United States Government Accountability Office

Report to Congressional Committees

May 2019

WEAPON SYSTEMS ANNUAL ASSESSMENT

Limited Use of Knowledge-Based Practices Continues to Undercut DOD's Investments

Part 4, Air Force and DOD program assessments

Accessible Version

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GAO-19-336SP

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Abbreviations

AEHF	Advanced Extremely High Frequency Satellite
CDR	Critical Design Review
CPAF	cost-plus-award-fee
CPFF	cost-plus-fixed-fee
CPIF	cost-plus-incentive fee
CVN 78	Gerald R. Ford Class Nuclear Aircraft Carrier
DAMIR	Defense Acquisition Management Information Retrieval

DDG 51	DDG 51 Arleigh Burke Class Guided Missile Destroyer
DOD	Department of Defense
eSRS	Electronic Subcontracting Reporting System
F-35	F-35 Lightning II Joint Strike Fighter
FFP	firm-fixed-price
FPDS-NG	Federal Procurement Data System-Next Generation
FPI	fixed-price incentive
IDIQ	indefinite-delivery/indefinite-quantity
MDAP	Major Defense Acquisition Program
MH-60R	MH-60R Multi-Mission Helicopter
MRL	manufacturing readiness level
NA	not applicable
NDAA	National Defense Authorization Act
OMB	Office of Management and Budget
P-8A Increment 3	P-8A Poseidon, Increment 3
SAR	Selected Acquisition Report
SBIRS High	Space Based Infrared System High
SSN 774	SSN 774 Virginia Class Submarine
TBD	to be determined
TRL	technology readiness level
USAF	United States Air Force
USMC	United States Marine Corps
USN	United States Navy
WIN-T Inc. 2	Warfighter Information Network-Tactical Increment 2
WIN-T Inc. 3	Warfighter Information Network-Tactical Increment 3
WSARA	Weapon Systems Acquisition Reform Act

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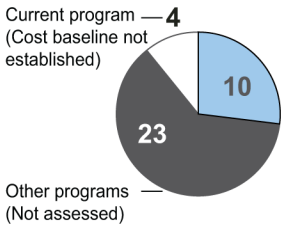
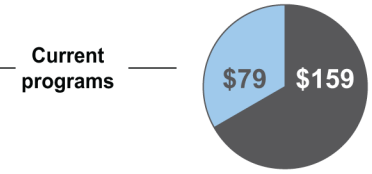
AIR FORCE PROGRAM ASSESSMENTS

GAO Assessed 10 of the Air Force's 37 Current Major Defense Acquisition Programs



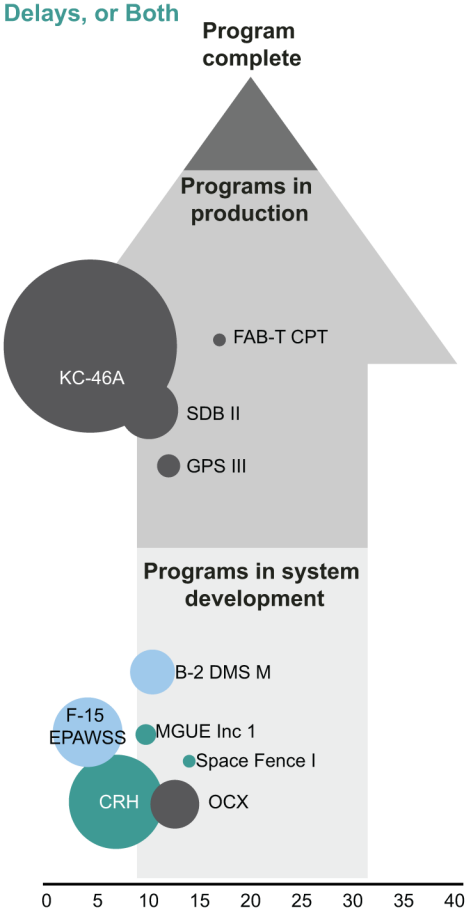
The 10 Current Programs GAO Assessed Represent 33 Percent of the Air Force's $238 Billion Estimated Total Acquisition Costs

(Fiscal Year 2019 dollars in billions)



■ We also assessed two future major defense acquisition programs. We did not assess programs that had yet to enter technology development or had already progressed into full-rate production.

Most Current Programs GAO Assessed Have Either Cost Growth, Schedule Delays, or Both

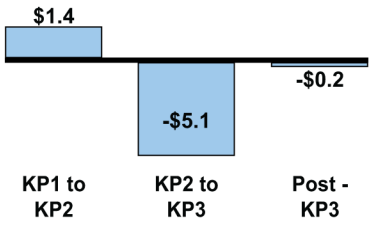


- Cost growth of more than 15 percent and/or schedule delays of more than 6 months
- Cost growth of 15 percent or less and/or schedule delays of 6 months or less
- Cost growth of 0 percent or less and schedule delays of 0 months or less

Note: Bubble size is based on each program's currently estimated future acquisition funding needed.

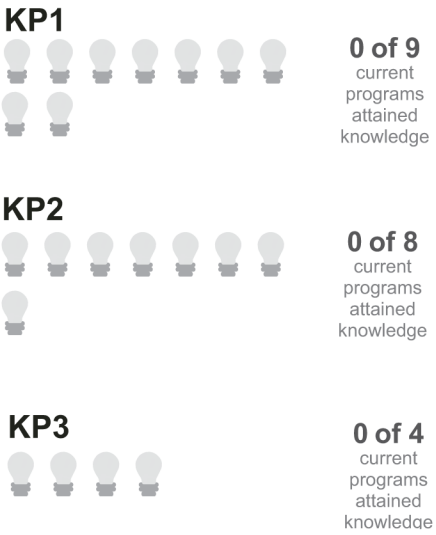
Total Acquisition Cost Performance in Current Programs Varied Among Knowledge Points (KP)

(Fiscal Year 2019 dollars in billions)



■ A cost decrease in one current program—KC-46A—accounted for most of the cost decrease between KP2 and KP3.

Current Programs Did Not Attain Knowledge at Key Points



Average Acquisition Cycle Time of Current Programs Increased by 25 Months from First Full Estimate (FFE) to Current Estimate

■ We could not calculate cycle time for GPS III because initial capability depends on the availability of complementary systems.

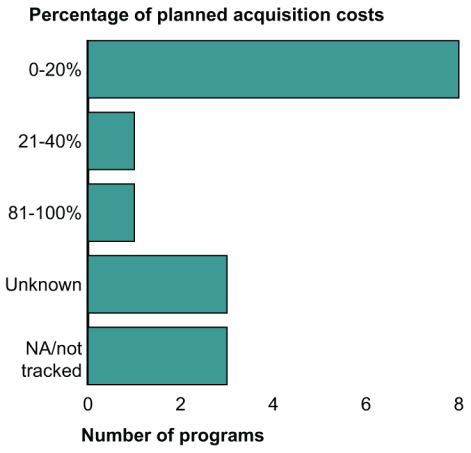
■ Four current programs—APT, GPS IIIF, UH-1N Replacement, and VC-25B—entered system development after December 2017 and therefore are excluded from our cost, schedule, knowledge attainment, and contract analysis.

■ Cost and schedule analysis is primarily based on estimates from December 2017 selected acquisition reports. This information may differ from the amounts reported in the individual assessments, which are based on more recent program estimates in some cases. Please see appendix II for details.

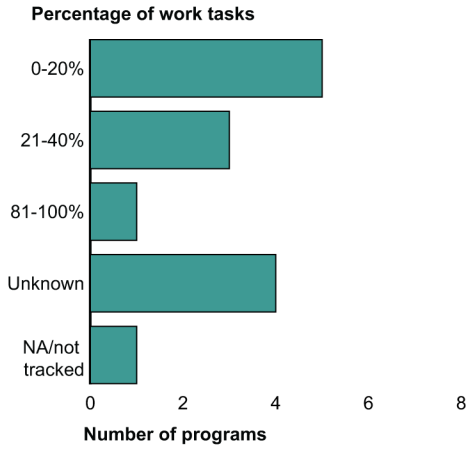
Source: GAO analysis of Department of Defense data. | GAO-19-336SP

AIR FORCE PROGRAM ASSESSMENTS

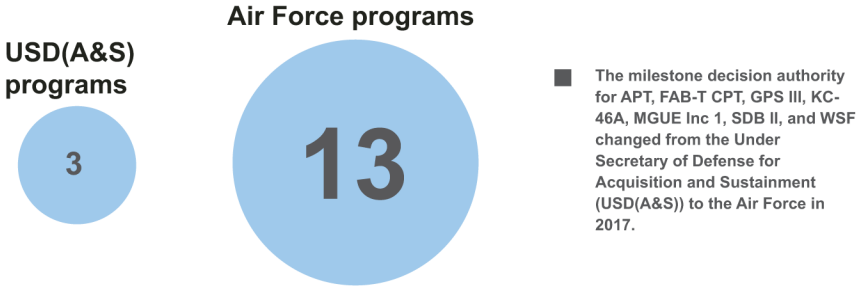
Half of the Current and Future Air Force Programs Report that Less than 20 Percent of Planned Acquisition Costs are Specifically for Software



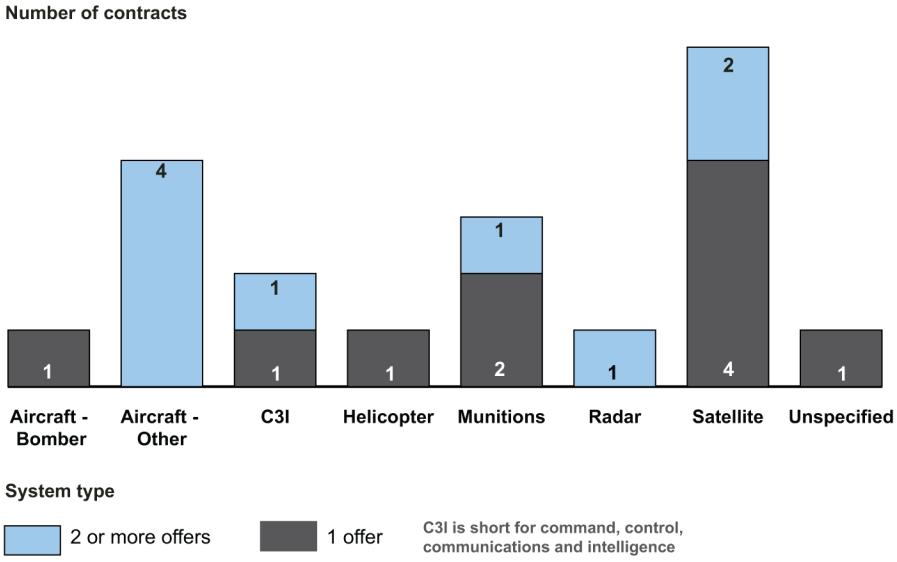
Most Current Air Force Programs Report that Less than 40 Percent of Work Tasks are Software-Related



The Air Force was the Milestone Decision Authority in 2017 for 13 of its Current and Future Programs in GAO's Review



The Air Force Received One Offer on Solicitations for Just Over Half of its Currently Reported Major Contracts for Development and Procurement



Source: GAO analysis of Department of Defense data. | GAO-19-336SP

Air Force Program Assessments[a]	Page number
2-page assessments	
Advanced Pilot Training (APT)	
B-2 Defensive Management System Modernization (B-2 DMS-M)	
Combat Rescue Helicopter (CRH)	
F-15 Eagle Passive Active Warning Survivability System (F-15 EPAWSS)	
Family of Advanced Beyond Line-of-Sight Terminals Command Post Terminals (FAB-T CPT)	
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Space Fence Ground-Based Radar System Increment 1 (Space Fence Inc 1)	
Utility Helicopter (UH-1N) Replacement	
1-page assessments[b]	
B-52 Radar Modernization Program (B-52 RMP)	
VC-25B Presidential Aircraft Recapitalization (VC-25B)	
Weather System Follow-On (WSF)	

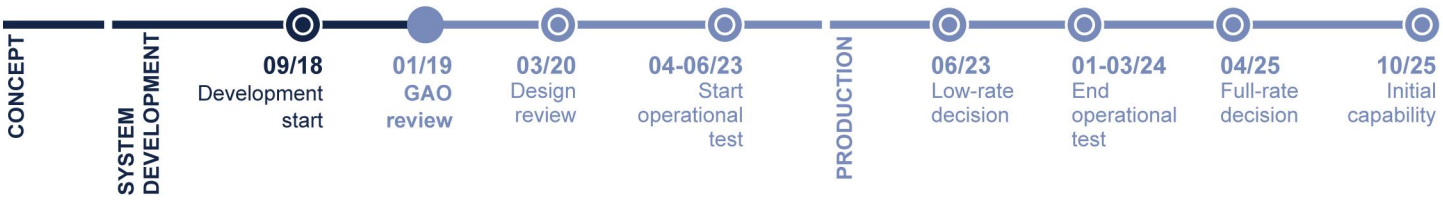
[a]We abbreviate the following contract types in the individual assessments: cost-plus-award-fee (CPAF), cost-plus-fixed-fee (CPFF), cost-plus-incentive-fee (CPIF), firm-fixed-price (FFP), and fixed-price incentive (FPI).

[b]The VC-25B program has entered system development but released a baseline late in our review, so we assessed it in a one-page format.

Source: U.S. Air Force.

Advanced Pilot Training (APT)

With its APT program, the Air Force is replacing its legacy T-38C trainer fleet and related ground equipment by developing and fielding newer, more technologically advanced trainer aircraft and an associated ground-based training system. The APT program responds to the Air Force's advanced fighter pilot training needs and seeks to close training gaps that the T-38C cannot fully address.



Program Essentials

Program office: Wright-Patterson Air Force Base, OH

Prime contractor: Boeing

Contract type: Indefinite-delivery indefinite-quantity with delivery orders: FPI (development)

Software development approach: TBD

Next major milestone: Design review (March 2020)

Program Performance (fiscal year 2019 dollars in millions)

	First full estimate (09/2018)	Latest (09/2018)	Percentage change
Development	$1,258.40	$1,258.40	0.0%
Procurement	$6,782.30	$6,782.30	0.0%
Unit cost	$23.40	$23.40	0.0%
Acquisition cycle time (months)	85	85	0.0%
Total quantities	351	351	0.0%

The Air Force approved an acquisition program baseline for APT in September 2018. Total quantities comprise 5 development quantities and 346 procurement quantities.

Funding and Quantities

(fiscal year 2019 dollars in millions)

Attainment of Product Knowledge

As of January 2019

	Status at Development Start	Current Status
Resources and requirements match		
• Demonstrate all critical technologies are very close to final form, fit and function within a relevant environment	NA	NA
• Demonstrate all critical technologies in form, fit and function within a realistic environment	NA	NA
• Complete a system-level preliminary design review	○	○
Product design is stable	**Design Review**	
• Release at least 90 percent of design drawings	NA	NA
• Test a system-level integrated prototype	NA	NA
Manufacturing processes are mature	**Production Start**	
• Demonstrate Manufacturing Readiness Level of at least 9, or critical processes are in statistical control	NA	NA
• Demonstrate critical processes on a pilot production line	NA	NA
• Test a production-representative prototype in its intended environment	NA	NA

● Knowledge attained, ○ Knowledge not attained, … Information not available, NA Not applicable

APT Program

Technology Maturity

The APT program office reported that APT does not rely on any critical technologies. According to the program's 2016 acquisition strategy, the program expected all competing vendors to either (1) not employ any critical technologies in their proposals or (2) only employ critical technologies that were mature and ready to demonstrate in a field environment. The strategy also said that the program office conducted a preliminary technology readiness assessment in 2015 that showed the technologies required for the major components of the APT—including airframe, propulsion, and ejection seat—were mature and demonstrated in operating environments similar to that for the APT. The strategy also acknowledged, however, that some new APT capabilities, such as embedded training systems, cockpit displays, and software, might need to be developed or integrated during the program's development phase.

