Selected Acquisition Report (SAR)

RCS: DD-A&T(Q&A)823-456

Next Generation Operational Control System (OCX)

As of FY 2020 President's Budget

Defense Acquisition Management
Information Retrieval
(DAMIR)

Table of Contents

Sensitivity Originator

No originator info Available at this time.

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

Next Generation Operational Control System (OCX)

DoD Component

Air Force

Joint Participants

Department of Transportation

Responsible Office

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References

SAR Baseline (Development Estimate)

Defense Acquisition Executive (DAE) Approved Acquisition Program Baseline (APB) dated November 19, 2012

Approved APB

Defense Acquisition Executive (DAE) Approved Acquisition Program Baseline (APB) dated September 27, 2018

Mission and Description

The Global Positioning System (GPS) is a space based positioning, navigation, and timing 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 is a satellite-based radio navigation system that serves military and civil users worldwide. GPS users process satellite signals to determine accurate position, velocity, and time. GPS must comply with 10 United States Code (USC) Section 2281 which requires that the Secretary of Defense ensures the continued sustainment and operation of GPS for military and civilian purposes and 51 USC Section 50112, which requires that GPS complies with certain standards and facilitates international cooperation.

The GPS Next Generation Operational Control System (OCX) program develops and fields a modernized satellite command and control (C2) system which replaces the current ground control system for legacy and new GPS satellites. OCX implements a modern flexible architecture with built-in robust information assurance to address emerging cyber threats. The Air Force is taking a block approach to develop OCX with each block delivering upgrades as they become available.

The OCX program of record consists of 2 block deliverables: Block 1, and Block 2. OCX Block 0, a subset of Block 1, will allow OCX to support the launch and checkout of GPS III satellites. OCX Block 1 replaces the existing legacy GPS C2 system and fields the operational capability to control legacy satellites (GPS IIR, IIR-M, and IIF) and control existing signals (L1 C/A, L1P(Y), L2P(Y)). OCX Block 1 also adds the operational capability to command and control the GPS III satellites and the modernized civil signals (L2C and L5). OCX Block 2 adds operational control of the new international open/civil L1C signal in compliance with 2004 European Union-United States agreement and adds control of the modernized Military Code signal. With the restructuring of the program as a result of the Nunn-McCurdy process, Block 1 and Block 2 capabilities will be delivered concurrently. The majority of Block 2 capabilities were merged into the Block 1 delivery during the 2014 OCX restructure. Recent analysis found it would be cheaper to merge the remaining Block 2 capabilities into Block 1 than to deliver Block 2 after Block 1. This approach delivers Block 2 capabilities sooner and eliminates the impact to GPS operations from a transition from Block 1 to Block 2.

Executive Summary

Program Highlights Since Last Report

On September 27, 2018, the MDA recertified the Next Generation Operational Control System (OCX) Milestone B and approved a new APB. This SAR reports against the new APB. OCX has held to plan since the post-Nunn-McCurdy re-baseline was established in April 2017.

Since the last SAR, the Program Office completed the Integrated Baseline Review on April 24, 2018, which concluded the contractor's current baseline to be reasonable and executable within the SCP. Two successful Deep Dives with USD(A&S) took place on March 27, 2018 and November 5, 2018.

The OCX program has participated in 95 independent reviews since program inception; including the FY 2017 National Defense Authorization Act (NDAA) section 1622 Independent Program Assessment led by the MITRE Corporation. This study identified significant legacy infrastructure shortfalls related to acquisition, schedule, and cybersecurity which precluded viability of Operational Control System as a replacement for OCX. In the FY 2019 NDAA, Congress directed a follow-on to the study; the Air Force is developing a response.

The Global Positioning System (GPS) III Launch and Checkout System, also known as OCX Block 0, is now at Lockheed Martin's Waterton, CO facility and supporting GPS III Space Vehicle 01 on-orbit. OCX Block 0 received a two-year Authority to Operate on October 2, 2018.

On OCX Block 1, the program established an automated software factory in March 2018 providing real-time performance metrics for software quality, further enabling data-driven programmatic decisions. Raytheon entered into Iteration 1.7/2.1 Detailed Design, Code and Unit Test, the final iteration of coding leading into the multi-year test campaign. The program completed Block 1 Iteration 1.7/2.1 Critical Design Review with zero liens in September 2018; this is the final design activity for the program and 1.6 coding is now in product test. Raytheon completed Development Operations (DevOps) Phase 1-3 in September 2018 which provides the first operationally representative test environment. Ground Terminal Equipment OCX Monitoring Station Receiver Element (OMSRE) development and factory testing completed at Harris. The OMSRE demonstration showed the receiver is capable of receiving all GPS III signals.

The current contract date for Government acceptance of Blocks 1 and 2 is June 2021, with a corresponding Ready to Transition to Operations date of January 2022. The Air Force projects seven months risk to this date. The program is currently executing within the APB approved on September 27, 2018.

This is a software-intensive program actively using DevOps, with routine, low-level development and program execution issues worked day-to-day.

