RCS: DD-A&T(Q&A)823-447

Military Global Positioning System (GPS) User Equipment Increment 1 (MGUE Inc 1)

As of FY 2021 President's Budget

Defense Acquisition Management
Information Retrieval
(DAMIR)

Table of Contents

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)
USD(A&S) - Under Secretary of Defense (Acquisition and Sustainment)

Program Information

Program Name
Military Global Positioning System (GPS) User Equipment Increment 1 (MGUE Inc 1)

DoD Component
Air Force

This is a United States Space Force program.

Responsible Office

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References

SAR Baseline (Development Estimate)

Defense Acquisition Executive (DAE) Approved Acquisition Program Baseline (APB) dated January 18, 2017

Approved APB

Defense Acquisition Executive (DAE) Approved Acquisition Program Baseline (APB) dated January 18, 2017

Mission and Description

The Global Positioning System (GPS) is a space based Positioning, Navigation, and Timing (PNT) distribution system, which operates through weather and electromagnetic environments (jamming, spoofing, etc.). GPS supports both civil and military users in air, space, sea, and land operations. GPS users process satellite signals to determine accurate position, velocity, and time. GPS must comply with section 2281 of title 10, United States Code (USC), which requires that the Secretary of Defense ensures the continued sustainment and operation of GPS for military and civilian purposes and section 50112 of title 51, USC, which requires that GPS complies with certain standards and facilitates international cooperation.

The objective of the Military GPS User Equipment Increment 1 (MGUE Inc 1) program is to deliver affordable advanced GPS capabilities to military users as rapidly as possible to meet the PNT needs of a broad user base. The MGUE program is developing standard, modernized receiver form factors and will integrate them into the Service nominated lead platforms. This new family of modernized GPS receivers will deliver improved capabilities to counter current and emerging PNT threats and enable military operations in a Navigation Warfare environment.

On December 20, 2019, the President of the United States established the United States Space Force which assumed the responsibility for all major space acquisition programs. This program is now a United States Space Force program.

Executive Summary

Program Highlights Since Last Report

Three contractors are producing MGUE Inc 1 Military Code (M-Code) receivers: L3Harris (L3H) (formerly L3 Technologies), Raytheon (RTN), and Collins Aerospace (formerly Rockwell Collins). All three contractors are producing a ground card, and RTN and Collins Aerospace are producing an aviation/maritime card. After lead platform Operational Test, the Services will procure and sustain MGUE Inc 1 receivers for their lead platforms and any other platforms they choose to equip. To assist the platforms, the GPS User Equipment Division will provide MGUE card-level Integration Guides for the integration of the MGUE GPS Receiver Application Module Standard Electronic Module (GRAM-S/M) and Ground Based GRAM Modernized (GB-GRAM-M) receiver cards.

Last year, the program office reported the issue on discovery of gaps in the formal requirement sell-off plan prior to Integrated System Test 3-3. The revised requirements sell-off plan was implemented and successfully demonstrated with the completion of the first GB-GRAM-M card-level test. The L3H GB-GRAM-M completed final verification testing, and the government successfully accomplished the Technical Requirements Verification (TRV) APB milestone on March 30, 2019. There were six liens to the TRV, which closed by the September 2019 commitment date to the Services.

There is potential loss of Trusted Foundry for MGUE digital Application Specific Integrated Circuits (ASICs). To mitigate this issue, the Program Office placed 14nm ASIC early design work on contract through special studies and continues to work closely with the Defense Micro-Electronics Activity (DMEA) to achieve International Traffic in Arms (ITAR) and Trust compliance for Global Foundries 14nm ASIC design and manufacturing process. GlobalFoundries agreed to Cat1B trust and DASD(SE), Defense Technology Security Administration, and the Department of State continue to lay out ITAR way forward. A contract modification was awarded to current MGUE vendors to conduct Next-Generation ASIC preliminary design activities culminating in three Preliminary Design Reviews (PDR). The first PDR is expected to take place in second quarter FY 2021. The Program Office is also coordinating with DMEA, who is pursuing MGUE ASIC production life extensions with GlobalFoundries. GlobalFoundries has announced end-of-life for L3H lines after FY 2020, for Raytheon after CY 2021, and for Collins Aerospace after CY 2024. The DoD Positioning, Navigation, and Timing Oversight Council agreed Inc 1 technology maturity supports exploration of lifetime buy strategies by the Services. The Defense Logistics Agency is developing a bulk buy acquisition strategy to procure, store, and distribute the MGUE Inc 1 ASIC bulk buy with assistance from the Space Force.

Requirements have evolved since establishing the MGUE APB in January 2017. On March 28, 2017, the joint requirements community sent a legacy weapons initialization (also known as Hot Start) requirements clarification memorandum for Enterprise Hot Start (M-Code only). The program office implemented a Roving Channel solution that enables M-Code receiver equipped platforms to hot-start munitions to acquire GPS signal after launch. The Roving Channel capability was introduced into the technical baselines and all three vendors have delivered Roving Channel capability. Based on a favorable assessment of the capabilities provided by the roving channel hot start solution, the MGUE program office reached an agreement with the Air Force (AF) which resulted in a re-prioritization of post-delivery product improvement Requests for Change (RFCs). The program office will complete the Inc 1 baseline development and higher priority RFCs before considering Enterprise Hot Start implementation, subject to the availability of funds. The agreement reached with the AF does not increase cost and schedule beyond the APB.

RTN GRAM-S/M Build 6 was delivered to the Government on September 3, 2019 without resolving key software deficiencies required for integration. Government test results confirmed Build 6 does not satisfy the minimum capability established by the Navy Arleigh Burke Guided Missile Destroyer (DDG) and AF B-2 lead platforms. Based on RTN's schedule, resolution of the deficiencies extends beyond current APB threshold dates for 1st GRAM-S/M TRV, DDG PEO Certification, and B-2 PEO Certification. On October 31, 2019, the program manager signed a Program Deviation Report to provide formal notification of schedule and cost deviations against the three APB milestones stated above. An Independent Program Assessment and Independent Schedule Risk Assessment will inform an updated APB by March 2020.