The program did not conduct a preliminary design review (PDR) before its September 2018 development start. Instead, it plans to hold the PDR in approximately June 2019, some 9 months after development start. The program received a statutory waiver from the Assistant Secretary of the Air Force (Acquisition, Logistics, and Technology) that allowed it to delay the PDR. The waiver stated that conducting PDR-related activities prior to development start would prevent the program from meeting national security objectives because it would delay transition of pilots to 4th and 5th generation fighter aircraft. Further, the waiver noted that holding PDR post-development start was low-risk because APT would leverage mature systems and technologies and a PDR would increase the program's cost as well as delay the program by 12-18 months with "no appreciable decrease" in technical risk. However, as we have observed in prior work, a PDR conducted prior to development start helps ensure a system's design is feasible—which in turn contributes to a match between customer needs and available time, funding, and other resources. Additionally, we have found that major defense acquisition programs that held a PDR prior to starting development had fewer schedule delays than other programs.

Design Stability

The APT program has initiated system design activities, but is not currently tracking design drawings. The program's acquisition strategy called for vendors to provide flight test data for their systems in order to be considered for contract award. The strategy further stated that the program office would structure the acquistion to require the use of mature systems. Looking ahead, the program expects to hold a critical design review no later than March 2020.

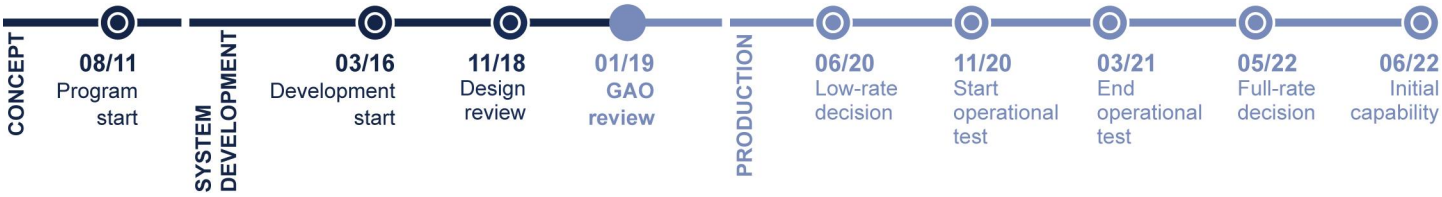
Program Office Comments

We provided a draft of this assessment to the program office for review and comment. The program office provided technical comments, which we incorporated where appropriate.

Source: U.S. Air Force.

B-2 Defensive Management System Modernization (B-2 DMS-M)

The Air Force's B-2 DMS-M program plans to upgrade the aircraft's 1980s-era defensive management system to a more capable system. This system detects and locates enemy radar systems to provide threat warnings and avoidance information. This upgrade is expected to improve the system's frequency coverage and sensitivity, update pilot displays, and enhance in-flight rerouting capabilities. It will improve the reliability and maintainability of the DMS system and the B-2's readiness.



Program Essentials

Milestone decision authority: Under Secretary of Defense for Acquisition and Sustainment

Program office: Wright-Patterson Air Force Base, OH

Prime contractor: Northrop Grumman

Contract type: FFP (development)

Software development approach: Agile development

Next major milestone: Low-rate initial production decision (June 2020)

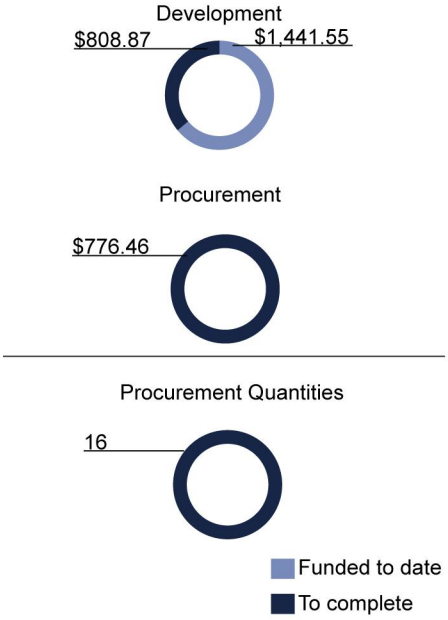
Program Performance (fiscal year 2019 dollars in millions)

	First full estimate (05/2016)	Latest (06/2018)	Percentage change
Development	$1,914.60	$2,250.40	+17.5%
Procurement	$771.6	$776.50	+0.6%
Unit cost	$134.31	$151.34	+12.7%
Acquisition cycle time (months)	124	130	+4.8%
Total quantities	20	20	0.00%

The Air Force released a new service cost position for the B-2 DMS-M program in June 2018. Total quantities comprise 4 development quantities and 16 procurement quantities.

Funding and Quantities

(fiscal year 2019 dollars in millions)



Attainment of Product Knowledge

As of January 2019

	Status at Development Start	Current Status
Resources and requirements match		
• Demonstrate all critical technologies are very close to final form, fit and function within a relevant environment	●	●
• Demonstrate all critical technologies in form, fit and function within a realistic environment	○	●
• Complete a system-level preliminary design review	●	●
Product design is stable	**Design Review**	
• Release at least 90 percent of design drawings	●	●
• Test a system-level integrated prototype	○	○
Manufacturing processes are mature	**Production Start**	
• Demonstrate Manufacturing Readiness Level of at least 9, or critical processes are in statistical control	NA	NA
• Demonstrate critical processes on a pilot production line	NA	NA
• Test a production-representative prototype in its intended environment	NA	NA

● Knowledge attained, ○ Knowledge not attained, … Information not available, NA Not applicable

B-2 DMS-M Program

Technology Maturity and Design Stability

The B-2 DMS-M program has fully matured its critical technologies and stabilized its design. The program entered system development in March 2016 with four critical technologies approaching maturity. Since then, Northrop Grumman proposed, and the Air Force accepted, an alternative system that provides additional capabilities. The alternative system is leveraged from other programs and has the same four critical technologies. Because the Air Force has tested the major subsystems on an existing program, it now considers its critical technologies mature.

The Air Force's decision to pursue an alternative system led to some initial program delays. For example, although the Air Force held a preliminary design review before entering system development, it completed a second preliminary design review for the alternative system in March 2018. The program also held its critical design review in November 2018, nearly 2 years later than originally planned. Consistent with acquisition best practices, the program released more than 90 percent of its design drawings by the critical design review. However, the program did not test a system-level integrated prototype—an approach inconsistent with acquisition best practices. This decision puts the program at risk for costly design changes following system-level integration testing if the program identifies deficiencies.

The program continues to face delays and increased integration risk in its software development, a critical factor for achieving required B-2 DMS-M capabilities. The contractor is utilizing an Agile software development process for the first time on this program and has taken longer than expected to achieve the development efficiency to complete the functionality of a software block, known as PD 7.1. The program requires certification of software block PD 7.1 functionality to support developmental flight testing. Program officials stated that over the last year the contractor has made significant progress in addressing software development risk by increasing the number of software developers and expanding overtime for existing staff. However, software version PD 7.1 may still be at risk of not being certified with full functionality by June 2019, when the program has scheduled developmental flight tests. Lack of software certification could delay these tests. Program officials continue to monitor the effectiveness of the contractor's mitigation plans and possible schedule delays.

Other Program Issues

Program officals report that, in May 2017, due to the selection of the alternative DMS system, the program office and contractor agreed to an undefinitized contract action that changed the development contract from a cost-type contract to a firm-fixed-price contract. The program office stated that the undefinitized contract action included a not-to-exceed amount of $741 million until the contract scope and price could be definitized. Because there were issues with the contractor delivering a complete proposal, the program has delayed definitization. The program office reports approximately 50 percent of the $741 million not-to-exceed amount has been obligated, and officials do not expect to definitize the contract action until the spring of 2019, nearly 2 years after award.

As program officials began negotiations for using the alternative DMS system, they recognized they could not execute the related development work within the existing Air Force budget. As a result, the Air Force conducted a cost-versus-capability trade analysis of the program and ultimately decided on a course of action that continued with the alternative system but required hardware changes on the aircraft. In June 2018, the Air Force released an updated service cost position to reflect the latest acquisition approach, which identified a 13 percent unit cost increase over the program's acquisition baseline. This increase was largely due to hardware changes and integration updates as a result of the increased capabilities of the alternative DMS system.

Program Office Comments

We provided a draft of this assessment to the program office for review and comment. The program office provided technical comments, which we incorporated where appropriate. In reviewing the draft, program officials noted that the revised program strategy leverages development from other Air Force programs, implements additional capability to improve weapon system survivability, and provides risk reduction for other programs.

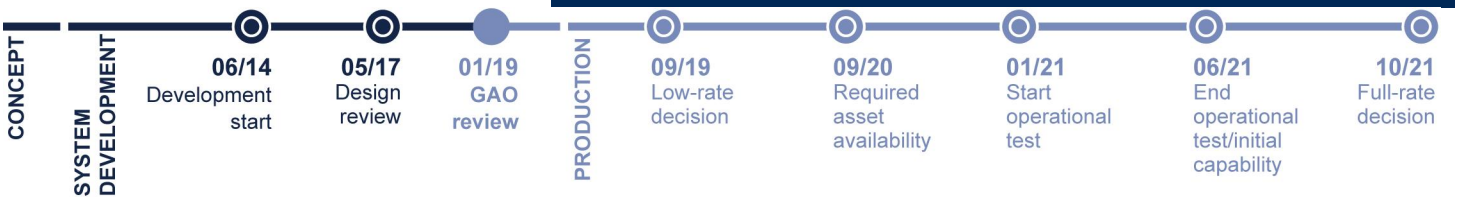
In addition, program officials stated the cost-versus-capability analysis ensured that while hardware requirements were decreased in order to reduce procurement costs, the program will still meet performance requirements.They also stated that the service cost position now estimates a 12.5 percent increase in program acquisition unit cost as well as the potential for delays.This estimate includes the increased capabilities and associated risk reduction, and is not constrained to the not-to-exceed value.

Program officials also noted that design efforts are complete as presented at the critical design review. They said that DMS-M installation into the B-2 flight test aircraft is underway. According to the officials, the critical path to beginning flight test is completion of software development and PD 7.1 certification efforts. The program office stated that it continues to work closely with the prime contractor to achieve schedule milestones.

Source: © 2017 Sikorsky, A Lockheed Martin Company. Used with permission for supporting of the Air Force's Combat Rescue Helicopter Program and Combat Rescue Helicopter associated efforts.

Combat Rescue Helicopter (CRH)

The Air Force's CRH program will replace the Air Force's aging HH-60G Pave Hawk rescue helicopter fleet. It will provide 113 new air vehicles, related training systems, and support for increased personnel recovery capability. CRH uses a derivative of the operational UH-60M helicopter. Planned modifications to the existing design include a new mission computer and software, a higher capacity electrical system, larger capacity main fuel tanks, armor for crew protection, a gun mount system, and situational awareness enhancements.



Program Essentials

Milestone decision authority: Air Force

Program office: Wright-Patterson Air Force Base, OH

Prime contractor: Sikorsky Aircraft Corporation

Contract type: FPI/FFP (development)

Software development approach: Mixed

Next major milestone: Low-rate initial production (September 2019)

Program Performance (fiscal year 2019 dollars in millions)

	First full estimate (06/2014)	Latest (12/2018)	Percentage change
Development	$2,106.00	$2,013.80	-4.4%
Procurement	$6,567.50	$6,240.80	-5.0%
Unit cost	$77.67	$73.66	-5.2%
Acquisition cycle time (months)	75	75	+0.0%
Total quantities	112	113	0.9%

Acquisition cycle time as of November 2018. Cycle time is based on required asset availability date. Initial capability is not a formal program milestone. Quantities comprise 10 development quantities and 103 procurement quantities.

Funding and Quantities
(fiscal year 2019 dollars in millions)

Attainment of Product Knowledge
As of January 2019

	Status at	Current Status
Resources and requirements match	**Development Start**	
• Demonstrate all critical technologies are very close to final form, fit and function within a relevant environment	○	●
• Demonstrate all critical technologies in form, fit and function within a realistic environment	○	○
• Complete a system-level preliminary design review	○	●
Product design is stable	**Design Review**	
• Release at least 90 percent of design drawings	●	●
• Test a system-level integrated prototype	○	○
Manufacturing processes are mature	**Production Start**	
• Demonstrate Manufacturing Readiness Level of at least 9, or critical processes are in statistical control	NA	NA
• Demonstrate critical processes on a pilot production line	NA	NA
• Test a production-representative prototype in its intended environment	NA	NA

● Knowledge attained, ○ Knowledge not attained, … Information not available, NA Not applicable

CRH Program

Technology Maturity and Design Stability

The CRH program has matured its one critical technology—a radar warning receiver—and stabilized its design. At development start in June 2014, however, the program had not demonstrated the receiver to final form, fit, or function in either a relevant or realistic environment—an approach inconsistent with best practices. Program officials stated that CRH's one critical technology, the radar warning receiver, was proven mature through Integrated Demonstrations and Applications Laboratory testing in May 2018 that tested based on over 100 simulated real-world threats. As indicated by our attainment of production knowledge section, we believe that the program cannot demonstrate the full maturity of critical technologies until they are tested in their realistic environment, such as on a helicopter in flight.

Approximately 72 percent of the CRH design is based on the fully operational and fielded UH-60M helicopter, while the remainder is based on new design drawings that are unique to the CRH. Although the program reports that it has released all its planned design drawings, the program continues to resolve and test fixes for system deficiencies identified in recent testing. Program officials noted that, for the identified deficiencies—including those that involve the mission computer, fuel gauge, and ballistic armor—they are either implementing corrections or awaiting testing to confirm resolution. These deficiencies may require the program to revise currently completed design drawings to accommodate necessary changes, which could compromise the CRH's design stability.

The CRH program also has yet to test a system-level integrated prototype to demonstrate its design, although best practices criteria state that such a prototype should be tested by a program's critical design review. Instead, CRH program officials reported that, in February 2017, they began lab-based prototype tests using a partial CRH system. However, these tests will not fully demonstrate certain CRH subsystems and software, which continue to pose technical risk in the program.

Production Readiness

In accordance with best practices, program officials plan to conduct system-level developmental prototype testing and demonstrate critical manufacturing processes on a pilot production line prior to the low-rate initial production decision, which is planned for September 2019. Since our 2018 assessment, the program office has delayed planned dates for low-rate initial production, the start of developmental testing and the helicopter's first flight. According to program officials, problems with suppliers and software integration and testing required the program to extend the developmental schedule and delay initiating flight tests. The contractor had previously pursued an accelerated program schedule. Program officials stated that the contractor is now following the program's approved 75-month baseline schedule, due primarily to delayed design and supplier performance issues. Program officials reported that first flight has changed from October 2018 to May 2019 with no changes in required or planned testing.

