Updates to Selected Analyses from the *Performance of the Defense Acquisition System* Series

2019 SARs Update

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1. Introduction and Summary

In 2013, 2014, 2015, and 2016 the Department of Defense (DoD) produced annual reports on the *Performance of the Defense Acquisition System*, along with partial updates with 2017 and 2018 data.[1] We encourage the interested reader to consult those volumes for background on defense acquisition, spending levels, and trends as well as a range of analyses on cost, performance, and schedule of Major Defense Acquisition Programs (MDAPs). Additional analyses look at contractor performance, the acquisition workforce, and source selection practices.

Here, we update selected sections from the *Performance of the Defense Acquisition System* series with recent data.[2] To provide continuity, we use the methodologies established in the original reports, noting corrections and improvements in the relevant sections.

We provide updates on four topics:

- **Nunn-McCurdy Breaches.** We present the Department of Defense's official list of Nunn-McCurdy breaches (Table 1) categorized by Component (Figure 2 and Table 2) and commodity type (Table 3). The counts of both critical and significant Nunn-McCurdy breaches have continued their downward trend since 2006, with the decreasing trend in critical breaches being statistically significant. This could be due to better program management, better baseline cost estimates, or a combination of these factors.

- **Program Cost Performance (Development).** We examine MDAP development (Research, Development, Test, and Evaluation [RDT&E]) cost growth on both a cumulative and biennial basis. In addition to showing the data on a program basis with all programs weighted equally, we also present the analyses with each program weighted by its size in dollars.

  Of note, by program, cumulative cost growth for RDT&E has been stable since 2010 (see Figure 3). Median RDT&E program cost growth in the last two years (biennial period 2017-2019) remains less than 0.5 percent (see Figure 7). However, on a dollar basis, larger programs (in terms of spending) have systematically larger total RDT&E funding growth, and that growth has been increasing.

  On a biennial (marginal) basis, there has been declining cost growth on programs except for a slight increase from 2018 to 2019 (less than 0.5%) which was not statistically significant (see Figure 7), but an increase on a dollar basis since 2017 (see Figure 9), suggesting that larger programs are experiencing higher biennial cost growth than smaller programs of late.

  Program Cost Performance (Procurement). We also examine MDAP procurement cost growth on both a cumulative and biennial basis. In addition to showing the data on a program basis with all programs weighted equally, we also present the analyses with each program weighted by its size in dollars.

[1] See Under Secretary of Defense for Acquisition, Technology, and Logistics (USD[AT&L]) (2013), USD(AT&L) (2014), USD(AT&L) (2015), and USD(AT&L) (2016); Office of the Under Secretary of Defense for Acquisition and Sustainment [OUSD(A&S)], 2019.
[2] We extracted the data for the cost growth analyses from the Defense Acquisition Management Information Retrieval (DAMIR) and Data Set capabilities within the Defense Acquisition Visibility Environment (DAVE) on July 28, 2020.

Of note, quantity-adjusted cumulative unit-procurement flyaway cost growth has fallen from 7 percent in 2013 to just under 0 percent in 2019, at the median (see Figure 10), and cost growth throughout the portfolio has been statistically lower in 2016–2019 than in prior years. Quantity-adjusted unit-procurement flyaway cost growth in the last two years (biennial period 2017-2019) has been -0.7 percent at the median (see Figure 13). Unlike on a program basis, cost growth on a dollar basis has been hovering near 25% in recent years. This indicates that larger programs (in terms of procurement spending) have systematically larger unit procurement cost growth than smaller programs.

On a program basis, biennial procurement cost growth has been statistically slightly lower since about 2011 than in prior years, hovering near zero percent.

- **Program schedule growth of cycle time (program start to IOC).** We analyzed the growth of cycle time of all active programs working towards or achieving IOC in a given year. Compared to data reported in 2016, actual cycle times at the median for combined MS B/C MDAPs has dropped from 7.6 years to 6.2 years, but growth from plans has increased, possibly due to more aggressive schedule plans in recent years.

2. Nunn-McCurdy Program Breaches

Each Major Defense Acquisition Program (MDAP) is required by law to submit a comprehensive annual Selected Acquisition Report (SAR) to Congress within 30 days after the annual President's budget (PB) submission. Quarterly SARs are required under various other circumstances and shall be submitted within 45 days after the end of the fiscal-year quarter (see 10 U.S.C. § 2432). A SAR reflects what is included in the PB as well as a comprehensive summary of MDAP cost, schedule, and technical performance (requirements) measures. Historical SAR data serve as the primary sources for much of our program-level analysis due to their relative availability and comprehensiveness.

Common program cost metrics[3] (such as Program Acquisition Unit Cost (PAUC)[4], which considers total acquisition costs (i.e., RDT&E, procurement, military construction, and acquisition operation and maintenance costs)—and total (i.e., fully configured development and procurement) quantities, and Average Procurement Unit Cost (APUC)[5], which includes only procurement dollars and quantities) are codified in statute. The statute also requires that programs exceeding certain thresholds (measured by PAUC or APUC changes relative to their original and current program baselines) must go through a rigorous reexamination and, in some cases, certification to Congress along a variety of specified criteria. This process is commonly referred to as the "Nunn-McCurdy" process, named for the original sponsors of the legislation dating back to 1982 (see 10 U.S.C. § 2433).

