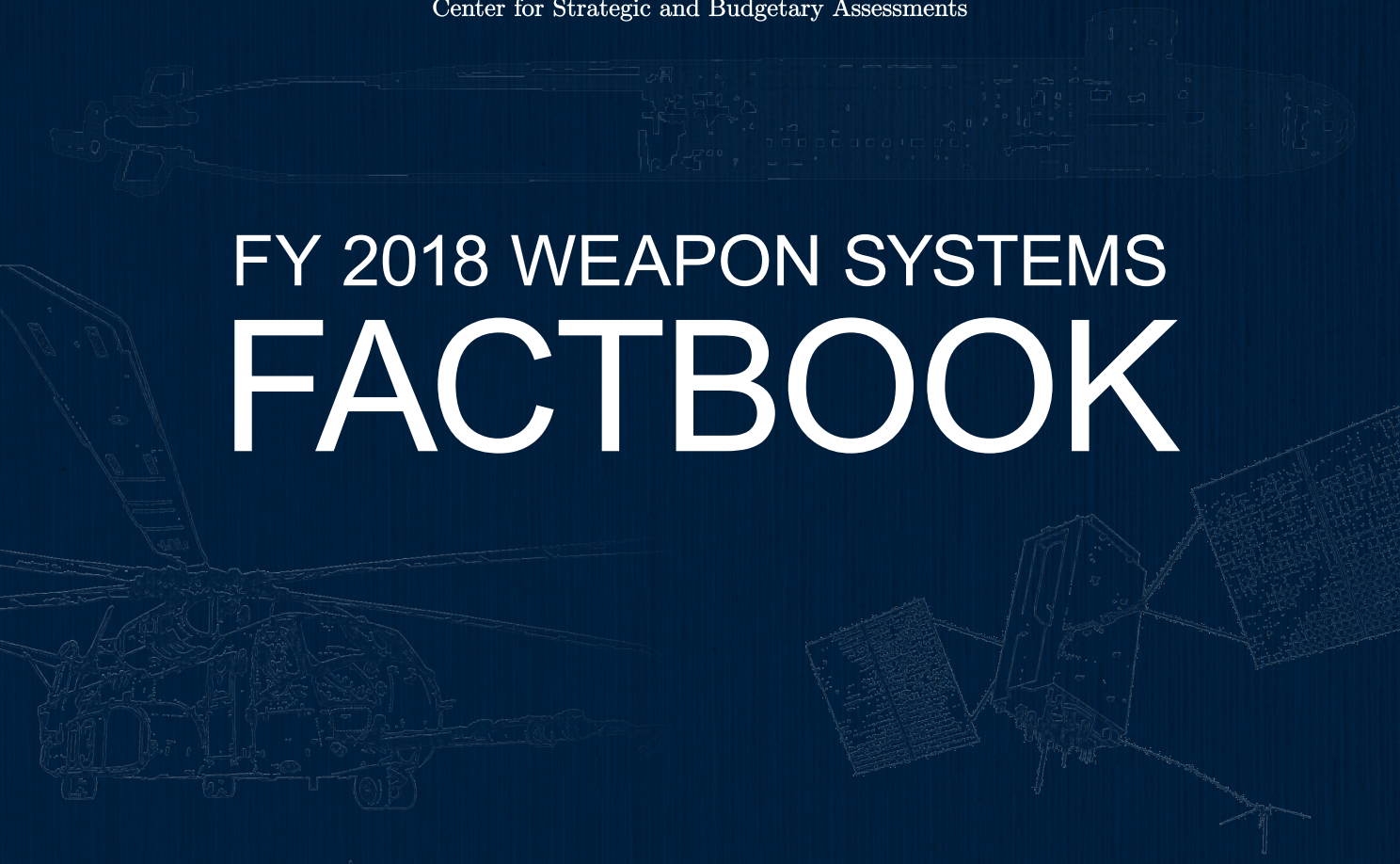
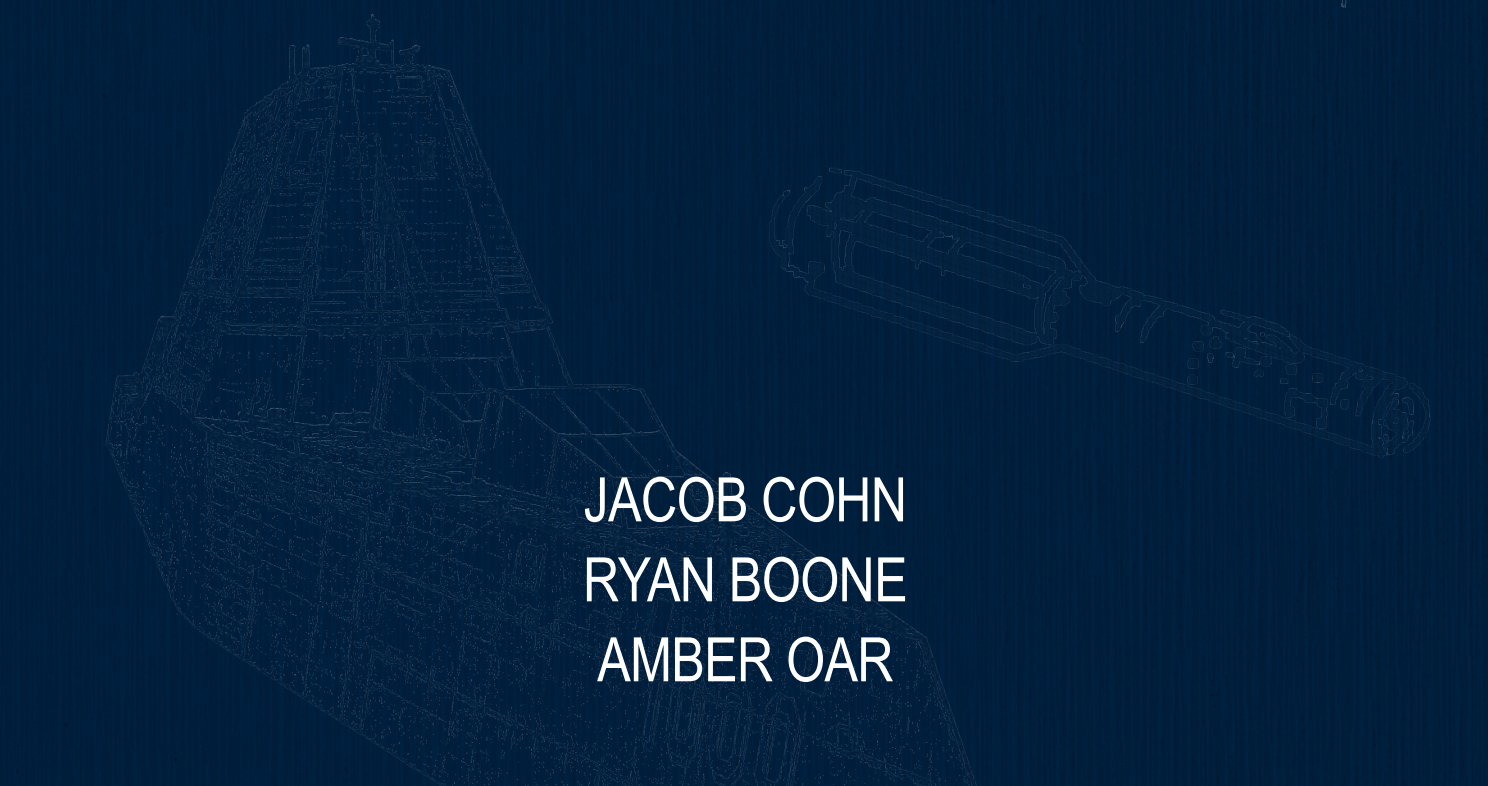
CSBA

Center for Strategic and Budgetary Assessments



FY 2018 WEAPON SYSTEMS FACTBOOK



JACOB COHN
RYAN BOONE
AMBER OAR

FY 2018 WEAPON SYSTEMS FACTBOOK

JACOB COHN
RYAN BOONE
AMBER OAR

CSBA
Center for Strategic and Budgetary Assessments

2017

ABOUT THE CENTER FOR STRATEGIC AND BUDGETARY ASSESSMENTS (CSBA)

The Center for Strategic and Budgetary Assessments is an independent, nonpartisan policy research institute established to promote innovative thinking and debate about national security strategy and investment options. CSBA's analysis focuses on key questions related to existing and emerging threats to U.S. national security, and its goal is to enable policymakers to make informed decisions on matters of strategy, security policy, and resource allocation.

ABOUT THE AUTHORS

Jacob Cohn is a research fellow at the Center for Strategic and Budgetary Assessments, where he manages the Strategic Choices Tool and conducts research and analysis for both the Strategic Studies and the Budgetary Studies programs. His primary areas of interest concern trends in the overall defense budget and, in particular, the linkages between resources and strategy. His research also focuses on the utilization of scenarios and wargames to facilitate long-range strategic planning and operational concept development. Mr. Cohn has authored a number of publications on trends in the defense budget and defense acquisitions as well as case studies exploring the Second Nuclear Age and defending European frontline states. He contributes to print and broadcast media and is also an adjunct lecturer at the Johns Hopkins School of Advanced International Studies.

Ryan Boone is an analyst at the Center for Strategic and Budgetary Assessments. In addition to research, he assists in the design and analysis of CSBA's operational-level wargames and concept development workshops. His work examines competitive strategies, operational planning, trends in U.S. and foreign military force structure and capabilities, and operations research. He is currently pursuing an M.A. in Strategic Studies and Economics at the Johns Hopkins University School of Advanced International Studies. He was a Robertson Scholar at Duke University.

Amber Oar is an analyst at the Center for Strategic and Budgetary Assessments. Prior to joining CSBA, Mrs. Oar served as an acquisitions officer for the U.S. Air Force. She holds a B.S. in Political Science and Legal Studies from the United States Air Force Academy and a M.P.P. specializing in international security and economic policy from the University of Maryland.

ACKNOWLEDGMENTS

The authors would like to thank the CSBA staff for their assistance with this report. Special thanks go to Katherine Blakeley, Bryan Clark, Mark Gunzinger, Dave Johnson, and Thomas Mahnken for reviewing and commenting on this report and to Kamilla Gunzinger, Adam Lemon, and Michelle Shevin-Coetzee for their editorial assistance. Any shortcomings, however, are solely the responsibility of the authors. CSBA receives funding from a broad and diverse group of contributors, including private foundations, government agencies, and corporations. A complete list of these organizations can be found on our website at www.csbaonline.org/about/contributors.

Cover Graphic:

From top left to bottom right:

1) Ohio Replacement Submarine cutaway from a U.S. Navy slide presentation from the Naval Sea Systems Command, presented at the Sea, Air, and Space Symposium, April 8, 2014. Author: CAPT William J. Brougham, USN.

2) CH-53K King Stallion heavy-lift helicopter. Photo courtesy of Lockheed Martin.

3) Artist's impression of a GPS Block IIIA satellite in orbit. U.S. Air Force graphic.

4) USS Zumwalt (DDG 1000) underway for the first time, December 7, 2015. U.S. Navy photo courtesy of General Dynamics Bath Iron Works.

5) An artist's rendering of Lockheed Martin's JAGM. Graphic courtesy of Lockheed Martin.

Contents

Introduction

Each year, the Department of Defense (DoD) submits Selected Acquisition Reports (SARs) to Congress detailing the status, plans, procurement quantities, and funding requirements for each Major Defense Acquisition Program (MDAP).[1] MDAPs are programs where total projected expenditures exceed $517.24 million in Fiscal Year (FY) 2018 dollars for research, development, and test and evaluation (RDT&E) or $3.10 billion in FY 2018 dollars for procurement.[2] The most recent unclassified SARs, which were submitted in December 2016 and are consistent with the President's FY 2018 budget request, include 87 programs, some of which extend more than 20 years into the future. The SARs project that these programs, in then-year dollars, will require roughly $334 billion in funding over the Future Years Defense Program (FYDP) spanning FY 2018 to FY 2022 and an additional $451 billion in FY 2023 and beyond. The public SARs included in this report represent 32 percent of the total modernization budget in the FY 2018 FYDP.[3] The remaining 68 percent of funding is used for programs that are too small or too early in their development to have their own SARs.

This report will discuss each of the 87 MDAPs with a public SAR, as well as the new B-21 bomber; the Long-Range Standoff Missile; and the Ground Based Strategic Deterrent, the future replacement for the Minuteman III, all three of which do not have public SARs.[4] This report summarizes the purpose of each program, its capabilities, its planned development and

1 For an overview of DoD's acquisition system, see Moshe Schwartz, *Defense Acquisitions: How DoD Acquires Weapon Systems and Recent Efforts to Reform the Process*, RL34026 (Washington, DC: Congressional Research Service, May 23, 2014), available at https://fas.org/sgp/crs/natsec/RL34026.pdf.

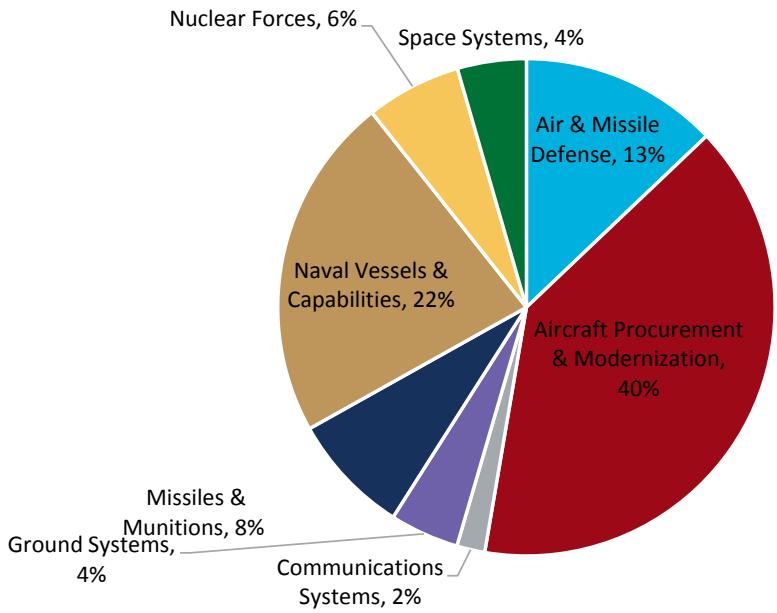
2 Under Secretary of Defense (USD) (AT&L), "Operation of the Defense Acquisition System," DoD Directive 5000.2, January 7, 2015, available at http://acqnotes.com/wp-content/uploads/2014/09/DoD-Instruction-5000.02-Operations-of-the-Defense-Acquisition-System-7-Jan-2015.pdf.

3 Modernization funding refers to the FYDP projections for RDT&E and procurement in Office of Management and Budget (OMB), *Analytical Perspectives: Budget of the U.S. Government, Fiscal Year 2018* (Washington, DC: U.S. Government Printing Office, August 2017), Table 25-1, "Net Budget Authority by Function, Category, and Program," available at https://www.gpo.gov/fdsys/pkg/BUDGET-2018-PER/pdf/BUDGET-2018-PER-9-5-1.pdf.

4 As significant acquisition programs in DoD's portfolio, CSBA believes it is important to include known information about these programs. Funding reported for each of these programs reflects assessments of data from official DoD sources only and is not intended to suggest total program cost estimates.

procurement schedule, its annual procurement rate, and past and future program funding. When available, it also includes Average Procurement Unit Costs (APUC) and estimated total Operations and Support (O&S) costs for each program.

SELECTED ACQUISITION REPORT FUNDING BY CATEGORY IN 2017 FYDP



The *Weapon Systems Factbook* presents a long-term projection of Department of Defense modernization programs beyond the five-year horizon of the FYDP. By presenting the entire projected life of a program, the *Factbook* displays the expected funding and procurement profile of each program, and highlights schedule, cost, or quantity deviations within a program that may warrant further scrutiny. Moreover, it helps identify the systems or categories of systems that will absorb the largest portions of the Department of Defense's modernization budget.

As a reference book, the *Factbook* also provides a big-picture look at current and projected major acquisition programs that goes beyond the year-to-year variations seen in successive FYDP plans.

The *Weapon Systems Factbook* is organized into categories of weapon systems: air and missile defense; aircraft capability enhancements; aircraft procurement: fixed-wing aviation; aircraft procurement: rotary-wing aviation; aircraft procurement: unmanned systems; communications systems; ground systems; missiles and munitions; naval vessels and capabilities; nuclear forces; and space systems. The combined aircraft categories (fixed, rotary, unmanned, and capability enhancements) are the largest category of planned modernization, both in terms of the number of programs and the total funding projected over the FYDP.

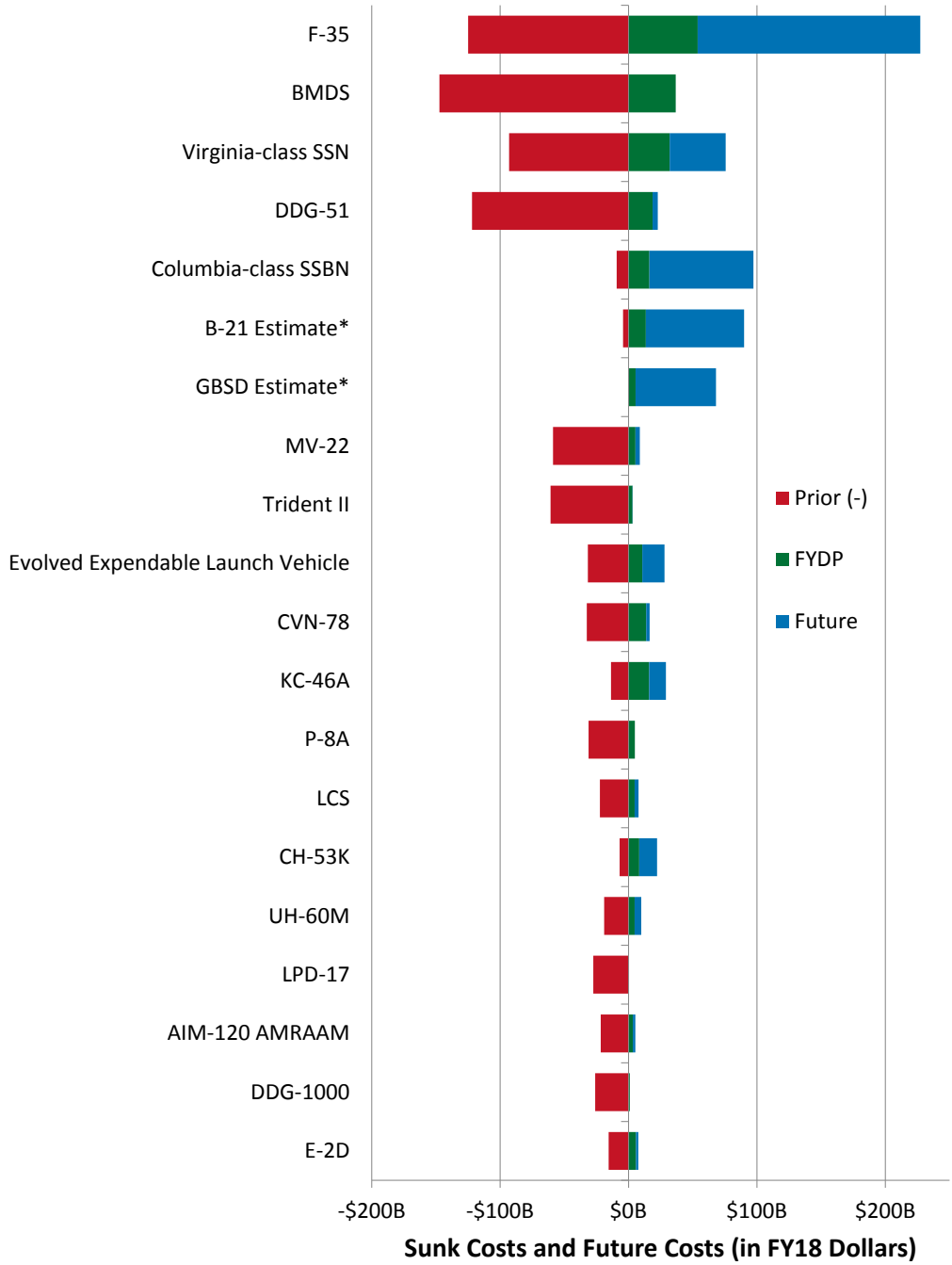
The MDAPs could also be grouped by military service. The table below presents the number of MDAPs, as well as the projected funding covered by those MDAPs by service. The Navy has the largest number of MDAPs and is projected to require the most funding for MDAPs over the FYDP. The MDAPs, however, do not capture all modernization spending. For example, the Air Force plans to spend $408.50 billion on modernization over the FYDP, the most of all the services, but only 20 percent of Air Force modernization spending, $83.14 billion, is contained in the MDAPs reported in a public SAR, the lowest percentage of any service. In contrast, 55 percent of total Navy modernization spending is represented in a public SAR, offering far more transparency into Navy plans.

Public MDAPs by Service and Spending in Then-Year Millions of Dollars						
	Number of MDAPs	Pre-FY2018 MDAP Program Spending	FY 2018 FYDP MDAP Spending	Outyears	Total Service FYDP Modernization Funding	MDAPs as Percent of FYDP Modernization
USAF	27	$195,307	$83,140	$226,568	$408,502	20%
USN	39	$559,679	$184,582	$272,659	$355,150	55%
USA	17	$71,784	$36,498	$60,256	$136,567	27%
DoD Wide	4	$141,029	$42,933	$1,744	$134,864	32%

Unless otherwise noted, the cost and quantity figures used in this report are from the December 2016 SARs.[5] Unlike other CSBA budget analyses, most cost figures in this report are shown in then-year dollars. Then-year dollars are used to show the projected funding levels of programs, as well as APUC and O&S estimates when a comparison is not being made to any other program. When programs are compared to one another, as in the figure on p. ii, the report uses FY 2018 dollars to adjust for the effects of inflation. In addition, in some cases, the SAR does not include a complete funding projection for the program, as noted throughout the report.

5 The President's Budget (PB) 2018 request does not always accurately reflect the FY 2017 appropriations. Accordingly, the FY 2017 figures in the SARs should be treated as estimates and not appropriated funding and quantities. For additional information on the discrepancies between the FY 2017 appropriations listed in the PB 2018 request and the actual FY 2017 appropriations, see Katherine Blakeley, *Overview of the FY 2018 Defense Budget Request* (Washington, DC: Center for Strategic and Budgetary Assessments, 2017).

TOP 20 ACQUISITION PROGRAMS BY SUNK AND FUTURE COSTS[6]



6 Programs marked by an "*" do not have public SARs and reflect a summary of data from official DoD sources only. They are not intended to suggest total program cost estimates.

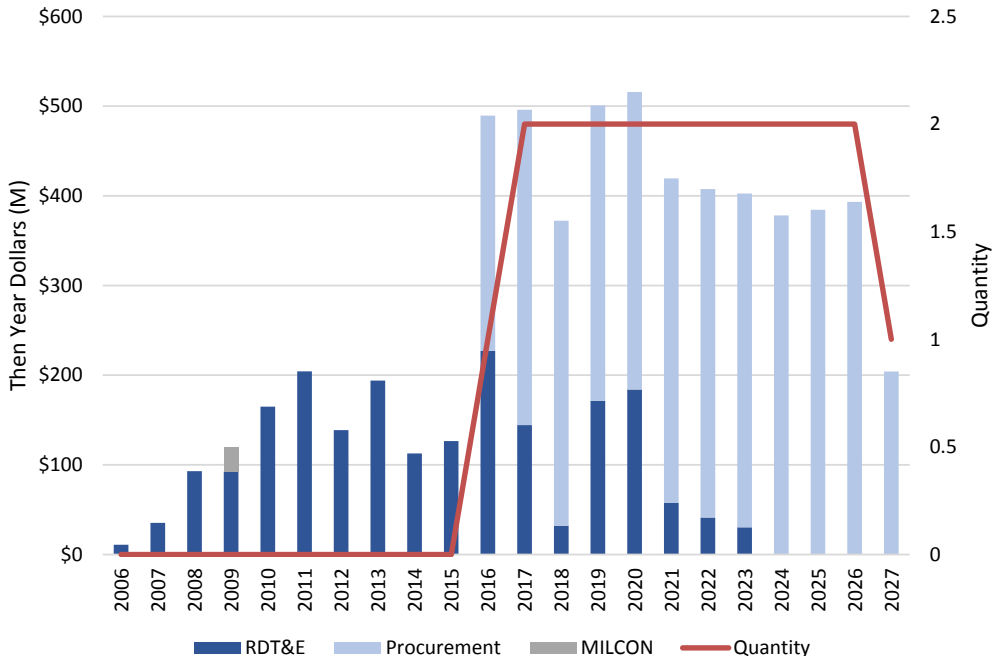
Air & Missile Defense

Five programs are covered in this section: two radar programs and three initiatives to enhance air and missile defense network integration and functionality. The United States faces increasingly sophisticated air and missile threats across the full spectrum of conflict, including the proliferation of low-cost drones, such as those employed by the Islamic State; the development Intercontinental Ballistic Missiles by North Korea; and the fielding of mature precision strike networks by Russia and China. These five Air & Missile Defense (AMD) programs collectively represent more than $137 billion in investment through FY 2017. DoD is planning to spend at least an additional $44.86 billion over the FYDP to improve defenses against air and missile threats to safeguard the forces, persons, and territories of the United States and its partners.

Air and Missile Defense Radar (AMDR)

The Navy's AMDR (now designated the AN/SPY-6) is an improved radar suite for ballistic missile and air defense against advanced threats that is to be installed aboard DDG 51 Flight III *Arleigh Burke* destroyers. The program has three components: the new AMDR-S radar; an X-band horizon-search radar based on current technology; and a Radar Suite Controller designed to manage radar resources efficiently against complex missile attacks. The AMDR has a modular assembly and scalable design that can be reconfigured based on future ship size and mission requirements.[7] The program has entered Low Rate Initial Production (LRIP) and is currently structured to procure 22 total units, with two units procured each year over the FYDP. Testing on land has occurred at the Pacific Missile Range Facility in Hawaii since 2016, and testing at sea will begin in 2020.[8] Initial operational capability (IOC) is anticipated for 2023–2024.

Approximately $2.19 billion has been appropriated through FY 2017 for the AMDR. An additional $2.22 billion was requested over the FY 2018 FYDP, with $1.76 billion planned for beyond the FYDP. The current APUC estimate prices each AMDR set at $185.24 million. The AMDR program has an estimated total O&S cost of $7.40 billion over an estimated service life of 40 years per system.



7 Seiko Okano, "AN/SPY-6(V) Air & Missile Defense Radar," briefing slides, Naval Sea Systems Command Integrated Warfare Systems Program Executive Office, January 2017, available at http://www.navsea.navy.mil/Portals/103/Documents/Exhibits/SNA-AboveWaterSensors.pdf?ver=2017-01-12-142032-183.

8 Government Accountability Office (GAO), *Defense Acquisitions: Assessment of Selected Weapon Programs* (Washington, DC: GAO, March 2017), p. 89, available at https://www.gao.gov/assets/690/683838.pdf.

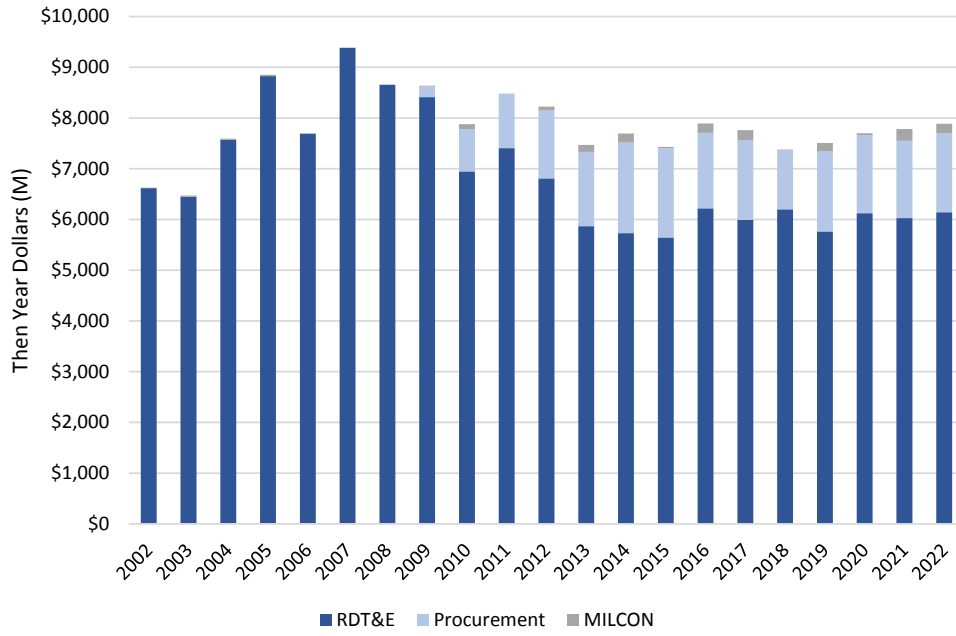
Ballistic Missile Defense System (BMDS)

BMDS is a defense-wide program headed by the Missile Defense Agency (MDA) to develop and deploy layered defensive systems to protect the United States and its allies and partners from ballistic missile attack. The program incorporates many sub-components that are themselves major defense programs, including ground-based interceptors (GBI) for homeland defense, transportable radars like the AN/TPY-2 to track missile launches, Terminal High Altitude Area Defense (THAAD) batteries to protect deployed forces, ships and shore-based sites equipped with the Aegis Ballistic Missile Defense System, and other supporting programs.

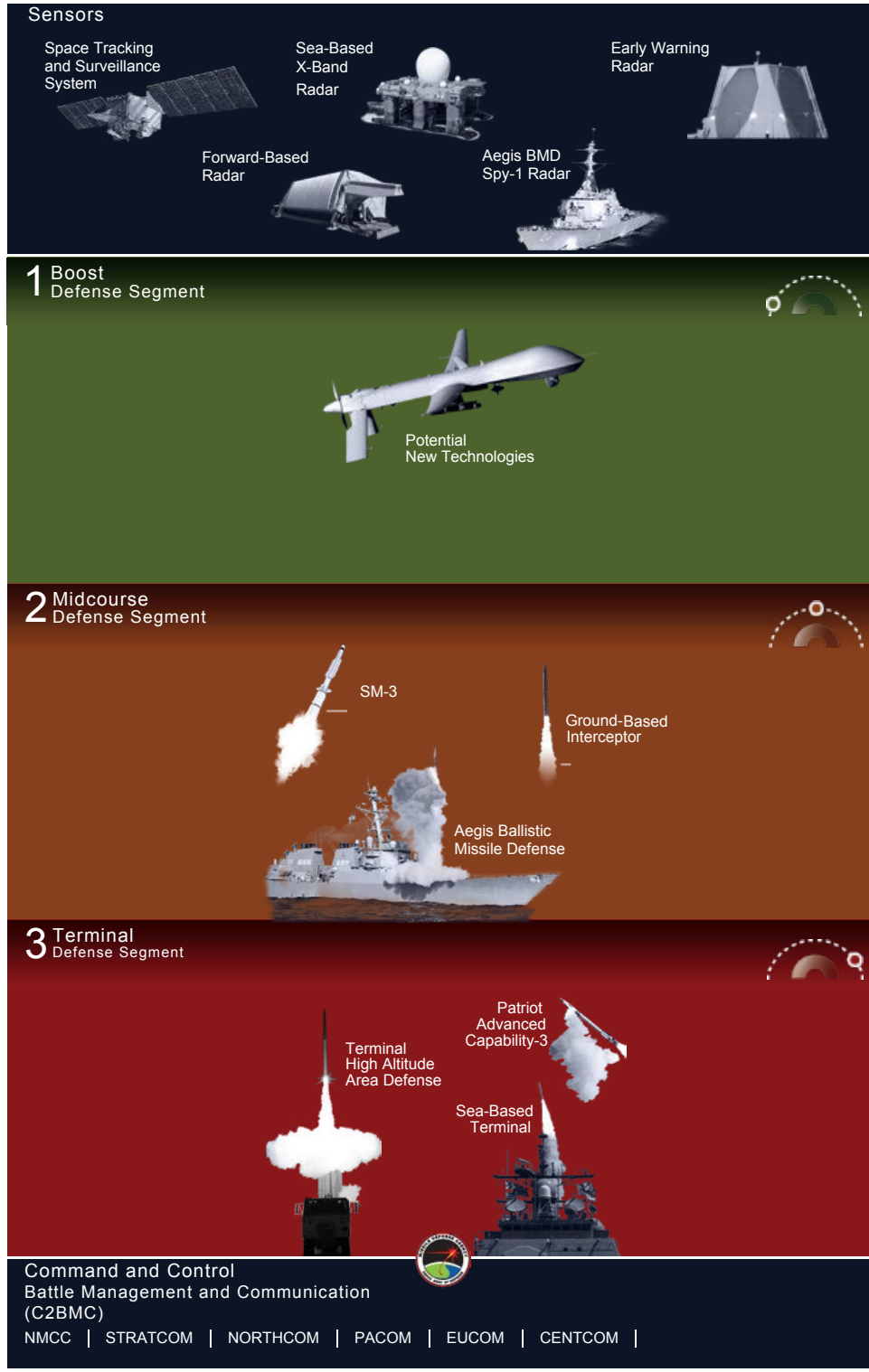
One of the largest development programs within BMDS is the Multi-Object Kill Vehicle (MOKV), which will be designed to enable multiple ballistic missile kills from a single GBI. Six additional GBIs were added in 2016, with eight more planned in 2017 to bring the total deployed to 44. Construction began in 2017 on the new Long-Range Discrimination Radar at Clear Air Force Station in Alaska following the completion of a design review in 2016.

BMDS features several cooperative initiatives with U.S. partners. The program supports the European Phased Adaptive Approach (EPAA) to improve Ballistic Missile Defense (BMD) for North Atlantic Treaty Organization (NATO) allies and deployed troops. EPAA Phase II was completed in May 2016 when the Aegis Ashore site in Romania was operationally certified; Phase III will be completed in 2018 when work on a second Aegis Ashore site in Poland is finished. Japan and the United States are pursuing cooperative development of the SM-3 Block IIA mid-course ballistic missile interceptor. The Missile Defense Agency provides support to Israel for several ballistic missile systems such as David's Sling and Iron Dome. Foreign military sales of U.S. missile defense systems also fall under BMDS, including continued fulfillment of the 2011 sale of two THAAD batteries to the United Arab Emirates.

Approximately $126.74 billion has been appropriated through FY 2017 for BMDS. An additional $38.26 billion was requested over the FY 2018 FYDP. While the BMDS SAR does not project funding beyond the FYDP, the ongoing ballistic missile defense mission will require continued spending. The SAR does not report annual O&S estimates for BMDS or its constituent components.



THE BALLISTIC MISSILE DEFENSE SYSTEM

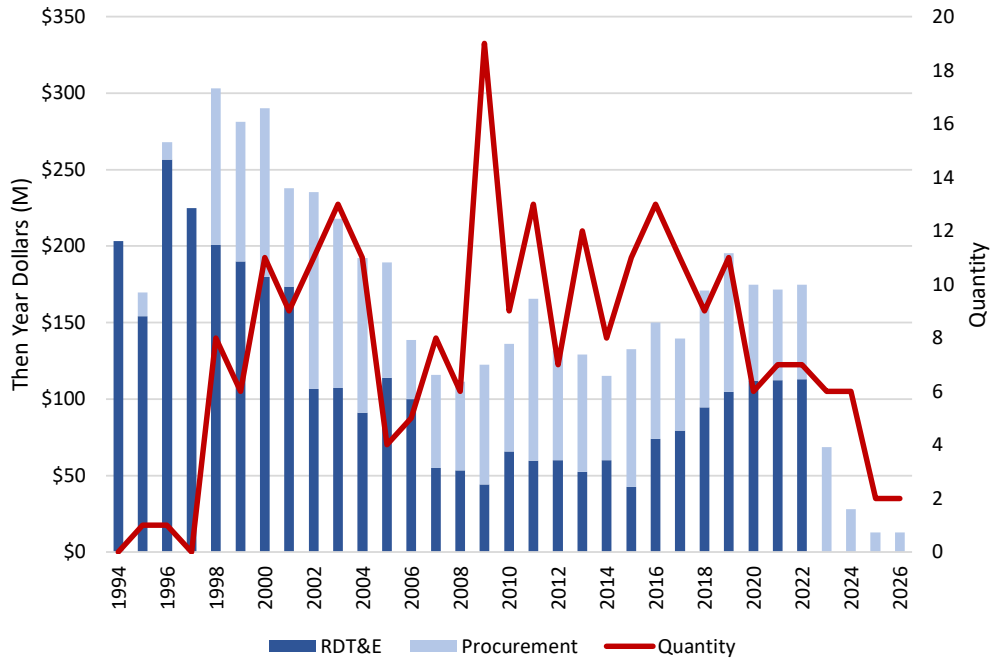


This graphic from the Missile Defense Agency webpage for BMDS illustrates some of its component programs and research efforts.

Cooperative Engagement Capability (CEC)

The CEC is a Navy-led program to develop a datalink that will improve overall naval air defense capabilities by integrating sensors and weapons into a single network, optimizing target detection and weapon guidance across a group of ground mobile units, ships, and aircraft belonging to the United States and select allies. It is also the foundation of Naval Integrated Fire Control-Counter Air (NIFC-CA), which allows the E-2D to connect platforms with Link-16 to those with CEC and extends the range at which platforms in the NIFC-CA network can engage targets.[9] The shipboard and airborne (on the E-2D) versions have been in full rate production since 2002 and 2014, respectively, which is projected to continue through 2026. Production and cost details associated with variants for foreign military partners are classified.

Approximately $4.40 billion has been appropriated through FY 2017 for CEC. An additional $887.10 million was requested over the FY 2018 FYDP, with an additional $122.10 million planned for beyond the FYDP. 197 of 253 production units will be procured by the end of FY 2017, not including 30 units that were purchased for RDT&E purposes. The current APUC estimate prices each CEC unit at $8.40 million, likely averaged across the different platform variants. The CEC program has an estimated total O&S cost of $2.77 billion. The service life for each CEC system is estimated at anywhere from five to twenty years, depending on the platform.

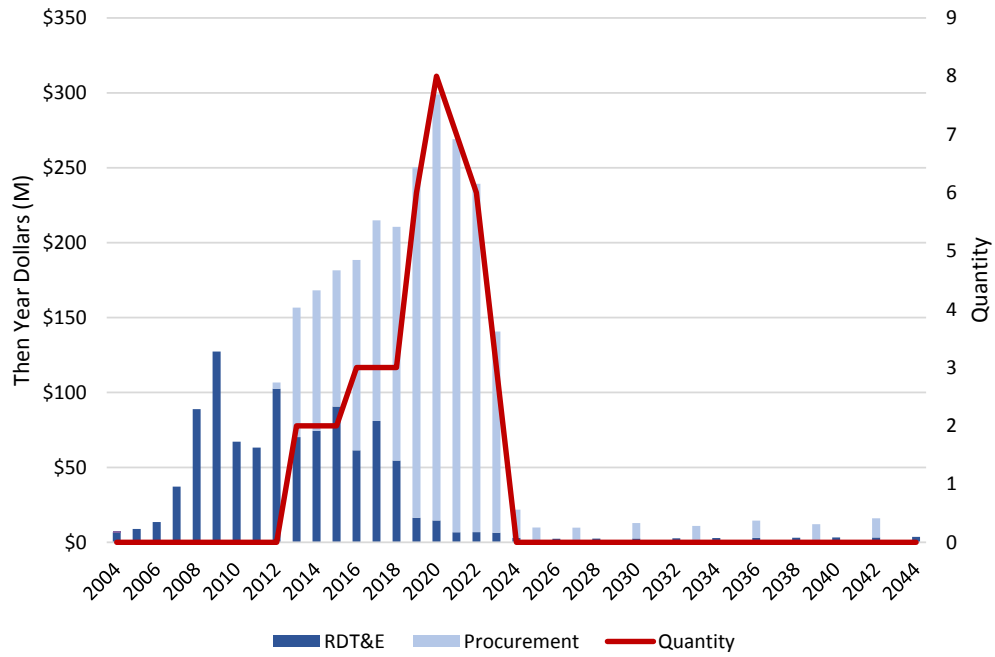


9 "Cooperative Engagement Capability," factsheet, U.S. Navy, available at http://www.secnav.navy.mil/rda/Pages/Programs/CEC.aspx.