Program officials stated they do not anticipate engineering-related changes to pose a serious risk after production begins, but that software development and deficiency corrections may be necessary. Program officials stated that correcting deficiencies identified during testing would not require any increase in the government's program costs. According to these officials, the government's liability is capped at a negotiated ceiling price under the fixed-price incentive contract for CRH development, and program officials project reaching this ceiling. Program officials expect to complete integration of CRH's software and hardware prior to the start of operational testing in January 2021.

Other Program Issues

Program officials expect to meet CRH affordability requirements for average unit cost, but the program's cost estimate for military construction currently exceeds its baseline cost constraints by $10 million due to increased trainer facilities requirements. In addition, program officials reported that this estimate may further change due to DOD pricing guide rate changes in the future.

Program Office Comments

We provided a draft of this assessment to the program office for review and comment. The program office provided technical comments, which we incorporated where appropriate. According to the program office, CRH has advanced significantly and the contractor has mitigated its design and supplier performance issues.

The program office also said that the contractor completed testing of CRH hardware and initial software required for-production flight testing in an aircraft-representative laboratory. According to the program, CRH's critical technology tested successfully in a simulated environment using production hardware. The program office stated that all data required to support the production decision will be in place.

The program office also expressed confidence that it will achieve its planned dates for production decision, subsequent contract award for low-rate initial production, and required asset availability.

Source: U.S. Air Force.

F-15 Eagle Passive Active Warning Survivability System (F-15 EPAWSS)

The Air Force's F-15 EPAWSS program plans to modernize the F-15's electronic warfare (EW) system used to detect and identify threats, employ counter-measures, and jam enemy radars. The program plans to reconfigure hardware and software from other military aircraft to meet the challenges of today's EW threat environment. The Air Force developed EPAWSS Increment 1 to replace the F-15's legacy EW system. The Air Force has yet to budget for a proposed Increment 2, which adds a new towed decoy. We assessed Increment 1.

Program Essentials

Milestone decision authority: Air Force

Program office: Wright-Patterson Air Force Base, OH

Prime contractor: Boeing

Contract types: CPIF/CPFF (technology maturation and risk reduction)

CPIF/CPFF/FFP (development)

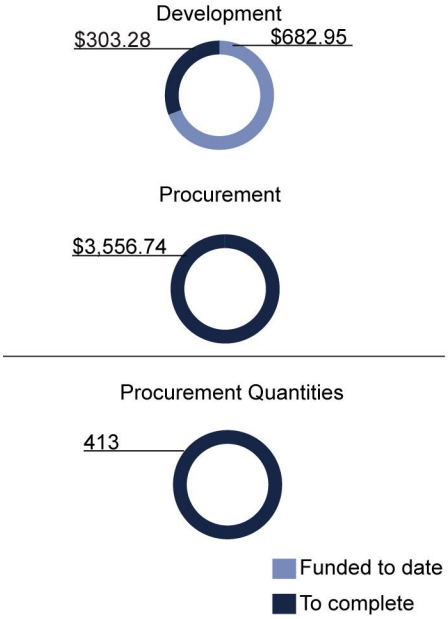
Software development approach: Mixed

Next major milestone: Low-rate initial production (July 2019)

Program Performance (fiscal year 2019 dollars in millions)

	First full estimate (11/2016)	Latest (12/2018)	Percentage change
Development	$921.10	$986.20	7.1%
Procurement	$3,546.70	$3,556.70	0.3%
Unit cost	$10.82	$11.00	1.7%
Acquisition cycle time (months)	83	82	-1.2%
Total quantities	413	413	0.0%

Funding and Quantities
(fiscal year 2019 dollars in millions)



Attainment of Product Knowledge
As of January 2019

	Status at	Current Status
Resources and requirements match	**Development Start**	
• Demonstrate all critical technologies are very close to final form, fit and function within a relevant environment	●	●
• Demonstrate all critical technologies in form, fit and function within a realistic environment	○	○
• Complete a system-level preliminary design review	●	●
Product design is stable	**Design Review**	
• Release at least 90 percent of design drawings	○	●
• Test a system-level integrated prototype	○	●
Manufacturing processes are mature	**Production Start**	
• Demonstrate Manufacturing Readiness Level of at least 9, or critical processes are in statistical control	NA	NA
• Demonstrate critical processes on a pilot production line	NA	NA
• Test a production-representative prototype in its intended environment	NA	NA

● Knowledge attained, ○ Knowledge not attained, … Information not available, NA Not applicable

F-15 EPAWSS Program

Technology Maturity

Over 2 years after entering development, the EPAWSS program reported each of its four critical technologies as approaching maturity—a condition inconsistent with best practices. The program delayed ground-based testing of the critical technologies by several months in 2018 because of performance shortfalls with some components where the technologies reside. The remaining technology maturation work also delayed software development and other activities needed to support flight testing. Specifically, the first flight of an EPAWSS-equipped test aircraft is now delayed by 3 months from December 2018 to March 2019. As a result, the Air Force has yet to demonstrate the full maturity of EPAWSS technologies.

Design Stability

The program reported the release of all EPAWSS design drawings, but technology immaturity and the redesign of key components pose risk to maintaining design stability. For example, the program released only 87 percent of the EPAWSS drawings at its February 2017 critical design review (CDR), with the remaining drawings released in the months that followed. As a result of subsequent redesign efforts to address performance shortfalls, the program modified some released drawings in the past year. The design changes also required a subcontractor to remanufacture components of the program's initial test articles which led the program to delay key integration and testing activities by several months.

According to program officials, the components in need of redesign performed adequately during prototype testing at development start, but did not perform as needed during more rigorous testing after CDR. Officials indicated that they are still experiencing a problem with one of the desired capabilities and may need to make additional design changes after the start of flight testing. In addition, a subcontractor experienced low yield rates for the initial fabrication of a critical test article component, leaving a limited number of test articles available to support development activities before flight testing. As a result, the program plans to install EPAWSS hardware without this component on several F-15 test aircraft, limiting aircraft functionality during the early months of flight testing until the missing component is equipped.

Production Readiness

The program plans to test a production-representative prototype and demonstrate manufacturing processes on a pilot production-line before EPAWSS production begins.The program schedule, however, indicates concurrency between testing and production is increasing. For example, the Air Force moved up the EPAWSS low-rate initial production decision by one month, from August 2019 to July 2019.

Further, the program is now following a tailored approach where its production decision involves two separate decision points. The first, in July 2019, authorizes the start of EPAWSS low-rate production and will be reported as the program's Milestone C decision for statutory purposes. The second decision point in 2020 authorizes installation of the already-procured hardware on fielded F-15 aircraft. If the second decision is delayed, the program may accrue a stockpile of unused hardware until installation is approved.

Also as a result of the tailored approach, the program will not attain certain pieces of knowledge before it starts production. For example, the Air Force decided that the EPAWSS program no longer needs to complete all hardware qualification testing, conduct an operational assessment, or demonstrate full EPAWSS performance in-flight prior to the July 2019 production decision. The program will instead complete these activities in support of the later deployment decision in 2020. This approach increases the risk that the program would need to retrofit already-installed units if system testing finds EPAWSS design problems after July 2019.

Other Program Issues

Several ongoing modifications to other F-15 aircraft subsystems need to be accomplished before EPAWSS can be successfully installed on the aircraft. According to EPAWSS program officials, these predecessor modifications are on schedule to support EPAWSS. In addition, the Air Force now plans to procure EPAWSS for both the F-15C and F-15E after reporting last year that only the F-15E would be upgraded. As a result, the program increased its current cost estimate over the past year, but it is now in keeping with the first full estimate, which included both F-15 models.

Program Office Comments

We provided a draft of this assessment to the program office for review and comment. The program office provided technical comments, which we incorporated where appropriate. The program office stated that to expedite replacement of the functionally obsolete EW self-protection system on F-15s today, the EPAWSS acquisition heavily leverages mature hardware from existing U.S. and foreign military EW programs. The program office indicated that availability of critical hardware components unique to F-15 EPAWSS drives the program schedule. The program office maintained that the system's design is now stable and noted that it expects to begin flight tests by early summer 2019. The program office contended that the technical maturation of EPAWSS components will help support a decision to purchase a small quantity of production hardware before development is complete to help accelerate initial operational capability. The program office stated that while this strategy is not without risk, it provides the Air Force an opportunity to transfer operational risk from F-15 aircrews to the acquisition community.

Source: U.S. Air Force.

Family of Advanced Beyond Line-of-Sight Terminals Command Post Terminals (FAB-T CPT)

The Air Force's FAB-T program plans to provide a family of satellite communication terminals for airborne and ground-based users to replace legacy communication terminals. In July 2015, DOD separated FAB-T into two subprograms: command post terminals (CPT), which we assess here, and force element terminals (FET). CPT is expected to provide communications for nuclear and conventional forces through ground command posts and E-6 and E-4 aircraft. FET is expected to provide capabilities for B-52 and RC-135, at a minimum.

Program Essentials

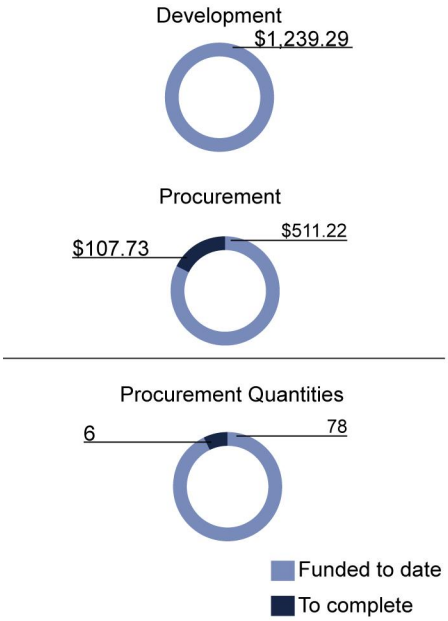
Milestone decision authority: Air Force
Program office: Bedford, MA
Prime contractor: Raytheon
Contract type: FPI (development)
FFP (production)
Software development approach: Incremental
Next major milestone: Start of operational testing (August 2019)

Program Performance (fiscal year 2019 dollars in millions)

	First full estimate (12/2007)	Latest (10/2018)	Percentage change
Development	$739.20	$1,239.30	+67.6%
Procurement	$993.50	$619.10	-37.7%
Unit cost	$18.24	$17.05	-6.5%
Acquisition cycle time (months)	129	225	+74.4%
Total quantities	95	109	+14.7%

Latest estimate reflects amounts from the Defense Acquisition Executive Summary following the new acquisition program baseline in July 2018. Total quantities comprise 25 development quantities and 84 procurement quantities.

Funding and Quantities
(fiscal year 2019 dollars in millions)



Attainment of Product Knowledge
As of January 2019

	Status at	Current Status
Resources and requirements match	**Development Start**	
• Demonstrate all critical technologies are very close to final form, fit and function within a relevant environment	…	●
• Demonstrate all critical technologies in form, fit and function within a realistic environment	…	○
• Complete a system-level preliminary design review	…	●
Product design is stable	**Design Review**	
• Release at least 90 percent of design drawings	○	●
• Test a system-level integrated prototype	○	●
Manufacturing processes are mature	**Production Start**	
• Demonstrate Manufacturing Readiness Level of at least 9, or critical processes are in statistical control	○	○
• Demonstrate critical processes on a pilot production line	●	●
• Test a production-representative prototype in its intended environment	○	●

● Knowledge attained, ○ Knowledge not attained, … Information not available, NA Not applicable

FAB-T CPT Program

Technology Maturity, Design Stability, and Production Readiness

The FAB-T CPT program has several critical technologies, half of which continue to approach maturity, and reports a stable design. However, until the program fully matures all of its critical technologies—and demonstrates each of them in a final form, fit, and function within a realistic environment—current design stability remains at risk of disruption. The program has also entered low-rate initial production, but has yet to demonstrate statistical control of critical manufacturing processes—an approach inconsistent with best practices.

FAB-T CPT is comprised of five terminal configurations, some of which have different critical technologies. Two modification kit terminals adapt existing antennas for ground fixed and airborne platforms and are fully functional but will eventually be retrofitted with new antennas. The other three configurations use new antennas for ground fixed, ground transportable, and airborne platforms. According to the program office, the four configurations currently in production—the two modification kit terminals and the new antenna ground fixed and transportable terminals—are now mature. The program previously planned for all the new antenna terminals to be fully mature by July 2016, but delays continue in developing the final configuration, the new airborne antenna.

The program office now expects to achieve initial operational capability by June 2021—an 18-month delay from the December 2019 date it previously reported—and full operational capability by March 2023—a 15 month delay from the December 2021 date it anticipated. The program's revised acquisition program baseline was approved in July 2018.

The program reported that, as of October 2018, it intends to procure approximately 63 percent of FAB-T total units during low-rate production. The program's purchase of such a quantity corresponds with 2015 direction from the Under Secretary of Defense for Acquisition, Technology, and Logistics, which authorized the FAB-T program to purchase more than 60 percent of its total units during low-rate production. Programs generally must provide a rationale to Congress if low-rate production quantities will exceed 10 percent of total planned procurement quantities. FAB-T officials said that the higher number of units are required to demonstrate initial operational capability due to the various configurations and platforms needed. Officials said they plan to request permission to procure additional terminals before a full-rate procurement decision to take advantage of cost control opportunities from volume discounts. With the majority of terminals already approved, officials noted that initial operational testing would not significantly inform a full-rate decision. We have previously found that beginning production before demonstrating that a system will work as intended increases the risk of needing substantial design changes and costly modifications to already-produced systems.

The FAB-T program reported that its manufacturing processes are nearing maturity. Officials also reported the program has contracted for a total of 51 terminals to date: 27 modification kit terminals, 15 new antenna ground fixed terminals, and 9 ground transportable terminals. As of December 2018, the contractor has delivered 22 terminals, and the program has installed 5 to begin testing.

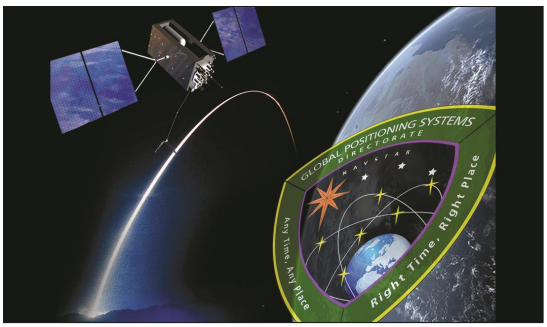
Other Program Issues

The program office is developing the acquisition strategy for FET, its other subprogram, as a middle tier acquisition—also referred to as a Section 804 program—which uses a streamlined acquisition process to rapidly prototype or field capabilities within a 5-year period. The program expects the Air Force to approve this strategy in February 2019 and to then award a development contract by June 2019. Until the FET subprogram is executed, FAB-T cannot achieve its planned capabilities that are based on the interaction of bomber aircraft with intelligence, surveillance, and reconnaissance aircraft and CPTs.

FAB-T is designed to communicate through the Advanced Extremely High Frequency (AEHF) network of satellites, four of which have already been launched. As FAB-T delays mount, the first launched AEHF satellite might near the end of its projected 14-year operational lifespan by the time FAB-T is available. All six AEHF satellites are expected to be on-orbit before FAB-T is operational. The lack of synchronization between the two programs has resulted in the underutilization of costly satellite capabilities.