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

History of Significant Developments Since Program Initiation

History of Significant Developments Since Program Initiation	
Date	**Significant Development Description**
February 2007	The United States Air Force began the OCX program with a technology development phase (Phase A). Awarded Phase A contracts for $160M each to Northrop Grumman and Raytheon to produce competitive prototypes.
February 2010	OCX development contract awarded to Raytheon for $886M, with an option to begin preliminary work on Blocks 3 & 4 which are to provide additional capabilities to support follow-on, upgraded versions of GPS III satellites.
March 2012	OCX Program received Milestone B approval and was authorized to begin EMD. An updated APB was signed by the MDA, USD(AT&L).
June 2013	Raytheon conducted a Critical Design Review for the GPS III Launch and Checkout System (LCS) (Block 0). The design artifacts assessed by the Government team demonstrated that Raytheon's design and software architecture were adequate to meet requirements.
June 2014	Government completed Over Target Baseline (OTB) / Over Target Schedule (OTS). The result of the OTB/OTS resulted in revised milestone dates which required the program to submit a Program Deviation Report to USD (AT&L). As part of the OTB/OTS initiatives, Raytheon paused software development activities and focused its effort on completing the balance of Block 1 & Block 2 systems engineering.
February 2015	Program Office and Raytheon held a Deep Dive with USD(AT&L) which directed the development of a new APB and established new milestones to measure schedule and cost performance.
October 2015	A revised APB was signed on October 19, 2015.
December 2015	Second Deep Dive with USD(AT&L) was conducted resulting in OSD and the Air Force jointly agreeing to a 24-month replanto the schedule objectives for Milestone C, Block 1 Ready to Transition to Operations (RTO) and Block 2 RTO in the APB.
December 2015	Program Office reported a schedule breach against current baseline on December 23, 2015.
February 2016	Due to reported schedule delays, the Air Force awarded GPS III Contingency Operations to bridge capability between Block 0 and Block 1.
June 2016	The Secretary of the Air Force declared a critical Nunn-McCurdy breach on June 30, 2016.
July 2016	Raytheon completed Block 0 Factory Qualification Test (FQT) Golden Dry Run, demonstrating the maturity of Block 0 requirements to support LCS.
September 2016	Quarterly review conducted with USD(AT&L). Raytheon reported they met Block 0 LCS FQT Test Readiness Review key milestones. Raytheon also reported on improvements on implementing Development Operations processes, including increased automation in software development, platform deployment, and test as well as an updated configuration management and software development approach.
October 2016	OCX was recertified on October 12, 2016 and the Milestone B, original and current APBs were rescinded. The contract was restructured to reflect a 24-month plus six-month risk schedule extension. All Block 2 content was re-phased to deliver concurrently with Block 1.
March 2017	Program Office and Raytheon completed OTB/OTS process on March 28, 2017. Execution against the new baseline began on April 1, 2017.
June 2017	The DAB occurred on June 20, 2017, and USD(AT&L) agreed to approve OCX's new Milestone B certification and new APB objective dates of April 2021 for Milestone C and April 2022 for Block 1 and 2.
June 2017	GPS OCX CDD approved.

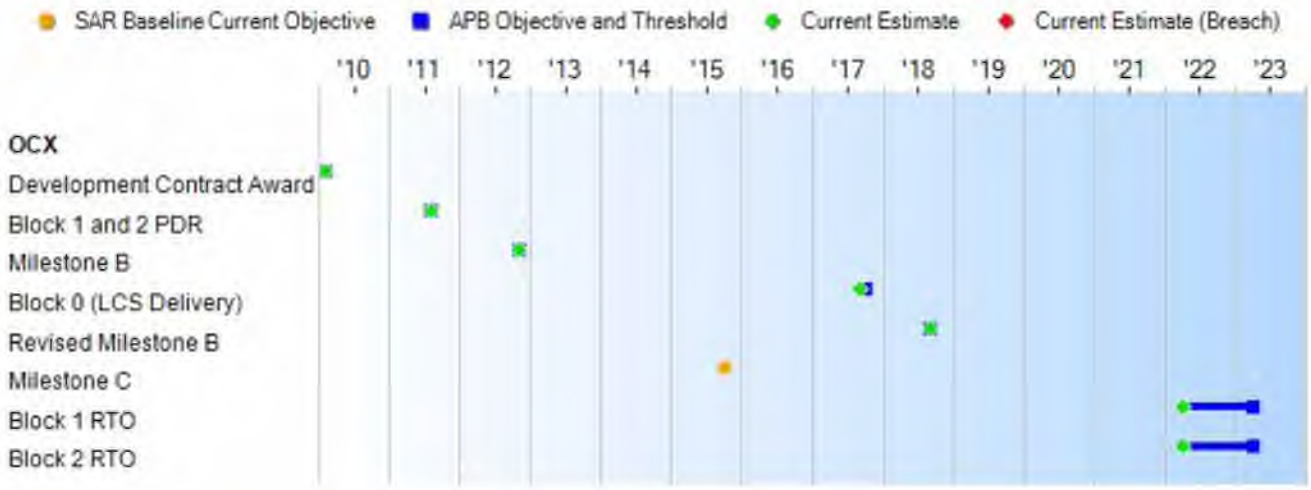
October 2017	The program office accepted Block 0 LCS delivery to support the first GPS III launch, which successfully occurred on December 23, 2018.
September 2018	USD(A&S) recertified Milestone B on September 27, 2018. The recertification established a new APB and revalidated the program funding to the SCP. The MDA remains with USD(A&S) and Milestone C was waived.
October 2018	LCS received Authority to Operate on October 2, 2018, which is valid for two years.
December 2018	LCS supported launch of first GPS III Space Vehicle 01 on December 23, 2018.

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

Schedule



Schedule Events					
Events	SAR Baseline Development Estimate	Current APB Development Objective/Threshold		Current Estimate	
Development Contract Award	Feb 2010	Feb 2010	Feb 2010	Feb 2010	
Block 1 and 2 PDR	Aug 2011	Aug 2011	Aug 2011	Aug 2011	
Milestone B	Nov 2012	Nov 2012	Nov 2012	Nov 2012	
Block 0 (LCS Delivery)	Nov 2014	Oct 2017	Oct 2017	Sep 2017	
Revised Milestone B	N/A	Sep 2018	Sep 2018	Sep 2018	
Milestone C	Oct 2015	N/A	N/A	N/A	(Ch-1)
Block 1 RTO	Oct 2016	Apr 2022	Apr 2023	Apr 2022	
Block 2 RTO	Jun 2017	Apr 2022	Apr 2023	Apr 2022	

Change Explanations

(Ch-1) Milestone C current estimate changed from April 2021 to N/A as a result of the elimination of the milestone in the September 27, 2018 APB.

Notes

OCX Block 1 RTO will be achieved when the Control Segment can support GPS III SV01-10 and operational Block II satellites, can monitor broadcast GPS navigation signals, and can support NAVWAR mission planning by JSpOC. At RTO, the system is turned over to the operational community.

Block 1 and 2 RTOs are the same due to contract change that re-phases the remaining Block 2 content to deliver concurrently with Block 1.

