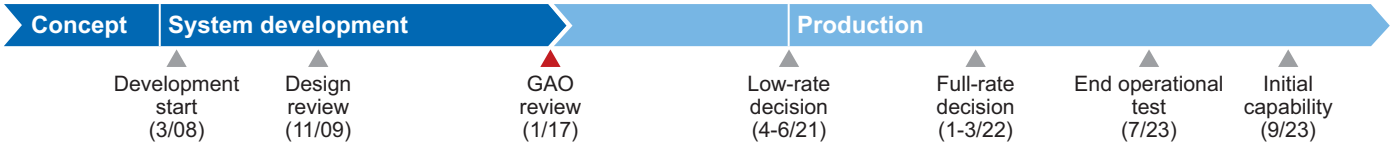
Airborne and Maritime/Fixed Station (AMF)

The Army's AMF program plans to acquire non-developmental, software-defined radios—the Small Airborne Networking Radio (SANR)—and associated equipment for integration into Army rotary wing and unmanned aerial systems. These radios will provide simultaneous voice and data communications between Army platforms and ground forces. The program previously planned to also acquire the Small Airborne Link 16 Terminal (SALT) radio, but, in August 2015, the Army directed program officials to close out the SALT sub-program. We assessed SANR only.

Source: U.S. Army.



Program Essentials

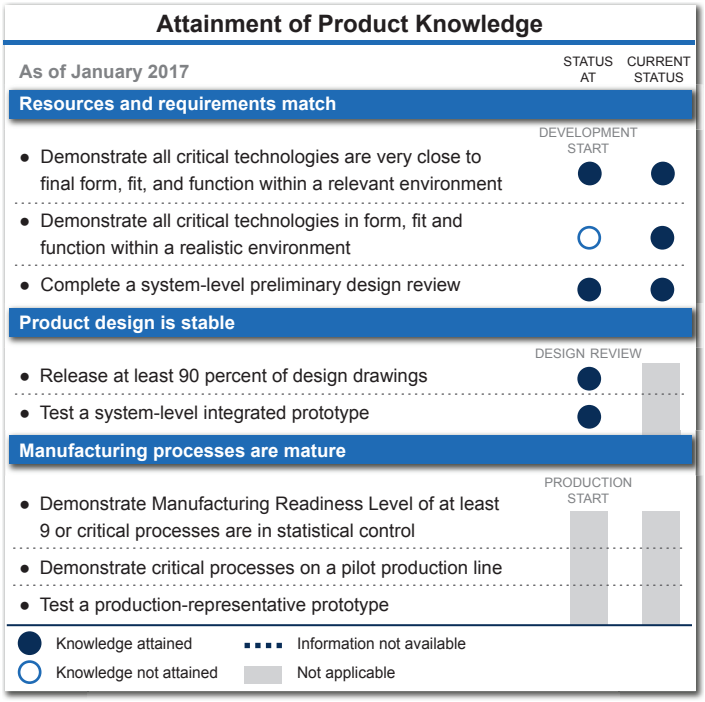
Prime contractor: TBD
Program office: Aberdeen Proving Ground, MD
Funding needed to complete:
- R&D: $71.8 million
- Procurement: $1,645.9 million
- Total funding: $1,717.7 million
- Procurement quantity: 14,060

Program Performance (fiscal year 2017 dollars in millions)

	As of 10/2008	Latest 08/2016	Percent change
Research and development cost	$2,109.8	$1,668.1	-20.9%
Procurement cost	$6,735.0	$1,645.9	-75.6%
Total program cost	$8,844.7	$3,314.1	-62.5%
Program unit cost	$.326	$.233	-28.6%
Total quantities	27,102	14,222	-47.5%
Acquisition cycle time (months)	80	186	132.5%

The quantities identify the total number of channels required; currently one SANR radio is capable of providing two channels.

In July 2012, as part of an overall Joint Tactical Radio System (JTRS) reorganization, DOD directed the AMF program to pursue a restructured acquisition approach and acquire the desired radios as a modified non-developmental item, leveraging to the maximum extent practical investments made since 2008 within the original program. As a result, the program will procure existing radios, which will be tested for technology maturity as part of the formal testing process. Due to the program's non-developmental strategy, we do not have insight into the percentage of design drawings released and officials report the testing of a system-level integrated prototype is not applicable. The first planned procurement of radios is currently scheduled for after the non-developmental item contract award, which is expected in 2019 with full-rate production decision scheduled to begin in 2023.



AMF Program

Technology, Design, and Production Maturity

In July 2012—as part of an overall JTRS reorganization of several related programs—the Under Secretary of Defense for Acquisition, Technology and Logistics directed the AMF program to pursue a restructured acquisition approach and acquire the desired radios as a modified non-developmental item, leveraging to the maximum extent practical prior investments made on the original program since development started in 2008. Under the program's original acquisition strategy, AMF achieved a stable design by releasing at least 90 percent of its drawings and testing an integrated prototype before it held its critical design review. The restructuring of the acquisition strategy, however, shifted the program from a development effort supporting Army, Air Force, and Navy platforms to a non-developmental effort that supports only Army aviation efforts. Since the government is procuring an already existing item from a commercial entity in a non-developmental effort, the design knowledge criteria related to drawings and prototypes are no longer applicable. The program officials have identified critical technologies necessary for the existing radios the Army intends to procure, and the program plans to have the technology maturity demonstrated as part of the overall test and demonstration process. The program does not intend to develop any new technologies or software for the radios. In 2014, the Army split AMF into two separate sub-programs—SALT and SANR. In August 2015, the Army directed the close-out of the SALT sub-program as these radios would not have met the Army's operational requirements until fiscal year 2021 and were expected to be more expensive than other options. The Army no longer intends to procure these radios.

The SANR sub-program is currently in the pre-solicitation phase. No production contracts have been awarded yet. Program officials stated that the non-developmental item strategy will ensure that a certain level of production readiness is achieved. They added that 110 radios, out of the 7,111 expected, will be purchased for verification testing and initial platform integration. Reliability verification testing is expected to begin after purchase of the first radios in fiscal year 2019 and will be completed prior to the start of full-rate production in 2023.

The government plans to acquire engineering drawings for SANR to conduct depot level maintenance. Program officials told us they will also ask for some data rights for use in building government-operated depots for maintaining program software and hardware.

Other Program Issues

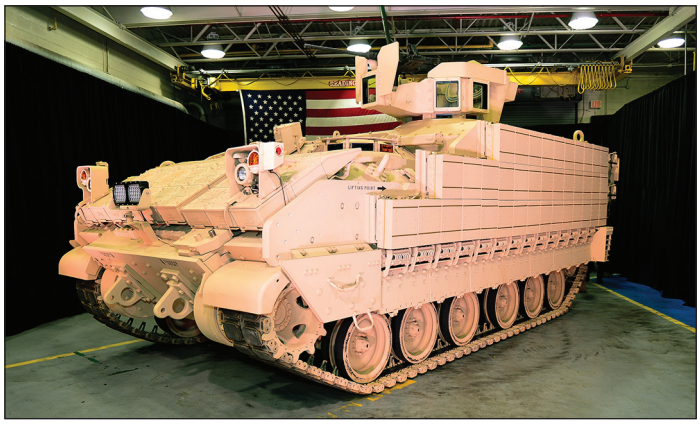
Program officials stated that they have developed a revised acquisition strategy and test and evaluation master plan for the program, which are expected to be approved mid-2017, to reflect the close out of the SALT sub-program. They added that they have also developed a revised acquisition program baseline to reflect this change, which is expected to be approved in early 2018. Program officials stated that they expect to complete an affordability and a should-cost analysis for SANR in 2021 to support the future production contract award.

Program Office Comments

In commenting on a draft of this assessment, the program office provided technical comments, which were incorporated where appropriate.

Armored Multi-Purpose Vehicle (AMPV)

The Army's Armored Multi-Purpose Vehicle (AMPV) is the replacement to the M113 family of vehicles at the Brigade level and below. The AMPV will replace the M113 in five mission roles: general purpose, medical evacuation, medical treatment, mortar carrier, and mission command. The Army determined that development of the AMPV is necessary due to mobility, survivability, and force protection deficiencies identified with the M113, as well as space, weight, power, and cooling limitations that prevent the incorporation of future technologies.



Source: U. S. Army.

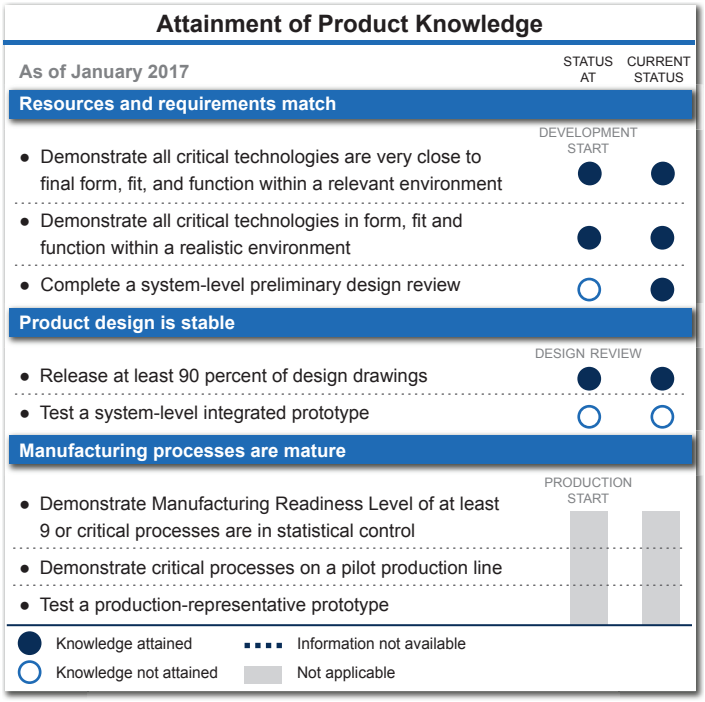
Program Essentials

Prime contractor: BAE Systems
Program office: Warren, MI
Funding needed to complete:
- R&D: $661.5 million
- Procurement: $10,030.7 million
- Total funding: $10,692.2 million
- Procurement quantity: 2,897

Program Performance (fiscal year 2017 dollars in millions)

	As of 05/2015	Latest 12/2015	Percent change
Research and development cost	$1,018.0	$1,043.6	2.5%
Procurement cost	$10,030.5	$10,030.7	0.0%
Total program cost	$11,048.5	$11,074.3	0.2%
Program unit cost	$3.763	$3.772	0.2%
Total quantities	2,936	2,936	0.0%
Acquisition cycle time (months)	87	87	0.0%

The AMPV program held a critical design review in June 2016, with its critical technologies mature and a design that was stable, but not demonstrated. Following this review, the program received approval to modify a key performance requirement and several system attributes, which DOD had previously judged AMPV would be challenged to meet. To support design demonstration, BAE Systems started fabricating prototype vehicles in May 2016, with the first being delivered in December 2016. Delays related to engineering drawing releases, manufacturing planning, and ballistic weld certification have impeded fabrication work, although program officials noted these issues have largely been overcome. The program has also identified and is mitigating interface issues between AMPV and certain platforms it will rely upon for communication and networking capabilities.



AMPV Program

Technology and Design Maturity

The AMPV program entered system development in December 2014 with its critical technologies fully mature as determined by an independent review team. According to program officials, while the AMPV design utilizes a new hull design, a majority of subsystems are derived from existing vehicle designs.

Although the program held its critical design review in June 2016 with over 90 percent of its design drawings released to manufacturing, the program had not yet demonstrated a system-level integrated prototype. BAE Systems started fabricating AMPV prototype vehicles in May 2016 to support design demonstration and developmental testing. However, delays related to releasing engineering drawings and manufacturing planning efforts disrupted these fabrication activities. Program officials report that these issues are being addressed and the program delivered its first prototype in December 2016.

Prior to AMPV's critical design review, the Office of the Deputy Assistant Secretary of Defense for Systems Engineering assessed that the AMPV preliminary design would be challenged to meet survivability and force protection requirements and identified a need to modify these requirements to match the capabilities that the AMPV was likely to provide. In response, the program requested and received approval from the Army Requirements Oversight Council to modify the system's survivability requirement as well as several key system attributes. In September 2016, the Joint Requirements Oversight Council validated the survivability requirement change. AMPV's survivability and force protection is still expected to exceed that of the M113 vehicle it is intended to replace.

Production Maturity

Although the AMPV program expects to demonstrate its critical manufacturing processes on a pilot production line, it does not anticipate that these processes will achieve statistical control prior to production start in February 2019. In addition, BAE Systems has had difficulty attaining ballistic weld certification—essential for the government ensuring that the contractor can successfully weld ballistic materials—due to qualification test failures. While this delayed deliveries of ballistic hulls, a key vehicle component, this issue has been resolved according to program officials. BAE redesigned these welds and validated their design in August 2016.

Other Program Issues

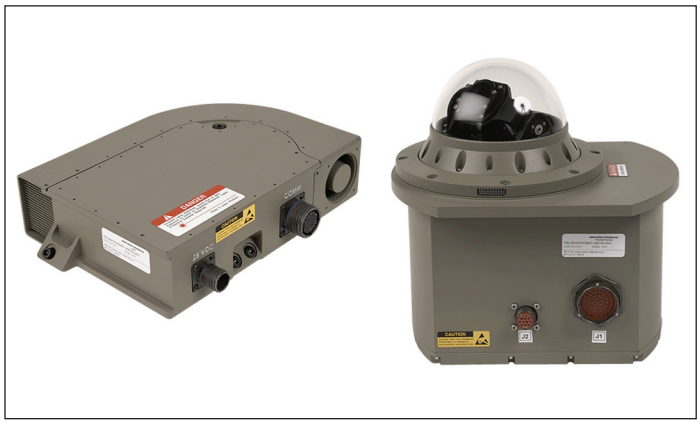
AMPV is dependent on other programs for its key communication and networking capabilities. While most systems providing these capabilities exist on current platforms, the program has unresolved interface issues with some of them. For example, the Manpack radios—separately produced as part of the Army's Joint Tactical Radio System Handheld, Manpack, and Small Form Fit (JTRS HMS) Radios program—requires design changes to be fully compatible with AMPV's interface. To mitigate the Manpack radio integration risk, program officials plan to include a legacy radio platform in the AMPV's design. However, if other communications and networking systems—some of which have experienced their own developmental challenges—are not available when needed to support AMPV's testing and fielding, the Army will likely face a choice of adjusting the AMPV's schedule or accepting reduced capabilities.

Program Office Comments

In addition to providing technical comments, which we incorporated where appropriate, the program office noted that the program successfully rolled-out the first AMPV prototype on-time in December 2016. Further, the program office stated that the prototypes are built on existing production lines using production-representative work instructions, material, manpower, and tooling. These manufacturing processes are being continuously updated and refined as prototypes move down the line, and will stabilize and mature in fiscal year 2017. The program successfully completed ballistic weld joint redesign and testing to confirm the armor weldments met ballistic shock requirements. The associated welding procedures used for building hulls are now fully certified and there are no schedule delays. The program is coordinating with other program offices to understand the detailed interfaces required to ensure seamless integration of emerging radios and does not currently anticipate any program schedule delays.

Common Infrared Countermeasure (CIRCM)

The Army's CIRCM is the next generation of Advanced Threat Infrared Countermeasures (ATIRCM) designed to defend aircraft from infrared-guided missiles. The program is developing a laser-based system for use with a missile warning system and countermeasure dispenser that deploys expendables, such as flares and chaff. CIRCM will be installed on rotary-wing, tilt-rotor, and small fixed-wing aircraft across DOD. CIRCM was originally started as a subprogram under the ATIRCM/Common Missile Warning System.



Source: Northrop Grumman.

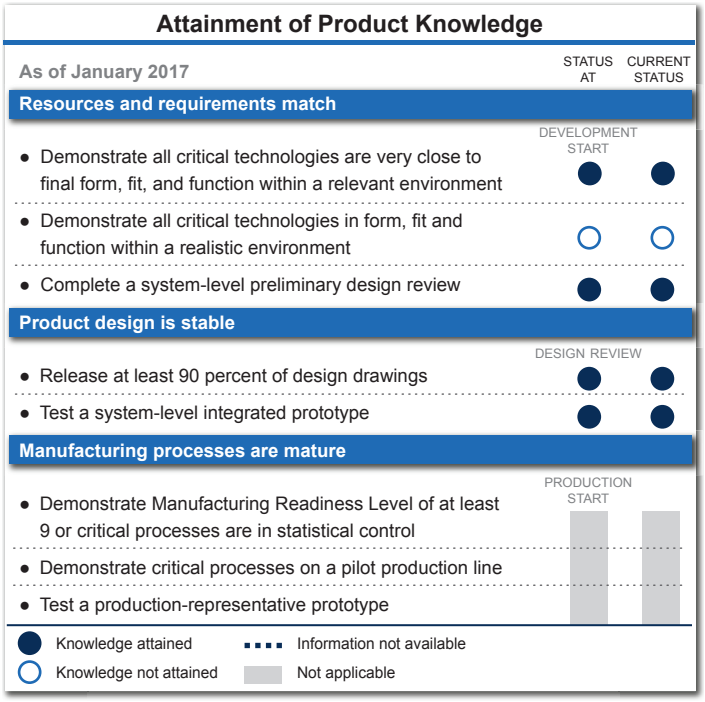
Program Essentials

Prime contractor: Northrop Grumman
Program office: Huntsville, Alabama
Funding needed to complete:
- R&D: $379.7 million
- Procurement: $1,836.3 million
- Total funding: $2,216.0 million
- Procurement quantity: 1,076

Program Performance (fiscal year 2017 dollars in millions)

	As of 07/2016	Latest 10/2016	Percent change
Research and development cost	$777.4	$777.4	0.0%
Procurement cost	$1,836.3	$1,836.3	0.0%
Total program cost	$2,613.7	$2,613.7	0.0%
Program unit cost	$2.325	$2.325	0.0%
Total quantities	1,124	1,124	0.0%
Acquisition cycle time (months)	115	115	0.0%

The CIRCM program entered system development in August 2015 with its critical technologies approaching maturity based on the results of a technology readiness assessment conducted in December 2014. The independent review team was not able to determine whether any of the critical technologies achieved full maturity as testing of the CIRCM prototypes in an operational environment was not performed. The program completed its critical design review in October 2016, with a stable design and almost all drawings released to manufacturing. The program office has identified key manufacturing risk areas and included them in its plans for a pilot line validation and production readiness review to assess the program's readiness to enter production.



CIRCM Program

Technology Maturity

The CIRCM program entered system development in August 2015 with its critical technologies approaching maturity. In December 2014, an independent review team conducted an assessment of the program's nine critical technologies in a relevant environment—including the gimbal assembly, camera assembly, the quantum cascade laser, and others—and determined that all technologies were nearing maturity. However, according to a November 2016 program document, none of the technologies have achieved maturity yet. The program originally planned to enter the acquisition cycle at system development. However, after competitive prototyping, the program determined none of the vendors had built prototypes with the required technology readiness levels and all required major redesigns to meet weight requirements. The key risks going into the technology development phase were the CIRCM's weight, probability of countermeasure, and reliability. The program entered the acquisition cycle at technology development, which resulted in allowing vendors 3 years to further develop their designs. Government test results indicate that weight, probability of countermeasure, and reliability are meeting or exceeding exit criteria and/or the system requirements.

Design Maturity

The program completed its critical design review (CDR) in October 2016 and reports that the design is stable based on the number of design drawings released to manufacturing. One hundred percent of the drawings for the CIRCM system and 95 percent of the drawings for the modification kits—which include the hardware, wiring harness, and cables necessary to install CIRCM on each aircraft—have been delivered. The program office had one critical action from the CDR and closed it in January 2017.

Production Maturity

According to program officials, key manufacturing risk areas have been identified and included in the program's pilot line validation and production readiness review plans. Both of these events will cover all manufacturing concerns to determine the program's readiness to enter production. Pilot line validations are conducted to validate manufacturing capabilities are in place to produce CIRCM units and address manufacturing maturity progression toward achieving a production capability and capacity that will meet full rate production requirements. This validation will be conducted while initial CIRCM units are manufactured so that instructions, equipment, tooling, test equipment, and workers can be observed. The Production Readiness Review, scheduled for August 2017, determines if the system design is ready for production and if the developer has accomplished adequate production planning for entering both low-rate initial production and full-rate production.

Program Office Comments

The program office reports that it completed CDR in October 2016 and is preparing for pilot line validations and production readiness reviews to validate the contractor's ability to manufacture the final CIRCM design in the quantities required. The CIRCM program has begun building production representative articles based on the design presented at the design review, which will begin system level developmental testing in preparation for operational testing scheduled for fiscal year 2019. According to program officials, CIRCM remains on track for completion of the system development phase and movement towards full-rate production readiness within the cost, schedule, and performance requirements set forth in its Acquisition Program Baseline. The program also provided technical comments, which were incorporated where deemed appropriate.

Indirect Fire Protection Capability Increment 2-Intercept Block 1 (IFPC Inc 2-I Block 1))

The Army's IFPC Inc 2-I is a follow-on effort to enhance and extend the range of the first IFPC increment, which provided a short-range capability to counter threats from rockets, artillery, and mortars. IFPC Inc 2-I consists of four separate sub-systems: an existing sensor; an interceptor; a command and control system; and a new multi-mission launcher (MML) being developed by the Army. IFPC Inc 2-I consists of three blocks. Block 1 adds the capability to counter cruise missiles and unmanned aircraft. We assessed Inc 2-I Block 1.

Source: U.S. Army.

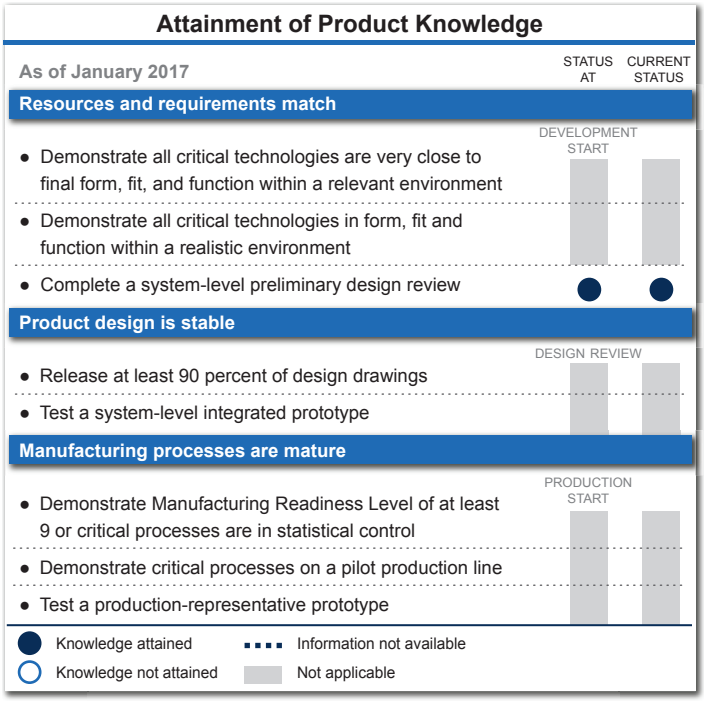
Program Essentials

Prime contractors: Aviation and Missile Research, Development and Engineering Center; Letterkenny Army Depot
Program office: Huntsville, Alabama
Funding needed to complete:
R&D: $404.3 million
Procurement: $2,729.6 million
Total funding: $3,133.9 million
Procurement quantity: 368

Program Performance (fiscal year 2017 dollars in millions)

	As of	Latest 09/2016	Percent change
Research and development cost	NA	$736.8	NA
Procurement cost	NA	$2,729.6	NA
Total program cost	NA	$3,466.5	NA
Program unit cost	NA	$9.420	NA
Total quantities	NA	368	NA
Acquisition cycle time (months)	NA	46	NA

The IFPC Inc 2-I Block 1 program plans to enter development with no critical technologies. The program has released all design drawings and considers its system design stable ahead of the planned May 2017 critical design review. However, this stability may be compromised if changes are needed before the May 2017 critical design review to integrate the MML with the other three subsystems. The program continues to develop the MML at two Army facilities, a strategy that was previously determined to be the most cost effective. Program officials acknowledged that they have a limited amount of time and flexibility in their current development schedule to correct any deficiencies identified during developmental testing. As a result, this optimistic schedule could leave the program at risk for unplanned cost increases and schedule delays to correct any such deficiencies that emerge.



IFPC Inc 2-I Block 1 Program

Technology Maturity

In May 2016, the Army completed a technology readiness assessment for the IFPC Inc 2-I Block 1 program that identified no critical technologies ahead of the program's planned entry into system development. Although three of the four sub-systems that comprise IFPC Inc 2-I Block 1 are either fielded or in production, officials acknowledged that these systems pose potential integration challenges to Block 1 system development because their capabilities will be used in new ways to prosecute different threats. The AIM-9X missile, the designated interceptor, was originally developed as an air-to-air missile and designed to be fired from Navy tactical aircraft. The Army is relying on its Integrated Air and Missile Defense program to produce the command and control system, which is currently designed to control the Patriot missile launcher and radar system. Previously, we found the IAMD program faces its own development challenges. The program office also intends to use the existing Sentinel air defense radar as its sensor component.

The Army will develop and produce the fourth system—the multi-mission launcher (MML)—at two facilities: the Aviation and Missile Research, Development, and Engineering Center (AMRDEC) and Letterkenny Army Depot (LEAD). According to program officials, AMRDEC is responsible for developing the MML units used for testing during system development, whereas LEAD will assume responsibility for MML low-rate initial production.

Design Maturity

According to program officials, the program has released all of its expected engineering drawings. However, program officials stated the prototype design of the MML presented at the program's preliminary design review in September 2015 is being assessed and updated, as necessary, in preparation for the critical design review (CDR) in May 2017. The CDR will evaluate the integration of the MML with the existing sensor, interceptor, and command and control system. The program has no plans for additional prototyping during system development following its CDR.

Program officials acknowledged the program schedule is oriented on successful testing outcomes throughout system development. As a result, program officials acknowledge there is limited time available to correct any deficiencies that may be found during testing before production begins. This optimistic schedule could leave the program at risk for unplanned cost increases and schedule delays to correct those deficiencies.

Production Maturity

Program officials stated that LEAD has the capability and capacity to manufacture 60 MML units per year, but they are unsure how easily the depot can exceed that number. The current production schedule increases the annual MML production rate to a maximum of 72 units in fiscal year 2022. Program officials stated they are committed to utilizing Army facilities for MML development and production and are developing mitigation strategies, including identifying additional Army sources for production tooling equipment to supplement the equipment already available at LEAD. However, program officials stated that, should they determine LEAD is unable to manufacture the MML at required rates, they have the option of soliciting proposals from contractors for MML production ahead of the IFPC Inc 2-I Block 1 full rate production decision in 2020.

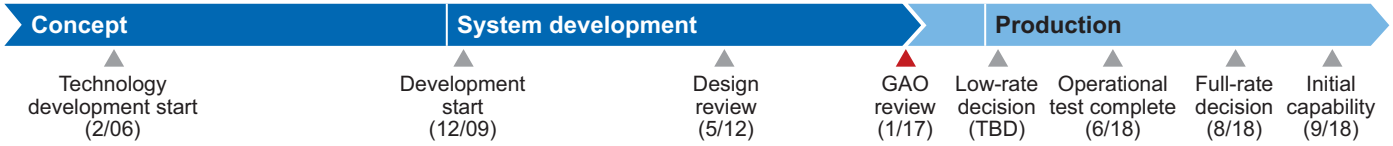
Program Office Comments

In commenting on a draft of this assessment, the program office provided technical commments, which were incorporated where deemed appropriate.

Integrated Air and Missile Defense (IAMD)

The Army's Integrated Air and Missile Defense (IAMD) program is being developed to network sensors, weapons, and a common battle command system across an integrated fire control network to support the engagement of air and missile threats. The IAMD battle command system will provide a capability to control and manage IAMD sensors and weapons, such as the Sentinel radar and Patriot launcher and radar, through an interface module that supplies battle management data and enables networked operations.

Source: Northrop Grumman.



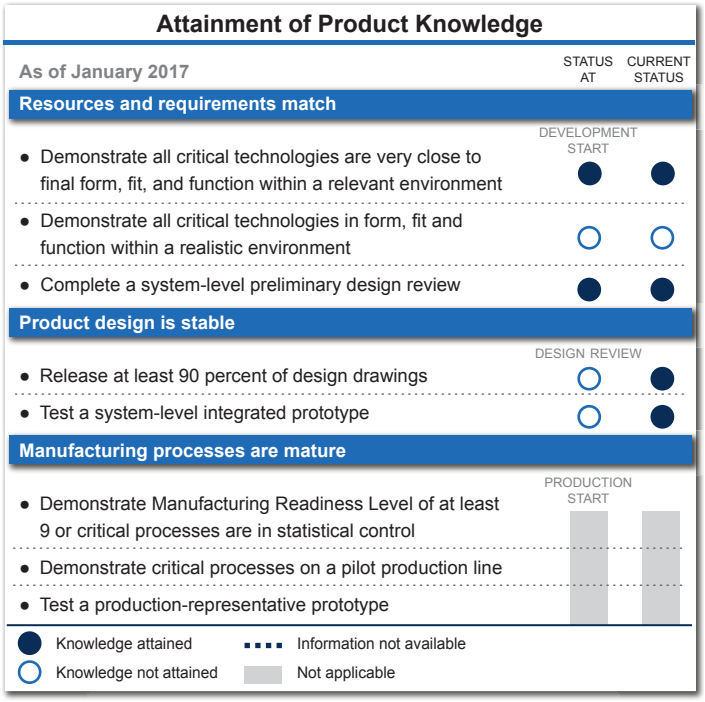
Program Essentials

Prime contractors: Northrop Grumman Space & Mission Systems Corp., Raytheon Company
Program office: Redstone Arsenal, AL
Funding needed to complete:
- R&D: $715.7 million
- Procurement: $3,802.0 million
- Total funding: $4,517.7 million
- Procurement quantity: 427

Program Performance (fiscal year 2017 dollars in millions)

	As of 12/2009	Latest 08/2016	Percent change
Research and development cost	$1,730.2	$2,678.6	54.8%
Procurement cost	$3,724.2	$3,822.7	2.6%
Total program cost	$5,454.4	$6,501.2	19.2%
Program unit cost	$18.427	$14.675	-20.4%
Total quantities	296	443	49.7%
Acquisition cycle time (months)	80	105	31.3%

IAMD critical technologies achieved full maturity in 2016—more than 6 years after development start. Best practices recommend that technology maturity be achieved prior to starting development. The program's low-rate production decision has been delayed more than 4 months to allot more time for developmental testing. According to program officials, the root causes for this delay include the program office's inability to schedule test range time as well as the extra time required for review of recent testing results. Program officials noted that it will be challenging to start operational testing by the planned September 2017 date and anticipate changes to developmental and operational testing schedules going forward.



IAMD Program

Technology Maturity

As of September 2016, the IAMD program demonstrated that all of its critical technologies—integrated battle command, integrated defense design, integrated fire control network, and distributed track management—are fully mature. This achievement comes over 6 years after the start of system development—a schedule that is inconsistent with best practices.

Design Maturity

IAMD completed its critical design review with a stable design in 2012, but the total number of design drawings has increased, with program officials reporting that 5 percent of them still need to be released before production starts. Program officials report they have released 95 percent of IAMD's design drawings. In addition, IAMD software development delays, which we have previously reported, persist. Program officials stated that, most recently, the program experienced software challenges going into an IAMD operational assessment with some software upgrades remaining undelivered. However, these officials noted the IAMD program will need software updates on a continuing basis due to threat changes. The program is also currently developing a software version (version 4.0) that officials anticipate will incorporate fixes for previous software deficiencies.

Production Maturity

The Army has delayed the IAMD low-rate production decision—previously planned for August 2016—to allot more time for developmental testing. According to program officials, the root causes for this delay include limited access to needed test resources, such as test ranges, as well as extra time required for reviewing the limited user test results. IAMD full-rate production start remains planned for fiscal year 2018.

Other Program Issues

The program conducted "limited user testing" from March to May 2016 to collect data on the IAMD's system of systems operational effectiveness, suitability, and survivability. This assessment of IAMD was designed to evaluate its ability to defeat aerial threats in an operationally realistic environment and determine hardware and software maturity, among other goals.

As a result of the limited user testing, the Army Operational Test Command made several recommendations to address issues with IAMD's operational effectiveness, suitability, and survivability. These recommendations are based on tester observations made during the test and do not reflect the Army Test and Evaluation Command's final evaluation recommendations, which the U.S. Army Evaluation Center is currently developing based on the results of this test. According to program officials, IAMD completed successful flight tests in 2016, which demonstrated new capabilities. For example, officials noted a successful first flight test where a PAC-3 missile intercepted a tactical ballistic missile using IAMD software and a composite tracker.

Program officials noted it will be challenging to start operational testing by September 2017. They stated that IAMD's developmental and operational testing schedules are likely to change. The program's initial operational capability date has been moved from June 2018 to September 2018, but program officials stated that this is still within the program's acquisition program baseline parameters. According to program officials, this minor schedule change will provide the program more time to test, analyze, fix, and re-test.

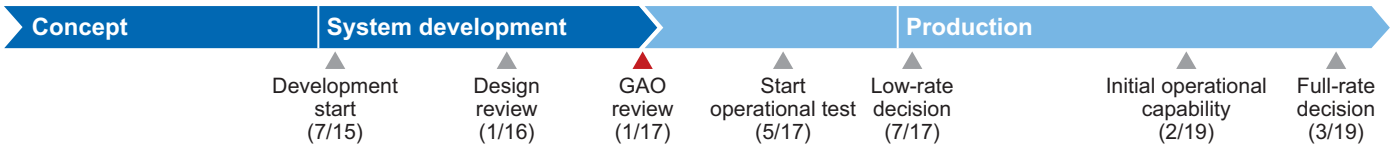
Program Office Comments

The limited user testing provided less than satisfactory results per the Army Test and Evaluation Command's final assessment. As a result, the Army Acquisition Executive placed the Milestone C decision on hold until the software deficiencies identified were resolved. According to program officials, the Milestone C decision is expected to occur in 2017. Officials also noted the initial operational capability date will be adjusted accordingly to accommodate the necessary initial operational testing needed prior to fielding of the system.

Joint Air-to-Ground Missile (JAGM)

The Joint Air-to-Ground Missile is an Army-led program with joint requirements from the Navy and Marine Corps. The missile is designed to be air-launched from helicopters and unmanned aircraft systems to target tanks, light armored vehicles, missile launchers, bunkers, and buildings. It is intended to provide precision attack capabilities no matter the time of day or weather conditions. JAGM will replace all Hellfire missile variants.

Source: U.S. Army.



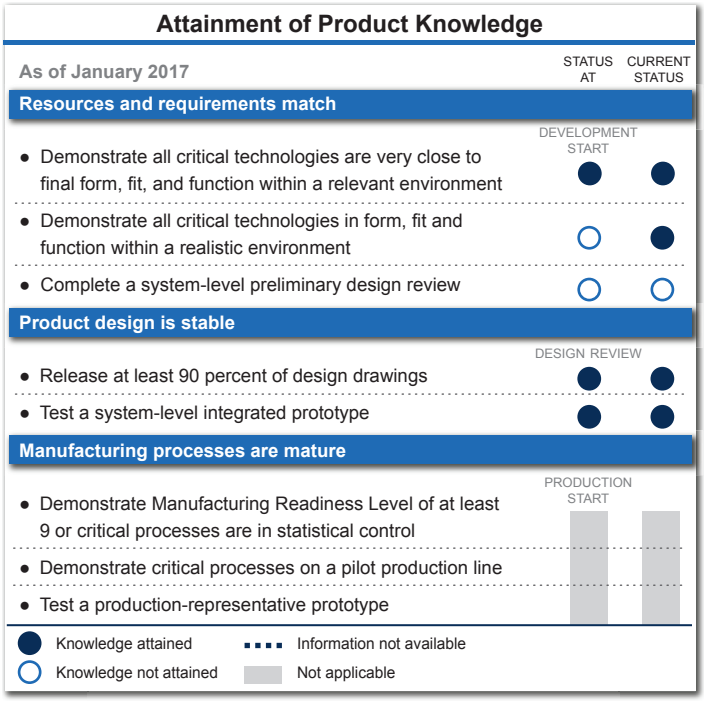
Program Essentials

Prime contractor: Lockheed Martin
Program office: Redstone Arsenal, AL
Funding needed to complete:
- R&D: $95.5 million
- Procurement: $4,831.9 million
- Total funding: $4,927.4 million
- Procurement quantity: 26,319

Program Performance (fiscal year 2017 dollars in millions)

	As of 09/2015	Latest 08/2016	Percent change
Research and development cost	$1,008.0	$996.3	-1.2%
Procurement cost	$4,833.0	$4,858.0	0.5%
Total program cost	$5,841.0	$5,854.3	0.2%
Program unit cost	$.221	$.221	0.2%
Total quantities	26,437	26,437	0.0%
Acquisition cycle time (months)	38	38	0.0%

The Army has fully matured all three of the JAGM program's critical technologies. Following a 2012 program restructuring, the Army redesigned JAGM to employ existing Hellfire missile components. DOD subsequently waived the requirement to complete a preliminary design review (PDR) of the redesigned missile prior to development start. The Army held a critical design review (CDR) in January 2016, which assessed the JAGM design as stable. The program has delayed initial operational testing due to a requirement for new Apache platform software and will instead begin a limited user test in May 2017. The program plans to manufacture JAGM on the existing production line used for Hellfire missiles, and program officials told us they expect all production processes to be mature prior to the start of low-rate production in July 2017.