Ground/Air Task Oriented Radar (G/ATOR)

The Marine Corps' G/ATOR program is a short-range, three-dimensional, multi-role radar designed to detect aircraft, Unmanned Aerial Vehicles (UAV), cruise missiles, rockets, mortars, and artillery. G/ATOR will replace five different legacy radar systems within the Marine Corps.[10] G/ATOR is a block acquisition program, with follow-on blocks providing software upgrades that expand the radar's capabilities: Block 1 provides short-range air defense and surveillance; Block 2 provides counter-battery radar capabilities; and a future Block 4 will address air traffic control, but is not included in the current program acquisition timeline (and consequently the SAR).[11] LRIP units were first delivered in 2017; after the first six units, subsequent radars will be produced with upgraded gallium nitride modules that improve functionality while reducing cost. Both Block 1 and Block 2 are scheduled for IOC in 2018.

Approximately $1.43 billion has been appropriated through FY 2017 for G/ATOR. An additional $1.27 billion was requested over the FY 2018 FYDP, with a further $269 million planned for beyond the FYDP, not including upgrades beyond Block 2. Current plans indicate 45 units will be procured through FY 2023. The current APUC estimates each G/ATOR radar at $43.02 million. The G/ATOR program has an estimated total O&S cost of $3.55 billion over an estimated service life of 20 years per system.



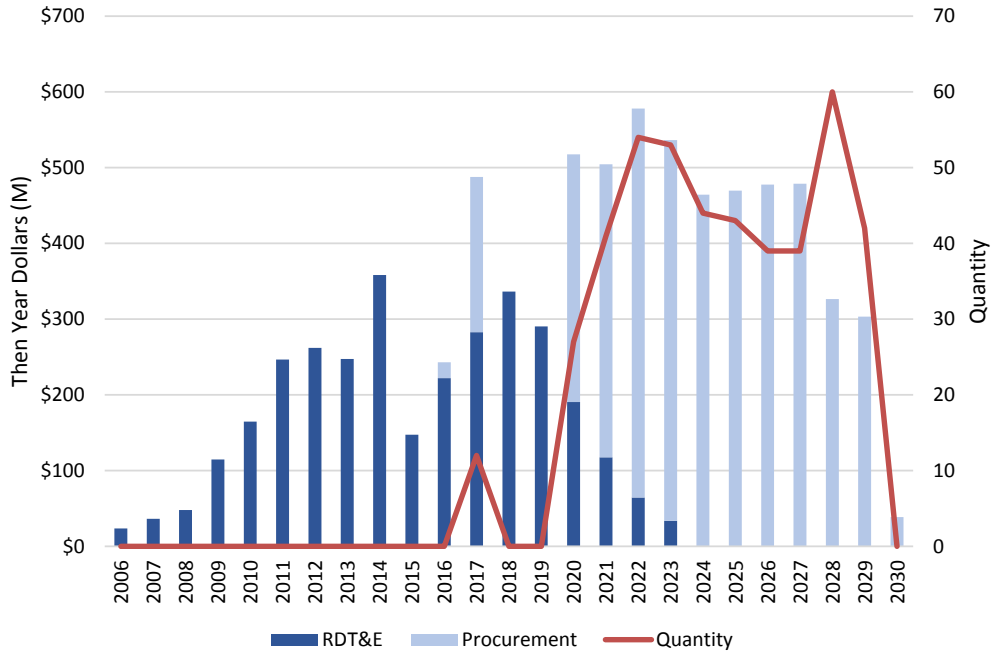
10 GAO, *Defense Acquisitions*, 2017, p. 99.

11 No mention is made in the SAR of a Block 3 upgrade.

Integrated Air and Missile Defense (IAMD)

The Army's IAMD program aims to enable a "plug and play" framework for the Army's air and missile defense assets, supporting the networking of sensors and weapons through a common command system. Analogous to the Navy's CEC program, the Integrated Battle Command System (IBCS) will provide a common command and control system as well as networked functionality for the Army's various defensive systems.[12] The Army serves as the lead system integrator for IBCS, which means it will own the resulting architecture and consequently streamline the integration of future air and missile defense assets into the Army network.

Approximately $2.38 billion has been appropriated through FY 2017 for IAMD. An additional $2.23 billion was requested over the FY 2018 FYDP, with over $3.09 billion planned for beyond the FYDP. The first 12 of 454 production units will be procured by the end of FY 2017, not including 25 systems purchased for RDT&E purposes. The current APUC prices each IAMD system at $9.94 million. The IAMD program has an estimated total O&S cost of $5.80 billion over an estimated service life of 20 years per system.



Some of the SAR for this program is marked FOUO. CSBA will update this entry once DoD responds to CSBA's FOIA request

12 "Integrated Air & Missile Defense (IAMD)," Program Executive Office Missiles & Space, September 2017, available at: https://www.msl.army.mil/Pages/IAMD/default.html.

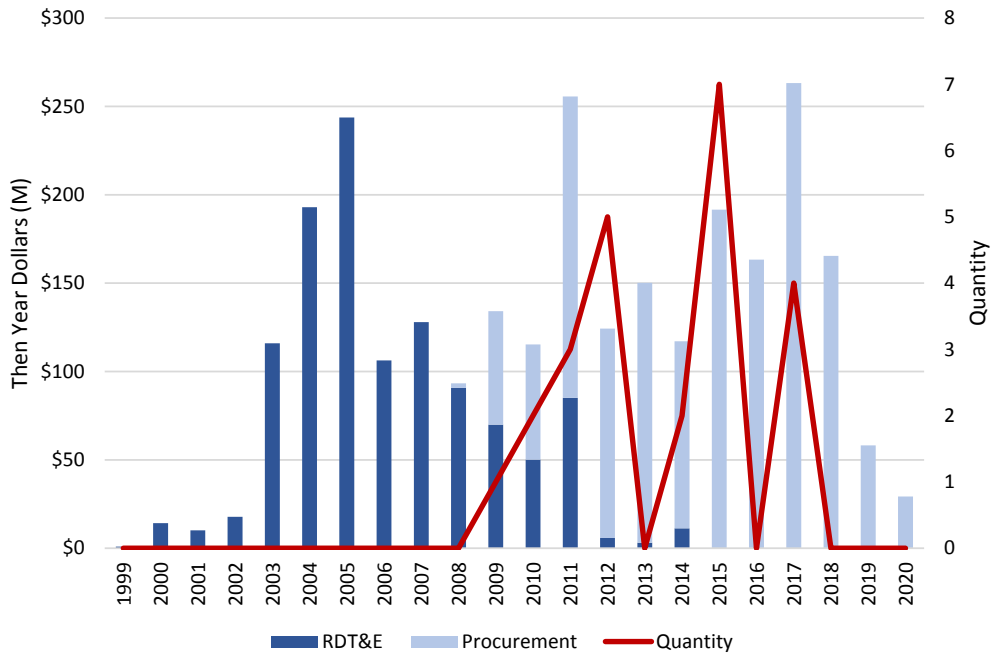
Aircraft Capability Enhancements

Nine programs are included in this section, which covers improvements to existing aircraft fleets across the joint force ranging from the Air Force's B-2 stealth bomber to Army and Marine Corps helicopters. As aircraft age, they face both greater maintenance burdens and increasing risk of technological obsolescence. These programs address those challenges through the replacement of hardware, software upgrades, and/or the integration of new capabilities to extend or even dramatically improve the capability of these platforms well into the 21st century. Of the ten aircraft modernization programs, four will end within the FY 2018 FYDP. These upgrades collectively represent roughly $17.11 billion in investments through FY 2017. DoD is planning to spend at least an additional $8.47 billion over the FYDP to improve the capabilities of its existing air fleets and ensure they keep pace with modern and emerging threats.

Airborne Warning and Control System (AWACS) Block 40/45 Upgrade

AWACS aircraft provide a battle management, wide area surveillance, and command and control capability to improve the coordination and effectiveness of U.S. and partner aircraft and other force elements. The AWACS Block 40/45 upgrade program enhances the E-3 Sentry's radar and gives the E-3 greater networking capability with other joint assets, including improved target track data sharing and the ability to distinguish between friendly and enemy aircraft. Upgraded aircraft are designated E-3Gs; several E-3Gs have already participated in operations abroad since the 2014 IOC, including in support of Operation Inherent Resolve against the Islamic State.[13] In FY 2013, the Block 40/45 upgrade program reported a significant Nunn-McCurdy breach due to a decision to upgrade only 24 rather than all of the 31 primary mission aircraft in the Air Force inventory, though the program has since been on budget and on schedule.

Approximately $2.44 billion has been appropriated through FY 2017 for the AWACS Block 40/45 upgrade. An additional $252.90 million was requested over the FY 2018 FYDP, with the program anticipated to terminate in FY 2020. The last four sets of equipment will be procured in FY 2017, and installation has been completed on at least 12 aircraft thus far. The current APUC estimates each upgrade set at $64.37 million. The Block 40/45 upgrade program is estimated to increase total O&S cost for the AWACS program by $726.70 million over an estimated service life of 25 years per system.

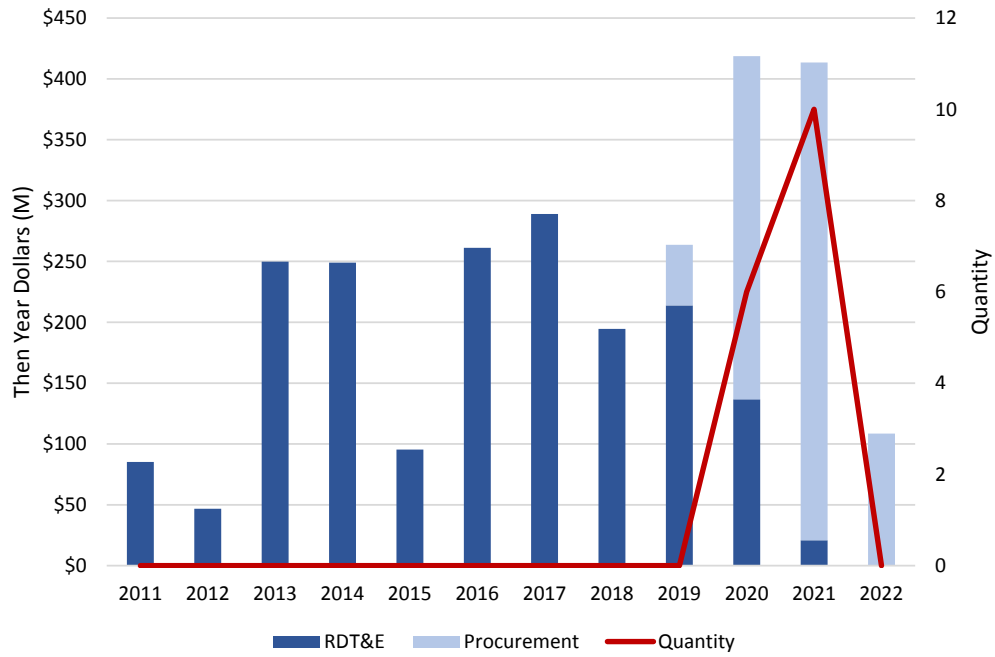


13 Darren D. Heusel, "Upgraded E-3 Sentry Deploys to Combat Theater," *U.S. Air Force News*, November 19, 2015, available at http://www.af.mil/News/Article-Display/Article/630606/upgraded-e-3-sentry-deploys-to-combat-theater/.

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

The fleet of 20 B-2 Spirit stealth bombers are among the Air Force's premier deterrence assets and can strike even well-defended targets with conventional or nuclear weapons. The B-2 DMS-M program is a new SAR this year and is the largest upgrade yet to the B-2, involving more structural modification and alteration than past efforts.[14] The B-2's existing defensive system will be overhauled for the first time since the aircraft's production in the 1980s and 1990s, updating it to counter current and emerging threats. The upgrades will improve the aircraft's ability to detect, identify, and avoid adversary air defense radars, and they will replace aging and increasingly difficult to maintain 1980s analog systems. Software development is proceeding slower than scheduled, but not enough to trigger a breach in the acquisition program's baseline schedule. The first eight upgraded aircraft should be available by 2022.

Approximately $1.28 billion has been appropriated through FY 2017 for the B-2 DMS-M upgrade. An additional $1.40 billion was requested over the FY 2018 FYDP, with no additional funding projected beyond FY 2022. The current APUC estimate for each upgrade is $52.06 million. Additional O&S costs stemming from the upgrade are not given, but are projected to be less than 1 percent of total B-2 O&S costs.

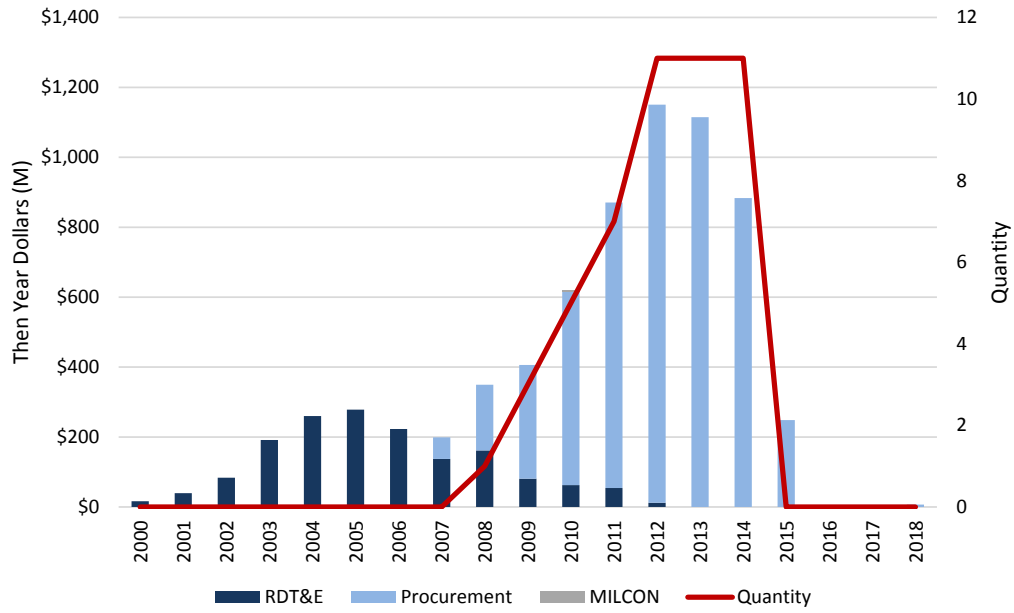


14 GAO, *Defense Acquisitions*, 2017, p. 132.

C-5 Reliability Enhancement and Re-Engining Program (C-5 RERP)

This is the final SAR for the C-5 RERP and no funding is planned beyond FY 2018. The C-5 RERP program is the second phase of a two-part modernization effort for the C-5. The first stage modernized aircraft avionics and the second will improve aircraft reliability and mission availability by replacing the current engine with a cleaner, more powerful Commercial Off-the-Shelf (COTS) engine. After the completion of the second phase, each C-5 will be designated a C-5M, with improved payload and enhanced communications, navigation, and safety. IOC was declared in February 2014 after delivery of the first 16 C-5Ms, and 44 of 52 aircraft have already been delivered.

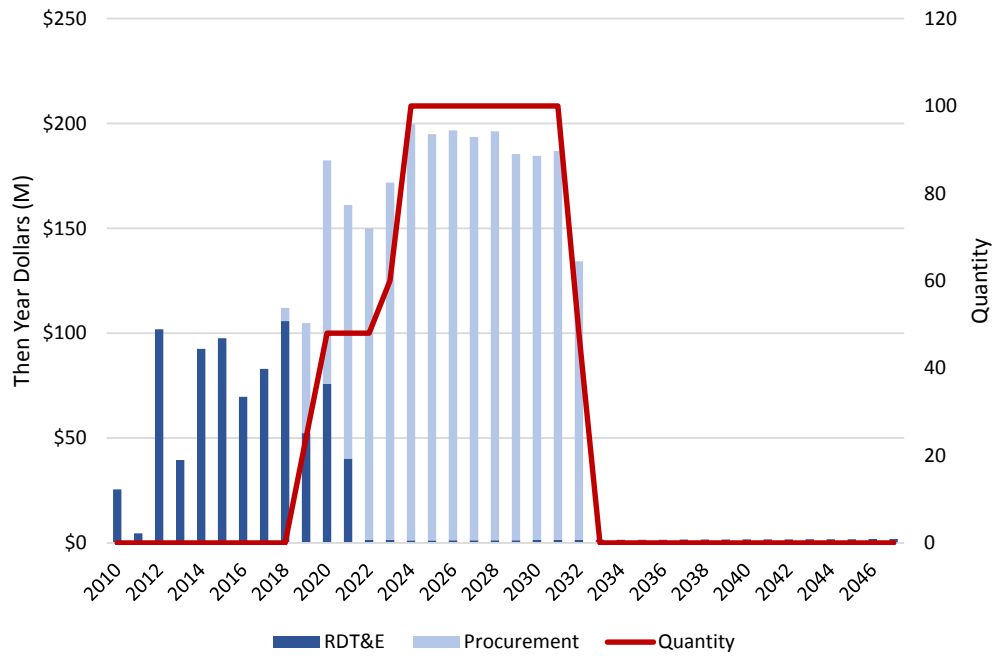
Approximately $6.94 billion has been appropriated through FY 2017 for C-5M upgrades. Only $6.80 million is requested for FY 2018, with no further funding projected over the FYDP. The current APUC estimate prices each C-5M upgrade at $108.91 million. No O&S cost adjustments are given for the upgrades.



Common Infrared Countermeasure (CIRCM)

This is a new SAR issued for the first time for FY 2018. CIRCM is an Army initiative to improve aircraft countermeasures against infrared missiles, particularly man-portable air defense systems (MANPADS).[15] It replaces the Advanced Threat Infrared Countermeasures (ATIRCM) system onboard Army helicopters and small fixed-wing aircraft. CIRCM will identify a launched missile and focus an infrared laser countermeasure on the incoming weapon's seeker to blind it, preventing the missile from tracking the aircraft's heat signature. It is an additional defense beyond existing flare and chaff countermeasures. The system remains in the development phase, with only 29 of 48 planned development units delivered. Current plans project a buy of 1,076 production units. IOC is projected for 2021, with procurement running through 2032. Although the program has not reported a breach of cost or schedule, the SAR notes minor challenges that may cause a slight delay in the next major program decision milestone.

Approximately $514.30 million has been appropriated through FY 2017 for the CIRCM program. An additional $710.50 million was requested over the FY 2018 FYDP, with $1.87 billion in additional funding projected beyond FY 2022. The current APUC estimate is $2.11 million.



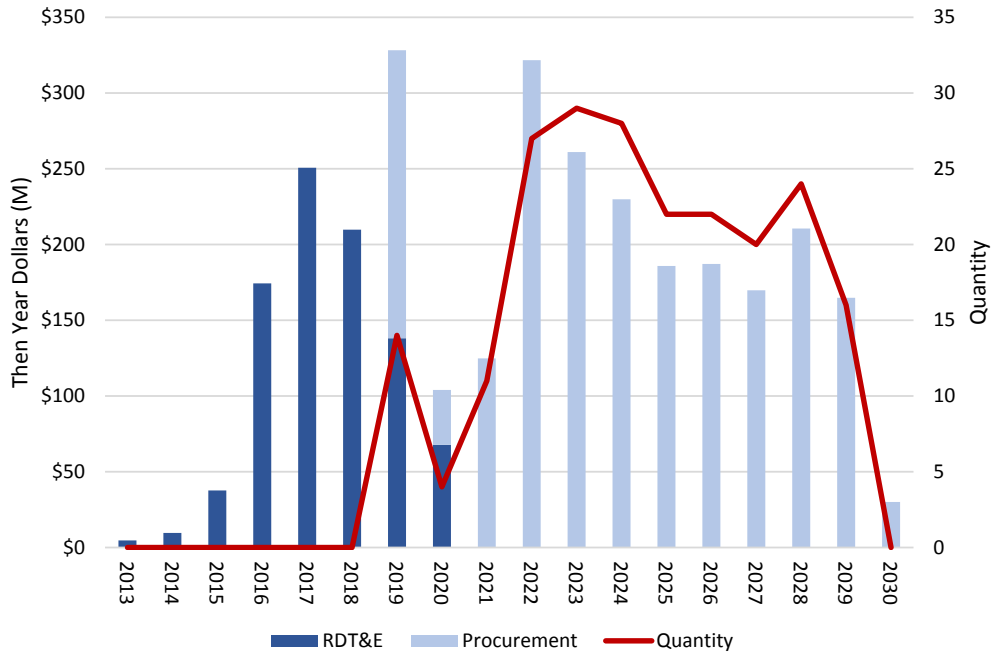
Some of the SAR for this program is marked FOUO. CSBA will update this entry once DoD responds to CSBA's FOIA request.

15 "Common Infrared Countermeasure (CIRCM)," factsheet, United States Army Acquisition Support Center, available at http://asc.army.mil/web/portfolio-item/common-infrared-countermeasure-circm/.

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

This is the first SAR for F-15 EPAWSS program, which will replace the self-protection system for portions of the F-15C air superiority fighter and F-15E multi-role strike fighter fleets. The F-15 fleet and other fourth generation fighters face increasing threats from the improving fourth generation fighter aircraft of other states, as well as the proliferating advanced Surface-to-Air Missile (SAM) threat. EPAWSS will improve F-15 survivability via an improved ability to detect, identify, and locate adversary radars, in addition to upgrades to the F-15's counter-radar and counter-electro-optical/infrared (EO/IR) protective measures to avoid or neutralize incoming missiles. EPAWSS has two increments; Increment 1 will replace the current F-15 defensive system with EPAWSS, and Increment 2 will add a new towed decoy and additional countermeasures. The program suffered a breach in the acquisition program baseline Program Acquisition Unit Cost (PAUC) estimates due to a nearly 50 percent reduction in planned upgrades, from 413 to 221 aircraft, with non-recurring development costs being distributed across fewer upgrade sets. IOC is planned for FY 2022–2023 for the F-15E fleet and FY 2023–2024 for the F-15C fleet.

Approximately $477.10 million has been appropriated through FY 2017 for the F-15 EPAWSS program. An additional $1.09 billion was requested over the FY 2018 FYDP, with $1.44 billion in additional funding projected beyond FY 2022. The current APUC estimate for each EPAWSS set is $9.74 million.



Some of the SAR for this program is marked FOUO. CSBA will update this entry once DoD responds to CSBA's FOIA request.

F-22 Increment 3.2B (F-22 Mods)

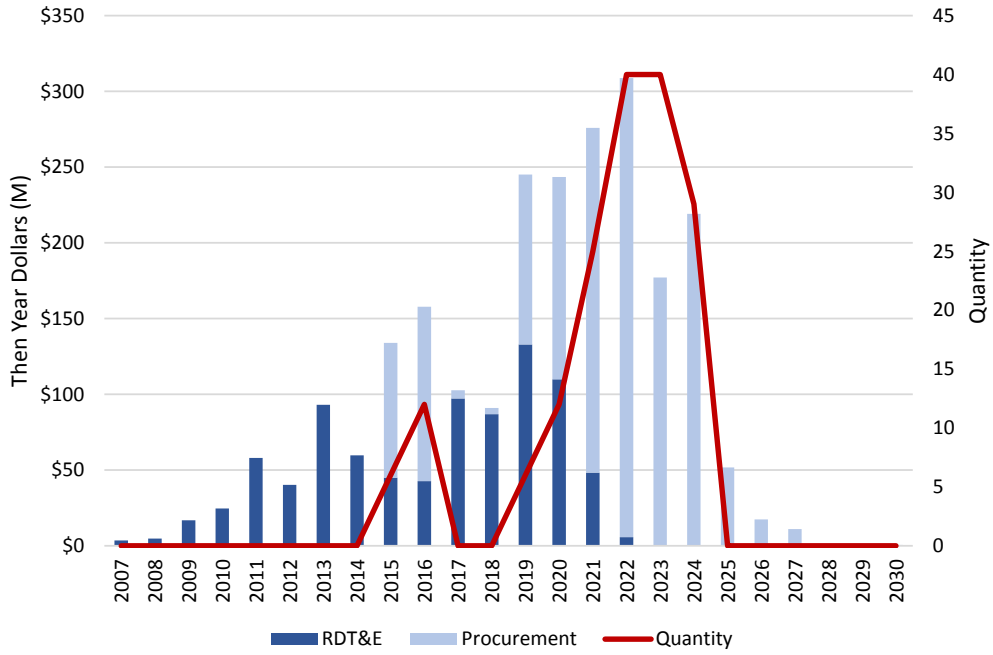
The F-22 is the Air Force's most advanced air superiority fighter and the world's first fifth generation fighter. It incorporates both stealth and advanced avionics and sensor technologies, which permit improved cooperation and data-sharing with other aircraft.

Some of the SAR for this program is marked FOUO. CSBA will update this entry once DoD responds to CSBA's FOIA request.

Infrared Search and Track (IRST)

A SAR for IRST was issued for the first time for FY 2018. IRST is a Navy program that incorporates a passive infrared sensor on an external fuel tank for use on F/A-18E/F fighter aircraft, the latest model of the Navy's principal carrier-based fighter aircraft. IRST sensors provide an alternative means to search for and engage targets in high threat environments where adversaries may be listening for or jamming U.S. radars. The IRST's capabilities will be sufficient to guide beyond-visual-range missiles. The IRST program began in 2008 but has been repeatedly delayed due to budget cuts. LRIP contracts were issued in 2015 and 2016, procuring nine developmental units and the first 18 production sets for operational evaluation. 170 production units are planned. IOC is currently projected for FY 2021–2022.

Approximately $695.20 million has been appropriated through FY 2017 for the IRST program. An additional $1.16 billion was requested over the FY 2018 FYDP, with $478.40 million in additional funding projected beyond FY 2022. The per unit APUC estimate is $8.64 million. The IRST program is expected to increase estimated total O&S cost for the F/A-18 E/F program by $1.32 billion over an estimated service life of just under 19 years per aircraft.

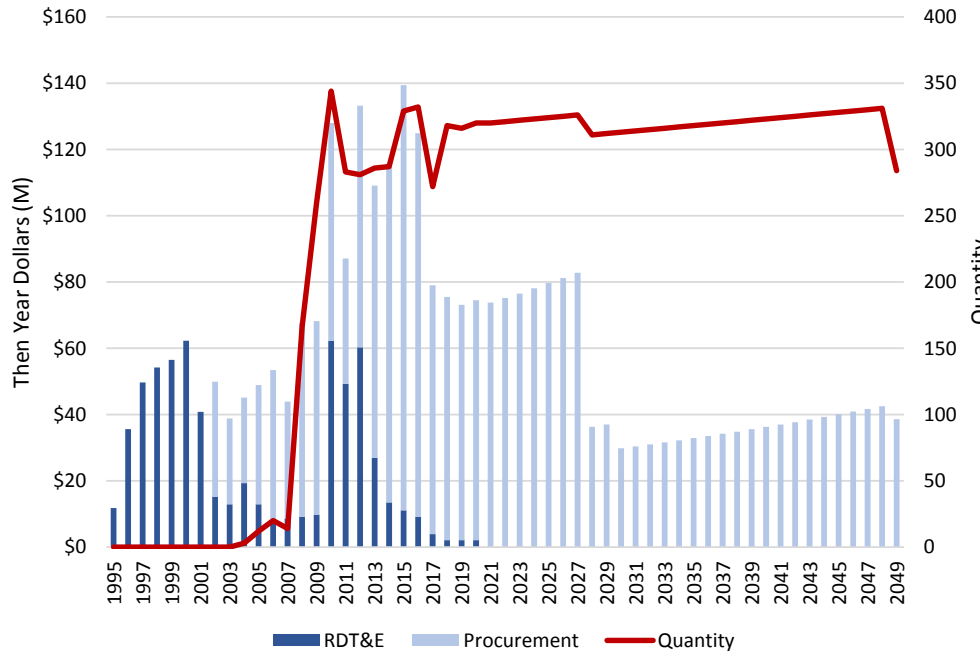


Integrated Defensive Electronic Countermeasures (IDECM)

IDECM is a Navy program to design an upgraded radio frequency electronic countermeasure suite for the F/A-18, the Navy's principal carrier-based fighter aircraft. The system is designed to identify signals from enemy radars and disrupt these signals using jammers and decoys deployed from the F/A-18. IDECM systems are being developed in four blocks, with increasing capability in each block. Subsystems include the ALQ-165 On-Board Jammer (OBJ), the more advanced ALQ-214 OBJ, ALE-50 expendable decoys, and ALE-55 towed decoys. The first three blocks are only compatible with later-model F/A-18E/F aircraft, and the fourth variant will be fully compatible with earlier F/A-18C/Ds while retaining full functionality on F/A-18E/F aircraft.

Blocks 2 and 3 have reported procurement and APUC breaches, while Block 4 has reported procurement, O&S, and APUC breaches in the acquisition program baseline. The breaches occurred because planned buys of the ALE-55 decoy have been repeatedly delayed due to budget cuts, increasing the unit cost above the baseline, and because the program requested 134 additional ALQ-214 jammers, exceeding the original baseline estimates of 190 systems. These breaches were reported in the FY 2017 SAR.

Approximately $1.64 billion has been appropriated through FY 2017. An additional $372.10 million was requested over the FY 2018 FYDP, with $1.19 billion in further funding projected beyond FY 2022. The APUC estimate for the Block 2/3 IDECM system is roughly $123,000 per unit, whereas the Block 4 IDECM system estimate is $3.01 million each. The IDECM program has an estimated total O&S cost of $290.60 million over an estimated service life of 20 years per system, more than 20 percent greater than the O&S cost of its predecessor system.

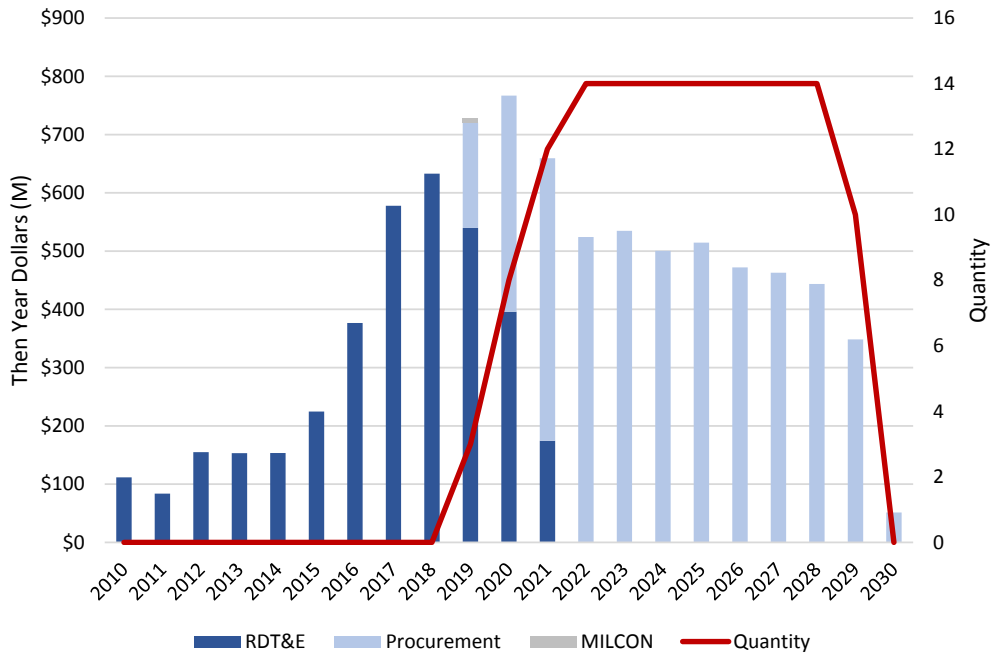


Some of the SAR for this program is marked FOUO. CSBA will update this entry once DoD responds to CSBA's FOIA request.

Next Generation Jammer Increment 1 (NGJ Inc 1)

A SAR for NGJ Inc 1 was issued for the first time for FY 2018. NGJ is a jammer pod that improves Navy electronic attack capabilities for emerging challenges and mitigates shortfalls of the existing ALQ-99 Tactical Jamming System. NGJs will be flown on Navy EA-18G Growler electronic warfare aircraft and will have greater capability to suppress newer and more numerous adversary air defense radars and communications systems in support of U.S. operations. The NGJ has been designed with an open architecture philosophy that will facilitate future upgrades to keep pace with emerging challenges and the accelerating rate of competition within the electromagnetic spectrum. The NGJ began major testing in 2017 on four test systems, and the program anticipates 131 production units. IOC is anticipated for 2021–2022. Future upgrade increments are already planned but will be separate programs; NGJ Increment 2, a low-band jamming capability, is scheduled to begin development in 2020.[16]

Approximately $1.84 billion has been appropriated through FY 2017 for the NGJ program. An additional $3.31 billion was requested over the FY 2018 FYDP, with $3.33 billion in further funding projected beyond FY 2022. The APUC estimate is $37.32 million per NGJ pod. The NGJ program is estimated to increase the EA-18G total O&S cost by $1.78 billion, which is roughly a 20 percent increase over the O&S of the ALQ-99 predecessor system.



16 GAO, *Defense Acquisitions*, 2017, pp. 113–114.

Aircraft Procurement: Fixed-Wing Aviation

There are seven entries in this section covering eight SARs, as well as a CSBA estimate for the B-21.[17] With substantial portions of the Air Force fleet purchased during the 1980s Reagan build-up and the high operational tempo of Air Force, Naval Aviation, and Marine Corps aircraft over the last decade and a half of conflict, many aircraft are rapidly approaching the end of their useful service life and need to be replaced. Successor aircraft, such as C-130J transports, P-8A Poseidon maritime patrol aircraft, and F-35 Joint Strike Fighters, bring considerably greater capability to their respective Services. These aircraft will serve well into the 21st century. For example, the FY 2018 F-35 SAR projects that F-35s may serve until FY 2070. Alongside recapitalization efforts, entirely new capabilities, like the B-21 Raider next-generation bomber, will enter the force. Though no SAR has been released yet for the B-21, an entry has been provided in this section for comparative purposes considering the size of the acquisition program.

Of the seven entries in this section, two, the EA-18G Growler and the P-8A Poseidon, will end during the FY 2018 FYDP. The SARs in this section collectively represent roughly $207.24 billion in investments through FY 2017. DoD is planning to spend at least a further $88.63 billion over the FYDP on new fixed-wing aviation, which does not include CSBA's estimates for the B-21.

17 CSBA combined the SARs for the C-130J, HC/MC-130J, and KC-130J into one entry since they are all variants of the same aircraft.

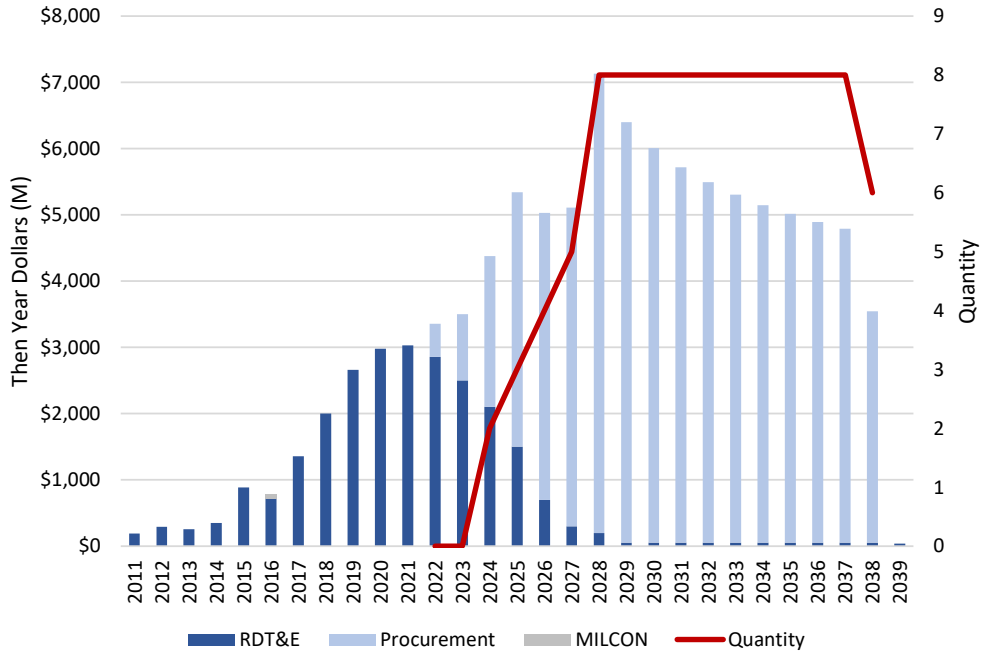
B-21 Raider Program

The B-21 Raider is intended to be a long-range stealth aircraft that is nuclear-capable and may be optionally manned in the future. The B-21 is a special access program and thus does not report detailed program information in unclassified documents. Although a formal cost estimate has not been released and the program is not included in DoD's most recent public SARs, DoD has revealed some information. It has stated that the average procurement unit cost will be $564 million per aircraft in FY 2016 dollars, beating the requirement of $606 million in FY 2016 dollars.[18] The FY 2018 budget also shows annual RDT&E funding ramping up from $2.00 billion in FY 2018 to $3.03 billion in FY 2021. RDT&E costs begin to level off in FY 2022, declining to $2.86 billion. Assuming costs gradually decline in subsequent years, the chart below depicts potential research and development spending that would comport with DoD's development cost estimate of $23.54 billion in FY 2016 dollars. Assuming procurement begins in the early 2020s and grows gradually to an estimated eight aircraft per year[19] in the late 2020s, a buy of a hundred aircraft would be completed by the late 2030s at a procurement cost of roughly $75.52 billion in then-year dollars (representing the equivalent of an average procurement unit cost of $564 million in FY 2016 dollars). The Air Force's Global Strike Command has indicated the B-21 would reach its IOC "in the late-2020s."[20] Based on the information released by DoD, as reflected in the graph below, this sums to a total program cost of roughly $101 billion in then-year dollars, or $94 billion in FY 2018 dollars.

18 "LRS-B Contract Award Sheet," U.S. Air Force, October 27, 2015, available at http://www.af.mil/Portals/1/documents/af%20events/FINAL%20LRS-B%20Contract%20Award%20One%20Sheet_27%20Oct.pdf.

19 The estimated procurement rate of eight aircraft per year is for illustrative purposes only. It is not based on information released by the U.S. government.

20 From remarks made by General Robin Rand, Commander Global Strike Command, as reported in John A. Tirpak, "B-21 Update," *Air Force Magazine*, March 3, 2017, available at http://www.airforcemag.com/DRArchive/Pages/2017/March%202017/March%2003%202017/B-21-Update.aspx.


$8,000
$7,000
$6,000
$5,000
$4,000
$3,000
$2,000
$1,000
$0
Then Year Dollars (M)
9
8
7
6
5
4
3
2
1
0
Quantity
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
2035
2036
2037
2038
2039
RDT&E
Procurement
MILCON
Quantity

C-130J Variants

This entry combines three separate SARs concerning the development and procurement of three variants of the C-130J tactical transport aircraft for the Air Force and Marine Corps.