History of Significant Developments Since Program Initiation

History of Significant Developments Since Program Initiation	
Date	**Significant Development Description**
May 2003	The Global Positioning System (GPS) Directorate first issued Program Research and Development Announcement (PRDA) contracts in 2003 to achieve technology demonstration of early MGUE concepts.
May 2006	The GPS Program Office continued the work of the PRDA contracts via three competitively awarded Modernized User Equipment development contracts in 2006.
June 2006	The Secretary of the Air Force submitted an Analysis of Alternatives (AoA) providing Congress with a summary of the studies conducted to modernize GPS. The AoA found that developing new Military-Code signals as the most cost effective solution to mitigate growing denial of service and integrity threats to the warfighter.
April 2012	USD(AT&L) approved the Milestone A ADM and 2366a certifications were made for the MGUE Inc 1 program, initiating awarding technology development contracts. Materiel Development Decision approved for Inc 2 and MGUE Inc 2 designated as a pre-MDAP with the Air Force as lead.
September 2012	Competitively awarded three technology development contracts to Raytheon, L-3 Interstate Electronics Corporation, and Rockwell Collins Inc.
February 2014	USD(AT&L) signed an ADM to accelerate the MGUE Inc 1 effort via a combined Milestone B/C. This ADM added software risk reduction efforts and accelerated delivery of security certification and test material into the Technology Development phase of the MGUE Inc 1 program previously planned for the EMD phase.
June 2014	In response to the February 2014 ADM, the GPS Directorate awarded Engineering Change Proposals (ECPs) on all three MGUE Inc 1 development contracts to add software development risk reductions scope.
July 2014	JROC operational requirements approved. Four KPPs identified in the CDD: (1) Positioning, Navigation, and Timing (PNT) Determination, (2) PNT Accuracy, (3) Integrity and (4) Cryptography, Security Architecture, and Key Distribution.
September 2014	MGUE Inc 1 Preliminary Design Reviews were completed by all three MGUE vendors.
November 2014	Completed a MGUE Technology Readiness Assessment indicating all critical technologies were at a Technology Readiness Level of 6 or higher.
January 2015	In response to the February 2014 ADM, the GPS Directorate awarded ECPs on all three MGUE Inc 1 development contracts for additional test hardware deliveries.
April 2015	USD(AT&L) signed an updated Acquisition Strategy capturing accelerated approach.
June 2015	Existing contracts modified again adding resiliency and increasing software assurance.
October 2016	L3 Technologies (L3T) became the first MGUE contractor to receive security and compatibility certification.
January 2017	USD(AT&L) approved the MGUE Inc 1 2366B certifications and determinations, the Milestone B APB and ADM, and established MGUE Inc 1 as an ACAT ID MDAP. The ADM also relieved the program of Milestone C as production decisions will be made by the hosting platforms.
March 2017	PEO Ammunition conducted a Live Fire event at Yuma Proving Ground to assess the maturity of MGUE Inc 1 technology for Precision Guided Munitions (PGMs). Conducted a combination of 5 ballistic trajectory shots and 3 First-Ever M-Code Guide-to-Hit test shots for each of the two vendors using a U.S. government-designed 81mm Mortar PGM.
July 2017	Four B-2 Developmental flight tests to confirm B-2 Operational Flight Program compatibility using

	an MGUE-based prototype Miniature Airborne Global Positioning System Receiver 2000 M-Code completed on July 14, 2017.
November 2017	USD(AT&L) delegated the MDA to the Secretary of the Air Force as an ACAT IC.
December 2017	All three MGUE contracts updated with ECP 4 for Roving Channel Hot Start modification.
May 2018	Completed the 1st edition MGUE Integration Guides, fulfilling an MGUE Increment 1 APB Exit Criteria.
May 2018	US Navy Communications and Navigation GPS Program Office awarded a contract modification to support M-Code Integration efforts aligning the GPS-based PNT Service development effort with MGUE program objectives and delivery schedules with Roving Channel Hot Start capabilities.
June 2018	United States Marine Corps (USMC) Joint Light Tactical Vehicle (JLTV) Joint Program Office delivered the five JLTVs to be used for the upcoming USMC lead platform integration.
August 2018	L3T's Ground Based GPS Receiver Applications Module (GB-GRAM) Modernized (GB-GRAM-M) card successfully completed Electromagnetic Interference/Electromagnetic Compatibility, Environmental, and Reliability testing.
August 2018	L3T received GB-GRAM-M delta security certification.
September 2018	L3T received GB-GRAM-M delta security approval.
November 2018	Raytheon received GPS Receiver Application Module Standard Electronic Module (GRAM-S/M) initial security certification.
March 2019	In March 2019, the US Army conducted a very successful "live-fire" test of a Precision Guidance Kit with a L3H (L3Harris) MGUE Inc 1 Application Specific Integrated Circuit (ASIC). The successful test gave the Army confidence to move out on a substantial Inc 1 ASIC procurement in late FY 2019.
July 2019	All three MGUE contracts were updated with ECP-6. Raytheon ECP 6 was awarded on June 24, 2019, L3H on June 28, 2019, and Collins Aerospace on July 31, 2019.
September 2019	Collins Aerospace GB-GRAM-M achieved the 10,000 hours reliability requirement at the US Army Electronic Proving Ground test facility in Fort Huachuca, AZ on September 19, 2019.
September 2019	L3H GB-GRAM-M card successfully closed all remaining TRV liens on September 30, 2019.
October 2019	L3H GB-GRAM-M was granted Delta Security Certification on September 13, 2019 and Security Approval on October 6, 2019.
October 2019	The program manager signed a program deviation report on October 31, 2019 indicating the first GRAM-S/M TRV, DDG PEO Certification, and B-2 PEO Certification events will extend beyond current APB threshold dates.