Program Office Comments

We provided a draft of this assessment to the program office for review and comment. The program office provided technical comments, which we incorporated as appropriate. The program office stated that it faced challenges resolving issues identified during testing and finalizing operational software, which delayed the completion of operational testing by 5 months. According to program officials, the program is still on track to complete operational testing by November 2019. Program officials said they installed the first operational terminal in January 2019 and plan to complete development of the new airborne antenna configuration by September 2019. However, the program office also noted that it is pursuing options to address significant funding shortfalls that could affect test and terminal procurement activities. According to program officials, the Air Force designated the FET subprogram as a middle tier acquisition, but the acquisition strategy has not yet been approved.



Source: U.S. Air Force.

Global Positioning System III (GPS III)

The Air Force's GPS III program is building and fielding a new generation of satellites to supplement and eventually replace GPS satellites currently in use. GPS III will provide a stronger military navigation signal, referred to as M-code, to improve jamming resistance, and will provide a new civilian signal that will be interoperable with foreign satellite navigation systems. Other programs are developing the related ground system and user equipment.

CONCEPT | SYSTEM DEVELOPMENT | PRODUCTION

- **05/08** Development start
- **08/10** Design review
- **01/11** Production decision
- **09/17** First satellite available for launch
- **01/19** GAO review
- **01/20** Start operational test
- **TBD** End operational test
- **TBD** Initial capability

Program Essentials

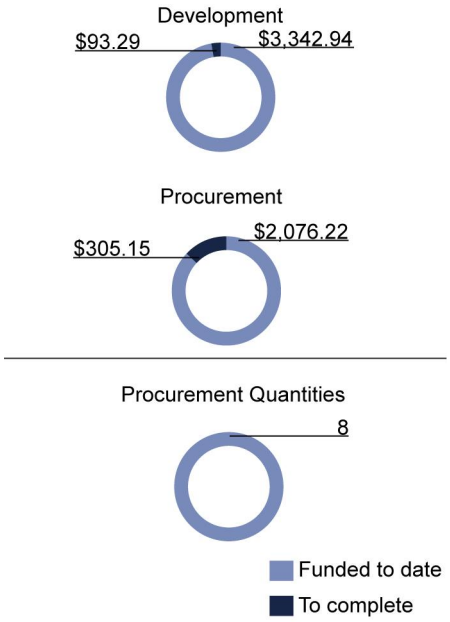
Milestone decision authority: Air Force
Program office: El Segundo, CA
Prime contractor: Lockheed Martin
Contract types: CPAF (development) CPAF/FPI (production)
Software development approach: Mixed
Next major milestone: Start of operational testing (January 2020)

Program Performance (fiscal year 2019 dollars in millions)

	First full estimate (05/2008)	Latest (06/2018)	Percentage change
Development	$2,826.50	$3,436.20	+21.6%
Procurement	$1,587.00	$2,381.40	+50.1%
Unit cost	$551.68	$581.76	+5.5%
Acquisition cycle time (months)	N/A	N/A	N/A
Total quantities	8	10	+25.0%

We could not calculate GPS III cycle times because the initial capability depends on the availability of complementary systems. Total quantities comprise 2 development quantities and 8 procurement quantities.

Funding and Quantities
(fiscal year 2019 dollars in millions)



Attainment of Product Knowledge
As of January 2019

	Status at Development Start	Current Status
Resources and requirements match		
• Demonstrate all critical technologies are very close to final form, fit and function within a relevant environment	●	●
• Demonstrate all critical technologies in form, fit and function within a realistic environment	NA	NA
• Complete a system-level preliminary design review	○	●
Product design is stable	**Design Review**	
• Release at least 90 percent of design drawings	●	●
• Test a system-level integrated prototype	○	●
Manufacturing processes are mature	**Production Start**	
• Demonstrate Manufacturing Readiness Level of at least 9, or critical processes are in statistical control	○	○
• Demonstrate critical processes on a pilot production line	○	●
• Test a production-representative prototype in its intended environment	○	○

● Knowledge attained, ○ Knowledge not attained, … Information not available, NA Not applicable

GPS III Program

Technology Maturity, Design Stability, and Production Readiness

The GPS III program office reported that all eight of its critical technologies are mature and that the design is stable. Lockheed Martin has delivered two of the 10 GPS III satellites to the Air Force, while the remaining eight are in various stages of production. In September 2017, the Air Force declared that the first GPS III satellite was available for launch. This declaration followed an Air Force investigation into performance anomalies observed in a propulsion subsystem common to multiple Air Force programs. Although the Air Force did not determine the root cause of the anomalies, it tested multiple GPS III propulsion subsystems and was satisfied with the performance. As a result, the program office certified that the first GPS III satellite met all documented requirements. While Defense Contract Management Agency officials indicated that there were no design changes to the subsystem, program officials stated that the Air Force introduced changes to how ground control operators fire the subsystem to raise a satellite into orbit and that the subsystem manufacturer introduced measures to ensure greater uniformity in the manufacturing process.

The Air Force declared in August 2018 that the second satellite was available for launch, and the third satellite will be available for launch in May 2019. After prior problems with delayed deliveries of navigation payload components, the program office has noted improvements in the navigation payload subcontractor's management and schedule performance over the past year. The program office continues to face delayed deliveries of certain other satellite components, such as a power regulation unit and the propulsion subsystem. The program office is working to reduce potential effects of propulsion subystem delivery delays by temporarily installing a non-flight propulsion subsystem on the affected satellites. This step allows the program to progress with assembly, integration, and testing while awaiting flight unit deliveries.

Other Program Issues

The Air Force launched the first GPS III satellite on December 23, 2018, on a SpaceX Falcon 9 rocket. In preparation for the launch, the Air Force conducted a series of mission readiness events, culminating in a final mission rehearsal in November. Next, the Air Force will conduct 6 months of on-orbit testing, including testing the satellite's non-navigation functions and turning on its navigation payload, according to program officials. The Air Force will not conduct operational testing of the navigation payload, however, until it modifies the Operational Control Segment (OCS) to operationally control the payload. That modification is currently scheduled to be fielded in October 2019. Afterward, the Air Force will begin 6 months of additional testing, including operational testing of the modified OCS with the GPS III satellite for all currently available GPS navigation signals beginning in January 2020. The Air Force plans for a second OCS modification in early 2020 to enable some of the GPS III M-code capabilities.

Because of delays to the GPS Next Generation Operational Control System (OCX)—needed to enable the full range of GPS III capabilities—the GPS III program expects to accept delivery of at least the first nine satellites before beginning developmental and operational testing with OCX Block 1. The Air Force anticipates that these tests, planned to begin in 2023, will confirm GPS III's modernized signal capabilities. This sequencing, however, introduces the possibility that testers will discover deficiencies to already produced or launched satellites—thus constraining the Air Force's corrective options—and carries risk to overall GPS III cost, schedule, and performance.

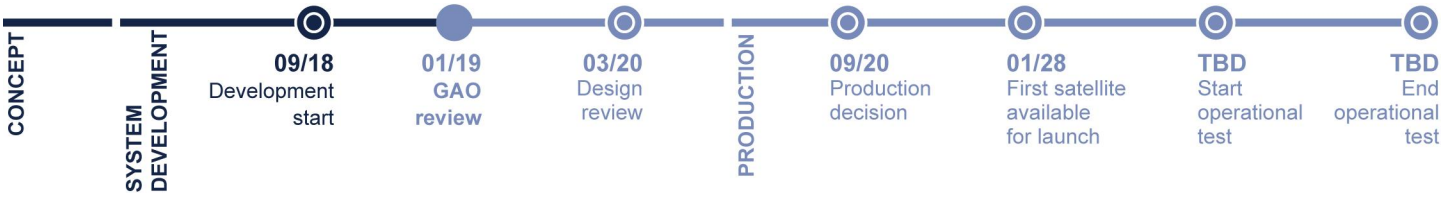
Program Office Comments and GAO Response

We provided a draft of this assessment to the program office for review and comment. The program office provided technical comments, which we incorporated where appropriate. The program office indicated that it is focused on GPS III production, launch, and mission operations. It stated that the first GPS III satellite successfully launched on December 23, 2018, and continues to progress through on-orbit checkout and testing. The program office also said the second GPS III satellite recently arrived at the Astrotech Space Operations facility in Titusville, Florida, in preparation for a planned July 2019 launch. According to the program office, the third GPS III satellite is on track to be available for launch in May 2019, and satellites 4 through 10 are progressing through various stages of production. In addition, the program office stated that GPS III's production is currently "robust" and has overcome past technical problems. We plan to seek further detail on the program's manufacturing metrics as part of our next annual assessment.

Source: Lockheed Martin Corporation.

Global Positioning System III Follow-On (GPS IIIF)

The Air Force's GPS IIIF program will build upon the efforts of the GPS III program to develop and field next generation GPS satellites to modernize and replenish the GPS satellite constellation. In addition to the capabilities built into the original GPS III design, GPS IIIF will provide new capabilities. These include a steerable, high-power military code (M-code) signal, known as Regional Military Protection, to provide warfighters with greater jamming resistance in contested environments.



Program Essentials

Milestone decision authority: Air Force
Program office: El Segundo, CA
Prime contractor: Lockheed Martin
Contract types: FPI (development)
Software development approach: Mixed
Next major milestone: Design review (March 2020)

Program Performance (fiscal year 2019 dollars in millions)

	First full estimate (09/2018)	Latest (09/2018)	Percentage change
Development	$3,214.50	$3,214.50	0.00%
Procurement	$6,216.80	$6,216.80	0.00%
Unit cost	$428.70	$428.70	0.00%
Acquisition cycle time (months)	N/A	N/A	N/A
Total quantities	22	22	0.00%

We could not calculate cycle time because initial capability depends on the availability of complementary systems.
Total quantities comprise 2 development quantities and 20 procurement quantities.

Funding and Quantities
(fiscal year 2019 dollars in millions)

Attainment of Product Knowledge
As of January 2019

	Status at Development Start	Current Status
Resources and requirements match		
• Demonstrate all critical technologies are very close to final form, fit and function within a relevant environment	●	●
• Demonstrate all critical technologies in form, fit and function within a realistic environment	NA	NA
• Complete a system-level preliminary design review	NA	NA
Product design is stable	**Design Review**	
• Release at least 90 percent of design drawings	NA	NA
• Test a system-level integrated prototype	NA	NA
Manufacturing processes are mature	**Production Start**	
• Demonstrate Manufacturing Readiness Level of at least 9, or critical processes are in statistical control	NA	NA
• Demonstrate critical processes on a pilot production line	NA	NA
• Test a production-representative prototype in its intended environment	NA	NA

● Knowledge attained, ○ Knowledge not attained, … Information not available, NA Not applicable

GPS IIIF Program

Technology Maturity

The GPS IIIF program office reports that its two critical technologies—an L-band traveling wave tube amplifier (TWTA) and a digital waveform generator—are mature to the level generally required for the program to begin development. The Air Force certified that the program has demonstrated the system's technologies in a relevant environment prior to development start.

The TWTA is designed to provide the signal amplification required for the GPS IIIF satellite's regional military protection capability. The Air Force's Space and Missile Systems Center (SMC) conducted an independent assessment prior to the program's development start and found that the TWTA provides lower technical risk and is more mature than the alternative amplifier the program office had previously considered. Program officials note that TWTAs have proven performance on orbit in other DOD space programs, such as the Advanced Extremely High Frequency satellite. Although the TWTAs have not been proven in space at the power level required for GPS IIIF, SMC reports that the contractor has successfully tested an engineering model in a representative environment.

The GPS IIIF navigation payload will incorporate a new digital waveform generator to produce the military and civil waveforms, or signals, that provide the basis of GPS navigation. SMC assessed the digital waveform generation as a low-risk function, but noted that integrating the navigation signal functions into a single electronics box presents a higher risk. Of note, integrating signal functions proved difficult in developing the GPS III program's navigation payload. The contractor demonstrated the digital waveform generator with hardware that was approaching maturity and which SMC assessed as being close to flight design. Program officials noted that the shift from the partially analog navigation payload of GPS III to the completely digital payload of GPS IIIF streamlines aspects of the manufacturing process.

Design Stability

The Air Force waived the requirement that the program conduct a preliminary design review prior to development start, in part to expedite a contract award given DOD's critical national security need for the GPS IIIF's unique capabilities. As part of required certifications at development start, the Air Force certified that GPS IIIF had already demonstrated a level of technological maturity beyond preliminary design review. According to the Air Force, the program demonstrated this level of maturity in the production readiness feasibility work it conducted between May 2016 and June 2017. However, we have found that completing a preliminary design review prior to development start is an acquisition best practice associated with lower cost and schedule growth.

The GPS IIIF program schedule plans for the contractor to deliver a production-ready satellite design soon after contract award. The program office is currently working toward a critical design review in spring 2020 to demonstrate design stability in advance of a production decision, planned for 6 months later. According to program officials, the GPS IIIF satellite will heavily leverage mature technologies from GPS III, primarily in the satellite bus design. The program plans to test a system-level integrated prototype that includes all key subsystems and components, but with less redundancy than the final configuration, prior to integrating and testing the first GPS IIIF satellite.

Program Office Comments

We provided a draft of this assessment to the program office for review and comment. According to the program office, since the Air Force awarded Lockheed Martin the fixed-price-type contract for GPS III Follow-On satellites in 2018, the program has been working closely with the contractor to validate contractor delivery milestones to ensure no schedule growth occurs. The program office also reported that it recently completed an integrated baseline review in March 2019 and is currently pursuing a critical design review to validate a production-ready satellite design.

Source: © 2016 Boeing Company - Photo by Paul Weatherman.

KC-46 Tanker Modernization Program (KC-46A)

The Air Force's KC-46A program plans to convert an aircraft designed for commercial use into an aerial refueling tanker for operations with Air Force, Navy, Marine Corps, and allied aircraft. The program is in the first of three planned phases to replace roughly a third of the Air Force's aging aerial refueling tanker fleet, comprised mostly of KC-135s. The Air Force has designed the KC-46A to improve on the KC-135's refueling capacity, efficiency, and capabilities for cargo and aeromedical evacuation, and to integrate defensive systems.

Program Essentials

Milestone decision authority: Air Force

Program office: Wright-Patterson Air Force Base, OH

Prime contractor: Boeing

Contract types: FPI (development)

FFP (production)

Software development approach: Mixed

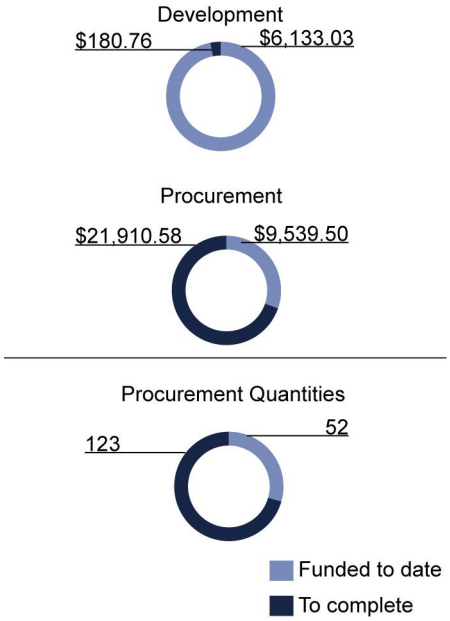
Next major milestone: Start of operational testing (May 2019)

Program Performance (fiscal year 2019 dollars in millions)

	First full estimate (02/2011)	Latest (01/2019)	Percentage change
Development	$7,671.90	$6,313.80	-17.7%
Procurement	$37,253.70	$31,450.10	-15.6%
Unit cost	$274.12	$225.76	-17.6%
Acquisition cycle time (months)	78	112	+43.6%
Total quantities	179	179	0.0%

Total quantities comprise 4 development quantities and 175 procurement quantities.