JAGM Program

Technology Maturity

JAGM has three critical technologies—the guidance seeker assembly/sensor platform, sensor software, and mission software, all of which the program assessed as mature following two successful test shot events in June 2016. JAGM components, including the motor, warhead, and electronics, are common with the existing Hellfire missile. The Army's decision to include these components in the JAGM design followed a 2012 restructuring of the program, which included extending technology development by more than 2 years to address affordability concerns and risk reduction needs.

Design Maturity

The Army completed a system-level PDR for JAGM in June 2010. Following the program's 2012 restructuring, the Army implemented design changes to the missile, but DOD waived the requirement to conduct a PDR for the new design before the start of system development. At the CDR in January 2016, the program reported that the number of drawings expected had increased from 180 to 198. Program officials reported that nearly 97 percent of these drawings have been released and that the increase in drawings was due to design changes to existing hardware as well as a new drawing for the guidance section. The CDR determined that the design was stable and able to meet system performance requirements. The program held five flight tests of a system level prototype prior to the CDR and held an additional two tests in 2016, including the first missile test from a MQ-1C Gray Eagle.

JAGM officials reported a 5 month delay to the production of engineering and manufacturing development missiles because of a manufacturing defect in the seeker head assembly's dual-sensor interface circuit card, which may have resulted in the failure of the sensor. The contractor has since redesigned the interface to new specifications. The program also found that the material used to coat a portion of the transceiver failed under vibration loads. The contractor plans to use a different coating beginning with the 81st testing missile it produces, but program officials do not anticipate performance limitations to earlier missiles or schedule disruptions.

Production Maturity

JAGM will be manufactured at the same facility as the Hellfire missile. The program office is tracking 15 different metrics related to hardware and software to assess JAGM's readiness for production. According to program officials, these metrics currently meet expected values, and the program expects all production processes to be mature prior to the start of low-rate production in July 2017.

Other Program Issues

The Army has delayed initial operational testing and evaluation (IOT&E) by 2 years because the AH-64 Apache helicopter's current software—used to launch Hellfire missiles—requires more pilot input to access JAGM functionality than expected. New platform software in development for integration and testing in fiscal year 2018 will enable pilots to select the full range of options with far less physical interface with the platform. Flight testing of this software is planned for August 2018 to be followed by IOT&E. In the interim, the program has planned a limited user test in May 2017 of 10 missile shots with existing platform software and hardware to demonstrate the missile's capabilities. Program officials told us they do not expect any material changes to the missile between the limited user test and IOT&E.

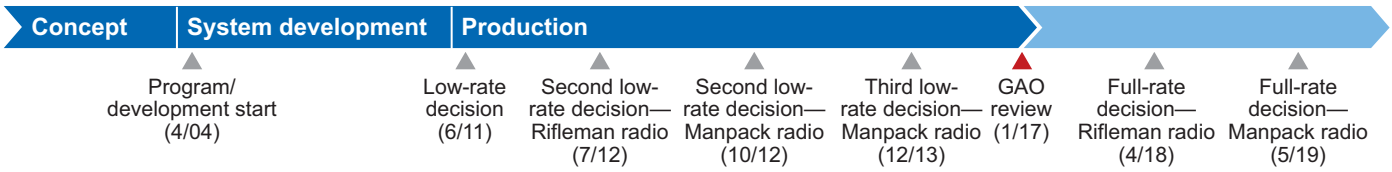
Program Office Comments

In commenting on a draft of this assessment, the program office provided technical comments, which were incorporated where appropriate.

Joint Tactical Radio System Handheld, Manpack, and Small Form Fit Radios (JTRS HMS)

DOD's Joint Tactical Radio System (JTRS) program, now restructured, was developing software-defined radios to interoperate with existing radios and increase communications and networking capabilities. The Army's JTRS HMS program continues efforts to procure two radios—the Rifleman and Manpack radios. A subset of Manpack radios are designed to operate with the Mobile User Objective System (MUOS)—a Navy satellite communication system planned to serve a worldwide, multiservice population of mobile and fixed-site terminal users.

Source: © 2012 General Dynamics C4S.



Program Essentials

Prime contractors: Harris Corporation, Thales Defense & Security
Program office: Aberdeen Proving Ground, MD
Funding needed to complete:
- R&D: $156.4 million
- Procurement: $7,073.9 million
- Total funding: $7,230.4 million
- Procurement quantity: 243,464

Program Performance (fiscal year 2017 dollars in millions)

	As of 05/2004	Latest 12/2015	Percent change
Research and development cost	$590.9	$1,434.3	142.8%
Procurement cost	$10,297.3	$8,129.4	-21.1%
Total program cost	$10,888.2	$9,563.7	-12.2%
Program unit cost	$.033	$.035	6.4%
Total quantities	328,674	271,202	-17.5%
Acquisition cycle time (months)	85	124	45.9%

The JTRS HMS program has demonstrated that its critical technologies are mature, and program officials report currently stable designs for both the Rifleman and Manpack radio systems. Developmental and operational testing in recent years identified deficiencies affecting both radio systems, which program officials report have since been resolved. However, the Army has not yet fully verified the resolution of these issues, or the operability of both radios, through operational testing. According to officials, the JTRS HMS program will conduct manufacturing readiness assessments for both the Rifleman and Manpack radios as part of separate full rate production decisions scheduled in 2018 and 2019, respectively. Initial fielding of the Navy's Mobile User Objective System (MUOS) waveform in some radios is delayed while the Navy corrects deficiencies it identified in operational testing.

Attainment of Product Knowledge

As of January 2017	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	●	●

● Knowledge attained ▪▪▪▪ Information not available
○ Knowledge not attained Not applicable

JTRS HMS Program

Technology and Design Maturity

At the JTRS HMS program's development start in 2004, the program did not assess the maturity of its critical technologies—an approach inconsistent with best practices. Further, the program had not fully matured all of its critical technologies by its 2011 production start. Instead, the program completed development of individual critical technologies in May 2015. The program assessed both radio designs as stable at critical design review in 2008, but now forecasts new design changes that could undermine this stability.

In fiscal year 2014, developmental testing of the Manpack radio identified deficiencies with the system's reliability. Initial operational testing that same year flagged suitability shortfalls, specifically related to excessive weight of the Manpack units. Similarly, operational testing of the Rifleman radio in fiscal year 2014 identified suitability problems related to overheating and rapid battery depletion. Program officials stated that the contractor has redesigned both radio systems to resolve these various problems. However, the Army has not yet completed operational testing to ensure that all deficiencies have been addressed.

Production Maturity

According to JTRS HMS program officials, the program conducted manufacturing readiness assessments for the Rifleman radio system and intends to evaluate the results in advance of that system's full rate production decision in April 2018. They also stated that the JTRS HMS program will conduct manufacturing readiness assessments for the Manpack radio as part of its separate full rate production decision in May 2019. However, the program office has not yet conducted or scheduled these assessments, citing anticipated design changes.

Other Program Issues

At present, use of the MUOS waveform—on which some Manpack radios will rely—is largely unavailable to the warfighter because of delays with authorizing its use in an operational environment. Although the program has not identified MUOS as a critical technology, without this waveform, affected Manpack radios are only able to communicate through legacy communications capabilities. Officials stated that the authorization delay would not impact the time frame for the fielding of Manpack radios but would affect the level of MUOS availability in the field. The Navy conducted initial operational testing of the MUOS waveform in October and November 2015. Based on those results, the Navy has programmed additional work to correct deficiencies along with an additional round of operational testing. The Army plans to leverage this operational testing to inform future fielding decisions. According to program officials, changes to the Manpack radios, necessary for implementation of MUOS, required the program to extend software development. JTRS HMS has successfully completed the initial set of MUOS conformance tests but will have to complete additional conformance tests in order to be fully certified for use in the field.

Program Office Comments

In commenting on a draft of this assessment, the program office provided technical comments, which were incorporated where deemed appropriate. The program office also disagreed with our characterization of past testing outcomes identified in this assessment.

GAO Response

Our characterization of past JTRS HMS testing outcomes is derived directly from reports issued by the program's testing authorities within DOD.

M109A7 Family of Vehicles (M109A7 FOV)

The Army's M109A7 FOV system consists of two individual vehicles, a self-propelled howitzer (SPH), and a tracked ammunition carrier that provides operational support. The SPH is a tracked, aluminum armored vehicle armed with a 155 millimeter cannon. The M109A7 FOV is expected to provide improved sustainability over the current howitzer fleet through the incorporation of a newly designed hull; modified M2 Bradley infantry fighting vehicle power train, suspension system, and track; and a modernized electrical system.

Source: U.S. Army.

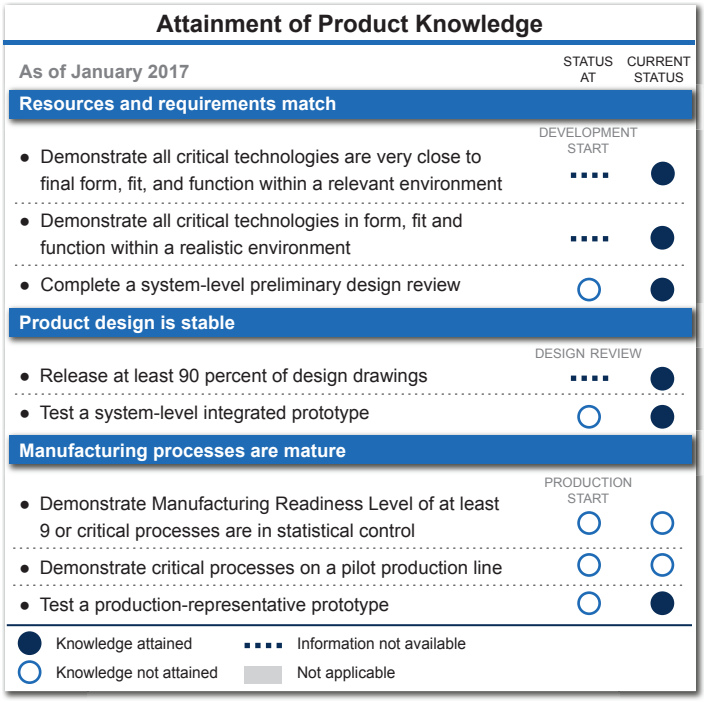
Program Essentials

Prime contractor: BAE Systems Land & Armament L.P.
Program office: Warren, MI
Funding needed to complete:
- R&D: $46.2 million
- Procurement: $5,384.8 million
- Total funding: $5,431.0 million
- Procurement quantity: 503

Program Performance (fiscal year 2017 dollars in millions)

	As of 02/2012	Latest 12/2015	Percent change
Research and development cost	$1,093.3	$1,149.5	5.1%
Procurement cost	$6,160.7	$6,255.2	1.5%
Total program cost	$7,254.0	$7,404.7	2.1%
Program unit cost	$12.464	$12.991	4.2%
Total quantities	582	570	-2.1%
Acquisition cycle time (months)	118	120	1.7%

The M109A7 FOV program entered low-rate initial production in October 2013 with its two critical technologies mature and design stable. However, the program now plans costly retrofits to the first 67 vehicles to improve their transmission systems and, for the howitzers, their cannon tubes. To date, the program has not demonstrated that its manufacturing processes are in statistical control, almost 3 years after production began. The program's schedule also hinges on completing developmental and operational testing with few, if any, additional technical discoveries. In the event that remaining testing identifies new deficiencies requiring design changes or additional retrofitting, the program will likely incur cost increases and capability delays.



M109A7 FOV Program

Technology and Design Maturity

The M109A7 FOV program's two critical technologies—power pack integration and the ceramic bearing of the generator assembly—have been assessed as fully mature. According to program officials, the design is currently stable with all of the expected drawings released and a system-level integrated prototype demonstrated. Despite this, a program official indicated that the current M109A7 transmission will be replaced by a more efficient transmission in fiscal year 2019, resulting in retrofits to all 67 low-rate production vehicles. The program official also stated that the SPH's current steel cannon tube will be replaced with a chrome-plated design in order to better meet its required service life. This retrofit began in January 2016 and the program is planning for 611 cannon tube upgrades in total.

Production Maturity

The program started low-rate initial production in October 2013, and the first vehicle was delivered in March 2015. To assess its production maturity, the program compares totals for expected and actual manufacturing hours to assess efficiency gains over time. To date, the program has not demonstrated statistical control of its critical manufacturing processes. Our best practices work has shown that if a program's critical manufacturing processes are not demonstrated and in control before production begins, it is at risk of increased cost and schedule delays. Additionally, quality control issues with the engine forced the program to adjust the test schedule. For example, some vehicles overheated. However, the program determined the root cause for the overheating and is making the necessary corrections.

Other Program Issues

The program's current schedule is predicated on completing remaining developmental testing and initial operational test and evaluation (IOT&E) with few, if any, new discoveries of technical deficiencies. The M109A7 FOV's IOT&E was originally planned for June 2016 has now been further delayed until the second quarter of fiscal year 2018, due to problems associated with soldiers being exposed to toxic fumes during a test event in October 2016. Root-cause analysis indicated a combination of breech malfunctions, improper crew procedures, and improper maintenance caused toxic fumes in certain guns to rise to dangerous levels. The program has addressed hardware issues and added additional training, to address the factors that led to this dangerous situation. The low-rate initial production is now being extended through fiscal year 2017 and the full-rate production decision was planned for December 2017 is now scheduled for June 2018. Additional schedule delays and cost increases could result if additional deficiencies are found during IOT&E that affect the M109A7 FOV's ability to be found operationally effective and suitable and, subsequently, require design changes or retrofits. For example, based on previous developmental testing results, program officials redesigned howitzer hardware and software to improve maximum rate of fire performance.

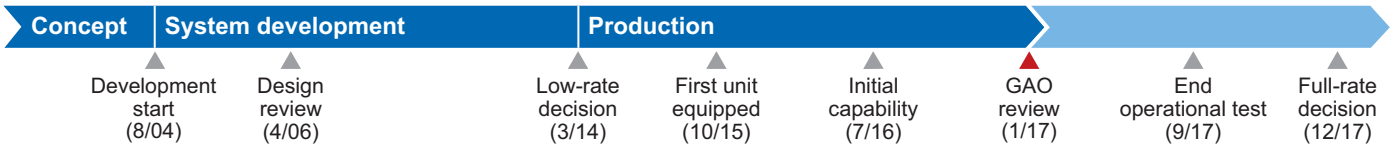
Program Office Comments

In commenting on a draft of this assessment , the program office provided technical comments, which were incorporated where deemed appropriate.

Patriot Advanced Capability-3 Missile Segment Enhancement (PAC-3 MSE)

The Army's PAC-3 MSE is a surface-to-air missile designed to defeat tactical ballistic missiles and other aerial threats. The MSE is the latest version of PAC-3 missiles integrated into the PATRIOT system, which includes radars, launchers, and a command and control system. The PAC-3 MSE improves upon earlier PAC-3 variants and is expected to provide a more lethal interceptor with expanded range and accuracy against complex threats.

Source: U.S. Army.



Program Essentials

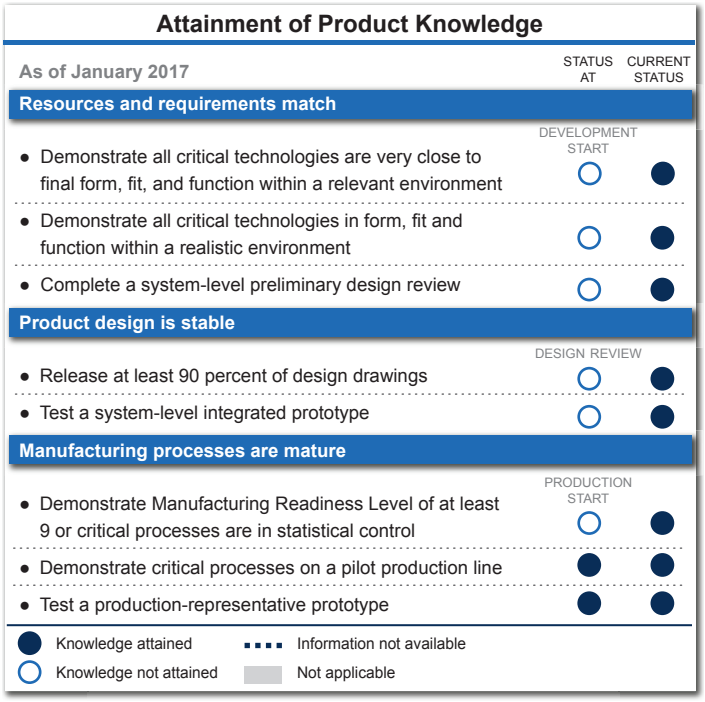
Prime contractor: Lockheed Martin
Program office: Redstone Arsenal, AL
Funding needed to complete:
- R&D: $0.0 million
- Procurement: $3,875.3 million
- Total funding: $3,884.9 million
- Procurement quantity: 813

Program Performance (fiscal year 2017 dollars in millions)

	As of 08/2004	Latest 10/2016	Percent change
Research and development cost	$585.6	$971.6	65.9%
Procurement cost	$7,318.9	$5,556.6	-24.1%
Total program cost	$7,904.6	$6,537.8	-17.3%
Program unit cost	$5.173	$5.811	12.3%
Total quantities	1,528	1,125	-26.4%
Acquisition cycle time (months)	NA	143	NA

Table note: Change in acquisition cycle time could not be calculated as initial estimates did not include an initial operational capability date.

The PAC-3 MSE program entered production in 2014 with mature technologies and a stable design. Two years after production start, the program successfully demonstrated its manufacturing processes were under control. The program achieved initial operational capability in 2016 ahead of schedule, which program officials attribute to early missile deliveries and training efficiencies. The Army has also successfully completed three flight tests of the missile during developmental testing for various PATRIOT system software and hardware upgrades. While the program has made some progress finalizing the terms of its 2015 missile production undefinitized contract action, the Army does not expect to complete this process until nearly a year and a half after the issuance of the action, which may place the program at risk of cost growth.



PAC-3 MSE Program

Technology and Design Maturity

The PAC-3 MSE program entered production in March 2014 with a stable design and all four of its critical technologies mature. Although the PAC-3 MSE has components that are 90 percent common with an earlier PAC-3 variant, four unique technologies required development—a dual pulse solid rocket motor, thermal batteries, an ignition safety device, and insensitive munitions to prevent inadvertent launch or detonation.

Production Maturity

The PAC-3 MSE program has demonstrated its manufacturing processes are in control. However, this demonstration did not occur until over 2 years after production start, which is inconsistent with best practices. PAC-3 MSE began production in March 2014 by demonstrating that all materials, manpower, tooling, and facilities were proven on a pilot production line and were available to meet the low rate production schedule, as recommended by DOD guidance. However, according to best practices, programs should demonstrate manufacturing processes to be in statistical control prior to production start. Specifically, critical processes should be repeatable, sustainable, and consistently producing parts within the quality standards.

Other Program Issues

The PAC-3 MSE program achieved initial operational capability in July 2016—about 5 months ahead of schedule—by equipping a PATRIOT battalion with 48 missiles. Program officials attributed the early completion of this milestone to faster than expected missile deliveries from the prime contractor and synergies with existing training for PATRIOT battalions.

In 2016, the program successfully completed three flight tests for the PAC-3 MSE during developmental testing for various PATRIOT system software and hardware upgrades. The PATRIOT system required these upgrades to fully test and utilize the missile's capabilities. Future results from system-level operational testing of the missile with these upgrades, which began in fiscal year 2016, will be used to support a PAC-3 MSE full-rate production decision, which is currently planned for 2017.

The PAC-3 MSE program continues to encounter delays in definitizing its production undefinitized contract actions. Last year, we reported that completion of the final contract pricing and terms for the program's 2014 production contract was delayed over a year beyond its expected date. We previously reported delays in finalizing this type of contract places the program at risk of cost growth as the government normally reimburses contractors for all allowable costs incurred during the undefinitized period, giving contractors little incentive to control costs. The program is also facing delays in finalizing terms for its 2015 production contract. Although the program made some progress by determining nearly 85 percent of the contract terms within 180 days, officials do not expect to fully complete this process until December 2016—nearly a year and a half after the issuance of the action.

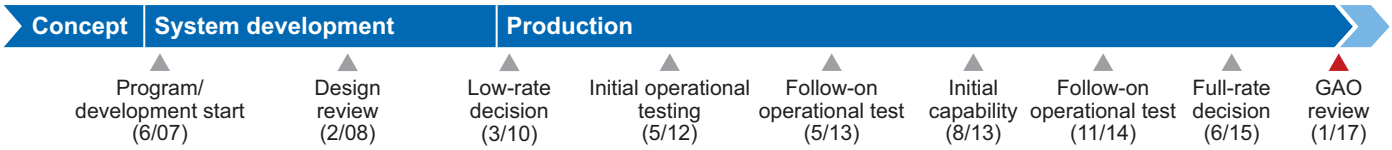
Program Office Comments

In commenting on a draft of this assessment, the program office provided technical comments, which were incorporated where appropriate.

Warfighter Information Network-Tactical Increment 2 (WIN-T Inc 2)

WIN-T is the Army's high-speed and high-capacity tactical communications network. It connects units with higher levels of command and is being fielded in three increments. The Army completed fielding of the first increment in 2012 and ended the development of the third increment in 2016. Together, those increments provided data, voice, and video networking capability, along with critical software upgrades. The Army expects the second increment, Increment 2, to provide required networking on-the-move capability. We assessed Increment 2.

Source: U. S. Army.



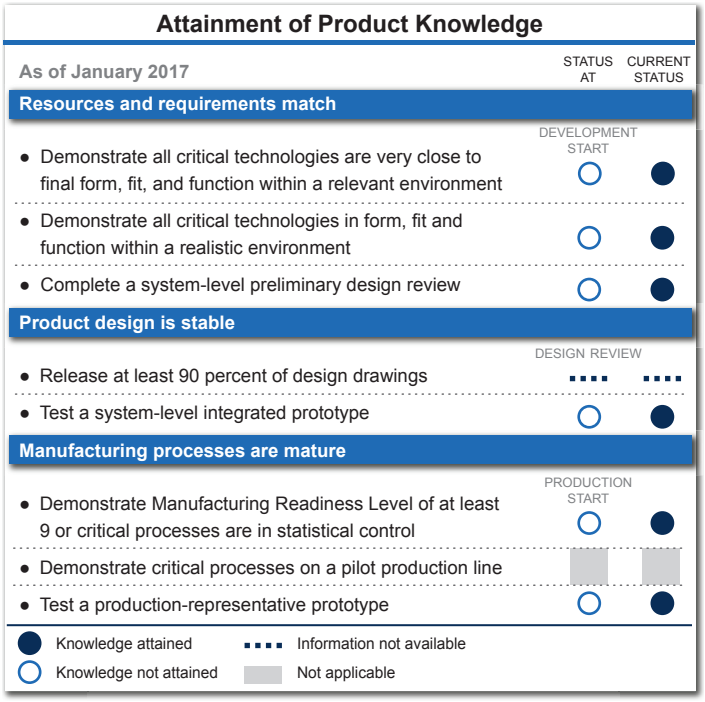
Program Essentials

Prime contractor: General Dynamics C4 Systems, Inc.
Program office: Aberdeen Proving Ground, MD
Funding needed to complete:
- R&D: $44.2 million
- Procurement: $7,525.0 million
- Total funding: $7,569.2 million
- Procurement quantity: 2,137

Program Performance (fiscal year 2017 dollars in millions)

	As of 10/2007	Latest 09/2016	Percent change
Research and development cost	$258.8	$334.8	29.4%
Procurement cost	$3,763.4	$10,875.1	189.0%
Total program cost	$4,022.2	$11,209.9	178.7%
Program unit cost	$2.125	$3.005	41.4%
Total quantities	1,893	3,730	97.0%
Acquisition cycle time (months)	50	74	48.0%

WIN-T Increment 2 entered production in March 2010 with its critical technologies mature. The program does not track the metric we use to measure design stability as WIN-T is primarily an information technology integration effort. Instead, design performance is measured through testing designed to demonstrate performance at increasing levels of system integration. The program has met its revised reliability criteria and has improved its cyber-defense capabilities. In January 2015, the Army reported that the program had breached a statutory unit cost growth threshold. Program officials stated that they are undertaking steps to reduce future unit costs below this threshold level.



WIN-T Inc 2 Program

Technology, Design, and Production Maturity

WIN-T Increment 2 entered development in June 2007 with 15 critical technologies. Of these, 3 were mature, 4 were approaching maturity, and 8 were immature or not assessed at development start. By the program's March 2010 production start, all 15 critical technologies were mature. The program does not track the metric we use to measure design stability—the number of releasable drawings—as WIN-T is primarily an information technology integration effort. Instead, design performance is measured through a series of tests designed to demonstrate performance at increasing levels of system integration. The program began testing a production representative prototype in March 2011 and assessed that its manufacturing processes were within statistical control in 2012, both after production began.

Other Program Issues

The program made progress against performance and reliability objectives—issues evident during earlier rounds of operational testing. This was achieved, in part, due to a relaxing of the reliability objectives as part of an update to the program's capability production document. The prior operational reliability standard of 90 percent—or probability of mission success without an essential functional failure—was deemed "excessively high when compared to predecessor, current, and analogous systems during similar periods in their respective life cycles." The operational reliability threshold was revised to 80 percent, and the program met this threshold during prior testing.

While the program continues to carry a high risk regarding its defensive capabilities against cyber-attacks, it is also making progress in mitigating these deficiencies. According to program officials, in order to reduce this risk, the program is consistently updating its cyber defenses, testing them against both internal and independent third-party attack teams, and then refining its cyber defenses based on the results. For example, the program is working with an independent team at Johns Hopkins University that attempts to hack the program's system and must also defend against other U.S. Army cyber attackers as part of the program's network integration tests. Program officials stated that since fiscal year 2015, the program has improved its cyber defenses, but expects to continue to improve over time and reduce the risk level. However, officials also noted that given the nature of cyber-attacks and cyber defense, the risk would likely remain throughout the life of the program as an issue that will always need attention.

The program continues to track cost growth as a concern following the January 2015 announcement that the program had breached a statutory significant unit cost threshold. Program officials stated that the program continues to reduce unit costs, which should bring down average unit costs over time. In addition, officials stated that the program is working to reduce costs further by decreasing the complexity of the hardware—both in terms of size and number of components—and by employing better buying power initiatives. With these efforts, officials are targeting further reduced costs in the future.

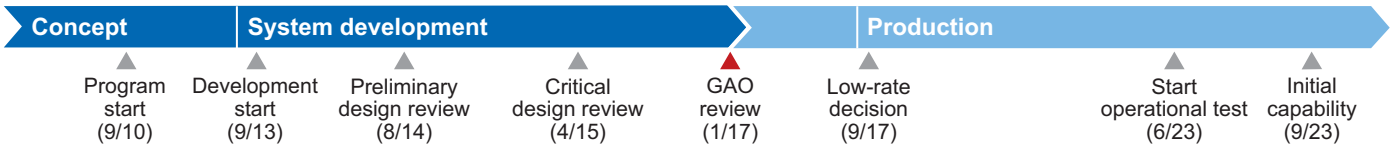
Program Office Comments

Program officials stated that WIN-T is currently fielded to 14 Brigade Combat Teams, 7 Division Headquarters, and the U.S. Army Signal School, Fort Gordon, GA. Officials noted the program remains on track to field additional units as directed by the Army at a rate of approximately two per year. Officials also reported the program continues to use soldier feedback from theater and test results to improve WIN-T Increment 2 capabilities with the primary focus being on simplifying the operations and maintenance of the equipment. Finally, officials reported the program office has developed new vehicle-based capabilities to meet emerging Army expeditionary and transportability needs and will test these capabilities at an integration test event in summer 2017.

Air and Missile Defense Radar (AMDR)

The Navy's AMDR is a next-generation radar program supporting surface warfare and integrated air and missile defense. AMDR is developing an S-band radar—known as SPY-6—that is expected to have increased sensitivity for long-range detection to improve ballistic missile defense against advanced threats. The program is also developing a radar suite controller to provide radar resource management and coordination, and to interface with an upgraded Aegis combat system to provide integrated air and missile defense for DDG 51 Flight III destroyers.

Source: © 2015 Raytheon Company.



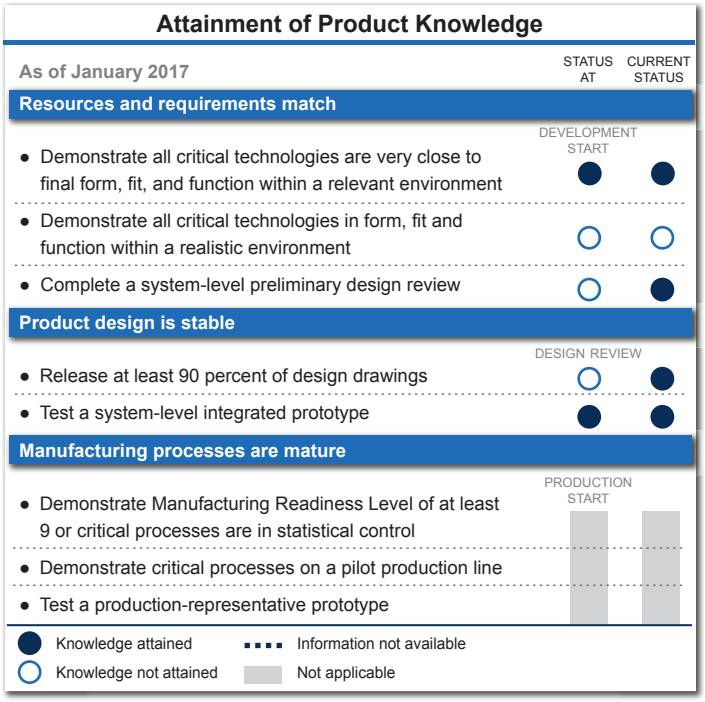
Program Essentials

Prime contractor: Raytheon
Program office: Washington, DC
Funding needed to complete:
- R&D: $468.7 million
- Procurement: $3,191.6 million
- Total funding: $3,660.2 million
- Procurement quantity: 22

Program Performance (fiscal year 2017 dollars in millions)

	As of 10/2013	Latest 12/2015	Percent change
Research and development cost	$1,966.4	$1,955.2	-0.6%
Procurement cost	$4,066.9	$3,440.2	-15.4%
Total program cost	$6,063.7	$5,425.6	-10.5%
Program unit cost	$275.625	$246.619	-10.5%
Total quantities	22	22	0.0%
Acquisition cycle time (months)	155	155	0.0%

AMDR completed its critical design review in April 2015 with four critical technologies nearing maturity and its design stable. The program has largely completed its four planned software builds, with the last build's completion expected by April 2017. In June 2016, a full-scale, production-representative SPY-6 radar array was installed at the Navy's Pacific Missile Range Facility for land-based testing. Testing of the radar system at sea is not planned until 2020, and initial operational test and evaluation is expected in 2023. The program's test and evaluation master plan remains unapproved by DOD's Director, Operational Test and Evaluation (DOT&E) due to concerns that the Navy's proposed testing approach would not perform testing under realistic operational conditions. The test plan may not be approved before the AMDR low-rate initial production decision in September 2017.



AMDR Program

Technology Maturity

AMDR's four critical technologies—digital beamforming, transmit/receive modules, multi-mission scheduling and discrimination software, and distributed receivers/exciters—are nearing maturity. The program is expected to deliver its first radar for installation on the lead DDG 51 Flight III ship in early 2020. To support initial integration between the radar and the combat system, the AMDR contractor developed and delivered SPY-6 simulator and emulator capabilities to help inform the program's knowledge of the radar and Aegis combat system interface performance prior to a 6-month risk reduction test period planned for the second half of fiscal year 2017. Additionally, the contractor built and tested a full-scale, single-face, 14-foot S-band radar array. In June 2016, this production-representative array was delivered and installed at the Navy's Pacific Missile Range Facility in Hawaii for live testing in a more representative environment. This testing is expected to reduce technical risk for the radar and help inform a low-rate initial production decision in September 2017.

The AMDR program's software has been developed in four builds using an approach that includes upfront requirements and architecture analysis for each build, as well as continuous integration of new software and automated testing to ensure functionality and performance. This includes aligning software features to test events to ensure timely software completion and delivery to support dry runs and tests. The first two builds developed basic infrastructure, anti-air warfare, and ballistic missile defense capabilities. The third and fourth provide the full extent of radar capabilities, including debris detection and mitigation and advanced discrimination of missile threats. As of December 2016, the fourth build was 80 percent complete, with completion planned by April 2017—about half a year later than previously planned. The Navy also plans to upgrade the combat system for integration with the SPY-6 radar, which will require significant software development for the interface between the radar and the combat management system. These software builds are expected to be completed in fiscal year 2021.

Design and Production Maturity

In April 2015, the program office completed a critical design review, with 100 percent of design drawings finalized. The design has remained stable as the program moves toward its initial production decision. However, because the decision to begin low-rate initial production will be made prior to demonstrating technology maturity at sea and before combat system integration and test, design stability remains a risk. Any design issues identified through testing the radar at sea and with the combat system will need to be addressed during SPY-6 production. The program office identified four key product characteristics that will be closely monitored during manufacturing. The characteristics are associated with the structural features of the radar and elements of the transmit/receive modules and beamforming technologies.

Other Program Issues

In 2013, DOT&E disapproved AMDR's test and evaluation master plan due to concerns the Navy's proposed testing approach would not provide realistic operational conditions. A senior DOT&E official noted the concern that the Navy has not involved DOT&E in efforts to update the test plan and anticipates that, without DOT&E involvement, the plan is likely to remain unapproved by DOT&E when the program reaches its September 2017 production decision.

Program Office Comments

In commenting on a draft of this assessment, the program office stated the SPY-6 testing it completed at the Pacific Missile Range Facility validated the system performance previously measured in testing at the contractor’s facility, allowing the program to procure long lead material for the first DDG 51 Flight III in December 2016. Upcoming live testing of several systems is expected to demonstrate the advanced features and unprecedented capability of this radar. The program reports being on track to provide this much-needed capability to the warfighter.

Amphibious Combat Vehicle (ACV)

The Marine Corps' ACV is the successor program to the canceled Expeditionary Fighting Vehicle (EFV). The ACV is intended to transport Marines from ship to shore and provide improved mobility and high levels of protection. The acquisition approach calls for three increments of development (1.1, 1.2, and 2.0) and leverages work accomplished under the EFV program. The Marine Corps expects later ACV increments to have improved amphibious capability over the first increment, ACV Increment 1.1. We assessed ACV Increment 1.1.

Source: U.S. Marine Corps.

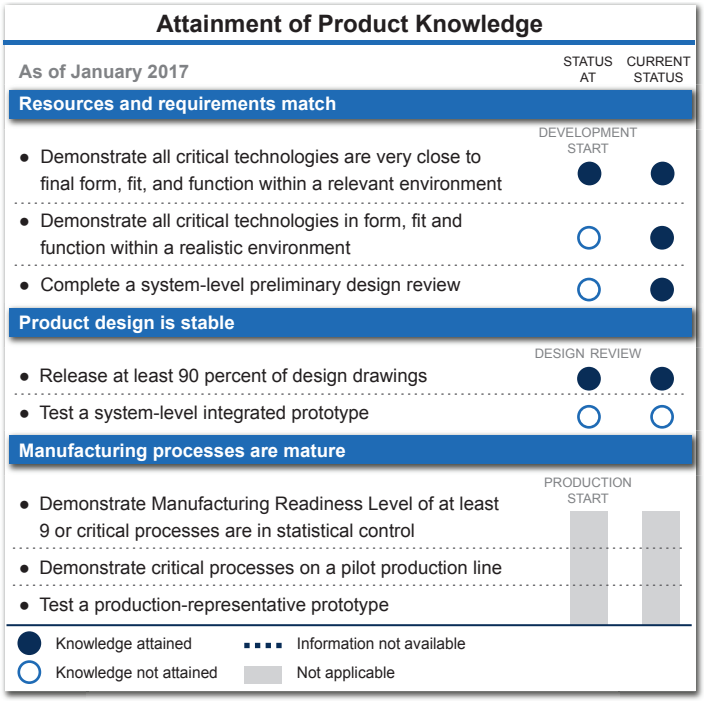
Program Essentials

Prime contractor: BAE Systems Land & Armaments LP, Science Applications International Corporation
Program office: Stafford, VA
Funding needed to complete:
- R&D: $382.0 million
- Procurement: $1,057.8 million
- Total funding: $1,477.7 million
- Procurement quantity: 204

Program Performance (fiscal year 2017 dollars in millions)

	As of	Latest 08/2016	Percent change
Research and development cost	NA	$796.3	NA
Procurement cost	NA	$1,057.8	NA
Total program cost	NA	$1,903.4	NA
Program unit cost	NA	$7.931	NA
Total quantities	NA	240	NA
Acquisition cycle time (months)	NA	57	NA

The ACV program completed a combined preliminary/critical design review in October 2016 with mature critical technologies and stable designs from its two contractor teams. The program includes two critical technologies, one of which is currently in use on an existing platform. The other technology, the Remote Weapon Station, completed testing in June 2016, demonstrating it can operate in a marine environment. According to the program office, both contractors released 90 percent of their drawings at the design review and are developing prototypes. The program schedule includes concurrent testing and production that place ACV at risk for costly retrofits as knowledge is gained in testing. Plans are in place for corrective action periods to implement modifications stemming from system-level developmental testing. The Marine Corps plans to select a single vendor in 2018 to produce the ACV.