Threshold Breaches

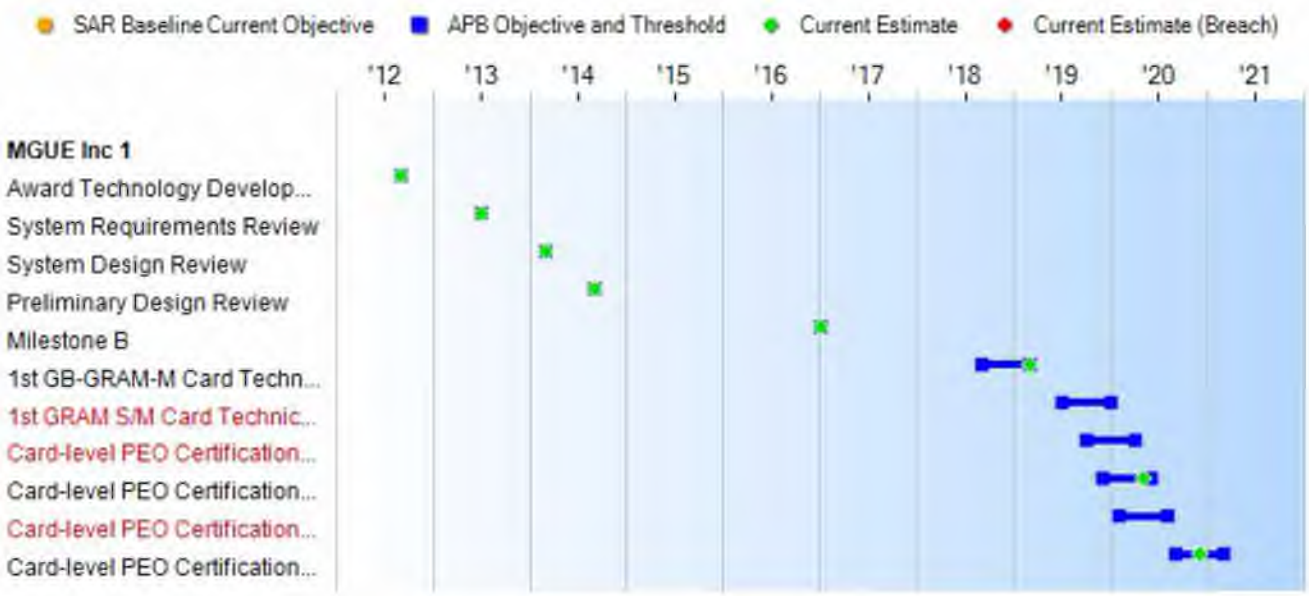
APB Breaches		
Schedule		☑
Performance		☐
Cost	RDT&E	☐
	Procurement	☐
	MILCON	☐
	Acq O&M	☐
O&S Cost		☐
Unit Cost	PAUC	☐
	APUC	☐

Nunn-McCurdy Breaches		
Current UCR Baseline		
	PAUC	None
	APUC	None
Original UCR Baseline		
	PAUC	None
	APUC	None

Explanation of Breach

On October 31, 2019, the program manager provided formal notification of a schedule deviation against the following APB milestones: (1) 1st GPS Receiver Application Module Standard Electronic Module Card Technical Requirements Verification (2) Card -level PEO Certification for the Navy Arleigh Burke Guided Missile Destroyer (DDG), and (3) Card-level PEO Certification for B-2. Initial government test results of the 1st aviation/maritime receiver confirmed a level of maturity that is insufficient and does not satisfy the Service requirements or minimum capability established by the DDG and Air Force B-2 programs. Resolution of technical deficiencies extends beyond the current APB schedule milestone threshold date. The Program Office will be conducting an Independent Schedule Risk Assessment (ISRA) to provide new objective and threshold dates to the breached milestones that will feed into a new cost estimate. Until that happens, the Program Office cannot accurately and confidently provide a current estimate and will continue to carry TBD as the current estimate. ISRA estimated completion date is March 2020.

Schedule



Schedule Events					
Events	**SAR Baseline Development Estimate**	**Current APB Development Objective**	**Current APB Threshold**	**Current Estimate**	
Award Technology Development Contract	Sep 2012	Sep 2012	Sep 2012	Sep 2012	
System Requirements Review	Jul 2013	Jul 2013	Jul 2013	Jul 2013	
System Design Review	Mar 2014	Mar 2014	Mar 2014	Mar 2014	
Preliminary Design Review	Sep 2014	Sep 2014	Sep 2014	Sep 2014	
Milestone B	Jan 2017	Jan 2017	Jan 2017	Jan 2017	
1st GB-GRAM-M Card Technical Requirements Verification	Sep 2018	Sep 2018	Mar 2019	Mar 2019	
1st GRAM S/M Card Technical Requirements Verification	Jul 2019	Jul 2019	Jan 2020	**TBD**[1]	(Ch-1)
Card-level PEO Certification for DDG	Oct 2019	Oct 2019	Apr 2020	**TBD**[1]	(Ch-1)
Card-level PEO Certification for JLTV	Dec 2019	Dec 2019	Jun 2020	May 2020	(Ch-2)
Card-level PEO Certification for B-2	Feb 2020	Feb 2020	Aug 2020	**TBD**[1]	(Ch-1)
Card-level PEO Certification for Stryker	Sep 2020	Sep 2020	Mar 2021	Dec 2020	(Ch-3)

[1] *APB Breach*

Change Explanations

(Ch-1) The 1st GRAM S/M Card Technical Requirement Verification has changed from October 2019 to TBD, the Card-level PEO Certification for DDG has changed from March 2020 to TBD, and the Card-level PEO Certification for B-2 has changed from October 2020 to TBD due to the immaturity and insufficiency of the card to satisfy service requirements by the Navy Arlight Burke Guided Missile Destroyer and the Air Force B-2 programs. On October 31, 2019, the program has declared an APB breach.
(Ch-2) The card-level PEO Certification for JLTV changed from February 2020 to May 2020 due to integration and testing delays associated with the host application. Margin still remains to the APB threshold date.
(Ch-3) The card-level PEO Certification for Stryker went from October 2020 to December 2020 due to hardware (V9A) delivery delays.

Acronyms and Abbreviations

B-2 - US Air Force B-2 Bomber
DDG - Arleigh Burke Class Guided Missile Destroyer
GB-GRAM-M - Ground Based GRAM Modernized
GRAM - GPS Receiver Applications Module
GRAM S/M - GRAM Standard Electronic Module
JLTV - US Marine Corps Joint Light Tactical Vehicle

