	
2012	--	196.1	--	--	196.1	--	196.1	
2013	--	17.4	--	--	17.4	--	17.4	
2014	--	11.0	--	--	11.0	--	11.0	
2015	--	148.4	--	--	148.4	--	148.4	
2016	--	2.0	--	--	2.0	--	2.0	
2017	--	--	--	--	--	--	--	
2018	--	--	--	--	--	--	--	
2019	--	--	--	--	--	--	--	
2020	--	--	--	--	--	--	--	
2021	--	--	--	--	--	--	--	
2022	--	--	--	--	--	--	--	
2023	--	33.1	--	--	33.1	--	33.1	
2024	1	436.6	--	--	436.6	--	436.6	
Subtotal	4	2165.4	--	--	2165.4	--	2165.4	

FY 2017 PB WPN Controls (TY): \$3063.9M
 Total WPN Acquisition (TY): \$2719.9M

Procurement O&S (TY):

FY 2014 - \$3.1M
 FY 2015 - \$18.5M
 FY 2016 - \$31.7M
 FY 2017 - \$36.7M
 FY 2018 - \$46.1M
 FY 2019 - \$41.9M
 FY 2020 - \$40.3M
 FY 2021 - \$37.5M
 FY 2022 - \$12.4M
 FY 2023 - \$14.5M
 FY 2024 - \$21.2M
 FY 2025 - \$13.4M
 FY 2026 - \$13.7M
 FY 2027 - \$13.0M

Total Procurement O&S (TY): \$344.0M
 Total Procurement O&S (BY 2004): \$247.9M

Cost Quantity Information		
1507 Procurement Weapons Procurement, Navy		
Fiscal Year	Quantity	End Item Recurring Flyaway (Aligned With Quantity) BY 2004 \$M
2008	--	--
2009	1	446.5
2010	1	433.4
2011	1	437.5
2012	--	--
2013	--	--
2014	--	--
2015	--	--
2016	--	--
2017	--	--
2018	--	--
2019	--	--
2020	--	--
2021	--	--
2022	--	--
2023	--	--
2024	1	848.0
Subtotal	4	2165.4

Annual Funding 1205 MILCON Military Construction, Navy and Marine Corps	
Fiscal Year	TY \$M
	Total Program
2007	26.1
2008	8.5
Subtotal	34.6

Annual Funding 1205 MILCON Military Construction, Navy and Marine Corps	
Fiscal Year	BY 2004 \$M
	Total Program
2007	23.3
2008	7.5
<hr/>	
Subtotal	30.8

Annual Funding 1804 Acq O&M Operation and Maintenance, Navy	
Fiscal Year	TY \$M
	Total Program
2002	4.2
2003	4.6
2004	4.5
2005	--
2006	--
2007	--
2008	4.6
2009	5.0
2010	3.9
Subtotal	26.8

Annual Funding 1804 Acq O&M Operation and Maintenance, Navy	
Fiscal Year	BY 2004 \$M
	Total Program
2002	4.3
2003	4.6
2004	4.4
2005	--
2006	--
2007	--
2008	4.1
2009	4.4
2010	3.4
Subtotal	25.2

Low Rate Initial Production

There is no LRIP for this program.