ACV Program

Technology Maturity

ACV entered system development in 2015 with one mature critical technology and another critical technology approaching maturity. The program now assesses both technologies as fully mature. One technology, the Driver's Vision Enhancement, assists the ACV driver in safely operating the vehicle with a closed hatch during both the day and night and is currently used on the Assault Amphibious Vehicle. The other critical technology, the Remote Weapon Station (RWS), is a stabilized, remote operated, weapon station designed to operate in the maritime environment. The RWS is government-furnished equipment that will be integrated into the ACV by the contractor and is a version of a similar system developed for the Navy's Mark VI Patrol Boat. RWS successfully completed water tank drop testing in June 2016.

Design Maturity

According to the program office, the two ACV contractors released 90 percent of their drawings at the time of the combined preliminary/critical design review in October 2016. Each contractor is expected to provide a vehicle hull that will accommodate a minimum crew of three along with 10 combat equipped Marines. Both contractors are now developing prototypes of their designs, each using some form of a "V" hull design for added force protection from underside blasts and improved seats to protect occupants. The Marine Corps expects prototype delivery ahead of the contractual due date of March 2017.

ACV Increment 1.1 units will rely on connector vessels to transport them from amphibious ships to the shore. The Marine Corps anticipates ACV Increment 1.2 will be capable of self-deploying to shore. According to program officials, the ACV contractor teams designed Increment 1.1 vehicles with sufficient growth margins to accomodate the requirements of Increment 1.2. The Marine Corps is also investing in studies that could lead to a high water speed vehicle for ACV Increment 2.0.

Production Maturity

The ACV program's schedule includes concurrent testing and production activities that could leave the program with little flexibility to correct deficiencies identified during developmental testing and result in costly retrofits. The Marine Corps plans to select a single vendor in 2018 to produce the ACV, whereas system-level developmental testing is not expected to complete until December 2019, approximately one and a half years after production start. The program office has plans for a corrective action period for the first lot and potentially second lot of low-rate production vehicles to implement any remaining modifications resulting from developmental testing. According to the program office, the Marine Corps already budgeted for these potential retrofits. Program officials reported they plan to demonstrate critical manufacturing processes on a pilot production line prior to entering production and that low-rate production quantities comprise more than 10 percent of the total ACV Increment 1.1 production quantity, but attributed this decision to ensuring an efficient ramp up to full-rate production.

Other Program Issues

Contract performance was delayed due to a bid protest filed with GAO, which was denied in March 2016. According to the program office, the bid protest pushed the expected production decision out to the third quarter of fiscal year 2018. In the fiscal year 2017 budget, the Marine Corps funded ACV Increment 1.1 to the level identified in the program's independent cost estimate.

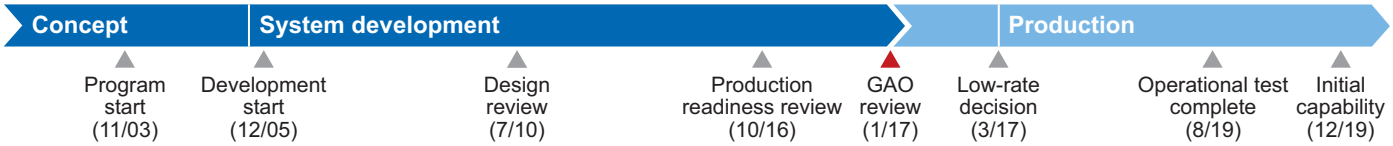
Program Office Comments

In commenting on a draft of this assessment, the program office stated that, although the ACV program leverages previous EFV program work, it predominantly utilized the Marine Personnel Carrier technology demonstrator and prototype demonstration efforts to inform ACV requirements. Program officials also noted program funding is depicted in base year fiscal year 2017 dollars, making costs appear greater than if presented in the program's base year fiscal year 2014 dollars. Program officials further noted that "Program unit cost" depicts Program Acquisition Unit Cost, not Average Procurement Unit Cost (APUC). The program unit cost value includes military construction funding and acquisition operations and maintenance funding, which are not included in APUC.

CH-53K Heavy Lift Replacement Helicopter (CH-53K)

The Marine Corps' CH-53K heavy-lift helicopter is intended to transport armored vehicles, equipment, and personnel to support operations deep inland from a sea-based center of operations. The CH-53K is expected to replace the legacy CH-53E helicopter and provide increased range and payload, survivability and force protection, reliability and maintainability, and coordination with other assets, while reducing total ownership costs.

Source: Sikorsky Aircraft Corporation.



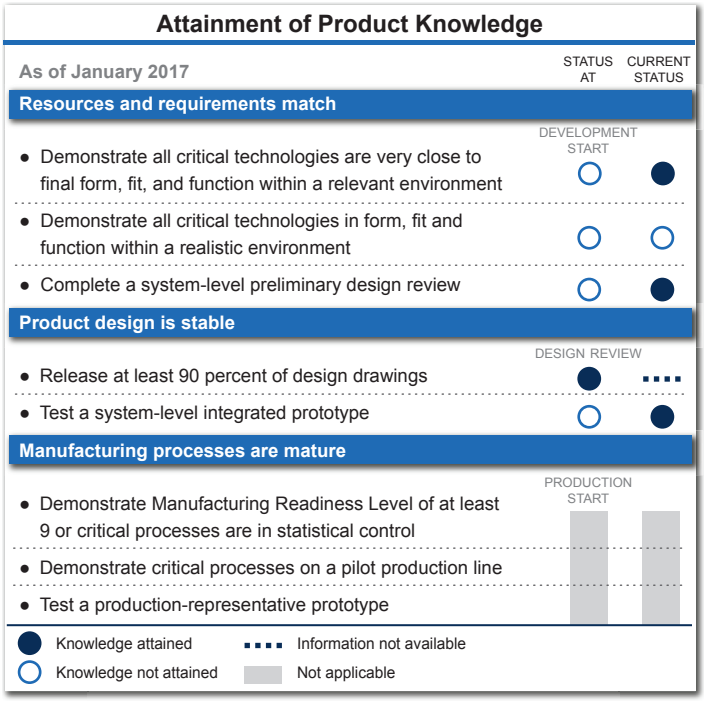
Program Essentials

Prime contractor: Sikorsky Aircraft Corporation
Program office: Patuxent River, MD
Funding needed to complete:
- R&D: $1,130.2 million
- Procurement: $19,232.3 million
- Total funding: $20,388.0 million
- Procurement quantity: 194

Program Performance (fiscal year 2017 dollars in millions)

	As of 12/2005	Latest 08/2016	Percent change
Research and development cost	$4,749.5	$6,936.7	46.1%
Procurement cost	$13,208.9	$19,273.1	45.9%
Total program cost	$17,958.4	$26,251.9	46.2%
Program unit cost	$115.118	$131.259	14.0%
Total quantities	156	200	28.2%
Acquisition cycle time (months)	119	168	41.2%

CH-53K critical technologies are approaching maturity and the program is completing flight tests to demonstrate recent redesigns to key components. These redesigns, which follow the program's July 2010 critical design review, have delayed aircraft assembly and testing and slowed delivery of test aircraft. As a result, the program has delayed its entry into low-rate initial production until March 31, 2017. The program also faces uncertainty associated with the relocation of the CH-53K production facility, and officials report they continue to assess potential impacts. The program has also accepted delivery of its four test aircraft and, as of January 2017, has completed over 370 flight test hours.



CH-53K Program

Technology and Design Maturity

The CH-53K program entered system development in December 2005 with immature critical technologies—an approach inconsistent with best practices. These technologies, which include the main rotor blade and main gear box, were approaching maturity at the program's critical design review (CDR) in July 2010. The program began flight testing both of the technologies in October 2015. Although this testing constitutes an operational environment, the technologies have not yet been assessed for final form, fit, and function.

At CDR, the program assessed what was later proven to be an unstable design. The extent of this instability is unknown, however, as the program no longer tracks information on design drawings. Unanticipated design changes to non-critical technology components after CDR caused test and production delays. We previously found that components within the rear module assembly, part of the main gear box, required a number of redesigns. For example, we found equipment holding one of the gears in place failed, which required a reconfiguration of the rear module assembly retention design. The contractor completed and installed the new design on each of the five test aircraft. Program officials reported that since the redesign, the program has successfully tested the main gear box, and actions are underway to mitigate the remaining design risks in the program. The program estimates the CH-53K will not only meet, but will exceed all of its key performance requirements.

Production Maturity

To date, the CH-53K program has taken delivery of five test vehicles, which includes the ground test vehicle and four flight test aircraft. All four aircraft were modified to include the redesigned main gear box and have entered flight testing—accumulating over 370 flight test hours, as of January 2017. However, delays producing test articles have slowed the overall schedule. As a result, the program postponed its low-rate initial production decision to March 31, 2017. This delay exceeded the program’s schedule parameters, which required the Marine Corps to report the delay to the Under Secretary of Defense for Acquisition, Technology and Logistics (USD AT&L).

USD AT&L subsequently approved a schedule extension and decided not to require the program to establish a new acquisition program baseline until the CH-53K's low-rate production decision is reached. Our best practices work has shown that if a program's critical manufacturing processes are not demonstrated and in control before production begins, it is at risk of increased cost and schedule. The program is nearing its expected low-rate production decision on March 31, 2017, and does not have all of its critical manufacturing processes under statistical control, nor has its manufacturing readiness level been assessed at DOD's recommended level for starting production.

According to program officials, production will be moved from its current location in West Palm Beach, Florida, to Sikorsky’s headquarters, which is located in Stratford, Connecticut. According to officials, the current location in West Palm Beach is owned by United Technologies—Sikorsky’s prior owner—and Lockheed Martin’s acquisition of Sikorsky necessitated the change. The move will require a number of equipment and configuration changes to Sikorsky’s Stratford facility, which will take time to complete and pose risk to the CH-53K production schedule. Program officials continue to assess the potential impacts of the production relocation.

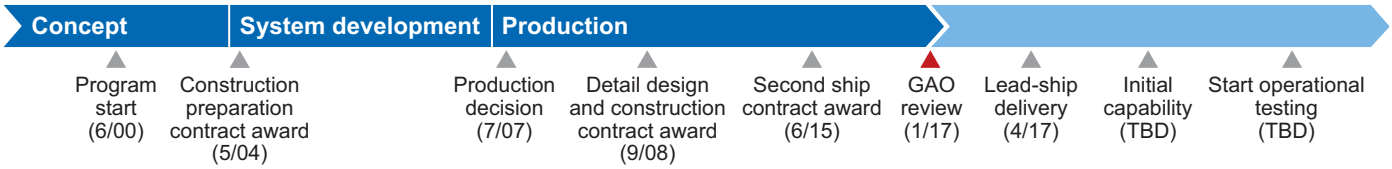
Program Office Comments

In commenting on a draft of this assessment, the program office concurred with the contents, but provided additional information. While the program's production readiness was assessed as below DOD's required level for production, the program expects to meet DOD's recommended standard upon successful completion of initial operational test and evaluation. In addition, the program office stated the movement of the production facility was driven by required capacity and not the Lockheed Martin acquisition. The program is monitoring the contractor's move plans, which just competed the second of six gates. There is a planned gap of 8 months between the completion of the fourth and fifth system demonstration test articles in order to facilitate the final assembly move. The program also provided other technical comments, which were incorporated where deemed appropriate.

CVN 78 Gerald R. Ford Class Nuclear Aircraft Carrier (CVN 78)

The Navy developed the Ford-class nuclear-powered aircraft carrier to introduce new propulsion, aircraft launch and recovery, and survivability capabilities to the carrier fleet. The Ford-class is the successor to the Nimitz-class aircraft carrier, and its new technologies are intended to create operational efficiencies while enabling a 25 percent increase in operational aircraft flights, as compared to legacy carriers. The Navy also expects the new technologies to enable Ford-class carriers to operate with reduced manpower.

Source: U.S. Navy.



Program Essentials

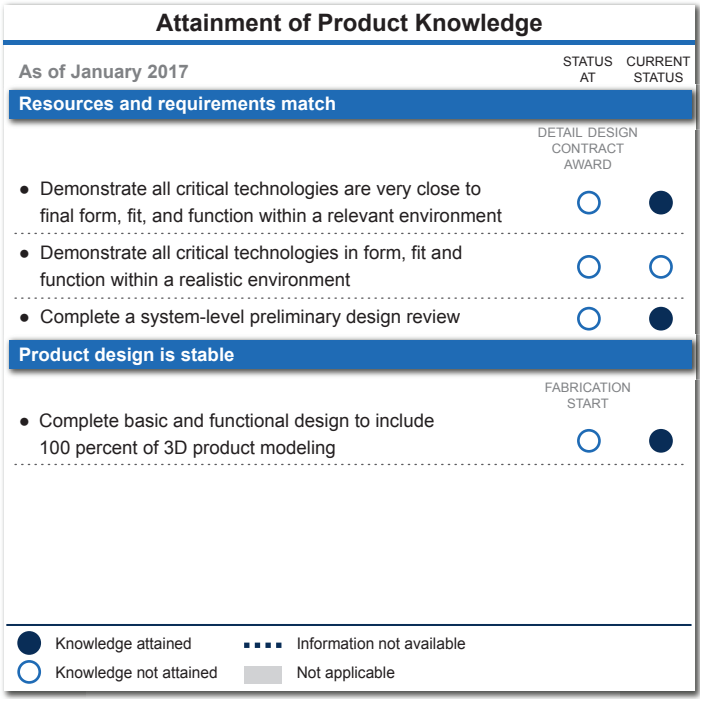
Prime contractor: Huntington Ingalls Industries
Program office: Washington, DC
Funding needed to complete:
- R&D: $624.9 million
- Procurement: $12,620.7 million
- Total funding: $13,275.2 million
- Procurement quantity: 1

Program Performance (fiscal year 2017 dollars in millions)

	As of 04/2004	Latest 09/2016	Percent change
Research and development cost	$5,210.1	$5,486.3	5.3%
Procurement cost	$33,377.1	$31,918.1	-4.4%
Total program cost	$38,587.3	$37,539.7	-2.7%
Program unit cost	$12,862.418	$12,513.220	-2.7%
Total quantities	3	3	0.0%
Acquisition cycle time (months)	137	TBD	NA

Total program and unit cost decreases are driven by a decrease in the estimated costs for the third ship (CVN 80), which has not yet been validated by an independent cost estimate.

The Navy reported 9 of the program's 13 critical technologies are mature, though testing continues to reveal issues and delay lead ship (CVN 78) delivery—most recently due to problems with the ship's propulsion plant. CVN 78 construction is nearly complete, but the Navy reported ship delivery was delayed to April 2017. CVN 78 procurement costs remain at the limit of the current legislated cost cap of $12.9 billion, and the Navy has identified $48 million in cost risk from extended testing. The National Defense Authorization Act for Fiscal Year 2016 reduced the cost cap for the first follow-on ship (CVN 79) to $11.4 billion, though we found the funds the Navy has budgeted are likely insufficient to complete ship construction. The Navy adopted a two-phased acquisition approach for CVN 79 and has deferred certain construction activities and costs to after ship delivery.



CVN 78 Program

Technology, Design, and Production Maturity

The Navy reported 9 of the program's 13 critical technologies are mature, though testing continues to reveal issues. CVN 78 began construction with immature technologies and an incomplete design, leading to cost and schedule growth. The Navy completed deadload testing of the electromagnetic aircraft launch system from the ship's deck in 2016. The advanced arresting gear (AAG) began shipboard testing in July 2015, with projected completion in March 2017. The dual band radar (DBR) also began shipboard testing in 2015, despite known problems that could affect air traffic control functionality. Both the AAG and DBR are engaged in concurrent land-based testing. The advanced weapons elevators are also experiencing problems, and, as of January 2017, the Navy projected that only 2 of the 11 elevators would be built and tested by ship delivery. In June 2016, a turbine generator in the ship's propulsion plant experienced a catastrophic failure, likely due to a manufacturing defect. A follow-on review revealed additional problems requiring design modifications to the voltage regulator and protection systems, which has delayed the propulsion plant testing schedule. As a result of key subsystem deficiencies, the Under Secretary of Defense for Acquisition, Technology and Logistics directed an independent review team to identify and mitigate potential technology risks for follow-on ships.

The Navy recently reported additional schedule delays for CVN 78 delivery and major post-delivery test events. Construction continues on CVN 79, which is 23 percent complete. This ship uses the CVN 78 design with some modifications, namely replacing DBR with the Enterprise Air Surveillance Radar suite. The Navy awarded the detail design and construction contract for CVN 79 in June 2015 and the advance procurement contract for CVN 80 in May 2016.

Other Program Issues

In 2007, Congress established a procurement cost cap of $10.5 billion for CVN 78, and lead ship procurement costs have since increased by 23 percent to the current cost cap of $12.9 billion. While CVN 78 construction is nearly complete, the Navy identified $48 million in cost risk and more recent technical issues suggest additional costs, meaning that the current cost cap likely does not represent necessary funding to deliver a complete ship. The National Defense Authorization Act for Fiscal Year 2016 reduced the cap for follow-on ships, including CVN 79's to $11.4 billion, though costs for this ship may also increase. The Office of the Secretary of Defense projected CVN 79 would exceed the program's cost estimate by about $235 million. We also found that the funds the Navy has budgeted based on CVN 79's cost estimate are likely to be insufficient to complete ship construction. The Navy has expressed confidence that CVN 79 will deliver within its cost cap, which assumes unprecedented efficiency gains in construction—namely that CVN 79 production hours will be significantly lower than CVN 78. The Navy adopted a two-phase acquisition approach for CVN 79 to shift some construction to a post-delivery period. This strategy results in a less capable and complete ship at delivery, and transfers the costs of known capability upgrades to other accounts by deferring work to future maintenance periods—obscuring CVN 79's actual costs.

Program Office Comments

With 93 percent of the CVN 78's test program complete, the Navy has made progress resolving first-of-class issues and has resumed critical-path testing to support delivery in April 2017. The Navy is managing the $48 million cost risk associated with extended shipboard testing and the costs for schedule delay to delivery. The Navy continues to pursue cost mitigation within the program to offset this cost risk to deliver the ship within the cost cap. According to the program, with 26 percent of CVN 79's construction complete, cost performance to-date remains aligned with the contract target to realize an 18 percent reduction in production labor hours from CVN 78. The Navy will deliver a complete and deployable ship at the end of Phase II, with the construction costs from both phases accounted within the cost cap.

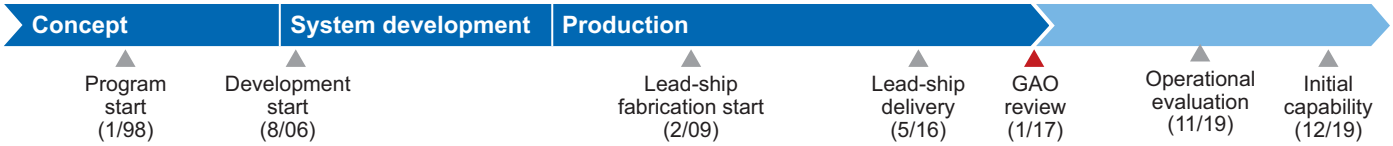
GAO Response

Navy cost mitigation plans will not reduce actual CVN 78 costs; instead, the costs will be shifted to follow-on ships or to other support accounts. CVN 79 cost performance is degrading, and, if trends continue, the ship is at risk of exceeding its cost cap.

DDG 1000 Zumwalt Class Destroyer (DDG 1000)

The DDG 1000 destroyer is a multi-mission surface ship designed to provide advanced capability for littoral operations and land attack to support forces ashore. DDG 1000 class ships feature an integrated power system and a total ship computing environment. The Navy accepted delivery of the lead ship—comprised of the hull, mechanical, and electrical systems—in May 2016. The Navy has scheduled a separate, post-delivery phase to activate and test the lead ships combat systems. The remaining two ships of the class are under construction.

Source: U.S. Navy.



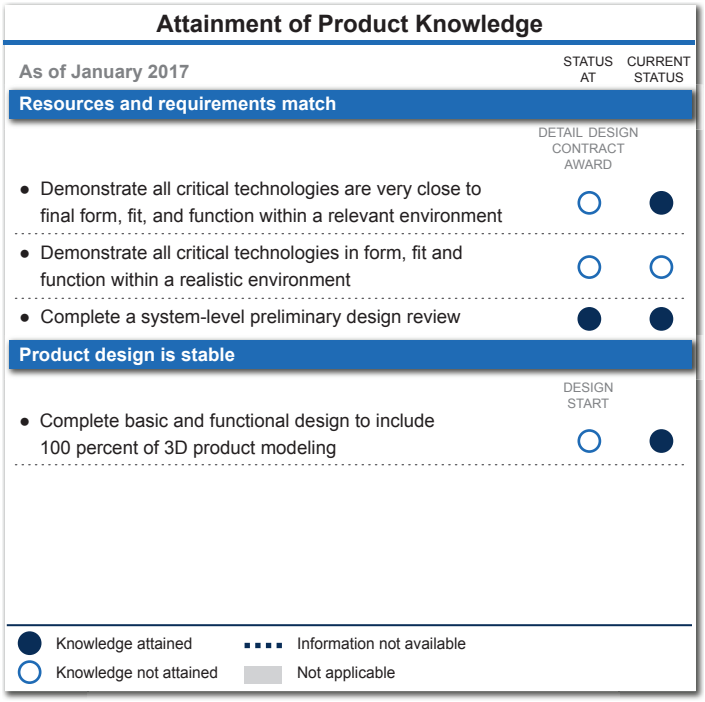
Program Essentials

Prime contractors: BAE Systems, General Dynamics Bath Iron Works, Huntington Ingalls, and Raytheon
Program office: Washington, DC
Funding needed to complete:
- R&D: $96.3 million
- Procurement: $664.7 million
- Total funding: $761.0 million
- Procurement quantity: 0

Program Performance (fiscal year 2017 dollars in millions)

	As of 1/1998	Latest 10/2016	Percent change
Research and development cost	$2,471.1	$10,931.2	342.4%
Procurement cost	$35,280.4	$12,714.5	-64.0%
Total program cost	$37,751.5	$23,645.7	-37.4%
Program unit cost	$1,179.734	$7,881.885	568.1%
Total quantities	32	3	-90.6%
Acquisition cycle time (months)	128	264	106.3%

To date, the Navy has fully matured fewer than half of DDG 1000's 11 critical technologies. The program reports that the ship's design is stable, but ongoing development and shipboard testing of technologies pose risk for design changes. The 2016 delivery of the lead ship's hull, mechanical, and electrical systems followed significant technical challenges with the integrated power system, which contributed to an 18-month delay. As the program begins to test the lead ship's combat systems—an effort that relies on stable power from the integrated power system—it faces challenges achieving its cost and schedule baselines. After completing delayed combat system acceptance trials for the lead ship, the Navy will conduct initial operational testing. The program's planned date for initial operating capability has slipped more than 2 years from July 2016 to December 2019.



DDG 1000 Program

Technology Maturity

At start of detail design in 2005, the DDG 1000 program had matured 1 of its current 11 critical technologies—an acquisition approach inconsistent with best practices. The DDG 1000 program has since fully matured 5 of 11 critical technologies. The program states that 5 of the remaining 6 will be demonstrated during post-delivery availability and combat systems activation, extending from the second quarter of fiscal year 2017 to the first quarter of fiscal year 2019. The Navy has since delayed the start of this activity to early 2018. Prior to the May 2016 delivery of the lead ship's hull, mechanical, and electrical systems, the program experienced significant technical issues with the integrated power system, a critical technology which supplies power to the ship's propulsion and electronic systems. Challenges were due, in part, to the Navy's decision not to fully test and validate the performance of the system in a representative environment prior to installation on the ship. Program officials noted that combat systems testing and activation relies on stable power, and will introduce new challenges for the power system beyond those encountered to date. After scheduling combat systems acceptance trials for the lead ship in the third quarter of fiscal year 2017, the Navy has delayed this activity to early 2018.

The program reported land-based testing of modifications to the multifunction radar, to include a volume search capability, is complete. In 2017, testing of the modified multifunction radar will move to a Navy test bed for ship self-defense, before initial operational testing aboard the lead ship. The program also reported that the planned date for completion of software development for the class was delayed from January 2016 to December 2017 to prioritize cybersecurity enhancements and software corrections related to integration of the ship's power and engineering control systems. The program did not make a low-rate initial production decision on the long-range land-attack projectile in fiscal year 2016 as planned.

Design and Production Maturity

The DDG 1000 design was not stable at lead ship fabrication start in 2009. Since then, the Navy and its contractors stabilized the design, but ongoing development and shipboard testing of technologies may result in design changes. Delivery of the lead ship's hull, mechanical, and electrical systems was 18 months behind schedule due in part to challenges completing electrical work, with the shipbuilder citing resource shortages and workforce turnover. Program officials noted the lead ship will not complete final contract trials, foregoing an opportunity to identify and mitigate technical and design deficiencies prior to completing construction of the remaining two ships.

As of October 2016, construction of the two remaining ships was 91 and 59 percent complete, respectively. Program officials noted the shipbuilder continues to face challenges in completing electrical work and since March 2016, delivery dates for the remaining two ships have each slipped by about two fiscal quarters. With the Navy as lead integrator, program officials noted that timely delivery of government-furnished equipment to the shipbuilder will be critical to achieving cost and schedule baselines for these ships' hulls, under the terms of their fixed-price construction contracts.

Other Program Issues

During the lead ship's transit between its Maine construction site and California home port, the ship's propulsion system experienced two seawater intrusions which required unscheduled repairs.

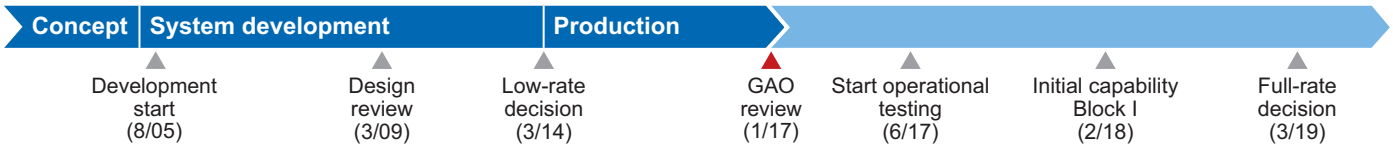
Program Office Comments

In commenting on a draft of this assessment, program officials stated the program reached a significant milestone with delivery of the first-of-class ship in fiscal year 2016. Program officials noted that DDG 1000 underwent an extensive period of testing including three sets of trials prior to delivery and the ship continued test and activation activities during its transit to San Diego. Officials also noted that during transit, seawater contamination occurred in two propulsion motor bearing lubricating oil sumps and it is not uncommon for first-of-class ships to identify deficiencies and undergo repairs during underway periods following construction. According to program officials, the ship’s post-delivery availability will include periods of in-port and at-sea testing and activation of ship systems. Finally the program noted that following combat system activation, the ship will conduct dockside and at-sea trials as well as start operational testing.

Ground/Air Task Oriented Radar (G/ATOR)

The Marine Corps' Ground/Air Task Oriented Radar (G/ATOR) is a three-dimensional, short-to-medium range, multi-role radar designed to detect, identify, and track threats such as incoming cruise missiles, rockets, and artillery. It will replace five legacy radars. G/ATOR is being acquired in blocks, with later blocks focused on software upgrades. We assessed Block 1, which has an air defense and surveillance role, and made observations on Block 2, which will determine enemy firing positions and point of impact for incoming fire.

Source: U.S. Marine Corps.



Program Essentials

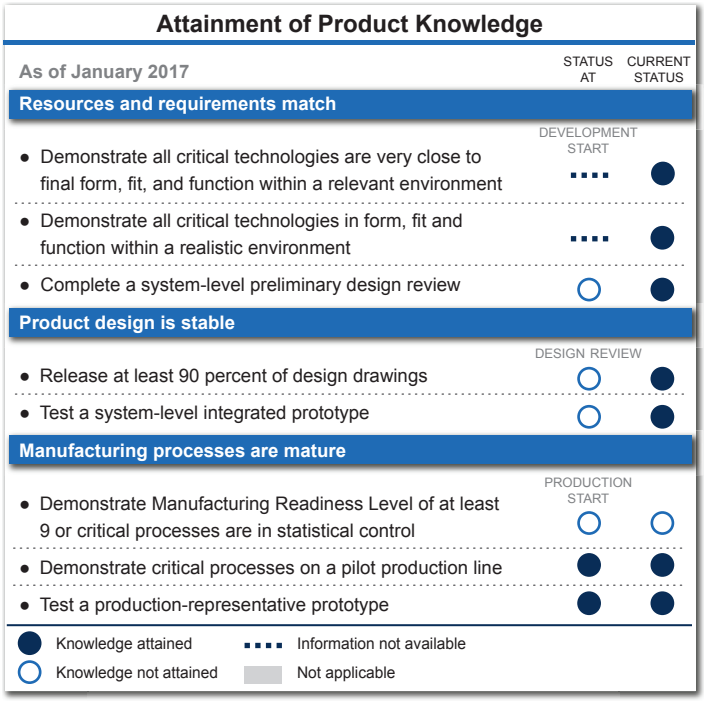
Prime contractor: Northrop Grumman
Program office: Quantico, VA
Funding needed to complete:
- R&D: $185.1 million
- Procurement: $1,346.5 million
- Total funding: $1,531.6 million
- Procurement quantity: 36

Program Performance (fiscal year 2017 dollars in millions)

	As of 08/2005	Latest 12/2015	Percent change
Research and development cost	$384.1	$1,061.9	176.5%
Procurement cost	$1,206.0	$1,752.8	45.3%
Total program cost	$1,590.1	$2,818.4	77.3%
Program unit cost	$24.845	$62.632	152.1%
Total quantities	64	45	-27.7%
Acquisition cycle time (months)	66	155	134.8%

The cost data includes G/ATOR Blocks 1 and 2. The acquisition cycle time was calculated for Block 1 only.

The G/ATOR program received approval to enter low-rate initial production (LRIP) in March 2014 with mature technologies, a stable design, and production processes that were demonstrated, but not in control. In early testing, software stability was a major problem that degraded reliability. Since then, software performance and reliability has improved and the program continues to make software updates to address quality and reliability issues. The next opportunity to collect representative data on reliability will be in 2017. Program officials noted G/ATOR transitioned to a new semiconductor technology in 2016, which will be used in initial operational testing and for all future radars produced for the program. A revised test and evaluation master plan (TEMP) capturing the new technology was approved by Director, Operational Test and Evaluation (DOT&E) in March 2016.



G/ATOR Program

Technology and Design Maturity

As of August 2016, the program reported that all six G/ATOR critical technologies are fully mature. Further, the program reported a mature design, with more than 99 percent of design drawings released. Although G/ATOR hardware has proven to be reliable, software maturity and quality problems have affected the reliability of the overall system. After G/ATOR failed to meet its reliability target during developmental testing, a panel of experts convened by the Navy in June 2014 conducted an in-depth analysis of the program and found G/ATOR's reliability requirement was likely unachievable and did not reflect operational needs. In March 2015, the Marine Corps clarified the reliability requirement to ensure it was consistent with G/ATOR's operational mission profile. Since then, software performance and reliability has improved. The program manager noted that the program continues to make software updates to address quality and reliability issues, and that the next opportunity to collect representative reliability data will be 2017 when the first LRIP radar is delivered and tested.

Beginning with radars produced in 2016, the program upgraded the radar's transmit and receive modules by using a newer semiconductor technology. According to program officials, this new gallium nitride (GaN) technology is mature and the new modules will fit inside the system the same as the older gallium arsenide (GaAs) modules, which minimizes design changes. The GaN technology is expected to achieve better performance with higher reliability at a lower cost by reducing the number of modules required.

Production Maturity

The Assistant Secretary of the Navy for Research, Development and Acquisition [ASN(RDA)] approved the program's entry into LRIP in March 2014. At the time of this decision, the G/ATOR program had demonstrated its production processes to the level recommended by DOD, but had not brought them into statistical control, which is inconsistent with best practices. This status is unchanged.

In August 2016, ASN(RDA) approved an increase in LRIP units from 14 to 15 radar systems. According to the program office, the first 6 of the 15 units will use the older GaAs modules and the follow-on 9 will use the newer GaN modules. The program office awarded a contract in August 2016 to Northrop Grumman to procure the 9 GaN radars. According to the program office, the first LRIP deliveries of GaAs radars and GaN radars are expected in early 2017 and 2018, respectively.

Other Program Issues

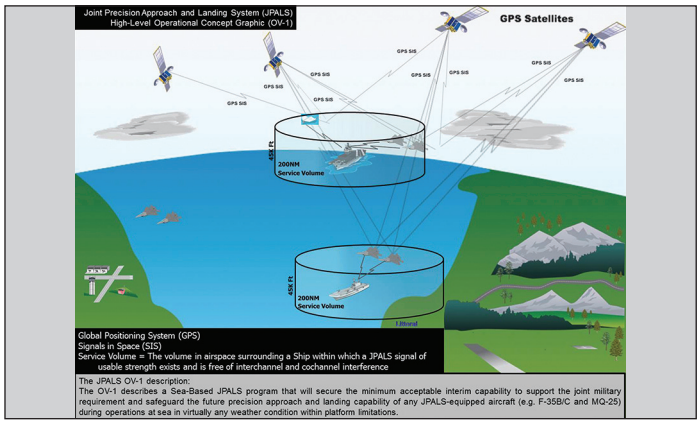
The G/ATOR program revised its test strategy to address reliability concerns raised by the expert panel, to include a test strategy for GaN, and clarify the operational reliability requirements. Originally, the program planned to conduct initial operational testing with the older GaAs configuration, but DOD's DOT&E raised concerns about the production representativeness of this configuration, as a majority of the planned G/ATOR procurements are with the newer GaN modules. Program officials said testing using GaN will occur in 2018. In March 2016, DOT&E approved a revised TEMP capturing the clarified reliability requirements and use of GaN technology.

Program Office Comments

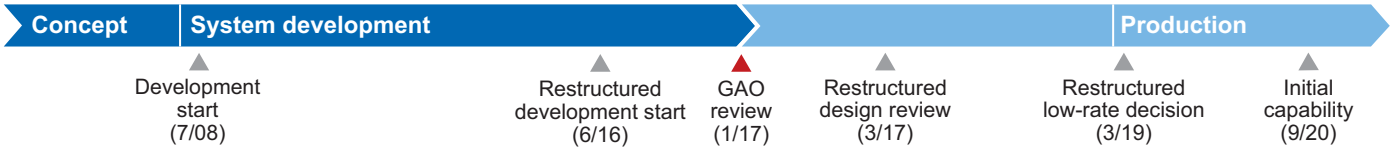
In commenting on a draft of this assessment, the program office provided the following information. G/ATOR has remained on schedule and decreased the estimated total program cost by 10 percent since the program was rebaselined in 2010. The program expects on-time delivery of the first system in February 2017, demonstrating the program remains on schedule and production processes are in control. G/ATOR has successfully demonstrated all Block 1 key performance requirements and the capability to meet all Block 2 performance requirements. There are 15 LRIP systems under contract; 6 systems will be delivered in 2017 to support developmental testing and operational assessments of Blocks 1 and 2, culminating with initial operational capability in 2018. Three systems will be delivered in 2018 to support initial operational test and evaluation and the full rate production decision in 2019. G/ATOR's operational availability has exceeded objective requirements and early software quality challenges are being addressed. Program officials stated they are positioned to deliver the required capabilities to the warfighter per their commitments.

Joint Precision Approach and Landing System (JPALS)

JPALS is a program to develop a GPS-based landing system for aircraft carriers and amphibious assault ships to support operations with the F-35 Lightning II and the MQ-25 Unmanned Aircraft System. The program intends to provide a reliable sea-based precision approach and landing capability in adverse weather conditions. The program has restructured from multiple increments to one, and incorporates capabilities into its base design originally planned for additional increments.



Source: U. S. Navy.



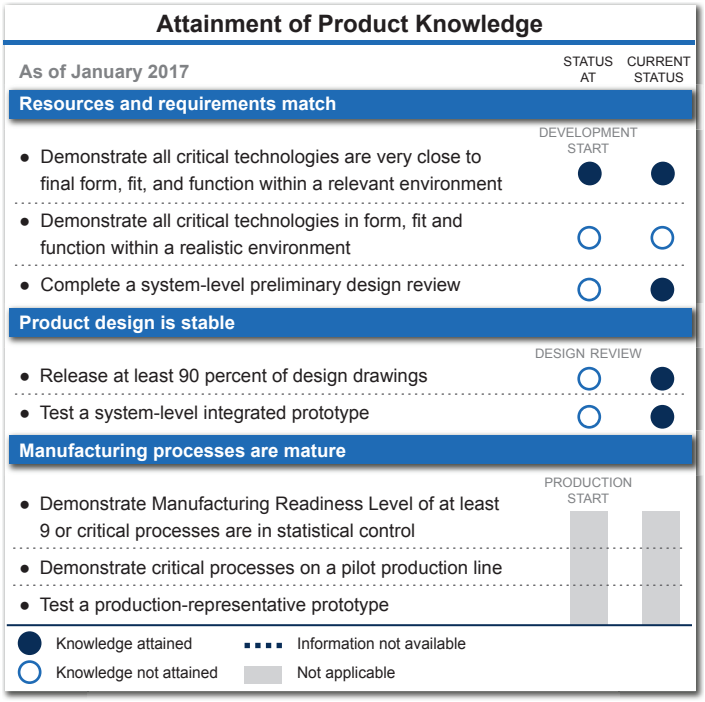
Program Essentials

Prime contractor: Raytheon
Program office: Lexington Park, MD
Funding needed to complete:
- R&D: $437.4 million
- Procurement: $402.9 million
- Total funding: $840.2 million
- Procurement quantity: 23

Program Performance (fiscal year 2017 dollars in millions)

	As of 07/2008	Latest 10/2016	Percent change
Research and development cost	$859.2	$1,449.8	68.7%
Procurement cost	$231.3	$402.9	74.2%
Total program cost	$1,098.0	$1,860.2	69.4%
Program unit cost	$29.677	$56.370	89.9%
Total quantities	37	33	-10.8%
Acquisition cycle time (months)	75	194	158.7%

JPALS originally began development in July 2008, but the Navy restructured the program in 2014 due to affordability concerns, as well as other military services and civilian plans to continue using their current landing systems. The Navy assessed the restructured program through a new system-level preliminary design review in March 2016 and approved a development restart in June 2016. The program previously accepted delivery of eight prototypes, and plans to procure two additional ones. These prototypes are expected to support JPALS developmental testing and F-35 Lightning II initial capability. Program officials reported conducting shipboard developmental testing in 2016, and the program plans to hold a critical design review in March 2017. The JPALS program has also contracted for a trade study to assess options for integrating future capability updates.