Performance

Performance Characteristics				
SAR Baseline Development Estimate	**Current APB Development Objective/Threshold**		**Demonstrated Performance**	**Current Estimate**
PNT Determination				
MGUE shall use M-Code, P(Y)-Code, and C/ACode; MGUE shall be capable of acquiring M-Code in the presence of J/S≤ 41 dB; MGUE shall use GPS signals needed to determine PNT in BFEA environments.	MGUE shall use M-Code, P(Y)-Code, and C/ACode; MGUE shall be capable of acquiring M-Code in the presence of J/S≤ 41 dB; MGUE shall use GPS signals needed to determine PNT in BFEA environments.	(T=O) MGUE shall use M-Code, P(Y)-Code, and C/ACode; MGUE shall be capable of acquiring M-Code in the presence of J/S≤ 41 dB; MGUE shall use GPS signals needed to determine PNT in BFEA environments.	TBD	MGUE shall use M-Code, P(Y)-Code, and C/ACode; MGUE shall be capable of acquiring M-Code in the presence of J/S≤ 41 dB; MGUE shall use GPS signals needed to determine PNT in BFEA environments.
PNT Accuracy				
Ground: 10.0 m H, 20.0 m V, 0.1 m/s (velocity, per axis) and 100 nsec; Aviation: 3.0 m H, 5.25 m V and 30 nsec; Maritime: 7.0 m H, 12.5 m V and 50 nsec.	Ground: 10.0 m H, 20.0 m V, 0.1 m/s (velocity, per axis) and 100 nsec; Aviation: 3.0 m H, 5.25 m V and 30 nsec; Maritime: 7.0 m H, 12.5 m V and 50 nsec.	(T=O) Ground: 10.0 m H, 20.0 m V, 0.1 m/s (velocity, per axis) and 100 nsec; Aviation: 3.0 m H, 5.25 m V and 30 nsec; Maritime: 7.0 m H, 12.5 m V and 50 nsec.	TBD	Ground: 10.0 m H, 20.0 m V, 0.1 m/s (velocity, per axis) and 100 nsec; Aviation: 3.0 m H, 5.25 m V and 30 nsec; Maritime: 7.0 m H, 12.5 m V and 50 nsec.
Integrity				
Ground: MGUE shall reject invalid GPS signals 99% of the time so they are not used in the PNT solution; MGUE shall detect and reject MSI provided from GPS satellites and reject that data from the PNT solution. Aviation: MGUE shall report when GPS should not be used for PNT. Maritime: MGUE shall report when GPS should not be used for PNT.	Ground: MGUE shall reject invalid GPS signals 99% of the time so they are not used in the PNT solution; MGUE shall detect and reject MSI provided from GPS satellites and reject that data from the PNT solution. Aviation: MGUE shall report when GPS should not be used for PNT. Maritime: MGUE shall report when GPS should not be used for PNT.	(T=O) Ground: MGUE shall reject invalid GPS signals 99% of the time so they are not used in the PNT solution; MGUE shall detect and reject MSI provided from GPS satellites and reject that data from the PNT solution. Aviation: MGUE shall report when GPS should not be used for PNT. Maritime: MGUE shall report when GPS should not be used for PNT.	TBD	Ground: MGUE shall reject invalid GPS signals 99% of the time so they are not used in the PNT solution; MGUE shall detect and reject MSI provided from GPS satellites and reject that data from the PNT solution. Aviation: MGUE shall report when GPS should not be used for PNT. Maritime: MGUE shall report when GPS should not be used for PNT.

Classified Performance information is provided in the classified annex to this submission.

Requirements Reference

CDD dated May 9, 2014 as approved and validated by JROC memorandum 077-14 dated July 24, 2014

Change Explanations

None

Acronyms and Abbreviations

BFEA - Blue Force Electronic Attack
C/A - Coarse Acquisition
dB - Decibel
GPS - Global Positioning System
H - Horizontal
J/S - Jamming-to-Signal Ratio
m - Meter
m/s - Meter(s) Per Second
M-Code - Military Code
MSI - Misleading Signal in Space Information
nsec - Nanosecond
O - Objective
P(Y) - Encrypted Precision
PNT - Position, Navigation, and Timing
T - Threshold
V - Vertical

Track to Budget

General Notes

In December 2019, the Office of Management and Budget directed the DoD to establish new Space Force RDT&E and procurement appropriations. Beginning in FY 2021, space-related RDT&E funding, formerly under 3600F (RDT&E, Air Force) is contained in 3620SF (RDT&E, Space Force) and space procurement funding formerly under 3021F (Space Procurement, Air Force) is contained in 3022SF (Procurement, Space Force).

RDT&E

Appn	BA	PE		
Air Force	3600 07	0301004F		
	Project	**Name**		
	677517	Resiliency and Software Assurance Modification		(Sunk)
Air Force	3600 04	0305164F		
	Project	**Name**		
	643833	Military Global Positioning System User Equip		(Sunk)
Air Force	3600 07	0305164F		
	Project	**Name**		
	673028	NAVSTAR Global Positioning System (User Equipment) (SPACE)		(Sunk)
Air Force	3600 04	1203164F		
	Project	**Name**		
	643833	Military Global Positioning System User Equip	(Shared)	(Sunk)
	Notes:	MGUE Inc 1 and Inc 2		
Air Force	3620 04	1203164F		
	Project	**Name**		
	643833	Military Global Positioning System User Equip	(Shared)	
	Notes:	MGUE Inc 1 and Inc 2		

Cost and Funding

Cost Summary

Total Acquisition Cost							
Appropriation	BY 2017 $M			BY 2017 $M	TY $M		
	SAR Baseline Development Estimate	Current APB Development Objective/Threshold		Current Estimate	SAR Baseline Development Estimate	Current APB Development Objective	Current Estimate
RDT&E	1505.7	1505.7	1656.3	1376.5	1531.2	1531.2	1400.4
Procurement	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Flyaway	--	--	--	0.0	--	--	0.0
Recurring	--	--	--	0.0	--	--	0.0
Non Recurring	--	--	--	0.0	--	--	0.0
Support	--	--	--	0.0	--	--	0.0
Other Support	--	--	--	0.0	--	--	0.0
Initial Spares	--	--	--	0.0	--	--	0.0
MILCON	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Acq O&M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	1505.7	1505.7	N/A	1376.5	1531.2	1531.2	1400.4

Current APB Cost Estimate Reference

MGUE Increment 1 ICE dated January 12, 2017

Cost Notes

No cost estimate for the program has been completed in the previous year.

The MGUE Inc 1 program includes $112.6M of external funding to support the MGUE Inc 1 Resiliency and Software Assurance Modification effort. Additionally, program includes $3.1M of external funding for a next generation Application Specific Integrated Circuit study. The $115.7M of RDT&E funds are included in the APB, but not included in the table above.

The MGUE Inc 1 program baseline does not include procurement or sustainment, however, maintenance of the MGUE technical baseline remains an enduring responsibility for the Global Positioning System program office throughout the acquisition and O&S phases.