Foreign Military Sales

None

Nuclear Costs

None

Unit Cost

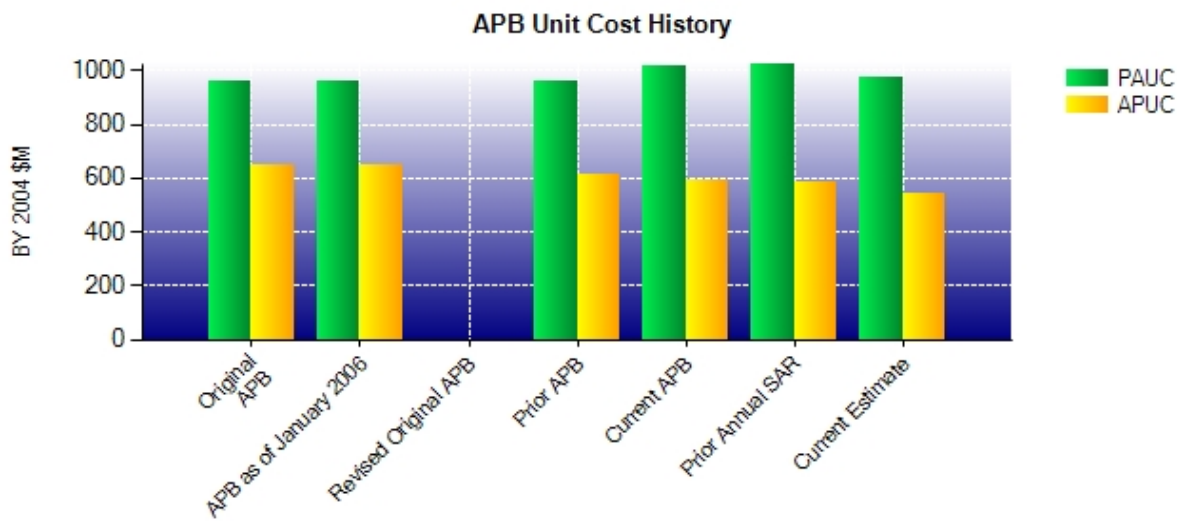
Unit Cost Report

Item	BY 2004 \$M	BY 2004 \$M	% Change
	Current UCR Baseline (Jul 2012 APB)	Current Estimate (Dec 2015 SAR)	
Program Acquisition Unit Cost			
Cost	6094.2	5826.3	
Quantity	6	6	
Unit Cost	1015.700	971.050	-4.40
Average Procurement Unit Cost			
Cost	2354.2	2165.4	
Quantity	4	4	
Unit Cost	588.550	541.350	-8.02

Item	BY 2004 \$M	BY 2004 \$M	% Change
	Original UCR Baseline (Dec 2004 APB)	Current Estimate (Dec 2015 SAR)	
Program Acquisition Unit Cost			
Cost	5738.0	5826.3	
Quantity	6	6	
Unit Cost	956.333	971.050	+1.54
Average Procurement Unit Cost			
Cost	2591.0	2165.4	
Quantity	4	4	
Unit Cost	647.750	541.350	-16.43

PAUC reflects the sum of six satellites, six launch vehicles, the entire ground segment, and the associated support, divided by the total quantity of six. APUC reflects the sum of four satellites and six launch vehicles, divided by a procurement quantity of four.

Unit Cost History



Item	Date	BY 2004 \$M		TY \$M	
		PAUC	APUC	PAUC	APUC
Original APB	Dec 2004	956.333	647.750	1080.183	776.025
APB as of January 2006	Dec 2004	956.333	647.750	1080.183	776.025
Revised Original APB	N/A	N/A	N/A	N/A	N/A
Prior APB	Mar 2008	961.483	615.075	1135.100	776.025
Current APB	Jul 2012	1015.700	588.550	1182.650	724.075
Prior Annual SAR	Dec 2014	1023.600	582.025	1213.800	736.275
Current Estimate	Dec 2015	971.050	541.350	1139.867	679.975

SAR Unit Cost History

Initial SAR Baseline to Current SAR Baseline (TY \$M)									
Initial PAUC Development Estimate	Changes								PAUC Production Estimate
	Econ	Qty	Sch	Eng	Est	Oth	Spt	Total	
1080.183	49.000	0.000	2.750	0.000	3.167	0.000	0.000	54.917	1135.100

Current SAR Baseline to Current Estimate (TY \$M)									
PAUC Production Estimate	Changes								PAUC Current Estimate
	Econ	Qty	Sch	Eng	Est	Oth	Spt	Total	
1135.100	-16.567	0.000	11.683	34.451	-24.800	0.000	0.000	4.767	1139.867