Revised Milestone B was added in the approved September 27, 2018 APB.

Acronyms and Abbreviations

GPS - Global Positioning System
JSpOC - Joint Space Operations Center
LCS - Launch and Checkout System
NAVWAR - Navigation Warfare
PDR - Preliminary Design Review
RTO - Ready to Transition to Operations
SV - Space Vehicle

Performance

Performance Characteristics				
SAR Baseline Development Estimate	**Current APB Development Objective/Threshold**		**Demonstrated Performance**	**Current Estimate**
Backward Compatibility				
All modifications made to the existing GPS Space Segment and Control Segment shall allow the continued operation of existing IS-GPS-200, IS-GPS-700, IS-GPS-705 and SS-GPS-001 compliant UE and continued operation of legacy receivers (to include Federal augmentation system receivers) IAW performance meeting the APB Precise Positioning Service Performance Standard and GPS Positioning Service Performance Standard, and Federal augmentation system specifications for the Local Area Augmentation System, Wide Area Augmentation System, Nationwide Differential GPS, and Maritime Differential GPS.	All modifications made to the existing GPS Space Segment and Control Segment shall allow the continued operation of existing IS-GPS-200, IS-GPS-700, IS-GPS-705 and SS-GPS-001 compliant UE and continued operation of legacy receivers (to include Federal augmentation system receivers) IAW performance meeting the APB, Precise Positioning Service Performance Standard and GPS Positioning Service Performance Standard, and Federal augmentation system specifications for the Local Area Augmentation System, Wide Area Augmentation System, Nationwide Differential GPS, and Maritime Differential GPS.	(T=O) All modifications made to the existing GPS Space Segment and Control Segment shall allow the continued operation of existing IS-GPS-200, IS- GPS-700, IS-GPS-705 and SS-GPS -001 compliant UE and continued operation of legacy receivers (to include Federal augmentation system receivers) IAW performance meeting the APB, Precise Positioning Service Performance Standard and GPS Positioning Service Performance Standard, and Federal augmentation system specifications for the Local Area Augmentation System, Wide Area Augmentation System, Nationwide Differential GPS, and Maritime Differential GPS.	TBD	All modifications made to the existing GPS SS and CS shall allow the continued operation of existing IS-GPS-200, IS-GPS-700, IS-GPS-705 and System Specifications-GPS-001 compliant UE and continued operation of legacy receivers (to include Federal augmentation system receivers) IAW performance meeting the APB Precise Positioning Service Performance Standard and GPS Positioning Service Performance Standard, and Federal augmentation system specifications for the Local Area Augmentation System, Wide Area Augmentation System, Nationwide Differential GPS, and Maritime Differential GPS.
Availability of Position Accuracy a. b. Horizontal c.d. Vertical				

UEE = 0.8 m rms a. 4.5 m (95%) @ 90% availability any lat/long b. 4.0 m (95%) @ 99.9% availability global average c. 7.0 m (95%) @ 90% availability any lat/long d. 7.0 m (95%) @ 99.9% availability global average UEE = 2.6 m rms a. 11.5 m (95%) @ 90% availability any lat/long b. 11.5 m (95%) @ 99.9% availability global average c. 17.7 m (95%) @ 90% availability any lat/long d. 17.7 m (95%) @ 99.9% availability global average.	UEE = 0.8 m rms HORIZONTAL Note 1) a. 4.5 m (95%) @ 90% availability (any lat/long) b. 4.0 m (95%) @ 99.9% availability (global Average) VERTICAL (see Note 1) c. 7.0 m (95%) @ 90% availability (any lat/long) d. 7.0 m (95%) @ 99.9% availability (global average) UEE = 2.6 m rms (See Note 1) HORIZONTAL (see Note 1) a. 11.5 m (95%) @ 90% availability (any lat/long) b. 11.5 m (95%) @ 99.9% availability (global average) VERTICAL (see Note 1) c. 17.7 m (95%) @ 90% availability (any lat/long)d. 17.7 m global average. (95%) @ 99.9% availability *Note 1: Availability of position accuracy is dependent on the GPS receiver's UEE.	(T=O) UEE = 0.8 m rms HORIZONTAL Note 1) a. 4.5 m (95%) @ 90% availability (any lat/long) b. 4.0 m (95%) @ 99.9% availability (global Average) VERTICAL (see Note 1) c. 7.0 m (95%) @ 90% availability (any lat/long) d. 7.0 m (95%) @ 99.9% availability (global average) UEE = 2.6 m rms (See Note 1) HORIZONTAL (see Note 1) a. 11.5 m (95%) @ 90% availability (any lat/long) b. 11.5 m (95%) @ 99.9% availability (global average) VERTICAL (see Note 1) c. 17.7 m (95%) @ 90% availability (any lat/long)d. 17.7 m global average. (95%) @ 99.9% availability *Note 1: Availability of position accuracy is dependent on the GPS receiver's UEE.	TBD	UEE = 0.8 m rms a. 4.5 m (95%) @ 90% availability any lat/long b. 4.0 m (95%) @ 99.9% availability global average c. 7.0 m (95%) @ 90% availability any lat/long d. 7.0 m (95%) @ 99.9% availability global average UEE = 2.6 m rms a. 11.5 m (95%) @ 90% availability any lat/long b. 11.5 m (95%) @ 99.9% availability global average c. 17.7 m (95%) @ 90% availability any lat/long d. 17.7 m (95%) @ 99.9% availability global average.	
Position and Time Transfer Integrity					
GPS III SV01-08 shall not transmit MSI to the user with a probability greater than 0.0001 per hour.	The GPS III Enterprise shall not transmit Misleading SIS Information (MSI) to the user with a probability greater than 0.0001 per hour.	(T=O) The GPS III Enterprise shall not transmit Misleading SIS Information (MSI) to the user with a probability greater than 0.0001 per hour.	TBD	GPS III SV01-08 shall not transmit MSI to the user with a probability greater than 0.0001 per hour.	
Availability of Dynamic Time Transfer Accuracy					
UEE = 0.8 m rms Any lat/long 15 nanoseconds (ns) (95%) @ 90% availability Global Average 15 ns (95%) @ 99.9% availability UEE = 2.6 m rms Any lat/long 40 ns (95%) @ 90% availability Global Average 50 ns (95%)	N/A	N/A	TBD	UEE = 0.8 m rms any lat/long 15 ns (95%) @ 90% availability Global Average 15 ns (95%) @ 99.9% availability UEE = 2.6 m rms any lat/long 40 ns (95%) @ 90% availability Global Average 50 ns (95%).	(Ch-1)
Availability of Static Time Transfer Accuracy					