Total Quantity			
Quantity	SAR Baseline Development Estimate	Current APB Development	Current Estimate
RDT&E	0	0	0
Procurement	0	0	0
Total	0	0	0

Cost and Funding

Funding Summary

Appropriation Summary									
FY 2021 President's Budget / December 2019 SAR (TY$ M)									
Appropriation	Prior	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	To Complete	Total
RDT&E	1182.4	133.2	73.9	10.9	0.0	0.0	0.0	0.0	1400.4
Procurement	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MILCON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Acq O&M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PB 2021 Total	1182.4	133.2	73.9	10.9	0.0	0.0	0.0	0.0	1400.4
PB 2020 Total	1216.8	142.6	76.3	10.9	0.0	0.0	0.0	0.0	1446.6
Delta	-34.4	-9.4	-2.4	0.0	0.0	0.0	0.0	0.0	-46.2

Quantity Summary										
FY 2021 President's Budget / December 2019 SAR (TY$ M)										
Quantity	Undistributed	Prior	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	To Complete	Total
Development	0	0	0	0	0	0	0	0	0	0
Production	0	0	0	0	0	0	0	0	0	0
PB 2021 Total	0	0	0	0	0	0	0	0	0	0
PB 2020 Total	0	0	0	0	0	0	0	0	0	0
Delta	0	0	0	0	0	0	0	0	0	0

Cost and Funding

Annual Funding By Appropriation

Annual Funding 3600 | RDT&E | Research, Development, Test, and Evaluation, Air Force							
Fiscal Year	Quantity	TY $M					
		End Item Recurring Flyaway	Non End Item Recurring Flyaway	Non Recurring Flyaway	Total Flyaway	Total Support	Total Program
2012	--	--	--	--	--	--	15.2
2013	--	--	--	--	--	--	63.7
2014	--	--	--	--	--	--	165.0
2015	--	--	--	--	--	--	152.1
2016	--	--	--	--	--	--	199.0
2017	--	--	--	--	--	--	231.9
2018	--	--	--	--	--	--	209.6
2019	--	--	--	--	--	--	145.9
2020	--	--	--	--	--	--	133.2
Subtotal	--	--	--	--	--	--	1315.6

Annual Funding 3600 | RDT&E | Research, Development, Test, and Evaluation, Air Force							
Fiscal Year	Quantity	BY 2017 $M					
		End Item Recurring Flyaway	Non End Item Recurring Flyaway	Non Recurring Flyaway	Total Flyaway	Total Support	Total Program
2012	--	--	--	--	--	--	16.1
2013	--	--	--	--	--	--	66.5
2014	--	--	--	--	--	--	169.9
2015	--	--	--	--	--	--	155.1
2016	--	--	--	--	--	--	199.9
2017	--	--	--	--	--	--	228.3
2018	--	--	--	--	--	--	202.2
2019	--	--	--	--	--	--	138.1
2020	--	--	--	--	--	--	123.5
Subtotal	--	--	--	--	--	--	1299.6

Annual Funding 3620 | RDT&E | Research, Development, Test, and Evaluation, Space Force, Air Force							
Fiscal Year	Quantity	TY $M					
		End Item Recurring Flyaway	Non End Item Recurring Flyaway	Non Recurring Flyaway	Total Flyaway	Total Support	Total Program
2021	--	--	--	--	--	--	73.9
2022	--	--	--	--	--	--	10.9
Subtotal	--	--	--	--	--	--	84.8

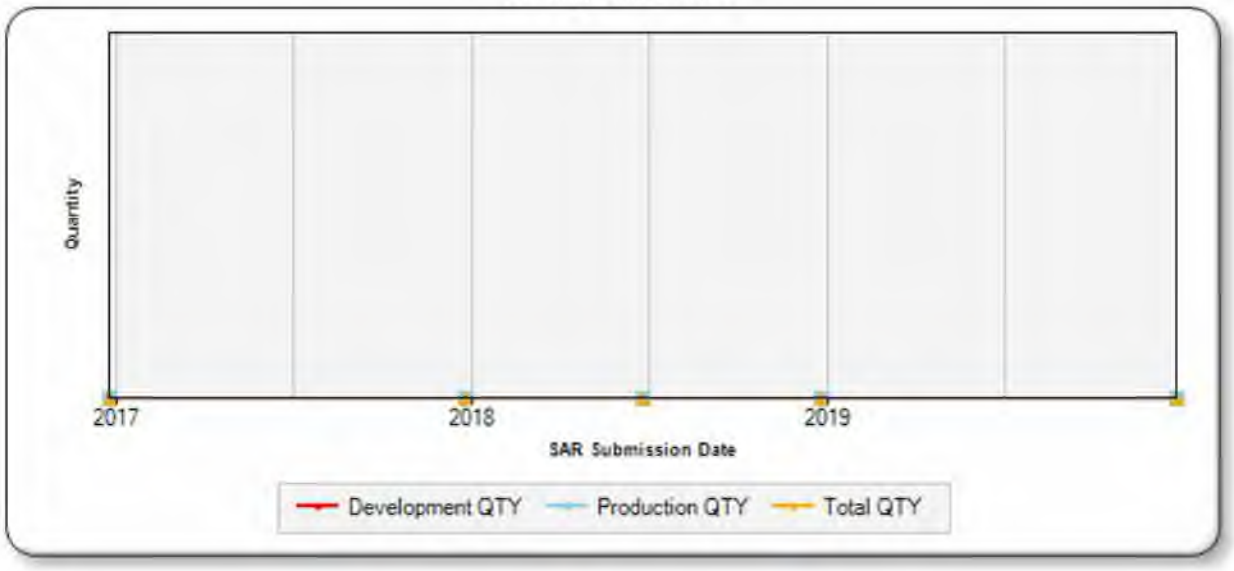
Annual Funding 3620 | RDT&E | Research, Development, Test, and Evaluation, Space Force, Air Force							
Fiscal Year	Quantity	BY 2017 $M					
		End Item Recurring Flyaway	Non End Item Recurring Flyaway	Non Recurring Flyaway	Total Flyaway	Total Support	Total Program
2021	--	--	--	--	--	--	67.2
2022	--	--	--	--	--	--	9.7
Subtotal	--	--	--	--	--	--	76.9