Two types of breaches are called out in the Nunn-McCurdy process: *significant* and *critical*. A significant breach is the lower threshold and is intended to warn Congress that a program is experiencing significant unit-cost growth relative to its baseline. A critical breach signifies the cost growth is even higher, triggering the formal reexamination and certification process mentioned above. The criteria for a significant breach are either 15 percent from the current baseline, or 30 percent cost growth in APUC or PAUC from the original baseline. A critical breach occurs when the program experiences 25 percent cost growth from the current baseline, or 50 percent cost growth from the original baseline. Figure 1 shows the Nunn-McCurdy breaches year-by-year from 1997 through 2019 by severity.

As with the previous PDAS update [OUSD(A&S), 2019), we continue to report Nunn-McCurdy statistics based on the DoD's official list of breaches from 1997 through December 2019 (see Table 1). The numbers of breaches per year are slightly different than in the DoD's 2013 and 2014 reports.[6] It is important to note that the National Defense Authorization Act (NDAA) for FY 2006 made changes to the Nunn-McCurdy statute by adding the requirement to report unit-cost growth from the original baseline in addition to the current baseline. This additional requirement caused a large spike in 2005 when 11 programs had to report preexisting significant breaches. Thus, for historical comparisons, we need to compare performance in years since 2006.

[3] Here, "cost" is synonymous with the total amount of funding because it reflects the prices paid on contracts as well as program execution costs.
[4] 10 U.S.C. § 2432(a)(1), defines PAUC as "the amount equal to (A) the total cost for development and procurement of, and system-specific military construction for, the acquisition program, divided by (B) the number of fully configured end items to be produced for the acquisition program."
[5] 10 U.S.C. § 2432(a)(2), defines procurement unit cost as "the amount equal to (A) the total of all funds programmed to be available for obligation for procurement for the program, divided by (B) the number of fully configured end items to be procured."
[6] The DoD's prior reports used quarterly SARs, whose dates may not align with the exact breach reporting dates to Congress. The DoD also used to report breaches by SAR years, which do not align completely with calendar years because SARs can include information from the beginning of the next calendar year. In addition, canceled programs may not have a final SAR, and programs stop reporting at 90 percent of cost expended or quantity delivered.

Table 1. Official DoD List of Nunn-McCurdy Breaches (SAR Years 1997–2019)

Year	Critical	Significant[#]
1997		• Chem Demil-Legacy/NSCMD
1998		• FMTV • Javelin • Longbow Apache
1999	• ATIRCM/CMWS • B-1B CMUP	• NAVSTAR GPS/Satellite
2000		
2001	• CH-47F • Chem Demil-CMA/CSD • F-22 • GMLRS • H-1 Upgrades (4BW/4BN) • LPD 17 • Navy Area TBMD[a] • SBIRS High	• B-1B CMUP • MH-60R • V-22
2002	• ATACMS-BAT:BAT P3I[b]	• Comanche • SSN 774
2003	• EELV	• F-35
2004	• Chem Demil-CMA • Chem Demil-CMA Newport	• AEHF • RQ-4A/B UAS Global Hawk • SBIRS High
2005*	• NPOESS • RQ-4A/B UAS Global Hawk • SBIRS High	• ATIRMC/CMWS* • C-130 AMP* • Chem Demil-CMA* • Chem Demil-CMA Newport* • EFV* • F/A-18E/F* • JASSM* • JPATS* • MH-60S* • SSN 774* • ASDS[b] • GMLRS • F-35*
2006	• C-130 AMP • Chem Demil-ACWA • EFV • GMLRS • JASSM • JPATS • Land Warrior[b] • WIN-T	• FBCB2
2007	• C-5 RERP	• AEHF • ARH • JAVELIN • JTRS GMR
2008	• AEHF • ARH[a] • VH-71[a,d]	• H-1 Upgrades (4BW/4BN)
2009	• Apache Block III (AB3) • ATIRCM/CMWS • DDG 1000 • E-2D AHE • F-35 • RMS • WGS	• C-130 AMP
2010	• Chem Demil-ACWA • EFV[b] • Excalibur • RQ-4A/B UAS Global Hawk	• C-27J • Inc1 E-IBCT[b] • JLENS • NPOESS
2011	• AIM-9X Block I[b] • C-130 AMP[b] • JLENS[c] • JTRS GMR[a]	
2012	• EELV	
2013	• JPALS Inc 1A • VTUAV	• AWACS Block 40/45 Upgrade • JTRS HMS
2014	• JSOW[b]	• WIN-T (Inc 2)
2015	• RMS[b]	
2016	• OCX	• Chem Demil-ACWA
2017	• AAG[e] • IDECM[f]	• LCS MM
2018		• OASuW Inc 1 LRASM • F-15 EPAWSS
2019		• SDB II • AGM-88E AARGM

Programs that declared a significant breach and subsequently a critical breach in the same SAR year are listed only as critical breaches. Programs that declared multiple significant breaches in the same SAR year are listed only once.