Initial SAR Baseline to Current SAR Baseline (TY \$M)									
Initial APUC Development Estimate	Changes								APUC Production Estimate
	Econ	Qty	Sch	Eng	Est	Oth	Spt	Total	
776.025	39.100	0.000	4.125	0.000	-43.225	0.000	0.000	0.000	776.025

Current SAR Baseline to Current Estimate (TY \$M)									
APUC Production Estimate	Changes								APUC Current Estimate
	Econ	Qty	Sch	Eng	Est	Oth	Spt	Total	
776.025	-20.875	0.000	17.150	0.000	-92.325	0.000	0.000	-96.050	679.975

SAR Baseline History					
Item	SAR Planning Estimate	SAR Development Estimate	SAR Production Estimate	Current Estimate	
Milestone A	N/A	N/A	N/A	N/A	
Milestone B	N/A	Sep 2004	Sep 2004	Sep 2004	
Milestone C	N/A	Oct 2006	Oct 2006	Aug 2006	
IOC	N/A	N/A	N/A	N/A	
Total Cost (TY \$M)	N/A	6481.1	6810.6	6839.2	
Total Quantity	N/A	6	6	6	
PAUC	N/A	1080.183	1135.100	1139.867	

Milestone (MS) B and C dates reflect National Security Space Acquisition Policy 03-01 dates for Key Decision Point B and C, not MS B and C as specified in DoD 5000.02.

Build Approval was authorized February 2008.

IOC is synonymous with the term On-Orbit Capability, which is referenced by the MUOS Program.

Cost Variance

Summary TY \$M					
Item	RDT&E	Procurement	MILCON	Acq O&M	Total
SAR Baseline (Production Estimate)	3636.2	3104.1	34.5	35.8	6810.6
Previous Changes					
Economic	-13.2	-74.5	+0.1	+0.1	-87.5
Quantity	--	--	--	--	--
Schedule	+1.5	+47.8	--	--	+49.3
Engineering	+206.7	--	--	--	+206.7
Estimating	+445.1	-132.3	--	-9.1	+303.7
Other	--	--	--	--	--
Support	--	--	--	--	--
Subtotal	+640.1	-159.0	+0.1	-9.0	+472.2
Current Changes					
Economic	-2.9	-9.0	--	--	-11.9
Quantity	--	--	--	--	--
Schedule	--	+20.8	--	--	+20.8
Engineering	--	--	--	--	--
Estimating	-215.5	-237.0	--	--	-452.5
Other	--	--	--	--	--
Support	--	--	--	--	--
Subtotal	-218.4	-225.2	--	--	-443.6
Total Changes	+421.7	-384.2	+0.1	-9.0	+28.6
CE - Cost Variance	4057.9	2719.9	34.6	26.8	6839.2
CE - Cost & Funding	4057.9	2719.9	34.6	26.8	6839.2

Summary BY 2004 \$M					
Item	RDT&E	Procurement	MILCON	Acq O&M	Total
SAR Baseline (Production Estimate)	3245.2	2460.3	30.7	32.7	5768.9
Previous Changes					
Economic	--	--	--	--	--
Quantity	--	--	--	--	--
Schedule	-0.4	+2.5	--	--	+2.1
Engineering	+144.9	--	--	--	+144.9
Estimating	+367.8	-134.7	+0.1	-7.5	+225.7
Other	--	--	--	--	--
Support	--	--	--	--	--
Subtotal	+512.3	-132.2	+0.1	-7.5	+372.7
Current Changes					
Economic	--	--	--	--	--
Quantity	--	--	--	--	--
Schedule	-1.5	--	--	--	-1.5
Engineering	--	--	--	--	--
Estimating	-151.1	-162.7	--	--	-313.8
Other	--	--	--	--	--
Support	--	--	--	--	--
Subtotal	-152.6	-162.7	--	--	-315.3
Total Changes	+359.7	-294.9	+0.1	-7.5	+57.4
CE - Cost Variance	3604.9	2165.4	30.8	25.2	5826.3
CE - Cost & Funding	3604.9	2165.4	30.8	25.2	5826.3