Funding and Quantities
(fiscal year 2019 dollars in millions)



Attainment of Product Knowledge
As of January 2019

	Status at	Current Status
Resources and requirements match	**Development Start**	
• Demonstrate all critical technologies are very close to final form, fit and function within a relevant environment	●	●
• Demonstrate all critical technologies in form, fit and function within a realistic environment	○	●
• Complete a system-level preliminary design review	○	●
Product design is stable	**Design Review**	
• Release at least 90 percent of design drawings	…	NA
• Test a system-level integrated prototype	○	●
Manufacturing processes are mature	**Production Start**	
• Demonstrate Manufacturing Readiness Level of at least 9, or critical processes are in statistical control	○	○
• Demonstrate critical processes on a pilot production line	●	●
• Test a production-representative prototype in its intended environment	●	●

● Knowledge attained, ○ Knowledge not attained, … Information not available, NA Not applicable

KC-46A Program

Technology Maturity and Design Stability

The KC-46A's three critical technologies—two software modules related to situational awareness and a display that allows the crew to monitor aerial refueling—are fully mature.

At its 2013 critical design review (CDR), the program had released over 90 percent of design drawings. However, as reflected in our attainment of product knowledge graphic, we lack insight into design stability from CDR forward because (1) the discovery of aircraft wiring deficiencies post-CDR and consequent re-design of the wiring system called into question the accuracy of the design drawing information available at CDR, and (2) after CDR, the program stopped using drawings to assess design and instead began using other methods to measure design status.

Based on developmental testing, the Air Force identified three critical refueling deficiencies that require design changes. First, refueling operators are not aware of instances when the boom strikes receiver aircraft. These strikes are due to a shortcoming with the system that provides information to their display screens and may damage the low observable aircraft coating on some receivers, possibly making stealth receiver aircraft visible to radar. Second, according to program officials, the aerial refueling operator's screen does not provide sufficient visual sharpness and adaptation to changing background and lighting to allow for safe refueling in all environmental conditions. The officials stated Boeing will make software or hardware changes related to these two deficiencies without cost to the government. Third, program officials reported that the boom remains too stiff during refueling attempts with lighter receiver aircraft, which could cause it to strike the receiver aircraft. Boeing is working to resolve this issue, but program officials said the Air Force will have to fund implementation of any corrective fixes because the system was designed to an international standard and the Air Force needed it to be designed to a lower stiffness standard. Program officials estimate that it will take 3 to 4 years to correct these deficiencies.

As of February 2019, Boeing has completed 92 percent of the development test program. All remaining tests relate to the wing aerial refueling pods. Until this testing is complete, Boeing may find additional technical issues that could require further design changes.

Production Readiness

Program officials said that Boeing has not demonstrated manufacturing readiness to the desired level due to the extension of low-rate initial production. However, they said the Federal Aviation Administration has certified Boeing's production process.

As of February 2019, Boeing has manufactured four development aircraft, delivered six low-rate production aircraft, and is in the process of producing 40 additional low-rate initial production aircraft. Boeing is completing the majority of production work on its 767 aircraft production line. According to program officials, Boeing is completing some production work out of sequence due to the earlier wiring and other design problems and expects to resolve these by early 2019. The program intends to purchase approximately 38 percent of its total planned number of production aircraft during low-rate initial production. In 2017, the Under Secretary of Defense for Acquisition, Technology, and Logistics approved this strategy to avoid a break in the production line.

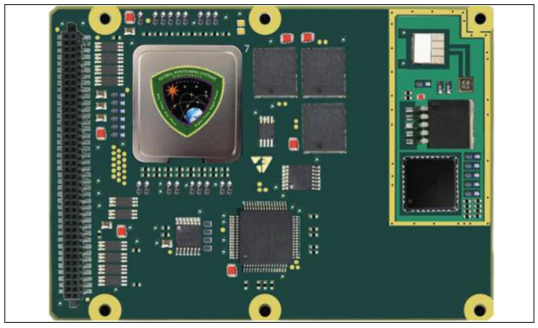
Other Program Issues

The original development contract required Boeing to deliver the first 18 aircraft with nine sets of wing aerial refueling pods by August 2017. However, because of wiring problems, test and certification delays, and other setbacks, the Air Force did not begin accepting aircraft until January 2019. As of that time, the Air Force has accepted four KC-46A aircraft that are capable of refueling other aircraft through two of three types of planned refueling options. According to program officials, the Air Force is withholding 20 percent of its payments to Boeing until Boeing demonstrates that it meets contract specifications. Boeing now plans to deliver the required aircraft and refueling pods in June 2020, at which time the aircraft will be capable of all three planned types of refueling. Under this plan, Boeing will complete work on the development contract 34 months later than initially planned.

Program officials negotiated considerations from Boeing to account for lost military tanker capability associated with the delivery delays, such as obtaining additional training at no cost to the government for KC-46A pilots and maintenance personnel and support for the aircrew training system. Officials reported that the Air Force and Boeing finalized the contract modification, including these considerations, in December 2018.

Program Office Comments

We provided a draft of this assessment to the program office for review and comment. The program office provided technical comments, which we incorporated where appropriate.



Source: U.S. Air Force.

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

The Air Force's MGUE program is developing GPS receivers that will be compatible with the military's next-generation GPS signal, military code (M-code). The modernized receiver cards will provide U.S. forces with enhanced position, navigation, and timing capabilities, and improved resistance to threats, such as jamming efforts by adversaries. Increment 1, assessed here, is developing receiver test cards for aviation, maritime, and ground platforms. The Air Force approved the Increment 2 acquisition strategy in 2018 for development of smaller receiver cards and a modernized handheld receiver.

Program Essentials

Milestone decision authority: Air Force

Program office: El Segundo, CA

Prime contractors: L-3 Technologies, Raytheon, Collins Aerospace

Contract type: CPIF/CPFF/FFP (development)

Software development approach: Other tailored approach

Next major milestone: Start of operational testing (February 2020)

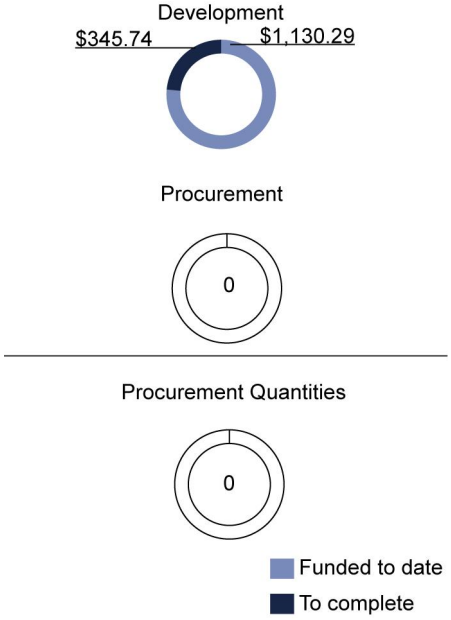
Program Performance (fiscal year 2019 dollars in millions)

	First full estimate (01/2017)	Latest (06/2018)	Percentage change
Development	$1,555.80	$1,476.00	-5.1%
Procurement	$0.0	$0.0	0.0%
Unit cost	N/A	N/A	N/A
Acquisition cycle time (months)	N/A	N/A	N/A
Total quantities	0	0	0.0%

According to program officials, the latest estimate reflects funding approved to date, but they will seek funding to match the approved full estimate.

Funding and Quantities

(fiscal year 2019 dollars in millions)



Attainment of Product Knowledge

As of January 2019

	Status at Development Start	Current Status
Resources and requirements match		
• Demonstrate all critical technologies are very close to final form, fit and function within a relevant environment	●	●
• Demonstrate all critical technologies in form, fit and function within a realistic environment	○	○
• Complete a system-level preliminary design review	●	●
Product design is stable	**Design Review**	
• Release at least 90 percent of design drawings	NA	NA
• Test a system-level integrated prototype	NA	NA
Manufacturing processes are mature	**Production Start**	
• Demonstrate Manufacturing Readiness Level of at least 9, or critical processes are in statistical control	NA	NA
• Demonstrate critical processes on a pilot production line	NA	NA
• Test a production-representative prototype in its intended environment	NA	NA

● Knowledge attained, ○ Knowledge not attained, … Information not available, NA Not applicable

MGUE Increment 1 Program

Technology Maturity

The MGUE Increment 1 program office has assessed four of its five critical technologies—M-code acquisition engine, M-code cryptography, selective availability anti-spoofing module cryptographic engine, and security protection—as fully mature. The program's fifth critical technology, anti-spoof software, is nearing maturity. Anti-spoof technology is designed to prevent MGUE from acquiring and tracking false GPS signals. Program officials said that two contractors have delivered full anti-spoof capability, and the third contractor is providing incremental capabilities. They noted the difficulty of applying maturity standards to MGUE because the program is not delivering a final weapon, but rather a chip-based receiver card that individual programs will integrate into final weapons before it is ever fielded in an operational environment. For example, to assess maturity for anti-spoof technology, the program is using a laboratory simulator as a relevant environment because of restrictions regarding open air testing of spoofing signals.

Program protection is included in the contractors' security certification process—a key step for the services to procure and integrate receiver cards. Program officials said all testing has been completed for initial security certification and that two of the three contractors have received initial security certification. The remaining contractor is expected to complete the certification process in spring 2019.

Design Stability

We previously recommended that the program incorporate a critical design review into its acquisition plan to demonstrate the stability of the MGUE design, prior to testing the receiver card with the first platform. However, DOD formally eliminated this review from the acquisition program in January 2017. Program officials previously told us the design is stable, and any further design problems will be found in ongoing developmental testing. In last year's assessment, we reported that contractors delivered final hardware test cards in 2017 for laboratory tests. Since that time, testing revealed deficiencies with the first ground card, which the program corrected in 2018. Additionally, the program office reports that it modified contracts with each contractor to incorporate a performance requirement known as "hot start"—the ability of receiver cards to transmit legacy signals to existing weapon systems. As of December 2018, government testing was ongoing for the two contractors' cards that incorporated this capability. The third contractor expects to deliver this capability in spring 2019.

Production Readiness

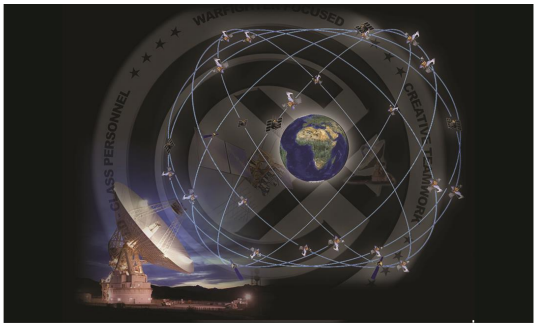
The MGUE program office will not make a production decision because the program's acquisition strategy does not include plans to procure cards beyond the final test articles. Instead, the program will end with operational testing of the first available test cards on four, military department-specific weapon systems. Integration and testing is ongoing on these systems and once completed, expected in April 2021, program offices will determine whether to undertake additional development and testing to integrate the receiver cards, identify their required quantities, and enter into a contract for production. While the military departments are developing some common solutions, individual program offices have the flexibility to pursue their own uncoordinated receiver card programs at different times and with different contractors.

Other Program Issues

The MGUE Increment 1 program is at risk of delaying schedule milestones because of delays from incorporating the hot start requirement and late discovery of hardware and software issues during government verification. The program office has taken steps to mitigate further delays, such as providing additional GPS simulators and test equipment to help resolve software problems. The program is also working with the Air Force Space Command to determine the extent of need for a more comprehensive hot start solution that would involve modifying the M-code signals, which could drive costs beyond the independent estimate. Such a change would also require changes to the GPS space and ground segments. Additionally, the manufacturer of the chips in the receiver cards plans to cease production as early as 2020, leading some program offices to consider procuring the chips in bulk.

Program Office Comments

We provided a draft of this assessment to the program office for review and comment. The program office provided technical comments, which we incorporated where appropriate. According to the program office, MGUE made progress this year demonstrating functionality and performance through card-level developmental testing of mature cards. The program stated that it expects to complete final verification testing of the first ground card in March 2019. It also said that two cards have met hardware reliability requirements, and all cards continue to demonstrate capabilities to meet user needs in various environments. The program office stated that, within the next year, it expects to integrate the final card of each type into the military departments' lead platforms and make those cards available to the military departments for procurement.



Source: U.S. Air Force.

Next Generation Operational Control System (OCX)

Through its OCX program, the Air Force is primarily developing software to replace the existing Global Positioning System (GPS) ground control system. The Air Force intends for OCX software to help ensure reliable, secure delivery of position, navigation, and timing information to military and civilian users. The Air Force is developing OCX in blocks that each provide upgrades as they become available. We assessed the first three blocks: Block 0, for launch and limited testing of new satellites; Block 1, for satellite control and basic military signals; and Block 2, for modernized military and additional navigation signals.

Program Essentials

Milestone decision authority: Under Secretary of Defense for Acquisition and Sustainment

Program office: El Segundo, CA

Prime contractor: Raytheon

Contract type: CPIF (development)

Software development approach: Mixed

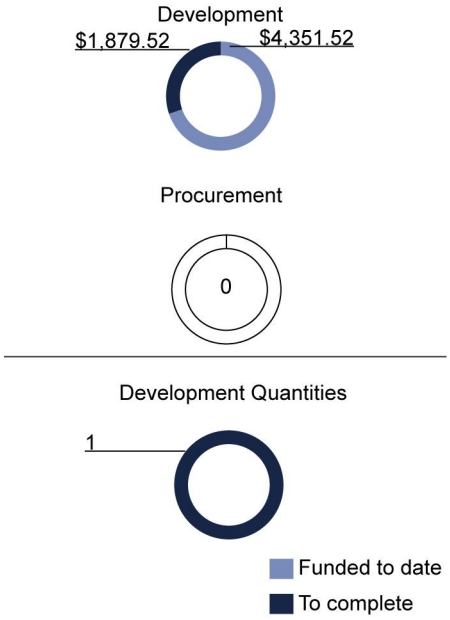
Next major milestone: Contractor delivery (February 2021)

Program Performance (fiscal year 2019 dollars in millions)

	First full estimate (11/2012)	Latest (09/2018)	Percentage change
Development	$3,707.60	$6,231.00	+68.1%
Procurement	$0.00	$0.00	0.0%
Unit cost	$3,707.60	$6,231.00	+68.1%
Acquisition cycle time (months)	55	113	+105.5%
Total quantities	1	1	0.0%

The Air Force approved a third development acquisition program baseline for the restructured OCX program in September 2018. We calculated acquisition cycle time using the program's initial capability date for Block 2.