Charts

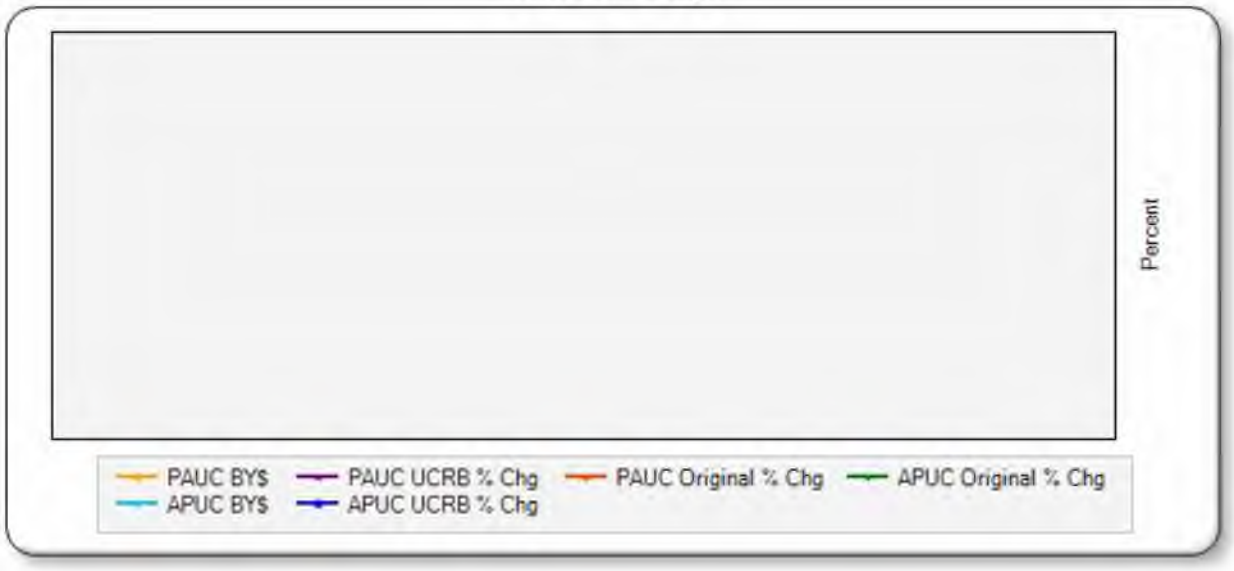
MGUE Inc 1 first began SAR reporting in December 2016

Program Acquisition Cost - MGUE Inc 1
Base Year 2017 $M

Quantity - MGUE Inc 1



Unit Cost - MGUE Inc 1
Base Year 2017 $M



Risks

Significant Schedule and Technical Risks

Significant Schedule and Technical Risks	
Milestone B (January 2017)	
1.	Late discovery of software deficiencies: Contractor incremental software deliveries will have new functionality that may result in deficiencies.
2.	Late discovery of hardware deficiencies: Defects in contractor hardware designs discovered in the Government reliability testing could cause delays in lead platform integration and testing.
3.	Test planning execution: Government test team may not be ready to test Final Test Articles. Test execution may be inefficient.
4.	Test coverage gaps: Due to the large number of technical requirements, a Design of Experiment (DOE) was created to ensure validation of the CDD in the lab. However, there may be some functions or interfaces not uniquely tested as part of the DOE, which could be discovered at the next higher level of assembly, particularly for non-lead platforms where box-level testing is not identified.
Current Estimate (December 2019)	
1.	B-2 Operational annual flight software upgrade (P6.4) Schedule: Deficiencies to the P6.2 Incremental Flight Capability and manning issues have caused a 3-5 month slip to the P6.4 schedule. This schedule delay has driven the beginning of Developmental Flight Testing to August 2020 which is past the need date for PEO Certification.
2.	Reduced US Marine Corps Joint Light Tactical Vehicle discrepancy reports Workoff Time: Instability in the M-Code-modernized lead platform host application, Command and Control Personal Computer, has caused a slip in the integration test schedule, forcing Phase 4 testing into February 2020.
3.	MGUE/Miniaturized Airborne GPS Receiver 2000 (MAGR2K)-M24 Readiness for B-2 Functional Qualification Testing Delays in card-level development by vendor slipped MAGR2K-M24 development of a production representative unit). This affected integration efforts at the Weapons System Sustainment Center.
4.	MGUE Readiness for GPS Based Position, Navigation, and Timing System (GPNTS) Systems Integration Test Quality Assurance Dry Run: Delays in card-level development by the MGUE vendor have slipped GPNTS software development and integration of the GRAM Standard Electronic Module. Iterative Navy government and contractor testing highlights that MGUE functionality may not meet technical specifications.

Risks

Risk and Sensitivity Analysis

Risks and Sensitivity Analysis	
Current Baseline Estimate (January 2017)	
1.	Development APB (BY17$M): Total Acquisition Cost - $1,505.7M (Qty 0); PAUC - N/A (Qty 0); APUC -N/A (Qty 0) Risks - MGUE cost/schedule baseline established prior to completion of outstanding Over Target Schedule/Over Target Baseline negotiations and aggressive Service-provided lead platform integration and operational test schedules.
Original Baseline Estimate (January 2017)	
1.	Development APB (BY17$M): Total Acquisition Cost - $1,505.7M (Qty 0); PAUC - N/A (Qty 0); APUC -N/A (Qty 0) Risks - MGUE cost/schedule baseline established prior to completion of outstanding Over Target Schedule/Over Target Baseline negotiations and aggressive Service-provided lead platform integration and operational test schedules.
Revised Original Estimate (N/A)	
None	
Current Procurement Cost (December 2019)	
1.	Development APB (BY17$M): Total Acquisition Cost - $1,384.6 (Qty 0); PAUC - N/A (Qty 0); APUC -N/A (Qty 0) Risks - Due to expected cost growth of the Raytheon's (RTN) GPS Receiver Application Module (GRAM) Standard Electronic Module (GRAM-S/M) development identified in the October 31, 2019 Program Deviation Report (PDR). Space and Missile Systems Center and Air Force (AF) Cost Analysis Agency are updating cost estimates for inclusion in the new APB. RTN GRAM-S/M Build 6 was delivered to the Government on September 3, 2019, however it did not address all technical deficiencies. Government test results confirm Build 6 does not satisfy the minimum capability established by the Navy Arleigh Burke Class Guided Missile Destroyer (DDG) and AF B-2 programs. Based on RTN schedule, resolution of the deficiencies extends beyond current APB threshold dates for GRAM-S/M Technical Requirements Verification, DDG PEO Certification, and B-2 PEO Certification. On October 29, 2019, the PEO notified the Service Acquisition Executive that deviations would occur to the APB. Way ahead: (1) The Program Manager signed a PDR on October 31, 2019. (2) Identify root cause of software deficiencies and develop corrective action plan. (3) Accelerate resolution of software deficiencies. (4) An Independent Schedule Risk Assessment (ISRA) was completed on December 3, 2019. (5) Independent Program Assessment (IPA) started on December 18, 2019. (6) Develop new APB informed by IPA and ISRA, expected to complete in March 2020.

Low Rate Initial Production

There is no LRIP for this program.