Previous Estimate: December 2014

RDT&E	\$M	
Current Change Explanations	Base Year	Then Year
Revised escalation indices. (Economic)	N/A	-2.9
Adjustment for current and prior escalation. (Estimating)	+1.0	+1.1
Stretch-out of procurement buy-profile from FY 2021 - FY 2022 to FY 2022 - FY 2023 in support of procurement of sixth satellite. (Schedule)	-1.5	0.0
Removal of previously identified acquisition cost to program sustainment efforts. (Estimating)	-153.5	-218.4
Revised estimate for miscellaneous budget adjustments from FY 2015 through FY 2027. (Estimating)	+1.4	+1.8
RDT&E Subtotal	-152.6	-218.4

Procurement	\$M	
Current Change Explanations	Base Year	Then Year
Revised escalation indices. (Economic)	N/A	-9.0
Adjustment for current and prior escalation. (Estimating)	+1.8	+2.2
Stretch-out of procurement buy-profile from FY 2023 to FY 2024 for advance procurement of sixth satellite. (Schedule)	0.0	+20.8
Revised estimate due to Congressional plus ups. (Estimating)	+87.6	+118.8
Removal of previously identified acquisition cost to program sustainment efforts. (Estimating)	-247.9	-344.0
Revised estimate for miscellaneous budget adjustments from FY 2016 through FY 2027. (Estimating)	-4.2	-14.0
Procurement Subtotal	-162.7	-225.2

Contracts

Contract Identification

Appropriation: Procurement
Contract Name: MUOS RRDD AOS Contract - CLIN 3
Contractor: Lockheed Martin (LMSSC)
Contractor Location: 1111 Lockheed Martin Way
 Sunnyvale, CA 94089-1212
Contract Number: N00039-04-C-2009/3
Contract Type: Fixed Price Incentive(Firm Target) (FPIF)
Award Date: September 24, 2004
Definitization Date: September 24, 2004

Contract Price							
Initial Contract Price (\$M)			Current Contract Price (\$M)			Estimated Price At Completion (\$M)	
Target	Ceiling	Qty	Target	Ceiling	Qty	Contractor	Program Manager
279.0	298.5	1	282.5	332.5	1	332.6	332.5

Target Price Change Explanation

The difference between the Initial Contract Price Target and the Current Contract Price Target is due to the inclusion of a contract Engineering Change Proposal.

Contract Variance		
Item	Cost Variance	Schedule Variance
Cumulative Variances To Date (5/31/2015)	-10.4	-19.1
Previous Cumulative Variances	-6.1	-22.8
Net Change	-4.3	+3.7

Cost and Schedule Variance Explanations

The unfavorable net change in the cost variance is due to the continued cost impact of the Output Multiplexer (OMUX) failure, repair and replacement, and re-testing, as well as level of effort tasks performed beyond baseline completion.

The favorable net change in the schedule variance is due to sustained recovery to the baseline plan with the restart of Single Line Flow after the replacement OMUX was installed on the satellite.

Notes

The final Cost Performance Report for CLIN 0003 was submitted June 25, 2015 for month end May 2015 contract and EVM data. Per contract modification P00236 dated August 12, 2015 further submittals of EVM contract deliverables for CLIN 0003 are no longer required as of July 10, 2015.

CLIN 0003 supports the milestone "5th Satellite Ready to Ship".

This contract is more than 90% complete; therefore, this is the final report for this contract.