3.0 ns (95%) @ > 99.9% availability	N/A	N/A	TBD	3.0 ns (95%) @ > 99.9% availability.	(Ch-1)
Net-Ready KPP					
The system must fully support execution of joint critical operational activities and information exchanges identified in the DoD Enterprise Architecture and solution architectures based on integrated DoD AF content, and must satisfy the technical requirements for transition to Net-Centric military operations to include: 1) Solution architecture products compliant with DoD Enterprise Architecture based on integrated DoD AF content, including specified operationally effective information exchanges 2) Compliant with Net-Centric Data Strategy, and Net-centric Services Strategy and the principles and rules identified in the DoD IEA, excepting tactical and non-IP communic-ations 3) Compliant with GIG Technical Guidance to include IT Standards identified in the TV-	Availability of Accuracy in the terrestrial Transfer Determination Capability; service volume with UE UEE = 0.8 m rms HORIZONTAL 4.5 m (95%)@ 90% availability (any lat/long) 4.0 m (95%) @ 99.9% availability (global VERTICAL 7.0 m (95%)@ 90% availability (any lat/long) 7.0 m (95%) @ 99.9% availability (global average) UEE = 2.6m rms HORIZONTAL 11.5 m (95%)@ 90% availability (any lat/long) 11.5 m (95%)@ 99.9% availability (global average) VERTICAL 17.7 m (95%)@ 90% availability (any lat/long) 17.7 m (95%) @ 99.9% availability (global average) Availability of Dynamic and Static Time Transfer Accuracy with UE. UEE = 0.8 m rms 15 ns (95%)@90% availability (any lat/long) 15 ns (95%)@ 99.9% availability (global coverage) UEE = 2.6 m rms 40 ns (95%)@ 90% availability (any lat/long) 50 ns (95%)@ 99.9% availability (global coverage) Static Time Transfer Threshold=Objective 30ns (95%) @> 99.9% availability Note: This represents the cumulative threshold/objective achieved by the collective contributions of the space, control, and/or user segments. Availability of position accuracy is dependent on	(T=O) Availability of Accuracy in the terrestrial Transfer Determination Capability; service volume with UE UEE = 0.8 m rms HORIZONTAL 4.5 m (95%)@ 90% availability (any lat/long) 4.0 m (95%) @ 99.9% availability (global VERTICAL 7.0 m (95%)@ 90% availability (any lat/long) 7.0 m (95%) @ 99.9% availability (global average) UEE = 2.6m rms HORIZONTAL 11.5 m (95%)@ 90% availability (any lat/long) 11.5 m (95%)@ 99.9% availability (global average) VERTICAL 17.7 m (95%)@ 90% availability (any lat/long) 17.7 m (95%) @ 99.9% availability (global average) Availability of Dynamic and Static Time Transfer Accuracy with UE. UEE = 0.8 m rms 15 ns (95%)@90% availability (any lat/long) 15 ns (95%)@ 99.9% availability (global coverage) UEE = 2.6 m rms 40 ns (95%)@ 90% availability (any lat/long) 50 ns (95%)@ 99.9% availability (global coverage) Static Time Transfer Threshold=Objective 30ns (95%) @> 99.9% availability Note: This represents the cumulative threshold/objective achieved by the collective contributions of the space, control, and/or user segments. Availability of position accuracy is dependent on	TBD	The system must fully support execution of joint critical operational activities and information exchanges identified in the DoD Enterprise Architecture and solution architectures based on integrated DoD AF content, and must satisfy the technical requirements for transition to Net-Centric military operations to include: 1) Solution architecture products compliant with DoD Enterprise Architecture based on integrated DoD AF content, including specified operationally effective information exchanges 2) Compliant with Net -Centric Data Strategy, and Net-centric Services Strategy and the principles and rules identified in the DoD IEA, excepting tactical and non-IP communic-ations 3) Compliant with GIG Technical Guidance to include IT Standards	

1 and implementation guidance of GESPs necessary to meet all operational requirements specified in the DoD Enterprise Architecture and solution architecture views 4) Information assurance requirements including availability, integrity, authentica-tion, confidential-ity, and non-repudiation, and issuance of an IATO or ATO by the DAA, and 5) Support-ability requirements to include SAASM, Spectrum, and JTRS require-ments.	the GPS receiver's UEE. Note: Mission: Provide: Positioning, Navigation, and Time Transfer Determination Capability; Military Protection and Operations Capability; and Constellation Management.	the GPS receiver's UEE. Note: Mission: Provide: Positioning, Navigation, and Time Transfer Determination Capability; Military Protection and Operations Capability; and Constellation Management.		identified in the TV-1 and implementation guidance of GESPs necessary to meet all operational requirements specified in the DoD Enterprise Architecture and solution architecture views 4) Information assurance requirements including availability, integrity, authentica-tion, confidential-ity, and non-repudiation, and issuance of an IATO or ATO by the DAA, and 5) Support-ability requirements to include SAASM, Spectrum, and JTRS require-ments.	
Sustainment--Materiel Availability					
The achievement of the Availability of Position Accuracy KPP and Time Transfer Accuracy KPP Thresholds.	N/A	N/A	TBD	The achievement of the Availability of Position Accuracy KPP and Time Transfer Accuracy KPP Thresholds.	(Ch-1)
System Survivability					
N/A	The System Survivability KPP is satisfied by meeting the thresholds of the Availability of Position Accuracy KPP (SS and CS); Position and Time Transfer Integrity KPP (SS and CS); Availability of Time Transfer Accuracy KPP (SS and CS); PNT Determination KPP (User Segment); Accuracy KPP (User	(T=O) The System Survivability KPP is satisfied by meeting the thresholds of the Availability of Position Accuracy KPP (SS and CS); Position and Time Transfer Integrity KPP (SS and CS); Availability of Time Transfer Accuracy KPP (SS and CS); PNT Determination KPP (User Segment);		The System Survivability KPP is satisfied by meeting the thresholds of the Availability of Position Accuracy KPP (SS and CS); Position and Time Transfer Integrity KPP (SS and CS); Availability of Time Transfer Accuracy	