Foreign Military Sales

None

Nuclear Costs

None

Unit Cost

Current UCR Baseline and Current Estimate (Base-Year Dollars)			
Item	BY 2017 $M Current UCR Baseline (Jan 2017 APB)	BY 2017 $M Current Estimate (Dec 2019 SAR)	% Change
Program Acquisition Unit Cost			
Cost	1505.7	1376.5	
Quantity	0	0	
Unit Cost	--	--	--
Average Procurement Unit Cost			
Cost	0.0	0.0	
Quantity	0	0	
Unit Cost	--	--	--

Original UCR Baseline and Current Estimate (Base-Year Dollars)			
Item	BY 2017 $M Original UCR Baseline (Jan 2017 APB)	BY 2017 $M Current Estimate (Dec 2019 SAR)	% Change
Program Acquisition Unit Cost			
Cost	1505.7	1376.5	
Quantity	0	0	
Unit Cost	--	--	--
Average Procurement Unit Cost			
Cost	0.0	0.0	
Quantity	0	0	
Unit Cost	--	--	--

APB Unit Cost History					
Item	Date	BY 2017 $M		TY $M	
		PAUC	APUC	PAUC	APUC
Original APB	Jan 2017	N/A	N/A	N/A	N/A
APB as of January 2006	N/A	N/A	N/A	N/A	N/A
Revised Original APB	N/A	N/A	N/A	N/A	N/A
Prior APB	N/A	N/A	N/A	N/A	N/A
Current APB	Jan 2017	N/A	N/A	N/A	N/A
Prior Annual SAR	Dec 2018	N/A	N/A	N/A	N/A
Current Estimate	Dec 2019	N/A	N/A	N/A	N/A

SAR Unit Cost History

Current SAR Baseline to Current Estimate (TY $M)									
PAUC Development Estimate	Changes								PAUC Current Estimate
	Econ	Qty	Sch	Eng	Est	Oth	Spt	Total	
0.000	--	--	--	--	--	--	--	--	0.000

A PAUC Unit Cost History is not available, since no Initial PAUC Estimate had been calculated due to a lack of defined quantities.

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

An APUC Unit Cost History is not available, since no Initial APUC Estimate had been calculated due to a lack of defined quantities.

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	Jan 2017	N/A	Jan 2017
Milestone C	N/A	N/A	N/A	N/A
IOC	N/A	N/A	N/A	N/A
Total Cost (TY $M)	N/A	1531.2	N/A	1400.4
Total Quantity	N/A	0	N/A	0
PAUC	N/A	N/A	N/A	N/A

Cost Variance

Summary TY $M				
Item	RDT&E	Procurement	MILCON	Total
SAR Baseline (Development Estimate)	1531.2	--	--	1531.2
Previous Changes				
Economic	+6.5	--	--	+6.5
Quantity	--	--	--	--
Schedule	--	--	--	--
Engineering	--	--	--	--
Estimating	-91.1	--	--	-91.1
Other	--	--	--	--
Support	--	--	--	--
Subtotal	-84.6	--	--	-84.6
Current Changes				
Economic	-0.5	--	--	-0.5
Quantity	--	--	--	--
Schedule	--	--	--	--
Engineering	--	--	--	--
Estimating	-45.7	--	--	-45.7
Other	--	--	--	--
Support	--	--	--	--
Subtotal	-46.2	--	--	-46.2
Total Changes	-130.8	--	--	-130.8
Current Estimate	1400.4	--	--	1400.4

Summary BY 2017 $M				
Item	RDT&E	Procurement	MILCON	Total
SAR Baseline (Development Estimate)	1505.7	--	--	1505.7
Previous Changes				
Economic	--	--	--	--
Quantity	--	--	--	--
Schedule	--	--	--	--
Engineering	--	--	--	--
Estimating	-86.2	--	--	-86.2
Other	--	--	--	--
Support	--	--	--	--
Subtotal	-86.2	--	--	-86.2
Current Changes				
Economic	--	--	--	--
Quantity	--	--	--	--
Schedule	--	--	--	--
Engineering	--	--	--	--
Estimating	-43.0	--	--	-43.0
Other	--	--	--	--
Support	--	--	--	--
Subtotal	-43.0	--	--	-43.0
Total Changes	-129.2	--	--	-129.2
Current Estimate	1376.5	--	--	1376.5

Previous Estimate: December 2018

RDT&E	$M	
Current Change Explanations	Base Year	Then Year
Revised escalation indices. (Economic)	N/A	-0.5
Revised estimate for Below Threshold Reprogramming for higher Air Force priorities in FY 2019. (Estimating)	-7.0	-7.4
Revised estimate for reallocation of funds from MGUE Inc 1 to MGUE Inc 2 in FY 2019 to pay for Application Specific Integrated Circuit obsolescence. (Estimating)	-17.5	-18.5
Revised estimate due to AF-wide funding adjustments. (Estimating)	-2.0	-2.2
Revised estimate due to Congressional reduction in FY 2020. (Estimating)	-8.8	-9.4
Adjustment for current and prior escalation. (Estimating)	+0.4	+0.4
Funds transferred within program from Research, Development, Test, and Evaluation, Air Force to newly added Research, Development, Test, and Evaluation, Space Force. (Estimating)	-76.9	-84.8
Funds transferred within program from Research, Development, Test, and Evaluation, Air Force to newly added Research, Development, Test, and Evaluation, Space Force. (Estimating)	+76.9	+84.8
Revised estimate due to Small Business Innovative Research in FY 2019. (Estimating)	-8.1	-8.6
RDT&E Subtotal	-43.0	-46.2

Contracts

Contract Identification

Appropriation: RDT&E
Contract Name: Military GPS User Equipment (MGUE)
Contractor: L3 Technologies (L3T)
Contractor Location: 602 E. Vermont Ave
Anaheim, CA 92803
Contract Number: FA8807-12-C-0011
Contract Type: Cost Plus Incentive Fee (CPIF)
Award Date: September 28, 2012
Definitization Date: September 28, 2012

Contract Price							
Initial Contract Price ($M)			Current Contract Price ($M)			Estimated Price At Completion ($M)	
Target	Ceiling	Qty	Target	Ceiling	Qty	Contractor	Program Manager
27.5	N/A	N/A	91.2	N/A	N/A	102.5	104.2

Target Price Change Explanation

The difference between the Initial Contract Price Target and the Current Contract Price Target is due to additional scope associated with software and security certification, hardware, Resiliency, Software Assurance Modification, Roving Channel Hot Start (Engineering Change Proposal (ECP 4), Enterprise Hot Start (ECP 5), and Long Term Extended Navigation (ECP 6).