Funding and Quantities
(fiscal year 2019 dollars in millions)



Attainment of Product Knowledge
As of January 2019

	Status at Development Start	Current Status
Resources and requirements match		
• Demonstrate all critical technologies are very close to final form, fit and function within a relevant environment	●	●
• Demonstrate all critical technologies in form, fit and function within a realistic environment	○	○
• Complete a system-level preliminary design review	●	●
Product design is stable	**Design Review**	
• Release at least 90 percent of design drawings	NA	NA
• Test a system-level integrated prototype	NA	NA
Manufacturing processes are mature	**Production Start**	
• Demonstrate Manufacturing Readiness Level of at least 9, or critical processes are in statistical control	NA	NA
• Demonstrate critical processes on a pilot production line	NA	NA
• Test a production-representative prototype in its intended environment	NA	NA

● Knowledge attained, ○ Knowledge not attained, … Information not available, NA Not applicable

OCX Program

Technology Maturity and Design Stability

The OCX program continues software development activities necessary to demonstrate system performance, but has yet to fully mature the critical technologies that underpin the full OCX system. As recently as 2017, the program reported that it had matured 14 critical technologies. For this and our 2018 assessment, however, the program identified only five critical technologies, which are all nearing maturity, because nine of the 14 were delivered with Block 0. The OCX program office does not track the metrics we used for this assessment to measure design stability, such as the number of releasable design drawings, as OCX is primarily a software development effort.

In September 2017, the OCX prime contractor, Raytheon, delivered Block 0. In December 2018, Block 0 successfully supported the Air Force launch of the first GPS III satellite. After launch, Block 0 began conducting 6 months of initial testing on the satellite. As of January 2019, Raytheon continues development work on Blocks 1 and 2. Officials report that under the terms of the development contract, Raytheon has approximately 2.5 years remaining to complete development of both blocks.

Since development start, the program has incurred persistent cost and schedule growth, which the Air Force has attributed to numerous root causes. The causes included an unrealistic schedule, underestimated costs to fully implement the information assurance requirements, and poor contractor and government performance. In June 2016, the Secretary of the Air Force notified Congress of a critical statutory unit cost breach in the program. In October 2016, the Air Force restructured the program. Subsequently, the Air Force (1) combined delivery of Blocks 1 and 2, set a new contractor schedule, and repeated the program review associated with system development in June 2017; and (2) completed a comprehensive baseline review in April 2018. In September 2018, DOD approved the current baseline, which completed the process to put in place new cost and schedule estimates.

Other Program Issues

Completion of the OCX program within the approved baseline requires both (1) timely delivery by the contractor and evaluation and acceptance by the Air Force, and (2) efficient completion of the planned 7-month government-run post-acceptance developmental testing before beginning operations that signify the end of the program.

The Air Force reported that the development contract with Raytheon ends in June 2021, which our analysis has shown is unlikely to provide enough time for the contractor to complete OCX development. Independent estimates outside of the contractor and program office vary on when the contractor will deliver OCX, and when the Air Force will subsequently accept OCX, which is planned for 2 months later. Independent estimates forecast an additional 11 months or more are needed past June 2021 to reach acceptance. The program will surpass the approved OCX baseline if operations do not commence by April 2023. To achieve this milestone, the Air Force has to accept OCX delivery 7 months prior in September 2022.

In 2018, the contractor reported it had increased the pace of software development activities compared to its past performance. Nonetheless, our analysis shows that the program faces numerous challenges that could negatively affect its cost and schedule. First, significant work and technical risk remain in the development plan, and the program has taken significantly more time to fix software defects than provided for in its schedule. Next, implementation of a new software development methodology took the program longer than planned and subsequently used up two-thirds of the allocated schedule reserve. At the same time, Raytheon has delayed by more than 1 year its planned decrease of OCX staffing levels, which suggests it is struggling to achieve the program's new baseline plan. Finally, our analysis shows that the program's 7-month developmental test schedule that occurs after acceptance is at risk of doubling in duration because of concurrent test events, test plan uncertainty, and risk of late discovery of problems.

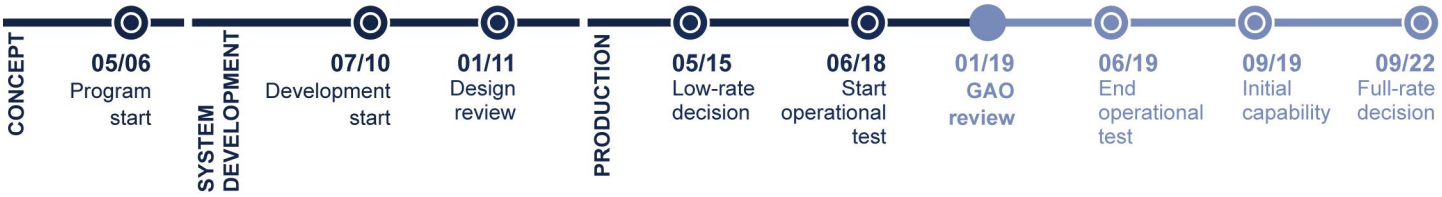
Program Office Comments

We provided a draft of this assessment to the program office for review and comment. The OCX program office said that, to inform future testing, it is leveraging lessons learned from the completion of product testing on two areas of software development. Additionally, the OCX program office said that it is exploring options with the GPS Directorate's lead development test organization to reduce schedule risk to the 7-month developmental testing period. These options, it said, include conducting a key risk reduction review and developmental test at the same time and allowing OCX to command some operational satellites before accepting OCX from the contractor.

Source: © 2009 Raytheon Company.

Small Diameter Bomb Increment II (SDB II)

The Air Force's Small Diameter Bomb Increment II (SDB II) is a joint interest program with the Navy and is designed to provide attack capability against mobile targets in adverse weather from extended range. It combines radar, infrared, and semi active laser sensors to acquire, track, and engage targets. It uses airborne and ground data links to update target locations, as well as a global positioning system and an inertial navigation system to ensure accuracy. SDB II will be integrated with Air Force and Navy aircraft, including the F-15E, F/A-18E/F, and F-35.



Program Essentials

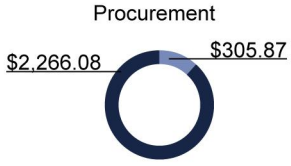
Milestone decision authority: Air Force
Program office: Eglin Air Force Base, FL
Prime contractor: Raytheon
Contract types: FPI (development)
FPI/FFP (low-rate initial production)
Software development approach: Agile development
Next major milestone: Complete operational testing (June 2019)

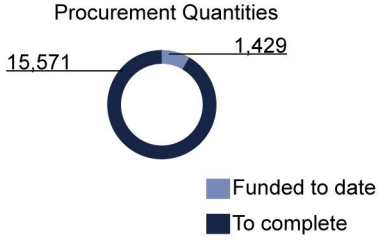
Program Performance (fiscal year 2019 dollars in millions)

	First full estimate (10/2010)	Latest (10/2018)	Percentage change
Development	$1,841.50	$1,934.30	+5.0%
Procurement	$3,423.00	$2,571.90	-24.9%
Unit cost	$0.31	$0.26	-14.4%
Acquisition cycle time (months)	72	110	+ 52.8%
Total quantities	17,163	17,163	0.00%

Total quantities comprise 163 development quantities and 17,000 procurement quantities.

Funding and Quantities
(fiscal year 2019 dollars in millions)





Attainment of Product Knowledge
As of January 2019

	Status at	Current Status
Resources and requirements match	**Development Start**	
• Demonstrate all critical technologies are very close to final form, fit and function within a relevant environment	●	●
• Demonstrate all critical technologies in form, fit and function within a realistic environment	○	●
• Complete a system-level preliminary design review	●	●
Product design is stable	**Design Review**	
• Release at least 90 percent of design drawings	…	●
• Test a system-level integrated prototype	○	●
Manufacturing processes are mature	**Production Start**	
• Demonstrate Manufacturing Readiness Level of at least 9, or critical processes are in statistical control	○	○
• Demonstrate critical processes on a pilot production line	●	●
• Test a production-representative prototype in its intended environment	●	●

● Knowledge attained, ○ Knowledge not attained, … Information not available, NA Not applicable

SDB II Program

Technology Maturity, Design Stability, and Production Readiness

The SDB II program has matured its critical technologies and has stabilized its system design. SDB II's four critical technologies—guidance and control, multi-mode seeker, net-ready data link, and payload—are mature. However, in 2018 we reported that after production start, qualification and flight test failures revealed design deficiencies that would require hardware and software changes.However, the program reports that it has released 100 percent of its design drawings, though it does not track revisions to previously released drawings. Consequently, we do not have visibility into whether design changes have disrupted the design stability the program previously reported at its January 2011 critical design review.

To address the deficiencies found in flight testing, the program released new software updates to improve stationary target performance. As a result, the program delayed the start of the operational testing and delayed completion of software development to January 2018, 5 months later than last year's plans.

The program office completed Government Confidence Tests (GCT) to demonstrate SDB II's technology and design after 5 months of delays. Officials told us that the delays were due to software deficiencies and difficulties scheduling use of the test range. The program office reported that 22 of the 28 test shots were successful. Six of the GCTs did not achieve their objective because of software deficiencies, most of which involved problems with the aircraft relaying inaccurate or incomplete information to the weapon. To address the six failures, the program office conducted one re-fly test and successfully verified the system was ready for operational testing. Program officials stated that it began operational testing 3 months late because of the GCT delays. As of January 2019, officials said the program has conducted 49 of its planned 56 operational test mission scenarios and estimated completion of the remaining tests by June 2019.

The program expects to declare initial operational capability in September 2019, 9 months later than anticipated. Despite these testing delays, program officials believe that a full-rate production decision in September 2022 is still achievable.

SDB II has been in low-rate initial production since March 2017. However, the contractor has yet to bring its critical manufacturing process into statistical control. As of January 2019, officials said that the program office delivered a total of 598 units and reports that the contractor is currently producing the remaining 108 units for Lot 3, which are scheduled for delivery completion by August 2019. Officials stated that in 2018, the program exercised options for production Lots 4 and 5 for a total of 1,920 units. The Air Force is the sole customer for the first three production lots, but officials stated that both the Air Force and the Navy will procure units under Lot 4 and Lot 5.

The program currently plans to purchase 58.5 percent of total SDB II production quantities during low-rate initial production. If a program's low-rate initial production quantity exceeds 10 percent of the total production quantity, the program must provide a rationale for these quantities in a report to Congress. In December 2017, the Air Force reported that SDB II exceeded the 10 percent level due to a delay in the completion of operational test and evaluation caused by schedule revisions to the F-35 program, a threshold aircraft. The Air Force further reported that it needed the increased quantities to provide production-configured or representative articles for operational tests, to establish an initial production base for the system, and to permit an orderly increase in the production rate for the system sufficient to lead to full-rate production following operational testing.

Other Program Issues

In 2017, the contractor reported cost growth on the first three production lots. Program officials said they expect this growth to occur in the first five production lots because of the contractor's overly aggressive cost proposals early in the system development phase and rework of initial production lots. The program stated that the government's liability for cost growth is capped by the fixed-price incentive production contract's terms and that the contractor is exploring opportunities to reduce production costs. Officials stated that the program has not yet negotiated the pricing for Lot 6 and Lot 7, and they expect it to be higher than Lots 1-5, which they reported were pre-priced options under a competively awarded contract.

Program Office Comments

We provided a draft of this assessment to the program office for review and comment. The program office provided technical comments, which we incorporated where appropriate. The program office stated that as of April 2019, it has seven operational test mission scenarios to complete. According to the program office, a January 2019 review of the weapon's performance in operational testing identified deficiencies with the weapon datalink communication, and a software update is planned for operational test missions in May 2019. The program office also said that in February 2019 it reported an acquisition program baseline schedule deviation for the F-15E required assets available threshold date of January 2019, with an estimated revised date of September 2019. For Lots 6 and 7, the program office said it anticipates a proposal from Raytheon by April 30, 2019.

Source: U.S. Air Force.

Space Fence Ground-Based Radar System Increment 1 (Space Fence Inc 1)

The Air Force's Space Fence Inc 1 program is developing a large, ground-based radar to detect and track objects in low and medium Earth orbit and provide data to a space surveillance network. Space Fence will use high radio frequencies to detect and track more and smaller objects than previous systems. The Air Force awarded a development and production contract for the first radar site in June 2014. The contract included an option that, if exercised, would enable the Air Force to acquire a second site under a separate program.

Program Essentials

Milestone decision authority: Air Force

Program office: Hanscom Air Force Base, MA

Prime contractor: Lockheed Martin

Contract type: FPI (development and production)

Software development approach: Incremental

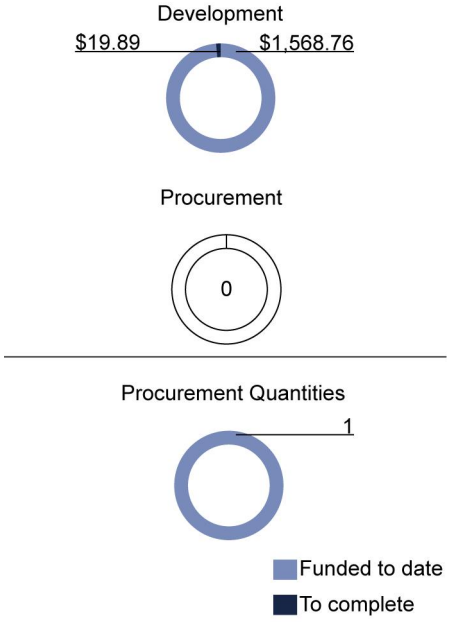
Next major milestone: Start operational testing (March 2019)

Program Performance (fiscal year 2019 dollars in millions)

	First full estimate (06/2014)	Latest (06/2018)	Percentage change
Development	$1,684.80	$1,588.6	-5.7%
Procurement	$0.0	$0.0	0.00%
Unit cost	$1,684.77	$1,588.65	-5.7%
Acquisition cycle time (months)	124	124	0.00%
Total quantities	1	1	0.00%

Funding and Quantities

(fiscal year 2019 dollars in millions)



Attainment of Product Knowledge

As of January 2019

	Status at Development Start	Current Status
Resources and requirements match		
• Demonstrate all critical technologies are very close to final form, fit and function within a relevant environment	●	●
• Demonstrate all critical technologies in form, fit and function within a realistic environment	○	●
• Complete a system-level preliminary design review	●	●
Product design is stable	**Design Review**	
• Release at least 90 percent of design drawings	●	●
• Test a system-level integrated prototype	○	●
Manufacturing processes are mature	**Production Start**	
• Demonstrate Manufacturing Readiness Level of at least 9, or critical processes are in statistical control	NA	NA
• Demonstrate critical processes on a pilot production line	NA	NA
• Test a production-representative prototype in its intended environment	NA	NA

● Knowledge attained, ○ Knowledge not attained, … Information not available, NA Not applicable

Space Fence Inc 1

Technology Maturity, Design Stability, and Production Readiness

The Space Fence Inc 1 program has matured its critical technologies, stabilized the system design, and completed planned production and assembly activities. The Space Fence Inc 1 program did not have a production start milestone as it is producing only a single radar, and thus our production metrics do not apply to this program.

In February 2015, the Air Force completed a technology readiness assessment that showed that all seven of the program's critical technologies are fully mature. Space Fence's critical technologies provide capabilities for transmitting and receiving radar signals from the radar array.

By its June 2015 critical design review, the program attained design stability with release of 100 percent of system drawings—a level that exceeds the best practices standard. Since early 2016, the contractor has tested production-representative hardware and operational software on a prototype testbed of the Inc 1 radar. Program officials stated that while the prototype testbed was not a contract requirement, they expect the contractor will choose to keep the testbed operational throughout the life of the Space Fence program to allow for testing of future upgrades and changes.