Contract Identification

Appropriation: Procurement
Contract Name: MUOS RRDD AOS Contract – CLIN 5
Contractor: Lockheed Martin (LMSSC)
Contractor Location: 1111 Lockheed Martin Way
 Sunnyvale, CA 94089-1212
Contract Number: N00039-04-C-2009/5
Contract Type: Fixed Price Incentive(Firm Target) (FPIF)
Award Date: September 24, 2004
Definitization Date: September 24, 2004

Contract Price							
Initial Contract Price (\$M)			Current Contract Price (\$M)			Estimated Price At Completion (\$M)	
Target	Ceiling	Qty	Target	Ceiling	Qty	Contractor	Program Manager
287.7	307.7	1	277.8	324.7	1	325.2	324.7

Target Price Change Explanation

The difference between the Initial Contract Price Target and the Current Contract Price Target is due to the change in methodology to align the target price to the Contract Performance Report data reported by the Prime Contractor, which excludes \$9.9M Mission Success Fee. In previous SAR submissions, the Mission Success Fee was included in the target price. In accordance with guidance, the Original Target Price remains unchanged, and continues to include the \$9.9M of Fee.

Contract Variance		
Item	Cost Variance	Schedule Variance
Cumulative Variances To Date (5/31/2015)	-7.4	-4.2
Previous Cumulative Variances	+1.1	-10.7
Net Change	-8.5	+6.5

Cost and Schedule Variance Explanations

The unfavorable net change in the cost variance is due to increased efforts for on orbit observation analysis, as well as the incurrence of Launch Operations, Program Support, and System Engineering, Integration, and Test level of effort tasks performed beyond baseline completion.

The favorable net change in the schedule variance is due to the recovery to the baseline plan as late tasks driven by the overall launch schedule delays were completed

Notes

The final Cost Performance Report for CLIN 0005 was submitted June 25, 2015 for month end May 2015 contract and EVM data. Per contract modification P00236 dated August 12, 2015 further submittals of EVM contract deliverables for CLIN 0005 are no longer required as of July 10, 2015.

CLIN 0005 supported the "3rd Satellite Ready to Ship" milestone.

This contract is more than 90% complete; therefore, this is the final report for this contract.

Contract Identification

Appropriation: Procurement
Contract Name: MUOS RRDD AOS Contract – CLIN 7
Contractor: Lockheed Martin (LMSSC)
Contractor Location: 1111 Lockheed Martin Way
 Sunnyvale, CA 94089-1212
Contract Number: N00039-04-C-2009/7
Contract Type: Fixed Price Incentive(Firm Target) (FPIF)
Award Date: September 24, 2004
Definitization Date: September 24, 2004

Contract Price							
Initial Contract Price (\$M)			Current Contract Price (\$M)			Estimated Price At Completion (\$M)	
Target	Ceiling	Qty	Target	Ceiling	Qty	Contractor	Program Manager
288.5	339.6	1	288.5	339.6	1	333.0	339.6

Contract Variance		
Item	Cost Variance	Schedule Variance
Cumulative Variances To Date (5/31/2015)	+15.7	-13.6
Previous Cumulative Variances	+20.1	-12.1
Net Change	-4.4	-1.5

Cost and Schedule Variance Explanations

The unfavorable net change in the cost variance is due to the Assembly, Integration, and Test Single Line Flow extension for technical issues associated with several components including Solar Array trim tabs and Uplink/Downlink Unit.

The unfavorable net change in the schedule variance is due to the delay of on orbit testing efforts performed by System Engineering, Integration, and Test.

Notes

The final Cost Performance Report for CLIN 0007 was submitted June 25, 2015 for month end May 2015 contract and EVM data. Per contract modification P00236 dated August 12, 2015 further submittals of EVM contract deliverables for CLIN 0007 are no longer required as of July 10, 2015.

CLIN 0007 supported the "4th Satellite Ready to Ship" milestone.

This contract is more than 90% complete; therefore, this is the final report for this contract.

Deliveries and Expenditures

Deliveries					
Delivered to Date	Planned to Date	Actual to Date	Total Quantity	Percent Delivered	
Development	2	2	2	100.00%	
Production	3	2	4	50.00%	
Total Program Quantity Delivered	5	4	6	66.67%	

Expended and Appropriated (TY \$M)			
Total Acquisition Cost	6839.2	Years Appropriated	17
Expended to Date	5826.0	Percent Years Appropriated	68.00%
Percent Expended	85.19%	Appropriated to Date	6048.1
Total Funding Years	25	Percent Appropriated	88.43%

The above data is current as of February 29, 2016.