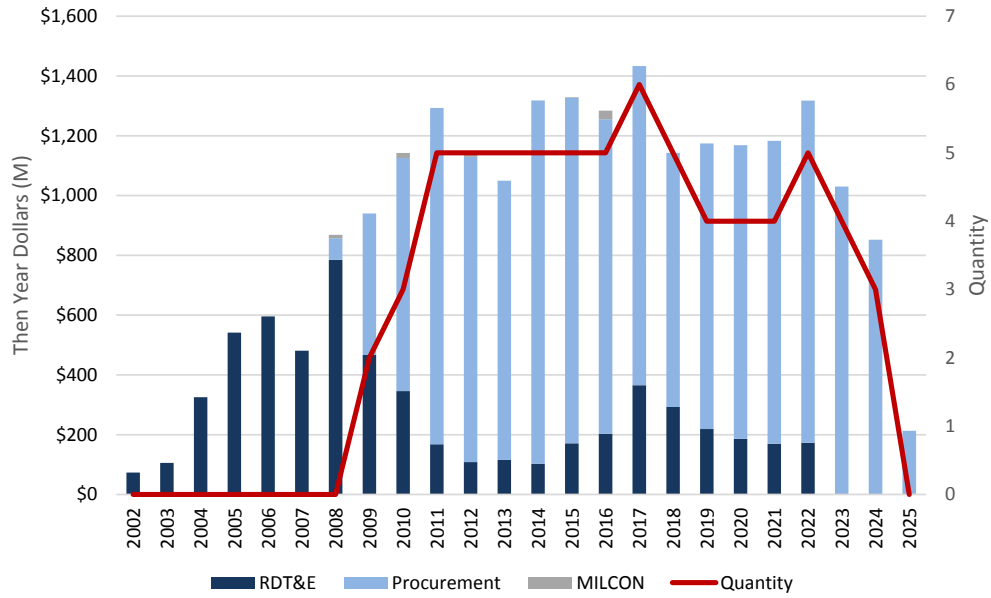
The C-130J is the next iteration of a turboprop tactical transport aircraft design that has been a workhorse of the joint force since its introduction in the 1950s. One of the keys to the success of the C-130's design has been its ability to adapt for different missions. The C-130J continues this trend, with DoD procuring several different versions for different Services and communities. A stretch version of the C-130J can carry 30 percent more volume. The HC/MC-130J variant provides aerial refueling, as well as infiltration, supply, and recovery of Special Forces. The MC-130J also serves as the baseline platform for conversion to the AC-130J gunship. The KC-130J air-to-air refueling variant is being procured for the Marine Corps to replace the KC-130 F/R/T aircraft and can be configured to support refueling; troop transport; cargo delivery; medical evacuation; intelligence, surveillance, and reconnaissance activities; and close air support. These aircraft are already operationally deployed around the world; accidents and other operational requirements occasionally prompt changes to the programs acquisition plans, often through the use of Overseas Contingency Operations (OCO) funds.

Some of the SAR for this program is marked FOUO. CSBA will update this entry once DoD responds to CSBA's FOIA request.

E-2D Advanced Hawkeye Aircraft (E-2D AHE)

The E-2D replaces the E-2C as the carrier-based aircraft for command and control (C2) and surveillance. The APY-9 radar on the E-2D is designed to detect and track more advanced adversary aircraft and cruise missiles than was possible on the E-2C, in addition to performing open-ocean or coastal maritime surveillance. The E-2D is also a part of ongoing Navy networking and data-sharing efforts, allowing the E-2D to augment fleet air and missile defense capabilities. The E-2D began full rate production in FY 2013 and declared IOC in October 2014. Further upgrades to software and hardware have been incorporated into the newly built aircraft and pushed to the fleet every two to three years, giving the program an ongoing development role even after the start of full rate production. The Navy plans to replace all legacy E-2C aircraft by 2027, with plans for 70 of the production model E-2D aircraft. Japan is a Foreign Military Sales (FMS) partner for the E-2D.

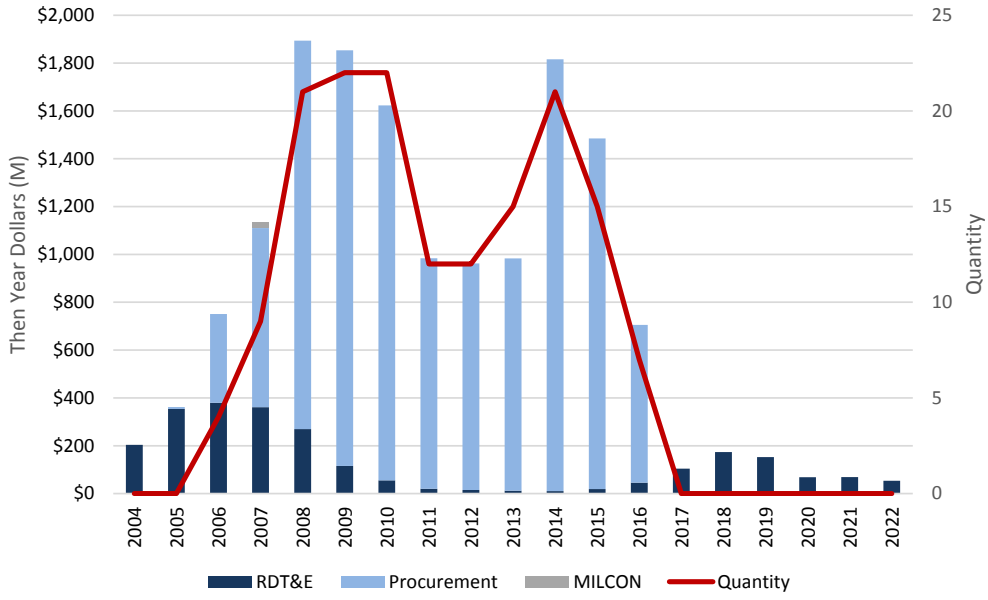
Approximately $13.93 billion has been appropriated through FY 2017 for the E-2D AHE program. An additional $5.99 billion was requested over the FY 2018 FYDP, with $2.10 billion in additional funding projected beyond FY 2022. The current APUC is $227.69 million per E-2D. The E-2D program has an estimated total O&S cost of $23.15 billion over an estimated service life of 20 years per aircraft, approximately 33 percent more than the E-2C.



EA-18G Growler Aircraft (EA-18G)

The EA-18G Growler, an electronic warfare variant of the F/A-18 Hornet, replaces the EA-6B Prowler and provides the Navy with the ability to detect and jam air defenses and communications to facilitate U.S. military operations and protect U.S. forces. The EA-18G is the principal platform for the Next Generation Jammer (see p. 18), which will replace the ALQ-99, the current system used for electronic attack. The Navy's last EA-6B squadron transitioned to the EA-18G in FY 2016, and the final contract for the EA-18G was issued in February 2017. Absent further changes, the EA-18G program will procure 160 aircraft. The program breached the acquisition program baseline estimate for RDT&E due to increased funding for additional upgrades. It breached the O&S estimate because of the increased sustainment costs associated with adding seven aircraft to the program and a change to how the Navy estimates O&S costs for aviation assets.[21]

Approximately $14.86 billion has been appropriated through FY 2017 for EA-18G development and procurement. An additional $516.60 million was requested over the FY 2018 FYDP, with no further funding requested in the outyears; all FYDP funding is RDT&E funds for further capability enhancements. The current estimated APUC is $80.45 million per aircraft. The EA-18G program has an estimated total O&S cost of $49.24 billion over an estimated service life of almost 30 years per aircraft, roughly 26 percent less than sustaining the EA-6B it replaces.



Some of the SAR for this program is marked FOUO. CSBA will update this entry once DoD responds to CSBA's FOIA request.

21 The additional seven aircraft and the changes to the O&S estimating methodology do not indicate real O&S cost growth.

F-35 Joint Strike Fighter (JSF)

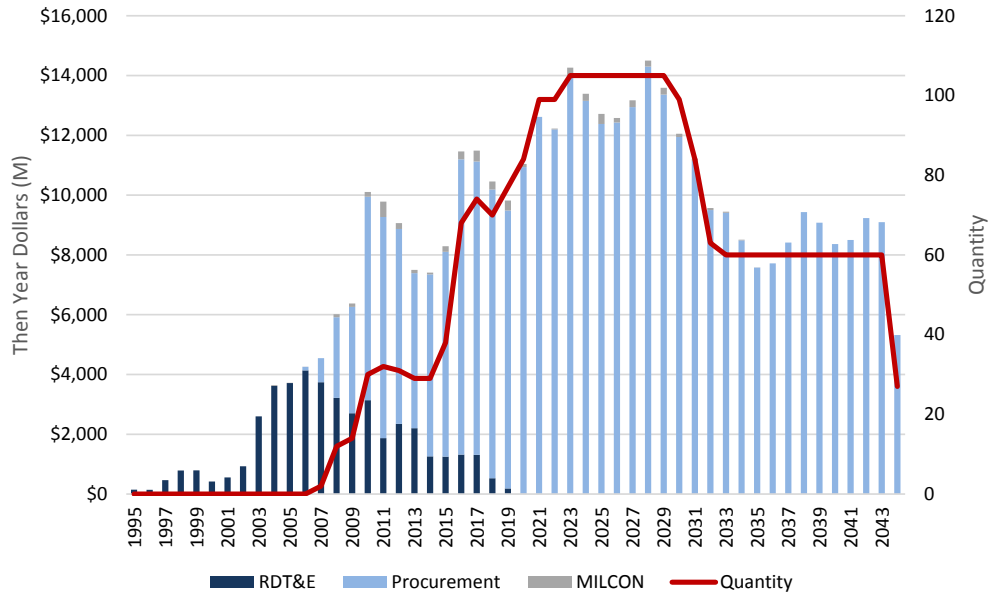
The F-35 is a joint program to develop a family of fifth-generation strike fighter aircraft for the Air Force, Navy, and Marine Corps. It is the largest ongoing acquisition program in DoD, and among the most expensive in DoD's history. Three different variants are intended to replace the A-10, F-16, AV-8B, and F/A-18C/D aircraft fleets. The Air Force F-35A is the conventional takeoff and landing variant, and the least complex, in relative terms, of the three variants. The Marine Corps F-35B is a short takeoff and vertical landing (STOVL) aircraft capable of taking off from short runways or amphibious warfare vessels like the *America*-class LHA and then landing vertically. The Navy F-35C will join the F/A-18E/Fs on aircraft carriers. As the second fifth-generation aircraft, the F-35 family features significant stealth and survivability improvements over older aircraft in addition to advanced avionics and sensors that will support other elements of the joint force. The United States is joined in the F-35's development and acquisition by the United Kingdom, Italy, the Netherlands, Turkey, Canada, Australia, Denmark, and Norway; in addition, Japan, South Korea, and Israel are part of the F-35 FMS program.

The Marine Corps and Air Force declared IOC for the F-35B in July 2015 and the F-35A in August 2016, respectively. The Navy projects that it will declare IOC for the F-35C in FY 2018–2019. The F-35 program has pursued development and procurement concurrently to increase the speed with which aircraft enter the force. This necessitates upgrades to older F-35s as new capabilities are developed. Current efforts, Block 3F, will provide full avionics and weapons functionality. Past blocks have provided an initial training capability (Blocks 1 and 2A); limited weapons capability (Block 2B); and export compliance, new technology functionality, and integration with helmet display systems (Block 3i).[22] The program plans to procure 2,470 aircraft, with 14 developmental aircraft, 1,763 production F-35As, and 693 F-35Bs and F-35Cs combined.

22 GAO, F-35 Joint Strike Fighter: DoD Needs to Complete Developmental Testing Before Making Significant New Investments (Washington, DC: GAO, April 2017), p. 9, available at http://www.gao.gov/assets/690/684207.pdf.

The F-35 program has faced challenges since its inception. It has been restructured three times, most recently following a critical Nunn-McCurdy breach in 2011 due to unit cost growth.[23] Since then, the program has reined in costs. Ongoing software development remains a risk to the development schedule. The GAO predicts that the Block 3F software may be five to twelve months behind the 2012 baseline,[24] which may delay full 3F functionality and completion of associated flight testing from the planned date of October 2017 to as late as May 2018. DoD has already begun RDT&E work on future upgrades to the F-35, known as Block 4, though the GAO has recommended resolving all issues with Block 3F before pursuing future upgrades or Full Rate Production (FRP).[25]

Approximately $110.52 billion has been appropriated through FY 2017. An additional $56.16 billion was requested over the FY 2018 FYDP, with $227.74 billion in additional funding projected beyond FY 2022; procurement is expected to end in 2044. The current estimated APUC is $140.96 million per aircraft.[26] The F-35 program has an estimated total O&S cost of $1.12 trillion over an estimated service life of 30 years per aircraft.



23 Ibid., p. 3.

24 Ibid., pp. 9–11.

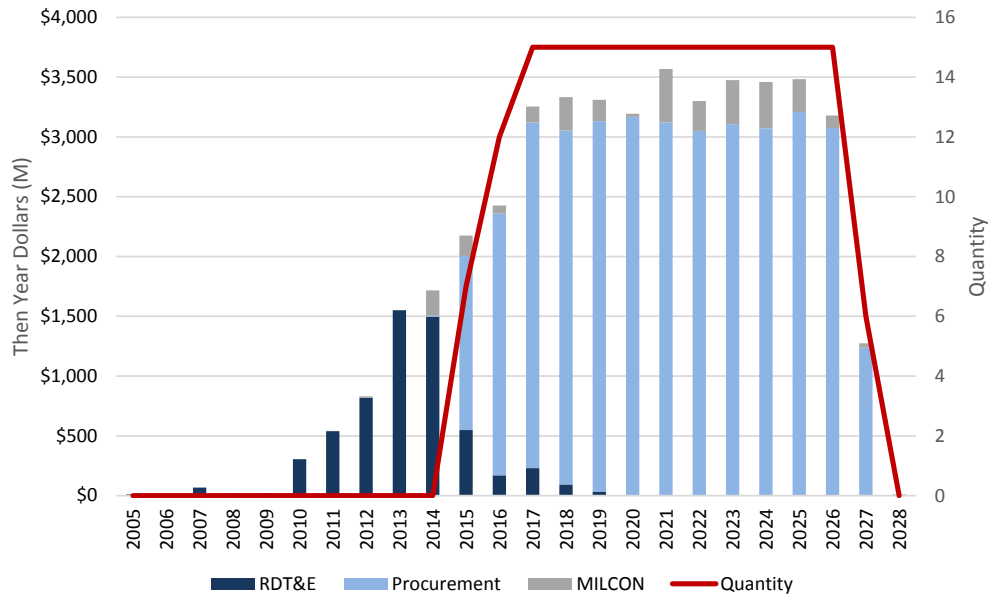
25 John Tirpak, "GAO: Hold off on F-35 Block 4 Until 3F Is Done," *Air Force Magazine,* April 25, 2017, available at http://www.airforcemag.com/Features/Pages/2017/April%202017/GAO-Hold-off-on-F-35-Block-4-Until-3F-is-Done.aspx.

26 DoD calculates costs for the F-35 airframe and engine separately. All numbers in this entry reflect the summation of those costs.

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

The Air Force's KC-46A tanker is a Boeing 767 modified for use as an aerial refueling tanker to support U.S. and allied aircraft. This program is the first of three planned phases to replace the Air Force's existing KC-135 tankers and will replace roughly one-third of the KC-135s in service.[27] The KC-46A will provide increased refueling capacity and efficiency over the KC-135s it will replace, as well as improved cargo, aeromedical evacuation, and defensive capabilities. Despite some delays in testing and a minor unplanned contractor-driven design change, the program is largely on track with 60 percent of flight testing complete. Delays associated with the design change have been incorporated into a new baseline schedule. Contracts for 34 of the production version KC-46As have already been issued, and the program projects procuring four developmental and 175 production aircraft. An initial capability of 18 aircraft is anticipated for FY 2018–2019, with October 2018 as the goal.

A total of $12.92 billion has been appropriated through FY 2017. The Air Force requested $16.70 billion over the FY 2018 FYDP and a further $14.88 billion in the outyears beyond the FYDP. The KC-46A APUC is $203.67 million. The KC-46A program has an estimated total O&S cost of $220.82 billion over an estimated service life of 40 years per aircraft.

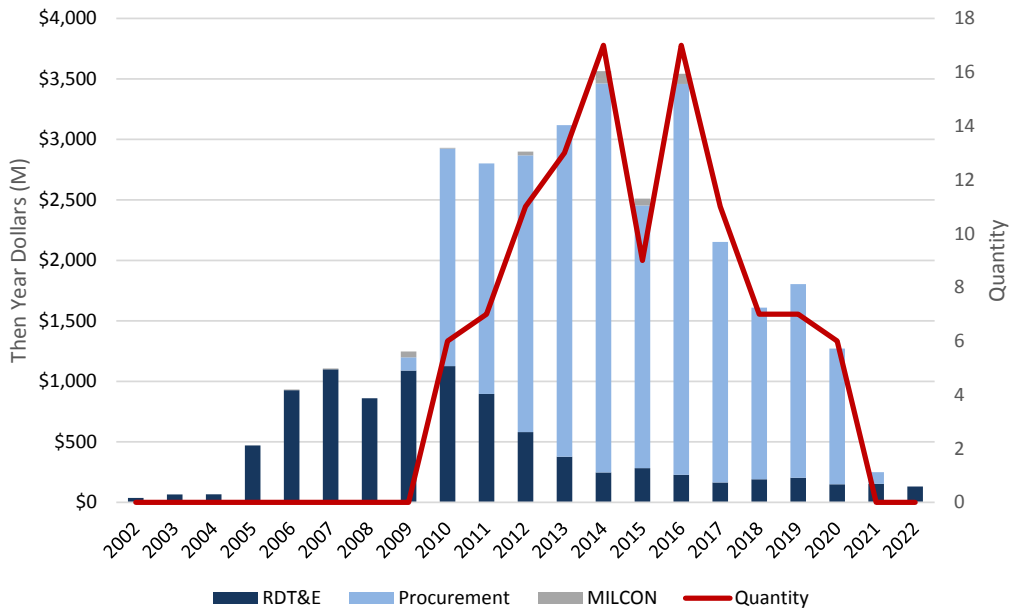


27 "Boeing KC-46 Pegasus," factsheet, *AeroWeb*, Forecast International, 2017, available at http://www.fi-aeroweb.com/Defense/KC-46-Tanker.html.

P-8A Poseidon Multi-Mission Maritime Aircraft (P-8A)

The Navy's P-8A Poseidon is being procured to replace the P-3C Orion for anti-submarine warfare; anti-surface warfare; and intelligence, surveillance, and reconnaissance missions. The P-8A is based on the Boeing 737. The program will be continuously upgraded to keep pace with evolving threats. The first upgrade, P-8A Increment 2, added a broad-area, multi-sensor acoustic capability that increased the P-8's ability to detect submarines in traditionally challenging coastal and shallow water areas. Increment 2 also includes integration with High Altitude Anti-Submarine Warfare Weapon Capability (HAAWC), a glide kit for torpedoes to allow the P-8A to deliver weapons from more efficient altitudes. Increment 3 upgrades will focus on communications, networking, and sensor improvements. The P-8 declared IOC in FY 2013, and 55 aircraft have already been delivered of the 91 contracted. 116 total aircraft are planned, of which 111 are production units. Norway and the United Kingdom are FMS partners, procuring five and nine aircraft, respectively.

A total of $28.30 billion has been appropriated through FY 2017. $5.07 billion has been requested over the FY 2018 FYDP, with no further funds requested in the outyears beyond the FYDP. Final procurement will be completed in FY 2020. The current APUC is $213.39 million. The P-8A program has an estimated total O&S cost of $52.85 billion over an estimated service life of 25 years per aircraft, approximately 36 percent more expensive than the P-3C aircraft the P-8A will replace.



Aircraft Procurement: Rotary-Wing Aviation

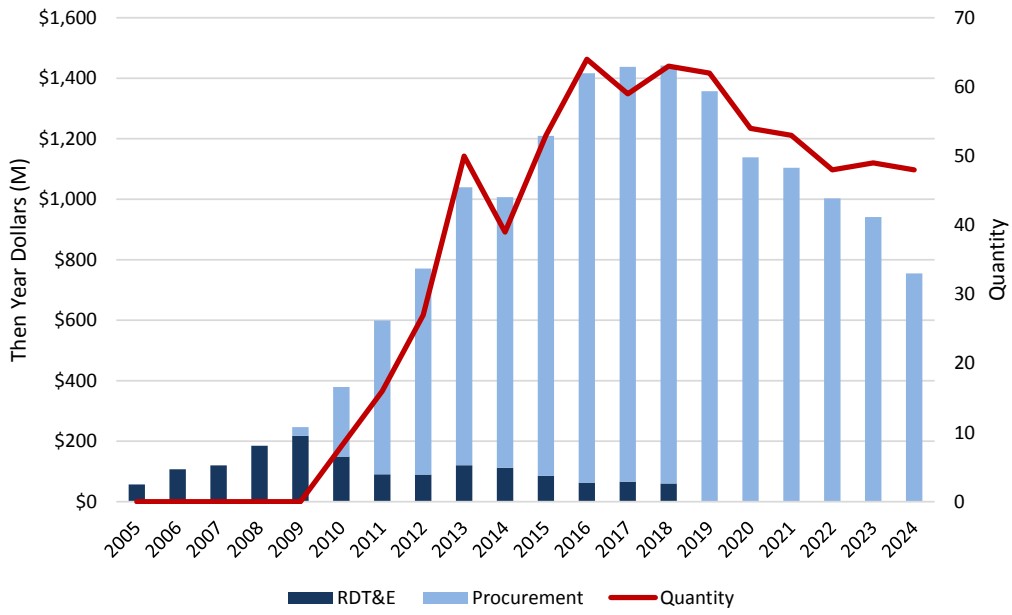
There are nine entries in this section, which covers the development and procurement of new and remanufactured rotary wing aircraft.[28] Many aircraft are iterations of designs that have served the joint force for decades, including the AH-64E Apache and AH-1Z attack helicopters; CH-47F and CH-53K heavy lift helicopters; and the HH-60W, MH-60R, UH-1Y, and UH-60M multi-mission utility helicopters. These are joined by three variants of the V-22 Osprey tilt-rotor aircraft, combining some of the best qualities of both rotary and fixed-wing aviation to expand the reach and speed of the joint force. Two programs, the procurement of the CH-47D and MH-60R, will end within the FY 2018 FYDP. Rotary wing aviation acquisitions collectively represent roughly $119.31 billion in investments through FY 2017. DoD is planning to spend at least a further $33.84 billion over the FYDP on new rotary aviation.

28 CSBA combined the AH-64E New Build and AH-64E Remanufactured SARs into one section since they are both part of the same effort to modernize the Apache helicopters in service today.

AH-64E Apache

The AH-64 Apache has been the Army's attack helicopter since its induction in the 1980s and has undergone several rounds of upgrades. The latest, from the AH-64D to the AH-64E, involves parallel programs detailed in two separate SARs. The larger program takes existing AH-64Ds out of the fleet for remanufacture, a process that replaces the helicopter's drive train and rotor system, making the AH-64E faster and more powerful than its predecessor. It also replaces the aircraft's avionics with a new open-architecture system capable of accepting future upgrades. So far, these include the capability to control UAVs from the AH-64E cockpit and, in the Lot 6 configuration, improved ability to track and engage maritime targets.[29] The AH-64E new build program will deliver a smaller number of entirely new aircraft to the Army. The AH-64E declared IOC in FY 2013 and entered full rate production in March 2014. Several international partners will upgrade existing or procure new Apache helicopters.

The FY 2018 budget request accelerates the procurement of 42 new build aircraft within the FYDP, but cuts four from the total buy. It delays the remanufacture of 19 aircraft to beyond the FYDP; 639 remanufactured AH-64Es are still planned in addition to 59 new aircraft. A total of $8.57 billion has been appropriated through FY 2017 for this program. $6.04 billion has been requested over the FY 2018 FYDP, with nearly $1.70 billion requested for the outyears beyond the FYDP. The current APUC for remanufactured aircraft is $20.20 million, and the APUC for new build aircraft is $33.58 million. The AH-64E program has an estimated total O&S cost of $56.33 billion over an estimated service life of 20 years per helicopter.

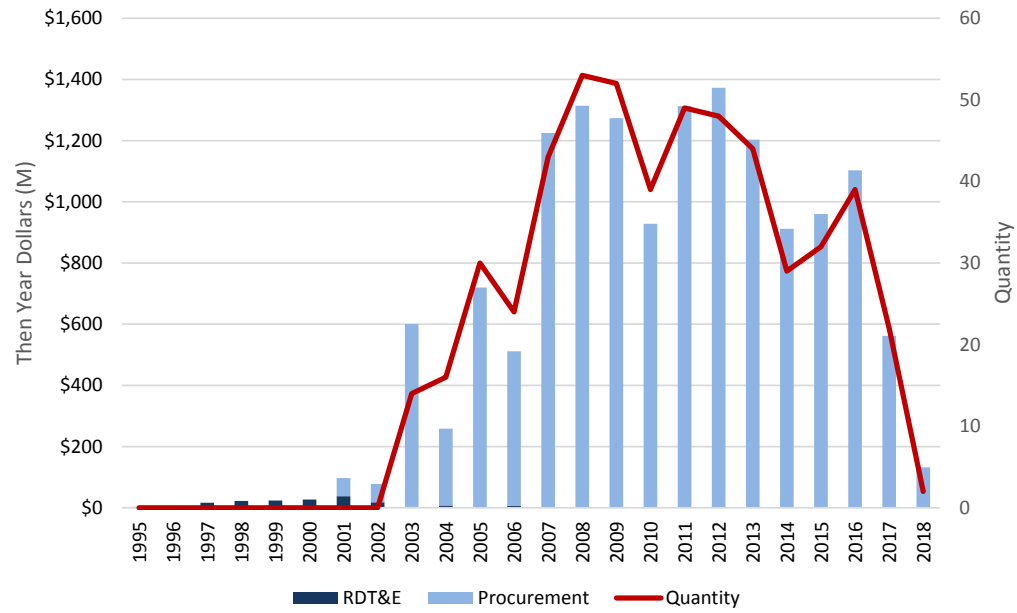


29 For upgrade details, see Gareth Jennings, "US Army Declares IOC for AH-64E Apache," *Jane's Defence Weekly*, November 27, 2013; and Gareth Jennings, "US Army to Upgrade AH-64E Apaches to New Lot/Version 6 Configuration," *Jane's Defence Weekly*, April 21, 2016.

CH-47F Improved Cargo Helicopter (CH-47F)

The CH-47F Chinook is the Army's current heavy-lift helicopter, the latest variant of a design in service since the 1960s. It is used to transport ground forces, supplies, and other critical cargo in support of combat missions. A variant, the MH-47G, also serves in the Army special operations community. Like the Apache upgrade program, the CH-47 modernization scheme is divided between remanufactured and new aircraft. 221 remanufactured aircraft will receive new engines, avionics, and other hardware components to increase operating efficiency and crew endurance, as well as decrease the time required to deploy the CH-47F helicopter via C-5 or C-17 transport aircraft. 246 new helicopters will be built to the CH-47F configuration, alongside the new MH-47Gs. 463 aircraft have been delivered to date, and procurement is scheduled to end in FY 2018. Some adjustments to the CH-47F baseline have occurred, and may still occur, due to operational requirements associated with Operations Freedom Sentinel and Inherent Resolve in Afghanistan and Iraq, respectively, with added funds coming through OCO accounts. Four partners operating old CH-47 models have already procured 48 aircraft.

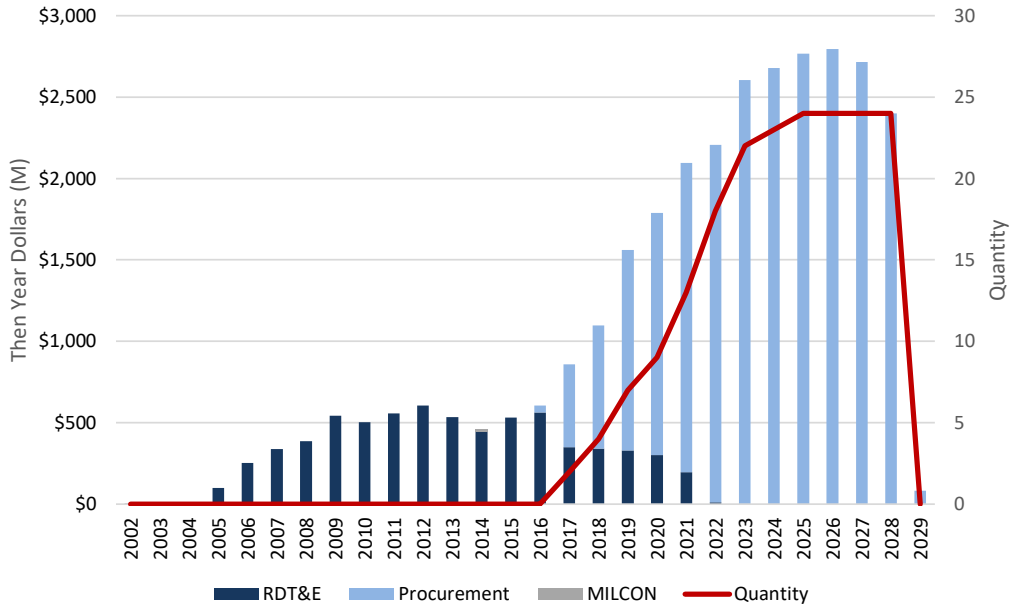
A total of $14.53 billion has been appropriated through FY 2017, with a final $131.80 million requested in FY 2018 to complete procurement. Seven fewer aircraft were requested in the FY 2018 budget than in FY 2017, resulting in a final projected procurement of 538 aircraft. APUC estimates price each CH-47F at $27.03 million. The CH-47F program has an estimated total O&S cost of $24.31 billion over an estimated service life of 20 years per helicopter.



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

The CH-53 series is the heavy lift helicopter of the Marine Corps, designed to ferry troops and supplies to and from Navy amphibious warfare ships. The CH-53K King Stallion is intended to replace the aging fleet of CH-53E helicopters and increase range, payload, survivability, and sustainability. Flight testing began in October 2015 and is ongoing. LRIP has been approved for up to 26 aircraft. In 2015, the CH-53K program breached the acquisition program baseline timeline for the LRIP decision, resulting in a schedule adjustment that has pushed back the Milestone C decision by over two years to FY 2019, which has also delayed subsequent program dates. IOC is currently projected for FY 2019–2020. The program expects to procure 200 helicopters through FY 2028, including 59 helicopters by the end of the FYDP.

A total of $6.28 billion has been appropriated through FY 2017, $8.75 billion was requested over the FY 2018 FYDP, and $16.04 billion is planned for beyond the FYDP. The current APUC is $124.96 million. The CH-53K program has an estimated total O&S cost of $77.94 billion over an estimated service life of 30 years per helicopter.



Combat Rescue Helicopter (CRH)

The Combat Rescue Helicopter will replace the Air Force's aging HH-60G Pave Hawk helicopters used to perform search and rescue missions. DoD waived the requirement for technology maturity, claiming that the program will rely on already proven technology. Additionally, DoD delayed the required preliminary design review, conducting it almost two years after development started. As such, there is an unknown level of additional risk facing the CRH as the program matures.[30]

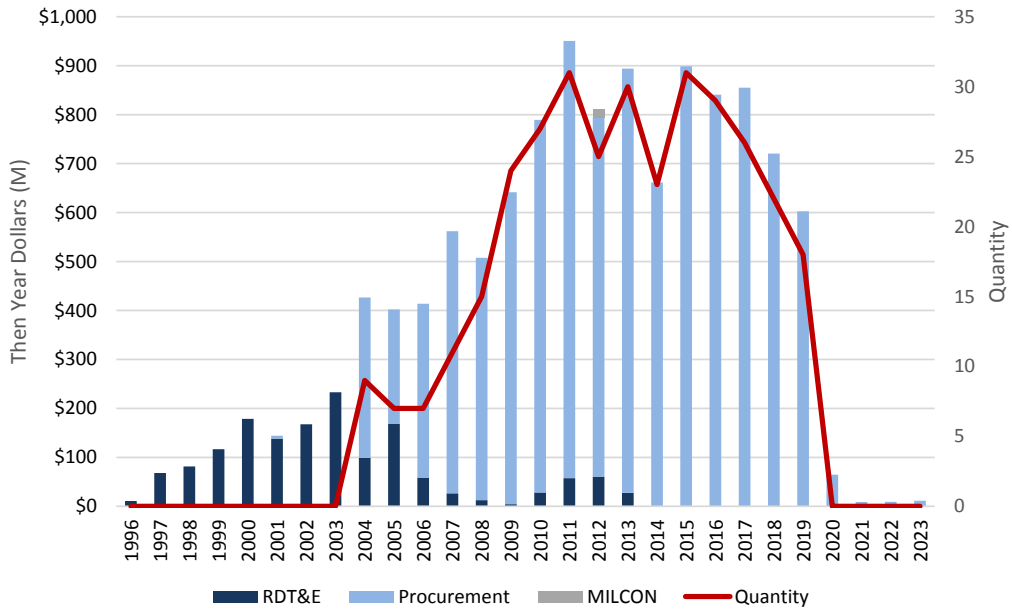
Some of the SAR for this program is marked FOUO. CSBA will update this entry once DoD responds to CSBA's FOIA request.

30 GAO, *Defense Acquisitions*, 2017, p. 134.

H-1 Upgrades (4BW/4BN)

The H-1 upgrade program recapitalizes the Marine Corps AH-1W attack helicopter and UH-1N utility helicopter fleets (to the AH-1Z and UH-1Y configuration, respectively), improving maneuverability, speed, and payload capability. 216 helicopters, including all planned remanufactured aircraft, have been delivered. West Coast Marine Expeditionary Units are already equipped with the upgraded aircraft. The Marine Corps requirement remains at 160 UH-1Y and 189 AH-1Z aircraft, although 14 AH-1Z aircraft are not funded in the current SAR. Pakistan has signed an FMS contract for 12 AH-1Z helicopters.

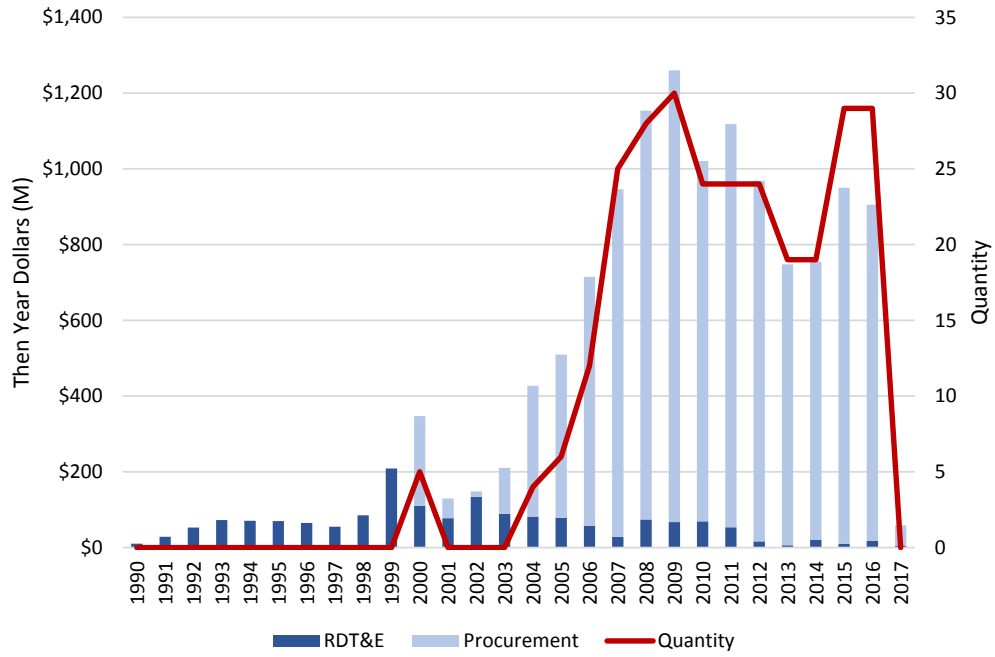
A total of $10.66 billion has been appropriated through FY 2017, an additional $1.41 billion was requested over the FY 2018 FYDP, and a remaining $11.40 million is planned for beyond the FYDP. Final procurement is scheduled for FY 2019. The H1 upgrade APUC is approximately $31.40 million per aircraft. The H-1 program has an estimated total O&S cost of $48.32 billion over an estimated service life of 30 years per helicopter.



MH-60R

This is the final SAR for this program, and no funding is planned after FY 2017. The MH-60R is a Navy variant of the Army's UH-60 Blackhawk helicopter (see p. 36) used for anti-submarine and surface warfare, search and rescue, medical evacuation, and limited logistics and transportation missions. It will be the principal multi-mission helicopter of the Navy. The MH-60R replaces the SH-60B and SH-60F helicopters and provides improved avionics, dipping sonar, radar, self-defense, and data-sharing capabilities. IOC was declared in December 2005. Saudi Arabia, Denmark, and Australia are FMS partners, requesting a combined 43 aircraft.

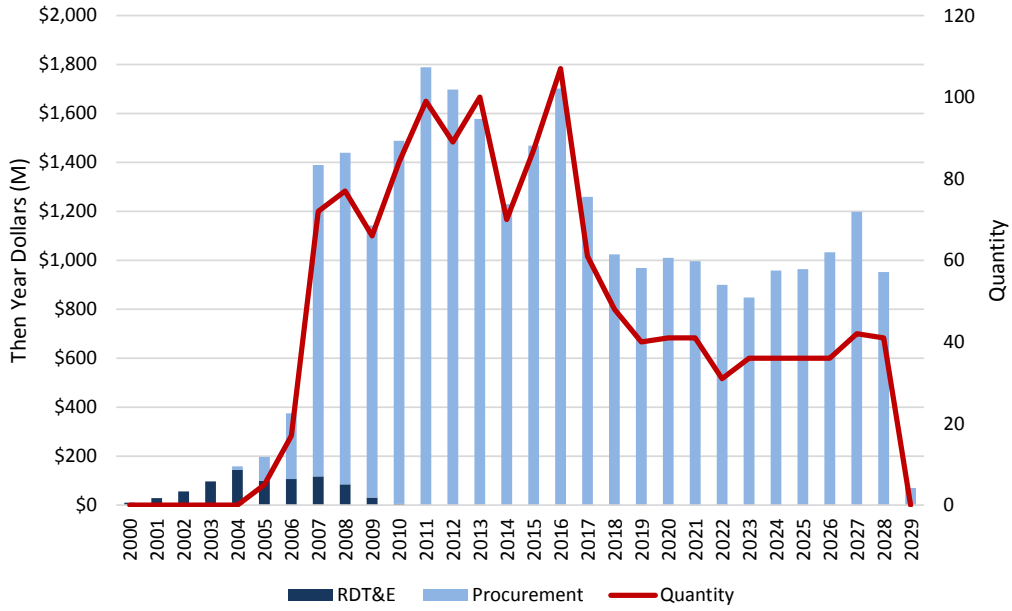
A total of $13.09 billion has been appropriated through FY 2017 for a total of 280 aircraft, with no further funding or procurement currently planned. Final procurement is scheduled for FY 2017. The APUC is $40.92 million per aircraft. The MH-60R program has an estimated total O&S cost of $42.65 billion over an estimated service life of almost 25 years per helicopter.



UH-60M Black Hawk Helicopter (UH-60M)

The UH-60 Black Hawk is the Army's primary utility helicopter for air assault, aeromedical evacuation, and general transportation needs. Variants of the UH-60 are also used by the Air Force and the Navy. The UH-60M variant includes upgraded engines, rotor blades, and instrumentation. Full rate production began in 2007, and 846 aircraft have been delivered thus far. DoD plans to buy a total of 1,370 helicopters through FY 2028 using multi-year procurement contracts to streamline acquisition. Ten foreign partners have purchased a further 228 UH-60M helicopters through FMS. Although a past O&S cost breach in the acquisition program baseline was reported in 2013, no issues currently exist with the program.

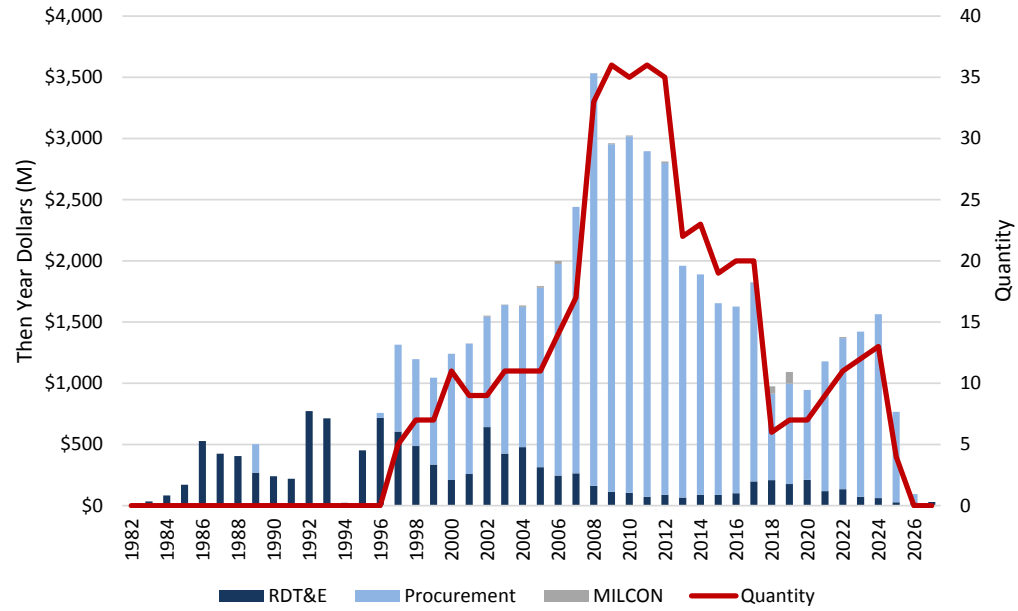
The FY 2018 budget request delays the procurement of 51 previously planned airframes to beyond the FYDP. 201 aircraft will be procured during the FYDP, with a further 227 aircraft planned beyond that. A total of $17.10 billion has been appropriated through FY 2017 for a total of 942 helicopters, including eight development aircraft. $4.90 billion has been requested over the FY 2018 FYDP, with a further $6.02 billion requested in the outyears beyond the FYDP. The current APUC estimate is $20.00 million. The UH-60M program has an estimated total O&S cost of $59.56 billion over an estimated service life of almost 25 years per helicopter.