The prime contractor completed production of the radar components in February 2018, followed by installation and checkout of the radar hardware in March 2018. The program identified a production deficiency that affected the power supply cabinets. Tests showed that capacitor components within the cabinets were failing in testing at an unexpectedly high rate, which could have led to performance problems had it not been discovered prior to the start of operations. To resolve this deficiency, the program replaced the capacitors with an upgraded design. This problem did not cause any schedule delays to the overall installation and checkout of the radar as there was sufficient margin in the schedule to cover the time needed for the replacement process.

Other Program Issues

The Air Force expects Space Fence Inc 1 to provide performance sufficient to declare initial operational capability. However, the program only plans to declare full capability if and when a second radar—identical in capability and size to Inc 1—becomes operational. The Air Force had included development and production of a second radar, which would comprise an Inc 2 program, as a contract option. However, officials state that because this option was not exercised by August 2018, the program likely will need to renegotiate the second site pricing, and the renegotiated pricing may be higher than what was negotiated at the time of the original June 2014 contract award.

Program officials stated that the Air Force has yet to budget for an Inc 2 program. According to the program office, if the Air Force does not budget for Inc 2 by fiscal year 2021, the capability will become significantly more costly to acquire. Namely, after fiscal year 2021, the program office reports that it will have completed the Inc 1 program to include reassignment of staff and ramping down of the program office.

Once operational, the Space Fence Inc 1 radar will provide a significantly increased number of space object observations than previous systems. In part to effectively utilize this data, the Air Force attempted to acquire new data processing capabilities under its Joint Space Operations Center Mission System (JMS) program. However, in late 2018, the Air Force ended development work on JMS because of numerous technical challenges the program encountered. Consequently, JMS will not have the capability to process Space Fence Inc 1 data. For the near term, the Air Force has planned an alternative for completing Space Fence operational testing and beginning operations. Specifically, the Space Fence program has coordinated with the Air Force's Non-traditional Data Pre-Processor (NDPP) program and established a method to transfer Space Fence data to existing legacy Air Force space situational awareness data processing systems. According to Air Force officials, updates to these legacy systems will enable them to use some of the Space Fence data to perform the space situational awareness mission as soon as Space Fence Inc 1 is operational. However, to fully utilize what Space Fence will provide, the legacy systems will need to be replaced by a modernized system. The Air Force hopes to complete these modernizations and retire the legacy system in December 2020.

Program Office Comments

We provided a draft of this assessment to the program office for review and comment. Program officials stated that since our assessment, the program has completed contractor testing and is preparing to enter developmental testing. This represents a 4-month delay from previously reported testing dates, with operational testing now expected to run from July 2019 through September 2019, and initial operational capability (IOC) occurring in November 2019. The program noted that Space Fence is still on track to meet the IOC threshold of January 2020 established in the program's baseline. The program also stated that the system has successfully exchanged test messages with NDPP, and that some key stakeholders have toured the Space Fence site and commended the contractor on the readiness of the program. The program said that the stakeholders also witnessed system demonstrations showing live Space Fence data, which according to the program, left the stakeholders satisfied that the system is on track to meet mission needs.

Source: U.S. Air Force.

Utility Helicopter (UH-1N) Replacement

The UH-1N Replacement program aims to replace the Air Force's 63-helicopter fleet, initially manufactured in the 1960s. The UH-1N helicopter's primary missions are securing intercontinental ballistic missile sites and convoys and transporting senior government officials in the National Capital Region. However, the program office reported that the current fleet does not comply with DOD's nuclear weapons security guidance and cannot meet all mission requirements. The program plans to acquire 84 helicopters, an integration laboratory, a training system, support and test equipment, and associated software.

Program Essentials

Milestone decision authority: Air Force

Program office: Wright-Patterson Air Force Base, OH

Prime contractor: Boeing

Contract type: FFP (integration)

Software development approach: TBD

Next major milestone: Design review (November 2019)

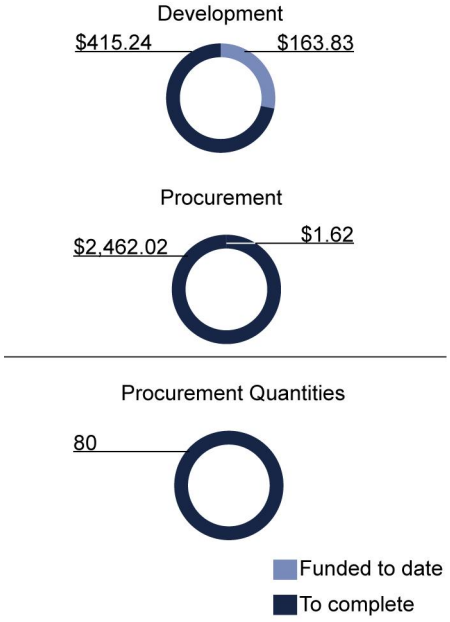
Program Performance (fiscal year 2019 dollars in millions)

	First full estimate (09/2018)	Latest (09/2018)	Percentage change
Development	$579.10	$579.10	0.00%
Procurement	$2,463.60	$2,463.60	0.00%
Unit cost	$40.06	$40.06	0.00%
Acquisition cycle time (months)	60	60	0.00%
Total quantities	84	84	0.00%

The Air Force approved an acquisition program baseline for UH-1N Replacement in September 2018. Total quantities comprise 4 development quantities and 80 procurement quantities.

Funding and Quantities

(fiscal year 2019 dollars in millions)



Attainment of Product Knowledge

As of January 2019

	Status at	Current Status
Resources and requirements match	**Development Start**	
• Demonstrate all critical technologies are very close to final form, fit and function within a relevant environment	NA	NA
• Demonstrate all critical technologies in form, fit and function within a realistic environment	NA	NA
• Complete a system-level preliminary design review	NA	NA
Product design is stable	**Design Review**	
• Release at least 90 percent of design drawings	NA	NA
• Test a system-level integrated prototype	NA	NA
Manufacturing processes are mature	**Production Start**	
• Demonstrate Manufacturing Readiness Level of at least 9, or critical processes are in statistical control	NA	NA
• Demonstrate critical processes on a pilot production line	NA	NA
• Test a production-representative prototype in its intended environment	NA	NA

● Knowledge attained, ○ Knowledge not attained, … Information not available, NA Not applicable

UH-1N Replacement Program

Technology Maturity and Design Stability

The UH-1N Replacement program has identified no critical technologies and has begun system integration activities ahead of its November 2019 critical design review. The UH-1N Replacement program plans to integrate an existing helicopter certified by the Federal Aviation Administration with previously developed—or non-developmental—items. As a result, the program office expects to reduce technical risk and facilitate an expedited delivery schedule for aircraft. Program officials said that through market research, they concluded this approach could meet the program's performance requirements and avoid development of new technologies.

In September 2018, the Air Force approved an acquisition program baseline and the program entered engineering and manufacturing development. Although the program is considered non-developmental, the Air Force determined that it needed this phase to facilitate contractor modifications (integration and testing) to the existing helicopter design. The program office anticipates that these integration and test activities will require up to 3 years and has scheduled a low-rate initial production decision for September 2021.

This schedule, however, is underpinned by the assumption that the existing helicopter's engine and the propulsion system meet program requirements. Program officials stated that if tests show that either of these systems requires additional development or modification to achieve certifications, the program office will likely have to extend its development phase. Any additional development efforts would likely portend program delays and cost increases. Officials stated that they awarded the UH-1N Replacement contract to Boeing (in September 2018) based in part on the program's assessment of Boeings's ability to provide technical components that can be certified through testing.

Production Readiness

Ahead of the low-rate initial production decision, the program plans to establish key metrics for assessing the UH-1N Replacement helicopter's production readiness. The program office indicated that it will involve the contractor, Boeing, in these future efforts. Officials explained that they anticipate Boeing will have valuable insight into the appropriate metrics because it has already produced the baseline helicopter for commercial purposes. Program officials said these metrics will be established after critical design review, which is planned for November 2019.

Similarly, the program has yet to determine a timeframe for reviewing and establishing software development metrics with the contractor, or for completing software development and integration. The timing of software development will be important for the program to maintain its cost and schedule. We have previously found that software development efforts that occur after production start place programs at risk of schedule delays and cost growth.

Other Program Issues

The Air Force Cost Analysis Agency, which produced the service cost position for the program, predicted that Boeing may lose money on the contract starting in fiscal year 2023 and may seek to renegotiate pricing as a result. According to the Agency, strict adherence to requirements can help the government avoid cost increases, particularly when the contractor may seek to renegotiate pricing, because changes to contract requirements could lead to a contract renegotiation.

The program office has also not yet determined whether the existing helicopter can meet DOD's cybersecurity requirements. Opportunities to change the design to implement additional cybersecurity controls are limited under the program's non-developmental item acquisition strategy. In addition, program documentation indicates that the Air Force may not implement some cybersecurity controls. If the helicopter is not able to meet cybersecurity requirements, the program office will have to determine whether and how to mitigate the deficiencies. Program officials said they are implementing a cybersecurity risk management framework and standing up a cyber security working group to understand the specific risks.

Program Office Comments

We provided a draft of this assessment to the program office for review and comment. The program office did not have any comments.

Source: U.S. Air Force.

B-52 Radar Modernization Program (B-52 RMP)

The Air Force's B-52 RMP supports nuclear and conventional operations by replacing the current APQ-166 radar on all 76 B-52H aircraft in the Air Force inventory. This modernization will allow the Air Force to fully utilize the capabilities of the B-52H aircraft to employ an array of nuclear and conventional weapons and to perform mission-essential navigation and weather avoidance functions.

Program Essentials

Milestone decision authority: Air Force

Program office: Wright-Patterson Air Force Base, OH

Prime contractor: Boeing

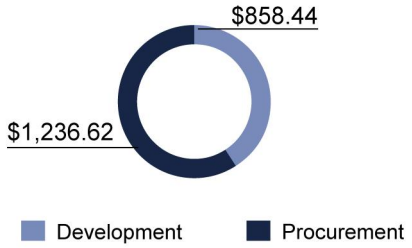
Contract type: CPFF (risk reduction and requirements development)

Software development approach: Mixed

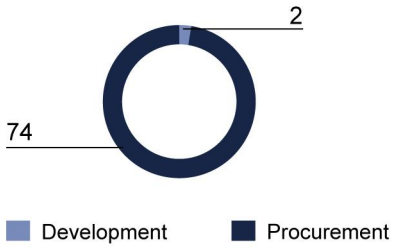
Next major milestone: Development start (September 2020)

Estimated Program Cost

(FY 2019 dollars in millions)



Planned Quantities



Current Status

The B-52 RMP program has completed the initial subsystem specifications for the radar, radome, and crew stations, and is currently defining performance requirements in preparation for the development contract award in 2020. Additionally, according to program officials, vendors have submitted proposals for radar source selection and the program expects to make a decision in June 2019. The Air Force plans to modify existing training systems, or develop new ones, in support of the B-52 RMP. This work will affect all three Air Force Weapon System Trainers (WST)—the WST Training Systems Integration Laboratory and both B-52 Offensive Station Maintenance Trainers—which are used to help aircrews learn the proper techniques and handling of the system.

The program office plans to release a developmental request for proposal in late July 2019. The program has yet to identify any critical technologies, but program officials said they are developing a technology readiness assessment plan as part of the developmental request for proposal and expect to identify candidate technologies as part of that effort by the fourth quarter of fiscal year 2019. Consistent with acquisition best practices, the program plans to conduct a preliminary design review in July 2020, prior to development start in September 2020.

Attainment of Technology Maturation Knowledge

As of January 2019

Conduct competitive prototyping	○	Complete technology readiness assessment	◐
Validate requirements	●	Complete preliminary design review	◐

● Knowledge attained, ◐ Knowledge planned, ○ Knowledge not attained, … Information not available, NA Not applicable

Program Office Comments

We provided a draft of this assessment to the program office for review and comment. The program office stated that B-52 RMP is executing its March 2018 approved acquisition strategy, as planned.

Source: Boeing Corporation.

VC-25B Presidential Aircraft Recapitalization (VC-25B)

Through its VC-25B program, the Air Force is replacing the current two VC-25A presidential aircraft with two modified Boeing 747-8 aircraft. The commercial aircraft will be uniquely modified to provide the President of the United States, staff, and guests with safe and reliable air transportation with the same level of security and communications available in the White House. Aircraft modifications will include electrical power upgrades, a mission communication system, military avionics, and other systems.

Program Essentials

Milestone decision authority: Under Secretary of Defense for Acquisition and Sustainment

Program office: Wright-Patterson Air Force Base, OH

Prime contractor: Boeing

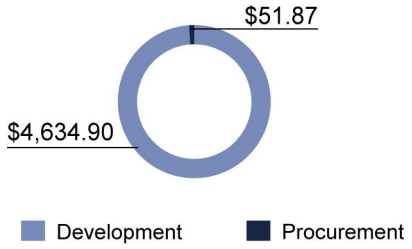
Contract type: CPFF/CPAF/FFP (studies, engineering services, commercial aircraft, and development)

Software development approach: Other

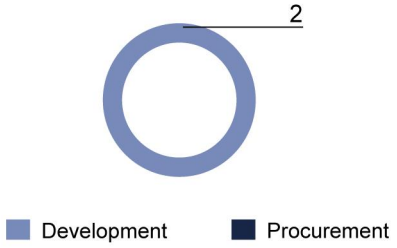
Next major milestone: Design review (August 2019)

Estimated Program Cost

(FY 2019 dollars in millions)



Planned Quantities



Current Status

The program reported that in January 2016, the Air Force awarded a sole-source contract to Boeing for VC-25B risk reduction activities and that it has since modified the contract based on the different phases of development work. The Air Force purchased two Boeing 747-8 aircraft in 2017.

Since then, the program has been refining system requirements and maturing sub-system designs. The program conducted a system-level preliminary design review in October 2018 and established a baseline for cost, schedule, and performance in December 2018. We are assessing VC-25B in a one-page format this year because the program baseline was approved late in our review. We plan to assess it in a two-page format going forward.

According to program officials, the Air Force is incorporating lessons learned from the KC-46 program, another commercial derivative aircraft, as appropriate. For example, the VC-25B team is implementing a new approach to better facilitate wire design, routing and installation processes. Program officials stated that they expect to definitize the engineering and manufacturing contract by the third quarter of 2019.

The program office plans to start modification of both aircraft as early as 2020 after the design is stable. By fiscal year 2024, the Air Force plans to accept delivery of aircraft capable to support presidential missions.

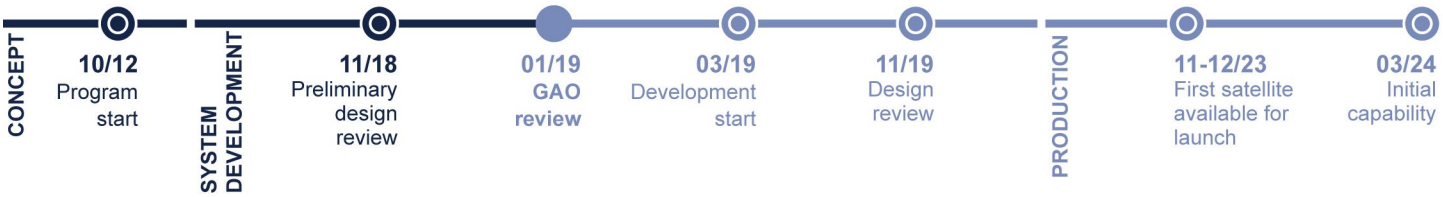
Program Office Comments

We provided a draft of this assessment to the program office for review and comment. The program office provided technical comments, which we incorporated where appropriate.

Source: U.S. Air Force.