JPALS Program

Technology, Design, and Production Maturity

JPALS entered system development in July 2008 with technologies that were nearing maturity. The program also held a critical design review in December 2010, which evaluated a design that later proved unstable. In June 2014, the Navy restructured the JPALS program due to funding concerns and to accelerate the development of aircraft auto-land capabilities. The Navy also attributed the restructuring to a review it conducted of its precision approach and landing capabilities, as well as the other military services and civilian plans to continue use of their current landing systems rather than investing in the new JPALS capability.

Following the program restructuring, the Navy began reassessing JPALS's technology maturity and design stability to account for the changes. The program reported conducting a system requirements review in March 2015 and a system-level preliminary design review (PDR) in March 2016. Subsequently, the Under Secretary of Defense for Acquisition, Technology and Logistics delegated milestone decision authority to the Navy. In June 2016, the Navy approved the start of engineering and manufacturing development for the restructured JPALS program. At that time, the Navy also approved the program's new procurement cost and quantity estimates. Because JPALS functionality is primarily software-based, the restructured program will require new software development. The PDR set a new technology baseline for software development and did not identify any critical manufacturing processes. The program's next technical review will be the critical design review planned for March 2017. At that review, the program will update the total number of expected design drawings, as well as reevaluate the need for any critical manufacturing processes. Program officials reported completing shipboard developmental testing aboard a Nimitz-class aircraft carrier in August 2016 and beginning testing aboard an America-class amphibious assault ship in October 2016.

Prior to the restructuring, the program had accepted delivery of eight prototypes—also referred to as engineering development models. The program awarded a contract in September 2016 to upgrade these prototypes, as well as to procure two additional prototypes for developmental testing. These prototypes will be production-representative, and the JPALS program plans to use them to provide early operational capability in support of F-35 Lightning II initial capability in fiscal year 2018.

Other Program Issues

Because JPALS is GPS-based, it will need to be compliant with any updates to DOD's GPS systems. The JPALS program contracted for a trade study to determine future GPS integration and implementation options, as well as potential costs and schedule issues. The program estimates the trade study will be completed no later than fiscal year 2019.

Program Office Comments

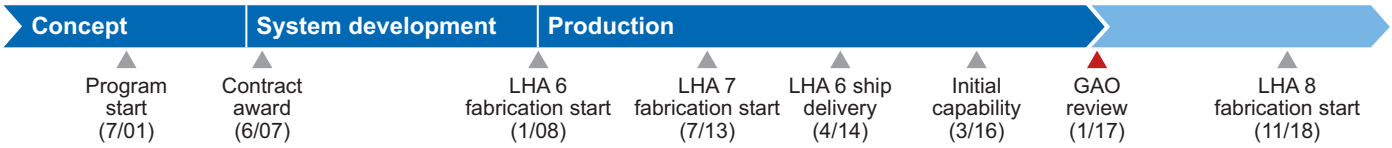
In commenting on a draft of this assessment, the program office noted "fact-of-life" changes in 2013 demanded the Navy's Precision Approach and Landing Capabilities Roadmap be revisited. By June 2013, the Navy validated the need for only the ship-based JPALS requirements. The associated reduction of JPALS quantities precipitated unit cost growth in excess of statutory critical thresholds. The Navy subsequently accelerated future JPALS capabilities into a single program to meet the sea-based requirement. The program reported completing PDR and development restart in March and June 2016, respectively.

Military GPS user equipment purchased after fiscal year 2017 is required to be M Code capable—a new military GPS signal designed to further improve anti-jamming and secure access to GPS signals for military users. JPALS has contracted for a trade study to identify alternatives for the incorporation of M Code into the JPALS ship systems. The results will be presented no later than fiscal year 2019. The program office also provided technical comments, which we incorporated where appropriate.

LHA 6 America Class Amphibious Assault Ship (LHA 6)

The Navy's LHA 6 class will replace the LHA 1 Tarawa-class amphibious assault ships. The LHA 6 class design is based on the fielded LHD 8 and consists of three ships. The ships feature enhanced aviation capabilities and are designed to support Marine Corps assets in an expeditionary strike group. LHA 6 construction began in December 2008 with delivery in April 2014. LHA 7 construction began in July 2013 with delivery expected in December 2018. The Navy plans to exercise an option for detail design and construction of LHA 8 in summer 2017.

Source: Huntington Ingalls Industries



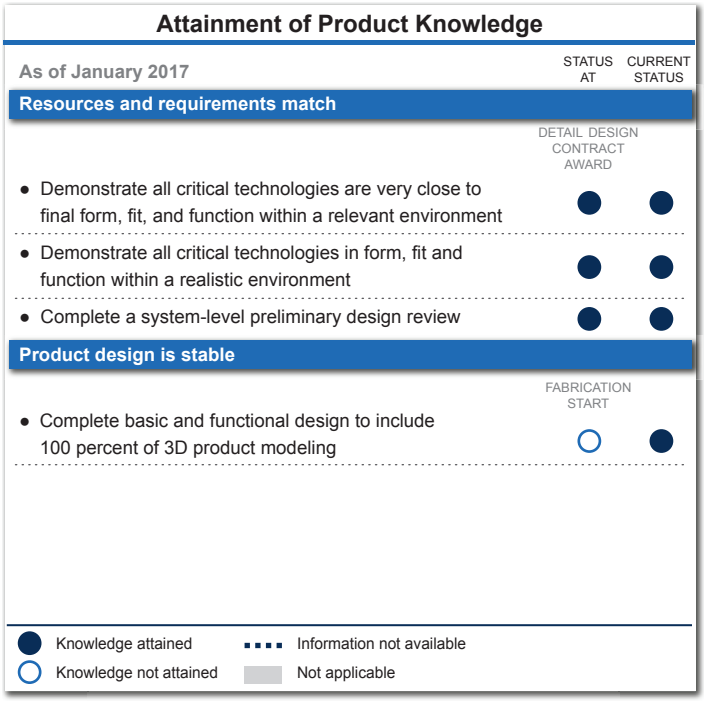
Program Essentials

Prime contractor: Huntington Ingalls Incorporated
Program office: Washington, DC
Funding needed to complete:
- R&D: $38.6 million
- Procurement: $2,755.1 million
- Total funding: $2,794.9 million
- Procurement quantity: 1

Program Performance (fiscal year 2017 dollars in millions)

	As of 01/2006	Latest 09/2016	Percent change
Research and development cost	$239.6	$454.2	89.5%
Procurement cost	$3,209.7	$9,532.5	197.0%
Total program cost	$3,449.3	$9,989.3	189.6%
Program unit cost	$3,449.293	$3,329.777	-3.5%
Total quantities	1	3	200.0%
Acquisition cycle time (months)	146	176	20.5%

LHA 6 lead ship construction began in December 2008 with mature technologies but an incomplete design. The Navy accepted delivery of the ship in April 2014 after a 20-month delay, and the ship has begun post-delivery activities. In March 2016, the program completed post shakedown availability and achieved initial operating capability—7 months ahead of schedule. LHA 7, which largely shares the LHA 6 design, began construction in July 2013 and is expected to deliver in December 2018. Design changes to LHA 8 are more significant and include the addition of a well deck. The program awarded an advanced engineering and procurement of long lead time material contract for LHA 8 in June 2016. This contract includes an option for LHA 8 detail design and construction, which the program intends to exercise in summer 2017.



LHA 6 Program

Technology, Design, and Production Maturity

The program awarded a construction contract for the lead ship, LHA 6, in June 2007 after determining the ship relied on six non-critical subsystems, but no critical technologies, to achieve capabilities. The Navy later restructured the acquisition program for one of these subsystems, the Joint Precision Approach and Landing System, to focus it on aircraft auto-land capabilities. Full integration of this subsystem is not expected until 2020. In the interim, the LHA 6 program will use backup aviation control systems to meet requirements.

LHA 6 is a modification of the LHD 8. When LHA 6 construction began in December 2008, the ship's design was only 77 percent complete. The Navy accepted delivery of LHA 6 in April 2014, 20 months late and more than $500 million over cost. The program declared initial capability in March 2016. Officials expect operational testing of LHA 6 to conclude in June 2017. Following delivery, the program had to execute design changes to accommodate the F-35 at a cost of nearly $60 million. According to officials, testing of these modifications to accommodate the F-35 will complete in fiscal year 2019. LHA 6 is scheduled to conduct its first deployment in mid-2017.

Construction of the first follow-on ship, LHA 7, began in July 2013. The LHA 7 design incorporates modifications to the LHA 6 design, and, as of September 2016, approximately 58 percent of the ship was built. The program plans to launch, or transfer to water, LHA 7 in mid-2017. The program anticipates a delay in the ship's delivery of approximately 6 months to December 2018 in order to execute design changes required for operations with the F-35. Program officials said the shipbuilder improved its performance on LHA 7 by implementing lessons learned and re-hiring staff from the lead ship construction. In addition, the Navy provided new incentives to the shipbuilder to promote a higher quality of work, and program officials noted improvements since these were implemented. However, the shipbuilder is not currently performing efficiently enough to construct the ship within planned costs.

The Navy held a limited competition between two shipbuilders and, in June 2016, awarded a contract to the current builder, Huntington Ingalls, to begin planning LHA 8 detail design and construction. Design changes on LHA 8 will be more significant than those on LHA 7, as the Navy is incorporating a well deck to accommodate two landing craft. To integrate a well deck, program officials estimate approximately 35 percent of LHA 8's design will change. Program officials told us they expect detail design plans to include three-dimensional models, unlike the two-dimensional drawings used for the detail design of LHA 6 and LHA 7.

Other Program Issues

In January 2015, DOD's Director, Operational Testing and Evaluation (DOT&E) expressed concern that LHA 6's self-defense system is incapable of defending against certain anti-ship cruise missile threats. In January 2016, DOT&E acknowledged actions taken by the program office to improve performance, but stated the LHA's 6's self-defense system is unlikely to meet all requirements. DOT&E also expressed concerns regarding the performance of LHA 6's missile launch system. In response, the Navy is investigating options to modify or replace the system, but in the interim has modified launch procedures and increased the supply of replacement parts.

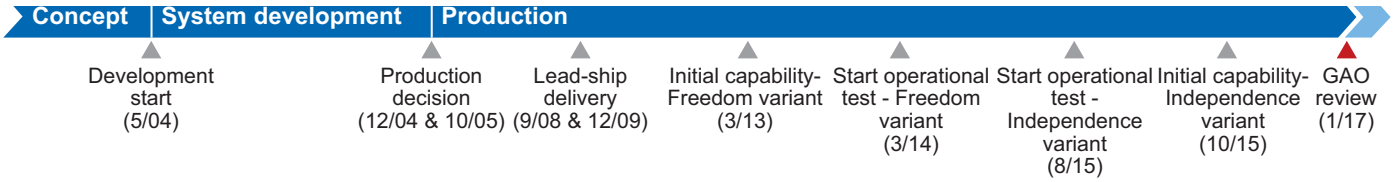
Program Office Comments

In commenting on a draft of this assessment, the Navy reported LHA 6 completed its post shakedown availability in March 2016. LHA 6's initial capability was declared less than one week later. Program officials reported the ship is currently conducting fleet exercises and other required certifications, and they expect to complete LHA 6 Initial Operational Test and Evaluation in summer 2017, prior to initial deployment. Program officials reported LHA 7 construction is not experiencing labor resource issues as seen in the past and continues to address labor efficiency concerns to control cost. Program officials reported LHA 7 is on schedule to meet its contract delivery date of December 4, 2018. LHA 8's planning, advanced engineering, and procurement of long lead time material began in June 2016 with contract award to Huntington Ingalls. Program officials expect to exercise the LHA 8 detail design and construction contract option in summer 2017.

Littoral Combat Ship (LCS)

The Navy's Littoral Combat Ship (LCS) is designed to perform mine countermeasures, antisubmarine warfare, and surface warfare missions. It consists of the ship itself, or seaframe, and the mission package it deploys. The Navy is buying two designs—the Freedom variant, a steel monohull (LCS 1 and odd numbered ships built by Lockheed Martin), and the Independence variant, an aluminum trimaran (LCS 2 and even numbered ships built by Austal)—and has awarded contracts for 26 seaframes with plans for 2 more in fiscal year 2017. We assessed both designs.

Sources: Lockheed Martin (left); General Dynamics (right).



Program Essentials

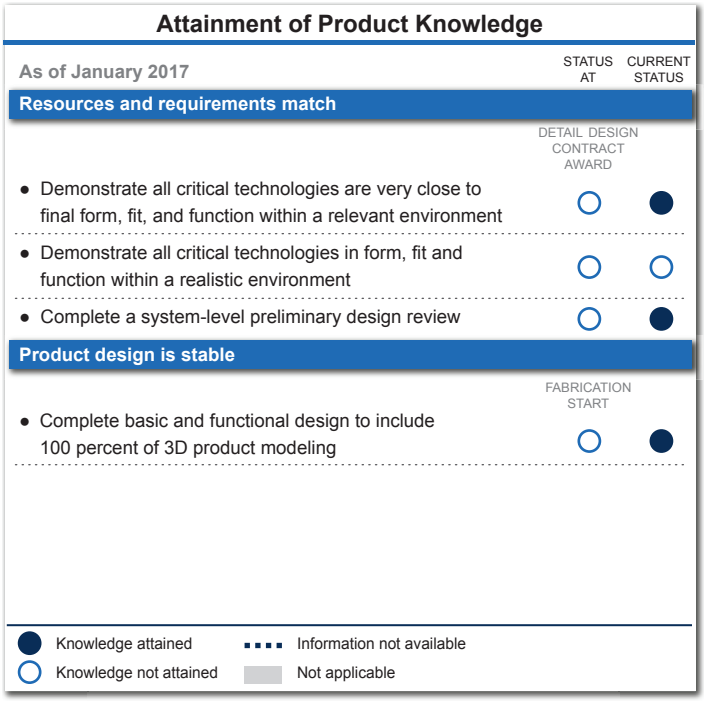
Prime contractors: Austal USA, Lockheed Martin
Program office: Washington Navy Yard, DC
Funding needed to complete:
- R&D: $678.9 million
- Procurement: $10,291.8 million
- Total funding: $11,082.1 million
- Procurement quantity: 14

Program Performance (fiscal year 2017 dollars in millions)

	As of 05/2004	Latest 10/2016	Percent change
Research and development cost	$962.0	$3,971.6	312.8%
Procurement cost	$511.6	$22,429.2	4,284.5%
Total program cost	$1,473.7	$26,650.5	1,078.4%
Program unit cost	$368.423	$666.262	80.8%
Total quantities	4	40	900%
Acquisition cycle time (months)	41	119	190.2%

Cost data are for the seaframe program only, which includes the cost of 29 LCS and 11 modified LCS/frigates in the current program baseline. Research and development funding includes detail design and construction of two ships.

The LCS seaframe program, now more than 12 years into production, has yet to demonstrate the maturity of two critical technologies—the aluminum hull structure and launch, handling, and recovery system of the Independence variant. The Navy undertook shock trials on both variants as well as a survivability trial on LCS 4. Both sets of tests revealed design deficiencies. Since December 2015, five LCS seaframes experienced engineering casualties that limited their availability. The Navy announced significant changes to LCS crewing and support concepts in response. Both shipbuilders continue to deliver LCS seaframes significantly behind schedule and in excess of cost targets.



LCS Program

Technology Maturity

Sixteen of the 18 critical technologies—the total number of technologies for both designs—are mature. However, efforts continue to further mature two Independence variant technologies—the aluminum hull structure and the launch, handling, and recovery system. The Navy reported that it expects the results of now completed survivability testing of the aluminum structure by early 2017. Regarding the launch, handling, and recovery system, the program demonstrated unmanned operations during LCS 8's acceptance trial, but has yet to receive Navy certification to conduct manned operations as intended.

Design and Production Maturity

The LCS 4 survivability trial in January 2016 revealed weaknesses in the Independence variant design, according to the Director, Operational Test and Evaluation (DOT&E). In July 2016, LCS 6 completed shock trials in accordance with the DOT&E approved plan. This trial was conducted at a reduced severity due to serious concerns about the potential for damage to the ship. LCS 5 did not complete the entire shock trial because the Navy stopped testing in September 2016 due to concerns with the shock environment, personnel, and equipment. The Navy and DOT&E disagree on the need to complete this trial. The program now expects results of rough water trials—testing that occurred and resulted in damage on both designs several years ago—by June 2017.

Since December 2015, five of the eight delivered LCS—ships of both variants—have suffered engineering casualties, which the Navy attributes to shortfalls in crew training, seaframe design, and construction quality. According to the Navy, these failures have resulted in substantial downtime and costs for repairs or replacements. We have found the Navy is responsible for paying for the vast majority of these types of damage, deficiencies, and defects on ships already delivered. While addressing deficiencies in the designs of each variant to increase the operational availability of the ships in-service, the Navy is also working to incorporate changes on follow-on ships. The Navy plans to make improvements to LCS either during construction or sometime after delivery, if funding is available.

To date, nine LCS have been delivered and 13 are in various phases of construction. In 2015, the Navy provided the LCS shipbuilders schedule relief; however, even with modified ship delivery dates, both shipbuilders continue to deliver LCS seaframes significantly behind the adjusted schedule. Program officials recently reported the shipyards would not deliver four LCS in fiscal year 2016 as planned. In addition to lagging schedule performance, the shipyards continue to deliver seaframes in excess of cost targets.

Other Program Issues

Following a pattern of LCS engineering casualties, in February 2016, the Navy initiated a program review to assess, among other things, LCS crewing, training, and maintenance. Recommended actions included, returning to a "Blue/Gold" crew rotation model; merging the seaframe and mission package crew into a single, approximately 70-person crew focused on a single mission area; and designating LCS 1-4 as test ships to support testing between fiscal years 2017 and 2022. In merging the seaframe and mission package crew, the Navy acknowledged that switching the LCS mission package—once a key building block of the LCS concept—will occur less often than originally conceived.

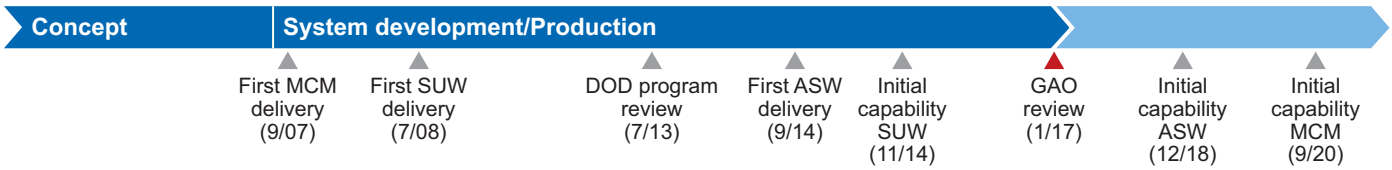
Program Office Comments

In addition to providing technical comments, the program office noted as of January 2017, there are nine LCS in the Fleet, with another 17 on contract. By 2018, LCS will be the second largest surface ship class in the Navy. Program officials reported the LCS design is stable, meets all validated and approved requirements, and is in full serial production at both shipyards. Program officials also reported the LCS program is on budget and below the congressional cost cap and hull over hull performance continues to improve, stabilizing the production cycle. Program officials stated LCS 5 and 6 successfully met all test objectives of the approved shock trial test plan, demonstrating the ability of both variants to survive the effects of underwater shock associated with the close-proximity detonation of a 10,000 pound charge. The program office stated they have completed required testing and are incorporating lessons learned into future LCS and frigates.

Littoral Combat Ship-Mission Modules (LCS Packages)

The Littoral Combat Ship (LCS) will provide mine countermeasures (MCM), surface warfare (SUW), and antisubmarine warfare (ASW) capability using mission packages. Packages include weapons and sensors launched and recovered from LCS seaframes. The Navy plans to deliver these capabilities incrementally and has set interim requirements that are below the baseline requirements for some increments. We assessed mission packages' progress against the threshold requirements that define the baseline capabilities currently expected for each package.

Source: U. S. Navy.



Program Essentials

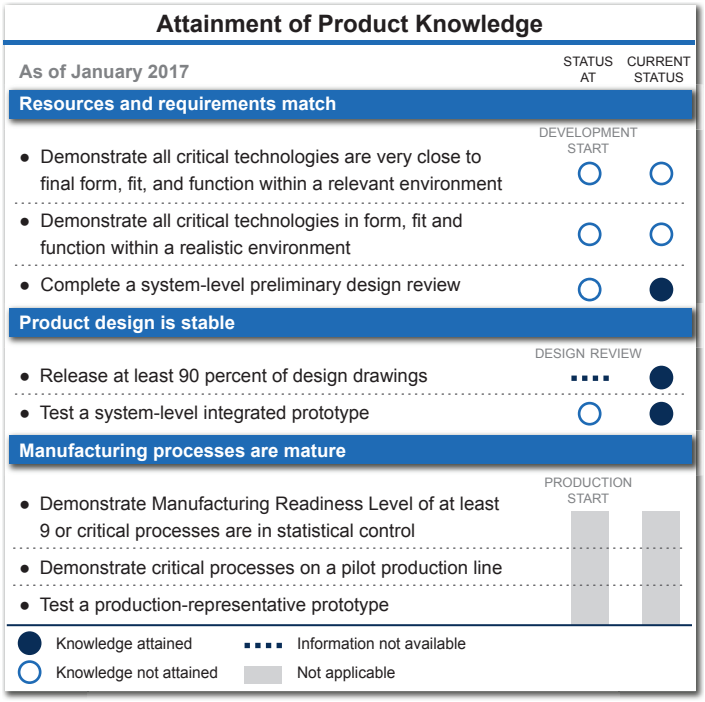
Prime contractor: Northrop Grumman Systems
Program office: Washington Navy Yard, DC
Funding needed to complete:
- R&D: $518.3 million
- Procurement: $3,657.4 million
- Total funding: $4,192.9 million
- Procurement quantity: 43

Program Performance (fiscal year 2017 dollars in millions)

	As of 08/2007	Latest 09/2016	Percent change
Research and development cost	NA	$2,611.6	NA
Procurement cost	$3,535.4	$4,456.3	26.0%
Total program cost	NA	$7,100.7	NA
Program unit cost	NA	$110.949	NA
Total quantities	64	64	0.0%
Acquisition cycle time (months)	NA	NA	NA

The current estimate does not include $3.6 billion of procurement funding for life cycle replacement and modernization of mission systems.

The Navy has accepted delivery of 15 mission packages without demonstrating whether any meet full threshold capability requirements for seaframes. These deliveries followed Navy decisions to design and produce mission package systems prior to maturing critical technologies. The Navy has recently revised its approach to develop the MCM package following the discovery of significant reliability issues during a series of development tests in fall 2015. The Navy intends to test the revised MCM package against threshold requirements by late fiscal year 2020. A portion of the SUW package has met its interim requirements on one of the seaframe variants. To meet threshold requirements, the Navy is currently modifying an Army missile it plans to test in fiscal 2018. ASW package initial capability has been delayed due to weight and contracting issues and is now scheduled for fiscal year 2019.



LCS Packages Program

Mine Countermeasures (MCM)

The Navy designed and produced MCM mission package systems prior to maturing critical technologies. The Navy accepted seven MCM packages without demonstrating they meet threshold performance requirements and, is now replacing a key system—the remote multi-mission vehicle (RMMV). There are six MCM systems (Near Surface Detection, Airborne Mine Neutralization, Remote Minehunting, Coastal Mine Reconnaissance, Buried Minehunting, and Unmanned Mine Sweeping) the Navy plans to assemble and fully test in fiscal year 2020. After the Navy suspended developmental testing in October 2015 following the discovery of significant reliability issues, it studied the package and revised its approach. The Navy is now replacing the RMMV, which towed the AQS-20A sonar, with an unmanned boat. The new boat rides on the surface of the water as opposed to the semi-submersible RMMV. Program officials state the boat will be easier to launch and recover but could be susceptible to wave-movement, which may make it more difficult to find mines. The Near Surface Detection Module and Airborne Mine Neutralization Modules achieved initial capability in 2016. The remaining systems are still in development and are planned to be tested over the next several years.

Surface Warfare (SUW)

The Navy designed and produced SUW mission package systems prior to demonstrating the maturity of key systems leading to changes and delays to the SUW package. The Navy has accepted eight SUW packages with no deliveries planned for fiscal year 2017. One package currently consists of two 30 millimeter guns, an armed helicopter, and two rigid hull inflatable boats. In August 2014, the Navy found that the current package met interim performance requirements on the Freedom variant and, in 2015, the Navy tested this part of the package on the Independence variant. To meet threshold requirements a surface-to-surface missile is required. According to program officials, initial missile demonstrations were successful, but operational testing was delayed by about a year to fiscal year 2018 due to ship integration issues.

Antisubmarine Warfare (ASW)

The Navy reconfigured the ASW package after determining planned systems would not provide adequate capability. According to the Navy, the ASW systems are mature as they have been fielded by U.S. Navy and foreign navies. Navy program officials stated that the package's weight issues have been resolved, and the Navy has purchased an initial ASW package to be used for testing. The Navy is now planning to meet the threshold requirement for ASW in fiscal year 2019, a 2-year delay from last year's estimate.

Other Program Issues

The Navy will not achieve the capability to meet threshold requirements for all three of the mission packages until late fiscal year 2020, by which time it plans to have taken delivery of 24 ships. Starting in 2018, the Navy plans to modify LCS as a frigate and permanently install most of the ASW and SUW mission packages. These changes have, to date, not deterred the Navy from its plans to purchase 64 mission packages.

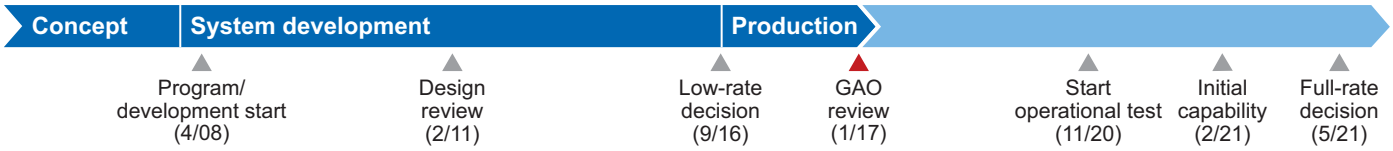
Program Office Comments

In commenting on a draft of this assessment, the Navy reported it is delivering operationally effective mission package capability to the fleet as it mature increments. The Navy stated it is purchasing the quantity of mission systems and packages needed for system integration, crew training, developmental and operational testing, and LCS deployments. The Navy reports it is purchasing the systems in accordance with relevant laws and DOD regulations. The SUW package achieved initial capability in fiscal 2015 and will meet requirements with the surface to surface missile module in fiscal 2018. ASW capability is planned to have an initial capability and meet requirements in fiscal 2019. The MCM package is delivering systems as they mature. Due to reliability of the RMMV, the Navy reports it is restructuring the MCM package to perform the minehunting mission with a different vehicle. The MCM package is planned to achieve an initial capability in fiscal year 2020. The Navy reported it intends to adjust the program's package quantities in 2017 to support changes to the LCS and frigate programs.

MQ-4C Triton Unmanned Aircraft System (MQ-4C Triton)

The Navy's MQ-4C Triton is intended to provide persistent maritime intelligence, surveillance, and reconnaissance (ISR) data collection and dissemination capability. Triton is planned to be an unmanned aircraft system operated from five land-based sites worldwide as part of a family of maritime patrol and reconnaissance systems. Based on the Air Force's RQ-4B Global Hawk air vehicle, Triton is part of the Navy's plan to recapitalize its airborne ISR assets by the end of the decade.

Source: Northrop Grumman.



Program Essentials

Prime contractor: Northrop Grumman Systems Corporation
Program office: Patuxent River, MD
Funding needed to complete:
- R&D: $120.3 million
- Procurement: $7,951.8 million
- Total funding: $8,165.8 million
- Procurement quantity: 63

Program Performance (fiscal year 2017 dollars in millions)

	As of 02/2009	Latest 09/2016	Percent change
Research and development cost	$3,407.8	$4,084.4	19.9%
Procurement cost	$10,113.1	$8,733.4	-13.6%
Total program cost	$13,935.8	$13,123.1	-5.8%
Program unit cost	$199.083	$187.473	-5.8%
Total quantities	70	70	0.0%
Acquisition cycle time (months)	92	154	67.4%

R&D costs of $681.2 million and procurement costs of $674 million associated with phased modifications to update sensor and system performance are not included in the cost data.

The MQ-4C Triton program entered low-rate production in September 2016 with a mature critical technology and a stable design, but prior to demonstrating full control of critical manufacturing processes. Developmental challenges caused the Navy to delay production start by over 3 years, and full-rate production has been delayed from September 2018 to May 2021. The program is developing new capabilities for Triton, including enhanced intelligence sensors and an aircraft avoidance capability. The program plans to integrate these into production aircraft beginning in fiscal years 2020 and 2024, respectively. Testing delays contributed to program decisions to concurrently develop software packages needed for Triton's baseline configuration and future upgrades. The baseline and enhanced intelligence capabilities are now scheduled to be demonstrated prior to full-rate production.

Attainment of Product Knowledge

As of January 2017	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	○	○

● Knowledge attained ▪▪▪▪ Information not available
○ Knowledge not attained Not applicable

MQ-4C Triton Program

Technology, Design, and Production Maturity

The Triton program entered low-rate production in September 2016. At production start, the program's only critical technology for its baseline configuration—the hydrocarbon sensor—was mature, and the Triton system design was stable. According to best practices criteria, technology maturity and design stability should occur prior to development start and critical design review, respectively, neither of which the Triton program achieved.

Further, Triton production began before the contractor brought its manufacturing processes for wing production under control, which was inconsistent with best practices. The Defense Contract Management Agency previously identified quality issues with the wing supplier and defects such as improperly drilled holes and gaps in the adhesive that bonds the wing skin to the wing frame. Triton wing quality problems continue to delay wing delivery for some test aircraft being built and further delays could impact testing schedules. According to the program, the subcontractor increased its work force and replaced leadership to expedite wing delivery and improve its manufacturing processes.

Triton developmental challenges caused the Navy to delay production start by over 3 years. In order to accommodate cost and schedule growth, the Navy delayed the start of full-rate production—from September 2018 to May 2021. As part of the new schedule, the program plans to increase the quantity of aircraft acquired during low-rate production from 10 to 15, increasing the risk that more vehicles may require design changes prior to demonstrating Triton capabilities.

The program is also developing new Triton capabilities it will implement in two future upgrade packages. The first upgrade will include enhanced intelligence capabilities, which the program plans to integrate into production in 2020, including retrofits to the first six production aircraft. The second upgrade will include electronic defense upgrades and an aircraft avoidance radar system. This upgrade package is scheduled to be integrated into the production line for the 19th production aircraft scheduled to be delivered in fiscal year 2024. The Navy originally planned to include the aircraft avoidance radar in the baseline configuration, but deferred this due to technical challenges.

The Triton program previously planned to complete the software to support the baseline configuration before initiating software development for the planned upgrades. However, under the new schedule the program will begin the enhanced intelligence software upgrade before completing the baseline software, thus increasing concurrency risk. The program now intends to demonstrate the software for the baseline configuration, along with the enhanced intelligence capabilities, by the May 2021 full-rate production date.

Other Program Issues

The Navy plans to deploy aircraft in 2018 that provides intelligence surveillance and reconnaissance capability, but some capabilities such as high resolution radar and fire detection have been deferred to future software builds to address cost and schedule growth. The Navy will field them as an early operational capability and plans to support the deployment with operational testing beginning in 2017.

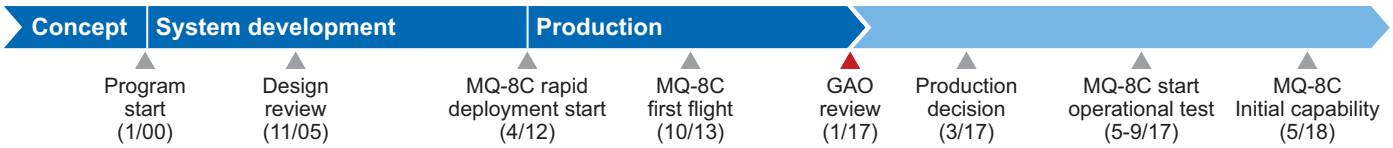
Program Office Comments

According to program officials, the MQ-4C Triton unmanned aircraft system program continues to demonstrate success during development and early operational flight and ground test. Officials noted modifications to install the baseline early operational capability software build into all test assets are ongoing in support of flight testing to commence in the second quarter of fiscal year 2017. Officials further noted MQ-4C Triton low-rate initial production has commenced and the program is planning to receive two additional test aircraft in the fourth quarter of fiscal year 2017 to subsequently support an operational test period.

MQ-8 Fire Scout

The Navy's MQ-8 unmanned aerial vehicle is intended to provide real-time imagery and data in support of intelligence, surveillance, and reconnaissance missions. The MQ-8 system is comprised of one or more air vehicles with sensors, a control station, and ship equipment to aid in vertical launch and recovery. The air vehicle operates from ships and the ground. The MQ-8 is intended for use in various operations, including surface, anti-submarine, and mine warfare, and it includes B and C variants. We assessed the latest variant, the MQ-8C.

Source: Northrop Grumman Systems Corporation.



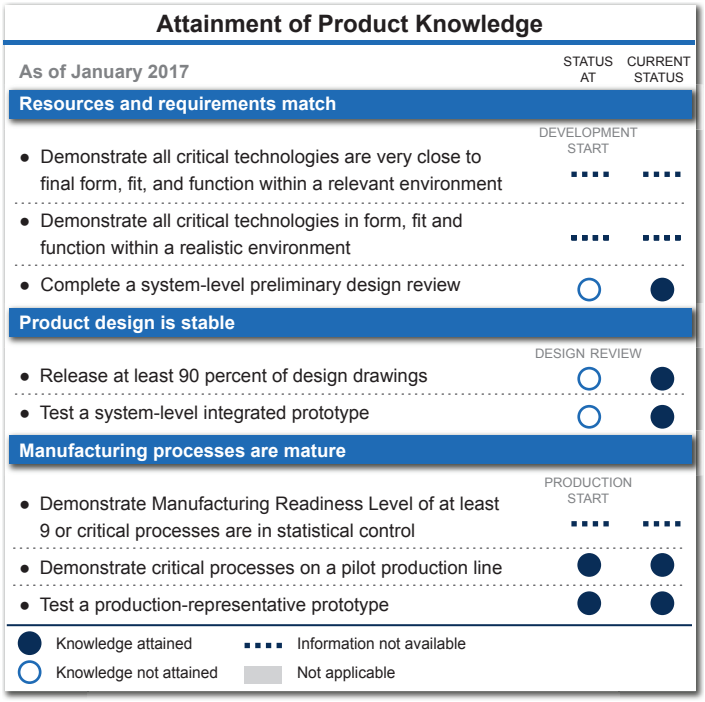
Program Essentials

Prime contractor: Northrop Grumman
Program office: Patuxent River, MD
Funding needed to complete:
- R&D: $77.4 million
- Procurement: $562.0 million
- Total funding: $639.4 million
- Procurement quantity: 11

Program Performance (fiscal year 2017 dollars in millions)

	As of 12/2006	Latest 09/2016	Percent change
Research and development cost	$648.6	$1,246.3	92.1%
Procurement cost	$1,825.0	$1,689.0	-7.4%
Total program cost	$2,836.8	$2,935.4	3.5%
Program unit cost	$16.027	$41.934	161.6%
Total quantities	177	70	-60.5%
Acquisition cycle time (months)	104	170	63.5%

The MQ-8C program has mature technologies and a stable design. The MQ-8C is a larger airframe but shares technology previously developed for the MQ-8B. The MQ-8C bypassed many standard acquisition practices, accepting risk for a quicker cycle time, because it was procured under the rapid deployment capability process. According to program officials, the program plans to start operational testing in spring and summer 2017 and demonstrate initial operational capability for the MQ-8C in May 2018. We could not assess production process maturity because the program does not collect statistical process control data or manufacturing readiness levels. The Navy restructured the program in 2015 after reporting to Congress the program had incurred unit cost growth in excess of statutory critical thresholds.