	Segment); System Survivability - Cybersecurity KPP (CS); Integrity KPP (User Segment); Cryptography, Security Architecture, and Key Distribution KPP (User Segment); and External Augmentation KPP (User Segment).* See Table 5-1 OCX System Survivability – Cybersecurity (KPP) in approved CDD for GPS OCX.	Accuracy KPP (User Segment); System Survivability - Cybersecurity KPP (CS); Integrity KPP (User Segment); Cryptography, Security Architecture, and Key Distribution KPP (User Segment); and External Augmentation KPP (User Segment).* See Table 5-1 OCX System Survivability – Cybersecurity (KPP) in approved CDD for GPS OCX.		KPP (SS and CS); PNT Determination KPP (User Segment); Accuracy KPP (User Segment); System Survivability - Cybersecurity KPP (CS); Integrity KPP (User Segment); Cryptography, Security Architecture, and Key Distribution KPP (User Segment); and External Augmentation KPP (User Segment).* See Table 5-1 OCX System Survivability – Cybersecurity (KPP) in approved CDD for GPS OCX.
Sustainment				
N/A	The achievement of the Availability of Position Accuracy KPP and Time Transfer Accuracy KPP thresholds satisfies this KPP.	(T=O) The achievement of the Availability of Position Accuracy KPP and Time Transfer Accuracy KPP thresholds satisfies this KPP.		The achievement of the Availability of Position Accuracy KPP and Time Transfer Accuracy KPP thresholds satisfies this KPP.
Availability of Time Transfer Accuracy				
N/A	UEE = 0.8 m rms (See Note 1) 15 nanoseconds (ns) (95%) @ 90% availability (any lat/long) 15 ns (95%) @ 99.9% availability (global average) UEE = 2.6 m rms (See Note 1) 40 ns (95%) @ 90% availability (any lat/long) 50 ns (95%) @ 99.9% availability (global average) Static Time Transfer 3.0 ns (95%) @ >99.9%	(T=O) UEE = 0.8 m rms (See Note 1) 15 nanoseconds (ns) (95%) @ 90% availability (any lat/long) 15 ns (95%) @ 99.9% availability (global average) UEE = 2.6 m rms (See Note 1) 40 ns (95%) @ 90% availability (any lat/long) 50 ns (95%) @ 99.9% availability (global average) Static Time Transfer 3.0 ns (95%) @ >99.9%		UEE = 0.8 m rms (See Note 1) 15 nanoseconds (ns) (95%) @ 90% availability (any lat/long) 15 ns (95%) @ 99.9% availability (global average) UEE = 2.6 m rms (See Note 1) 40 ns (95%) @ 90% availability (any lat/long) 50 ns

	availability Note 1: Availability of time transfer accuracy (dynamic) is dependent on the GPS receiver's UEE.	availability Note 1: Availability of time transfer accuracy (dynamic) is dependent on the GPS receiver's UEE.		(95%) @ 99.9% availability (global average) Static Time Transfer 3.0 ns (95%) @ >99.9% availability Note 1: Availability of time transfer accuracy (dynamic) is dependent on the GPS receiver's UEE.

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

Requirements Reference

GPS OCX CDD dated June 29, 2017.

Change Explanations

(Ch-1) The Current Estimate for Availability of Dynamic Time Transfer Accuracy, Availability of Static Time Transfer Accuracy, and Sustainment--Materiel Availability changed from the previous SAR as a result of the elimination of the performance characteristic in the September 27, 2018 APB.

Notes

This performance baseline is for OCX and was derived from the system-level CDD requirements. The GPS III program will track cost, schedule, and performance separately in its own APB.

Performance characteristics System Survivability, Sustainment, and Availability of Time Transfer Accuracy were added in the approved September 27, 2018 APB.

Acronyms and Abbreviations

AF - Air Force
ATO - Authority To Operate
CS - Control Segment
DAA - Designated Approval Authority
GESP - GIG Enterprise Service Profiles
GIG - Global Information Grid
GPS - Global Positioning System
IATO - Interim Authority to Operate
IAW - In Accordance With
IEA - Information Enterprise Architecture
IP - Internet Protocol
IS - Interface Specifications
IT - Information Technology
JTRS - Joint Tactical Radio System
lat - Latitude
long - Longitude
m - meter
MSI - Misleading Signal in Space Information
ns - nanosecond
O - Objective
PNT - Positioning, Navigation, and Timing
rms - root-mean-square
SAASM - Selective Availability/Anti-Spoofing Module
SS - Space Segment
SV - Space Vehicle
T - Theshold
TV - Technical View
UE - User Equipment
UEE - User Equipment Error

Track to Budget

RDT&E

Appn		BA	PE	
Air Force	3600	07	0603421F	
	Project		**Name**	
	674993		GPS III	(Sunk)
Air Force	3600	07	0603423F	
	Project		**Name**	
	67A021		INWS	(Sunk)
	67A025		GPS Enterprise Integrator	(Sunk)
Air Force	3600	07	1206423F	
	Project		**Name**	
	67A021		OCX	
	67A025		GPS Enterprise Integrator	

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	3591.8	6030.4	6633.4	6244.1	3413.0	6016.9	6278.8
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	3591.8	6030.4	N/A	6244.1	3413.0	6016.9	6278.8

Current APB Cost Estimate Reference

SCP dated May 25, 2017; SAF/FMC GPS OCX 2017 SCP memo dated June 12, 2018

The Base Year for the program has been updated from FY 2012 to FY 2017 using the following deflators:

Appn Category	Deflation Factor
RDT&E	1.07307651

Cost Notes

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

Total Quantity			
Quantity	SAR Baseline Development Estimate	Current APB Development	Current Estimate
RDT&E	1	1	1
Procurement	0	0	0
Total	1	1	1

Cost and Funding

Funding Summary

Appropriation Summary FY 2020 President's Budget / December 2018 SAR (TY$ M)									
Appropriation	Prior	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024	To Complete	Total
RDT&E	4013.5	509.3	445.3	487.4	406.3	291.1	125.9	0.0	6278.8
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 2020 Total	4013.5	509.3	445.3	487.4	406.3	291.1	125.9	0.0	6278.8
PB 2019 Total	4026.2	513.2	402.1	411.2	432.7	274.7	0.0	0.0	6060.1
Delta	-12.7	-3.9	43.2	76.2	-26.4	16.4	125.9	0.0	218.7

Funding Notes

The total funding requirement of the program is $6,290.2M with the Air Force part totaling to $6,278.8M shown in table above. Department of Transportation (DoT) funding in the amount of $11.4M (as of January 2019) is required and is critical to the development and delivery of the entire program.

Quantity Summary FY 2020 President's Budget / December 2018 SAR (TY$ M)										
Quantity	Undistributed	Prior	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024	To Complete	Total
Development	1	0	0	0	0	0	0	0	0	1
Production	0	0	0	0	0	0	0	0	0	0
PB 2020 Total	1	0	0	0	0	0	0	0	0	1
PB 2019 Total	1	0	0	0	0	0	0	0	0	1
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
2007	--	--	--	--	--	--	96.1
2008	--	--	--	--	--	--	249.5
2009	--	--	--	--	--	--	289.6
2010	--	--	--	--	--	--	288.4
2011	--	--	--	--	--	--	353.4
2012	--	--	--	--	--	--	346.4
2013	--	--	--	--	--	--	316.7
2014	--	--	--	--	--	--	361.4
2015	--	--	--	--	--	--	373.8
2016	--	--	--	--	--	--	463.4
2017	--	--	--	--	--	--	382.1
2018	--	--	--	--	--	--	492.7
2019	--	--	--	--	--	--	509.3
2020	--	--	--	--	--	--	445.3
2021	--	--	--	--	--	--	487.4
2022	--	--	--	--	--	--	406.3
2023	--	--	--	--	--	--	291.1
2024	--	--	--	--	--	--	125.9
Subtotal	1	--	--	--	--	--	6278.8

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
2007	--	--	--	--	--	--	110.7
2008	--	--	--	--	--	--	281.8
2009	--	--	--	--	--	--	322.8
2010	--	--	--	--	--	--	317.5
2011	--	--	--	--	--	--	381.8
2012	--	--	--	--	--	--	367.8
2013	--	--	--	--	--	--	330.7
2014	--	--	--	--	--	--	372.2
2015	--	--	--	--	--	--	381.1
2016	--	--	--	--	--	--	465.5
2017	--	--	--	--	--	--	376.2
2018	--	--	--	--	--	--	475.0
2019	--	--	--	--	--	--	481.5
2020	--	--	--	--	--	--	412.7
2021	--	--	--	--	--	--	442.9
2022	--	--	--	--	--	--	361.9
2023	--	--	--	--	--	--	254.2
2024	--	--	--	--	--	--	107.8
Subtotal	1	--	--	--	--	--	6244.1

Low Rate Initial Production

There is no LRIP for this program.

Foreign Military Sales

None

Nuclear Costs

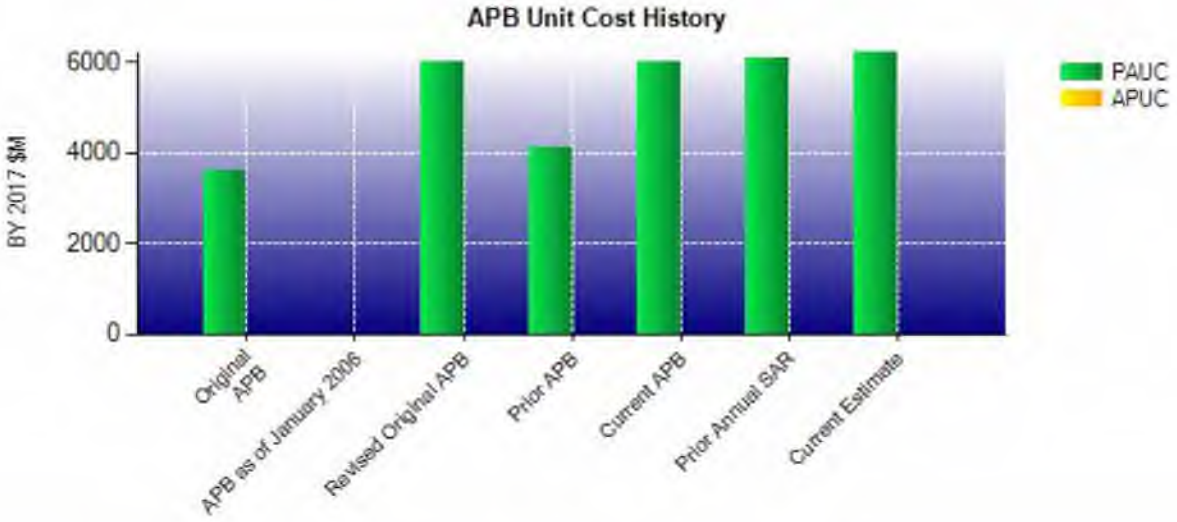
None

Unit Cost

Current UCR Baseline and Current Estimate (Base-Year Dollars)			
Item	BY 2017 $M Current UCR Baseline (Sep 2018 APB)	BY 2017 $M Current Estimate (Dec 2018 SAR)	% Change
Program Acquisition Unit Cost			
Cost	6030.4	6244.1	
Quantity	1	1	
Unit Cost	6030.400	6244.100	+3.54
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 Revised Original UCR Baseline (Sep 2018 APB)	BY 2017 $M Current Estimate (Dec 2018 SAR)	% Change
Program Acquisition Unit Cost			
Cost	6030.4	6244.1	
Quantity	1	1	
Unit Cost	6030.400	6244.100	+3.54
Average Procurement Unit Cost			
Cost	0.0	0.0	
Quantity	0	0	
Unit Cost	--	--	--

PAUC is based on RDT&E costs and quantities only. There is no APUC for this program because there are no procurement funds or quantities.