V-22 Osprey Joint Services Advanced Vertical Lift Aircraft (V-22)

The V-22 is a tilt-rotor helicopter capable of both vertical takeoff and landing and long-range cruise, like a turboprop fixed-wing aircraft. The MV-22 variant replaces the Marine Corps' CH-46E and CH-53D for transport of troops, equipment, and supplies, using speed and range to complement the CH-53K's (see p. 32) heavy lift capability. The Air Force's CV-22 variant replaces the MH-53J/M for long-range special operations missions. The Navy's CMV-22 will replace the C-2A Greyhound for delivery of parts and supplies to and from aircraft carriers. Contracts for the development and delivery of the first CMV-22s were issued in late 2016. In May 2016, the Navy selected Bell Boeing to develop and integrate an aerial refueling system that can be retrofitted onto the MV-22, increasing the range and flexibility of forces operating the V-22.[31] As of May 2017, a total of 295 MV-22s and 52 CV-22s have been delivered out of a projected buy of 462 aircraft. Japan is in the process of acquiring V-22s, while Israel has expressed interest and is currently conducting requirement studies.

A total of $46.69 billion has been appropriated through FY 2017 for a total of 393 aircraft, including two developmental aircraft. $5.57 billion has been requested over the FY 2018 FYDP, with a further $3.88 billion requested in the outyears beyond the FYDP. The current APUC is $96.55 million. The V-22 program has an estimated total O&S cost of $129.07 billion over an estimated service life of almost 25 years per aircraft.

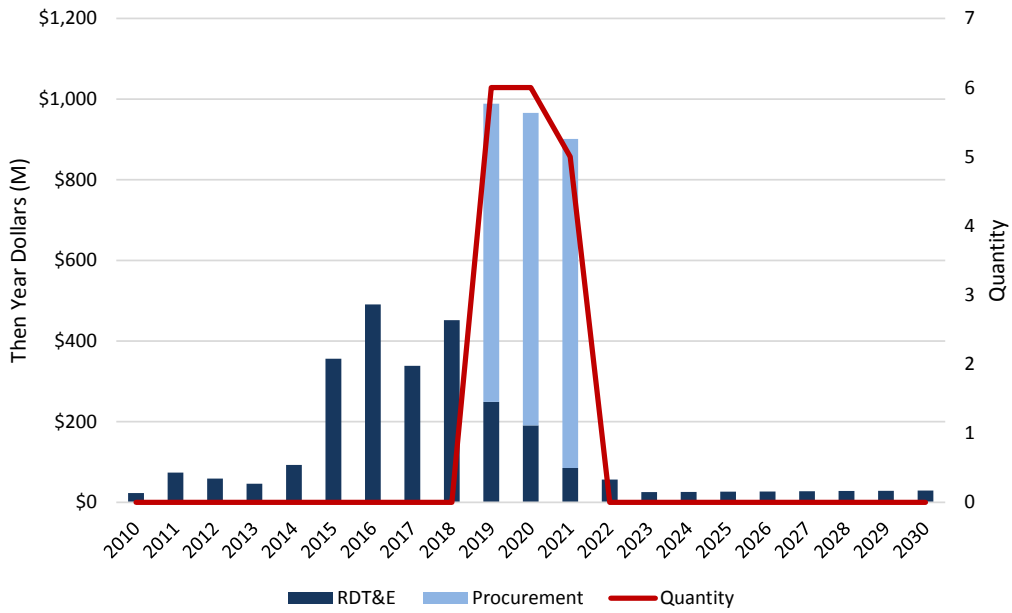


31 Justin Doubleday, "Bell-Boeing Awarded Deal for V-22 Aerial Refueling System Development," *Inside Defense*, June 7, 2016.

VH-92A Presidential Helicopter (VH-92A)

The VH-92 Presidential Helicopter is designed to provide safe transport for the President, other senior U.S. leaders, and visiting dignitaries. The VH-92 program is intended to replace the VH-3D and VH-60N currently flown by Marine Helicopter Squadron One (HMX-1) in support of the VIP transport mission. It will be a heavily modified variant of Sikorsky's S/H-92 civilian and military medium-lift helicopter. The VH-92A is expected to achieve IOC in 2020, with a projected buy of 21 operational and two test aircraft. Thus far, six developmental aircraft have been procured, with production aircraft procurement beginning in FY 2019. The program is a successor to the VH-71 helicopter replacement program, which was cancelled in 2009 after repeated delays, cost growth, and underperformance.[32]

A total of $1.48 billion has been appropriated through FY 2017. $3.36 billion has been requested over the FY 2018 FYDP, with a further $218.20 million requested in the outyears beyond the FYDP. The current APUC estimate is $137.08 million. The VH-92A program has an estimated total O&S cost of $16.48 billion over an estimated service life of almost 40 years per helicopter.



32 GAO, *Defense Acquisitions*, 2017, pp. 121–122.

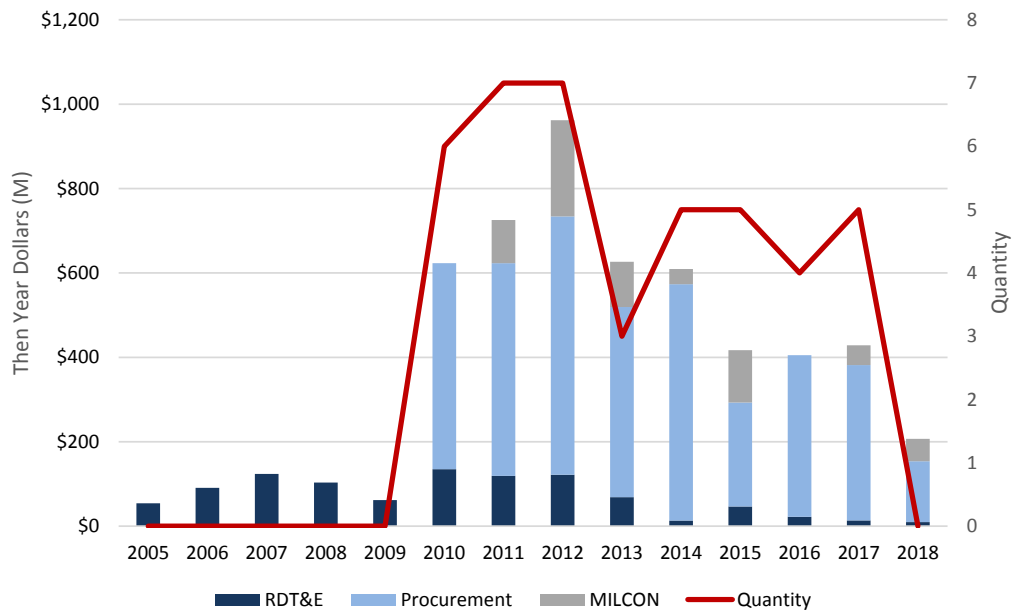
Aircraft Procurement: Unmanned Systems

Although only four programs are included in this section, they collectively represent a variety of mission sets and acquisitions by the Army, Air Force, and Navy. They comprise the most complex unmanned systems in the joint force thus far. Three UAV systems are fixed-wing aircraft, while a fourth, the MQ-8 program, includes two vertical take-off UAV designs. The Army MQ-1C Gray Eagle and Air Force MQ-9 Reaper both evolved from the Air Force MQ-1 Predator, whereas the MQ-4C Triton evolved from the Air Force RQ-4 Global Hawk. System procurement for the MQ-1C and MQ-8 are projected to end in FY 2017, and procurement for the MQ-9 is expected to end in FY 2018. These programs include $22.25 billion in investments through FY 2017. DoD is planning to spend at least a further $7.27 billion over the FYDP on these UAV programs. This category of acquisitions is likely to grow in the years ahead as more unmanned systems join the joint force.

MQ-1C Gray Eagle Unmanned Aircraft System

The Army's MQ-1C Gray Eagle UAV is an upgraded version of the Air Force's MQ-1 Predator UAV. It is used for reconnaissance and surveillance, target acquisition, and light strike. A Gray Eagle System consists of 12 aircraft; a variety of mission payloads; six ground control stations; and other sustainment and command, control, and communications equipment split among three platoons. Army requirements for MQ-1C UAVs are expanding. In FY 2015, Congress authorized the Army to procure 167 aircraft, of which 36 would come in an extended-range configuration. The new SAR indicates a 2017 revised Army acquisition objective of 204 aircraft, with 70 in the extended-range configuration. The revised procurement quantities, in addition to several previous aircraft additions, triggered a breach in the acquisition program baseline procurement projections. The program is in FRP and 134 aircraft have been delivered thus far. Eleven of a projected 15 Gray Eagle companies, each with a complete MQ-1C Gray Eagle System, have already been established, and the MQ-1C Gray Eagle System has served operational needs since before IOC in 2012.

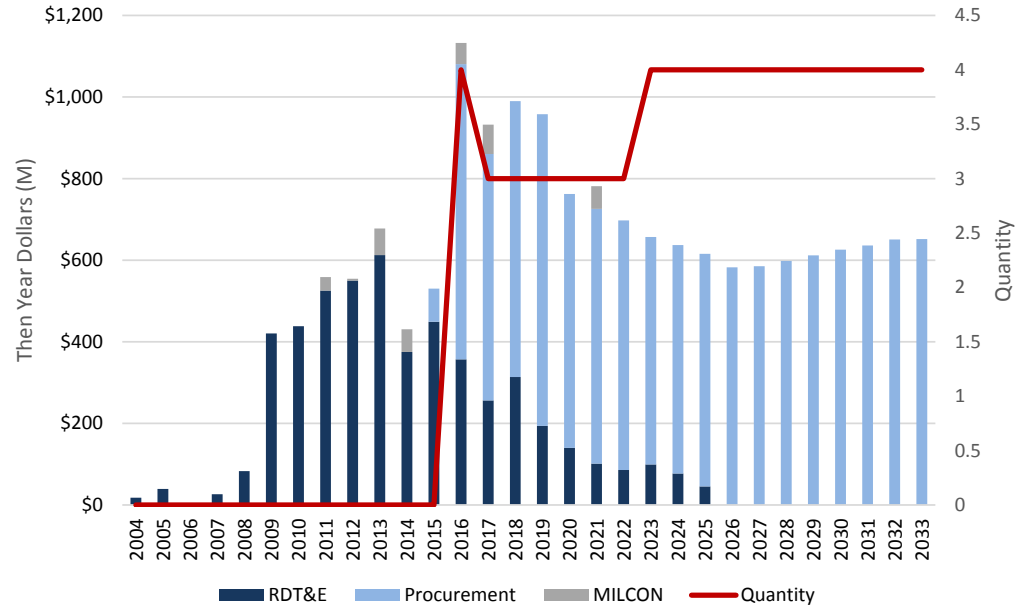
A total of $5.51 billion has been appropriated through FY 2017, and an additional $206.90 million was requested in FY 2018 to resource the increased requirement. It is possible further procurement increases may extend program funding farther into the FYDP. The current APUC estimate for each MQ-1C Gray Eagle System of 12 aircraft and supporting equipment is $93.77 million. The MQ-1C program has an estimated total O&S cost of $9.95 billion over an estimated service life of almost 20 years per system.



MQ-4C Triton Unmanned Aircraft System

The Navy's MQ-4C Triton, formerly known as the Broad Area Maritime Surveillance (BAMS) program, is designed to provide persistent maritime intelligence, surveillance, and reconnaissance. It is based on the Air Force's RQ-4B Global Hawk and will operate from five land-based sites to provide constant coverage of different regions.[33] Planned improvements include a signals intelligence collection capability and an upgraded communication relay. The first LRIP contracts were awarded in September 2016. Flight testing has begun for the third increment of software, which the Navy would like to demonstrate by the end of 2017.[34] IOC is projected for 2020–2021. Australia is expected to procure up to seven MQ-4C Tritons, while Germany is considering procurement of three to four of the UAVs. Canada, Japan, Norway, and the United Kingdom have also expressed interest in the system.

A total of $5.84 billion has been appropriated through FY 2017, $4.19 billion was requested over the FY 2018 FYDP, and $6.85 billion is planned for beyond the FYDP to procure a total quantity of 70 MQ-4Cs. The estimated APUC for MQ-4C is $171.78 million. The MQ-4C program has an estimated total O&S cost of $20.55 billion over an estimated service life of almost 20 years per system.



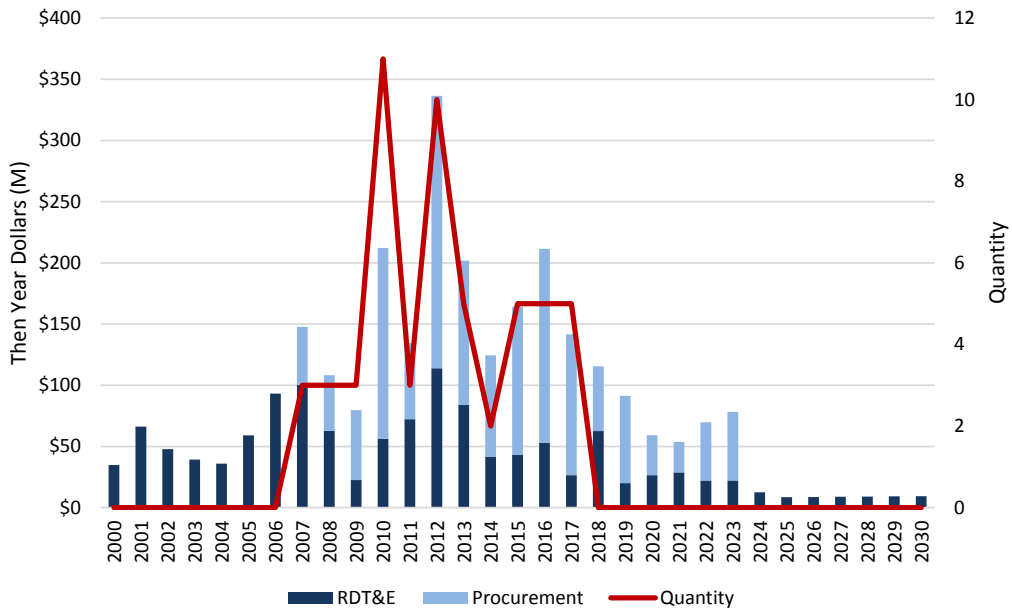
33 GAO, *Defense Acquisitions*, 2017, pp. 109–110.

34 Ibid.

MQ-8 Fire Scout

The MQ-8 Fire Scout UAV is designed to provide surveillance and targeting information for ground, air, and sea forces. Among other uses, it is intended to support the Littoral Combat Ship's surface warfare, mine countermeasures, and anti-submarine warfare mission packages. The MQ-8B was the baseline model. The larger MQ-8C model, with greater range, endurance, and payload, was developed using many of the same components of the MQ-8B. The MQ-8B has been deployed operationally for several years since declaring IOC in 2014. The larger MQ-8C remains in developmental flight testing, with IOC projected for 2018–2019. The Fire Scout program had a critical Nunn-McCurdy breach in 2014 due to unit cost growth. The subsequent 2015 program restructuring slightly delayed development.

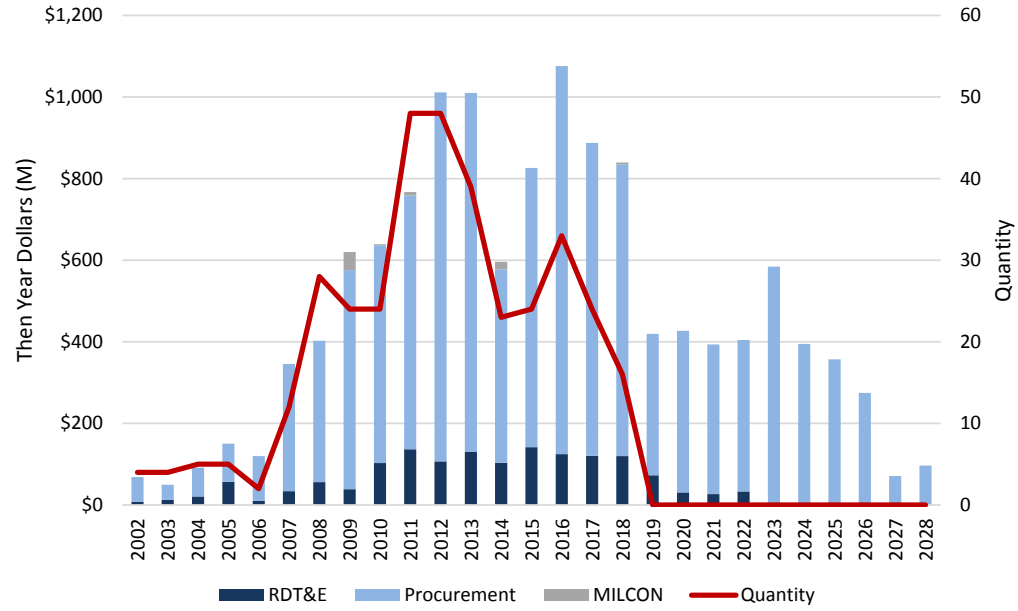
Thus far, 30 MQ-8B and 21 MQ-8C UAVs have been delivered out of a projected 64 total aircraft. The FY 2018 projection is six fewer aircraft than anticipated in FY 2017 and down from an original estimate of 177 aircraft. No further aircraft are planned for procurement in FY 2018 or beyond. A total of $2.24 billion has been appropriated through FY 2017, $389.40 million was requested over the FY 2018 FYDP, and $144.50 million is planned beyond the FYDP to complete the program. A single APUC of $26.75 million is given for both models. The MQ-8 program has an estimated total O&S cost of $4.03 billion over an estimated service life of almost 20 years per system.



MQ-9 Reaper Unmanned Aircraft System

The Air Force's MQ-9 Reaper UAV, based on the Service's earlier MQ-1 Predator, is a multi-role, medium-altitude, unmanned aircraft for surveillance and strike missions. The MQ-9 can be equipped with a variety of sensor packages and precision-weapons in support of operational requirements, and its long endurance facilitates persistent loiter and surveillance of targets of interest. The MQ-9 is in full rate production. 236 aircraft have been delivered thus far out of a projected 366 total aircraft. This represents an increase of 16 aircraft over FY 2017 projections. Beginning in 2015, new aircraft were procured with an extended range kit, and earlier models are now being retrofitted. Issues associated with MQ-9 starter-generator failures resulted in the loss of 13 aircraft and prompted several program adjustments; installing redundant electrical power systems resolved the problem. Six NATO partners have purchased 49 MQ-9 UAVs.

A total of $8.66 billion has been appropriated through FY 2017, $2.48 billion was requested over the FY 2018 FYDP, and $1.78 billion is planned beyond the FYDP. Procurement is scheduled to end in FY 2018. The MQ-9 program has an estimated total O&S cost of $58.83 billion over an estimated service life of almost 20 years per system.



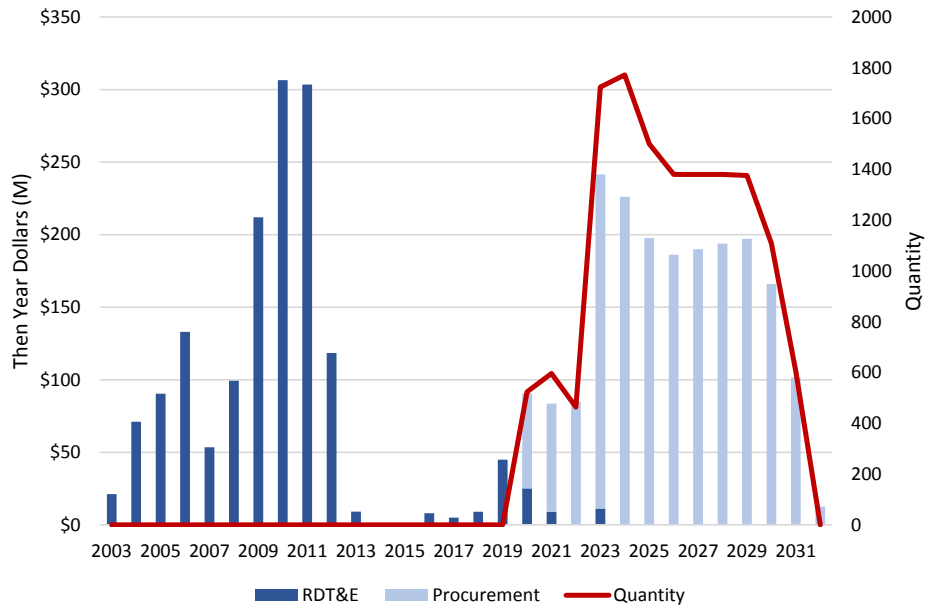
Communications Systems

Communications systems are foundational capabilities necessary to coordinate U.S. forces, share information, and keep in touch with coalition partners. These programs are complex, essential, and often poorly understood by those within DoD, let alone outside it. The communications programs featured in the FY 2018 SARs improve the security and functionality with which warfighters talk to each other and the chain of command—from the individual soldiers clearing Iraq of insurgents to the national command and control assets responsible for coordinating a potential nuclear war. The programs listed in this section alone represent a DoD investment of over $16.99 billion thus far in joint networking. DoD currently plans to spend $6.34 billion more on these programs over the coming FYDP. This section does not include funding for the military Satellite Communications (SATCOM) systems, which are listed in the Space Systems section.

Airborne and Maritime/Fixed Station Joint Tactical Radio System (AMF JTRS)

The AMF JTRS program plans to upgrade and standardize radios in Army helicopters and fixed-wing platforms through the acquisition of mature, software-defined radios capable of communicating over a variety of frequencies and adopting future operational and technology requirements. The program is in the process of procuring Small Airborne Networking Radios (SANR), which will replace current Single Channel Ground and Airborne Radio Systems (SINCGARS) in Army aviation platforms. It will provide interoperability with SINCGARS, as well as the Soldier Radio Waveform (SRW) and Wideband Networking Waveform (WNW) capabilities, improving overall Army networking and communications. SANR will be installed aboard AH-64E Apache attack helicopters, UH-60 Black Hawk utility helicopter variants, CH-47 Chinook heavy lift helicopter variants, and MQ-1C Gray Eagle UAVs. A 2014 program restructuring resulted in schedule delays, which were not serious enough to create a breach of the acquisition program baseline projections. IOC is projected for 2024.

In comparison with the FY 2017 request, FY 2018 funding and procurement profiles suggest a one-year delay in SANR acquisition; a major program ramp up anticipated for FY 2022 has now been pushed to just beyond the FY 2018 FYDP. A total of $1.43 billion has been appropriated through FY 2017, $313.20 million was requested over the FY 2018 FYDP, and an additional $1.71 billion is projected for beyond the FYDP to complete the planned procurement of more than 7,000 radios.[35] The current APUC is roughly $280 thousand per radio. The AMF-JTRS program has an estimated total O&S cost of $2.66 billion over an estimated service life of 20 years per system.

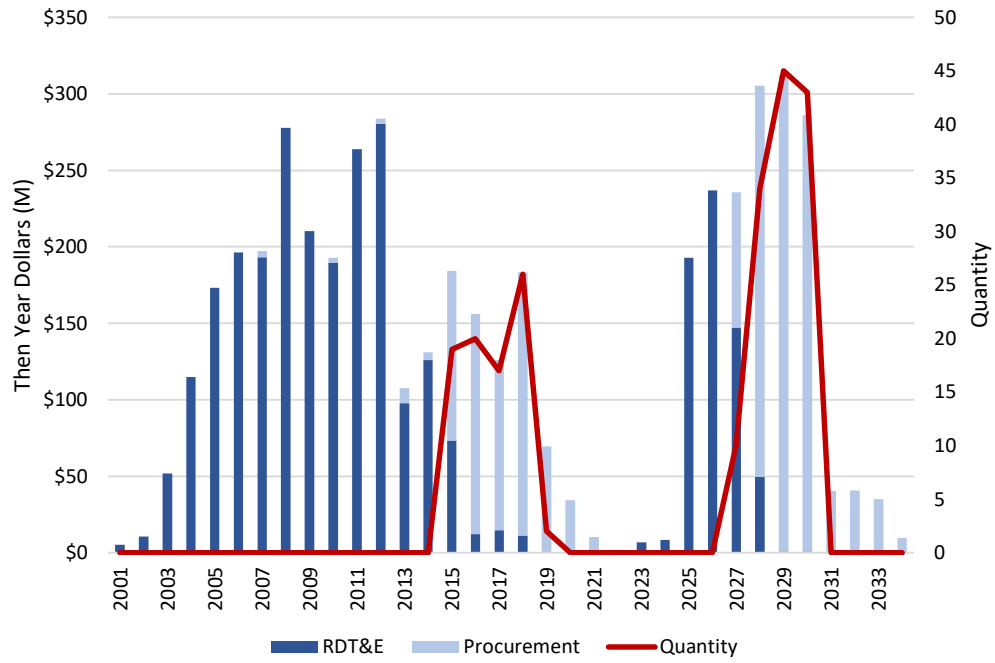


35 The AMF SAR gives procurement quantities, APUC, and O&S costs in terms of channels. Each radio will have two channels, so procurement units listed here have been halved and unit cost and sustainment estimates doubled.

Family of Beyond Line-of-Sight Terminals (FAB-T)

The FAB-T is an Air Force-led program to develop airborne and ground-based SATCOM terminals to recapitalize a communications capability that can operate in a nuclear war. FAB-T provides voice and data links for conventional and nuclear forces via the legacy Milstar and the newer Advanced Extremely High Frequency (see p. 98) SATCOM constellations. Current terminals are incompatible with the AEHF constellation and unable to capitalize on its improvements in data rates, jam resistance, and security. In July 2015, the FAB-T program was restructured into the Command Post Terminal (CPT) and the Force Element Terminal (FET) sub-programs, which caused a schedule breach from the acquisition program baseline. As a result, the AEHF satellites will arrive on orbit before the FAB-T terminals capable of using them are ready.[36] The CPT is expected to reach IOC in December 2019 and will be installed aboard the E-4 Nightwatch and E-6 Mercury. Deliveries of developmental CPT sets should begin in 2017.[37] FET terminals will be installed on the B-2, B-52, and some RC-135, though no funding has been allocated yet for procurement.

A total of $2.68 billion has been appropriated through FY 2017, $297.20 million was requested over the FY 2018 FYDP, and $1.71 billion is planned beyond the FYDP to procure 109 CPT terminals and 158 FET terminals. The estimated APUC is $8.07 million per terminal. The FAB-T program has an estimated total O&S cost of $1.79 billion over an estimated service life of 33 years per system.



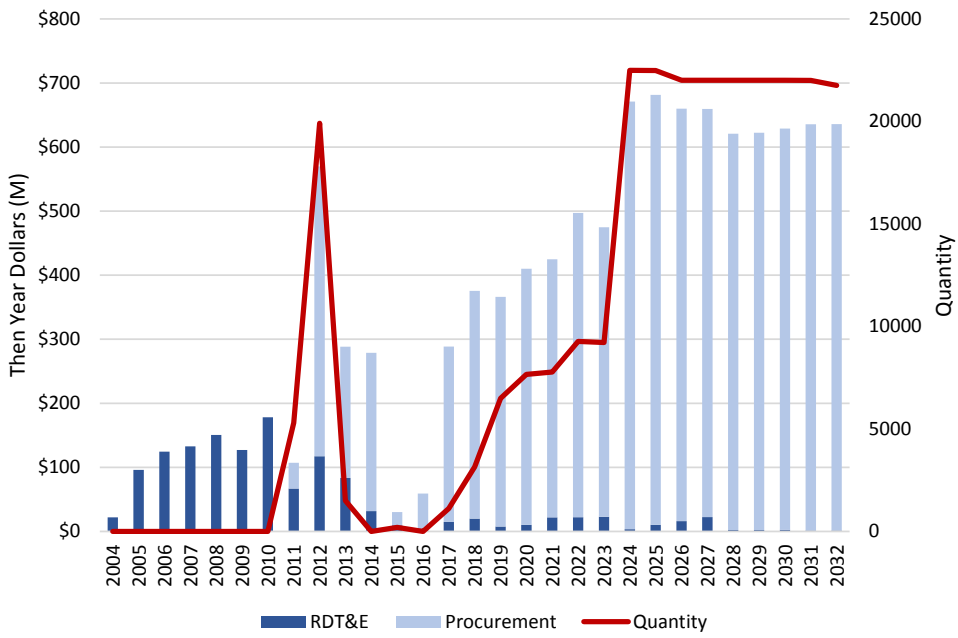
36 Ibid.

37 GAO, *Defense Acquisitions*, 2017, pp. 109–110.

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

The JTRS HMS is an Army-led program to procure a family of software-defined radios that can create secure and self-forming voice and data networks between individual soldiers, higher Army echelons, and other joint elements. The program will procure single-channel Rifleman Radios and two-channel Manpack, Leader, and Small Form Fit Radios. Rifleman, Leader, Manpack, and Small Form Fit radios will be interoperable with Soldier Radio Waveform (SRW). Manpack and leader radios will be interoperable with Single Channel Ground and Airborne Radio Systems (SINCGARS). Manpack radios will also use Demand Assigned Multiple Access Satellite Communication and eventually the Mobile User Objective System waveform (see p. 105).
A 2016 decision halted procurement of the single-channel Rifleman Radios after a two-channel requirement was presented, leading to the two-channel Leader Radio. This alteration has created a schedule breach in the acquisition program baseline pushing the FRP decision for the Rifleman Radio, and now Leader Radio, beyond 2018. Procurement figures have gone up to reflect the new acquisition effort, though no breach has been reported. Manpack Radio development is ongoing, and a FRP decision is expected in FY 2018. The FY 2018 SAR indicates that efforts are underway to assess radio network vulnerability. Program requirements may be adjusted in the future to improve security, leading to some program risk.

A total of $2.45 billion has been appropriated through FY 2017, and $2.07 billion was requested over the FY 2018 FYDP. An additional $6.29 billion is planned beyond the FYDP to complete the planned procurement of more than 270,000 radios. More than 193,000 Leader and Rifleman handheld radios are planned, along with more than 73,000 dismounted or vehicle-mounted Manpack radios. The APUC is $35,000 per radio, averaged across variants. The JTRS-HMS program has an estimated total O&S cost of $20.51 billion over an estimated service life of 20 years per system.



Multifunctional Information Distribution System (MIDS)

The MIDS program provides high-speed and secure data links to the U.S. and select partners and allies through the Link 16 network.[38]

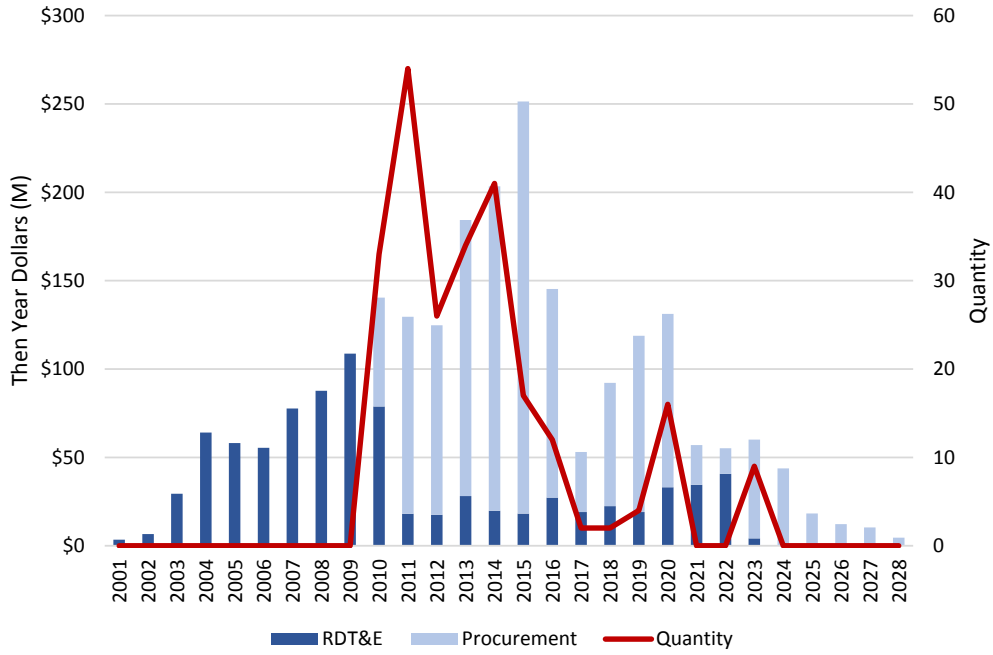
Some of the SAR for this program is marked FOUO. CSBA will update this entry once DoD responds to CSBA's FOIA request.

38 "Multifunctional Information Distribution Systems (MIDS)," factsheet, Rockwell Collins, September, 26, 2017, available at https://www.rockwellcollins.com/Products_and_Services/Defense/Communications/Tactical_Data_Links/Multifunctional_Information_Distribution_System.aspx.

Navy Multiband Terminal (NMT)

The NMT is a multiband SATCOM terminal that will be installed on U.S. ships and shore stations, in addition to those of several allies. The NMT leverages the Defense Satellite Communications System (DSCS), Wideband Global Satellite Communications, Military Strategic and Tactical Relay (Milstar), and Advanced Extremely High Frequency (see p. 98) SATCOM constellations. In comparison with current systems, NMT offers improved data throughput and resistance to both jamming and interference, reducing vulnerability to detection by adversaries.[39] The program declared IOC in 2012 and is in full rate production, having fielded 130 of 250 production systems. The United Kingdom, the Netherlands, and Canada are FMS partners.

A total of $1.72 billion has been appropriated through FY 2017, $454.40 million was requested over the FY 2018 FYDP, and $149.40 million is planned beyond the FYDP. The estimated APUC is $5.82 million per terminal. The NMT program has an estimated total O&S cost of $417.60 million over an estimated service life of 23 years per system.



39 "NMT Navy Advanced Extremely High Frequency Multi-band Terminal," factsheet, U.S. Navy, available at http://www.secnav.navy.mil/rda/Pages/Programs/NMT.aspx.

Warfighter Information Network-Tactical (WIN-T)

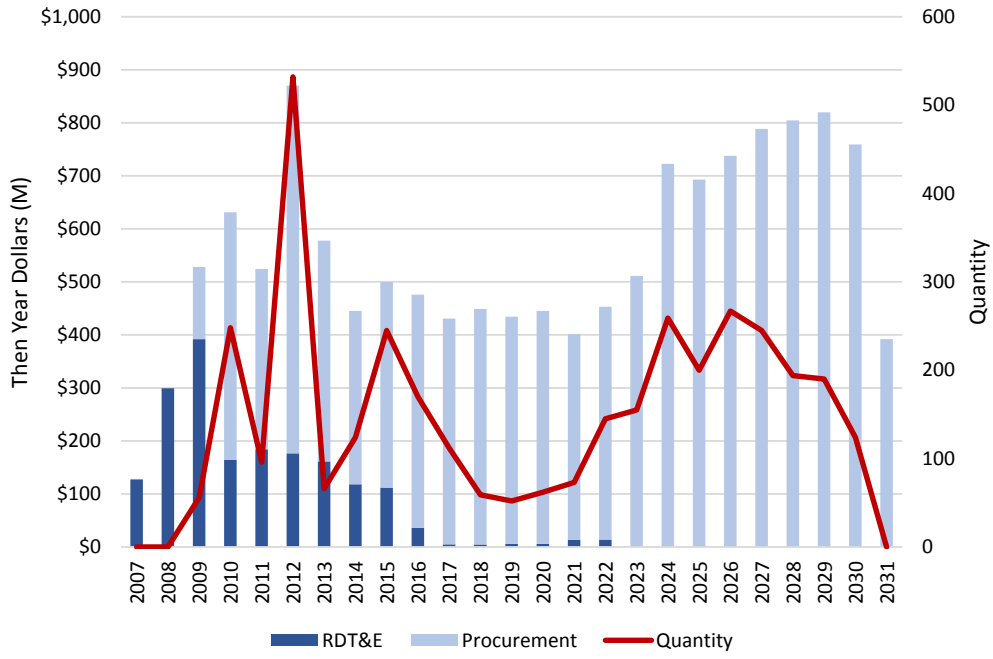
This entry combines two WIN-T SARs. WIN-T is a multi-increment program to provide Army commanders with a high throughput communications capability linking units down to the company level, leveraging both SATCOM and deployable local line-of-sight nodes. WIN-T Increment 1 was fielded between 2004 and 2012 to link divisions, brigades, and battalions.[40] WIN-T Increment 2 extends this functionality to vehicles and other command nodes in individual companies to provide responsive, on-the-move networking. This puts intelligence in the hands of more users, improves the common operating picture, and increases the speed of response for forward forces.[41] On-the-move access also reduces the reliance on fixed infrastructure, which may be attacked. Increment 2 entered FRP in June 2015 and has been fielded in 16 Brigade Combat Teams. Increment 3 was restructured in 2014, turning the program into a software development program to enhance Increment 2 capabilities. The restructuring of Increment 3 and the associated expansion of Increment 2 caused Increment 2 to report a significant Nunn-McCurdy breach in 2014. In September 2017, the Army requested Congressional permission to halt WIN-2 Increment 2. Congress has yet to approve that request.[42]

40 "WIN-T Increment 1," Army Program Executive Office Command Control Communications—Tactical, updated March 6, 2017, available at http://peoc3t.army.mil/wint/inc1.php.

41 "WIN-T Increment 2," Army Program Executive Office Command Control Communications—Tactical, updated March 6, 2017, available at http://peoc3t.army.mil/wint/inc2.php.

42 Courtney McBride, "After Thorough Review, Army to Halt WIN-T Increment 2," *Inside Defense*, September 27, 2017.

A total of $5.75 billion has been appropriated through FY 2017, $2.18 billion was requested over the FY 2018 FYDP, and $6.23 billion is planned beyond the FYDP. FY 2018 is the last SAR for Increment 3 with funding ending in FY 2016. The estimated APUC is $3.27 million per network node. The WIN-T program has an estimated total O&S cost of $16.87 billion over an estimated service life of 20 years per network node.



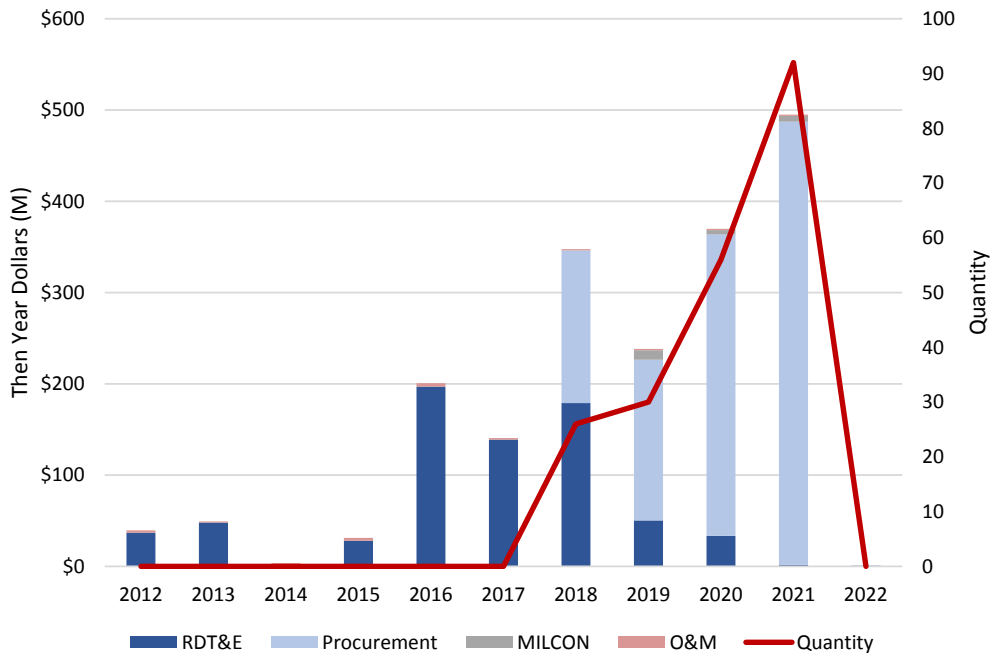
Ground Systems

DoD is currently pursuing relatively few major ground system acquisitions. Five programs are included in this section. The largest is the Joint Light Tactical Vehicle program, which will replace tens of thousands of existing Army and Marine Corps tactical vehicles. The JLTV and Army Armored Multi-Purpose Vehicle will both significantly increase procurement in the years beyond the FYDP. Although future program funding for the Marine Corps' Amphibious Combat Vehicle beyond Increment 1 was not projected in this year's SAR, acquisition of subsequent increments will also incur billions of dollars of future spending requirements. The ground system programs listed in this section represent a DoD investment of $8.07 billion thus far, and the FY 2018 budget request forecasts $15.63 billion more on these programs over the coming FYDP.