MQ-8 Fire Scout Program

Technology and Design Maturity

The MQ-8C relies on mature technologies common to the MQ-8B and has a stable design. According to the program office, the MQ-8C has 90 percent commonality with the previously developed MQ-8B. The primary differences between the two are structural modifications to accommodate the MQ-8C's larger airframe and fuel system. The MQ-8C was initiated under the Navy's rapid deployment capability acquisition process, which program officials stated enabled the program to bypass many standard acquisition practices designed to reduce risk in favor of a speedier acquisition cycle time. The Navy completed its first MQ-8C flight in October 2013. The program will continue with developmental testing and transition to operational testing in the spring and summer 2017. Despite being a separate increment of capability, the MQ-8C did not have a separate development start decision review which, according to program officials, was not required.

Production Maturity

The program awarded a contract for development and production of the MQ-8C in April 2012 after production of the MQ-8B variant stopped following delivery of 30 aircraft. As of September 2016, the program has taken delivery of 19 MQ-8C aircraft, which program officials consider low-rate initial production units. An additional 11 MQ-8C aircraft are under contract, including one fiscal year 2017 aircraft. According to program officials, the program plans to make a full-rate production decision, previously scheduled for May 2016, in the second quarter of fiscal year 2017. In addition, the program reports it plans to start operational testing in September 2017 and demonstrate initial operational capability in May 2018.

We could not assess whether critical manufacturing processes were in control as the program does not collect data on statistical manufacturing process controls or assess process capabilities using manufacturing readiness levels. Rather, the program office collects metrics on the status of production from the prime contractor, such as discovery of manufacturing defects. Program officials noted the MQ-8C has a commercial airframe procured by the government and provided directly to the prime contractor as government-furnished equipment for conversion to an MQ-8C. The prime contractor is responsible for integration of the avionics and working with the aircraft manufacturer to modify the commercial airframe with increased capacity fuel tanks.

Other Program Issues

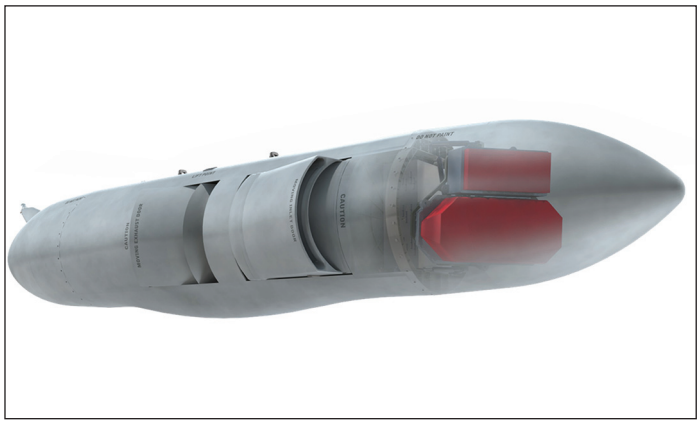
In June 2014, the program was certified as essential to national security and allowed to progress after reporting to Congress it had incurred unit cost growth in excess of statutory critical thresholds. Program officials told us the Navy restructured the program in 2014, with revised quantities of both variants, because the MQ-8C had more endurance than the MQ-8B, which reduced the total quantity of MQ-8 units required to support the Littoral Combat Ship. Following this determination, program officials said they stopped production of the MQ-8B and moved forward with only producing the MQ-C.

Program Office Comments

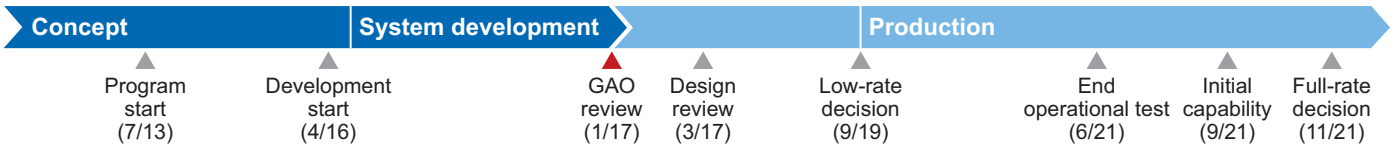
In commenting on a draft of this assessment, the program office noted the MQ-8C program is executing with no significant issues. The program further noted it awaits availability of the Littoral Combat Ship to complete MQ-8C testing, including planned start of operational testing in spring and summer 2017. The program office stated the MQ-8B continues deployments aboard the Littoral Combat Ship, including the first deployment with an upgraded radar. In addition, the program office provided technical comments, which were incorporated where deemed appropriate.

Next Generation Jammer Increment 1

The Navy's Next Generation Jammer (NGJ) is being developed as an external jamming pod system fitted on EA-18G Growler aircraft. It is expected to replace the ALQ-99 tactical jamming system and provide enhanced airborne electronic attack capabilities to disrupt adversaries' use of the electromagnetic spectrum. The Navy plans to field capabilities in three increments for different radio frequency ranges, beginning with Increment 1 (mid-band) in 2021, with Increments 2 and 3 (low- and high-band) to follow. We assessed Increments 1 and 2.



Source: Raytheon Corp.



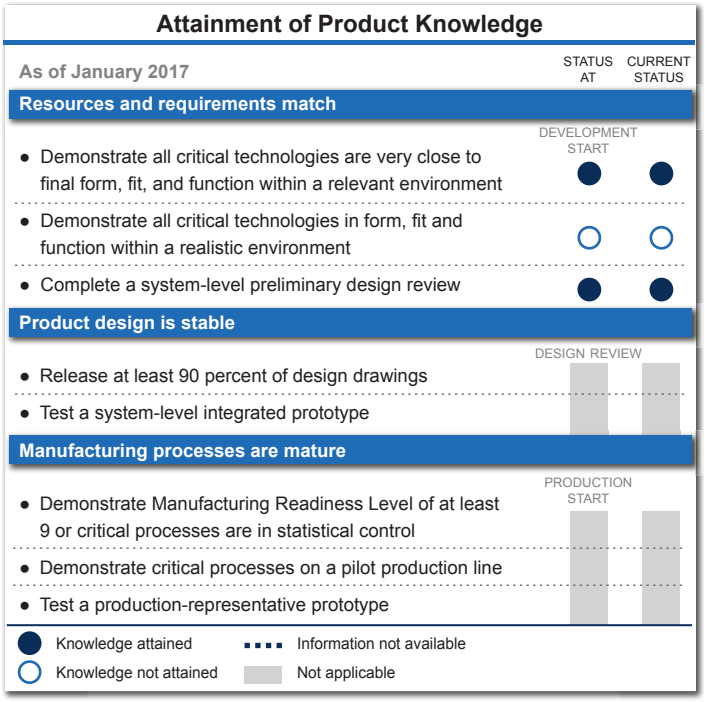
Program Essentials

Prime contractor: Raytheon
Program office: Patuxent River, MD
Funding needed to complete:
- R&D: $2,207.2 million
- Procurement: $4,074.7 million
- Total funding: $6,289.0 million
- Procurement quantity: 131

Program Performance (fiscal year 2017 dollars in millions)

	As of	Latest 09/2016	Percent change
Research and development cost	NA	$3,516.3	NA
Procurement cost	NA	$4,074.7	NA
Total program cost	NA	$7,598.2	NA
Program unit cost	NA	$56.283	NA
Total quantities	NA	135	NA
Acquisition cycle time (months)	NA	98	NA

NGJ Increment 1 entered development in April 2016 with its critical technologies nearing maturity. Consistent with best practices and statutory requirements, the program completed a preliminary design review prior to starting development. Program officials state NGJ is on track to hold its critical design review (CDR) in early 2017. As of November 2016, the contractor had released almost 76 percent of its design drawings. The Naval Air Systems Command benchmark for released drawings at critical design review is 80 percent, which is short of the 90 percent threshold under GAO identified best practices. The program's main risks include meeting weight and power requirements and integrating the jamming pods with the aircraft. NGJ is participating in a pilot program that allows it to streamline and tailor some acquisition processes.



NGJ Increment 1 Program

Technology Maturity

The NGJ program entered system development in April 2016, with its seven critical technologies approaching maturity. In November 2015, the program conducted an assessment of these technologies, which includes two separate arrays—each with different transmit/receive modules, circulators, and apertures—as well as a power generation system. All technologies were assessed as nearing maturity based on subsystem prototype testing conducted prior to starting development.

Design and Production Maturity

Program officials stated NGJ is on track to hold its CDR in March 2017, but the program is not following GAO identified best practices for this milestone. As of November 2016, the contractor had released about 76 percent of design drawings. This positions the program to meet the Naval Air Systems Command benchmark of releasing 80 percent of its design drawings by CDR. However, GAO identified best practices call for releasing 90 percent of drawings by CDR. The program also does not plan to test an early system prototype of the jamming pod before its CDR. GAO identified best practices recommend such testing prior to this key review to help determine whether the design will work as intended. The first test of a fully functional jamming pod is planned for May 2019, 4 months before the program's planned start of production.

However, program officials stated that the significant prototyping and associated testing conducted to date address NGJ's principal risks, which include weight, integration complexity, and transmit power. The program recently addressed the severity of its power risk by taking several mitigation actions. In addition, the program is managing software risk through modeling and simulation. The program is consulting with systems engineering experts from the Office of the Secretary of Defense for input regarding NGJ software metrics.

Regarding production maturity, NGJ officials stated they plan to identify critical manufacturing processes and key product characteristics at CDR. NGJ officials also stated they have begun assessing manufacturing readiness levels.

Other Program Issues

In September 2015, the Under Secretary of Defense for Acquisition, Technology and Logistics (USD AT&L) approved NGJ as the first program in the Skunk Works pilot, which aims to eliminate non-value added processes in order to deliver capabilities on time and within budget. NGJ officials stated they had direct access to the USD AT&L and other senior acquisition officials, and some approval authorities were delegated to lower levels. For example, the contract award authority was delegated down to Naval Air Systems Command, which officials said saved 2 to 3 months of time in the contract negotiation process. NGJ officials said the Skunk Works designation was beneficial to the program.

Studies for NGJ Increment 2, a separately-managed program for low-band jamming that had been planned for fiscal years 2014 and 2015, were postponed to fiscal year 2016 for funding reasons. As a result, program officials stated the Navy pushed back Increment 2's planned entry into development from fiscal year 2018 to 2020, although program officials stated this date may change as the studies progress. These design trade studies are intended to evaluate the maturity of technologies and refine requirements.

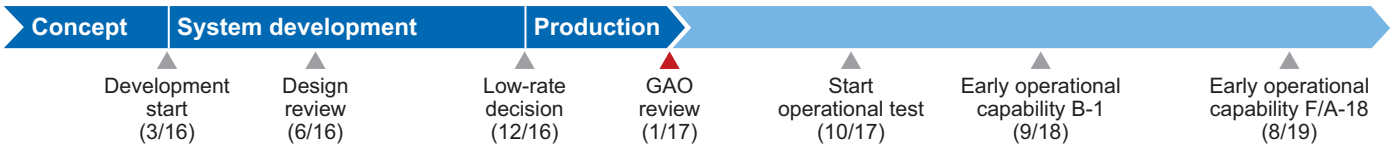
Program Office Comments

In commenting on a draft of this assessment, the NGJ program stated NGJ Increment 1 entered system development in April 2016 after successfully meeting required criteria. NGJ met required technology maturity for seven critical technologies and established a program baseline after completion of preliminary design review in October 2015. As of November 2016, the contractor had released 76 percent of the design drawings and is on track to exceed the Naval Air Systems Command best practice of 80 percent completed by critical design review. The program completed significant prototyping of key systems and subsystems prior to system development, which reduced risk to acceptable levels for system development as determined by the milestone decision authority. According to program officials, NGJ's extensive use of contractor and government systems integration labs, along with the use of test chambers to evaluate pod performance, will significantly reduce risk prior to the program’s planned start of production.

Offensive Anti-Surface Warfare Increment 1 (OASuW Inc 1)

The Offensive Anti-Surface Warfare Increment 1 (OASuW Inc 1) is a Navy-led program to develop an air-launched, long-range, anti-surface warfare missile to address an urgent operational need. The program is using an accelerated acquisition approach and leveraging previous technology demonstration efforts. It plans to field an early operational capability on Air Force B-1 bombers in 2018 and Navy F/A-18 aircraft in 2019. DOD is developing specifications for Increment 2 to address the threat in 2024 and beyond. We assessed Increment 1.

Source: U.S. Navy.



Program Essentials

Prime contractor: Lockheed Martin
Program office: Patuxent River NAS, MD
Funding needed to complete:
- R&D: $494.7 million
- Procurement: $341.0 million
- Total funding: $835.7 million
- Procurement quantity: 110

Program Performance (fiscal year 2017 dollars in millions)

	As of 03/2016	Latest 08/2016	Percent change
Research and development cost	$1,223.8	$1,154.3	-5.7%
Procurement cost	$304.4	$341.0	12.0%
Total program cost	$1,528.3	$1,495.3	-2.2%
Program unit cost	$12.325	$12.256	-0.6%
Total quantities	124	122	-1.6%
Acquisition cycle time (months)	43	42	-2.3%

The OASuW Inc 1 program received approval to enter production in December 2016 with its critical technologies mature, a stable hardware design, and demonstrated production processes. However, technology maturity has not been confirmed through independent assessment, and flight tests will not occur until after production begins. Software development challenges have delayed aspects of subsystem testing but are not assessed as presenting an overall schedule risk. The program's accelerated acquisition approach, designed to address an urgent operational need, includes concurrency between developmental testing and production, which increases the risk of late design changes and costly retrofits after production has started. The program seeks to mitigate risks by leveraging design commonalities with a missile already in production and limiting the number of missiles purchased.

Attainment of Product Knowledge

As of January 2017	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	○	○

● Knowledge attained ▪▪▪▪ Information not available
○ Knowledge not attained ▭ Not applicable

OASuW Inc 1 Program

Technology Maturity

While the most recent independent technology readiness assessment, conducted by the Navy in August 2016, assessed the program's six critical technologies are nearing maturity, in the past year, the OASuW Inc 1 program has fully matured all six of its critical technologies. The program's single, hardware-based critical technology—a radio frequency sensor—as well as five software-based ones—autorouter, low altitude control estimator, target tracker, electro-optical algorithms, and simultaneous time of arrival capbility—were demonstrated in a relevant environment. According to program officials, critical technologies were matured further through a combination of modeling and simulation and flying test bed events that did not involve launching a missile. The program office assessed all critical technologies were mature at its production start in December 2016, although this was not confirmed by an independent assessment or through missile flight tests, which are not planned to begin until the fourth quarter of fiscal year 2017.

Design Maturity

The OASuW Inc 1 hardware design is stable, but the program is addressing software and manufacturing challenges that have delayed testing used to demonstrate the design will work as intended. The program held its critical design review in June 2016, at which time all the drawings expected to support production were releasable to manufacturers. According to program officials, nearly all subsystems have been qualified, which means they have been tested to ensure that they can meet requirements, but software challenges delayed some subsystem testing. With hardware design stable, officials stated remaining software challenges can be addressed later in testing without negatively affecting the schedule. Additionally, program officials noted manufacturing challenges resulted in test unit delivery delays, but these delays are not expected to affect the program's testing schedule.

Production Maturity

In December 2016, a series of production readiness reviews found that critical production processes for OASuW Inc 1 were demonstrated in a production representative environment or on a pilot line. The system leverages the airframe and production facilities of the Joint Air-to-Surface Standoff Missile-Extended Range (JASSM-ER) program, which the program reports will decrease production risks. The program was tracking a risk related to the JASSM-ER fuze, which had not been qualified for use on Navy weapons, but its use has since been certified by the Navy. The first missiles to support an early operational capability are planned for delivery in the second quarter of fiscal year 2018.

Other Program Issues

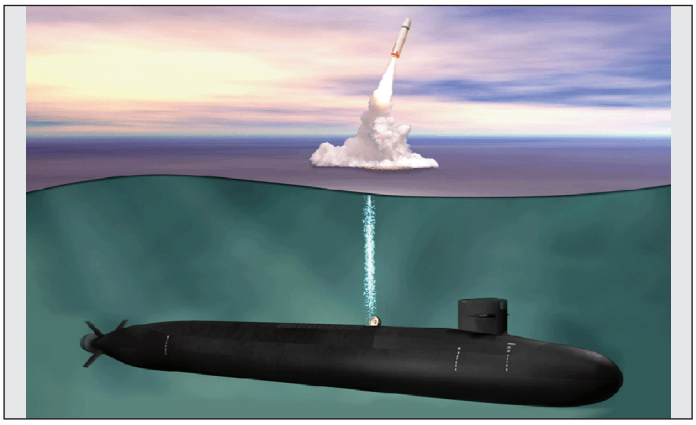
Maintaining the program's schedule is the primary concern for OASuW Inc 1, which is intended to address an urgent operational need. The program's current accelerated acquisition approach consists of decision points that align with key systems engineering reviews, test events, contract actions, and fielding decisions. The approach requires concurrency between developmental testing and initial production. Our past work has shown that beginning production before demonstrating that a design is stable and will work as intended increases the risk of discovering deficiencies during production that could require costly design changes, modifications, and retrofits. The program has accepted this risk and mitigated it, in part, by limiting the program to the 110 missiles needed to provide a capability until the second increment is fielded.

Program Office Comments

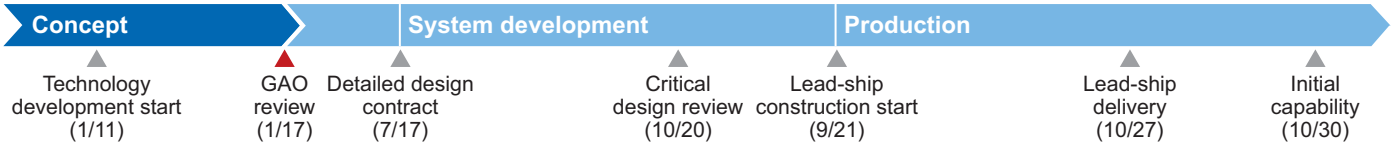
In commenting on a draft of this assessment, program officials noted OASuW Inc 1 is an accelerated acquisition program intended to fill an urgent capability requirement in the maritime domain. Accordingly, schedule is elevated as a priority with associated, increased emphasis on risk management, including those related to concurrent system test and production activities. According to the program, the hardware design is mature. Program risk assessments provide additional oversight and an executive steering board chaired by the senior Navy acquisition authority regularly reviews technical progress, facilitates risk management activities, and mitigates barriers to progress. According to the program, OASuW Inc 1 has successfully progressed from technology development through a production readiness decision in 10 months, and the program remains on track for early operational capability fielding in the fourth quarter of fiscal year 2018. The program also provided technical comments, which were incorporated where deemed appropriate.

SSBN 826 Columbia Class Ballistic Missile Submarine (SSBN 826)

The Navy's new Columbia Class (SSBN 826) will replace the current fleet of Ohio Class SSBNs as they begin to retire in 2027. The program seeks to provide affordable platforms for sea-based strategic deterrence that will remain in service through 2080. The Navy began technology development in January 2011 in order to avoid a capabilities gap between the Ohio Class's retirement and the fielding of a replacement system. The program plans to begin detail design in 2017, with lead ship construction starting in fiscal year 2021.



Source: © 2012 General Dynamics Electric Boat.



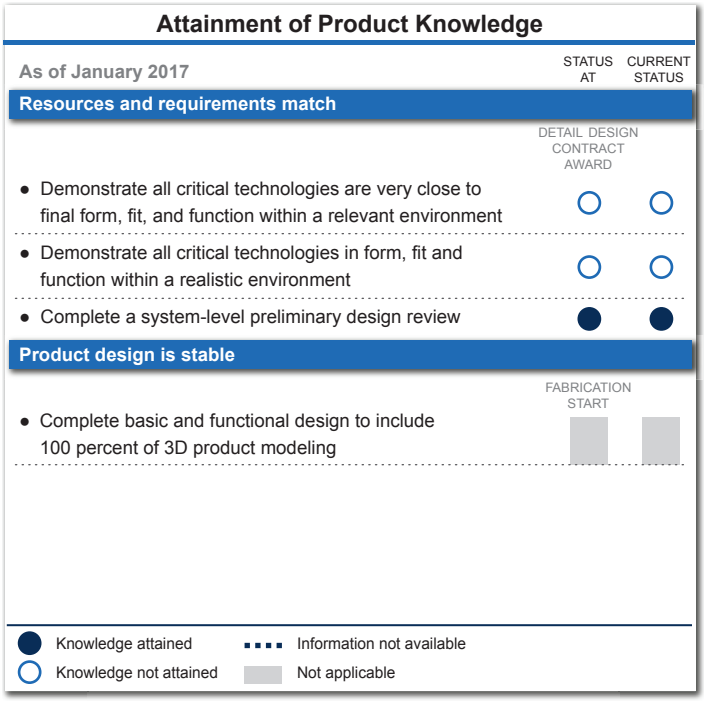
Program Essentials

Prime contractor: General Dynamics Electric Boat
Program office: Washington Navy Yard, DC
Funding needed to complete:
- R&D: $6,113.2 million
- Procurement: $87,426.5 million
- Total funding: $93,666.3 million
- Procurement quantity: 12

Program Performance (fiscal year 2017 dollars in millions)

	As of 01/2017	Latest 01/2017	Percent change
Research and development cost	$12,648.1	$12,648.1	0.0%
Procurement cost	$87,426.5	$87,426.5	0.0%
Total program cost	$100,221.9	$100,221.9	0.0%
Program unit cost	$8,351.825	$8,351.825	0.0%
Total quantities	12	12	0.0%
Acquisition cycle time (months)	232	238	2.6%

The Columbia Class program entered system development in 2017 with one critical technology that has not yet been demonstrated in a relevant environment and several other major development efforts. The Navy plans to complete detail design during this phase concurrently with efforts to reduce program cost and develop Columbia-class technologies. The Navy established an aggressive schedule for construction of the lead submarine and is working with future Columbia Class shipyards to identify production efficiencies needed to meet this goal.



SSBN 826 Program

Technology Maturity

The Columbia Class program's most recent Technology Readiness Assessment (TRA) identifies only two critical technologies—one carbon dioxide removal system and one major technical feature of the stern. The Navy has subsequently determined the carbon dioxide removal system is no longer a critical technology based on testing in a relevant environment. Only the stern feature remains as a critical technology, and the Navy does not expect to start detail design for this technology until fiscal year 2018. According to DOD's guidance for conducting TRAs, a technology is critical if it may pose major technological risk during development, particularly during the Engineering and Manufacturing Development (EMD) phase of acquisition. Prior to starting EMD, the program obtained a waiver as required by statute in order to proceed with technology that has not been demonstrated in a relevant environment. As a result, the program will continue technology development activities concurrent with detail design-this strategy is inconsistent with best practices.

Design Maturity

The Navy plans to include up to 70 percent of Virginia Class submarine parts and components in the Columbia Class design. It is also designing the Columbia Class to accommodate the existing Trident II D-5 strategic weapon system, and has already completed design work for the first article quad pack of missile tubes. The program is relying on a new three dimensional (3-D) computer model design tool, which it anticipates will produce electronic instructions in support of fabrication and assembly activities. In 2016, the design shipbuilder experienced a delay in issuing early design products due to problems with this software. According to the design shipbuilder, it has largely resolved the issue and is working to recover schedule. The program aims to complete 83 percent of the 3-D design model prior to the start of lead ship construction in fiscal year 2021.

Production Maturity

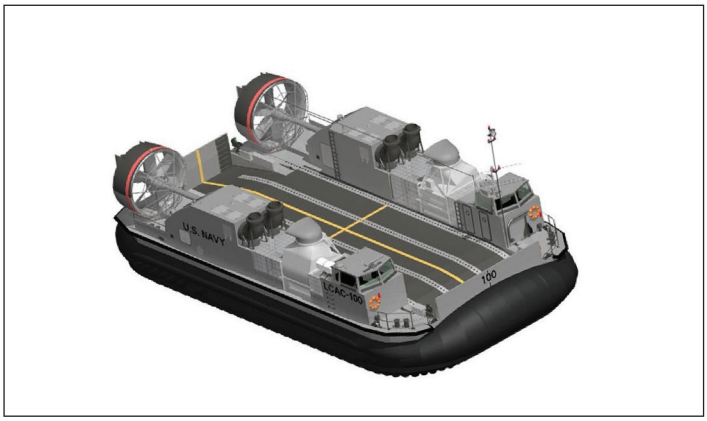
The Navy plans to award a contract to start detail design in 2017, with lead ship construction scheduled to begin in fiscal year 2021. The Navy expects to build the lead ship in 84 months with follow-on ships progressively decreasing to 70 months construction time. This schedule is aggressive, considering that it is approximately the same duration as the lead Virginia class submarine, even though the Columbia Class is over two times larger and the first ballistic missile submarine built in decades. According to the Navy, a decision in 2012 to delay construction start from 2018 to 2020 eliminated flexibility to accommodate delays during construction, given that the lead ship's first strategic deterrent patrol remains scheduled for 2030. In an effort to gain back some schedule margin, the Navy is working with the future Columbia Class construction shipyards to identify production efficiencies and is requesting funding authorities from Congress to begin some construction work prior to authorization of the lead ship. Under the Navy's current plans, the shipyards will construct two submarines per year (one Virginia Class and one Columbia Class) through the 2030s.

Program Office Comments

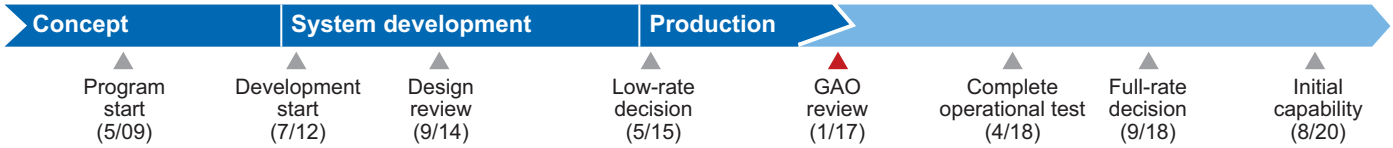
In commenting on a draft of this assessment, the program office provided technical comments, which were incorporated where deemed appropriate.

Ship to Shore Connector Amphibious Craft (SSC)

The Navy's SSC is an air-cushioned landing craft intended to transport personnel, weapon systems, equipment, and cargo from amphibious vessels to shore. SSC is the replacement for the Landing Craft, Air Cushion, which is approaching the end of its service life. The SSC is designed to deploy in and from Navy amphibious ships with well decks, such as the LPD 17 class, and will support assault and non-assault operations. The program entered system development in July 2012 and held its low-rate production decision in May 2015.



Source: U.S. Navy.



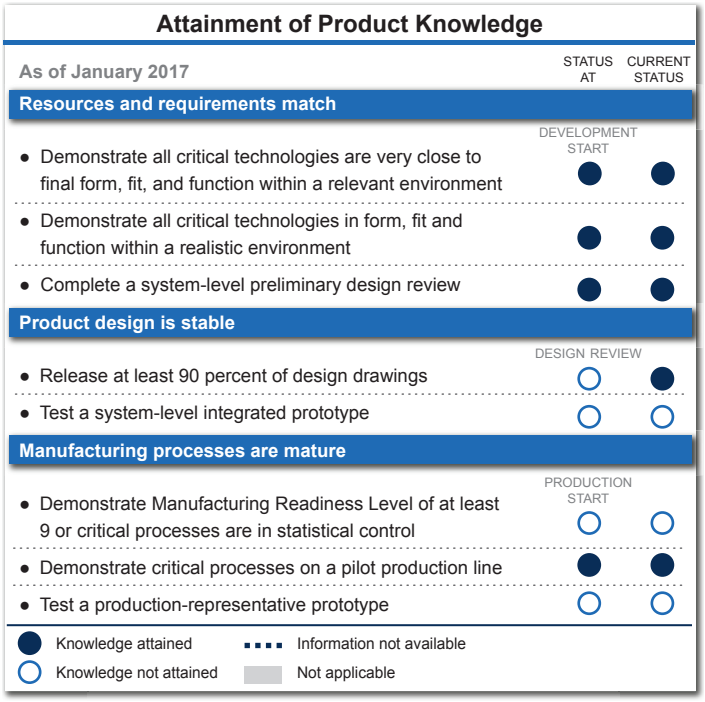
Program Essentials

Prime contractor: Textron Inc.
Program office: Washington, DC
Funding needed to complete:
- R&D: $20.9 million
- Procurement: $3,098.4 million
- Total funding: $3,134.0 million
- Procurement quantity: 64

Program Performance (fiscal year 2017 dollars in millions)

	As of 07/2012	Latest 10/2016	Percent change
Research and development cost	$603.7	$541.1	-10.4%
Procurement cost	$3,664.0	$3,444.3	-6.0%
Total program cost	$4,287.9	$4,000.2	-6.7%
Program unit cost	$58.739	$54.798	-6.7%
Total quantities	73	73	0.0%
Acquisition cycle time (months)	135	135	0.0%

SSC's critical technology is mature and its design is stable. The program entered low-rate production in May 2015 and has experienced some delays in its production schedule. It now anticipates delivery of the initial test and training craft in August 2017, three months later than the time of our last review. According to the program, the primary cause of these delays is its propeller supplier, whose production yields have not been reliable following a 2015 fire that destroyed its plant. The program has nine craft under contract, with four already under construction. It is seeking authority to use what it calls a "block buy contract" for fiscal years 2017 through 2018. If issues requiring design changes are identified during developmental testing—not scheduled for completion until December 2017—the program could face costly rework of the craft already in production.



SSC Program

Technology and Design Maturity

SSC's one critical technology is mature. Although the SSC's design was not stable at its design review in 2014, it has since achieved stability. The gearbox, which had shown premature wear, passed factory acceptance testing in fall 2016. However, further testing identified design issues with high speed bearings within the gearbox. A solution has been developed and will be tested by February 2017. In May 2015, the Navy's operational test agency reported that the steep angle of SSC's loading ramp may create operational hazards for certain vehicles. The program is designing a new approach ramp to mitigate this risk, but will not have an opportunity to fully assess this and other issues until developmental testing is completed in December 2017.

Production Maturity

The program entered low-rate production in May 2015 after demonstrating that all materials, manpower, tooling, and facilities were proven and available to meet the low-rate production schedule, as recommended by DOD guidance. However, according to best practices, programs should demonstrate manufacturing processes to be in statistical control prior to production start. Specifically, critical processes should be repeatable, sustainable, and consistently producing parts within the quality standards.

The program has experienced delays in its production schedule. Nine SSC craft are under contract, with four already under construction. It now expects delivery of the initial test and training craft in August 2017, a 3-month delay since our last review. Delivery of the second craft also slipped by 3 months to November 2017. According to the program, the primary cause of these delays is the supply of propellers, 12 of which are needed for each craft. A fire destroyed the manufacturer's facility in 2015 and production yield from the new facility has been unreliable, which officials stated poses risk to the SSC production schedule.

Delivery of the test craft in late 2017 will offer the first opportunity to demonstrate that the SSC design meets requirements and that no rework is needed. Testing of this craft will occur while the contractor produces eight other SSC craft. Our previous work has found that concurrent testing and production increases the risk of discovering deficiencies that could require costly design changes and modifications to units already produced.

Other Program Issues

The Navy is seeking authority from Congress to use what it calls a "block buy contract" for SSC craft in fiscal years 2017 and 2018. The program released a draft solicitation for these fiscal years in November 2016 and plans to release a final solicitation in February 2017. Because the program does not yet have authority for a block buy, the draft solicitation sought pricing for both block buy and annual procurement contracting methods. Program officials estimate the block buy would reduce costs by 3 percent compared to an annual procurement. However, the unknowns that persist in developmental testing undermine the Navy's business case for the block buy strategy. Until this testing is completed—and the program demonstrates the craft under construction are of a configuration that meets requirements—program execution is likely to be hampered, regardless of the contracting method.

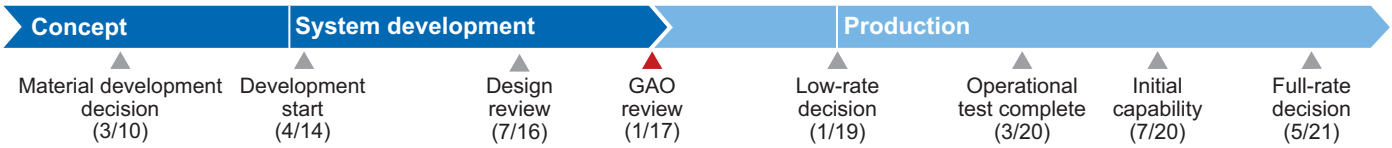
Program Office Comments

When provided with a draft of this assessment, program officials noted the following. The program is currently in the low-rate production phase. The design remains mature, and potential issues are being identified and addressed through integration and test. Currently, four craft are under construction with a fifth craft in the prefabrication stage. In addition to the items discussed in the Technology and Design Maturity section, after delays due to a fire at the manufacturer, propellers for the test and training craft are scheduled to be delivered in February 2017. The program is focused on delivering this craft in 2017 and beginning post-delivery testing in fiscal year 2018.

VH-92A Presidential Helicopter Replacement Program

The Navy's VH-92A program provides new helicopters for executive transport of the President, Vice President, heads of state, and others. A successor to the VH-71 program, which the Navy canceled due to cost growth, schedule delays, and performance shortfalls, the VH-92A will replace both legacy VH-3D and VH-60N aircraft. The VH-92A is expected to provide improved performance and communications capabilities, while offering increased passenger capacity.

Source: © Sikorsky Aircraft Corporation, a Lockheed Martin Company.



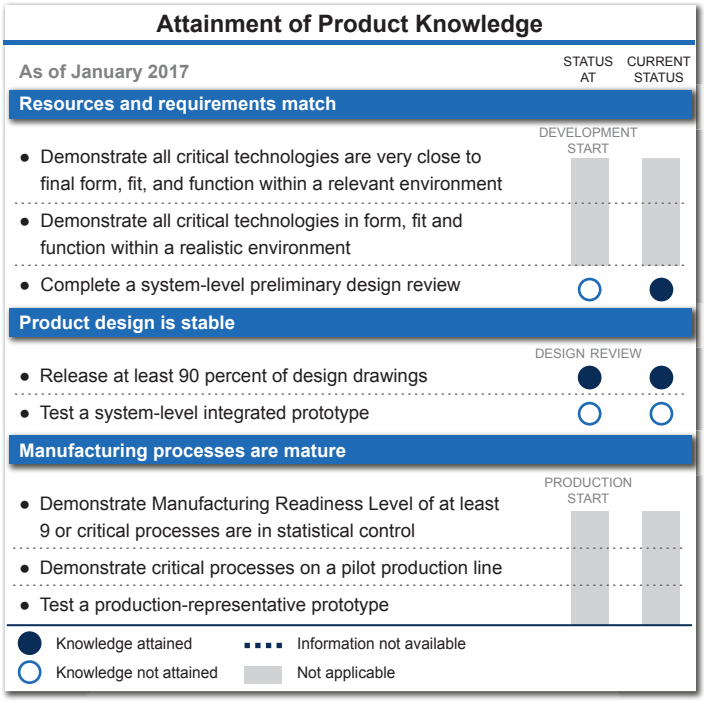
Program Essentials

Prime contractor: Sikorsky Aircraft Corp.
Program office: Patuxent River, MD
Funding needed to complete:
- R&D: $1,343.0 million
- Procurement: $2,296.6 million
- Total funding: $3,639.6 million
- Procurement quantity: 17

Program Performance (fiscal year 2017 dollars in millions)

	As of 04/2014	Latest 08/2016	Percent change
Research and development cost	$2,714.4	$2,522.2	-7.1%
Procurement cost	$2,128.0	$2,296.6	7.9%
Total program cost	$4,842.4	$4,818.9	-0.5%
Program unit cost	$210.540	$209.516	-0.5%
Total quantities	23	23	0.0%
Acquisition cycle time (months)	76	75	-1.3%

The VH-92A program completed its system-level critical design review (CDR) in July 2016 with stable designs for the VH-92A aircraft and all but one subsystem, which the contractor had not yet incorporated into its design. The program does not identify any critical technologies. The program is designing one subsystem, the mission communications system, which employs components currently in use on other platforms. The contractor identified design deficiencies with the aircraft's front and rear doors. In response, the contractor has undertaken efforts to address these deficiencies and ensure timely delivery of the development models. The program plans to enter production in 2019 prior to completing developmental testing—an approach inconsistent with best practices.



VH-92A Program

Technology Maturity

The VH-92A's acquisition strategy is underpinned by use of a commercial aircraft and mature technologies to reduce the potential for problems during development and early testing. As such, the program does not identify any critical technologies. The government designed mission communications system (MCS) is the only program technology that is not in use in another system in the same configuration required for the VH-92A. First flight with a fully configured MCS is planned for June 2017. The delays in the aircraft's build schedule caused by design revisions and availability of parts caused a 2-month delay in first flight. The MCS consists of both contractor and government furnished equipment either commercially available or already in use on other systems. According to the program office, the MCS software build is proceeding as scheduled, and updates are planned for May and October 2017, including those to address known software deficiencies associated with bandwidth and compatibility issues with ground network systems. The VH-92A program is pursuing approaches including having the MCS software be "user modifiable software," which will allow the program to modify the software and maintain compliance with the Federal Aviation Administration certification.

Design Maturity

According to the program office, the contractor released over 90 percent of VH-92A's design drawings at the time of the July 2016 CDR. These drawings represent the modifications to the baseline airframe—Sikorsky's S-92A aircraft. In addition, the program assessed designs for nearly all key sub-systems and components as stable at CDR. The only exception was the Wide-band Line-of-Sight communication system, which the contractor had not yet incorporated into its design. The program has experienced a few design challenges associated with the airframe and integration. For example, the contractor has undertaken extensive design and structural analyses and studies for rear and forward air-stair efforts to ensure the VH-92A's design does not affect existing aircraft loads, which could impact its airworthiness certification and to ensure timely delivery of the development models. The MCS/CSO (Communication System Operator) interface design has also progressed slower than planned; however, the program did not experience any delays to key milestones. Currently, the contractor is prioritizing work, increasing resources to address these challenges, and is identifying areas later in the aircraft build process where cost efficiencies can be applied.