Contract Variance		
Item	Cost Variance	Schedule Variance
Cumulative Variances To Date (1/3/2020)	-16.6	-0.2
Previous Cumulative Variances	-14.2	-0.1
Net Change	-2.4	-0.1

Cost and Schedule Variance Explanations

The unfavorable net change in the cost variance is due to higher than planned System Trouble Reports for software deficiencies and Technical Requirements Verification (TRV) liens closure.

The unfavorable net change in the schedule variance is due to The unfavorable net change in the schedule variance is due to the slow start up activities for ECP 6 effort.

Notes

The PM's Estimated Price at Complete is based on SCP (September 2016) plus ECPs 4, 5, and 6. L3Harris' contract is 81% complete.

Contract Identification

Appropriation: RDT&E
Contract Name: Military GPS User Equipment (MGUE)
Contractor: Raytheon Space and Airborne Systems
Contractor Location: 2000 E. El Segundo Blvd
El Segundo, CA 90245
Contract Number: FA8807-12-C-0012
Contract Type: Cost Plus Incentive Fee (CPIF)
Award Date: September 28, 2012
Definitization Date: September 28, 2012

Contract Price							
Initial Contract Price ($M)			Current Contract Price ($M)			Estimated Price At Completion ($M)	
Target	Ceiling	Qty	Target	Ceiling	Qty	Contractor	Program Manager
25.2	N/A	N/A	156.4	N/A	N/A	209.9	208.8

Target Price Change Explanation

The difference between the Initial Contract Price Target and the Current Contract Price Target is due to additional scope associated with software and security certification, hardware, and for Resiliency, Software Assurance Modification, ECP 4, ECP 5, and ECP 6.

Contract Variance		
Item	Cost Variance	Schedule Variance
Cumulative Variances To Date (12/31/2019)	-2.3	-1.1
Previous Cumulative Variances	+0.2	-1.5
Net Change	-2.5	+0.4

Cost and Schedule Variance Explanations

The unfavorable net change in the cost variance is due to multiple software deficiencies discovered during the government evaluation of the GPS Receiver Application Module Standard Electronic Module (GRAM-S/M) 6.0 software build.

The favorable net change in the schedule variance is due to the reprioritization of tasks to the support the delivery of Build 6.0. The cumulative schedule performance is still unfavorable as a result of ongoing delays due to software deliveries and performance issues.

Notes

The PM's Estimated Price at Complete is based on SCP (September 2016) plus ECPs 4, 5, and 6. Multiple software deficiencies have resulted in a program deviation report signed October 31, 2019. Currently awaiting outcome of the Independent Program Review for direction on how to proceed. Raytheon's contract is 86% complete.

Contract Identification

Appropriation: RDT&E
Contract Name: MGUE Technology Development
Contractor: Collins Aerospace
Contractor Location: 400 Collins Road NE
Cedar Rapids, IA 52498
Contract Number: FA8807-12-C-0013
Contract Type: Cost Plus Incentive Fee (CPIF)
Award Date: September 28, 2012
Definitization Date: September 28, 2012

Contract Price							
Initial Contract Price ($M)			Current Contract Price ($M)			Estimated Price At Completion ($M)	
Target	Ceiling	Qty	Target	Ceiling	Qty	Contractor	Program Manager
27.7	N/A	N/A	141.0	N/A	N/A	177.3	181.1

Target Price Change Explanation

The difference between the Initial Contract Price Target and the Current Contract Price Target is due to additional scope associated with software and security certification, hardware, Resiliency, Software Assurance Modification, approval of Over Target Baseline/Over Target Schedule (August 1, 2017), ECP 4, ECP-5, ECP 6, and ECP 7.

Contract Variance		
Item	Cost Variance	Schedule Variance
Cumulative Variances To Date (12/31/2019)	+1.5	-1.5
Previous Cumulative Variances	+2.8	-1.5
Net Change	-1.3	+0.0

Cost and Schedule Variance Explanations

The unfavorable net change in the cost variance is due to higher than expected effort required to support the Area Navigation Development requirements and design and the Military Standard Order. Collins' overall performance continues to be favorable.

Notes

The PM's Estimated Price at Complete is based on SCP (September 2016) plus ECPs 4, 5, 6, and 7. With the award of ECP 6 and 7, Collins' contract is now 80% complete.

Deliveries and Expenditures

Deliveries				
Delivered to Date	Planned to Date	Actual to Date	Total Quantity	Percent Delivered
Development	0	0	0	--
Production	0	0	0	--
Total Program Quantity Delivered	0	0	0	--

Expended and Appropriated (TY $M)			
Total Acquisition Cost	1400.4	Years Appropriated	9
Expended to Date	992.5	Percent Years Appropriated	81.82%
Percent Expended	70.87%	Appropriated to Date	1315.6
Total Funding Years	11	Percent Appropriated	93.94%

The above data is current as of February 10, 2020.

Operating and Support Cost

Cost Estimate Details

Date of Estimate:

Source of Estimate:

Quantity to Sustain:

Unit of Measure:

Service Life per Unit:

Fiscal Years in Service:

Sustainment Strategy

O&S requirements will be addressed by the DoD Services following completion of the MGUE development program.

Antecedent Information

No Antecedent

Annual O&S Costs BY2017 $M		
Cost Element	**MGUE Inc 1**	**Antecedent Item (Antecedent) YYYY**
Unit-Level Manpower	--	--
Unit Operations	--	--
Maintenance	--	--
Sustaining Support	--	--
Continuing System Improvements	--	--
Indirect Support	--	--
Other	--	--
Total	--	--

Item	Total O&S Cost $M			
	MGUE Inc 1			Antecedent Item (Antecedent)
	Current Development APB Objective/Threshold		Current Estimate	
Base Year	0.0	0.0	N/A	N/A
Then Year	0.0	N/A	N/A	0.0

O&S Cost Variance		
Category	**BY 2017 $M**	**Change Explanations**
Prior SAR Total O&S Estimates - Dec 2018 SAR	0.0	
Programmatic/Planning Factors	0.0	

Cost Estimating Methodology	0.0
Cost Data Update	0.0
Labor Rate	0.0
Energy Rate	0.0
Technical Input	0.0
Other	0.0
Total Changes	0.0
Current Estimate	0.0

Disposal Estimate Details

Date of Estimate:

Source of Estimate:

Disposal/Demilitarization Total Cost (BY 2017 $M):