APB Unit Cost History					
Item	Date	BY 2017 $M		TY $M	
		PAUC	APUC	PAUC	APUC
Original APB	Nov 2012	3591.800	N/A	3413.000	N/A
APB as of January 2006	N/A	N/A	N/A	N/A	N/A
Revised Original APB	Sep 2018	6030.400	N/A	6016.900	N/A
Prior APB	Oct 2015	4119.900	N/A	3964.400	N/A
Current APB	Sep 2018	6030.400	N/A	6016.900	N/A
Prior Annual SAR	Dec 2017	6081.600	N/A	6060.100	N/A
Current Estimate	Dec 2018	6244.100	N/A	6278.800	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	
3413.000	-2.800	0.000	0.000	212.300	2656.300	0.000	0.000	2865.800	6278.800

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	Nov 2012	N/A	Nov 2012
Milestone C	N/A	Oct 2015	N/A	N/A
IOC	N/A	N/A	N/A	N/A
Total Cost (TY $M)	N/A	3413.0	N/A	6278.8
Total Quantity	N/A	1	N/A	1
PAUC	N/A	3413.000	N/A	6278.800

Cost Variance

Summary TY $M				
Item	RDT&E	Procurement	MILCON	Total
SAR Baseline (Development Estimate)	3413.0	--	--	3413.0
Previous Changes				
Economic	-34.3	--	--	-34.3
Quantity	--	--	--	--
Schedule	--	--	--	--
Engineering	+212.3	--	--	+212.3
Estimating	+2469.1	--	--	+2469.1
Other	--	--	--	--
Support	--	--	--	--
Subtotal	+2647.1	--	--	+2647.1
Current Changes				
Economic	+31.5	--	--	+31.5
Quantity	--	--	--	--
Schedule	--	--	--	--
Engineering	--	--	--	--
Estimating	+187.2	--	--	+187.2
Other	--	--	--	--
Support	--	--	--	--
Subtotal	+218.7	--	--	+218.7
Adjustments	--	--	--	--
Total Changes	+2865.8	--	--	+2865.8
CE - Cost Variance	6278.8	--	--	6278.8
CE - Cost & Funding	6278.8	--	--	6278.8

Summary BY 2017 $M				
Item	RDT&E	Procurement	MILCON	Total
SAR Baseline (Development Estimate)	3591.8	--	--	3591.8
Previous Changes				
Economic	--	--	--	--
Quantity	--	--	--	--
Schedule	--	--	--	--
Engineering	+205.7	--	--	+205.7
Estimating	+2284.1	--	--	+2284.1
Other	--	--	--	--
Support	--	--	--	--
Subtotal	+2489.8	--	--	+2489.8
Current Changes				
Economic	--	--	--	--
Quantity	--	--	--	--
Schedule	--	--	--	--
Engineering	--	--	--	--
Estimating	+162.5	--	--	+162.5
Other	--	--	--	--
Support	--	--	--	--
Subtotal	+162.5	--	--	+162.5
Adjustments	--	--	--	--
Total Changes	+2652.3	--	--	+2652.3
CE - Cost Variance	6244.1	--	--	6244.1
CE - Cost & Funding	6244.1	--	--	6244.1

Previous Estimate: December 2017

RDT&E	$M	
Current Change Explanations	Base Year	Then Year
Revised escalation indices. (Economic)	N/A	+31.5
Adjustment for current and prior escalation. (Estimating)	-14.6	-15.1
Revised estimate due to Below Threshold Reprogramming in FY 2017. (Estimating)	+5.4	+5.5
Additional funding received in FY 2020 - FY 2024 to align with the CAPE ICE dated May 25, 2017. (Estimating)	+208.0	+235.3
Revised estimate due to higher AF priorities in FY 2018 - FY 2019. (Estimating)	-21.3	-22.1
Revised estimate due to rephasing of funds from FY 2020 to FY 2021. (Estimating)	-0.1	0.0
Revised estimate to reflect application of PB FY 2019 inflation indices using new post Nunn -McCurdy base year. (Estimating)	-1.5	-1.5
Revised estimate to reflect application of new outyear inflation. (Estimating)	-13.4	-14.9
RDT&E Subtotal	+162.5	+218.7

Contracts

Contract Identification

Appropriation: RDT&E
Contract Name: OCX Phase B Contract
Contractor: Raytheon (Intelligence and Information Systems)
Contractor Location: 16800 E Centre Tech Pkwy
Aurora, CO 80011
Contract Number: FA8807-10-C-0001
Contract Type: Cost Plus Incentive Fee (CPIF), Cost Plus Award Fee (CPAF)
Award Date: February 25, 2010
Definitization Date: February 25, 2010

Contract Price							
Initial Contract Price ($M)			Current Contract Price ($M)			Estimated Price At Completion ($M)	
Target	Ceiling	Qty	Target	Ceiling	Qty	Contractor	Program Manager
886.4	N/A	1	1198.5	N/A	1	3129.4	3789.2

Target Price Change Explanation

The difference between the Initial Contract Price Target and the Current Contract Price Target is due to recognized cost over-runs as a result of software development and systems engineering challenges. Engineering Change Proposals, Requests for Equitable Adjustments, and engineering studies were also contributors.

Contract Variance		
Item	Cost Variance	Schedule Variance
Cumulative Variances To Date (1/27/2019)	-51.0	-23.9
Previous Cumulative Variances	-5.5	-32.8
Net Change	-45.5	+8.9

Cost and Schedule Variance Explanations

The unfavorable net change in the cost variance is due to complexities in 1.7 software integration and checkout into the environments, higher than anticipated number of Discrepancy Reports (DRs), inefficiencies in DR work-off and delays in platform availability.