Amphibious Combat Vehicle Phase 1 Increment 1 (ACV 1.1)

This is the first SAR for the ACV program, which is the successor to the current Assault Amphibious Vehicle (AAV). The ACV effort is a more modest attempt to replace Marine Corps amphibious vehicles following the cancellation of the Expeditionary Fighting Vehicle program in 2011. ACVs procured in the first increment will use surface-to-shore connectors to get ashore and will focus solely on personnel transport. Self-deployment from the Navy's amphibious warfare vessels and variants for other missions will be in ACV 1.2, which will be a modification of the ACV 1.1 design.[43] The Marine Corps has expressed interest in a future ACV 2.0 with high swim speeds, but that would likely be a separate design.[44] The FY 2018 SAR projects a buy of 240 ACV 1.1 vehicles, of which 36 will be developmental units. Final ACV 1.1 design selection is scheduled for 2018. ACV 1.1 procurement is projected to end in FY 2021. IOC is anticipated in 2020–2021.

A total of $464.80 million has been appropriated through FY 2017. $1.45 billion is requested over the FY 2018 FYDP, with funding ending in FY 2022. Although no funding for ACV 1.2 is included in this SAR, Navy RDT&E budget documentation projects $121.70 million in RDT&E funding for ACV 1.2 across the FYDP, along with $623.37 million in procurement funding in FY 2022.[45] The ACV 1.1 APUC is $5.69 million and has an estimated total O&S cost of $4.18 billion over an estimated service life of 20 years per vehicle.



43 GAO, *Defense Acquisitions*, 2017, pp. 91–92.

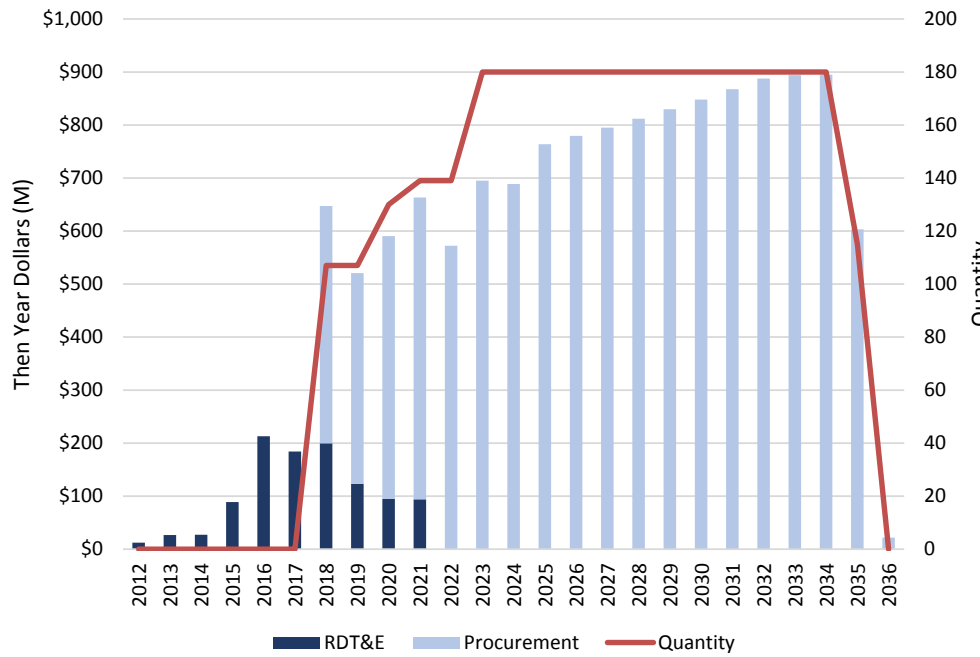
44 Ibid.

45 U.S. Navy, *Department of Defense Fiscal Year (FY) 2018 Budget Estimates: Navy*, Justification Book Volume 3 of 5, *Research, Development, Test & Evaluation, Navy Budget Activity 5* (Washington, DC: DoD May 2017), p. 1413, available at http://www.secnav.navy.mil/fmc/fmb/Documents/18pres/RDTEN_BA5_Book.pdf.

Armored Multi-Purpose Vehicle (AMPV)

AMPV vehicles will replace the aging M113 armored vehicles in Army service since the Vietnam War. The family of vehicles will include five variants, including command and control, medical treatment, casualty evacuation, mortar carrier, and general purpose. Upon completion, AMPVs will account for 30 percent of the tracked vehicles within Army Armored Brigade Combat Teams. The vehicles use mature technology and designs to expedite the acquisition process and save costs, and four of fifteen prototypes have already been delivered. Though production and testing delays have caused some schedule slippage, the program is largely on track and not at risk of any breaches of the acquisition program baseline. IOC is anticipated for 2022, and up to 2,936 vehicles are currently planned.

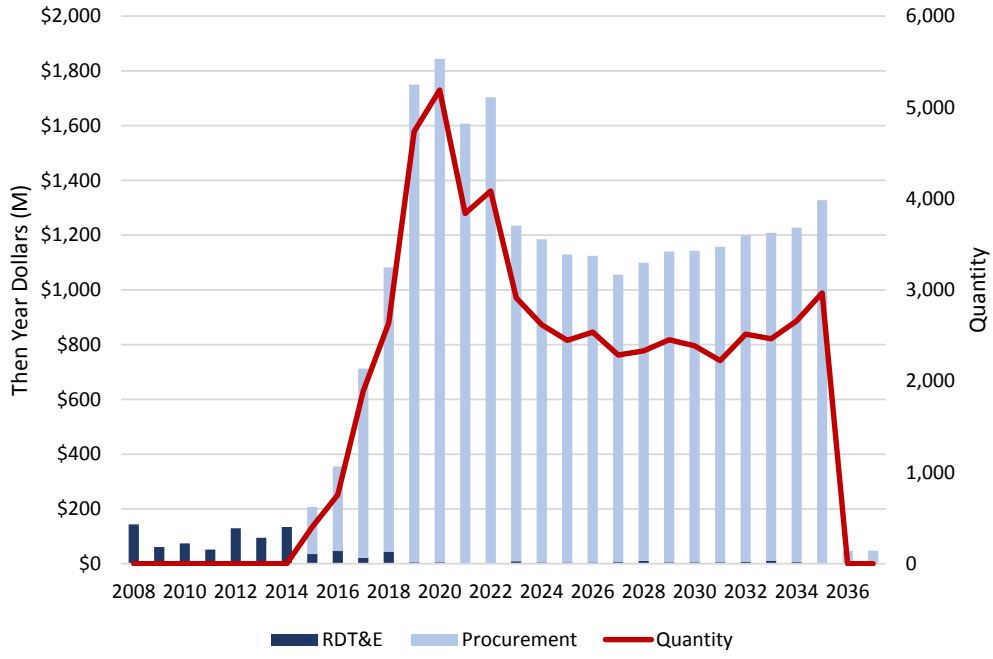
A total of $552.40 million has been appropriated through FY 2017, and $2.99 billion is requested over the FY 2018 FYDP. The FY 2018 budget request added $252.90 million in OCO funds to increase FY 2018 AMPV procurement from 42 to 107 vehicles, and it delayed vehicle purchases in FY 2021 and 2022 to future years. An additional $10.38 billion will be required to complete the program in the years after the FY 2018 FYDP. The AMPV APUC is $4.44 million per vehicle and has an estimated total O&S cost of $55.31 billion over a service life of 26 years per vehicle.



Joint Light Tactical Vehicle (JLTV)

This Army-led program will replace many of the High Mobility Multipurpose Wheeled Vehicles (HMMWVs, also known as "Humvees") used by the Army and Marine Corps. The JLTV will provide better protection and a greater payload capacity than the up-armored HMMWV. The HMMWV fleet is the largest in the Army and Marine Corps, numbering over 160,000 vehicles.[46] The FY 2018 SAR projects procuring 56,454 JLTVs through 2035, suggesting additional vehicle programs may replace other portions of the HMMWV fleet. Oshkosh Corporation was awarded a firm fixed-price production contract in 2015 for LRIP, and 266 vehicles have been delivered.[47] IOC is expected in 2019–2020. Program managers are monitoring three factors that may delay FRP, including the vehicle's command and control systems, several sustainment issues, and certification for vehicle transport.

A total of $1.96 billion has been appropriated through FY 2017, $7.99 billion was requested over the FY 2018 FYDP, and $15.33 billion is planned beyond the FYDP. The FY 2018 request increased total program funding by over $600 million and 1,740 vehicles beyond the FY 2017 request. The estimated APUC is $432 thousand. The JLTV program has an estimated total O&S cost of $41.11 billion over an estimated service life of 20 years per vehicle.



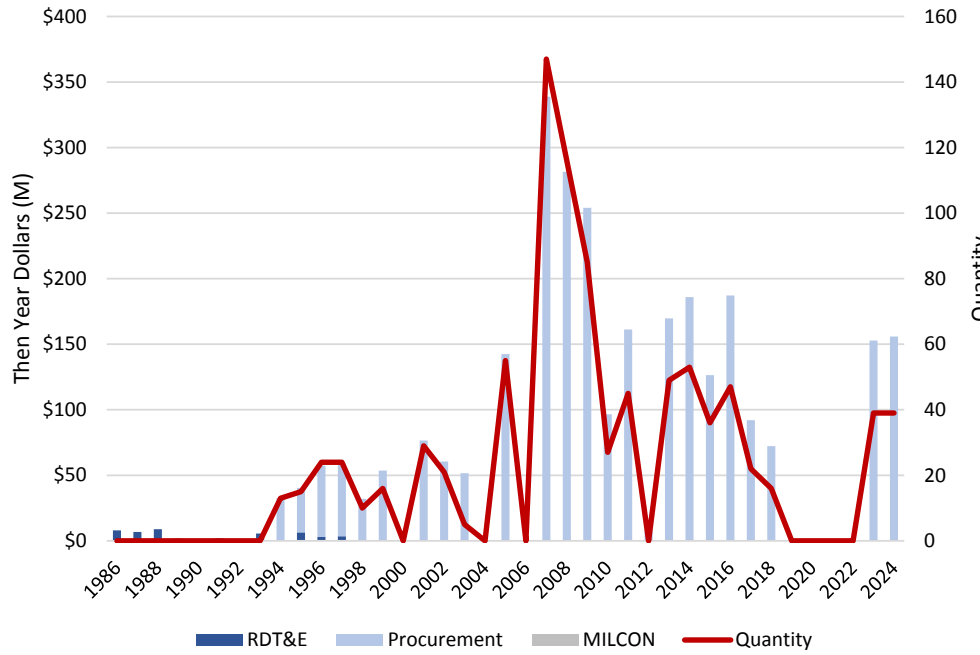
46 Christian Davenport, "Requiem for the Humvee, as the Army Readies for the Next War," *The Washington Post,* July 23, 2015, available at https://www.washingtonpost.com/news/checkpoint/wp/2015/07/23/requiem-for-the-humvee-as-the-army-readies-for-the-next-war/?utm_term=.ecb632c93a7d.

47 "JLTV Enters Low Rate Production," *U.S. Army News*, August 25, 2015, available at https://www.army.mil/article/154425/JLTV_enters_low_rate_production/.

M88A2 Heavy Equipment Recovery Combat Utility Lift Evacuation System (M88A2 HERCULES)

This is a new SAR for FY 2018. The M88A2 has received a SAR due to an expansion of procurement quantities and total program cost sufficient to elevate the program status. The M88A2 HERCULES is a heavy lift and recovery vehicle used within Army Armored Brigade Combat Teams and Marine Corps armor units to recover damaged M1 Abrams tanks and other heavy vehicles. The M88A2 succeeds and improves upon the M88A1 Medium Recovery Vehicle and is the only vehicle capable of handling recovery operations of up to 70 tons on its own. The M88A2 has been in FRP since 1997, and 743 vehicles have already been delivered. The Army has a requirement for 933 systems, though it has only funded for 855; no further funding is currently scheduled beyond FY 2018. Australia, Iraq, Egypt, and Kuwait have procured a combined 131 systems through FMS.

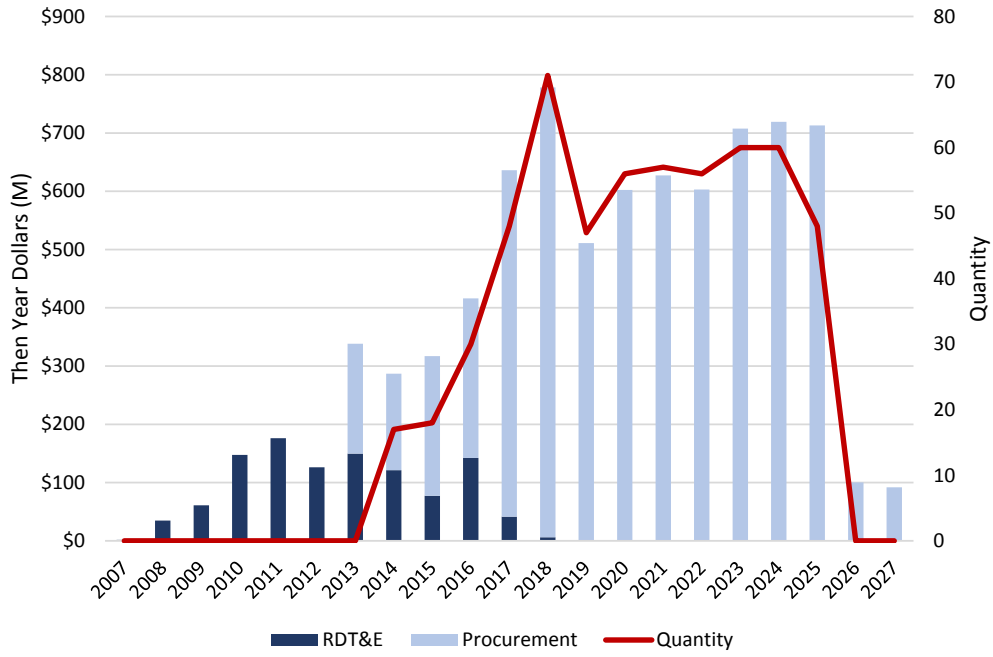
A total of $2.55 billion has been appropriated through FY 2017. A further $72.30 million has been requested in FY 2018, with no additional funding projected over the FYDP. An additional $308.60 million is planned beyond the FYDP. The estimated M88A2 APUC is $3.08 million. The M88A2 HERCULES program has an estimated total O&S cost of $17.46 billion over an estimated service life of 20 years per vehicle.



Paladin Integrated Management (PIM)

The Army's PIM program, also known as the M109A7 Family of Vehicles, is producing two new vehicles. The PIM self-propelled 155mm howitzer (SPH) and the PIM tracked ammunition carrier will replace the current M109A6 Paladin and the M992A2 Field Artillery Ammunition Supply Vehicle, respectively. The PIM program will rebuild the hull, providing improved protection and sustainability through the new hull and modernized electrical system, as well as by incorporating modified versions of the power train, suspension, and tracks from the Bradley Infantry Fighting Vehicle.[48] LRIP began in 2014. Issues discovered during testing have delayed the FRP decision from 2017 to 2018.[49]

A total of $2.54 billion has been appropriated through FY 2017. An additional $3.12 billion was requested over the FY 2018 FYDP, and $2.33 billion is planned beyond the FYDP to procure a total of 570 PIM systems. The PIM system, including both the SPH and ammunition carrier, has an APUC of $12.17 million. The PIM program has an estimated total O&S cost of $29.26 billion over an estimated service life of 26 years per vehicle.



Some of the SAR for this program is marked FOUO. CSBA will update this entry once DoD responds to CSBA's FOIA request.

48 Bill Good, "Army's Paladin Integrated Management Program Reaches Successful Milestone C Decision," *U.S. Army News*, October 24, 2013, available at https://www.army.mil/article/113779/armys_paladin_integrated_management_program_reaches_successful_milestone_c_decision.

49 GAO, *Defense Acquisitions*, 2017, pp. 79–80.

Missiles & Munitions

Thirteen programs are included in this section, representing offensive and defensive capabilities from each of the Services. This section includes new weapons such as the Long Range Anti-Ship Missile (LRASM), Small Diameter Bomb II, and Joint Air-to-Ground Missile. It also includes continued improvements on munitions that have served the joint force for decades such as the AIM-9X Sidewinder, Joint Direct Attack Munition, Tactical Tomahawk cruise missile; the Army's Patriot Advanced Capability-3 Missile Segment Enhancement; and the Navy's Standard Missile 6 surface-to-air interceptors used to defend against the air and missile forces of potential adversaries.[50] As the United States again considers the requirements of competition with great powers and an increasing possibility of major war in a world where potential U.S. adversaries also have precision weapons, DoD should examine whether patterns of munitions procurement and the resulting inventory levels that have developed over the last quarter century remain appropriate.

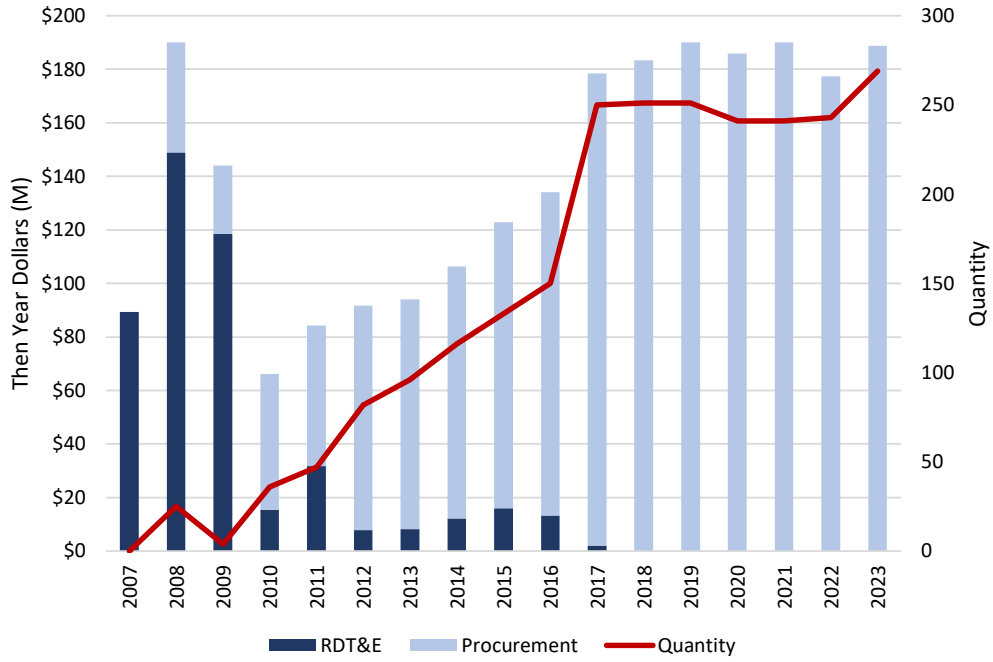
The programs listed in this section represent a DoD investment of $54.60 billion thus far, and the FY 2018 budget request forecasts $27.33 billion more on these programs over the coming FYDP. Several SARS in this section, including the JDAM and TACTOM, do not project additional program buys beyond a few years into the FYDP, yet those programs have a history of additional procurement due to heavy use in ongoing operations. Several programs also leverage previous weapon designs in their development; although this practice saves development costs in fielding next-generation capabilities, the costs included in their respective SARs do not reflect the full costs of developing the system.

50 In the CSBA FY 2017 Weapon Systems Factbook, these systems were listed in the Air and Missile Defense section. They have been moved here because their development and procurement profiles more closely align with the entries in this section.

AGM-88E Advanced Anti-Radiation Guided Missile (AARGM)

The AGM-88E is a Navy air-to-surface missile for targeting enemy air defense radars. The AARGM program upgrades existing AGM-88 High Speed Anti-Radiation Missiles (HARM) to reduce the effectiveness of adversary countermeasures and air defense tactics. The upgraded missile achieved IOC in 2012. The AARGM is currently fielded with Navy F/A-18s and EA-18G fighter aircraft; EA-6B, F-35 Joint Strike Fighter, and Air Force F-16C/J aircraft may be compatible in the future. The Navy plans to procure a total of 2,435 missiles through 2023. Australia is an FMS partner.

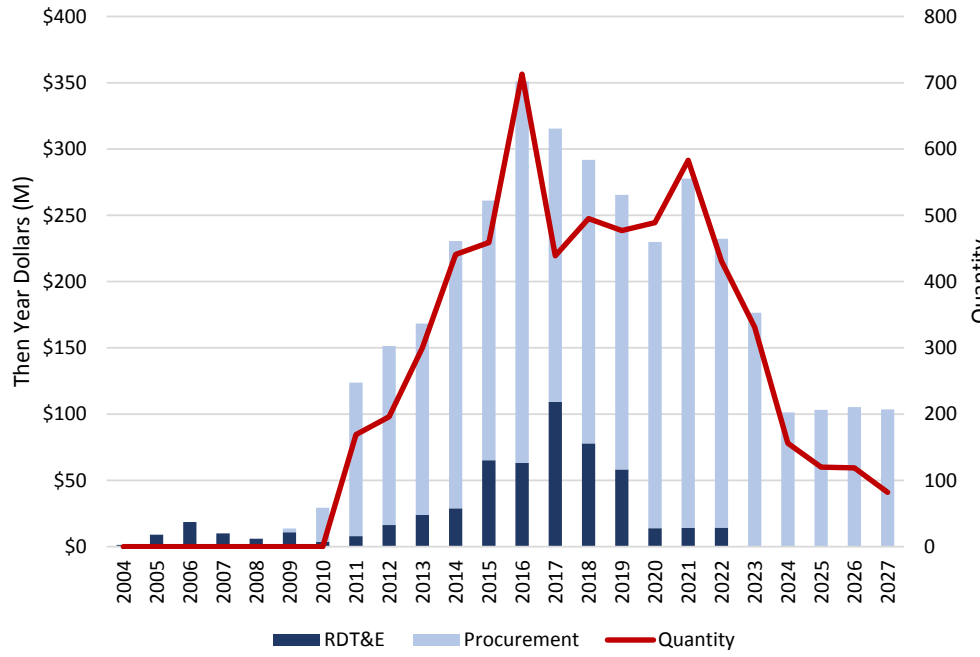
A total of $1.75 billion has been appropriated through FY 2017, and $926.80 million was requested over the FY 2018 FYDP. Only $188.80 million will be required beyond the FYDP to complete the AARGM program, though the FY 2018 budget also includes a request for funding for development and procurement of the AARGM Extended Range (AARGM-ER) variant, which may continue beyond the FYDP. That funding was not included in the SAR or as a separate budget line in the Navy FY 2018 budget request. Each upgrade has an APUC of approximately $802 thousand. The AARGM program has an estimated total O&S cost of $260.20 million over an estimated service life of 15 years per missile.



AIM-9X Block II Air-to-Air Missile

The AIM-9X Block II is a Navy-led joint program to acquire more advanced versions of the AIM-9 Sidewinder short-range infrared air-to-air missiles for use on F-15, F-16, F-18, F-22A, and F-35 aircraft. The Block II variant includes hardware and software upgrades to improve the range from which the missile can identify and engage targets. The most significant upgrade allows the Block II missiles to engage targets its seeker cannot see at launch by using targeting data from the launching aircraft. Additionally, the range upgrades to the Block II provide some beyond-visual-range capabilities. The program entered FRP in September 2015, and 6,000 missiles are currently planned. The Navy declared AIM-9X Block II IOC in March 2015, and the Air Force followed in September 2016. Although the Block II program is underway with no issues, some contractual and integration delays have affected a follow-on enhancement—the System Improvement Program III, now planned for implementation in FY 2020. Eighteen foreign partners have purchased over 1,500 AIM-9X Block II missiles via FMS.

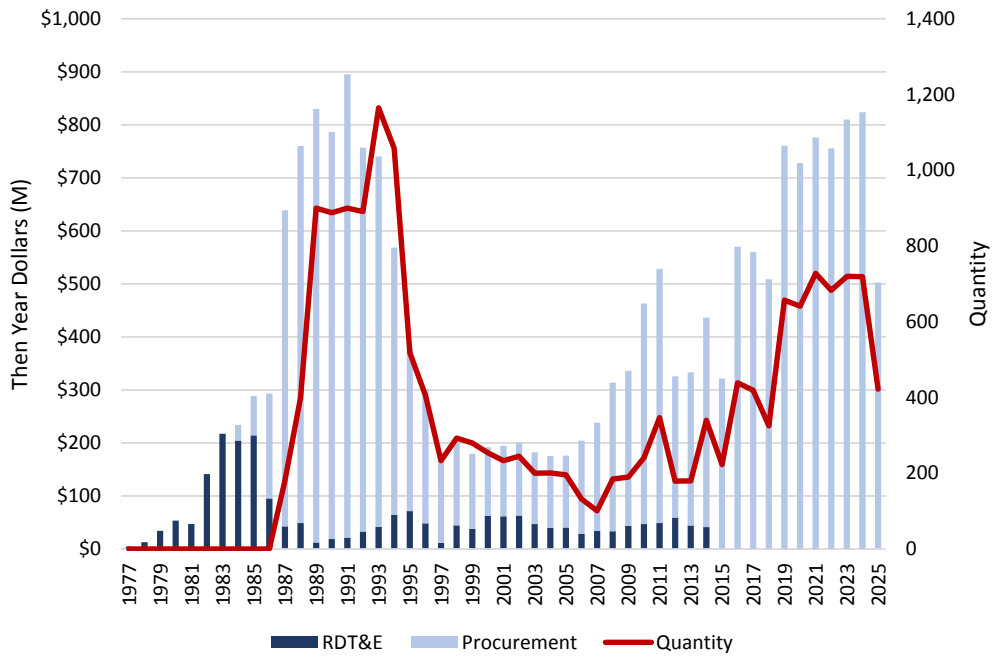
A total of $1.69 billion has been appropriated through FY 2017, $1.30 billion was requested over the FY 2018 FYDP, and $589.90 million is planned beyond the FYDP. The FY 2018 request increased FYDP procurement by 672 missiles from previous projections and reduces total AIM-9X Block II program cost projections by more than $550 million beyond the FYDP. The estimated APUC is $504 thousand. The AIM-9X program has an estimated total O&S cost of $1.40 billion over an estimated service life of 20 years per missile.



AIM-120 Advanced Medium Range Air-to-Air Missile (AMRAAM)

The AIM-120 AMRAAM program is an Air Force-led joint effort to acquire advanced medium-range air-to-air missiles; the AIM-120 is the longest-range air-to-air missile in U.S. service. Designed to replace the AIM-7 Sparrow missiles first introduced in the Vietnam era, the AIM-120 is an active radar-guided missile with electronic protection capabilities. The AIM-120D variant currently being procured has improved accuracy, network compatibility, and electronic protection; it achieved IOC with the Air Force and Navy in January 2015. 1,723 of 2,518 AIM-120D missiles have already been procured. Additional upgrade programs include software enhancements to AIM-120C7 and older missiles to improve the effectiveness of existing weapon inventories. The AIM-120C7 variant remains the most advanced variant sold under FMS, with over 2,160 missiles delivered to foreign partners.

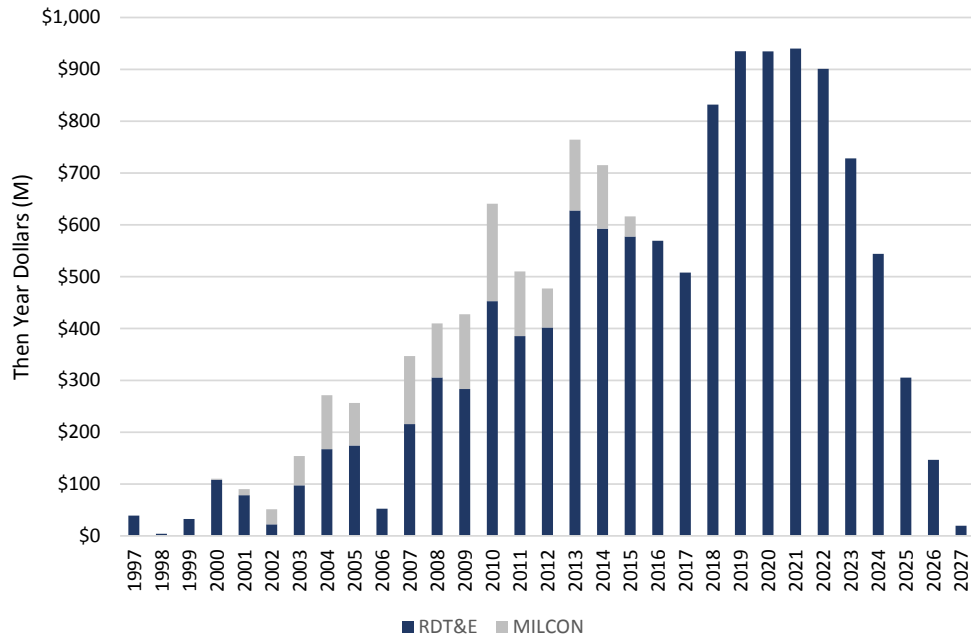
A total of $14.29 billion has been appropriated through FY 2017 for all AIM-120 variants, which have all been procured under the AMRAAM program. $3.53 billion was requested over the FY 2018 FYDP, and $2.14 billion in further funding is planned beyond the FYDP for a total procurement of 17,312 AIM-120 missiles. The AIM-120 missile has an estimated APUC of $1.02 million. The AIM-120 program has an estimated total O&S cost of $4.17 billion over an estimated service life of 25 years per missile.



Chemical Demilitarization-Assembled Chemical Weapons Alternatives (Chem Demil-ACWA)

This DoD-wide program is tasked with destroying lethal chemical agents and munitions, as well as other materials related to chemical warfare.[51] It is in the process of building two fixed-base, single-use systems at the Pueblo Chemical Depot in Colorado and the Blue Grass Army Depot in Kentucky. The Pueblo facility will be responsible for the destruction of munitions equipped with mustard gas and other blister agents, whereas the Blue Grass facility will eliminate Sarin and VX nerve gas projectiles. The FY 2018 SAR indicates that the program has incurred a significant Nunn-McCurdy breach due to PAUC growth in excess of 15 percent above program baseline estimates due to schedule and RDT&E cost growth. In short, the demilitarization of chemical weapons at both sites has taken longer than planned, partially due to equipment unreliability, which has increased the staffing requirements and the period of time necessary to complete the program. Program completion at the Pueblo Chemical Depot is now scheduled for March 2025 rather than the baseline estimate of November 2023. Operations at the Blue Grass Army Depot remain on track to finish in 2026–2027.

A total of $7.05 billion has been appropriated through FY 2017 for the construction of the demilitarization facilities and elimination of chemical munitions. $4.54 billion was requested over the FY 2018 FYDP, with $1.74 billion in further funding planned beyond the FYDP. Current estimates suggest the program will cost DoD more than $4.25 million per demilitarized munition. No O&S costs are given.

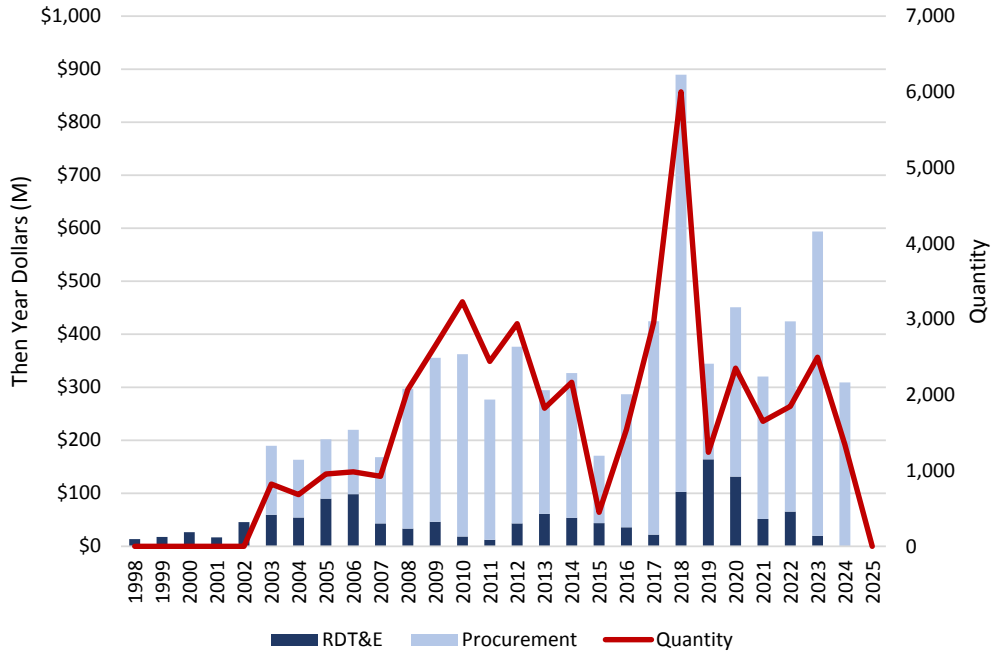


51 "Chemical Demilitarization Program—Assembled Chemical Weapons Alternatives (CHEM DEMIL-ACWA)," factsheet, U.S. Army, available at http://www.dote.osd.mil/pub/reports/FY2016/pdf/army/2016chemdemil.pdf.

Guided Multiple Launch Rocket System/Guided Multiple Launch Rocket System Alternative Warhead (GMLRS/GMLRS AW)

This Army-led program procures rocket munitions for Army and Marine Corps artillery systems. GMLRS uses a solid propellant rocket and an inertial measurement unit with GPS assistance for guidance, giving the new rockets longer range and greater precision than older rockets. GMLRS can be fired either from the M270A1 tracked vehicle or the High Mobility Artillery Rocket System (HIMARS) mobile launch vehicle. GMLRS can be equipped with either cluster munitions for targeting personnel and thinly armored vehicles or a 200-pound unitary warhead designed to limit collateral damage. A 2008 DoD policy directed the phase-out of cluster weapons with unexploded ordnance (UXO) risks above a 1 percent threshold; this led to the GMLRS alternative warhead (AW) program, which will use the explosive dispersal of tungsten fragments to provide an area-of-effect capability with no risk of UXO. Work began in FY 2018 on an extended-range GMLRS variant, which will improve range from 70 to 150 km. Ten countries have become GMLRS FMS partners; Jordan and Finland purchased GMLRS AW rockets in 2016, and the United Arab Emirates (UAE) maintains a stockpile of cluster munition variants.

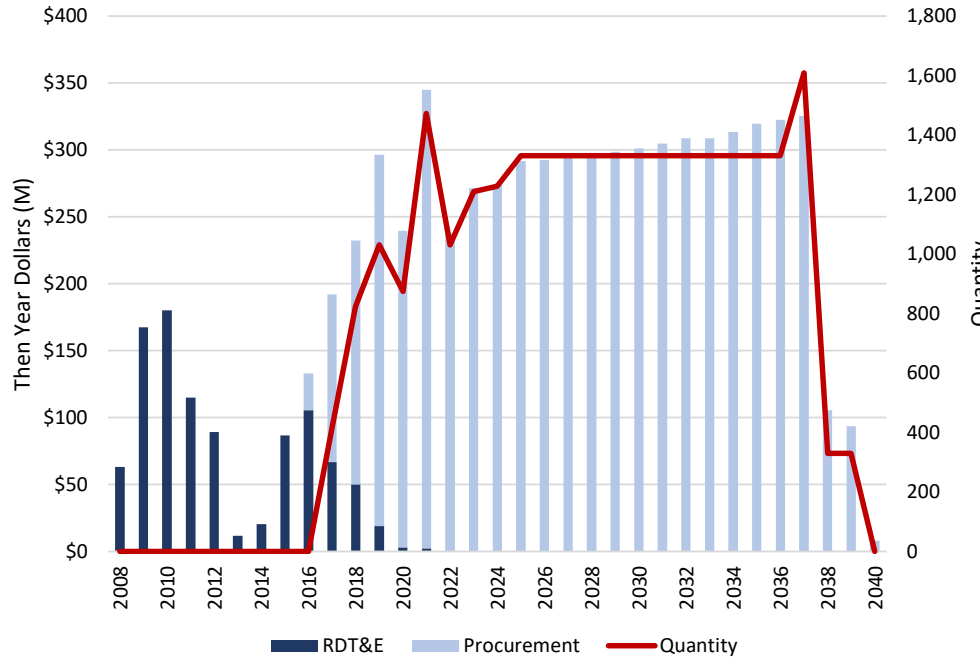
A total of $4.24 billion has been appropriated through FY 2017, $2.43 billion was requested over the FY 2018 FYDP, and $903.20 million is planned beyond the FYDP to complete a projected buy of 43,936 GMLRS rockets. The estimated per rocket APUC is $142 thousand. The GMLRS program has an estimated total O&S cost of $325.40 million over an estimated service life of ten years per rocket pod.



Joint Air-to-Ground Missile (JAGM)

This Army-led joint program will develop the next-generation air-launched ground attack missile to replace all Hellfire and Longbow missiles. The Hellfire missile is fired from helicopters and UAVs to target tanks, light armored vehicles, bunkers, and buildings; they have been used extensively in Iraq and Afghanistan. The JAGM shares many components with the Hellfire and will be produced on the same assembly line, saving time and costs.[52] The program has completed its critical design review and is continuing development. IOC is anticipated in 2019.[53] Procurement of the new missiles was scheduled to start in FY 2017, with over 5,600 procured by the end of the FYDP.

A total of $1.06 billion has been appropriated through FY 2017, $1.35 billion was requested over the FY 2018 FYDP, and $4.73 billion is planned beyond the FYDP for the procurement of 26,437 missiles. Each missile has a projected APUC of $234 thousand. The JAGM program has an estimated total O&S cost of $680.90 million over an estimated service life of 25 years per missile.



52 GAO, *Defense Acquisitions*, 2017, pp. 75–76.

53 Ibid.

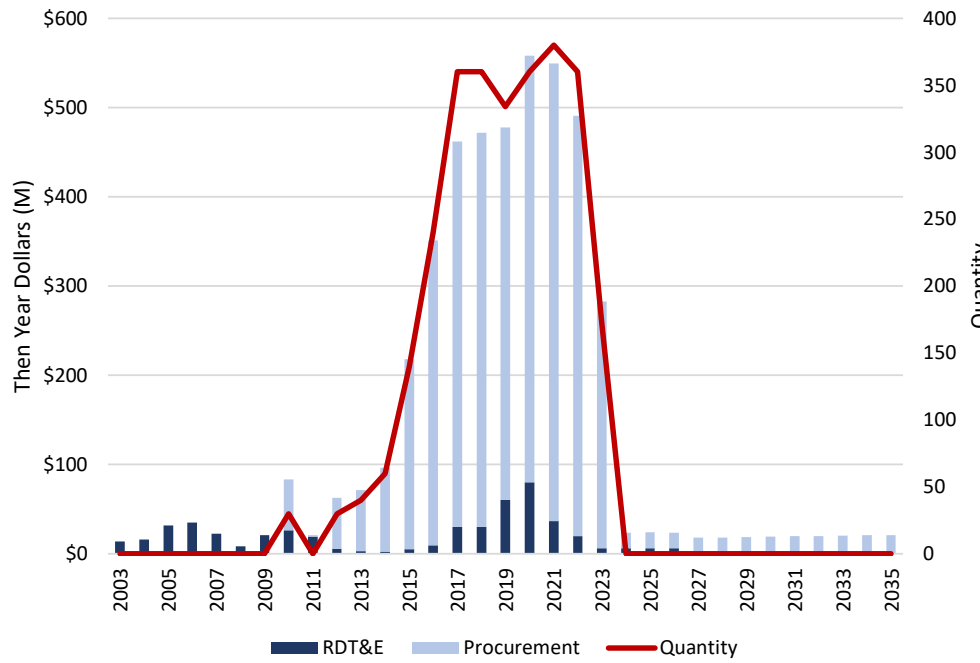
Joint Air-to-Surface Standoff Missile/JASSM-Extended Range (JASSM/JASSM-ER)

The JASSM program ended in FY 2017. The FY 2018 SAR focuses exclusively on the JASSM-ER, an upgraded missile, and thus may not include all relevant development costs previously reported in the baseline JASSM SAR.