Production Maturity

The program is planning to enter low-rate initial production in January 2019, prior to completing system-level developmental testing in September 2019—an approach inconsistent with best practices. The program intends to evaluate VH-92A's readiness to enter production following an operational assessment in fiscal year 2018 and plans to demonstrate critical manufacturing processes on a pilot production line prior to entering low-rate initial production.

Other Program Issues

The Navy determined it no longer required one capability planned for VH-92A and subsequently executed a contract modification. According to program officials, as part of the related negotiation, the government and contractor agreed on an appropriate credit amount in July 2016, which the Navy will apply to other program areas.

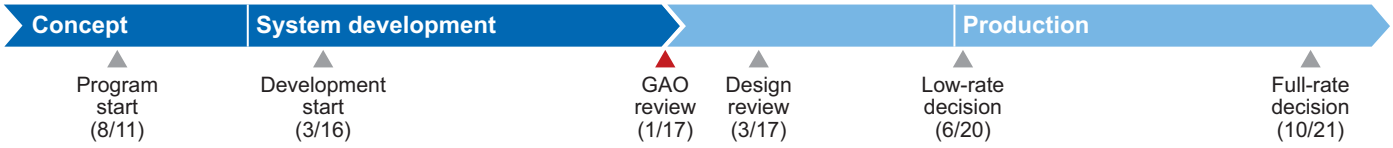
Program Office Comments

In commenting on a draft of this assessment, the program office provided technical comments, which were incorporated where deemed appropriate.

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 analog defensive management system to a digital capability. This system detects and locates enemy radar systems to provide threat warning and avoidance information. This upgrade is expected to improve the frequency coverage and sensitivity of the system, update pilot displays, and enhance in-flight rerouting capabilities to avoid air defense threats. It also expects to improve the reliability and maintainability of the DMS system and the B-2's readiness rate.

Source: U.S. Air Force.



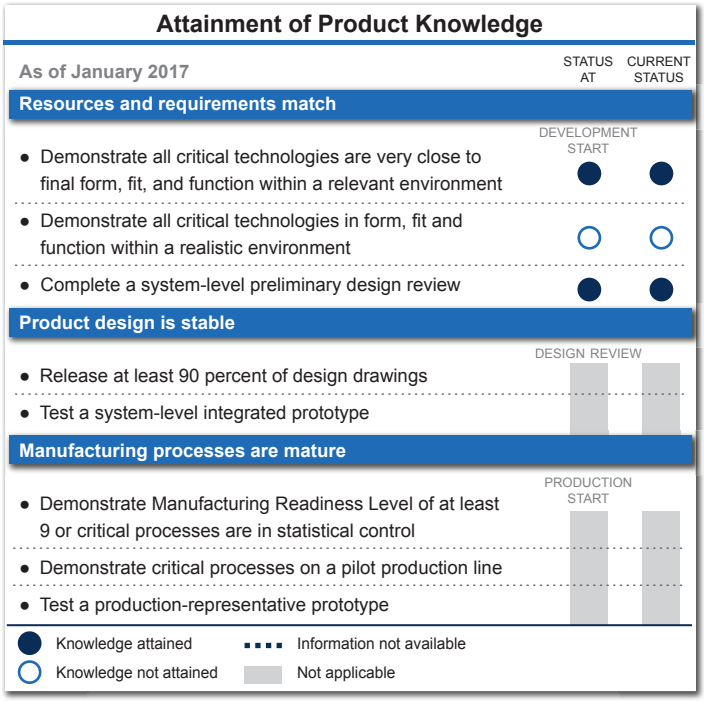
Program Essentials

Prime contractor: Northrop Grumman
Program office: Wright Patterson AFB, OH
Funding needed to complete:
- R&D: $820.0 million
- Procurement: $747.5 million
- Total funding: $1,567.5million
- Procurement quantity: 16

Program Performance (fiscal year 2017 dollars in millions)

	As of 05/2016	Latest 08/2016	Percent Change
Research and development cost	$1,854.7	$1,854.7	0.0%
Procurement cost	$747.5	$747.5	0.0%
Total Program cost	$2,602.3	$2,602.3	0.0%
Program unit cost	$130.113	$130.113	0.0%
Total quantities	20	20	0.0%
Acquisition cycle time (months)	124	130	4.8%

The program entered system development in March 2016 with four critical technologies nearing full maturity, but may fall short of meeting two key performance parameters. Consistent with best practices and statutory requirements, the program completed a preliminary design review prior to development start. The program expected to complete a critical design review in December 2016, but delayed it to study hardware changes that may reduce costs. The program will not test a system level integrated prototype until after this review, and system integration challenges remain, including a precise antenna installation and calibration as well as nuclear hardening of components. Test range availability, test data turnaround times, and software development may each present challenges to meeting schedules. In addition, there are limitations to verifying the system will work as intended.



B-2 DMS-M Program

Technology Maturity

The program entered system development in March 2016 with four critical technologies nearing maturity. A receiver-processor for bands 1-3 has been flight tested on another program. When the program entered the technology development phase in 2011, the other 3 technologies—band 4 antenna, band 4 receiver-processor, and geo-location algorithm—were immature with only limited demonstrations completed. The Air Force tested the fourth technology, a receiver-processor for bands 1-3 on another program. The program office subsequently refined requirements and better matched them with the maturity of the technologies. As a result, the Air Force reduced planned DMS-M capabilities, which the user determined was an acceptable trade given the additional cost and time needed to meet the more demanding requirements. The program office currently projects meeting two key performance parameters related to these technologies could be at risk, but it expects to mitigate these risks over the next 4 years prior to production start.

Design Maturity

The program expected to complete its critical design review in December 2016 with nearly 100 percent of the expected drawings released, but without testing a system level integrated prototype. However, the program office recently delayed the review to study potential hardware changes that may reduce costs. Consistent with best practices and statutory requirements, the program completed a preliminary design review prior to beginning development. The DMS-M contractor estimated over 80 percent of the software development was complete. However, technical integration challenges remain. The B-2 DMS-M is the largest and most invasive modification since the aircraft was fielded. The antenna design requires stringent tolerance limits for airframe installation due to stealth requirements and requires precise calibration. Most components require nuclear hardening to meet operating requirements. The system also requires a tightly coupled hardware and software integration to enable threat assessment and auto-rerouting for enhancing B-2 survivability.

Other Program Issues

The total estimated cost to develop and equip 20 B-2s with the DMS-M has increased about $500 million from estimates made at the start of technology development phase in 2011. The Air Force awarded a cost reimbursable type contract for system development with incentive fees tied to cost and performance. About two-thirds of the available fee is targeted at incentivizing the contractor to complete system verification, software, and test readiness events on time. If the contractor is successful, the program office predicts the estimated program cost would be reduced by $209.8 million. However, the contractor has had difficulties in meeting past schedules. Challenges remain that could impact its ability to meet the current schedule, including test range availability, test data turnaround times, and timely completion of software development.

Operational testers identified three potential limitations to verifying that the DMS-M works as intended: (1) testing in a dense signal environment will be limited to modeling and simulation; (2) determining whether the system is meeting reliability and availability requirements due to the limited number of flight test hours; and (3) testing on-aircraft cybersecurity may not be practical due to security and test asset concerns.

Program Office Comments

In commenting on a draft of this assessment, the program office provided technical comments, which were incorporated where deemed appropriate.

Combat Rescue Helicopter (CRH)

The Air Force's Combat Rescue Helicopter (CRH) is intended to recover personnel from hostile or denied territory as well as conduct humanitarian, civil search and rescue, and disaster relief. The CRH is intended to replace aging HH-60G Pave Hawk helicopters with a derivative of the operational UH-60M helicopter. Planned modifications to the commercial design include a new mission computer and software, a higher capacity electrical system, larger capacity main fuel tanks, armor for crew protection, and situational awareness enhancements.

Source: ©2015 Sikorsky Aircraft Corporation. Used with permission for support of CRH.

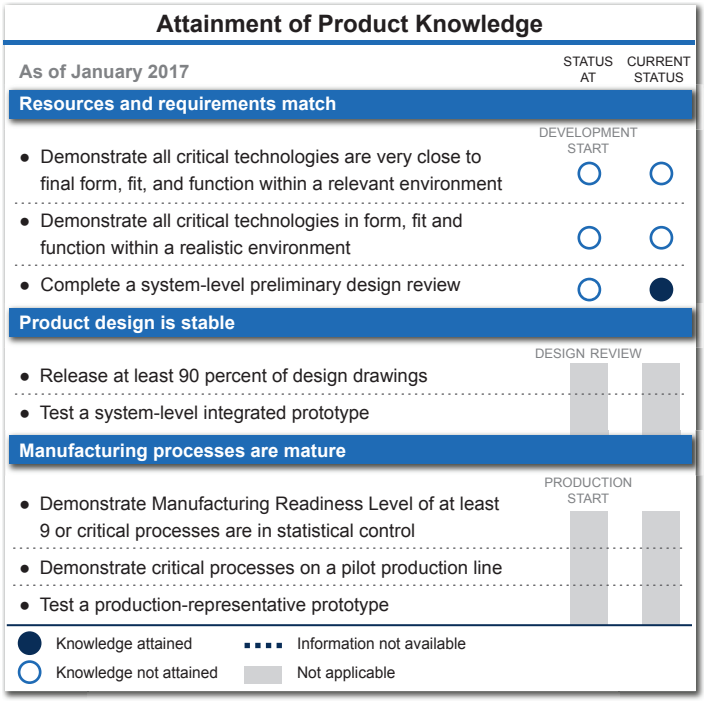
Program Essentials

Prime contractor: Sikorsky Aircraft Corporation
Program office: Wright Patterson AFB, OH
Funding needed to complete:
- R&D: $1,480.6 million
- Procurement: $6,614.9 million
- Total funding: $8,122.6 million
- Procurement quantity: 103

Program Performance (fiscal year 2017 dollars in millions)

	As of 06/2014	Latest 08/2016	Percent change
Research and development cost	$2,040.2	$2,040.8	0.0%
Procurement cost	$6,362.3	$6,614.9	4.0%
Total program cost	$8,427.1	$8,682.9	3.0%
Program unit cost	$75.242	$77.526	3.0%
Total quantities	112	112	0.0%
Acquisition cycle time (months)	75	82	9.3%

Following system development start in 2014, the CRH program completed a preliminary design review and technology readiness assessment in 2016, which identified the radar warning receiver technology as immature. Until this technology matures, the program's plan to achieve design stability by its 2017 critical design review (CDR) remains at risk. Additional knowledge gaps will persist after CDR given the program's plans to defer early prototype testing to 2018 and finish software development in 2020 after production begins in 2019. The program also plans for critical manufacturing processes to be in statistical control and to test a production representative prototype before the start of production in line with best practices.



CRH Program

Technology Maturity

The CRH program began system development in 2014 without identifying and assessing the maturity of its critical technologies. At the program's milestone review for entry into system development, the Under Secretary of Defense for Acquisition, Technology and Logistics (USD AT&L) waived the technology maturity requirements, citing the maturity of the program's technologies. Program officials said in 2016, however, the program completed an independent technology readiness assessment, which identified the one critical technology, the radar warning receiver, was immature. While an analog version currently functions on other military helicopters, it will require additional technology maturation for use on the CRH as a digital system providing threat warnings and situational awareness.

Design and Production Maturity

The CRH program conducted its preliminary design review (PDR) in April 2016, almost 2 years after system development started—an approach inconsistent with best practices. USD AT&L waived the statutory requirement for earlier completion of the PDR. Although program officials said no significant risks or issues were identified for the CRH program, they are tracking several moderate risks, including some related to aircraft weight.

As of August 2016, the program had released about 84 percent of the expected drawings and estimated 90 percent would be released by the July 2017 CDR. Achieving this 90 percent metric by CDR would be consistent with best practices, but design stability remains at risk until the radar warning receiver technology matures. In addition, the CRH program does not plan to demonstrate an early system prototype before CDR, which is inconsistent with best practices. Instead, the program plans to complete a prototype demonstration about 7 months after CDR in February 2018 and finish software development in 2020, after production is already underway.

Program officials stated system prototype testing at CDR is not needed for CRH since the program is modifying and enhancing an existing helicopter, the UH-60M, by integrating mature subsystems and associated software into this platform. However, the integration of these subsystems and software could be challenging and present some risks that must be successfully mitigated to achieve the desired capability. In our previous work, we found that when acquisition programs demonstrate technology and design maturity at appropriate points, they typically have better cost and schedule outcomes. Program officials stated they have planned for a sufficient amount of developmental testing to reduce these risks. Systems integration laboratory testing will begin in February 2017, several months before the CDR, although this testing will use partial system configurations.

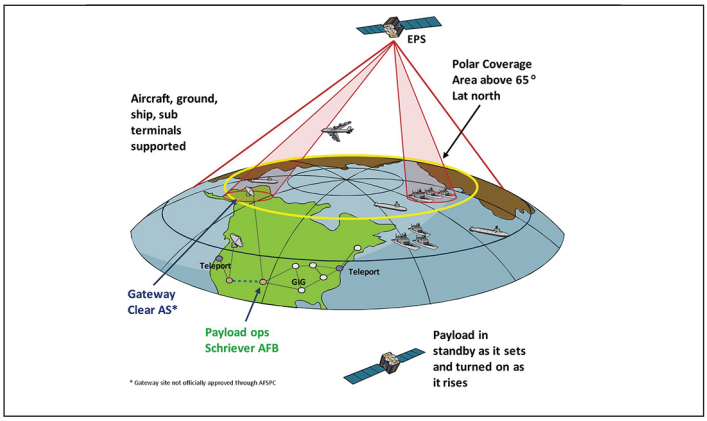
The program plans to make use of several other knowledge-based practices prior to its CDR, including identifying critical manufacturing processes and completing failure modes and effects analysis to increase confidence in the stability of the CRH design and mature its production processes. The program also plans for critical manufacturing processes to be in statistical control and to test a production representative prototype before the start of production, which is consistent with best practices.

Program Office Comments

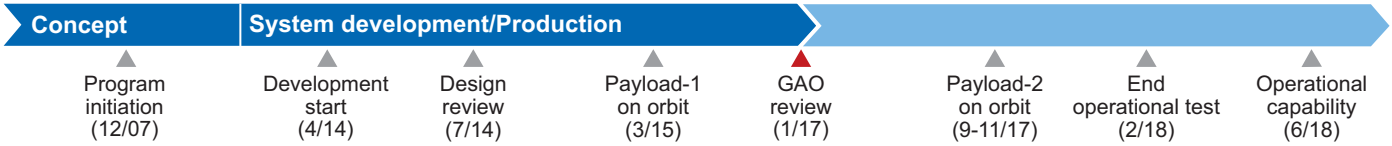
Program officials acknowledged software development could continue through the end of developmental test and evaluation in early 2020, but full capability is expected by CRH's initial test readiness review in 2018. Therefore, the only software development planned after 2018 will be to address any flight test anomalies, and program officials believe this will reduce the possibility of changes being needed during production in 2019. Testing to prove the technology maturity of the radar warning receiver in a relevant environment is planned to occur prior to the critical design review in 2017. To reduce the risk of an unsuccessful test, the Air Force Research Laboratory provided a test station to the radar warning receiver developer that will allow for up to 4 months of early risk reduction testing.

Enhanced Polar System (EPS)

The Air Force's Enhanced Polar System (EPS) will provide protected, next-generation extremely high frequency (EHF) satellite communications in the polar region. It will replace the current Interim Polar System and serve as a polar adjunct to the Advanced EHF (AEHF) system. EPS consists of three segments: two EHF payloads hosted on classified satellites, a Control and Planning Segment (CAPS), and a gateway to connect modified Navy Multiband Terminals to other communication systems.



Source: LinQuest Corporation.



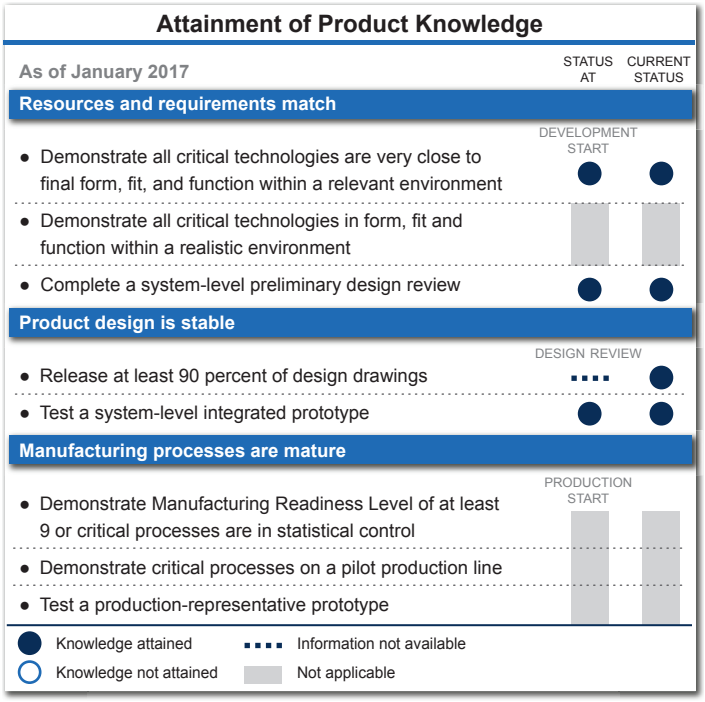
Program Essentials

Prime contractor: Northrop Grumman
Program office: El Segundo, CA
Funding needed to complete:
- R&D: $73.8 million
- Procurement: $0.0 million
- Total funding: $73.8 million
- Procurement quantity: 0

Program Performance (fiscal year 2017 dollars in millions)

	As of 04/2014	Latest 10/2016	Percent change
Research and development cost	$1,446.8	$1,430.4	-1.1%
Procurement cost	$0.0	$0.0	0.0%
Total program cost	$1,446.8	$1,430.4	-1.1%
Program unit cost	$723.414	$715.186	-1.1%
Total quantities	2	2	0.0%
Acquisition cycle time (months)	126	126	0.0%

The EPS program entered development in April 2014. The three segments of EPS—payloads, CAPS, and the gateway—are in various stages of completion with mature technologies and a stable design. The EPS program's two EHF payloads are built; the first is onorbit and the second will be available for on-orbit testing in fall 2017. The gateway site installation is complete and testing was completed in December 2015. CAPS completed software development in October 2015, but implementation of cybersecurity updates delayed delivery of the segment to April 2017. CAPS delays have pushed the expected completion of on-orbit inter-segment testing, which will test all three system elements together, from August 2016 to July 2017. Operational testing is scheduled for completion in 2018 and is the last significant event scheduled, as there are no production related decisions for the program.



EPS Program

Technology and Design Maturity

The EPS program formally entered development in April 2014 with all critical technologies for the payload segment mature or approaching maturity. These technologies are now fully mature. In July 2014, the program held a system-level critical design review, but the program was unable to provide the number of engineering drawings to us for our prior assessments. Our current assessment shows all drawings have been released, indicating a stable design. All three segments of the program will be completed under a development effort, and there will be no production-related decisions for this program.

Both payloads are built. The first payload is on-orbit and the second payload is integrated into the host satellite and is expected to be available for on-orbit testing in fall 2017. According to program officials, all EPS hardware development and critical technologies are associated with the payloads, but the CAPS segment is the program's critical path.

The only development work remaining within the program is CAPS. According to program officials, CAPS is primarily a software development effort and utilizes commercial off-the-shelf hardware. Program officials said CAPS software development was completed in October 2015, but implementation of cybersecurity updates has required restructuring of the CAPS schedule, delaying segment delivery to April 2017. DOD updates cybersecurity standards quarterly, which program officials stated makes it difficult to keep pace with ever-increasing security requirements while in software development. According to program officials, these requirements are described in detail via the Security Technical Implementation Guidelines programs must implement, the majority of which—along with associated verification—must occur manually, which can be time and labor intensive.

The gateway segment primarily involves integration of existing equipment and is considered low risk by the program office. Integration includes commercial off-the-shelf hardware, such as routing and switching equipment, and terminals developed under other programs. The Navy's Space and Naval Warfare Systems Command, Systems Center Pacific and MIT/Lincoln Laboratory are responsible for integrating, testing, and installing the gateway segment. Site installation for the gateway is complete, and testing was completed in December 2015. System-level on-orbit inter-segment interface testing of the payload, gateway, and CAPS was initially scheduled for completion in August 2016, but the updated CAPS schedule has delayed completion until the end of July 2017.

Other Program Issues

In our prior assessment, we reported initial operational capability was delayed from fiscal year 2016 to 2018—a timeline that now includes meeting both initial and full operational capability milestones. The program office considers implementation of cybersecurity updates to be low risk in terms of technical success, but medium risk in terms of schedule margin for system-level testing, which could further delay operational capability since the updates are changing critical path activities leading up to on-orbit testing.

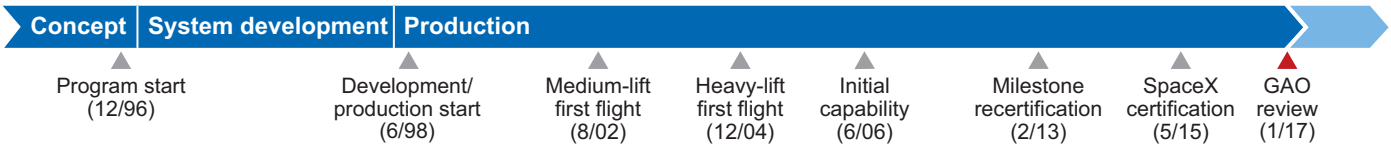
Program Office Comments

In commenting on a draft of this assessment, the program office provided technical comments, which were incorporated where deemed appropriate.

Evolved Expendable Launch Vehicle (EELV)

EELV provides spacelift support for DOD, national security, and other government missions. Currently, the United Launch Alliance (ULA) and Space Exploration Technologies Corporation (SpaceX) are the only certified providers of EELV launch services. SpaceX's Falcon 9 was certified to compete for national security launches in May 2015 and won a GPS III launch services contract in April 2016. ULA provides launch services for EELV using two families of launch vehicles, Atlas V and Delta IV. We assessed ULA 's and SpaceX's vehicle variants.

Source: United Launch Alliance and SpaceX.



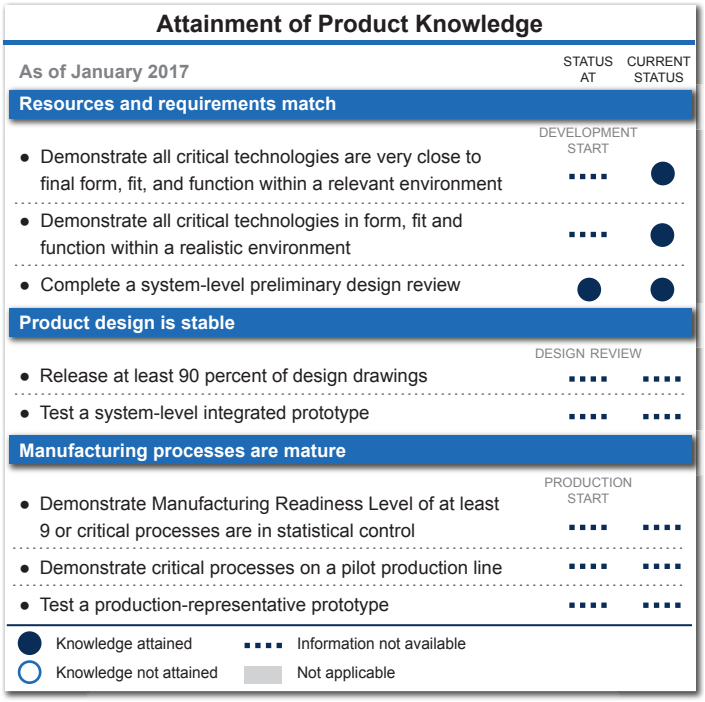
Program Essentials

Prime contractor: United Launch Services, LLC
Program office: El Segundo, CA
Funding needed to complete:
- R&D: $1,181.6 million
- Procurement: $30,532.8 million
- Total funding: $31,714.3 million
- Procurement quantity: 77

Program Performance (fiscal year 2017 dollars in millions)

	As of 10/1998	Latest 12/2015	Percent change
Research and development cost	$1,931.3	$4,170.4	115.9%
Procurement cost	$16,917.1	$55,467.3	227.9%
Total program cost	$18,848.4	$59,637.7	216.4%
Program unit cost	$104.135	$370.421	255.7%
Total quantities	181	161	-11.0%
Acquisition cycle time (months)	NA	114	NA

We assessed the EELV's technology and found it to be mature with 102 successful launches as of January 15, 2017. EELV's design and production maturity were not assessed using our best practices, but instead using an Aerospace Corporation measure developed for the program. Using this measure, 12 of the 15 EELV launch vehicle variants offered by ULA demonstrated design maturity, as has SpaceX's Falcon 9. EELV is currently assessing options for an alternative to the Russian-made RD-180 engine used on the Atlas V vehicle, and is investing in technology development with industry through agreements utilizing DOD's "other transaction" authorities. ULA phased out the Delta IV intermediate launch vehicle, which ULA plans to discontinue by fiscal year 2018 due to its high price.



EELV Program

Technology, Design, and Production Maturity

Fourteen of 15 EELV variants offered by ULA, and the Falcon 9 from SpaceX, have flown at least once, demonstrating technology maturity. For design stability and production maturity, launch vehicles are assessed using the "3/7 reliability rule" developed by the Aerospace Corporation. Once a variant is launched successfully three times, its design can be considered stable and mature. Similarly, if a variant is successfully launched seven times, both the design and production process can be considered mature. Twelve of the ULA variants have achieved design stability, and 4 have reached both design stability and production maturity, although some variants are used infrequently and may never reach design stability or production maturity. The Falcon 9 v1.1 achieved both design stability and production maturity, and a new variant—the Falcon 9 Upgrade, which SpaceX intends to use going forward for EELV launch service competitions—first flew in December 2015 and was certified for EELV launches in January 2016. New variants introduce changes to the original design which, until proven through multiple successful flights, pose potential cost and schedule risks.

Other Program Issues

The National Defense Authorization Act (NDAA) for Fiscal Year (FY) 2015 prohibited, with certain exceptions, the award or renewal of a contract for the procurement of property or services for space launch activities under the EELV program if such contract carries out such activities using rocket engines designed or manufactured in the Russian Federation. The NDAAs for fiscal years 2016 and 2017 amended the exceptions to the prohibition. In early 2016, the Air Force awarded agreements, utilizing DOD's "other transaction" authorities, for rocket propulsion systems.

ULA is phasing out its Delta IV Intermediate class of vehicles to make way for its new Vulcan launch vehicle currently in development with an initial capability expected, according to industry-stated timelines, in 2019. According to the program office, because the NDAA for Fiscal Year 2017 further amended the exceptions to the limitations in the NDAA for Fiscal Year 2015 to allow certain contracts to include the use of a total of 18 rocket engines designed or manufactured in Russia, the Air Force may be able to avoid a gap in launch capability for national security space launch missions. However, Air Force officials stated they consider these industry-stated rocket propulsion system timelines aggressive and optimistic.

The Air Force intends to procure three Delta IV Heavy-launch vehicles to support near-term national security launch requirements. However, while ULA has enough components to support these missions, if additional missions are required, some components are not available from suppliers and will require new ones. The use of components from new suppliers could require substantial testing, certification, and additional cost. According to the Air Force, the initial demonstration launch for SpaceX's Falcon Heavy is likely to take place in 2017.

The Air Force is developing an acquisition approach which supports two launch providers that can perform national security launches and also compete for commercial and civil government launches. Implementing this strategy may prove challenging as the demand for national security launches is expected to decline and providers will have to rely more heavily on civil government and commercial launches. Additionally, national security-unique requirements, such as additional lift capability, larger satellites, and increased structural capability for heavy payloads, can drive up costs. At the same time, commercial satellites do not require the same national security launch capability.

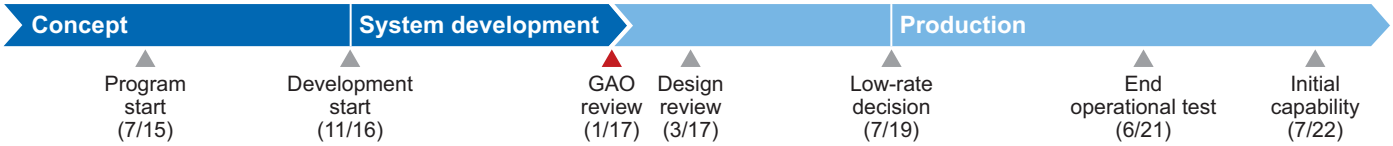
Program Office Comments

In commenting on a draft of this assessment, the program office provided technical comments, which were incorporated where deemed appropriate.

F-15 Eagle Passive/Active Warning and Survivablity System (F-15 EPAWSS)

The Air Force's F-15 EPAWSS program is developing a new electronic warfare system for fielded F-15C/E aircraft. The design of this upgraded system leverages components currently in use on other military aircraft that will enhance the F-15's ability to identify and neutralize advanced air and ground threat systems. Using an incremental acquisition approach, the Air Force will replace the aircraft's legacy system with EPAWSS in Increment 1 and add a new towed decoy and associated countermeasures in Increment 2. We assessed Increment 1.

Source: U.S. Air Force.



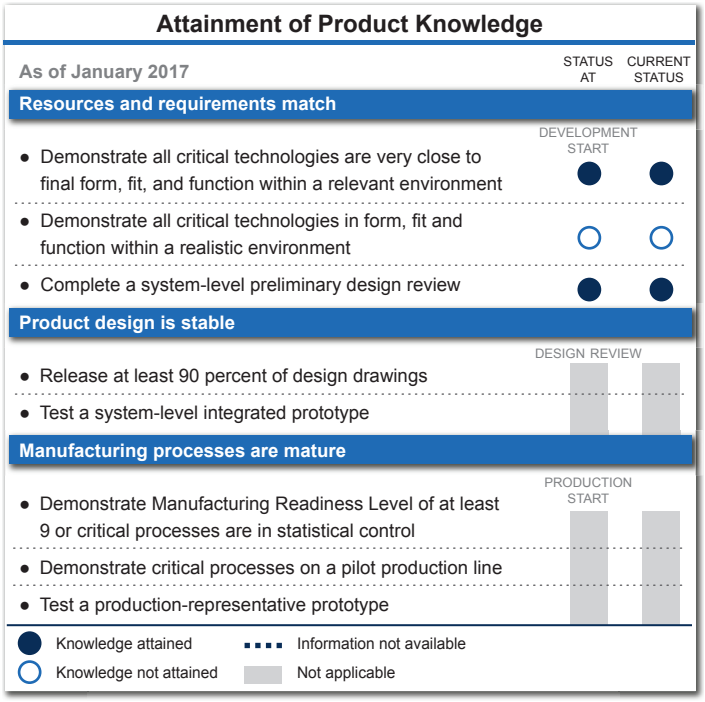
Program Essentials

Prime contractor: Boeing
Program office: Wright Patterson AFB, OH
Funding needed to complete:
- R&D: $786.7 million
- Procurement: $4,228.7 million
- Total funding: $5,015.4 million
- Procurement quantity: 403

Program Performance (fiscal year 2017 dollars in millions)

	As of	Latest 08/2016	Percent change
Research and development cost	NA	$1,028.2	NA
Procurement cost	NA	$4,228.7	NA
Total program cost	NA	$5,256.9	NA
Program unit cost	NA	$12.729	NA
Total quantities	NA	413	NA
Acquisition cycle time (months)	NA	84	NA

F-15 EPAWSS entered system development in November 2016 with its critical technologies approaching full maturity. The program did not conduct competitive prototyping, but consistent with best practices and statutory requirements, it did hold a preliminary design review before development start that validated the use of components from other military aircraft with many of them requiring little change. At the March 2017 critical design review, the program will focus on the components that require some hardware and software development. The program plans to attain the recommended level of manufacturing readiness, complete pilot production line demonstrations, and complete an operational assessment with production representative hardware all before production start in 2019, but some developmental testing and software design work remains to be completed after this point.



F-15 EPAWSS Program

Technology and Design Maturity

F-15 EPAWSS entered system development in November 2016 after testing by an independent review team demonstrated its four critical technologies as approaching full maturity in an operationally relevant, high-density radio frequency signal environment. Although best practices recommend fully maturing critical technologies to final form, fit, and function and demonstrating them in a realistic environment by development start, the program does not plan to attain this until 2018, leaving it at risk for flight test delays if the technologies do not function as planned. In 2015, the prime contractor for EPAWSS system integration, Boeing, competitively selected BAE Systems to develop the electronic warfare system, but competitive prototyping of an EPAWSS design was not conducted due to the leveraging of non-developmental components by the offerors, which DOD determined minimized the potential benefits of early system prototyping.

Consistent with best practices and statute, the program held a preliminary design review with Boeing before system development as well as other engineering reviews with Boeing and key sub-contractors. These reviews validated the program's strategy to leverage components from other military aircraft in a new design. Increment 1 consists of three key subsystems that will be replaced on the F-15—the radar warning receiver, electronic countermeasure processer, and countermeasure dispenser system. The program tracks design drawing estimates for both the EPAWSS hardware and aircraft changes needed to replace the legacy system with EPAWSS. According to program officials, a significant portion of the EPAWSS design is stable with many of the components requiring little or no change from a similar system already fielded on a foreign military F-15. Program officials stated the March 2017 critical design review will focus on the integration of updated subsystem components that require some hardware and software design work.

Production Maturity

Before production begins, the program plans to reach the level of manufacturing readiness for production start recommended by best practices and demonstrate critical manufacturing processes on a pilot production line to provide assurance quality requirements will be met. The program also plans to complete ground testing and a flight test based operational assessment of production representative hardware to ensure the system performs as planned before making a production start decision in 2019. However, some software development will take place after this point with about half of the developmental flight testing to be completed during production, leaving some risk EPAWSS might require unforeseen design or software changes due to performance shortfalls discovered late in testing.

Other Program Issues

To date, the Air Force has only funded Increment 1 of the program, but currently plans to request funds for Increment 2 development beginning in fiscal year 2018. Air Force officials assessed the new Increment 2 hardware and technology as mature, but it is not yet qualified for use on the F-15. In the event that the Air Force does not receive funding for Increment 2 development and production, program officials stated that the Increment 1 upgrade alone is a viable improvement to the F-15, as the legacy system it replaces is becoming functionally obsolete and unsustainable.

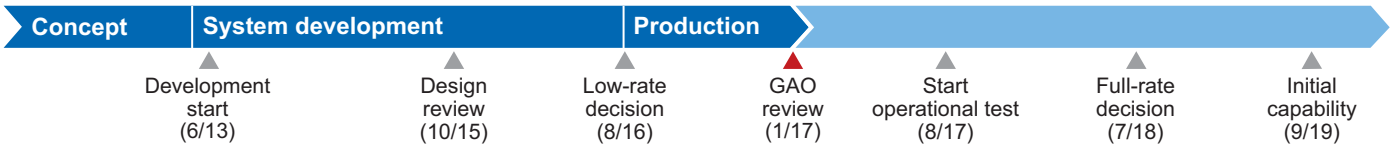
Program Office Comments

According to Air Force officials, the program is on-track in implementing a strategy to leverage mature non-developmental components as a key element of the program's efforts to drive positive schedule, affordability, and risk outcomes. They also noted the program successfully demonstrated the critical technologies needed to perform against advanced threats in a high fidelity, operationally relevant environment. Air Force officials state this demonstration greatly reduced technology risks and informed the preliminary design review as well as the November 2016 decision to enter into system development. The program's acquisition strategy enables the Air Force to continue testing EPAWSS early in system development to inform the critical design review and to ensure system maturity in time to meet the required entry criteria for the low-rate production decision, which includes completing an independent operational assessment of EPAWSS performance.

F-22 Increment 3.2B Modernization (F-22 Inc 3.2B Mod)

The Air Force's F-22 Raptor is a stealthy air-to-air and air-to-ground fighter/attack aircraft. The Air Force established an F-22 modernization and improvement program in 2003 to add enhanced air-to-ground, information warfare, reconnaissance, and other capabilities, and to improve the reliability and maintainability of the aircraft. Increment 3.2B, the fourth increment of the modernization program, was initially managed as part of the F-22 baseline program, but is now managed as a separate major defense acquisition program.

Source: U.S. Air Force.