The favorable net change in the schedule variance is due to baseline change adjustments that set schedule equal to performance, eliminating variance.

Notes

For tracking purposes, initial contract price information is based on the initial monthly contractor's performance report ending March 28, 2010.

Deliveries and Expenditures

Deliveries				
Delivered to Date	Planned to Date	Actual to Date	Total Quantity	Percent Delivered
Development	0	0	1	0.00%
Production	0	0	0	--
Total Program Quantity Delivered	0	0	1	0.00%

Expended and Appropriated (TY $M)			
Total Acquisition Cost	6278.8	Years Appropriated	13
Expended to Date	4074.3	Percent Years Appropriated	72.22%
Percent Expended	64.89%	Appropriated to Date	4522.8
Total Funding Years	18	Percent Appropriated	72.03%

The above data is current as of March 11, 2019.

Operating and Support Cost

Cost Estimate Details

Date of Estimate:	May 25, 2017
Source of Estimate:	SCP
Quantity to Sustain:	1
Unit of Measure:	System
Service Life per Unit:	10.00 Years
Fiscal Years in Service:	FY 2024 - FY 2034

O&S costs includes operating, maintaining, and supporting the dedicated Master Control Station (MCS) located at Schriever Air Force Base (AFB), CO and the Alternate MCS (AMCS) located at Vandenberg AFB, CA, both of which include connections to the ground antenna and monitoring stations which support the Global Positioning System III (GPS III) and GPS II legacy spacecraft. Also included are the costs of operating, maintaining, and supporting 17 monitoring stations, six controlled by the 50th Space Wing and 11 co-located at National Geo-spatial Intelligence Agency sites. Satellite operations at the MCS include mission planning, mission payload operations, and monitoring of satellite state of health. Monitor stations receive mission payload data and transfer this data to the MCS to ensure spacecraft are operating as desired.

The "system" to be supported will consist of the MCS, AMCS, Launch and Checkout System, Transition Support Facility, Data Storage and Archive System, GPS System Simulator, Standard Space Trainer software, four ground antennae elements, and 17 remote sites.

O&S cost estimate assumes OCX Block 1 is Ready To Operate in month end August 2022. Initial O&S activities start in August 2022 and continue until full O&S activities begin in May 2024. The system has a 10-year service life which will continue through May 2034. Manpower assumes a mixture of Air Force personnel performing organic work with assistance from contractor engineers.

Manpower, operations and maintenance is analogous to the currently operating GPS Operational Control System (OCS) with adjustments modeled to reflect the new OCX footprint.

Continuing system improvements are factored in as hardware modifications and software maintenance and modifications. The OCX hardware and software maintenance cost are based on OCS historical data and adjusted proportionally for the larger hardware profile and Software Lines of Code and cyber security differences between OCS and OCX.

In February 2016, the Air Force contracted with Lockheed Martin to modify the existing GPS OCS to support the GPS III satellite on-orbit command and control while delivering legacy capabilities. This effort is called Contingency Operations, and is not a part of the OCX system or its estimates.

Sustainment Strategy

Hardware depot maintenance will be 100% supported by Tobyhanna Army Depot while the Organizational Level maintenance will be Contractor Logistics Support (in alignment with operational unit's maintenance structure).

The estimate assumes organic depot hardware maintenance with 30% organic software maintenance and 70% contractor software maintenance. The cost estimate also includes Software Iteration 2.2 and the O&S requirements to support GPS III Space Vehicles on orbit.

Sustainment support is based on operator and non-operator training and sustainment engineering support is analogous to GPS OCS.

Antecedent Information

The antecedent system is GPS OCS. This system is the current operating control system and is limited to operating GPS II satellites. GPS OCS costs are derived from actual cost collected from the last GPS OCS official Cost Data Summary Report submission in 2011.

Annual O&S Costs BY2017 $M		
Cost Element	OCX Average Annual Cost Per System	GPS OCS (Antecedent) Average Annual Cost Per System
Unit-Level Manpower	9.248	12.100
Unit Operations	19.570	51.400
Maintenance	112.652	5.400
Sustaining Support	9.447	4.400
Continuing System Improvements	62.892	31.500
Indirect Support	3.882	0.500
Other	0.000	0.000
Total	217.691	105.300

The estimated GPS OCX average annual cost is higher than the GPS OCS actuals mainly due to the following significant cost drivers; OCX has a significantly more lines-of code (57% larger) to maintain, a significantly more complex and robust Information Assurance construct, and higher costs for hardware maintenance due to a larger hardware profile (76% larger).

Item	Total O&S Cost $M			
	OCX			GPS OCS (Antecedent)
	Current Development APB Objective/Threshold		Current Estimate	
Base Year	2303.2	2533.5	2303.2	N/A
Then Year	2955.1	N/A	2955.1	N/A

Estimate includes requirements for GPS IIF and GPS III and On-Orbit and Factory Support and updates Base Year from 2012 to 2017.

Equation to Translate Annual Cost to Total Cost

Average Annual Cost per System = Total OCX O&S Cost from FY 2024 through FY 2034 / number of service years

$217.69 = $2,176.90/ 10 Years

Total OCX O&S Cost from FY 2022 through FY 2034 = Total OCX O&S Cost in FY 2022 + Total OCX O&S Cost in FY 2023 + Total OCX O&S Cost from FY 2024 through FY 2034

$2,295.5M= $33.0M in FY2022 + $85.6M in FY 2023 + $2,176.9M in FY 2024 through FY 2034

O&S Cost Variance		
Category	**BY 2017 $M**	**Change Explanations**
Prior SAR Total O&S Estimates - Dec 2017 SAR	2303.2	
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	2303.2	

Total Prior O&S cost BY dollars updated from BY 2012 to BY 2017 using FY 2017 inflation rates and applying the BY 2017 rates to the approved SCP.

Disposal Estimate Details

Date of Estimate:	May 25, 2017
Source of Estimate:	SCP
Disposal/Demilitarization Total Cost (BY 2017 $M):	7.7