The Air Force-run JASSM/JASSM-ER program is developing and procuring cruise missiles for strikes against defended targets from beyond the range of adversary air defenses. These strikes would occur early in a potential conflict, opening the way for joint forces by attacking air defenses and command and control sites. The missiles are designed to be more difficult for adversaries to detect, and they carry a 1,000-pound penetrating warhead with either a range greater than 200 nautical miles (for JASSM) or greater than 500 nautical miles (for JASSM-ER).[54] The two missiles share 70 percent of the same hardware and 95 percent of the same software. The JASSM-ER entered full rate production in December 2014. The program has breached its RDT&E acquisition program baseline cost threshold due to the addition of funding for new requirements not included in baseline program estimates.

54 Lockheed Martin has received funding from the Air Force to develop a new wing for the JASSM-ER. According to Lockheed Martin, it has designed a novel wing that will provide "additional standoff range." "U.S. Air Force Awards Lockheed Martin $37 Million For New JASSM-ER Wing Design," press release, Lockheed Martin, July 19, 2017, available at http://news.lockheedmartin.com/2017-07-19-U-S-Air-Force-Awards-Lockheed-Martin-37-Million-For-New-JASSM-R-ER-Wing-Design.

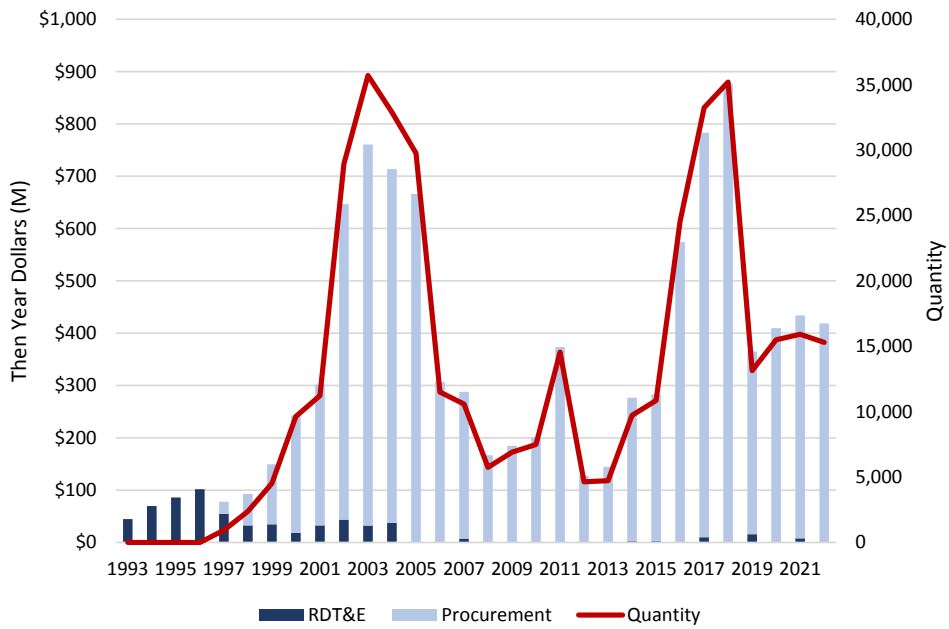
A total of $1.51 billion has been appropriated through FY 2017, $2.55 billion was requested over the FY 2018 FYDP, and $529.20 million is planned beyond the FYDP for the procurement of 2,897 JASSM-ER missiles. Each missile has a projected APUC of $1.43 million. The JASSM-ER program has an estimated total O&S cost of $975.10 million over an estimated service life of 15 years per missile.



Joint Direct Attack Munition (JDAM)

The JDAM program is a joint Air Force–Navy effort to upgrade the existing inventory of general-purpose bombs with GPS and inertial navigation tailkits to improve accuracy under all weather conditions. This upgrade to older weapons created an affordable precision weapon and has made the JDAM the principal precision-guided weapon in the U.S. and allied inventory, with over 60,000 employed in Iraq, Afghanistan, and other conflict areas over the past two decades.[55] Most U.S. fighters and bombers, including the B-52, B-2, B-1, F-16, F/A-18, F-15E, A-10, AV-8, and the F-22, employ JDAMs. The JDAM is also being integrated into the MQ-9 and F-35. Laser sensors are being incorporated onto some JDAMs to improve the bomb's ability to attack mobile targets. The program has breached its acquisition program baseline cost projections due to expanded procurement of JDAM kits. To meet this demand, Boeing has doubled production rates, nearing 150 kits per day and 36,500 kits per year. Thirty countries and NATO have purchased JDAMs via FMS.

A total of $7.66 billion has been appropriated through FY 2017, and $2.50 billion was requested over the FY 2018 FYDP. No procurement funding is projected beyond the FYDP, but given its utility and ongoing usage, those figures may change. The FY 2018 request increased planned JDAM buys by over 40,000 kits to fulfill requirements, with final procurement projections now nearing 400,000 kits. Each kit has a projected APUC of approximately $24,000. The JDAM program has an estimated total O&S cost of $1.49 billion over an estimated service life of 35 years per weapon.

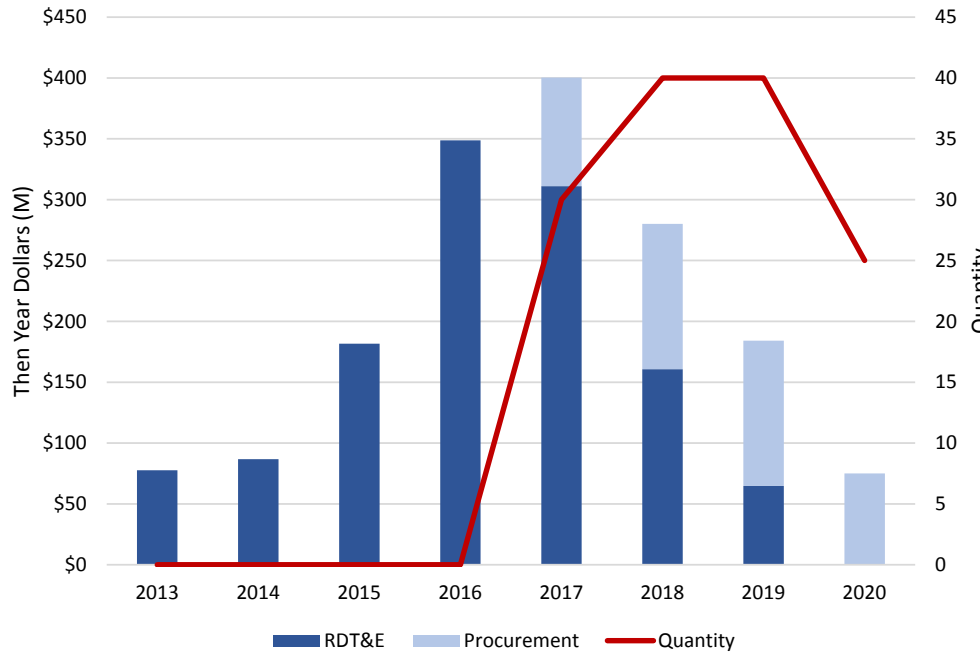


55 Jesse Bogan, "Boeing Boosts Production of Precision-Guided Bomb Kits Made in St. Charles to Fight Ongoing Wars by Air," *St. Louis Post-Dispatch*, January 27, 2017, available at http://www.stltoday.com/business/local/boeing-boosts-production-of-precision-guided-bomb-kits-made-in/article_09cb53c2-d2e6-5cb2-812c-fa23182f81f2.html.

Offensive Anti-Surface Warfare Increment 1 (Long Range Anti-Ship Missile) (OASuW Inc 1 [LRASM])

This is a new SAR for FY 2018. LRASM is a Navy-led joint program to field a long-range, air-delivered anti-ship missile for targeting adversary surface combatants. LRASM was deemed an urgent operational need and has followed an accelerated acquisition model to field a weapon more capable than the aging Harpoon anti-ship missiles currently in the inventory. The program leverages developments made in the JASSM/JASSM-ER program (see p. 66) to field a capability rapidly and minimize development costs. Early operational capability is expected for the Air Force B-1 bomber in FY 2018, with Navy F/A-18E/F fighter aircraft following in FY 2019.

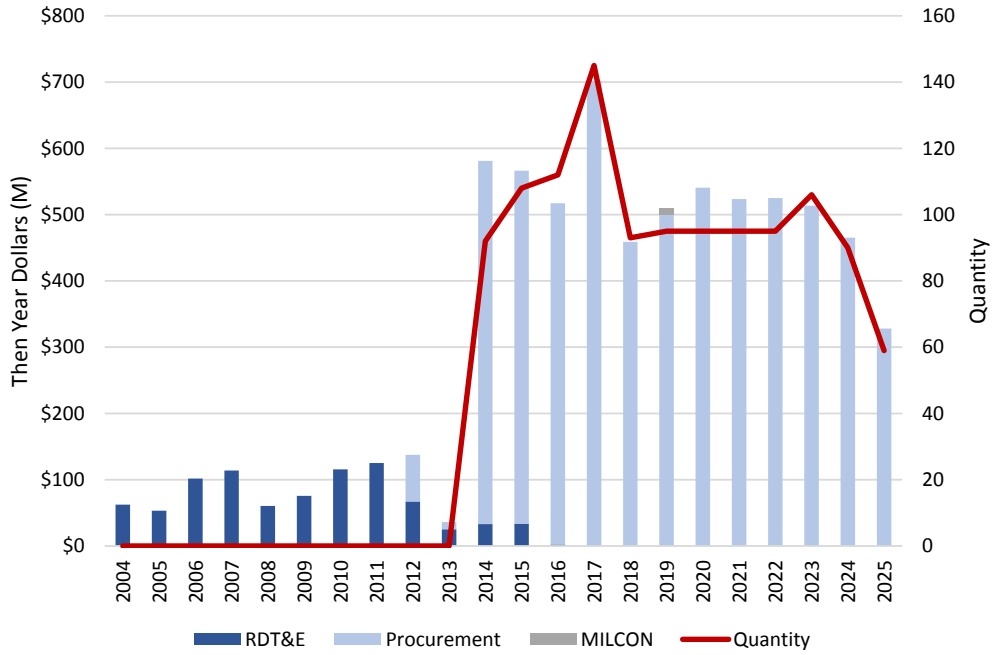
A total of $1.10 billion has been appropriated through FY 2017, $539.20 million was requested over the FY 2018 FYDP, and no further funding is currently planned beyond the FYDP. The program plans to procure 147 missiles, of which 12 are development units. Each missile has a projected APUC of $2.99 million. The LRASM program has an estimated total O&S cost of $269 million over an estimated service life of 15 years per missile.



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

The PAC-3 missile is a hit-to-kill, surface-to-air missile designed to intercept and destroy theater ballistic missiles, cruise missiles, and aircraft. The PAC-3 MSE missile is a follow-on to the PAC-3 missile, with improved performance due to an improved solid rocket motor, more responsive control surfaces, and upgraded guidance software. The PAC-3 MSE is being integrated into existing Patriot air and missile defense batteries, requiring only minor modifications to the existing hardware and utilizing existing system software. IOC was achieved ahead of schedule in July 2016, and the missile is now in LRIP.[56]

A total of $3.25 billion has been appropriated through FY 2017, $2.56 billion was requested over the FY 2018 FYDP, and an additional $1.31 billion is planned beyond the FYDP. 1,185 missiles are currently planned, with 457 procured by the end of FY 2017; the FY 2018 request added 60 missiles to the planned buy due to extra FY 2017 Congressional funding. The PAC-3 MSE APUC is $5.26 million. The PAC-3 MSE program has an estimated total O&S cost of $4.76 billion over an estimated service life of 30 years per missile.

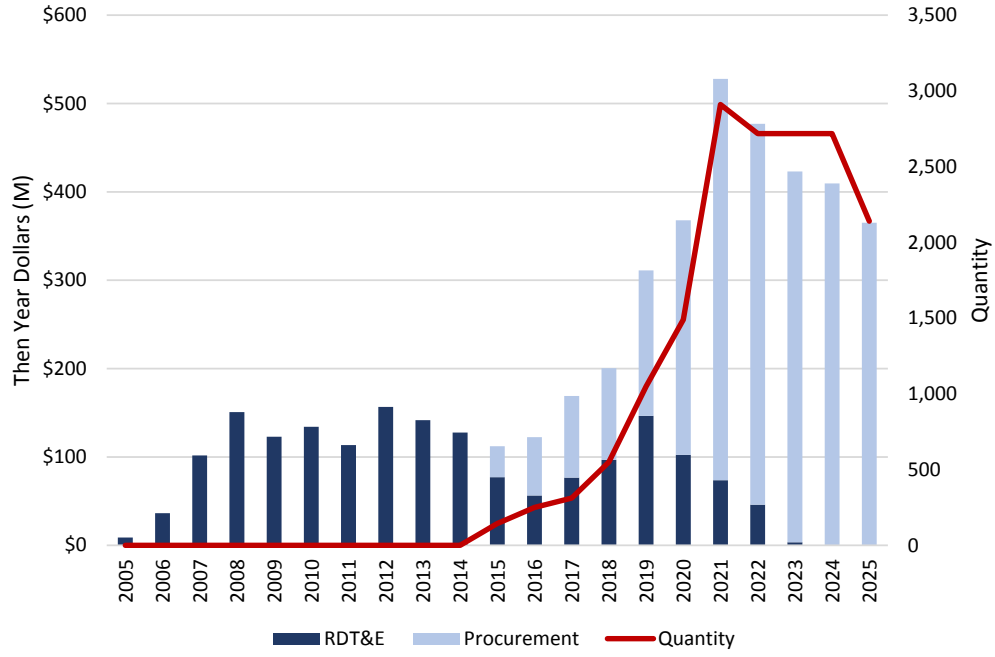


56 GAO, *Defense Acquisitions*, 2017, pp. 81–82.

Small Diameter Bomb Increment II (SDB II)

The SDB II is an Air Force-led joint program to develop and field a new air-to-ground precision glide bomb for use against mobile targets. It uses radar, infrared, and laser sensors to track targets. As funding becomes available, the SDB II will be integrated with the F-15E, F/A-18E/F, F-16, F-22, B-1, B-2, B-52, A-10, MQ-9, AC-130, and all variants of the F-35. The SDB II program began LRIP in 2015, and the first F-15Es capable of using SDB-IIs are projected to be ready in 2018. F-35B and F-35C IOC is scheduled for 2022–2023, which will extend the capability to the Marine Corps and Navy, respectively. Norway, Turkey, and the Netherlands have expressed potential FMS interest, while further interest is expected from future F-35 operators.

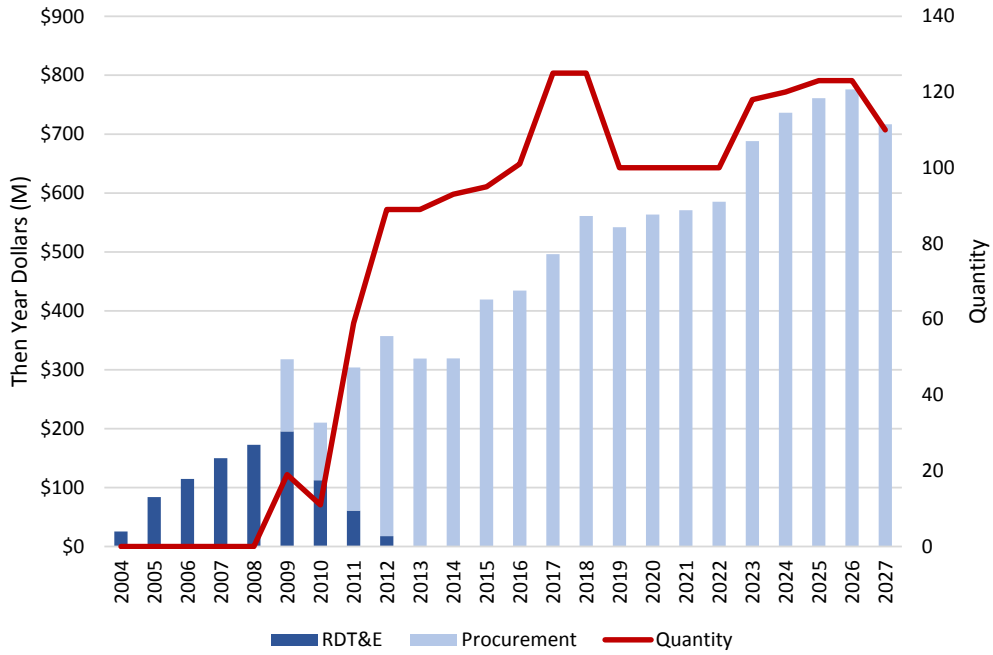
Slightly less than $1.50 billion has been appropriated through FY 2017, with $1.88 billion requested over the FYDP and $1.20 billion planned beyond the FYDP. DoD currently plans to procure 17,163 weapons through FY 2025. The SDB II APUC is $165 thousand. The SDB-II program has an estimated total O&S cost of $1.21 billion over an estimated service life of 20 years per weapon.



Standard Missile-6 (SM-6)

The SM-6 Extended Range Active Missile (ERAM) is a sea-based, supersonic surface-to-air missile designed to intercept aircraft and cruise missiles. In 2016, DoD revealed that the SM-6 can also be fired in an anti-surface warfare mode, providing Navy warships with an advanced anti-ship missile in addition to the Harpoon anti-ship missile introduced in the 1970s.[57] It is used by Navy cruisers and destroyers. The SM-6 ERAM is a multi-block program intended to keep pace with evolving threats through incremental upgrades to each subsequent block of missiles. The SM-6 ERAM Block I achieved IOC in November 2013. The program has breached its acquisition program baseline schedule projections due to earlier funding shortfalls and other obstructions that have delayed test and evaluation, pushing full operational capability back to the end of 2017.

A total of $3.72 billion has been appropriated through FY 2017, $2.82 billion is requested over the FYDP, and $3.68 billion is planned beyond the FYDP to complete the total buy of 1,800 SM-6 missiles. 681 of the 1,800 planned missiles should be procured by the end of FY 2017. Each SM-6 missile has a projected APUC of $5.16 million. The SM-6 program has an estimated total O&S cost of $845.90 million over an estimated service life of 30 years per missile.

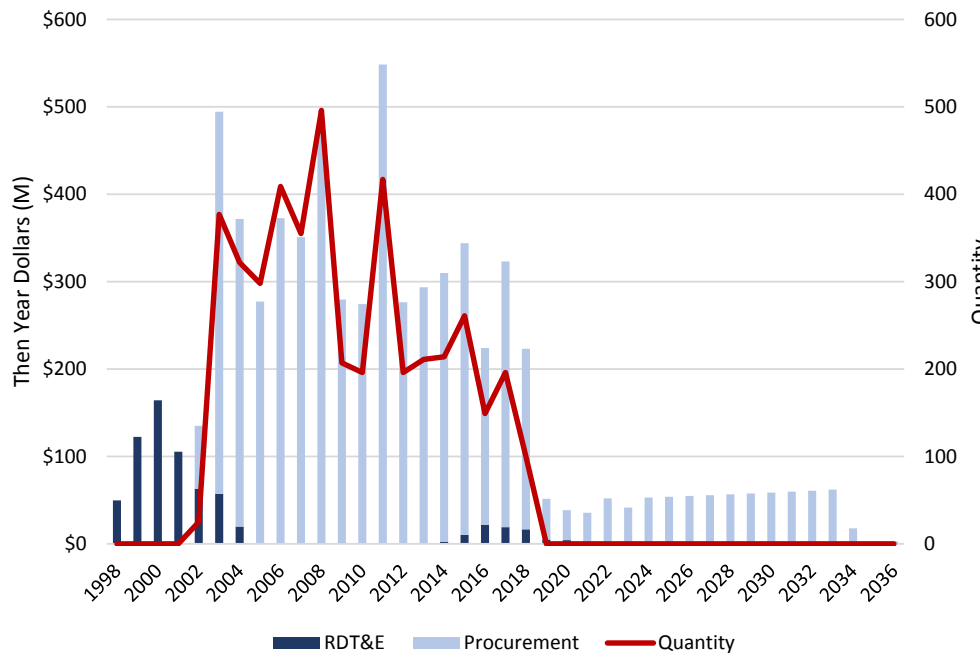


57 Sam LaGrone, "SECDEF Carter Confirms Navy Developing Supersonic Anti-Ship Missiles For Cruisers, Destroyers," *USNI News*, February 4, 2016, available at https://news.usni.org/2016/02/04/secdef-carter-confirms-navy-developing-supersonic-anti-ship-missile-for-cruisers-destroyers.

Tactical Tomahawk (TACTOM)

TACTOM is a Navy cruise missile designed to destroy fixed and mobile targets at a range of up to 1,000 miles. The Block IV design improves Tomahawk missile navigation capabilities and resistance to GPS jamming. It also makes the missile more responsive to launch commanders, while sharing more sensor data as its flies to its target. Tomahawk missiles have repeatedly been used in combat over the last several decades. The FY 2018 OCO request includes funding to replace 66 missiles used in Syria and elsewhere.[58] The FY 2017 SAR reported an RDT&E acquisition program baseline cost estimate breach; a new baseline estimate is still being revised as of the FY 2018 request. The United Kingdom is an FMS partner, with 89 TACTOMs purchased.

A total of $5.79 billion has been appropriated through FY 2017, $401 million is requested over the FYDP to finish current procurement and sustain the production line, and $637.80 million is planned beyond the FYDP. DoD will have procured 4,329 missiles by the end of FY 2019; apart from the 100 missiles requested in FY 2018, no further TACTOM buys are currently projected. Each TACTOM missile has a projected APUC of more than $1.39 million. The TACTOM program has an estimated total O&S cost of $2.53 billion over an estimated service life of 30 years per missile.



58 59 missiles struck Al Shayrat airfield in Syria in April 2017 in response to the Syrian Government's use of chemical weapons. See Michael Gordon, Helene Cooper, and Michael Shear, "Dozens of U.S. Missiles Hit Air Base in Syria," *The New York Times,* April 6, 2017, available at https://www.nytimes.com/2017/04/06/world/middleeast/us-said-to-weigh-military-responses-to-syrian-chemical-attack.html?mcubz=0.

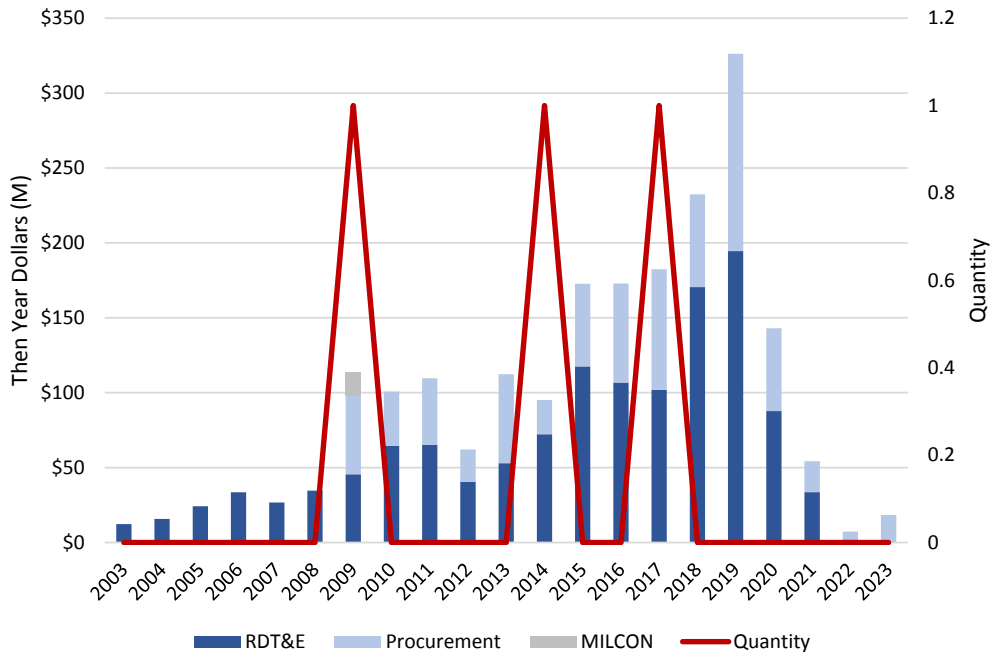
Naval Vessels & Capabilities

There are eleven programs in this section, representing the recapitalization of most components of the Navy's battle force. Programs range from the massive *Ford*-class supercarriers to the small Ship-to-Shore Connector transport, as well as from the silent *Virginia*-class nuclear-powered attack submarines to the Littoral Combat Ship anti-submarine warfare modules. Ships procured under these programs are expected to serve well into the 21st century and must remain capable of executing their missions in the face of accelerating technological competition above, on, and under the sea. The naval programs listed in this section represent a DoD investment of $271.34 billion stretching back, in the case of the *Arleigh Burke*-class destroyer, to the 1980s. The FY 2018 budget requests $77.71 billion more for these programs over the coming FYDP. Several SARs in this section do not fully incorporate all ships listed in the Navy's 30-year shipbuilding plans and are consequently likely to be revised and expanded in the years ahead.

Advanced Arresting Gear (AAG)

This is a new SAR for FY 2018. The AAG will be used to recover all types of aircraft that may be used on *Ford*-class aircraft carriers, ranging from the E-2D Hawkeye to various fighter aircraft and future UAVs of varying sizes. The AAG was also designed to reduce total sustainment costs over its service life in comparison to the preceding arresting gear system. The program is currently in a critical Nunn-McCurdy breach due to RDT&E cost growth above baseline estimates set early in the program in 2009; the AAG program is restructuring and will continue after an independent assessment revises baseline cost and schedule estimates. Shipboard testing began in July 2015, and system design and development is over 80 percent complete.[59] The Navy has issued a fixed price contract for installation aboard the third *Ford*-class carrier. The FY 2018 SAR only includes procurement funding for three aircraft carrier sets so the program may grow to outfit the remainder of the *Ford*-class carrier buy. India has expressed potential FMS interest in AAG, as well as the Electromagnetic Aircraft Launch System (see p. 79).

A total of $1.27 billion has been appropriated through FY 2017, $763.20 million was requested over the FY 2018 FYDP, and $18.30 million in further funding is currently planned beyond the FYDP. The AAG has an estimated APUC of $244.33 million and an estimated total O&S cost of $5.47 billion over an estimated service life of 50 years per system.

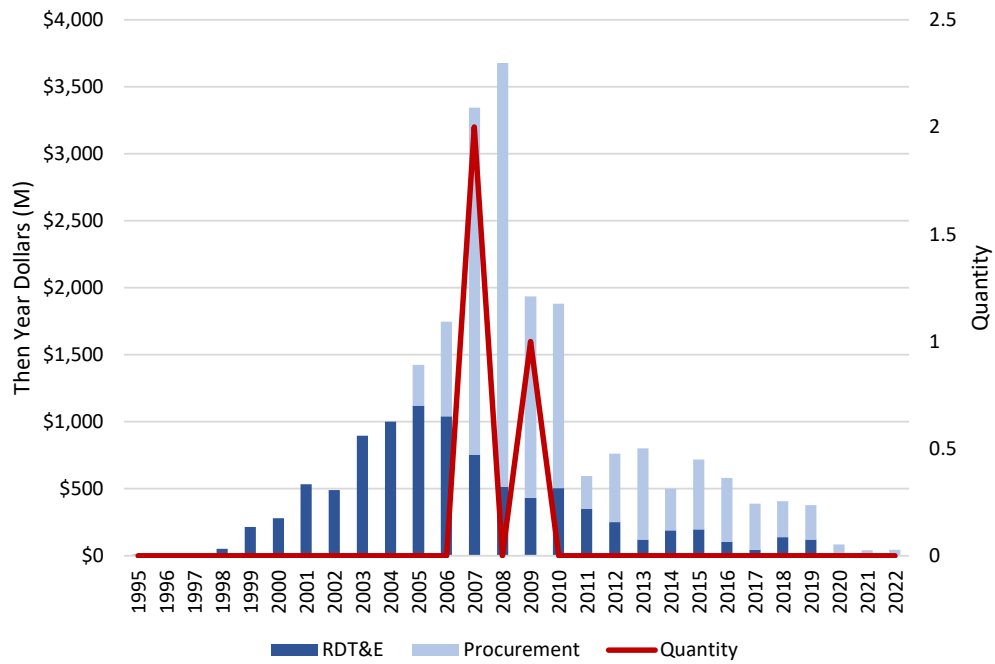


59 GAO, *Defense Acquisitions*, 2017, p. 96.

DDG-1000 *Zumwalt*-Class Destroyer

The Navy's *Zumwalt*-class (DDG 1000) destroyer is designed to provide precision fire support to forces ashore. Its advanced active and passive defenses and signature-reducing shape enhance its survivability in contested environments. The program originally envisioned at least ten multi-mission ships to replace early *Arleigh Burke*-class (DDG 51) destroyers. It has, however, since been scaled back to just three ships due to cost growth, with a more advanced version of the DDG 51 (see p. 78) destroyer taking its place. Much of the program's cost growth has been associated with the development of new technologies; of 11 critical program technologies, GAO estimates that fewer than half have fully matured.[60] The lead ship was delivered in May 2016, with final work scheduled to complete in May 2018. The second ship is nearly complete, with production on the third ship roughly 60 percent complete. IOC is scheduled for 2020. The program has breached its acquisition program baseline schedule estimates due to FY 2017 National Defense Authorization Act language adjusting the ship delivery milestone criteria from delivery of the ship to complete installation of mission systems, resulting in a roughly two-year delay.

A total of $21.86 billion has been appropriated through FY 2017, $955.40 million was requested over the FY 2018 FYDP, and no further funding was requested beyond the FYDP. The FY 2018 budget request projects a $413.00 million program cost increase over the FY 2017 request. The DDG 1000 APUC is $4.47 billion and has an estimated total O&S cost of $14.95 billion over an estimated service life of 35 years per ship.

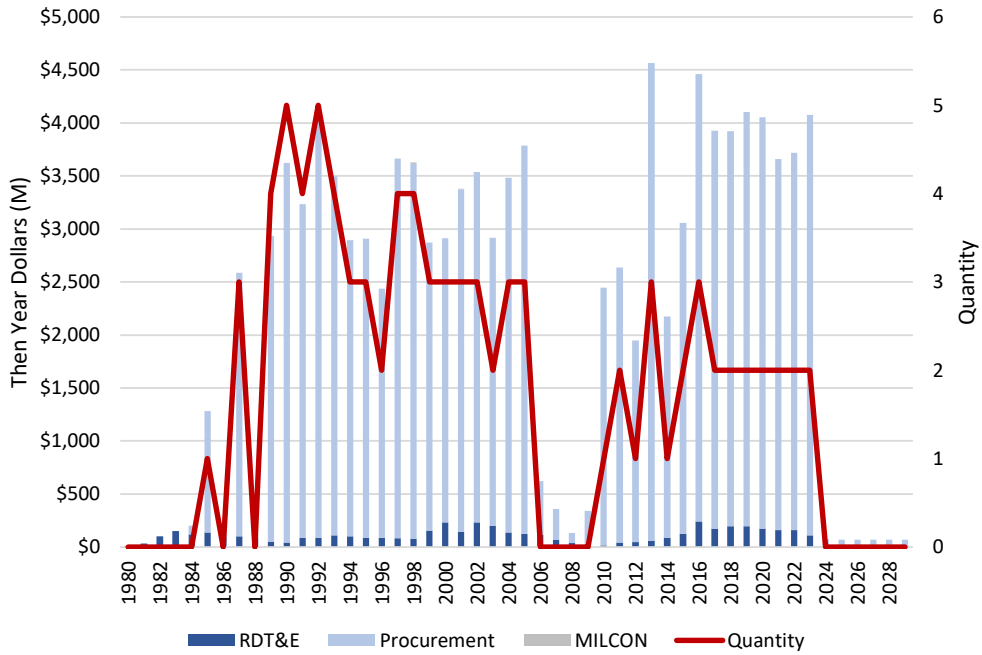


60 GAO, *Defense Acquisitions*, 2017, p. 97.

DDG-51 *Arleigh Burke*-Class Guided Missile Destroyer

The *Arleigh Burke*-class (DDG 51) destroyer is the Navy's principal surface combatant, designed to operate against air, surface, and subsurface threats. DDG 51s operate independently or in support of Carrier Strike Groups (CSGs) and Expeditionary Strike Groups (ESGs). If equipped with the Aegis Ballistic Missile Defense System and SM-3 interceptors, DDG 51s can also fulfill midcourse ballistic missile defense missions against short- and intermediate-range ballistic missiles. Variants of the destroyer have been in procurement since the 1980s, making it one of the oldest programs in DoD's current portfolio. 64 DDG 51s have been delivered thus far. The Navy restarted the program in 2008 after a four-year break in production. The latest version of this ship, the DDG 51 Flight III, will include the new Air and Missile Defense Radar (see p. 3). The entirety of the Navy's planned Flight III purchase is not included in the December 2016 SAR, so the total spending on the DDG 51 will likely exceed that reported below. Although no foreign partners have purchased DDG 51 ships, Norway, Japan, Spain, South Korea, and Australia have purchased systems, received training, or received other services associated with the DDG 51 program via FMS.

A total of $87.18 billion has been appropriated through FY 2017 for DDG 51 destroyers. $19.46 billion was requested over the FY 2018 FYDP, and $4.49 billion in further funding is projected beyond the FYDP. The DDG 51 has an estimated APUC of $1.19 billion, although this is an average across variants and thus may underestimate the cost of Flight III DDG-51s. The program has an estimated total O&S of $319.39 billion over an estimated service life of 40 years per ship.



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

The *Ford*-class aircraft carrier is designed to replace the *Nimitz*-class (CVN 68) carriers with a vessel capable of higher aircraft sortie rates and reduced manpower requirements through the use of new technologies. This would sustain the U.S. Navy's ability to provide air power independent of forward bases. Each CVN 78 will have the capacity to support 75 aircraft, including F-35C, F/A-18E/F, and EA-18G fighters; E-2D airborne early warning and control aircraft; MH-60 helicopters; and future unmanned systems. For comparison, CVN 68 carriers can embark 60 aircraft.[61] The first ship is over 99 percent complete and conducted its first fixed-wing aircraft launch and recovery operation on July 28, 2017;[62] IOC is projected for the end of 2018. The second *Ford*-class carrier, CVN 79, is over 30 percent complete and is projected to require 17 percent fewer production hours to complete than the first ship in the class. Long lead procurement for the third carrier has already begun.

Delays in the development of systems essential to the CVN 78's improved capabilities, like the Electromagnetic Aircraft Launch System (EMALS) and Advanced Arresting Gear (see p. 76), have pushed back delivery of the first *Ford*-class ship.[63] This breach of its acquisition program baseline schedule estimates was first reported in the December 2015 SAR. GAO has also noted that the increased cost estimates associated with each ship are at risk of violating Congressional cost caps.[64] The first ship is at least 23 percent over the cap set in 2007, and GAO is skeptical that the second ship will be delivered within the cap despite Navy cost mitigation efforts. A total of $28.50 billion has been appropriated through FY 2017, $14.26 billion was requested over the FY 2018 FYDP, and $2.96 billion is planned beyond the FYDP to complete the first three carriers in the program.[65] The FY 2018 budget request projects a $1.91 billion program cost increase over the FY 2017 request.

61 "*Gerald R. Ford* Class," *Jane's Fighting Ships*, IHS Jane's, updated August 10, 2017.

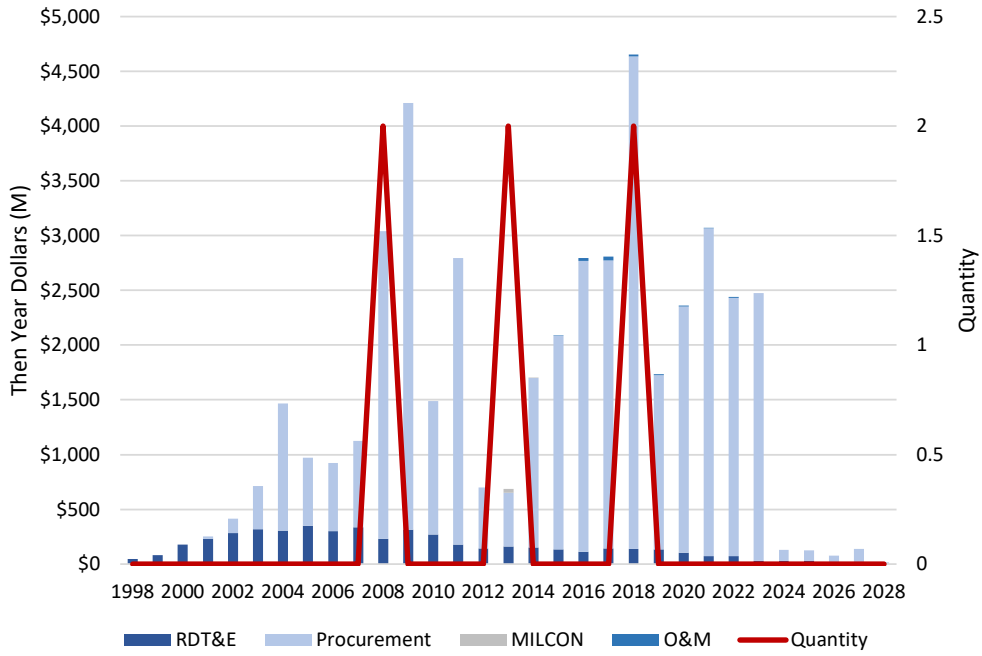
62 Commander, Naval Air Forces Atlantic Public Affairs, "USS *Gerald R. Ford* Completes First Arrested Landing and Launch," *U.S. Navy News*, July 29, 2017, available at http://www.navy.mil/submit/display.asp?story_id=101711.

63 Whereas the AAG is detailed in a separate SAR, EMALS is designated a major subprogram of the CVN 78 program and included in that SAR. EMALS has suffered schedule and RDT&E acquisition program baseline cost breaches. Although initial cost breaches were reported in the December 2014 SAR due to development costs, additional cost growth has resulted from delays to the CVN 78 program that have drawn out EMALS test facility sustainment costs.

64 GAO, *Defense Acquisitions*, 2017, p. 96.

65 This includes EMALS funding, but not AAG funding.

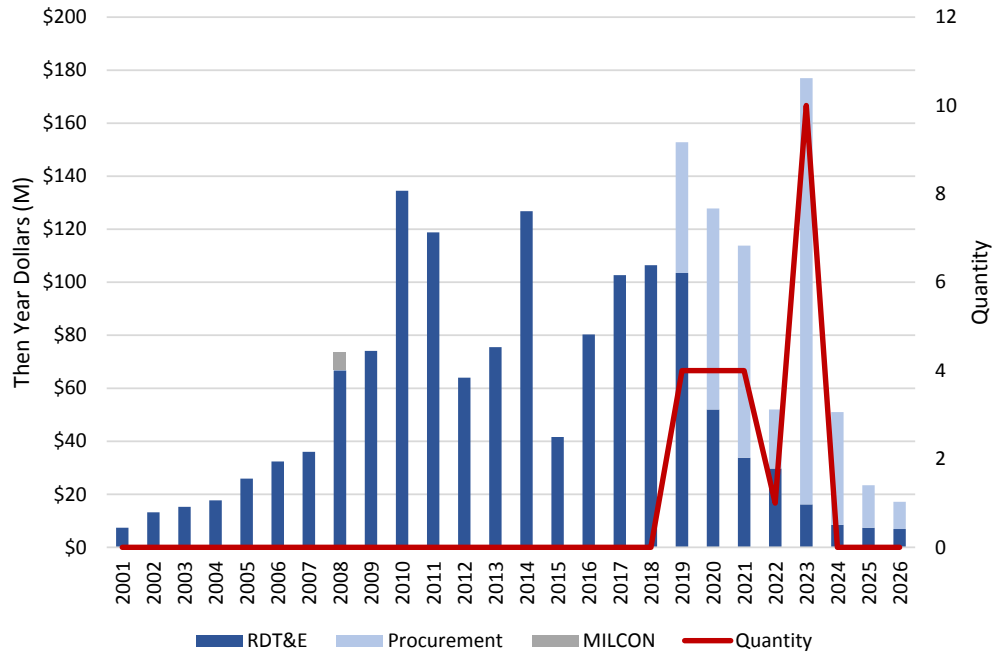
The program SAR does not include estimates for the full procurement of the 11 CVN 78s currently planned. Each of the first three ships has a projected APUC of $12.95 billion. If the program continues to a total buy of 11 ships, the program would have an estimated total O&S cost of $1.06 trillion over a service life of 50 years per ship.