Weather System Follow-On (WSF)

The Air Force's polar–orbiting WSF satellite is intended to contribute to a family of space-based environmental monitoring (SBEM) systems by providing 3 of 11 mission critical capabilities in support of military operations. WSF is being developed to conduct remote sensing of weather conditions, such as wind speed and direction at the ocean's surface, and provide real-time data to be used in weapon system planning and weather forecasting models. The family of SBEM systems replaces the Defense Meteorological Satellite Program.



Program Essentials

Milestone decision authority: Air Force

Program office: El Segundo, CA

Prime contractor: Ball Aerospace and Technologies Corporation

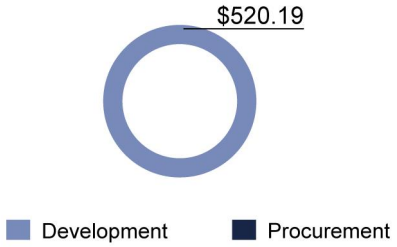
Contract types: FFP/CPIF (design, risk reduction, development, fabrication, integration, test, and operations)

Software development approach: Mixed

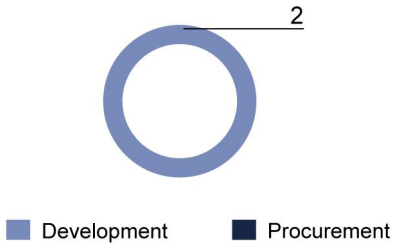
Next major milestone: Development start (March 2019)

Estimated Program Cost

(FY 2019 dollars in millions)



Planned Quantities



Current Status

WSF is to have two payloads: (1) a microwave imager to collect data on ocean surface vector wind and tropical cyclone intensity and (2) an energetic charged particle sensor to collect space weather data. The Air Force awarded a contract in November 2017 for WSF system design, with options for development and delivery of up to two WSF satellites, if needed. The Air Force plans to start system development in March 2019 and launch a satellite in late 2023.

As a precursor to WSF, the Air Force undertook a technology demonstration program using an existing microwave sensor and planned to launch it in June 2018. However, the Air Force did not complete the planned launch because of problems with the flight software. The Air Force is now working toward a potential launch in 2021 to the International Space Station. The timely launches of the demonstration and WSF, according to the acquisition strategy, are critical to mitigate potential capability gaps. Currently, WindSat, a payload operating over 13 years beyond its design life, is the only capability that fully meets the service's needs for ocean surface vector wind data.

The program continues to assess the maturity level of critical technology elements. Program officials stated that they plan to complete a technology readiness assessment in February 2019, shortly before the program's March 2019 development start.

Attainment of Technology Maturation Knowledge

As of January 2019

Conduct competitive prototyping	NA	Complete technology readiness assessment	◐
Validate requirements	◐	Complete preliminary design review	●

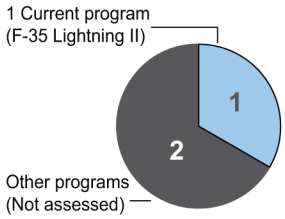
● Knowledge attained, ◐ Knowledge planned, ○ Knowledge not attained, … Information not available, NA Not applicable

Program Office Comments

We provided a draft of this assessment to the program office for review and comment. The program office provided technical comments, which we incorporated where appropriate.

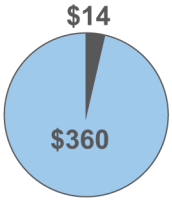
JOINT DOD PROGRAM ASSESSMENTS

GAO Assessed 1 of 3 Joint DOD-wide Current Major Defense Acquisition Programs



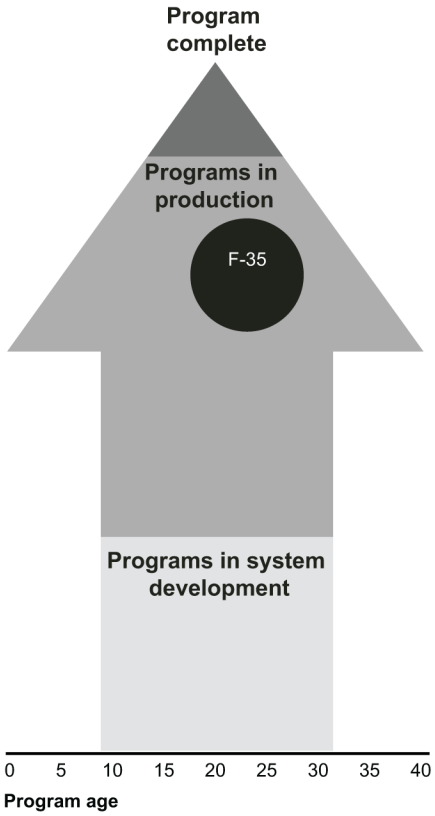
The F-35 Lightning II Program Costs are 96 Percent of the $374 Billion Joint DOD-wide Estimated Total Acquisition Costs

(Fiscal Year 2019 dollars in billions)



We assessed one current program—F-35 Lightning II. We did not assess programs that had yet to enter technology development or had already progressed into full-rate production.

F-35 Lightning II had Cost Growth and Schedule Delays



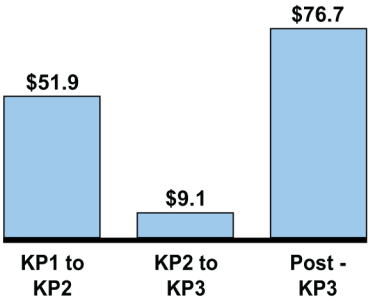
Cost growth of more than 15 percent and/or schedule delays of more than 6 months

Note: Bubble size is based on the program's currently estimated future acquisition funding needed.

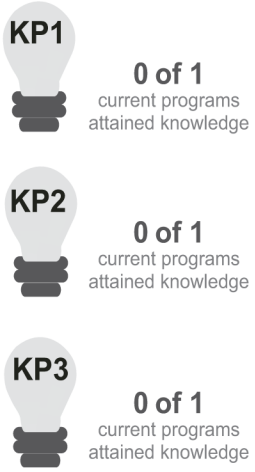
Cost and schedule analysis is based on estimates from the December 2017 selected acquisition report.

Total Acquisition Costs for the F-35 Lightning II Program Increased after Knowledge Points (KP)

(Fiscal Year 2019 dollars in billions)



F-35 Lightning II Did Not Attain Knowledge at Key Points



F-35 Lightning II's Acquisition Cycle Time Increased by 62 Months from First Full Estimate (FFE) to Current Estimate

- The Under Secretary of Defense for Acquisition and Sustainment was the milestone decision authority in 2017 for F-35 Lightning II.
- The F-35 Lightning II program reported that it does not know the percent of planned acquisition costs that are specifically for software.
- The F-35 Lightning II program reported that it does not know the percent of work tasks that are software related.
- DOD received single offers for its solicitations for its currently reported major procurement contracts for F-35 Lightning II.

Source: GAO analysis of Department of Defense data. | GAO-19-336SP

Joint DOD Program Assessment[a]	Page number
2-page assessment	
F-35 Lightning II (F-35)	

[a]We abbreviate the following contract types in the individual assessment: cost-plus-fixed-fee (CPFF), cost-plus-incentive-fee (CPIF), and fixed-price incentive (FPI).

Source: © 2016 Lockheed Martin.

F-35 Lightning II (F-35)

DOD is developing and fielding a family of fifth generation strike fighter aircraft integrating stealth technologies with advanced sensors and computer networking capabilities for the United States Air Force, Marine Corps, and Navy, eight international partners, and four foreign military sales customers. The family is comprised of three aircraft variants. The Air Force's F-35A variant will complement its F-22A fleet and is expected to replace the air-to-ground attack capabilities of the F-16 and A-10. The Marine Corps' F-35B variant will replace its F/A-18 and AV-8B aircraft. The Navy's F-35C variant will complement its F/A-18E/F aircraft.

Program Essentials

Milestone decision authority level: Under Secretary of Defense for Acquisition and Sustainment

Program office: Arlington, VA

Prime contractor: Lockheed Martin; Pratt & Whitney

Contract type: FPI/CPIF/CPFF (aircraft low-rate initial production)

FPI/CPIF (engine low-rate initial production)

Software development approach: Mixed

Next major milestone: F-35C initial capability (February 2019)

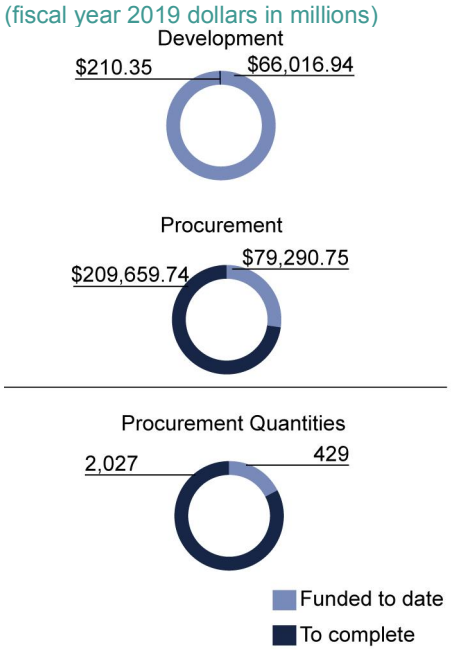
Program Performance (fiscal year 2019 dollars in millions)

	First full estimate (10/2001)	Latest (06/2018)	Percentage change
Development	$43,642.80	$66,227.30	+51.7%
Procurement	$193,622.50	$288,950.50	+49.2%
Unit cost	$83.49	$145.79	+74.6%
Acquisition cycle time (months)	175	237	+35.4%
Total quantities	2,866	2,470	-13.8%

Total quantities comprise 14 development quantities and 2,456 procurement quantities.

Funding and Quantities

(fiscal year 2019 dollars in millions)



Attainment of Product Knowledge

As of January 2019

	Status at	Current Status
Resources and requirements match	**Development Start**	
• Demonstrate all critical technologies are very close to final form, fit and function within a relevant environment	○	●
• Demonstrate all critical technologies in form, fit and function within a realistic environment	○	●
• Complete a system-level preliminary design review	○	●
Product design is stable	**Design Review**	
• Release at least 90 percent of design drawings	○	●
• Test a system-level integrated prototype	○	●
Manufacturing processes are mature	**Production Start**	
• Demonstrate Manufacturing Readiness Level of at least 9, or critical processes are in statistical control	○	●
• Demonstrate critical processes on a pilot production line	○	●
• Test a production-representative prototype in its intended environment	○	●

● Knowledge attained, ○ Knowledge not attained, … Information not available, NA Not applicable

F-35 Program

Technology Maturity and Design Stability

All of the F-35's critical technologies are mature and the baseline engineering drawings are complete for all three aircraft variants. The program office completed the final development test flights for the baseline program in April 2018, but continues to address over 900 deficiencies identified with the aircraft's performance prior to the end of development testing. For example, the program is developing a new helmet mounted display, which will resolve an existing green glow effect that can distort a pilot's vision during night time carrier landings. Program officials expect installation of some of the new displays in 2019. The program office is also testing and integrating software updates to resolve other deficiencies, but it did not fully resolve over 800 other deficiencies prior to the start of operational testing. The program obtained a waiver from the Under Secretary of Defense for Acquisition and Sustainment to start operational testing prior to fully resolving these deficiencies. Program officials stated that they expect to continue resolving these deficiencies through the start of full rate production in October 2019.

Program officials continue to identify and address technical risks, some of which are specific to individual variants of the F-35. For example, we reported last year that a problem with the F-35's main fuel throttle valve caused the aircraft to move suddenly and without stopping until the engine is shut down. In 2018, the program implemented software changes to fix this problem. Also, across all variants, pilots have reported experiencing extreme pressure in the cockpit during certain flight maneuvers. Contractor representatives told us they have identified the root cause of the excessive cockpit pressure and will implement a minor hardware change in 2019 to address the issue. Recently, following the crash of an F-35B in October 2018, the program grounded the F-35 fleet to inspect all of its engines. An investigation determined a manufacturing defect caused an engine fuel tube to rupture during flight, resulting in a loss of power to the engine. The program office reported that it identified 117 aircraft with the same type of fuel tubes that it must replace. According to program officials, the grounding generally did not impact the delivery of the aircraft, as the contractor has provided replacement fuel tubes that were installed on a majority of the affected aircraft by the end of 2018.

Production Readiness

As of December 2018, the prime contractor has delivered 264 production aircraft. Since the start of production, F-35 contractors have refined their production processes to improve manufacturing efficiency and quality. However, the prime contractor has identified quality control and late radar deliveries as the top production risks in the program. For example, because of supplier identified limitations, the prime contractor continues to fix gaps between adjacent aircraft surface panels attached to the airframe. These fixes are needed to meet low observable (stealth) performance requirements. The contractor is working with its supplier to resolve the problem through improved production processes as the program approaches its full-rate production decision in October 2019.

Other Program Issues

Following our 2018 assessment, the program delayed the start of operational testing by up to 3 months, to December 2018. This delay stemmed from software upgrades needed to assess the aircraft's performance. To mitigate further delays, the program received authorization to complete certain operational tests in advance of the formal start of operational testing. For example, the program completed cold weather operational testing in January 2018.

Because of evolving threats, the program office continues to move forward with Block 4 modernization efforts, which will modernize current capabilities and develop and integrate new capabilities onto the aircraft. In October 2018, the program office updated its acquisition strategy, providing a general schedule for future technology development and integration. The program plans to field new capabilities starting in October 2019, but it has yet to complete its acquisition program baseline. As a result, the program is concurrently testing, producing, and modernizing aircraft, which increases the risk of future schedule and cost overruns.

Program Office Comments

We provided a draft of this assessment to the program office for review and comment. The office provided technical comments, which we incorporated where appropriate. Program officials stated that since the start of developmental testing in 2006, more than 2,200 deficiencies have been discovered and corrected. Further, officials reported that, in coordination with the warfighting community, they have resolved the highest-priority deficiencies and have mitigated the remaining deficiencies. Finally, officials commented that aircraft deliveries have increased as planned and operational testing remains on track for completion in fall 2019.

Agency Comments

We provided a draft of this report to DOD for comment. In its comments, reproduced in appendix IX, DOD generally concurred with our observations. DOD also provided us with technical comments, which we incorporated as appropriate.

We are sending copies of this report to the appropriate congressional committees and offices; the Acting Secretary of Defense; the Secretaries of the Army, Navy, and Air Force; and the Director of the Office of Management and Budget. In addition, the report will be made available at no charge on the GAO website at http://www.gao.gov.

If you are your staff have any questions concerning this report, please contact me at (202) 512-4841. Contact points for our offices of Congressional Relations and Public Affairs may be found on the last page of this report. Staff members making key contributions to this report are listed in appendix X.

Shelby S. Oakley
Director, Contracting and National Security Acquisitions

List of Committees

The Honorable James M. Inhofe
Chairman
The Honorable Jack Reed
Ranking Member
Committee on Armed Services
United States Senate

The Honorable Richard Shelby
Chairman
The Honorable Richard J. Durbin
Ranking Member
Subcommittee on Defense
Committee on Appropriations
United States Senate

The Honorable Adam Smith
Chairman
The Honorable Mac Thornberry
Ranking Member
Committee on Armed Services
House of Representatives

The Honorable Pete Visclosky
Chairman
The Honorable Ken Calvert
Ranking Member
Subcommittee on Defense
Committee on Appropriations
House of Representatives