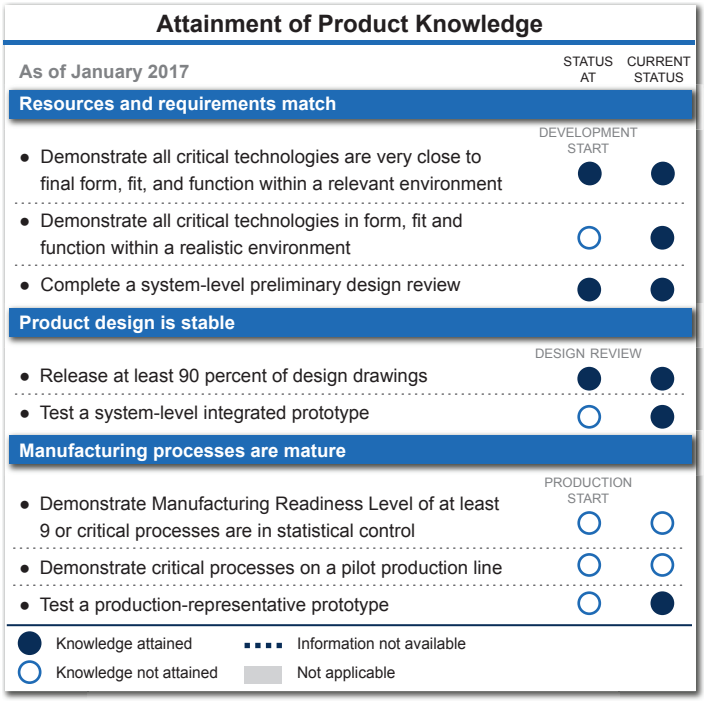
Program Essentials

Prime contractor: Lockheed Martin
Program office: Wright Patterson AFB, OH
Funding needed to complete:
- R&D: $69.5 million
- Procurement: $271.0 million
- Total funding: $340.4 million
- Procurement quantity: 108

Program Performance (fiscal year 2017 dollars in millions)

	As of 06/2013	Latest 08/2016	Percent change
Research and development cost	$1,268.0	$1,179.4	-7.0%
Procurement cost	$357.5	$365.0	2.1%
Total program cost	$1,625.5	$1,544.5	-5.0%
Program unit cost	$10.694	$10.161	-5.0%
Total quantities	152	152	0.0%
Acquisition cycle time (months)	72	75	4.2%

Increment 3.2B entered production in August 2016 with its one critical technology, a geolocation algorithm, mature and its design stable. Prior to production start, the program office met DOD criteria for manufacturing readiness but did not demonstrate manufacturing processes to be in statistical control, which is inconsistent with best practices. According to program officials, flight testing will conclude in June 2017, 6 months later than expected due to reduced test range availability, which may result in some cost growth. The program is using an iterative software development process with 13 releases of capability, which is 3 more than initially planned.



F-22 Inc 3.2B Mod Program

Technology and Design Maturity

The program's sole identified critical technology, a geolocation algorithm, is mature as it has been flight qualified in a realistic environment. According to program officials, the 3.2B program will complete flight testing in June 2017. The program demonstrated design stability prior to the October 2015 critical design review (CDR) by releasing 98 percent of its drawings. Currently, the program has released 100 percent of its system level drawings. The CDR was a culmination of multiple incremental CDRs, with the October 2015 review focused on software as the program had already completed its hardware reviews.

According to program officials, the 3.2B program intends to continue flight testing an integrated, system level prototype through June 2017, but has encountered challenges accessing adequate test facilities. The program is using an iterative software development process where 10 software releases were planned. However, due to interface issues, the program added 3 additional software releases, for a total of 13. Program officials stated these releases were only for lab use, but may add some cost and additional time to the program’s schedule.

Production Maturity

The Principal Deputy Assistant Secretary of the Air Force (Acquisition and Logistics) approved Increment 3.2B for production in August 2016, 2 months later than planned, after implementing a production readiness plan and completing qualification testing for the program's hardware components. The program office conducted an assessment of the production readiness in April 2016, finding 95 percent of critical manufacturing processes met the DOD standard for entering production. However, the contractor did not demonstrate manufacturing processes to be in statistical control prior to production start, which is inconsistent with best practices.

Other Program Issues

Program officials stated flight test delays are driven by reduced test facility availability, and noted delays in the F-35 test program have impacted test range availability for F-22 Inc. 3.2B. Program officials anticipate these delays will result in some cost and schedule growth. Program officials stated all F-22 Increment 3.2B modifications will be completed by contractor field teams at operating bases, which they believe is a more cost effective approach than depot-level maintenance. Depot-level maintenance is typically for major maintenance and repairs, such as overhauling, upgrading, or rebuilding parts, assemblies, or subassemblies, and is usually performed at a facility known as a depot.

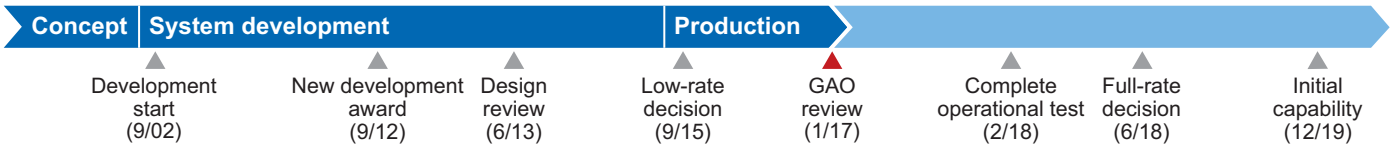
Program Office Comments

The program office was provided with a draft of this assessment and did not have any comments.

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 many legacy communication terminals. The FAB-T command post terminals (CPT) subprogram is expected to provide voice and data communications over military satellite networks for nuclear and conventional forces through ground command posts and E-6 and E-4 aircraft. Another subprogram is expected to provide force element capabilities on B-2, B-52, and RC-135 aircraft. We assessed the CPT subprogram.

Source: U.S. Air Force.



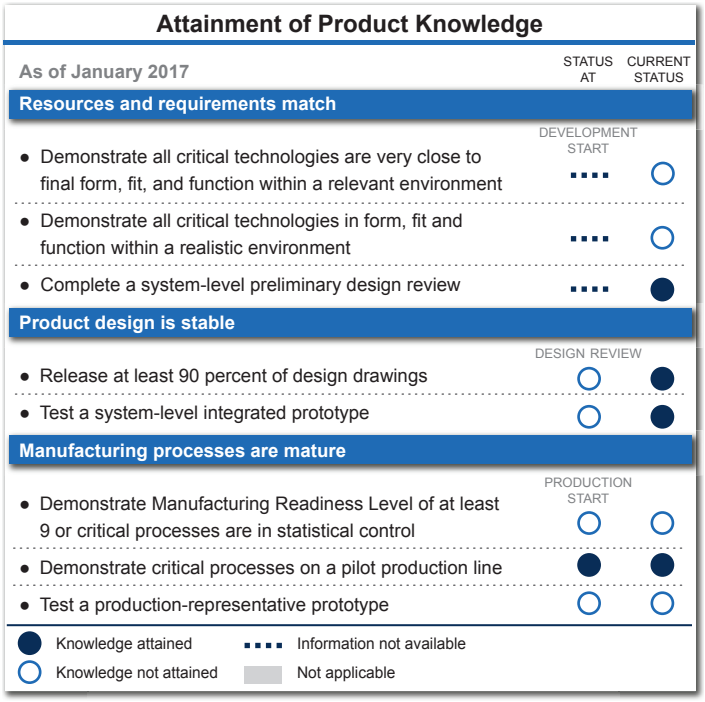
Program Essentials

Prime contractor: Raytheon
Program office: Bedford, MA
Funding needed to complete:
- R&D: $14.4 million
- Procurement: $350.3 million
- Total funding: $364.7 million
- Procurement quantity: 45

Program Performance (fiscal year 2017 dollars in millions)

	As of 12/2007	Latest 09/2016	Percent change
Research and development cost	$716.1	$1,175.3	64.1%
Procurement cost	$962.4	$637.6	-33.8%
Total program cost	$1,678.5	$1,812.9	8.0%
Program unit cost	$17.669	$16.632	-5.9%
Total quantities	95	109	14.7%
Acquisition cycle time (months)	129	207	60.5%

While the technologies for 22 initial FAB-T units appear mature, testing remains to be done to mature technologies for final configurations using new antennas and it is unclear whether FAB-T's design will remain stable. The Air Force expects to receive its first deliveries in 2017, but these initial units will eventually require retrofitting with new antennas. According to officials, issues discovered during testing and their resolution resulted in delays in maturing and stabilizing the new antenna configurations. The program expects to begin production of one of three new configurations in spring 2017, while the remaining two configurations will not be ready until the end of 2017. The program is conducting a cost and capability analysis for the force element terminals subprogram.



FAB-T CPT Program

Technology and Design Maturity

While FAB-T entered system development in 2002, the Air Force selected a new contractor to begin development in 2012. According to the program, technologies used for the first two lots of low-rate production units are now mature, but it is unclear whether the final design is stable. The initial units use fully functional modification kits for existing antennas but will eventually be retrofitted as technologies for new antennas are not yet mature. The program expected the new antennas to be fully mature prior to the second lot procurement decision, but delays continue. Officials attributed these delays to developmental testing issues. While testing the new antenna designs, the program reported a significant number of drawing increases, which indicates design instability. Going forward, program officials told us further design changes are possible for the new antennas while they are completing developmental testing.

Production Maturity

FAB-T received verbal approval to begin production in September 2015, followed by a formal acquisition decision in October 2015. At the time, FAB-T had not met best practice standards for beginning production, but, according to the program, it met DOD's standards. The program ordered 10 modification kits in September 2015 and 12 modification kits in July 2016. As of September 2016, the contractor had assembled eight terminals; however, issues identified in first article testing have delayed deliveries until 2017. According to officials, they expect one of three new antenna configurations—for fixed ground-based platforms—to be ready for production in spring 2017, at which time they may also purchase additional modification kits for existing airborne antenna. Officials do not expect the final two configurations—new antennas for airborne and transportable ground-based platforms—to be ready until the end of 2017.

FAB-T is authorized to purchase more than 60 percent of its total units during low-rate production. Generally, programs must provide a rationale if low-rate production quantities will exceed 10 percent of total quantities. Officials said these units are required to demonstrate initial operational capability by the end of 2019.

Other Program Issues

In July 2015, DOD separated the FAB-T program into two subprograms: CPT and force element terminals (FET). Currently, only the CPT subprogram is in development and production. In July 2016, the Air Force submitted a strategy for achieving the FET requirements to the Secretary of Defense. In September 2016, the program began a cost and capability analysis, which it expects to complete by September 2017. 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.

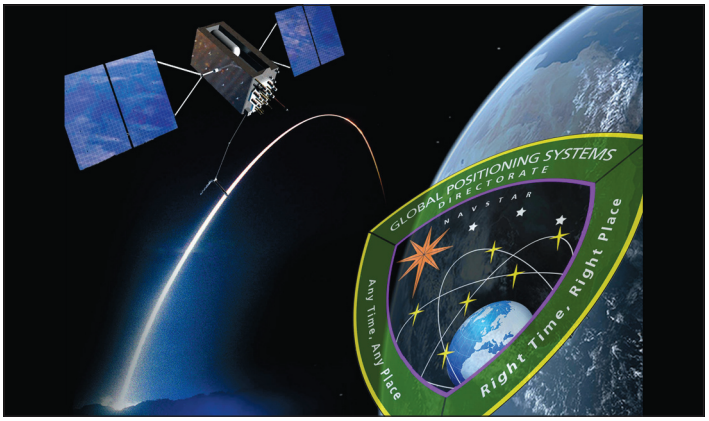
FAB-T is designed to communicate through the Advanced Extremely High Frequency (AEHF) network of satellites. Since FAB-T is not yet fielded while three of these satellites have already been launched, the lack of synchronization between the two programs has resulted in the underutilization of these costly satellite capabilities. By the time FAB-T achieves initial operational capability in 2019, one of the AEHF satellites will have been operating for nine years, over half of its projected 14-year operational lifetime.

Program Office Comments

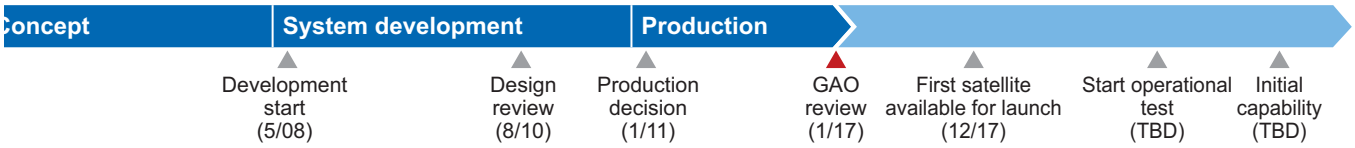
FAB-T officials stated the contractor continues development of the new ground fixed, ground transportable, and airborne antennas, and augments its workforce as needed by adding subject matter experts to address technical issues. Although the program has experienced delays in development of the new antennas, it has achieved success in government-led risk reduction testing. A FAB-T terminal was operated by space operations personnel in successful execution of over-the-air satellite telemetry, tracking, and control testing. All test objectives were successfully completed, which included all required active command functions for control of Milstar and AEHF satellites. In addition, the program office performed a series of free-field high-altitude electromagnetic pulse events simulating 68 nuclear air bursts, demonstrating the FAB-T will operate through electromagnetic effects. The program continues to actively visit sites in preparation for fielding FAB-T terminals in 2017.

Global Positioning System III (GPS III)

The Air Force's Global Positioning System (GPS) III program plans to develop and field a new generation of satellites to supplement and eventually replace the GPS satellites currently in use. Other programs are developing the related ground system and user equipment. GPS III is intended to provide capabilities for a stronger military navigation signal to improve jamming resistance and a new civilian signal that will be interoperable with foreign satellite navigation systems.



Source: U.S. Air Force.



Program Essentials

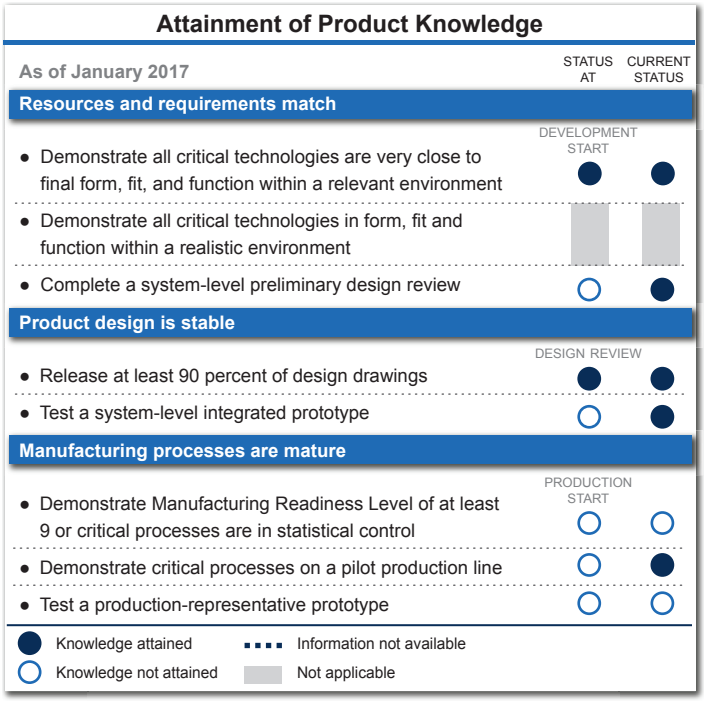
Prime contractor: Lockheed Martin
Program office: El Segundo, CA
Funding needed to complete:
- R&D: $183.7 million
- Procurement: $476.3 million
- Total funding: $660.1 million
- Procurement quantity: 0

Program Performance (fiscal year 2017 dollars in millions)

	As of 05/2008	Latest 09/2016	Percent change
Research and development cost	$2,738.0	$3,225.6	17.8%
Procurement cost	$1,537.2	$2,512.6	63.5%
Total program cost	$4,275.2	$5,738.3	34.2%
Program unit cost	$534.401	$573.827	7.4%
Total quantities	8	10	25.0%
Acquisition cycle time (months)	NA	NA	NA

We could not calculate acquisition cycle times for the first increment of the GPS III program because initial operational capability will not occur until satellites from a future increment are fielded.

The GPS III program currently reports mature technologies and a stable design, but manufacturing processes are not yet in statistical control. After a January 2016 rebaseline of the program's cost and schedule, the program identified deficiencies with subsystem components, which have contributed to new delivery delays of satellite equipment. The program has taken steps to mitigate these and other deficiencies, but now projects the first satellite's “available for launch” date will be delayed from August 2016 to February 2017 and additional delays are likely for the next seven satellites. Further, following extensive delays to the GPS III ground system—the Next Generation Operational Control System (OCX)—the Air Force now plans to accept delivery of the first eight satellites before operational testing confirms the satellite’s modernized signal capabilities.



GPS III Program

Technology, Design, and Production Maturity

The GPS III program currently reports all eight of its critical technologies are mature and the design is stable. In 2016, the program encountered technical issues involving capacitors—devices used to store energy and release it as electrical power. In investigating the capacitor failures, the program discovered the contractor skipped a key developmental step because a subcontractor had not conducted qualification testing for the capacitor's operational use in GPS III satellites. In response, the program conducted production lot reliability testing and design qualification testing of the capacitors. Design qualification successfully concluded in December 2016. However, test set-up problems invalidated the reliability testing of the production lot from which the failed capacitors originated. The program decided to assume risk and proceed “as is” with satellite 1, despite it being fitted mostly with capacitors from that lot. For satellites 2 and 3, the program ordered replacement of capacitors from the lot. The capacitor issue has also contributed to significant delays in the subcontractor’s delivery of navigation payload components, such as the mission data unit and transmitters. The program now projects a more than 6 month delay to the first satellite's “available for launch” date.

To prove out production processes prior to integrating and testing the first space vehicle, the program tested a system-level integrated prototype that includes all key subsystems and components but contains less built-in redundancy than the final configuration. Although the program previously reported a manufacturing process maturity level that indicated processes were in statistical control, the program has recently reported a lower level of maturity, indicating production processes are not yet fully in statistical control. While this reported maturity level is high enough to meet DOD's standards for production start, it does not meet the standard recommended by best practices.

Other Program Issues

Due to previously reported satellite launch availability delays, the program rebaselined its cost and schedule in January 2016. This rebaselining occurred prior to the February 2016 capacitor deficiencies, and, because of those and other subsequent technical issues, the contractor has now used up all available extra time in the program's schedule. The contractor is now projecting deliveries of satellites 1 through 8 will be delayed, on average, by about 6 months. The Defense Contract Management Agency is projecting an additional delivery delay of 9 months, on average, for each satellite beyond what the contractor now forecasts. According to contractor representatives, they are working with the navigation payload contractor to reduce the length of these delays.

Technical issues with both the GPS III satellite and the OCX Block 0 launch control and checkout system have combined to place the planned March 2018 launch date for the first GPS III satellite at risk. In order to launch in March 2018, the GPS III and OCX programs restructured their joint pre-launch integrated testing, reducing the campaign from 52 weeks to 42 weeks. Since then, a new 4 month delay to OCX readiness to begin launch preparation has forced additional campaign restructuring.

Because of extensive delays to OCX, the GPS III program is projecting to have delivered at least the first eight satellites and to have awarded a new contract for additional GPS III satellites before operational testing of the GPS III satellite with OCX Block 1 confirms the satellite's modernized signal capabilities.

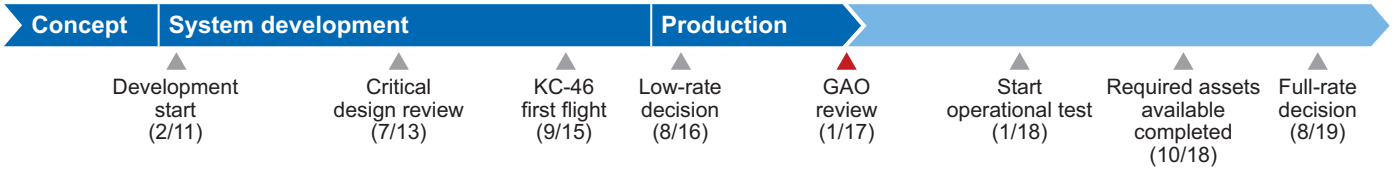
Program Office Comments

In commenting on a draft of this assessment, the program office noted the Air Force placed the first GPS III satellite into storage on February 27, 2017, after successfully completing all planned test and integration activities. The Air Force deferred declaring the first GPS III satellite available for launch due to a review of the Lockheed Martin A2100 propulsion sub-system. This review involved multiple space programs. The GPS program office is participating in the review and continues to monitor for any impacts to the planned GPS III initial launch capability in Spring 2018. The program office also provided technical comments, which were incorporated where deemed appropriate.

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

The Air Force's KC-46 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 the first of three planned phases to replace the Air Force's aging aerial refueling tanker fleet. The KC-46 has been designed to improve on the KC-135's refueling capacity, efficiency, capabilities for cargo and aeromedical evacuation, and to integrate defensive systems.

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



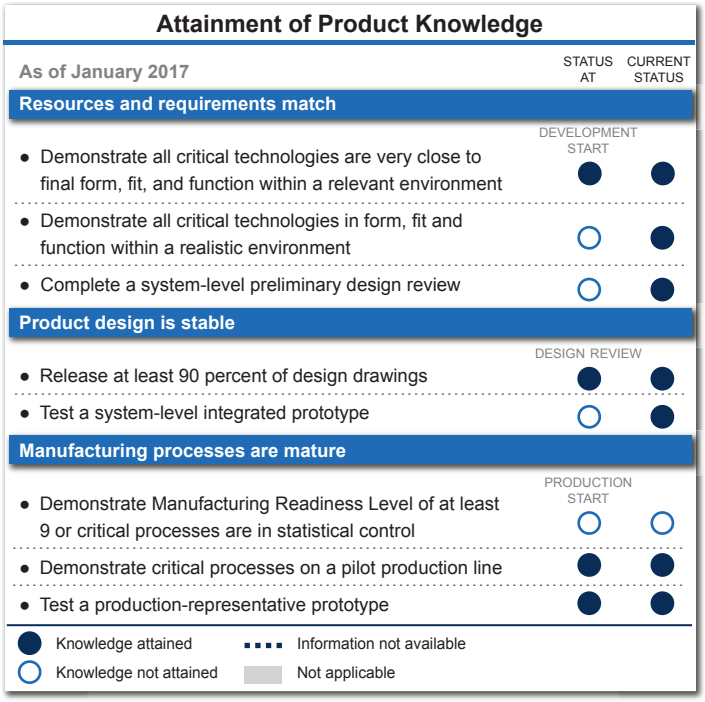
Program Essentials

Prime contractor: Boeing
Program office: Wright Patterson AFB, OH
Funding needed to complete:
- R&D: $283.0 million
- Procurement: $30,455.3 million
- Total funding: $33,098.9 million
- Procurement quantity: 156

Program Performance (fiscal year 2017 dollars in millions)

	As of 02/2011	Latest 06/2016	Percent change
Research and development cost	$7,432.2	$6,531.3	-12.1%
Procurement cost	$36,089,9	$34,266.5	-5.1%
Total program cost	$47,534.9	$43,626.5	-8.2%
Program unit cost	$265.558	$243.724	-8.2%
Total quantities	179	179	0.0%
Acquisition cycle time (months)	78	92	17.9%

In August 2016, the KC-46 program entered low-rate production with its three critical technologies fully mature. Although the Air Force considered the KC-46 design stable at the July 2013 critical design review, Boeing later discovered wiring issues that resulted in several changes to the aircraft's wiring system. The wiring design was finalized in March 2016 after Boeing had started producing aircraft. Boeing plans to correct the wiring on already produced aircraft prior to delivery to the Air Force. Under the terms of the development contract, Boeing bears the cost of correcting these deficiencies. According to Air Force and Boeing officials, Boeing will not make contractually-required deliveries at the required assets availability date in August 2017. Instead, Boeing plans to deliver the first 18 aircraft by February 2018, with the wing aerial refueling pods following in October 2018.



KC-46A Program

Technology and Design Maturity

The KC-46's three critical technologies—two software modules related to situational awareness and a three-dimensional display that allows the crew to monitor aerial refueling activities—are fully mature. At its July 2013 critical design review (CDR), the program had released over 90 percent of its design drawings. However, following CDR, Boeing discovered aircraft wiring deficiencies that have required it to re-design the wiring system to resolve separation issues. After several modifications, Boeing finalized the wiring design in March 2016.

As of December 2016, Boeing had completed about half of the planned KC-46 developmental testing. Until this testing completes, Boeing may find additional technical issues that may require design changes. For example, during demonstration flights, Boeing found a technical issue with the refueling boom that delayed the production decision by 4 months.

Production Maturity

Boeing has manufactured four development aircraft and has begun producing the first 12 low-rate initial production aircraft. Boeing is correcting the wiring on already produced low-rate initial production aircraft by incorporating the final wiring design. Under the terms of the development contract, Boeing bears the cost of correcting these deficiencies. Program officials state they will continue to monitor and assess production maturity leading up to the full-rate production decision in 2019. The program intends to purchase more than 25 percent of its total aircraft during low-rate initial production. Generally, programs must provide a rationale if low-rate initial production quantities are going to exceed 10 percent of total quantities. The Under Secretary of Defense for Acquisition, Technology and Logistics approved this acquisition strategy for the KC-46 program to avoid a break in the production line.

Other Program Issues

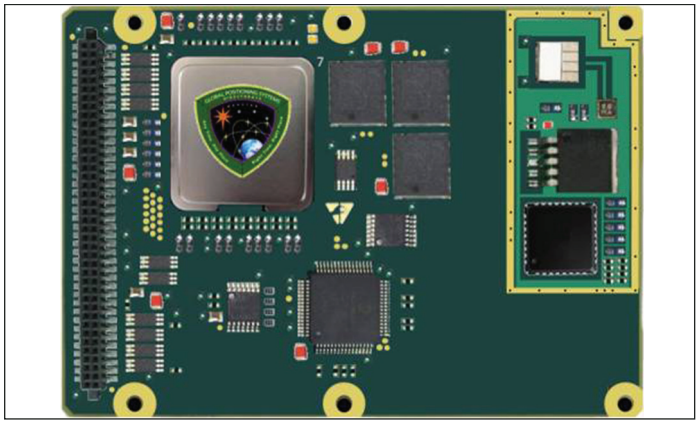
The Under Secretary of Defense for Acquisition, Technology and Logistics approved the KC-46 program to enter low-rate initial production in August 2016, one year later than originally planned. Boeing has proposed modifying its contract to delay delivery dates to account for testing and other delays it is currently experiencing, including qualifying the wing aerial refueling pod drogue systems, which are used to refuel two Navy or allied aircraft simultaneously. According to program officials, Boeing plans to deliver the first 18 aircraft with refueling booms and centerline drogue systems by February 2018. Wing aerial refueling pod components will be delivered in October 2018. At that point, Boeing will have delivered these items 14 months after their required availability in August 2017. Program officials are currently negotiating the necessary contract modifications related to this delay.

Program Office Comments

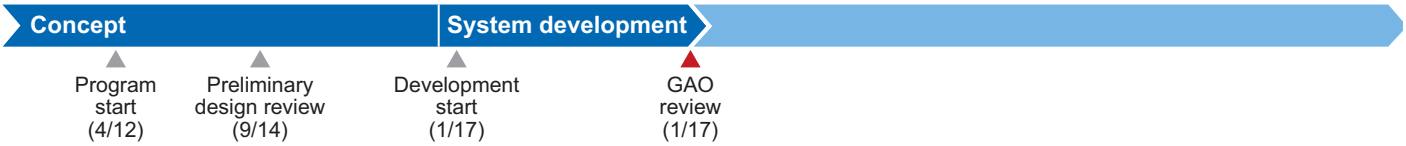
In commenting on a draft of this assessment, the program office provided technical comments, which were incorporated where deemed appropriate.

Military GPS User Equipment (MGUE) Increment 1

The Air Force's MGUE program plans to develop GPS receivers compatible with the military's next-generation GPS signal, Military-Code. The modernized receivers will provide U.S. forces with enhanced position, navigation, and time capabilities, while improving resistance to existing and emerging threats, such as jamming. The program consists of two increments. Increment 1, assessed here, leverages technologies from the Modernized User Equipment program to develop receivers for aviation, maritime, and ground platforms.



Source: U.S. Air Force.



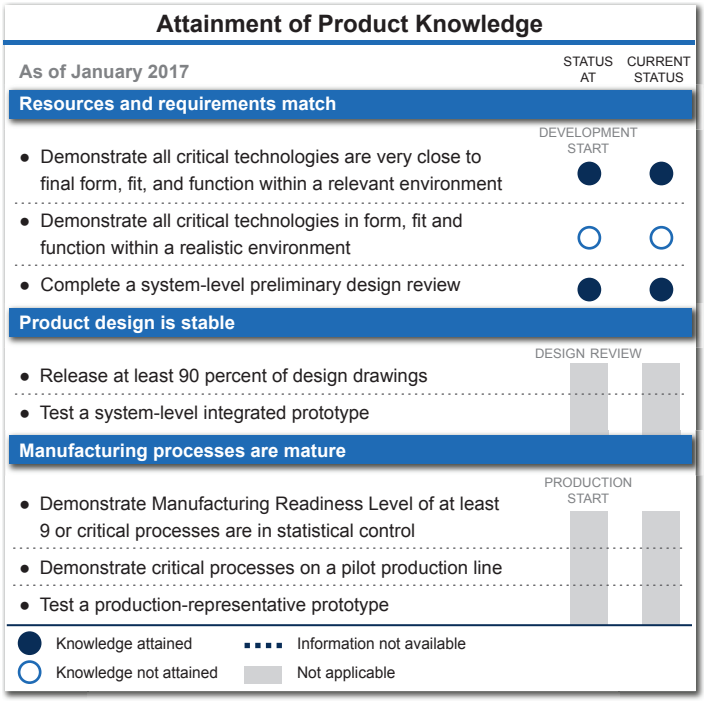
Program Essentials

Prime contractors: L-3, Raytheon, Rockwell Collins International
Program office: El Segundo, CA
Funding needed to complete:
- R&D: $585.1 million
- Procurement: $0.0 million
- Total funding: $585.1 million
- Procurement quantity: 0

Program Performance (fiscal year 2017 dollars in millions)

	As of	Latest 10/2016	Percent change
Research and development cost	NA	$1,143.5	NA
Procurement cost	NA	NA	NA
Total program cost	NA	$1,143.5	NA
Program unit cost	NA	NA	NA
Total quantities	NA	0	NA
Acquisition cycle time (months)	NA	NA	NA

MGUE entered system development in January 2017 with four of five critical technologies mature, but independent reviews raised concerns about past technology maturity assessments. MGUE recently began building finished hardware for testing and integration, but contractors will continue to incrementally develop and deliver software. Integration testing—during which time problems may be discovered—will not be completed until 2021, meaning the services are unlikely to have sufficient knowledge on which to base a procurement decision. The National Defense Authorization Act for Fiscal Year 2011 generally prohibits DOD from obligating or expending funds for GPS user equipment after fiscal year 2017 unless that equipment is capable of receiving military-code. The Secretary of Defense may waive this limitation under certain circumstances, or certain exceptions may apply.



MGUE Increment 1 Program

Technology and Design Maturity

The MGUE Increment 1 program entered system development in January 2017 and has assessed four of its five critical technologies—military-code acquisition engine, military-code cryptography, selective availability anti-spoofing module functionality, and anti-tamper—as mature. Anti-spoof is nearing maturity. However, independent reviews questioned past assessments of the program's technology maturity. MGUE maturity levels were last formally assessed during a November 2014 independent technology readiness assessment. At that time, DOD's Director, Operational Test and Evaluation expressed concerns about one of the Air Force's test demonstrations and emphasized in a memorandum to the Under Secretary of Defense for Acquisition, Technology and Logistics the Air Force had overstated MGUE maturity, and the demonstration results were more mixed than the service indicated. In September 2015, the Air Force Operational Test and Evaluation Center initiated an operational assessment of MGUE, but then terminated the assessment before completing it due to immature test articles and the lack of developmental performance testing and data. A senior program official indicated the software immaturity in MGUE test articles was largely responsible for the poor performance during the operational assessment.

In 2016, the program began providing final test articles to ground, air, and maritime platform offices to support risk reduction and subsystem integration activities. These test articles are finished hardware components, but the software they contain is incomplete. The three MGUE contractors will develop and deliver additional software increments, which will be uploaded to the existing hardware to support further test activities, including integration testing with the services' lead platforms. MGUE is scheduled to complete this phase of testing, which commonly reveals problems, in 2021.

Other Program Issues

MGUE will not have a production decision and the program's acquisition strategy does not provide for equipment procurement beyond the final test articles. Once operational testing is complete, the military services will assume responsibility for developing MGUE technology to a production-ready status, as well as funding, procuring, and integrating the components on their platforms.

The National Defense Authorization Act for Fiscal Year 2011 generally prohibits DOD from obligating or expending funds for GPS user equipment after fiscal year 2017 unless that equipment is capable of receiving military-code signals. However, due to delays in the program's operational testing schedule, the military services are unlikely to have sufficient knowledge to begin MGUE procurement at the start of fiscal year 2018. The Secretary of Defense may waive this funding limitation under certain circumstances, or exceptions may apply. Officials from each military service indicated they are likely to request a waiver.

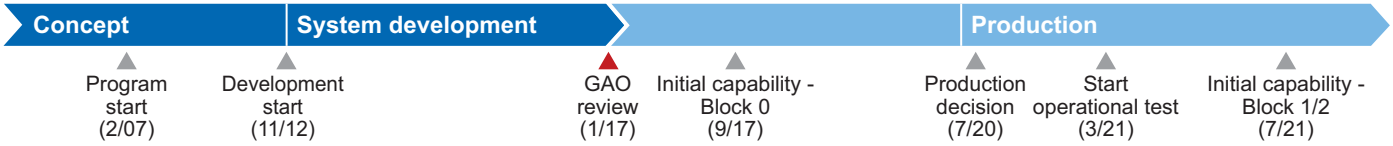
Program Office Comments

According to program officials, MGUE is conducting a test program intended to uncover risk as early as possible and verify the functional baseline, including testing on platforms and in software integration labs. Program officials report performance will be demonstrated through testing and will support the services need to procure MGUE receivers. Officials further noted program managers for non-lead platforms may make decisions on when to incorporate MGUE Increment 1 technology prior to the completion of the program.

Next Generation Operational Control System (GPS OCX)

The Air Force's GPS OCX is primarily a software development program to replace the existing ground control system. Intended to ensure reliable, secure delivery of position and timing information to military and civilian users, OCX software will be delivered in blocks, each providing upgrades as they become available. We assessed the first three blocks: Block 0 for initial, limited testing of new satellites; Block 1 for satellite control and basic military signals; and Block 2 for modernized military and additional navigation signals.

Source: U.S. Air Force.



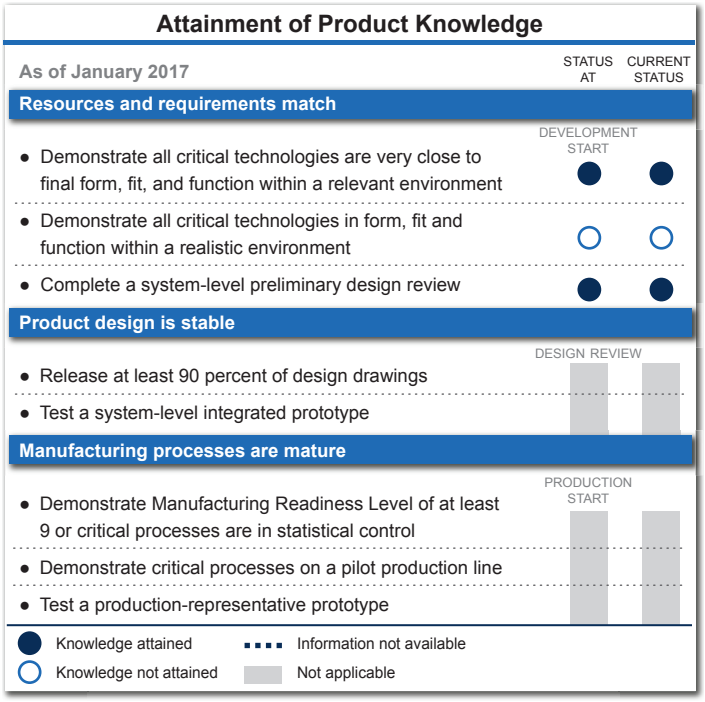
Program Essentials

Prime contractor: Raytheon
Program office: El Segundo, CA
Funding needed to complete:
- R&D: $2,183.4 million
- Procurement: $0.0 million
- Total funding: $2,183.4 million
- Procurement quantity: 1

Program Performance (fiscal year 2017 dollars in millions)

	As of 11/2012	Latest 09/2016	Percent change
Research and development cost	$3,591.8	$5,498.4	53.1%
Procurement cost	$0.0	$0.0	0.0%
Total program cost	$3,591.8	$5,498.4	53.1%
Program unit cost	$3,591.802	$5,498.444	53.1%
Total quantities	1	1	0.0%
Acquisition cycle time (months)	55	116	110.9%

The GPS OCX program considers all of its 14 critical technologies mature. The program awarded a development contract in early 2010 and entered system development in late 2012. The next year, the Air Force paused OCX development to address problems it believed were causing significant cost and schedule growth, and acknowledged program and contractor understanding of key requirements, especially cybersecurity, was deficient. The Air Force resumed OCX development in 2015, but the program continued to experience cost and schedule growth. Last year, the Air Force determined OCX would breach a statutory critical unit cost growth threshold, and require recertification to continue development. DOD recertified the program in October 2016, with cost growth of over 50 percent from the original program baseline and a 24-month schedule extension.



GPS OCX Program

Technology and Design Maturity

The OCX program currently assesses its 14 critical technologies as mature. The OCX program does not track the metrics we use to measure design maturity, such as the number of releasable design drawings, as it is primarily a software development effort.