Joint Precision Approach and Landing System (JPALS)

JPALS is a Navy program to develop a jam-resistant, GPS-based aircraft landing system for ships to replace the current radar-based systems. Increment 1A will install the system aboard all Navy aircraft carriers and amphibious assault ships. Increment 1B will integrate JPALS onto sea-based aircraft, including the F-35B, F-35C, and MQ-25A Stingray Carrier-based Aerial Refueling System (CBARS) UAVs. In 2013, the program reported a critical Nunn-McCurdy breach due in part to the elimination of ten training systems following the Air Force's withdrawal from what had originally been a joint program.[66] The program has been restructured with no further issues. Due to a decision by the F-35 program to incorporate features of the JPALS program, allowing 2-way Ultra-High Frequency (UHF) radio communications early, F-35s will begin to deploy with Early Operational Capability (EOC) variants of JPALS beginning in FY 2018, with full IOC to be declared in FY 2021–2024. The United Kingdom is a potential FMS partner with the JPALS program.

Approximately $1.04 billion has been appropriated through FY 2017 for JPALS. An additional $552.80 million has been requested over the FY 2018 FYDP, and $268.60 million is planned beyond the FYDP. The FY 2018 budget request projects an increase in JPALS units, from 27 to 33 sets, of which 26 will be installed aboard ships and two at naval aviation training sites. The current JPALS APUC is $19.87 million per unit. The JPALS program has an estimated total O&S cost of $627.60 million over a service life of 20 years per system

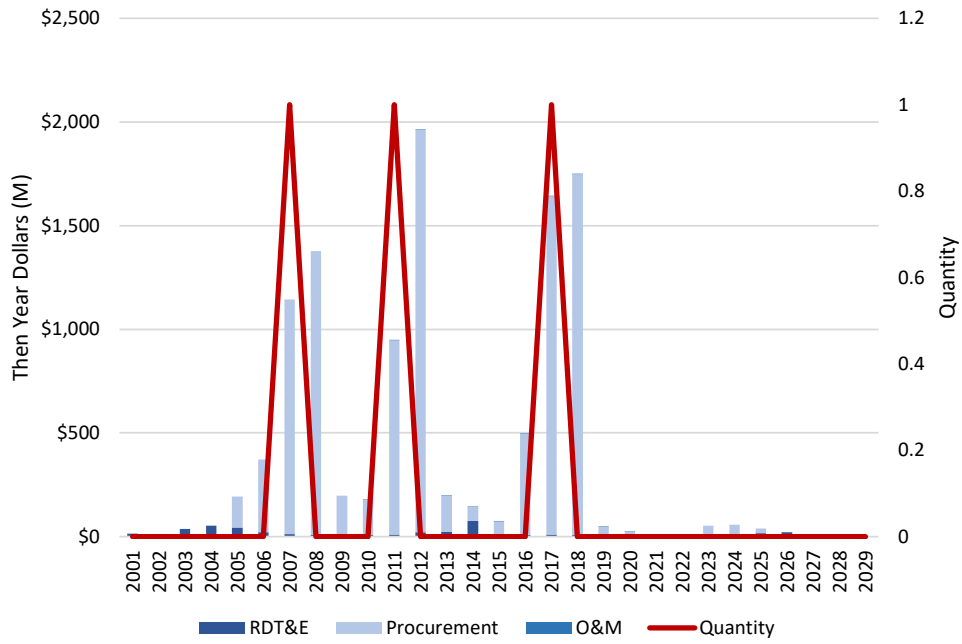


66 Bill Carey, "Raytheon Advances JPALS Landing System for F-35B/Cs," *Aviation International News Online*, October 20, 2016, http://www.ainonline.com/aviation-news/defense/2016-10-20/raytheon-advances-jpals-landing-system-f-35b/cs.

LHA 6 *America*-Class Amphibious Assault Ship

The *America*-class (LHA 6) amphibious assault ship is a small deck aircraft carrier capable of supporting helicopters and short takeoff/vertical landing fixed-wing aircraft, such as the F-35B. The class is intended to replace existing *Tarawa*-class (LHA 1) amphibious assault ships. LHA 6 and 7 do not have a well deck for landing craft, but LHA 8 will be redesigned to include a well deck. This will decrease aviation fuel capacity from 1.5 million pounds to 680,000 pounds. The flight deck of LHA 6 also has to be reconfigured to withstand the exhaust and downwash from the F-35B. The LHA 6 class can transport up to 1,600 troops and their equipment as well as the reconfigurable air combat element of a Marine Air Ground Task Force, which could include nine F-35B fighters, four AH-1Z attack helicopters, four CH-53E helicopters, 12 MV-22 Ospreys, and two MH-60S search and rescue helicopters.[67] The first LHA 6 was delivered 20 months behind schedule in April 2014 and achieved IOC in March 2016. LHA 7 is under construction with delivery scheduled for FY 2019, and the contract for the third was awarded to Ingalls Shipbuilding in June 2016.

A total of $9.04 billion has been appropriated through FY 2017, $1.83 billion was requested over the FY 2018 FYDP, and $180.10 million in further funding is projected beyond the FYDP. The program SAR only includes funding for three ships, despite Navy plans for additional LHAs to be procured in roughly four-year increments well beyond the FYDP. The LHA 6 has an estimated APUC of $1.19 billion, and the program has a projected total O&S cost of $38.38 billion over an estimated service life of 40 years per ship.



67 "The LHA 6 *America*-class of Amphibious Assault Ships," factsheet, Huntington Ingalls, available at: http://ingalls.huntingtoningalls.com/our-products/lha/class/.

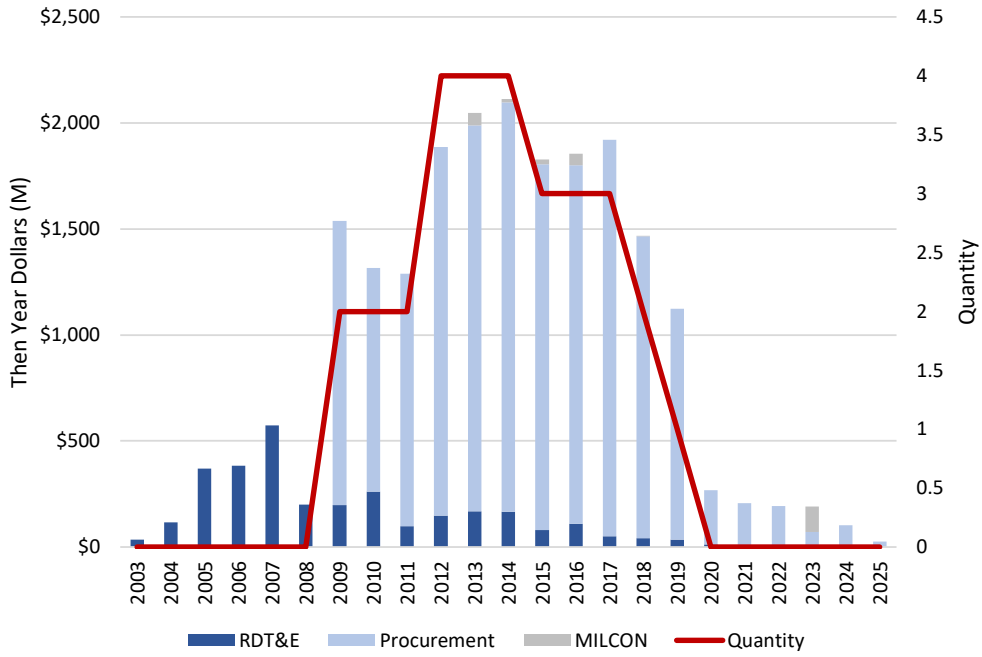
Littoral Combat Ship (LCS)

The LCS is a fast, networked small surface combatant with a modular design capable of conducting mine countermeasure, anti-submarine warfare, and/or anti-surface warfare missions when the relevant module is installed. The LCS modules have a separate SAR (see p. 85). There are two versions of the LCS: the steel monohull (*Freedom*) variant and the aluminum trimaran hull (*Independence*) variant. The Navy intended to select a single design after the first four ships, but instead supported both designs. Nine LCS have been delivered, with 13 additional vessels under construction.

The LCS program has undergone major changes from its original goals. Given growing Navy focus on operating in contested environments, the Navy plans to truncate the LCS buy in favor of a future small surface combatant (referred to in the LCS SAR as the "Frigate") better suited for distributed naval operations and possible escort missions.[68] Although the FY 2017 budget projections included future frigate procurement in the LCS program, the FY 2018 request and SAR indicated frigate acquisition will be handled in a separate program. Three additional LCS were requested to fill the gap until frigates could be introduced, which would result in a total buy of 32 LCS, which, while down from the original program requirement of 52, is greater than the 29 ships projected in the FY 2017 request.

68 See the "FFG(X)—US Navy Guided Missile Frigate Replacement Program," Request for Information (RFI) N0002418R2300, U.S. Navy, Naval Sea Systems Command, NAVSEA HQ, posted July 10, 2017, available at https://www.fbo.gov/index?s=opportunity&mode=form&id=cdf24447b8015337e910d330a87518c6&tab=core&_cview=0.

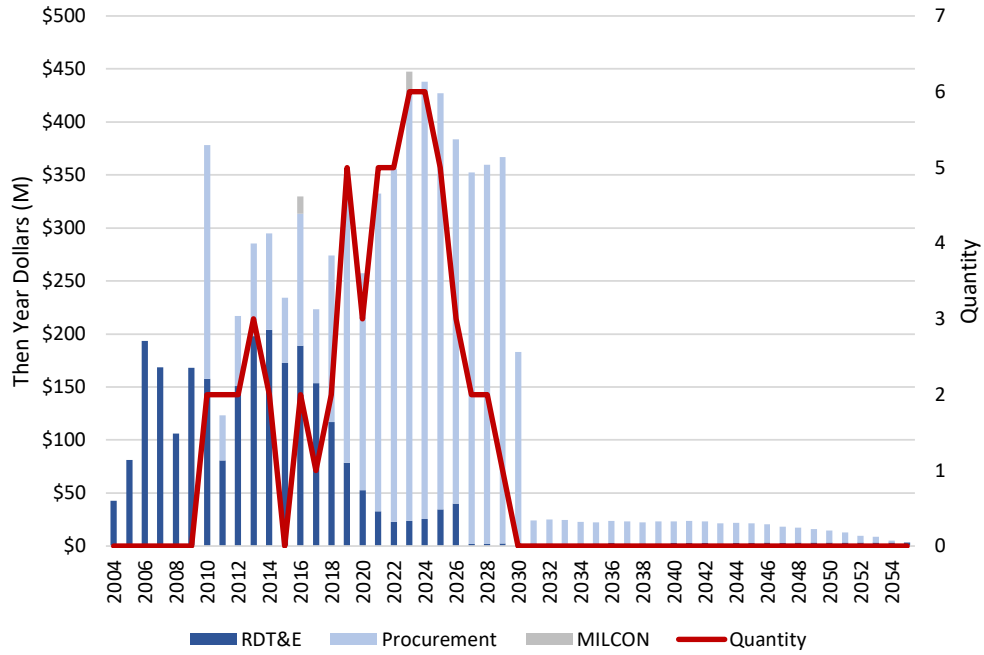
A total of $17.47 billion has been appropriated through FY 2017, $3.26 billion was requested over the FY 2018 FYDP, and $320.10 million in further funding is projected beyond the FYDP. This is $7.85 billion less than the FY 2017 projection due to changes to the future frigate program. The program's APUC is $590.73 million and its estimated total O&S cost is $65.53 billion over a projected service life of 25 years per ship.



Littoral Combat Ship Mission Modules (LCS MM)

LCS mission modules combine mission systems, including unmanned systems, sensors, and weapons, with support equipment and can be installed in Navy ships, principally the LCS, via standard interfaces (the LCS is discussed in a separate SAR; see p. 83). Mission module components can be incrementally upgraded as improvements become available, rather than waiting for a future major procurement program. The modules are designed to be rapidly interchangeable, increasing the operational flexibility of the LCS. The Surface Warfare Mission Package (SUW MP) has achieved IOC and includes two 30mm naval guns and a maritime security module, with a *Hellfire* missile capability in development. The Anti-Submarine Warfare Mission Package (ASW MP) is projected to achieve IOC in FY 2019 and will include acoustic arrays necessary to provide anti-submarine escort capabilities and anti-torpedo defense capabilities. IOC for the Mine Countermeasures Mission Package (MCM MP) has been delayed from 2016 to 2020 while the Navy develops an alternative unmanned system to replace the Remote Multi-Mission vehicle, which was deemed insufficiently reliable to fulfill MCM requirements. Delays in the ASW and MCM MP modules, reported in the September 2016 SAR, have resulted in a breach of the acquisition program baseline schedule estimates.

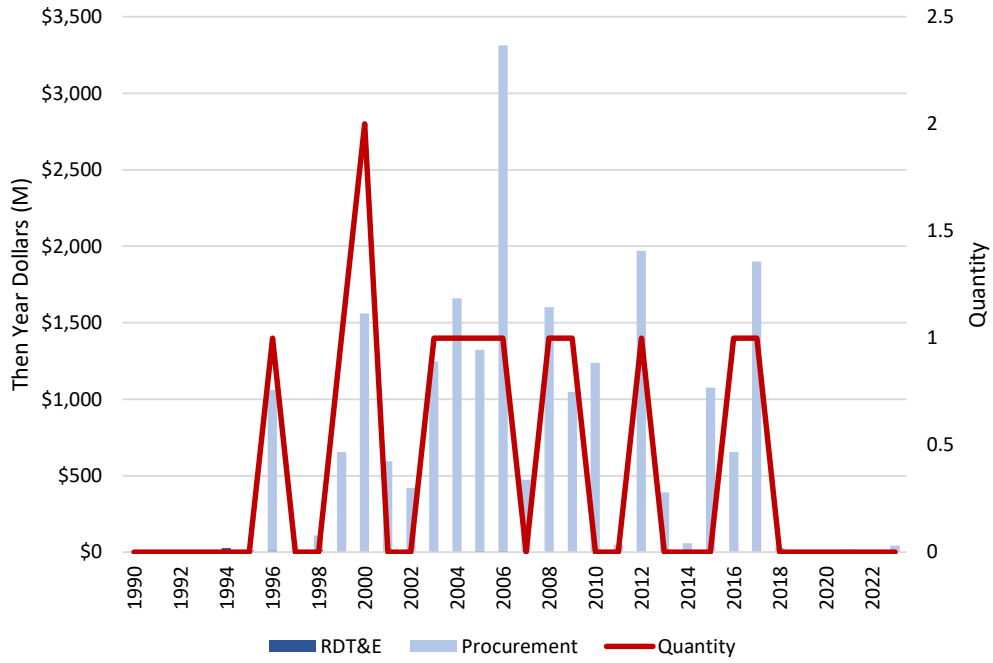
A total of $2.85 billion has been appropriated through FY 2017, $1.55 billion was requested over the FY 2018 FYDP, and $3.43 billion in further funding is projected beyond the FYDP. The FY 2018 request increased total program cost estimates by $242.40 million. Despite adjustments to the planned number of LCS in the FY 2018 request, the Navy still plans to procure 64 LCS MM systems. Each module has an estimated APUC of $88.50 million, and the program has an estimated total O&S cost of $25.22 billion over an estimated service life of 30 years per mission module.



LPD 17 *San Antonio*-Class Amphibious Transport Dock

The *San Antonio*-class (LPD 17) landing platform dock is designed to transport and land elements of a Marine landing force by helicopter, landing craft, and amphibious vehicles. LPD 17 was designed to replace the *Austin*-class LPD and other older amphibious warfare vessels to provide a broad amphibious capability to the fleet. The ships incorporated substantial improvements over previous amphibious warfare vessels, including features that lessen the ship's risk of detectability. Each LPD 17 can carry up to 800 personnel (surge) and support two MV-22 tilt-rotor aircraft. Ten LPD 17s are already in service, with two more in construction. The FY 2018 request added one more LPD 17, for a total planned buy of 13 ships. The first ship of the class declared IOC in 2008. The Navy currently plans to leverage the LPD 17 design as a starting point for the LX(R) program to replace aging *Whidbey Island*-class dock landing ships (LSDs).[69]

A total of $22.45 billion has been appropriated through FY 2017 for 12 ships and development of the ship class. $58.80 million was requested over the FY 2018 FYDP, along with $43.90 million in further funding beyond the FYDP to finish outfitting the twelfth ship and procure the new thirteenth ship. The LPD 17 has an estimated APUC of $1.73 billion and an estimated total program O&S cost of $48.16 billion over an estimated service life of 40 years per ship.

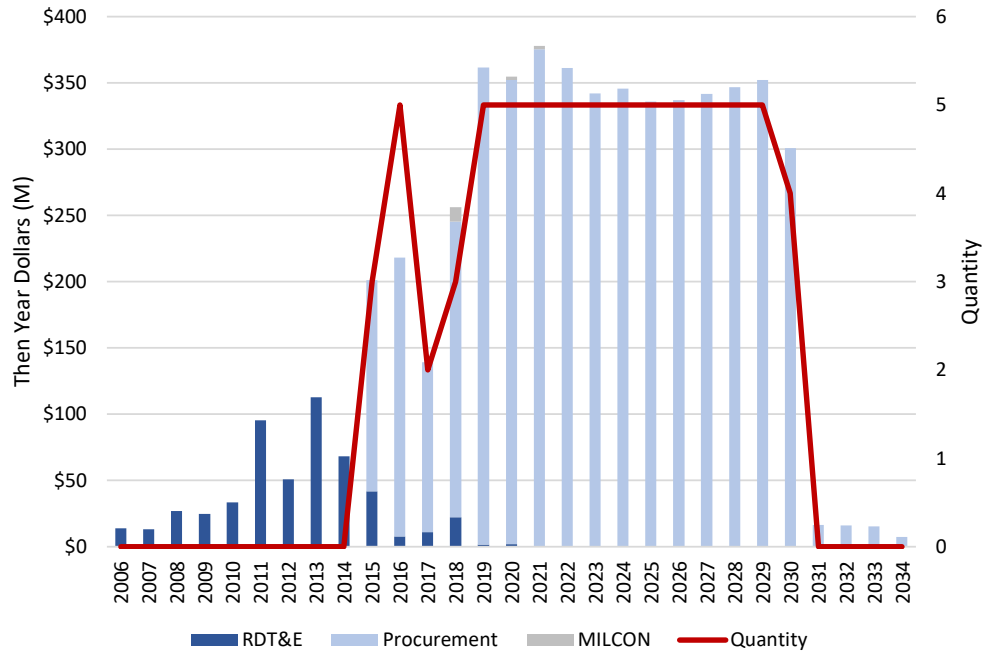


69 GAO, *Defense Acquisitions*, 2017, p. 123.

Ship to Shore Connector Amphibious Craft (SSC)

The Navy's SSC is an air cushioned landing craft designed to transport personnel, equipment, and supplies from amphibious vessels to shore from long distances. It will be lighter and more environmentally friendly than the system it replaces, the Landing Craft Air Cushion (LCAC), which was first introduced in the 1980s. The Navy currently plans to buy 73 SSCs. The SSC was designed to not only be compatible with U.S. amphibious warfare vessels like the LPD 17, but also the vessels of several partner navies, including French and Japanese amphibious warfare vessels. The program has incurred an acquisition program baseline schedule breach due to issues with the propeller and gearbox. FRP has been delayed until 2019–2020, with IOC still projected for August 2020.

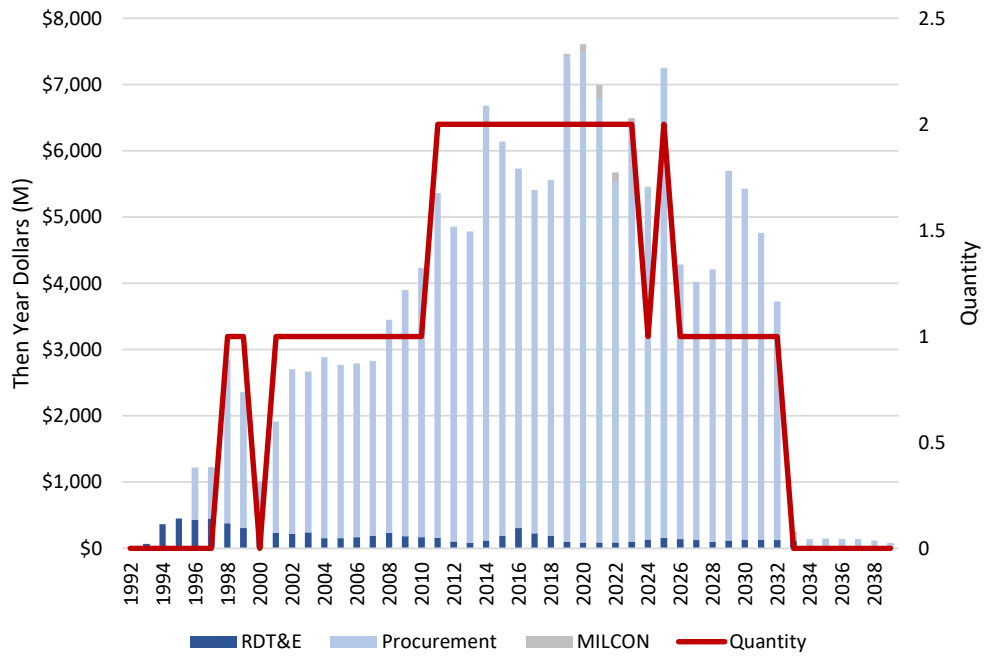
A total of $998.50 million has been appropriated through FY 2017, $1.71 billion was requested over the FY 2018 FYDP, and $2.76 billion in further funding is planned beyond the FYDP. The SSC has an estimated APUC of $68.40 million and projected total program O&S cost of $15.66 billion over an estimated service life of 30 years per landing craft.



SSN 774 *Virginia*-Class Submarine

The *Virginia*-class (SSN 774) nuclear attack submarine is the replacement for the *Los Angeles*-class attack submarine and features significant improvements in stealth and sensor performance. In addition to performing traditional submarine missions, SSN 774s also support special operations forces and possess a vertical launch cruise missile capability. A February 2017 program update increased the projected procurement quantity of SSN 774s from 33 to 48 and incorporated the Virginia Payload Module (VPM) into future submarines, which would add four large payload tubes to each submarine with each tube capable of carrying seven cruise missiles; with the submarine's existing two payload tubes, the addition of the VPM will provide a total capacity of 40 missiles per submarine. This expansion of undersea strike capacity is intended to mitigate the pending loss of capacity that will occur following the retirement of the Navy's four *Ohio*-class guided missile submarines (SSGNs). SSN 774s will continue to be procured at a rate of two per year over the FYDP. The first boat of the class achieved IOC in March 2007; the first VPM-equipped submarine is projected to achieve IOC in September 2026.

A total of $78.69 billion has been appropriated through FY 2017 for the development and procurement of SSN 774s. $33.30 billion was requested over the FY 2018 FYDP, with $52.34 billion projected beyond the FYDP. The FY 2018 request added more than $60.06 billion in funding to the SSN 774 program for the 15 additional submarines and upgrades, although these submarines had long been included in Navy shipbuilding plans. The SSN 774 has an estimated APUC of $3.25 billion and projected total program O&S cost of $160.91 billion over an estimated service life of 33 years per submarine.



Nuclear Forces

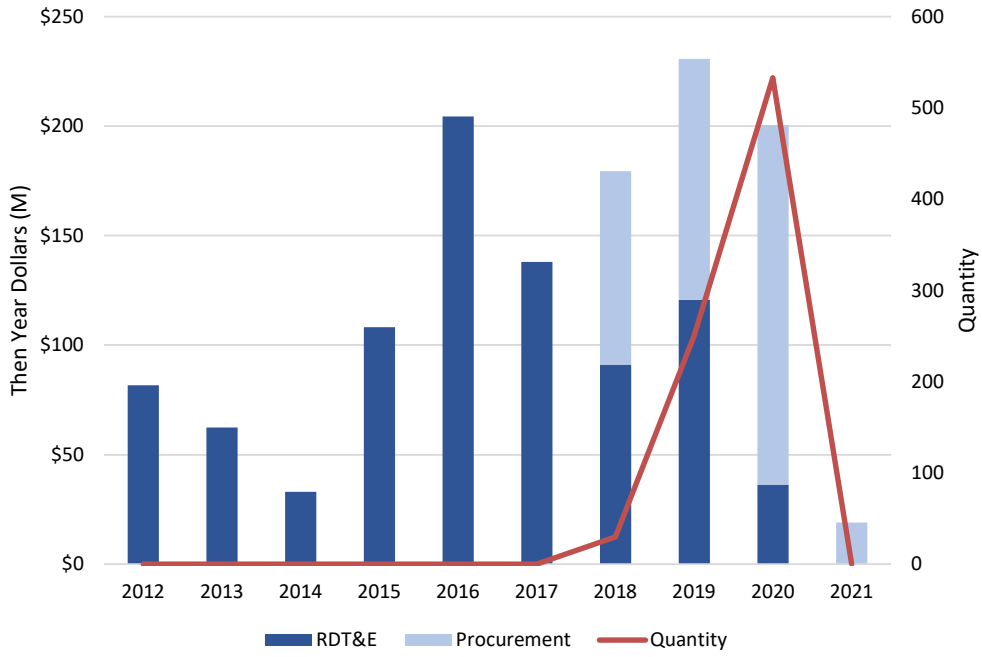
There are six programs in this section, representing the recapitalization of all three legs of the nuclear triad. Programs range from those modernizing existing weapons, such as the B61 and Trident II life extension plans, to programs replacing aging weapons, such as the Minuteman III Intercontinental Ballistic Missile and Air-Launched Cruise Missile. This section also includes the first SAR for the *Columbia*-class program, which will replace the *Ohio*-class ballistic missile submarine. The B-21 bomber supports the nuclear mission, but since it also has a significant conventional role, it is reviewed in the fixed-wing aircraft procurement section (see p. 20). There are no public SARs for the GBSD or LRSO programs; however, CSBA has included an estimate for the GBSD and summarized known spending to date on the LRSO. The SARs in this section represent a DoD investment of $48.22 billion through FY 2017. The FY 2018 budget requests an additional $21.61 billion for these programs over the coming FYDP.[70] In addition to the DoD funding noted here, the Department of Energy (DoE) funds the nuclear warhead modernization necessary for these programs.

70 Since there are no official SARs for the GBSD or LRSO, the past and FYDP spending noted here do not include any funding for either program.

B61 Mod 12 Life Extension Program Tailkit Assembly

The B61 nuclear gravity bomb is the United States' only remaining tactical nuclear weapon.[71] The B61 modernization program will consolidate four variants of the existing B61 air-delivered nuclear gravity bomb—the Mod 3, Mod 4, Mod 7, and Mod 10—into one Mod 12 version with a variable yield and an extended service life. It is a joint DoD–DoE program. The Air Force-led portion of the modernization effort adds a tailkit to the bomb to improve its accuracy, reducing the yield required to destroy a target. The program expects the first tailkits to be delivered in August 2019, with a decision on full rate production in March 2020.

For DoD's share of the program, a total of $627.60 million has been appropriated through FY 2017, and $629.60 million was requested in the FY 2018 FYDP through program completion in 2020. These figures do not include DoE's share of the program's funding. The Air Force currently plans to procure 890 tailkits, including 77 developmental models. Each tailkit has a projected APUC of $469 thousand and a projected total program O&S cost of $2.89 billion over an estimated service life of 20 years per weapon.

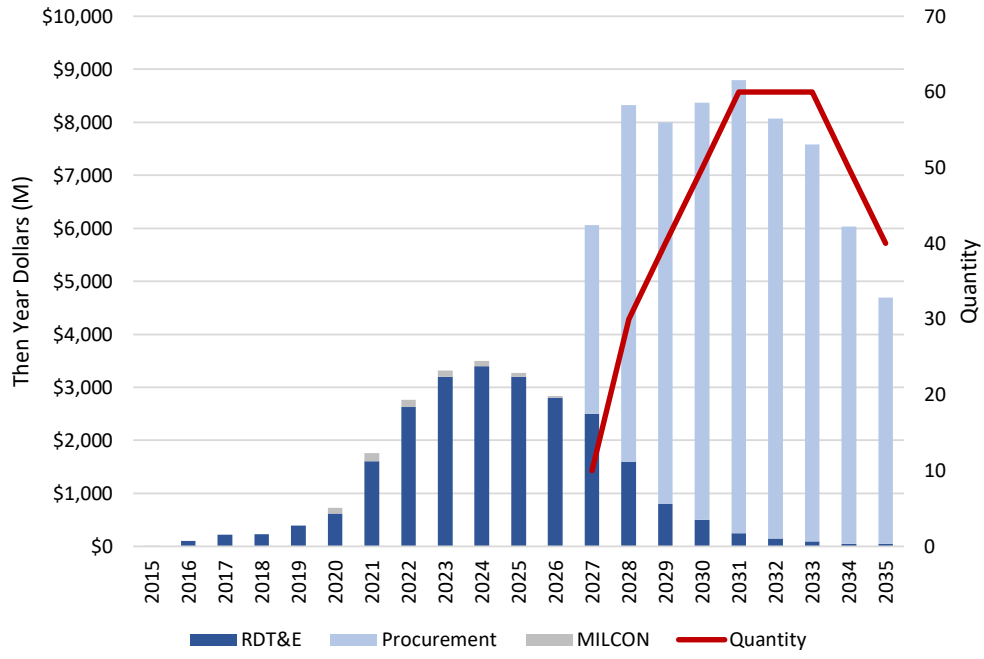


71 Hans M. Kristensen and Robert S. Norris, "United States Nuclear Forces 2017," *Bulletin of the Atomic Scientists* 73, no. 1, January 2017, pp. 48–57.

Ground Based Strategic Deterrent (GBSD)

The GBSD is designed to replace the Minuteman III ICBM. The Air Force is currently funding a development program, which is in the technology maturation and risk reduction phase. The project is structured to deliver a fully integrated system in the late 2020s. The GBSD, however, does not yet have a public SAR, but the Air Force and Cost Assessment Program Evaluation (CAPE) have both estimated the costs of the program. The Air Force relied on historical data for the Minuteman and Peacekeeper programs, whereas CAPE used data from the Trident II and Ground Based Interceptor programs. CAPE also noted that its estimate exceeded the Air Force estimate by 35 percent.[72]

The FY18 budget request suggests that total development will be roughly $18 billion in then-year dollars. Increasing that by 35 percent suggests that CAPE estimated that development costs would be closer to $24.40 billion in then-year dollars. Assuming a total procurement cost of $59.94 billion in then-year dollars for the entire integrated program,[73] including 600 missiles, the total program cost will likely be roughly $85 billion in then-year dollars. Since CAPE's assessment used more modern data sources, the graph below presents a funding profile that may be similar to CAPE's estimate.



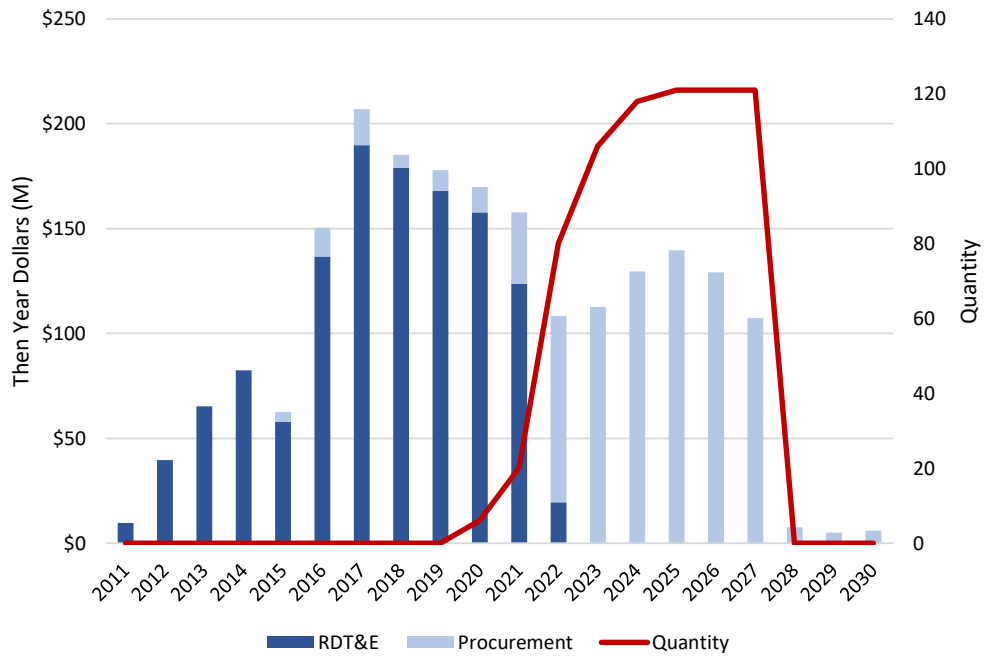
72 Director, Cost Assessment and Program Evaluation, *FY 2016 Annual Report on Cost Assessment Activities* (Washington, DC: DoD, January 2017), p. 28, available at http://www.cape.osd.mil/files/Reports/CA_AR_2016.pdf.

73 Based on an unclassified assessment obtained by CSBA, the Air Force estimate is $63 billion dollars. Subtracting known Military Construction (MILCON) and RDT&E funding leaves the Air Force procurement estimate. CSBA increased that amount by 35 percent to mirror the CAPE estimate, which results in $59.94 billion in then-year dollars for GBSD procurement.

Intercontinental Ballistic Missile Fuze Modernization (ICBM Fuze Mod)

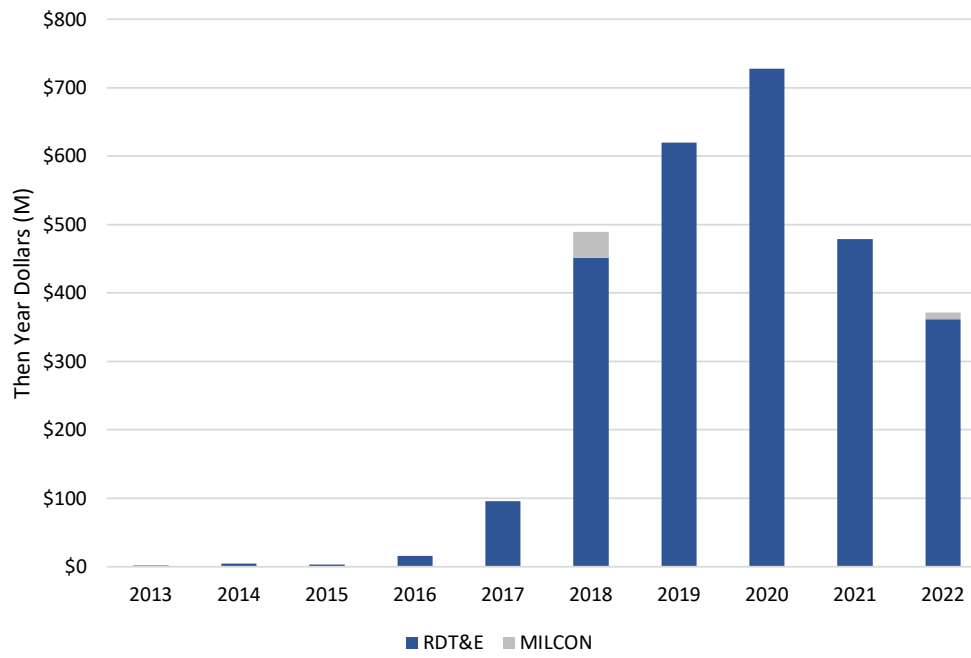
The ICBM fuze modernization program will develop and procure a replacement for the legacy Mk21 arming and fuzing assembly in the W87 warhead on Minuteman III ICBMs. These fuzes are responsible for the successful arming and detonation of nuclear weapons. Current fuzes have been in service three times longer than their designed service life. The new fuze, with a 30-year service life, will meet the requirements of the current generation Minuteman III missiles, as well as the planned replacement missile—the Ground Based Strategic Deterrent (see p. 91). The ICBM Fuze Modernization program plans to procure 781 fuzes by FY 2030, with an initial capability in 2023–2024.

A total of $617.10 million has been appropriated through FY 2017, $799.10 million is requested through the FYDP, and an additional $637.40 million is planned beyond the FYDP. Unlike other nuclear programs, no DoE funding is provided for this program. Of the 781 planned fuzes, 88 will be development articles for test and evaluation. Each fuze has a projected APUC of $1.19 million. The fuze modernization program is estimated to have a total O&S cost of $456 million over a service life of 30 years per missile.



Long Range Standoff Weapon (LRSO)

The LRSO will replace the AGM-86B nuclear-capable, air-launched cruise missile. It will be designed to penetrate and survive advanced Integrated Air Defense Systems (IADS) and GPS-denied environments. In August 2017, the Air Force awarded contracts to Lockheed Martin and Raytheon for a 54-month technical maturation and risk reduction phase.[74] The LRSO should begin entering service by 2030, and the Air Force would like to buy approximately 1,000 missiles.[75] The LRSO, however, does not yet have a public SAR or a formal cost estimate, and there is insufficient official information to create a reliable cost estimate. The graph below only includes RDT&E and MILCON funding for the program as reported in the FY 2018 PB submission. To date, DoD has spent $2.81 billion in then-year dollars on the LRSO.



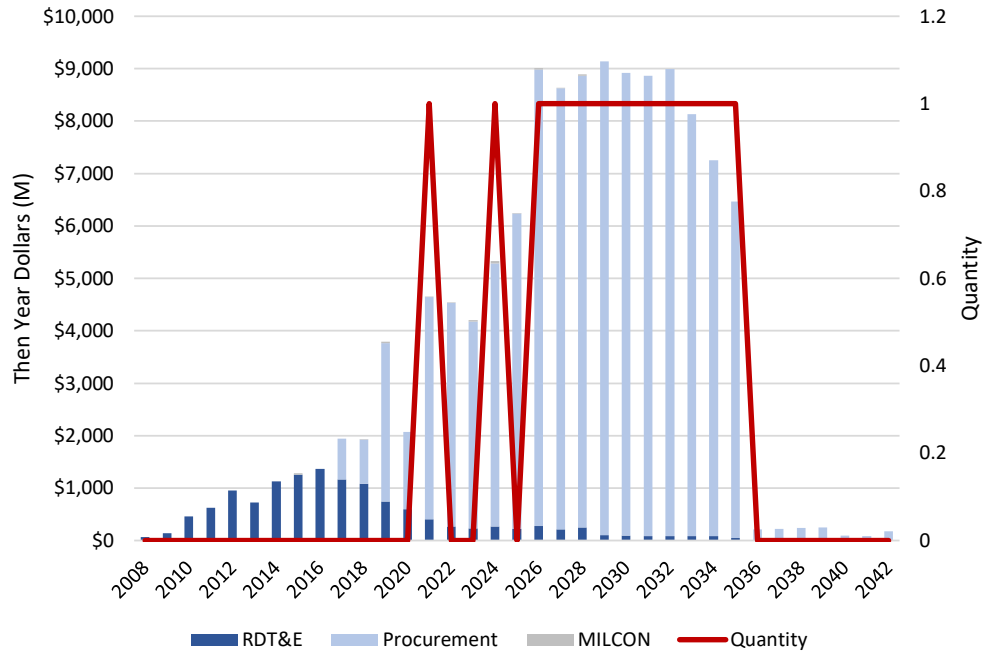
74 Valerie Insinna, "Lockheed, Raytheon Nab Contracts for Nuclear Cruise Missile," *Defense News*, August 23, 2017, available at https://www.defensenews.com/air/2017/08/23/lockheed-raytheon-nab-contracts-for-nuclear-cruise-missile/.