Operating and Support Cost

Cost Estimate Details

Date of Estimate:	October 15, 2015
Source of Estimate:	POE
Quantity to Sustain:	6
Unit of Measure:	Ground Station
Service Life per Unit:	17.00 Years
Fiscal Years in Service:	FY 2011 - FY 2027

The MUOS constellation consists of five satellites, four operational and one on-orbit spare. In addition, the APB includes procurement of a sixth satellite to replace the first satellite at end-of-life. MUOS O&S costs include sustainment of all satellites and six ground sites located in Wahiawa (Hawaii), Chesapeake (Virginia), Niscemi (Italy), Geraldton (Australia), and MUOS Ground System hardware and software at Naval Satellite Operations Center (NAVSOC) Point Mugu (California) and NAVSOC Detachment Delta. O&S reflects primary sustainment of ground stations.

Sustainment Strategy

The MUOS sustainment strategy is based on a Performance Based Logistics plan to optimize total system availability while minimizing cost and logistics footprint. The majority of sustainment work is focused on the sustainment of the MUOS Ground System (hardware and software) from handover of the Ground System in FY 2010 through the program lifecycle (end FY 2027).

Antecedent Information

The antecedent system to MUOS was the Ultra High Frequency (UHF) Follow-on (UFO) satellite communications program. Comparisons of O&S costs for UFO are not provided. Although the MUOS system continues to support UHF capabilities, the infrastructure of MUOS and its sustainment are not comparable to UFO.

Annual O&S Costs BY2004 \$M			
Cost Element	MUOS Average Annual Cost Per Ground Station	UFO (Antecedent) Cost Per Ground Station Per Year	
Unit-Level Manpower	0.000		0.000
Unit Operations	0.000		0.000
Maintenance	0.333		0.000
Sustaining Support	10.123		0.000
Continuing System Improvements	0.000		0.000
Indirect Support	0.715		0.000
Other	0.000		0.000
Total	11.171		--

Changes to unitized costs from prior year SAR are due to FY 2015 update of the O&S estimate.

Item	Total O&S Cost \$M			
	MUOS			UFO (Antecedent)
	Current Production APB Objective/Threshold		Current Estimate	
Base Year	379.9	417.9	1139.4¹	0.0
Then Year	508.2	N/A	1577.8	N/A

¹ APB O&S Cost Breach

Funds for sustainment were identified within acquisition cost in prior SAR submissions. The funding profile within this SAR submission accurately categorizes sustainment costs and aligns them within the O&S estimate. Total O&S costs are comprised of RDT&E, Weapons Procurement, Navy (WPN), and O&M Navy.

Equation to Translate Annual Cost to Total Cost

The unitized annual costs reflect the total O&S cost divided by six ground stations and sustainment of the MUOS Ground System over 17 years (FY 2011 through FY 2027).

O&S Cost Variance		
Category	BY 2004 \$M	Change Explanations
Prior SAR Total O&S Estimates - Dec 2014 SAR	387.5	
Programmatic/Planning Factors	0.0	
Cost Estimating Methodology	0.0	
Cost Data Update	751.9	Studies/test results identified a higher level of Ground System obsolescence than originally projected, resulting in an increase in O&S costs.
Labor Rate	0.0	
Energy Rate	0.0	
Technical Input	0.0	
Other	0.0	
Total Changes	751.9	
Current Estimate	1139.4	

The \$751.9M of O&S Cost Variance includes the correct categorization of \$401.4M (BY 2004) O&S costs that were previously identified as acquisition costs in prior SAR submissions.

Disposal Estimate Details

Date of Estimate: October 15, 2015
Source of Estimate: POE
Disposal/Demilitarization Total Cost (BY 2004 \$M): Total costs for disposal of all Ground Station are 0.0

Satellites will be disposed on-orbit using on-board fuel paid for during the procurement phase of the program. Ground stations will not be disposed of and will be utilized and sustained by follow on program.