OCX entered system development in November 2012 with all 14 critical technologies nearing maturity. This milestone was preceded by development contract award in February 2010 and preliminary design review in August 2011. In 2013, following high cost and schedule growth, the Air Force paused OCX development to identify and address the root causes thereof. According to program officials, the Air Force and the contractor had poorly understood key requirements, particularly for cybersecurity, which led to difficulty in developing effective software. Specifically, OCX contractor representatives said they did not fully understand the cybersecurity implementation requirements designed to help ensure system resistance to, and operation during, cyber-attacks.

In 2015, the Air Force restarted OCX software development activities prior to fully identifying and addressing root causes and without realistic cost and schedule estimates. DOD recently conducted a new root cause analysis, which identified that (1) external factors drove the program to an unrealistic schedule, (2) costs to fully implement information assurance requirements were underestimated, and (3) both the contractor and government had performed poorly. In December 2015, 2 months after re-baselining the schedule, the Office of the Under Secretary of Defense for Acquisitions, Technology and Logistics directed a high-risk, 24-month schedule extension to Block 1. OCX is also scheduled to repeat the milestone review associated with entry into system development by June 2017, after the contractor develops new cost and schedule baselines.

Other Program Issues

The program remains at high-risk of cost growth, schedule delays, and performance shortfalls to the deliveries of Block 0 and Block 1. The revised schedule optimistically assumes higher levels of software coding productivity than the contractor has previously accomplished, and reductions in defect rates using an entirely new software development methodology. Further, the schedule has insufficient margin for unexpected issues. In addition, although the contractor has nearly doubled the software engineers working on OCX, it is having difficulty training those staff on software development.

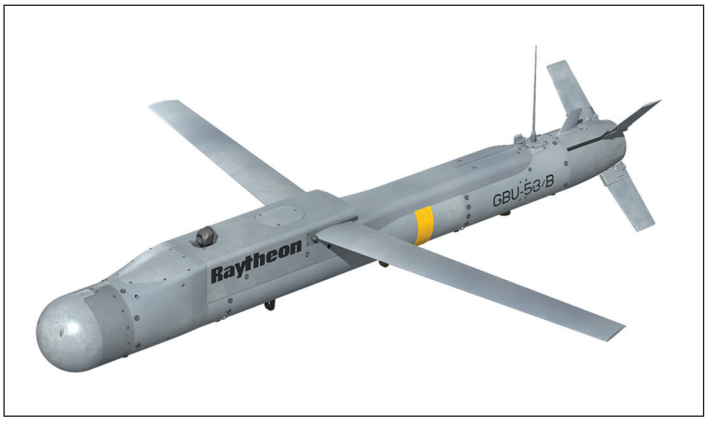
Delivery of OCX Block 0 may affect the program created to offset OCX delays, known as the Contingency Operations (COps) program. The COps program is intended to modify the existing GPS ground control system to allow it to control GPS III satellites after launch. The OCX Block 0 contractor delivery has slipped to September 2017, requiring some replanning with COps to prevent disrupting testing plans for common test equipment.

Program Office Comments

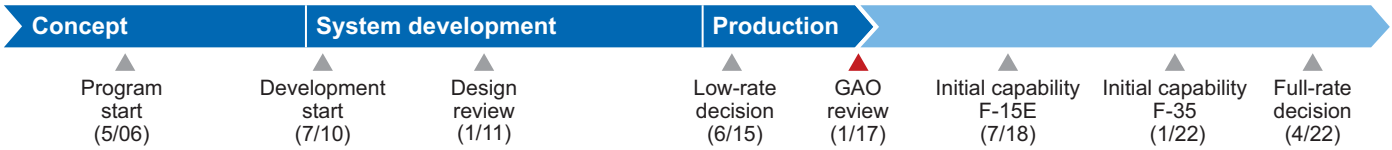
In commenting on a draft of this assessment, program officials provided the following information. Block 0 acceptance is on track for September 2017. The Air Force was directed at the December 2015 Deep Dive program review to plan to have the Block 1 software ready to transition to operations by July 2021. This date is being reassessed as part of the program's breach of a statutory critical unit cost growth threshold and subsequent program re-baselining planned for the summer 2017. All remaining Block 2 scope has been rephased to deliver concurrently with Block 1, so there is no longer a separate Block 2 delivery for OCX. Technical comments were also provided by the program office, which were incorporated where deemed appropriate.

Small Diameter Bomb Increment II (SDB II)

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



Source: © 2009 Raytheon Company.



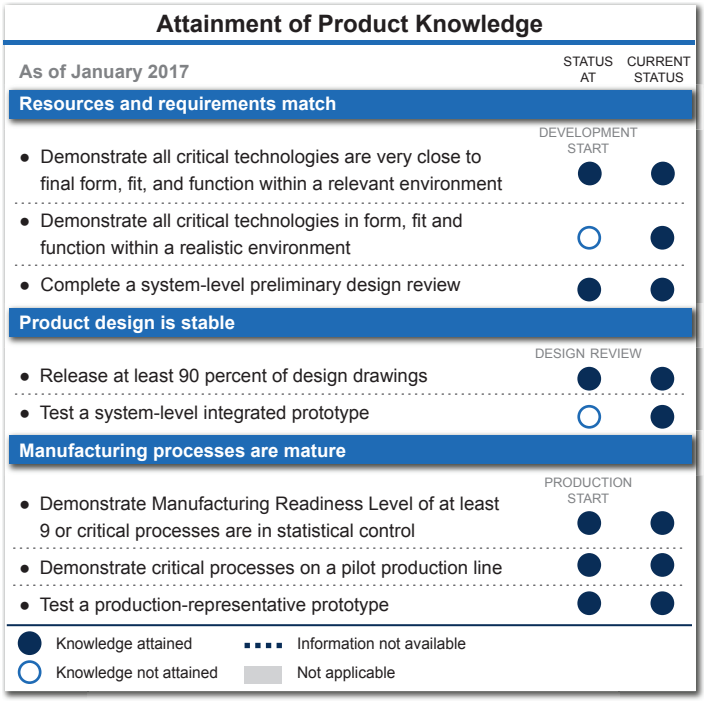
Program Essentials

Prime contractor: Raytheon
Program office: Eglin AFB, FL
Funding needed to complete:
- R&D: $497.2 million
- Procurement: $2,349.3 million
- Total funding: $2,846.5 million
- Procurement quantity: 16,606

Program Performance (fiscal year 2017 dollars in millions)

	As of 10/2010	Latest 08/2016	Percent change
Research and development cost	$1,784.1	$1,832.2	2.7%
Procurement cost	$3,316.2	$2,454.6	-26.0%
Total program cost	$5,100.3	$4,286.8	-15.9%
Program unit cost	$0.297	$0.250	-15.9%
Total quantities	17,163	17,163	0.0%
Acquisition cycle time (months)	72	96	33.3%

SDB II entered production in June 2015 with all of its critical technologies mature; however, its design was unstable. The program still has significant testing to complete, and any problems discovered could result in further design changes. Since January 2016, the program has conducted 25 flight tests and failed 6 of them. These flight test failures occurred during all three of SDB II's attack modes. The program successfully retested two of the failed tests and plans to retest others. These failures have contributed to the program's 6-month delay in initial operational capability with the F-15E. The program also successfully completed the corrosive atmosphere testing that was required before awarding a second production contract in September 2016. The program's critical processes for production are in statistical control.



SDB II Program

Technology and Design Maturity

SDB II's four critical technologies—guidance and control, multi-mode seeker, net ready data link, and payload—are mature. These technologies did not mature though until almost 5 years after development start, in time for the program's low-rate production decision in June 2015.

Deficiencies in SDB II's design were revealed at production start as a result of qualification and flight test failures that required hardware and software changes. Additional changes and retrofits remain possible as SDB II continues developmental testing. Since January 2016, the program has conducted 25 flight tests in all three of the SDB II attack modes. Six of these tests did not achieve their objectives. Specifically, one live fire test, one government confidence test, and 2 guided flight tests failed to impact their intended targets; one laser flight test performed as intended, but the pilot lost the track of the intended target and the weapon missed; and one coordinate attack flight test detonated 10 times above the planned detonation height. The program successfully retested the 2 guided flight tests and plans to retest both the laser flight test and the coordinate attack flight test. According to officials, the program has modified SDB II software and hardware to correct for known failures.

These testing outcomes contributed to a 6-month delay in SDB II's initial operational capability with the F-15E. The program began a "government confidence test" program in October 2016 and has conducted 6 of the 28 shots, all of which will occur in the normal attack mode. The program added these tests at the direction of the Office of the Secretary of Defense to test against additional, real world scenarios. The program plans to complete this test program within 9 months. However, failures of any of the government confidence tests could delay subsequent tests.

Production Maturity

The contractor is scheduled to begin low-rate initial production of the first 144 units (Lot 1) in March 2017, following current production of SDB II test assets. The program awarded a second production contract (Lot 2) in September 2016 for 250 additional units and a third production contract (Lot 3) in January 2017 for 312 additional units. According to the program, its critical manufacturing processes are in statistical control.

Other Program Issues

In 2016, the program completed corrosive atmosphere environmental testing of SDB II, which revealed deficiencies. This testing built upon prior testing in 2014 and 2015, which informed SDB II's low-rate production decision in June 2015. According to officials, this testing simulated the bomb's exposure to various environmental conditions for an extended period outside of its protective container. In the 2016 testing, SDB II passed the required software tests but failed functionality tests. Specifically, the dome cover, wings, air turbine alternator, and UHF antenna failed to deploy. The program implemented corrective fixes and then retested successfully. According to the program, this successful test was necessary before the program could award the Lot 2 production contract. Officials stated the design changes from the environmental test will be incorporated into Lot 2 production, which will cause Lot 1 and 2 configurations to be slightly different. According to officials, recent environmental testing was mainly to ensure SDB II survivability after exposure to the environment of Navy ships, although the Navy does not intend to procure any bombs until Lot 4 production.

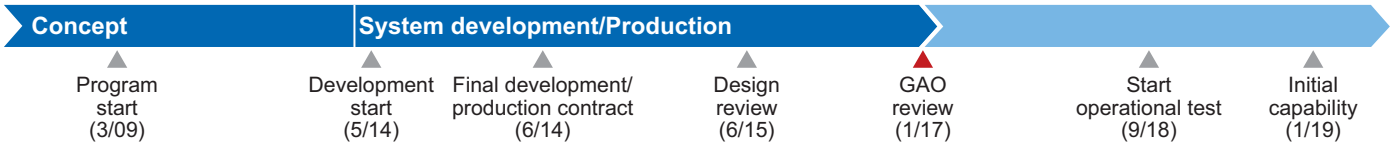
Program Office Comments

According to program officials, SDB II is demonstrating effectiveness and lethality in flight test. The program is events-based and is effectively resolving technical issues. Recent flight tests demonstrated successful performance against two important requirements: performance in adverse weather and weapon control by a third party.

Space Fence Ground-Based Radar System Increment 1

The Air Force's Space Fence Increment 1 program is developing a large, ground-based radar to detect and track objects in low and medium Earth orbit and provide this information to a space surveillance network. Space Fence is designed to 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 site in June 2014, and included a second site as an option, which, if exercised, will be acquired as Increment 2 in a separate program.

Source: U.S. Air Force.



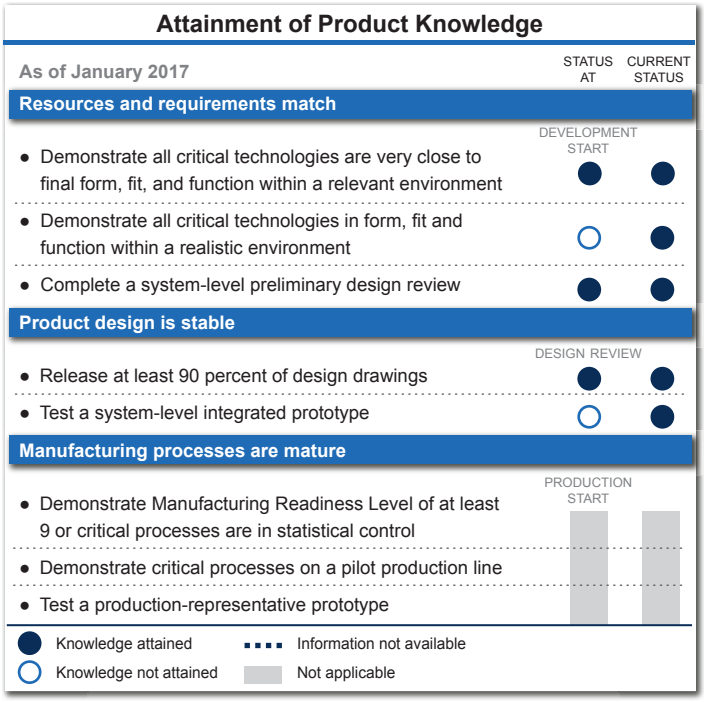
Program Essentials

Prime contractor: Lockheed Martin
Program office: Hanscom AFB, MA
Funding needed to complete:
- R&D: $219.9 million
- Procurement: $0.0 million
- Total funding: $219.9 million
- Procurement quantity: 0

Program Performance (fiscal year 2017 dollars in millions)

	As of 06/2014	Latest 08/2016	Percent change
Research and development cost	$1,632.1	$1,553.3	-4.8%
Procurement cost	$0.0	$0.0	0.0%
Total program cost	$1,632.1	$1,553.3	-4.8%
Program unit cost	$1,632.122	$1,553.276	-4.8%
Total quantities	1	1	0.0%
Acquisition cycle time (months)	124	118	-4.8%

Since our last assessment, the Space Fence program began testing an integrated prototype radar that includes production-representative elements and uses software developed for the operational radar. According to the Air Force, the prototype has demonstrated up to 70 percent of the operational radar's capability. The program recently delayed its operational testing and initial capability dates due to challenges with construction of the facilities to house the radar. However, program officials report these delays will not affect the program's ability to meet its schedule requirements. To accommodate the projected volume of data generated by Space Fence, the Air Force is developing a new data processing system under a separate program. Despite recent delays in this program, the Air Force expects to developmentally test the data processing system with Space Fence in 2018.



Space Fence Inc 1 Program

Technology Maturity

A February 2015 technology readiness assessment showed all seven of the program's critical technologies are fully mature. This maturity was achieved by integrating the technologies into a prototype radar array—and demonstrating that array in an operational environment—in support of the critical design review. Space Fence technologies provide capabilities for transmitting and receiving radar signals from the radar array.

Design and Production Maturity

In early 2016, the program began testing a prototype that uses production-representative hardware and runs the software designed for the operational radar. According to the program, the prototype has demonstrated about 70 percent of Space Fence performance requirements. According to the program office, the prototype is not a contract requirement; the contractor elected to build it as part of the development process and it has helped them learn more about the installation of radar components and to identify and correct software defects.

The Space Fence program is tracking the maturity of two critical manufacturing processes for components of the radar's transmit and receive modules. The contractor has not demonstrated these processes to be in statistical control, as recommended by best practices, but has achieved the level of maturity required in the system development contract. According to the program office, it is tracking a manufacturing delay for one component of the radar but expects to complete production and ship the components within the necessary timeline.

Other Program Issues

The Space Fence program delayed its operational testing and initial operational capability events due to challenges constructing facilities to house the radar and poor performance by a subcontractor. These delays eliminated the extra time built into the contractor's schedule, but program officials stated the program remains on track to meet its baseline schedule requirements.

Space Fence Increment 1 is expected to meet the Air Force's requirements for initial operational capability, but full capability will only be achieved once a second site is operational. Development and production of the second site, which will represent an Increment 2 program, is a contract option. The program noted the Air Force will need to make a preliminary decision on an Increment 2 by summer 2017 for budgeting purposes, though the option for a second site will not be exercised until Increment 1 achieves initial operational capability.

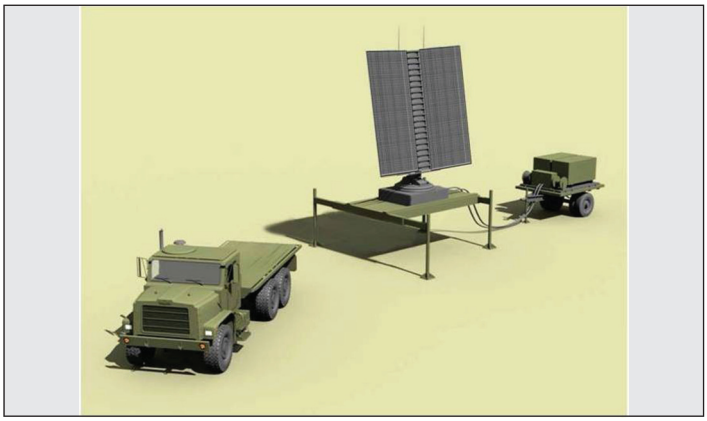
The Joint Space Operations Center (JSpOC) at Vandenberg AFB is acquiring new data processing capabilities under its JSpOC Mission System (JMS), designed in part to enable processing of the increased volume of data expected from Space Fence. However, the JMS program has experienced delays over the past year. Completion of developmental testing of JMS software has been delayed from August 2015 to February 2018. According to the Space Fence program office, this software is needed to complete Space Fence testing in September 2018, and the JMS schedule currently supports this date. Alternatively, if JMS software is further delayed, Space Fence developmental testing could be accomplished through modeling and simulating JMS capabilities, according to the Space Fence program. However if this option were used for operational testing, it may cause schedule delays as it would require accreditation of the model—an activity for which the Air Force has not budgeted or planned.

Program Office Comments

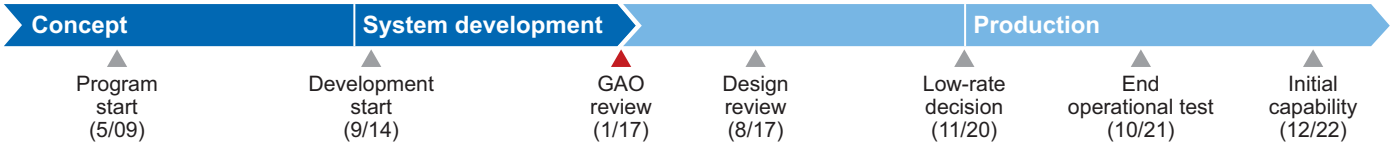
In commenting on a draft of this assessment, the program office noted the program continues to move forward with minimal impacts to cost and schedule since contract award. It concluded software development in October 2016 and anticipated completing 85 percent of radar manufacturing by the end of 2016. The program stated the construction of the sensor site and power plant annex facilities on Kwajalein was an issue early in 2016, and the contractor took steps to offload work from an underperforming second tier subcontractor, including replacing the construction subcontractor team lead and bringing in its own senior construction managers. In December 2016, the program successfully verified 94 percent of the 298 requirements tested by the contractor. In 2017, the program will focus on completing facility construction, radar installation and check out, integrating the sensor site with the power plant annex, and providing power to the transmit and receive arrays.

Three-Dimensional Expeditionary Long-Range Radar (3DELRR)

The Air Force's 3DELRR is being developed as a long-range, ground-based sensor for detecting, identifying, tracking, and reporting aerial targets, including highly maneuverable and low observable targets. The system intends to provide real-time data and support a range of operations in all types of weather and terrain. It will replace the Air Force's AN/TPS-75 radar system, which has reached the end of its service life and is becoming more costly to maintain.



Source: U.S. Air Force.



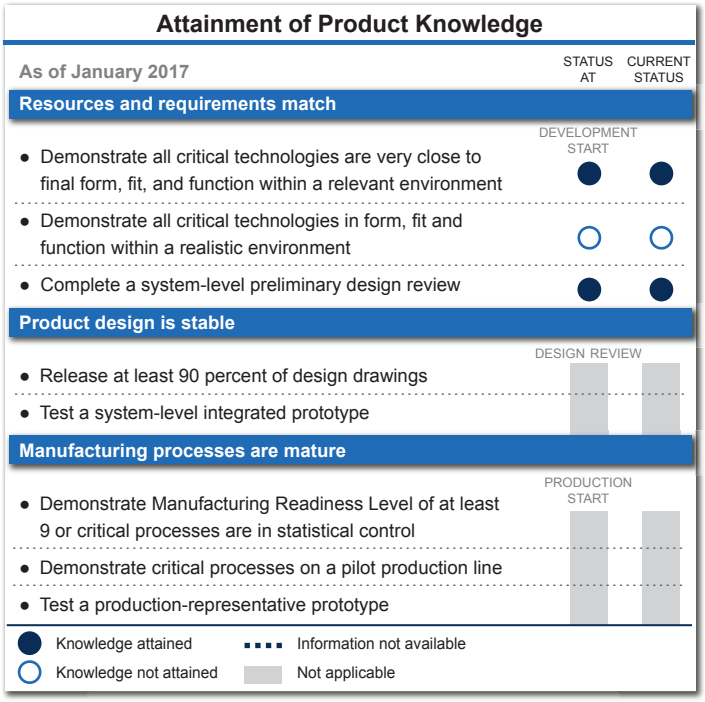
Program Essentials

Prime contractor: TBD
Program office: Hanscom AFB, MA
Funding needed: (FY 2017 to FY 2021):
- R&D: $150.7 million
- Procurement: $267.5 million
- Total funding: $418.2 million
- Procurement quantity: 11

Program Performance (fiscal year 2017 dollars in millions)

	As of	Latest 11/2016	Percent change
Research and development cost	NA	$483.8	NA
Procurement cost	NA	$938.5	NA
Total program cost	NA	$1,422.2	NA
Program unit cost	NA	$40.636	NA
Total quantities	NA	35	NA
Acquisition cycle time (months)	NA	163	NA

In October 2014, 3DELRR entered system development and awarded a development contract. At this point, all of the program's critical technologies were nearing maturity. However, bid protests delayed the start of development work, and the Air Force re-opened the competition in response to issues raised in the protests. The Air Force plans to award a new development contract in the second quarter of fiscal year 2017, more than 2 years after the original contract award. Prior to the start of development, the program took steps to reduce technical risk and costs by conducting system-level competitive prototyping and analyzing the tradeoffs between costs and requirements. The program's remaining risks may vary based on the design selected for development, although software integration will be a risk regardless of the contractor.



3DELRR Program

Technology and Design Maturity

The 3DELRR program entered system development in October 2014 with all of its critical technologies approaching maturity. Shortly thereafter, the Air Force suspended performance on the development contract awarded to Raytheon as a result of bid protests by Lockheed Martin and Northrop Grumman. In January 2015, GAO dismissed the protests when the Air Force agreed to take corrective actions to address the issues raised. The program subsequently re-entered the source selection phase, which it expects to conclude in early 2017.

Following the new source selection, the program plans to fully mature its critical technologies by demonstrating them in a realistic environment. According to program officials, the critical technologies will vary based on the contractor design selected for development. Further, as a result of the ongoing source selection process, the program office was not yet able to provide us with data on 3DELRR design drawings, which we use to evaluate design stability under our best practices criteria. The program office did, however, identify several developmental risks it is tracking that could carry design implications. For example, 3DELRR's planned design is software-intensive, and program officials identified software development as a risk because, if not performed adequately, subsequent integration of hardware and software could be delayed. Program officials also stated integrating the extensive amount of re-used software code contributed to the level of risk, but noted each contractor is planning to test software prior to integration with the system. In addition, 3DELRR is expected to use a new semiconductor technology, which relies on gallium nitride-based modules for individual radiating elements key to transmitting and receiving electromagnetic signals, rather than the legacy gallium arsenide transmit/receive modules. While the long-term reliability and performance of gallium nitride is unknown and could affect radar sensitivity and power requirements, it has the potential to provide higher efficiency with lower power and cooling demands than legacy semiconductor technology.

To reduce technical risk ahead of system development, the 3DELRR program conducted system-level competitive prototyping, held preliminary design reviews with multiple contractors, and conducted capability demonstrations. According to program officials, these efforts helped the program develop critical technologies, refine technical requirements and cost estimates, and assess manufacturing readiness.

Other Program Issues

Program officials stated the program re-entered source selection in May 2015 and had originally planned to award a new system development contract in the second quarter of fiscal year 2016. However, program officials stated the contract award has been delayed a year to the second quarter of fiscal year 2017, in part because the program added a full-rate production option to the solicitation in July 2016. The original development contract awarded in October 2014 included a low-rate initial production option, and the Air Force had planned to award a separate sole source contract for full-rate production. Program officials stated the full-rate production option was added to take advantage of the increased competition resulting from 3DELRR's participation in the Defense Exportability Features Program, which provides contractors an early opportunity to engage in DOD-sponsored foreign military sales and associated logistics support.

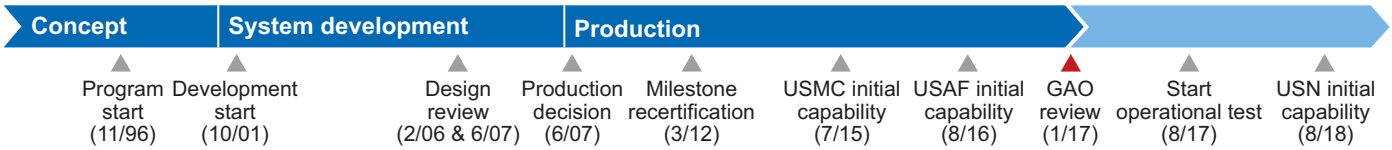
Program Office Comments

The program office concurred with this assessment and provided technical comments, which were incorporated where appropriate.

F-35 Lightning II Program (F-35)

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

Source: © 2016 Lockheed Martin.



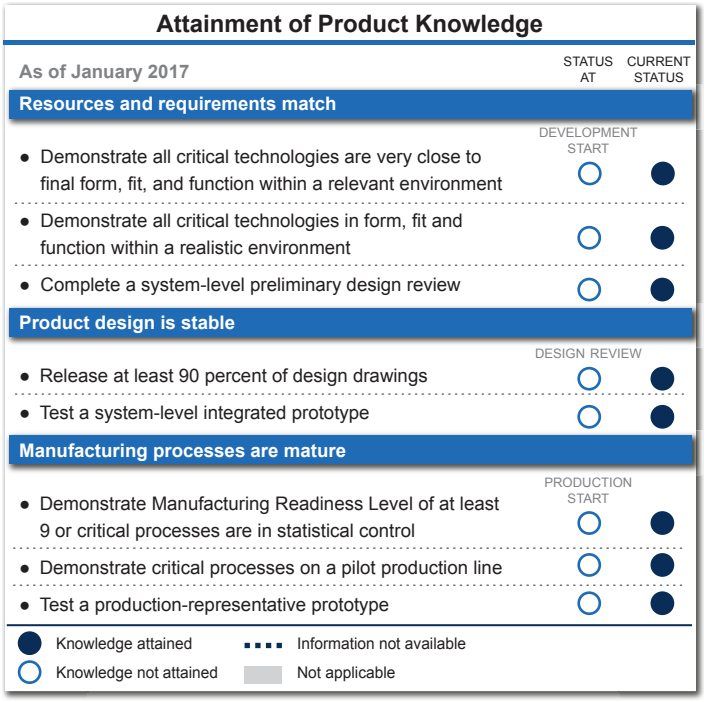
Program Essentials

Prime contractors: Lockheed Martin, Pratt & Whitney
Program office: Arlington, VA
Funding needed to complete:
- R&D: $1,706.7 million
- Procurement: $209,658.2 million
- Total funding: $213,918.1 million
- Procurement quantity: 2,158

Program Performance (fiscal year 2017 dollars in millions)

	As of 10/2001	Latest 12/2015	Percent change
Research and development cost	$42,277.5	$63,838.6	51.0%
Procurement cost	$187,565.4	$267,912.7	42.8%
Total program cost	231,806.3	$336,152.4	45.0%
Program unit cost	$80.881	$136.814	69.2%
Total quantities	2,866	2,457	-14.3%
Acquisition cycle time (months)	175	237	35.4%

All of the F-35 program's critical technologies are fully mature. A previous critical technology that had not been fully matured has now been deferred to follow-on development. Although the aircraft designs were not stable at their critical design reviews in 2006 and 2007, all baseline engineering drawings have since been released. While developmental testing is progressing, design changes are likely until the program completes these tests. Manufacturing efficiency is steady, and program officials stated that critical production processes are in control. The program is planning follow-on modernization to address capability deferrals, upgrade existing capabilities, and integrate additional weapons into the F-35 aircraft.



F-35 Program

Technology and Design Maturity

All of the F-35 program's critical technologies are fully mature. In 2013, the program deferred plans for integrating a prognostics and health management system technology into the aircraft design. The program had identified this technology, which is part of the F-35 Autonomic Logistics Information System (ALIS), as critical but not fully mature. The program now plans to integrate this technology into the F-35 design as part of a later block of aircraft. In addition, the program has yet to incorporate engine health data into ALIS. Further, the program continues to address issues with other technologies including the next-generation helmet, which is currently providing degraded night vision capabilities at sea.

Although the aircraft designs were not stable at their critical design reviews in 2006 and 2007, the program has since released all baseline engineering drawings. As the program nears the end of developmental testing, officials continue to identify and address technical risks. For example, the prime contractor implemented design changes to address deficiencies with the arresting hook and engine and, during 2016, began addressing ejection seat problems. In addition, the Navy recently identified problems affecting the F-35C wing structure when carrying an AIM-9X missile and is identifying design changes. The program faces the risk of further design changes until developmental testing is complete.

Production Maturity

Aircraft manufacturing deliveries remain steady and totaled 199 production aircraft as of December 2016. Since the start of production, the contractor's production processes have continued to mature, and program officials stated that critical production processes are now in control. To enable continued improvements and to increase quality, the contractor tracks process control data and other quality indicators. Production part shortages remain a risk as suppliers face additional pressures of balancing an increased production rate amid the simultaneous need to sustain a growing operational fleet.

Other Program Issues

In July 2015, the Marine Corps declared F-35B initial operational capability (IOC) prior to meeting all expected requirements. In particular, F-35B offered only limited capabilities with respect to eight performance requirements, including those centered on sensor fusion, electronic warfare, and communication. The full capabilities for these requirements were delivered in a subsequent software upgrade. The Air Force declared F-35A IOC in August 2016 having met and delivered all expected capabilities. The Navy F-35C IOC date is scheduled for August 2018.

F-35 flight testing has been consistently delayed over the past several years, and in the past year, the program encountered additional delays. The program estimates it needs an additional 5 months to complete developmental testing and $451 million to complete the development program. These estimates are optimistic and assume that the program will be able to accomplish remaining tests at a significantly faster pace than historically demonstrated. The Director, Operational Test and Evaluation reported that the program will need significantly more time and money than it now forecasts, which could jeopardize the program's schedule for initial operational test and evaluation, full-rate production, and follow-on modernization.

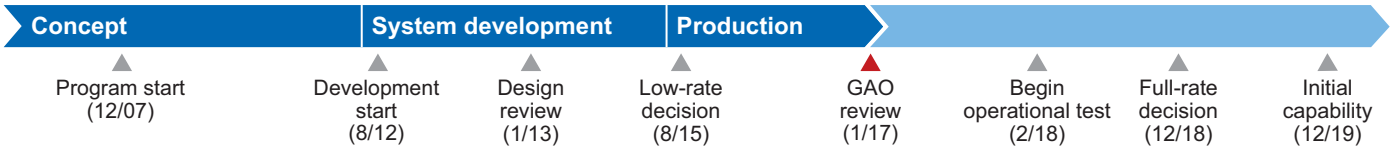
Program Office Comments

According to program officials, the prognostics and health management system, less the downlink capability, has been operating on the aircraft and continues to mature. The prognostics and health management system downlink capability was deferred due to certification concerns, not immature technology. Currently, officials state engine maintenance data is processed using a dedicated engine tool. Engine data will be processed in ALIS with the fielding of ALIS 2.0.2 in spring 2017, and the update will eliminate the need for the engine tool workaround. Officials also said the night vision capability of the helmet has been significantly improved with the newest generation helmet. F-35s are now permanently operating overseas. In January 2017, the Marine Corps deployed 10 F-35Bs from its air station in Yuma, Arizona to the air station in Iwakuni, Japan. Program officials noted some risk exists to completion of system development; however, steady reduction of known challenges and a slowly decreasing rate of new discovery should allow for completion within the established acquisition program baseline.

Joint Light Tactical Vehicle (JLTV)

The Army and Marine Corps' JLTV is a family of vehicles being developed to replace the High Mobility Multipurpose Wheeled Vehicle (HMMWV) for some missions. The JLTV is expected to provide protection for passengers against current and future battlefield threats, increased payload capacity, and improved automotive performance over the up-armored HMMWV. It will also be transportable by air and ship. Two- and four-seat variants are planned with multiple mission configurations.

Source: U.S. Army.



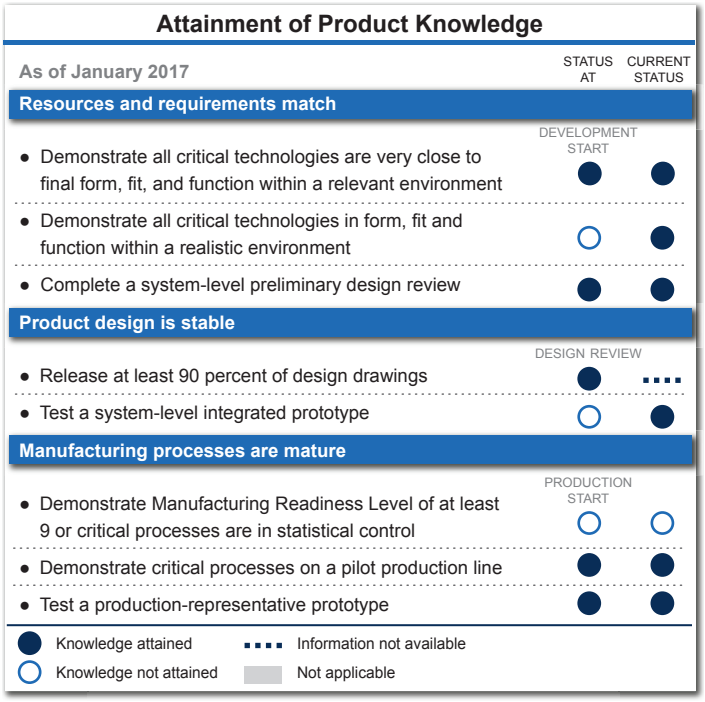
Program Essentials

Prime contractor: Oshkosh Defense LLC
Program office: Harrison Township, MI
Funding needed to complete:
- R&D: $122.0 million
- Procurement: $19,010.8 million
- Total funding: $19,132.8 million
- Procurement quantity: 53,372

Program Performance (fiscal year 2017 dollars in millions)

	As of 10/2012	Latest 12/2015	Percent change
Research and development cost	$1,032.6	$978.2	-5.3%
Procurement cost	$23,373.8	$19,489.0	-16.6%
Total program cost	$24,444.9	$20,467.2	-16.3%
Program unit cost	$0.447	$0.374	-16.2%
Total quantities	54,730	54,714	0.0%
Acquisition cycle time (months)	125	144	-29.6%

Both JLTV critical technologies—underbelly protection armor and side-kit armor—are mature and, according to officials, have been integrated and tested on production-representative vehicles. During development, operational testers found shortcomings that can likely only be overcome with changes in tactics or procedures. The government conducted design understanding reviews, instead of a formal critical design review, for three competing vehicle designs to assess their technical baselines. To assess manufacturing readiness and risk prior to production start, the program conducted a manufacturing readiness assessment using manufacturing readiness levels. While the program's manufacturing process maturity may have reached DOD's recommended level for production, it has not reached a level that indicates processes are in control, as recommended by best practices.



JLTV Program

Technology and Design Maturity

According to the program office, JLTV's two critical technologies—underbelly protection armor and side-kit armor—are fully mature. According to Army officials, prototype systems with the critical technologies have been tested in a realistic environment. The JLTV program office declared both technologies are mature and have been demonstrated under operational conditions.

The program office did not hold a formal critical design review during development, but instead conducted design understanding reviews with contractors between December 2012 and January 2013. According to program officials, these reviews were at a level of detail similar to a critical design review and verified that all contractors had more than 90 percent of the design files under configuration control. According to operational testers, the Oshkosh JLTV design, which the Army ultimately selected for production, more than doubles the reliability of the up-armored HMMWV, as measured by average miles traveled before mechanical failure. Testers also noted Army units cannot accomplish air assault missions with JLTVs that already have add-on armor installed because the combined weight exceeds the CH-47F helicopter's lift capacity. However, program officials stated the JLTV requirement for CH-47F air assault missions is with base armor protection and not with the add-on armor installed. Operational testers also noted the JLTV's design did not offer sufficient capability to carry mission equipment, supplies, or water for more than a single day, which limits the vehicle's mission type and duration. This limitation may require operational commanders to manage mission payloads to remain within JLTV's capacities.

Production Maturity

The Army did not demonstrate production readiness with statistical process control data prior to awarding the production contract in August 2015. For the engineering and manufacturing development phase, Oshkosh built 20 prototype JLTV vehicles on an assembly line used to produce the Family of Medium Tactical Vehicles and a version of the Mine-Resistant Ambush Protected vehicle. According to program officials, this quantity was insufficient for providing meaningful statistical control data. To assess production readiness and manufacturing risks prior to production start, the program conducted a manufacturing readiness assessment using manufacturing readiness levels. According to program officials, the contractor has now begun collecting production process capability index data from low-rate production units for statistical control purposes. Also, the design and manufacturing teams continue identifying key product characteristics and manufacturing processes. The program and the contractor are working together to identify critical and significant characteristics for each subsystem, a process the program office says should take a year. While program officials declared manufacturing process maturity reached DOD's recommended level for production, the program has not yet demonstrated that JLTV manufacturing processes are in statistical control as recommended by best practices.

Program Office Comments

In commenting on a draft of this assessment, the program office provided technical comments, which were incorporated where deemed appropriate.