75 Based on an unclassified assessment obtained by CSBA, the Air Force estimates it will procure more than 1,000 LRSOs.

SSBN 826 Columbia-class Submarine (SSBN 826)

This is the first SAR for the Ohio Replacement Program, now designated the *Columbia*-class submarine. It will replace the Navy's current fleet of 14 *Ohio*-class ballistic missile submarines, widely seen as the most survivable leg of the nuclear triad. The Navy has already extended the life of the *Ohio*-class boats beyond their original design life and is planning to begin retiring them in the late 2020s at a rate of one per year. The Navy plans to procure 12 SSBN 826s, two fewer than the fleet being replaced. Advances in ship reactor cores eliminate the need to refuel, which will reduce the length of time required for mid-life overhaul, ultimately reducing the fleet size required to maintain a given at-sea presence. The Navy has attempted to mature as many of the required technologies as possible prior to construction to lessen the likelihood of cost growth and schedule delays. The Navy estimates 83 percent of the technologies required for SSBN 826 are mature, as opposed to just 43 percent at the beginning of construction on *Virginia*-class submarines. Large-scale cost control efforts have also reduced program costs by approximately 40 percent since early estimates. The program remains in the development stage, and the design will not be finalized until 2020. Construction of the first boat is projected to start in October 2020, with delivery in 2027. Subsequent ships will be produced faster. SSBN 826 is scheduled to achieve IOC in 2030. The United Kingdom and United States are partners in the Common Missile Compartment Program; future British SSBNs will incorporate elements of the SSBN 826 missile compartment.

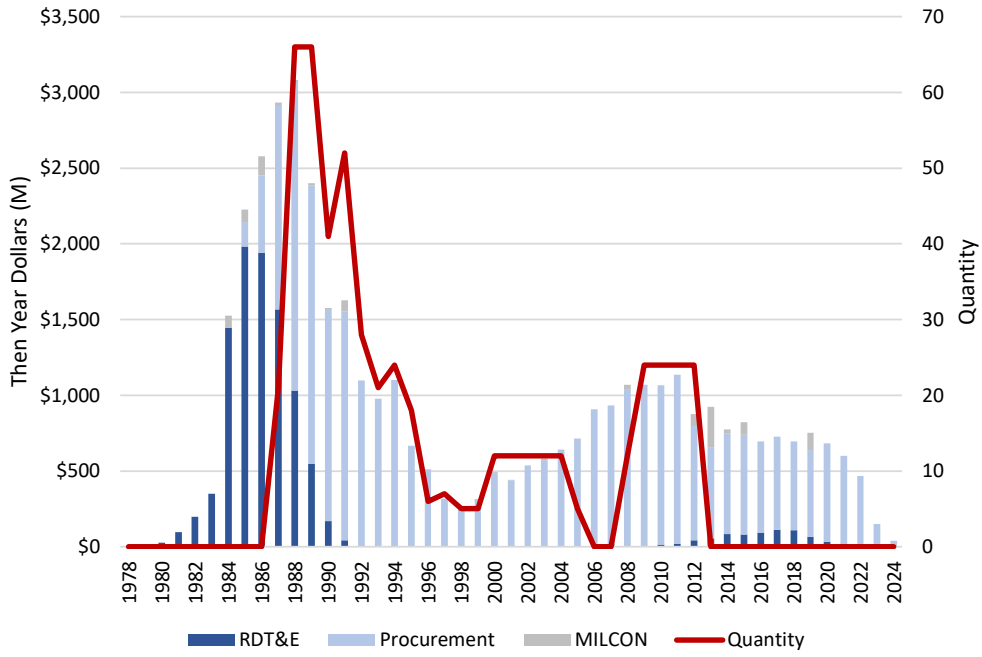
A total of $8.69 billion has been appropriated through FY 2017. Approximately $16.98 billion was requested over the FY 2018 FYDP, and more than $101.36 billion in further funding is planned beyond the FYDP to complete the program. This is second only to the F-35 program in terms of future funding requirements. Early projections estimate an APUC of $9.49 billion per SSBN 826. The program has an estimated total O&S cost of $133.38 billion over a service life of almost 43 years per submarine.



Trident II (D-5) Sea-Launched Ballistic Missile UGM 133A

The Trident II is a submarine-launched nuclear ballistic missile fielded on the *Ohio-class* SSBN. The current program modernizes and extends the service lives of existing Trident II missiles. Due to the high rate of Trident II production early in the program, a significant portion of the inventory will be due for modernization in the coming years. The industrial base for solid fuel rocket motors in the United States is shrinking, and ongoing consolidation efforts by remaining manufacturers may result in indirect cost or schedule adjustments to the Trident II life extension program. IOC for the modernized missile is expected in October 2017.

A total of $38.29 billion has been appropriated through FY 2017, $3.20 billion was requested over the FY 2018 FYDP, and $188.50 million in additional funding will be required beyond the FYDP to complete the program. The program is now over 90 percent complete. All 561 modernized missiles have already been procured, of which 28 were development units. Each missile has an estimated APUC of $57.18 million, and the program has an estimated total O&S cost of $66.08 billion over a projected service life of 43 years per missile.



Space Systems

There are nine entries in this section covering eleven SARs,[76] representing the recapitalization and improvement of capabilities essential to U.S. military operations. Programs listed in this section are fundamental to how the United States military accesses space, communicates with forces around the world, conducts operations, and defends the homeland. The most expensive program, the Evolved Expendable Launch Vehicle, contracts for the delivery of payloads to space on behalf of the entire U.S. national security enterprise. Six different communications and data relay programs enable information traffic relevant to everything from the dissemination of UAV video feeds to the coordination of nuclear deterrence. Three separate SARs related to the GPS constellation detail how DoD is improving its capabilities to maintain positioning, navigation, and timing (PNT) capabilities in the face of jamming and other threats.

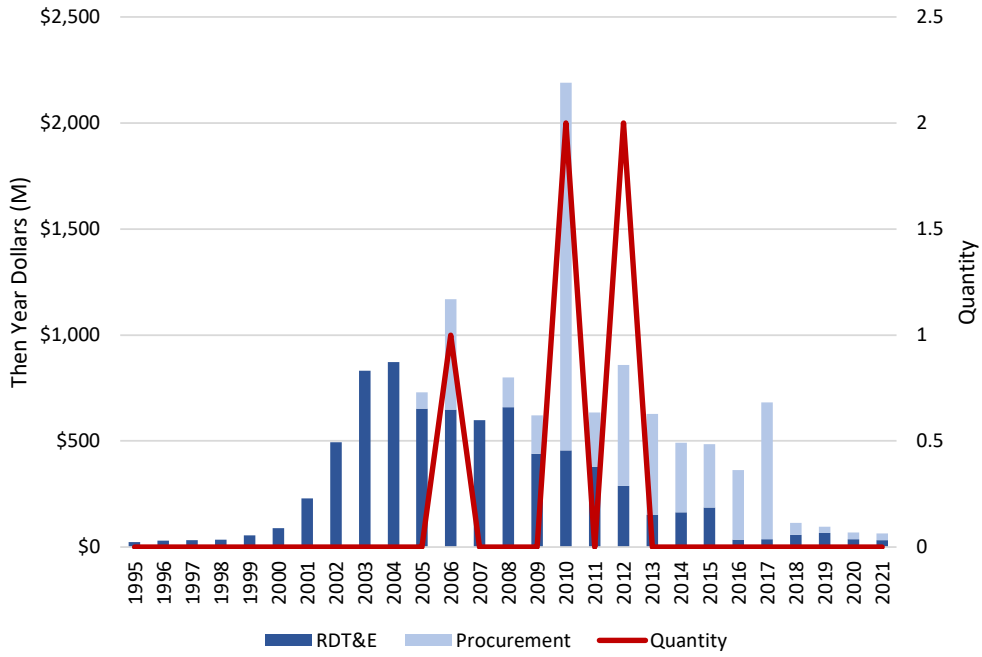
DoD has invested more than $65.54 billion in these programs thus far and will invest another $15.47 billion more over the coming FYDP. A further $20.71 billion is planned beyond the FYDP. The FY 2018 submission marks the final SAR for the Advanced Extremely High Frequency Satellite, Enhanced Polar System, Global Broadcast Service, and Wideband Global SATCOM programs. Both the Mobile User Objective System and Space Based Infrared System High programs have passed program thresholds where further SARs are not necessarily required, but they still submit SARs due to ongoing test and evaluation and additional relevant procurement, respectively.

76 CSBA combined three SARs (for the satellites, ground control station, and GPS receivers) in the GPS entry since all are necessary for the GPS system to function.

Advanced Extremely High Frequency Satellite (AEHF)

This is the final SAR for the AEHF Space Vehicle program. SATCOM terminals and mission control elements for the AEHF system are handled separately (see FAB-T, p. 47). AEHF is a constellation of satellites in geosynchronous orbit that provides secure communications for conventional and nuclear forces around the world. AEHF systems are hardened against the radiation effects that may occur during a nuclear conflict to provide a survivable backbone for coordinating U.S. deterrence efforts. The new constellation provides ten times the bandwidth of legacy systems. Three satellites are already in orbit and integrated into the Milstar/AEHF constellation. A fourth satellite is scheduled for launch by the end of 2017, while the final two planned satellites will launch in 2018 and 2019. The constellation declared IOC in July 2015. Canada, the Netherlands, and the United Kingdom are AEHF partners; they utilize a portion of the constellation's communications capacity in exchange for participation in the constellation's development and financing.

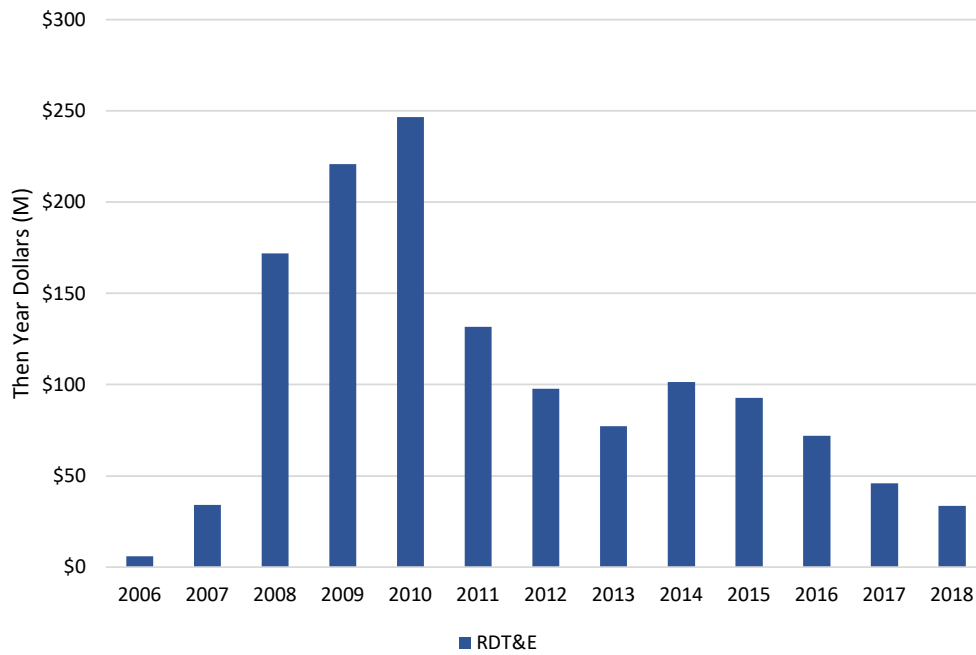
A total of $12.95 billion has been appropriated through FY 2017. $341.30 million in additional funding has been requested over the FY 2018 FYDP, with no further funding projected in the outyears. Each AEHF satellite has an estimated APUC of $1.53 billion. The program has an estimated total O&S cost of $1.82 billion over a service life of 14 years per satellite.



Enhanced Polar System (EPS)

This is the final SAR for the Enhanced Polar System program, with the final program funds requested in FY 2018. EPS is an Air Force-led joint program to provide extremely high frequency (EHF), low probability of interception and detection communications over the north polar region. EPS satellites utilize highly elliptical orbits that allow them to linger over the polar region for far longer than possible with most other satellite orbits. The program has four segments: two hosted payloads, user terminals, a ground installation that connects users in the north polar region to users in middle latitudes, and a fixed command and control center. One payload became operationally available in March 2015, while the other will be available for on-orbit evaluation by the end of 2017. The other three segments have all successfully demonstrated most program criteria and are in the final test and evaluation stages. Full operational use is projected for July 2018.

Slightly less than $1.30 billion has been appropriated through FY 2017 for EPS, and the FY 2018 request for an additional $33.60 million marks the last funds required to complete the program. The SAR does not include an APUC estimate since the program never included procurement funding. The EPS program has an estimated total O&S cost of $189.40 million over a service life of ten years.

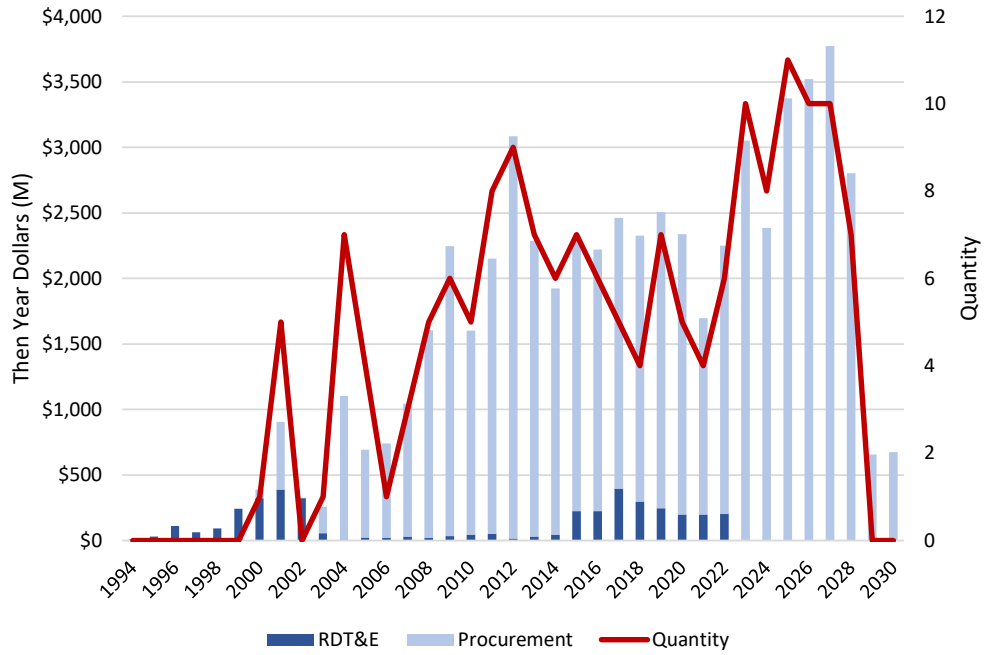


Evolved Expendable Launch Vehicle (EELV)

The Air Force's EELV program provides space launch services to support the Department of Defense and other government agencies. Nine National Security Space (NSS) payloads will be delivered in 2017, with additional missions used to support non-NSS payloads, including support to the International Space Station.

The EELV program has several phases, all aimed at affordably fulfilling space launch missions for the U.S. Government. Phase 1 moved towards block buy-like procurement of United Launch Alliance (ULA) space launch vehicles from FY 2013–2017 to cover launches through FY 2019. ULA was, until recently, the sole provider of launch vehicles for the U.S. military and intelligence community, providing multiple configurations of the Atlas V and Delta IV rockets. Current ULA rockets rely upon Russian-made RD-180 rocket motors; the RD-180 is authorized for use through FY 2022, at which point it must be replaced by a domestically-produced engine. Phase 1A reintroduced competition to space launch, with several contracts awarded to SpaceX for delivery of GPS satellites following 2015 vehicle design certification. Future competitions are planned through 2019. Phase 2 is an effort to produce an alternative rocket motor, with funding provided to SpaceX, Orbital ATK, Aerojet Rocketdyne, and ULA for technology exploration and initial development. This phase aims to produce a U.S. rocket motor by FY 2022. The program is revising cost estimates following a 2015 breach in the acquisition program baseline RDT&E estimates due to a Congressional appropriation of funding to accelerate development of the alternative engine.

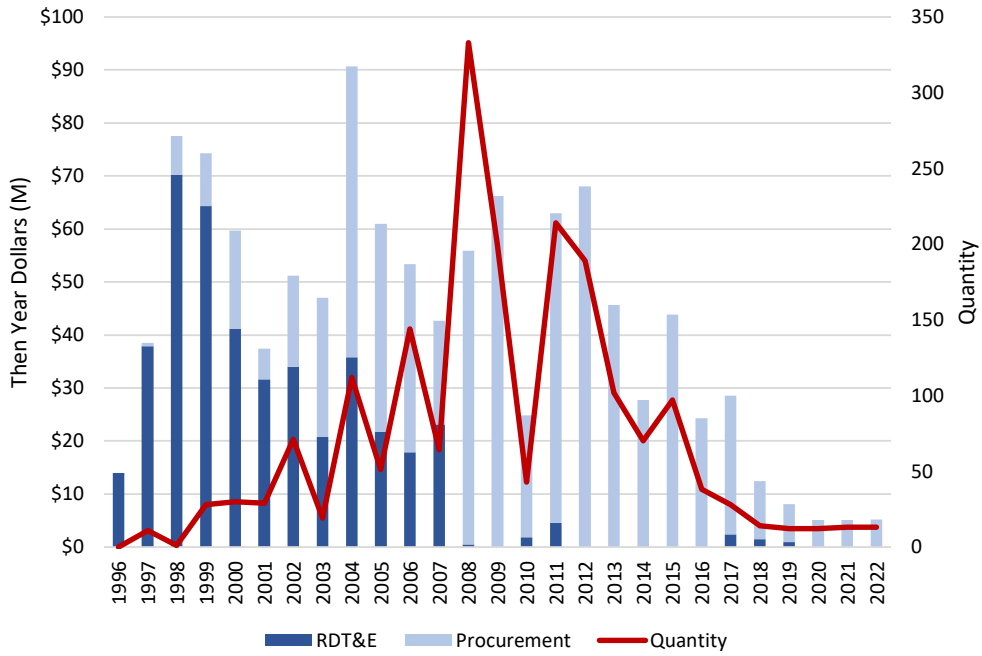
A total of $27.87 billion has been appropriated through FY 2017 for the EELV space launch program. $11.11 billion in additional funding has been requested over the FY 2018 FYDP, with $20.24 billion in additional funding projected beyond the FYDP. 26 launches are currently planned across the FYDP, with 56 beyond. The FY 2018 request slowed the rate of launches over the FYDP, but added eight launches in net across the program while projecting a program savings of $3.21 billion when compared to the FY 2017 estimate. Actual costs of each launch vary depending on rocket type and payload characteristics; averaged across all EELV launches, however, the FY 2018 SAR projects an estimated APUC of $329.07 million per launch.



Global Broadcast Service (GBS)

This is the final SAR for the Global Broadcast Service program, with the final program funds anticipated in FY 2022. This Air Force program supports global transmission of video, imagery, and geospatial intelligence from forward assets, often UAVs, to command centers and combat forces. The service supports high bandwidth, one-way transmission to quickly put reconnaissance products in the hands of users. The program leverages available commercial technologies and broadcasts over GBS-payloads hosted on two UHF Follow-On satellites, commercially leased transponders, and the Wideband Global SATCOM constellation to connect data sources (e.g., UAVs) to commanders via 2,039 receiver suites procured and maintained by the GBS program. The program achieved IOC in 2008. Although the program had suffered an acquisition program baseline schedule breach in 2008 and procurement cost breach in 2010 due to growing demand for GBS receivers, the remainder of the program has progressed without issue.

Approximately $1.10 billion has been appropriated through FY 2017 for GBS, and the FY 2018 request plans for an additional $35.90 million to complete the program. The SAR projects a final buy of 2,074 receivers of different varieties, with a cross-variant APUC of $365 thousand. It estimates that the GBS program will have a total O&S cost of $339 million over a projected service life of 17 years.



Global Positioning System III (GPS III) and Next Generation Operational Control System (GPS OCX)

This entry combines three separate SARs for the Global Positioning III, the Operational Control System (OCX), and the Military Global Positioning System User Increment 1 (GPS MGUE Inc 1) programs. GPS MGUE Increment 1 is a new SAR for FY 2018. The programs are combined here because the satellites, ground control segments, and receiver units are all required to fully implement the next generation of PNT capability.

The GPS III program will replace the existing GPS constellation responsible for providing PNT data worldwide. GPS III leverages technology advances to increase signal strength and resistance to jamming. It also provides new military- and civilian-specific signals (M-Code and L1C), along with the three existing civilian signals. M-Code will feature anti-exploitation features to mitigate attempts to disrupt military GPS, and L1C will be cross-compatible with the European Galileo satellite constellation. GPS III satellites will also host nuclear detonation detection payloads. GPS III has declared an acquisition program baseline schedule breach due to a review of the propulsion systems used in the GPS satellites and a number of other satellite systems. Additional delays have occurred since the baseline estimates were revised, and each satellite may be delivered between six to fifteen months behind the original schedule.[77] The SAR includes costs for two developmental satellites and the first eight operational satellites.

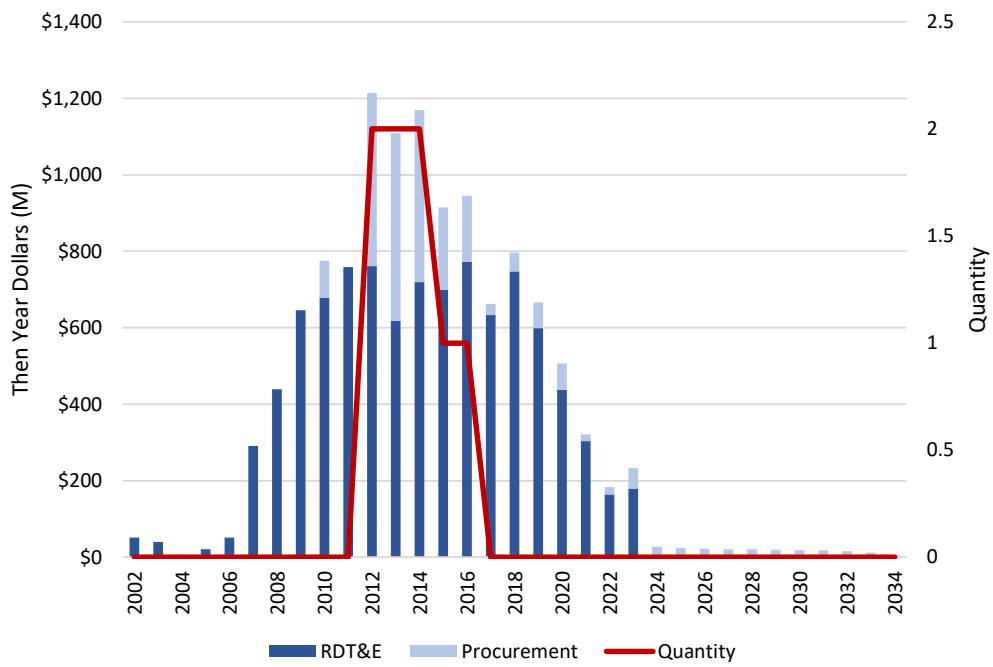
The OCX subprogram is developing a new satellite command and control system to support the GPS III constellation. The Air Force originally envisioned an incremental development approach, with greater capability delivered in multiple program blocks. Block 0 planned an initial operational test and evaluation of GPS III satellites. Block 1 would replace existing GPS control systems and allow control of legacy GPS signals from GPS III and legacy satellites. Block 2 would enable control of the new M-Code and L1C signals. Due to a critical Nunn-McCurdy breach in 2016, the program has since been restructured, and Block 2 capabilities will be developed alongside Block 1 functionality. This program restructuring has delayed OCX IOC until July 2021, meaning that initial GPS III satellites in orbit will have to use older signals until OCX is ready.

77 GAO, *Defense Acquisitions*, 2017, pp. 145–146.

The MGUE Increment 1 program develops and procures modern GPS receivers for integration into U.S. military platforms. These receivers will access the GPS III M-Code signal, improving the PNT capabilities of U.S. military assets operating in areas where GPS signals may be jammed or otherwise disrupted. The receivers will be tested on the Air Force B-2 bomber, Navy DDG 51 destroyer, Army Stryker armored fighting vehicle, and JLTV from FY 2019–2021 before expanding to other platforms. SAR data is currently given for the RDT&E phase of the program; future additions of procurement and sustainment costs will alter future SAR figures.

The costs reported in the SARs cover the first eight GPS III satellites, the OCX ground segment, and the RDT&E phase of MGUE Increment 1. Additional GPS III satellites and the procurement of MGUE receivers will increase these costs. Each GPS III satellite has a projected APUC of $296.44 billion. Although no O&S costs are given for the GPS III constellation or the MGUE receivers, the OCX program has an estimated total O&S cost of $1.79 billion over the ten-year service life of the program.

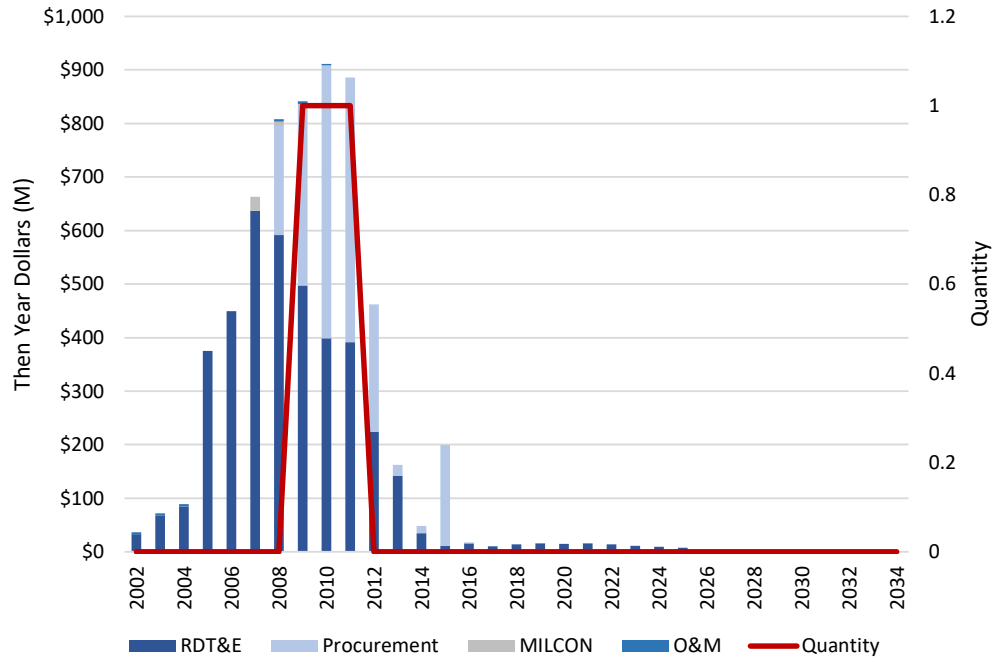
GPS Component Spending ($B)			
Item	**Through FY 2017**	**FY 2018 FYDP**	**Outyears**
GPS III	$4,786.80	$385.90	$264.40
OCX	$3,531.20	$1,690.30	$173.30
MGUE Inc 1	$768.80	$397.60	—



Mobile User Objective System (MUOS)

The Navy's MUOS satellite constellation is designed to provide increased SATCOM capacity in a specific band for Navy installations and ships. It will replace the Ultra High Frequency Follow-On (UFO) satellite system currently in use and will leverage commercial technologies to provide a replacement network capable of higher bandwidth. The program includes funding for satellites and the ground control segment. The FY 2018 budget request cut a satellite, dropping total procurement from six to five. All five remaining satellites have already been launched, though the fifth, intended to be an on-orbit spare, suffered problems that required the burning of fuel normally used to maintain the satellite's orbital position, which may have an impact on its service life. Several deficiencies were also found with the ground system during operational test and evaluation, pushing back the full operational capability declaration from July 2017 to April 2020 and triggering a breach of the acquisition program baseline schedule projection. The program has also incurred an O&S acquisition program baseline cost breach due to additional hardware and software components that needed to be replaced to support MUOS efforts.

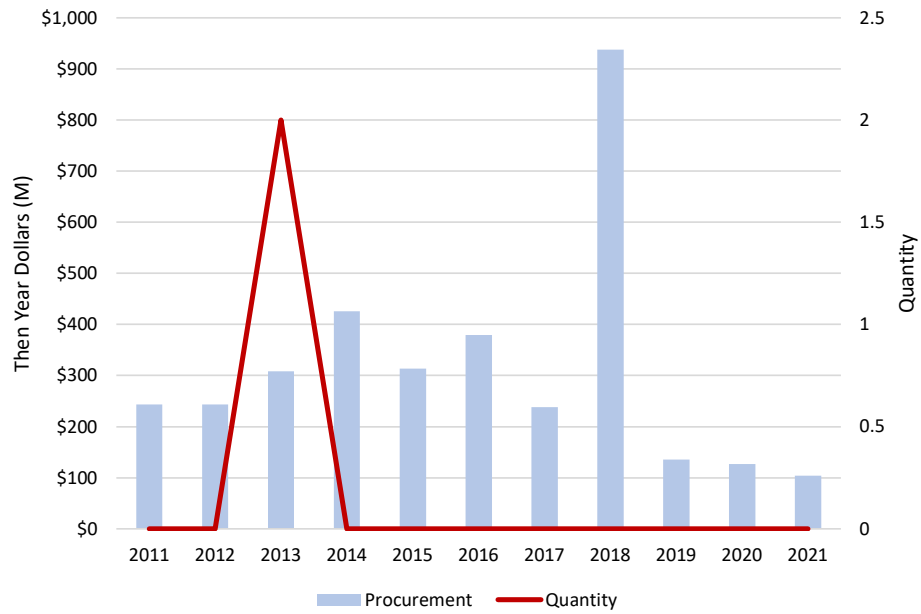
Approximately $6.07 billion has been appropriated through FY 2017 for MUOS, and the FY 2018 budget request plans an additional $74.30 million across the FYDP. $27.90 million beyond the FYDP is required to complete the program. The cancellation of a future sixth MUOS satellite decreased total program cost by $668.30 million. Each satellite has an APUC of $670.27 million. O&S costs are given per ground station; six ground stations, result in a total program O&S cost of $1.66 billion over a service life of 21 years per ground station.



Space Based Infrared System High (SBIRS High)

Many elements of the SBIRS High program have been or are nearly completed. The FY 2018 SAR focuses principally on two spare satellites scheduled for delivery in 2021. The Space-Based Infrared System includes multiple satellite constellations and supporting systems to provide early warning of ballistic missile launches. Some elements of SBIRS are included in other programs, such as a collection of satellites in low earth orbit (SBIRS Low) that were moved into the Missile Defense Agency's Space Tracking and Surveillance System (STSS).[78] The SBIRS High component includes four geostationary (GEO) SBIRS satellites, two SBIRS-hosted payloads on satellites in a highly elliptical orbit (HEO), two replenishment satellites and sensors, and fixed and mobile ground stations. The program is on track to have both hosted HEO payloads and four GEO satellites on orbit by the end of 2017. The two GEO spares should be available by 2021. The Air Force now has plans for two additional HEO payloads that were not part of the program baseline and whose costs are not included in the FY 2018 SAR.

Based on data from the December 2014 SBIRS High SAR, total costs for the two HEO and four GEO satellites, plus ground support, come to approximately $13.66 billion in then-year dollars.[79] An additional $2.15 billion has been appropriated through FY 2017 for the two spare GEO satellites, and $1.31 billion more has been requested across the FY 2018 FYDP to complete their procurement. Each of the satellites, including the two spares in the SBIRS High baseline, has an estimated APUC of $1.73 billion. The entire constellation has an estimated total O&S cost of $1.75 billion over the 35-year service life of the system.



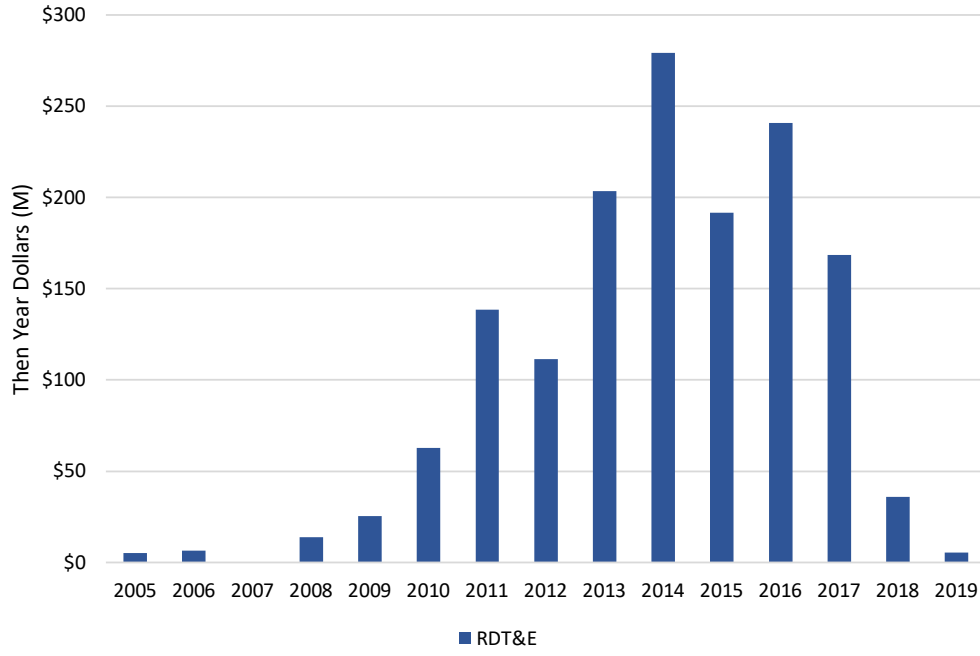
78 "Space-Based Infrared System (SBIRS)," *CSIS Missile Defense Project*, updated August 11, 2016, available at https://missilethreat.csis.org/defsys/sbirs/.

79 These costs are not included in the chart below, but they are given to reflect accurately the cost of the entire SBIRS constellation.

Space Fence Ground-Based Radar System Increment 1

The Space Fence Ground-Based Radar system is designed to detect and monitor orbiting objects in Low-Earth/Medium-Earth Orbit (LEO/MEO), replacing a previous Air Force radar system that was decommissioned in FY 2013. The program will have improved capabilities to detect and characterize small objects. When complete, the system will include one ground station and two S-band radar stations. Increment 1 funds one radar site at Kwajalein Atoll and the ground station in Huntsville, Alabama. A prototype has demonstrated over 70 percent of the capability of the full system using much of the software and hardware that will be used on the actual system. Different conditions at each site have resulted in schedule variances from baseline estimates, but the program remains on track, and construction should largely be complete by the end of 2017. An initial operational capability is anticipated in FY 2019. No decision on Space Fence Increment 2 will be made until completion of Increment 1.[80]

$1.45 billion has been appropriated through FY 2017, and the FY 2018 budget request plans an additional $41.30 million through FY 2019 to complete Space Fence Increment 1. No costs are currently projected within the SAR for Increment 2. The SAR does not present an APUC estimate since the program does not have any procurement funding. The Space Fence Increment 1 capability has an estimated total O&S cost of $1.55 billion over the 20-year service life of the system.

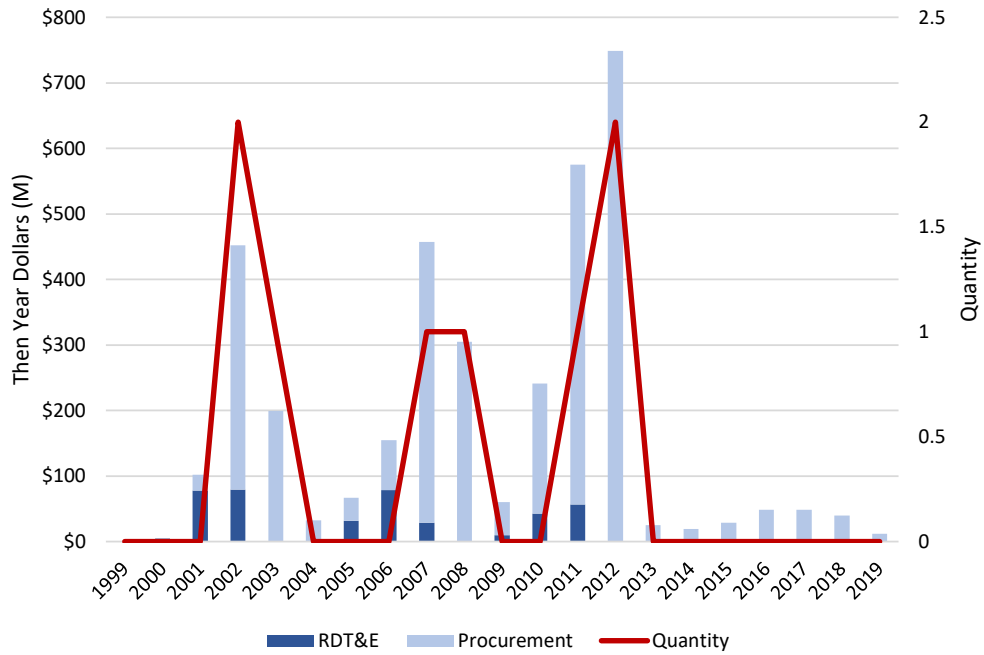


80 GAO, *Defense Acquisitions*, 2017, pp. 155–156.

Wideband Global SATCOM (WGS)

This is the final SAR for the WGS program, with program funding ending in FY 2019. This Air Force-led program, previously known as the Wideband Gapfiller System, provides DoD with its highest capacity communications satellites. The satellites are based on a Boeing commercial satellite design, leveraging commercial capabilities to save development costs and improve efficiency. All satellites have been launched, and the final satellite is projected to become operational by the end of 2017. The system reached full operational capability in May 2014 once the sixth satellite arrived on station. Australia, Canada, Denmark, Luxembourg, the Netherlands, and New Zealand are providing funding to the United States in exchange for the right to use some of the WGS constellation's global capacity, which has enabled the Air Force to expand the constellation.

A total of $3.57 billion has been appropriated through FY 2017. $51.90 million through FY 2019 is required to complete the WGS program. Each satellite has an estimated APUC of $401.61 million, and the entire constellation has an estimated total O&S cost of $650.70 million over the 14-year life of the system.



LIST OF ACRONYMS

COTS	commercial off-the-shelf
EOC	Early Operational Capability
FMS	Foreign Military Sales
FRP	Full Rate Production
FYDP	Future Years Defense Program
GAO	Government Accountability Office
IOC	Initial Operational Capability
LRIP	Low Rate Initial Production
O&S	Operating & Support
OCO	Overseas Contingency Operations
RDT&E	Research, Development, Test, & Evaluation
SAR	Selected Acquisition Report
SATCOM	satellite communication
UAV	unmanned aerial vehicle
Average Procurement Unit Cost (APUC)	the average recurring cost per unit procured; does not include development costs
developmental units	articles procured for test and evaluation purposes which may not feature full functionality and which may or may not be suitable for operational use
Nunn-McCurdy breach	Programs incur breaches when their current PAUC or APUC estimates exceed original or restructured baseline estimates by a large margin. "Significant" breaches occur when program cost growth exceeds original estimates by 30 percent or restructured estimates by 15 percent. "Critical" breaches occur for cost growth of 25 percent above restructured estimates, or 50 percent above baseline estimates.[1]
production units	units procured for the field, as opposed to development units purchased principally for RDT&E purposes that may not possess full capability
Program Acquisition Unit Cost (PAUC)	the total cost of the program divided by the quantity of units procured; spreads development costs over the items bought

1 See Moshe Schwartz and Charles V. O'Connor, *The Nunn-McCurdy Act: Background, Analysis, and Issues for Congress* (Washington, DC: CRS, May 12, 2016), available at https://fas.org/sgp/crs/natsec/R41293.pdf.

CSBA
Center for Strategic and Budgetary Assessments

1667 K Street, NW, Suite 900
Washington, DC 20006
Tel. 202-331-7990 • Fax 202-331-8019
www.csbaonline.org