* Programs in purple shading (2006–2015 for critical; 2005–2015 for significant) breached against the original baseline as per the FY 2006 NDAA. Programs in blue shading (1997–2005 for critical; 1997–2004 for significant) breached according to prior criteria that allowed re-baselining. Eleven programs that did not have a breach prior to the new FY 2006 criteria had significant breaches as a result of this legislative change. The FY 2006 NDAA also permitted the following 25 programs to revise their original baselines to equal their current baseline estimates as of January 6, 2006, without declaring a critical breach: AEHF; AMRAAM; ASDS; Black Hawk Upgrade; Bradley Upgrade; C-17A; CH-47F; EELV; F-22A; FCS; FMTV; Global Hawk; GMLRS; Javelin; JSOW; H-1 Upgrades; Longbow Apache; LPD-17; MH-60R; Minuteman III Guidance Replacement Program; NPOESS; SBIRS High; T-45TS; Trident II Missile; V-22. Program abbreviations are defined in Appendix A.

a Following a declared breach, the program was terminated rather than certified.

b Breach resulted from a decision to terminate the program.

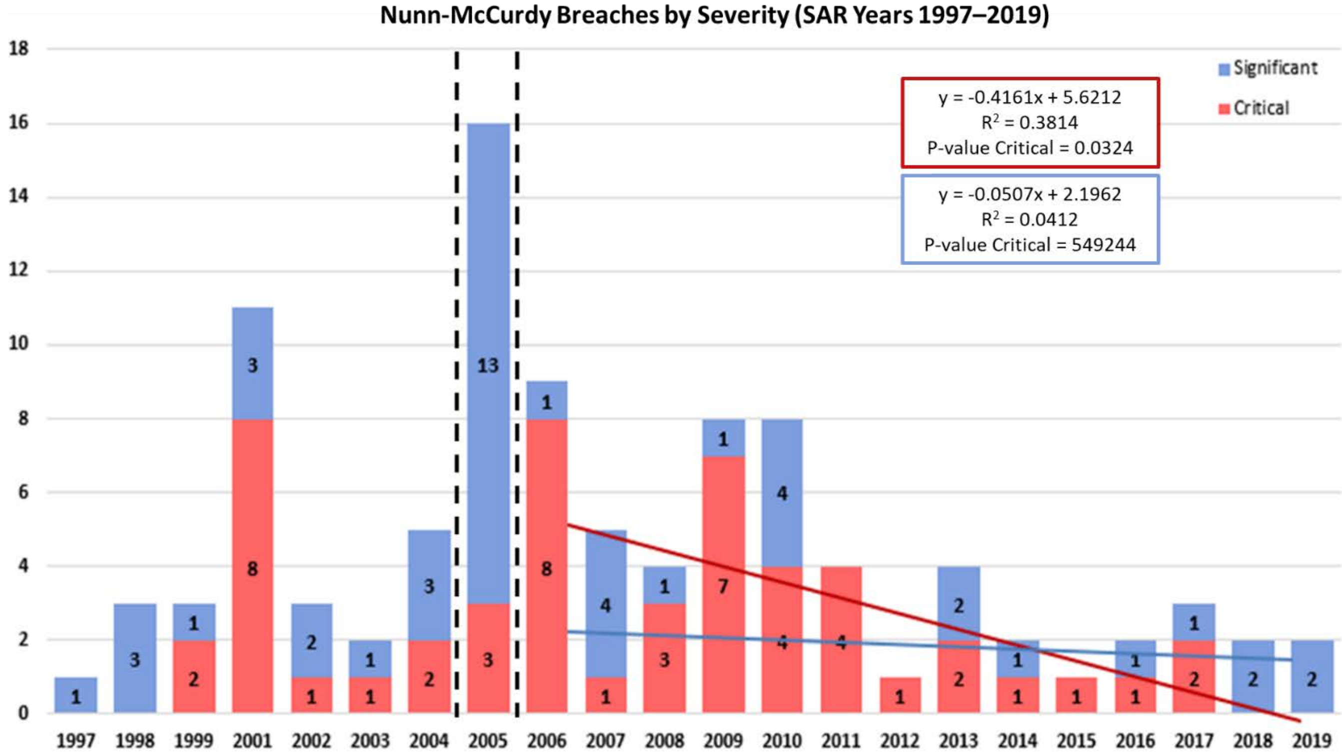
c Breach resulted from a decision to terminate procurement phase; Engineering, Manufacturing and Development (EMD) units were completed.

d DoD did not submit a December 2008 SAR to Congress. The VH-71 breach was reported in the March 2009 SAR, but the breach occurred in the 2008 reporting period.

e AAG was directed to report a critical Nunn-McCurdy breach in the FY 2017 NDAA using their FY 2009 ACAT II APB as the original estimate. The out-of-cycle Nunn-McCurdy SAR was submitted on May 15, 2017 but is not used as the initial SAR for the program.

f Breach resulted from a quantity reduction.

Figure 1. Nunn-McCurdy Breaches by Severity (SAR Years 1997–2019)

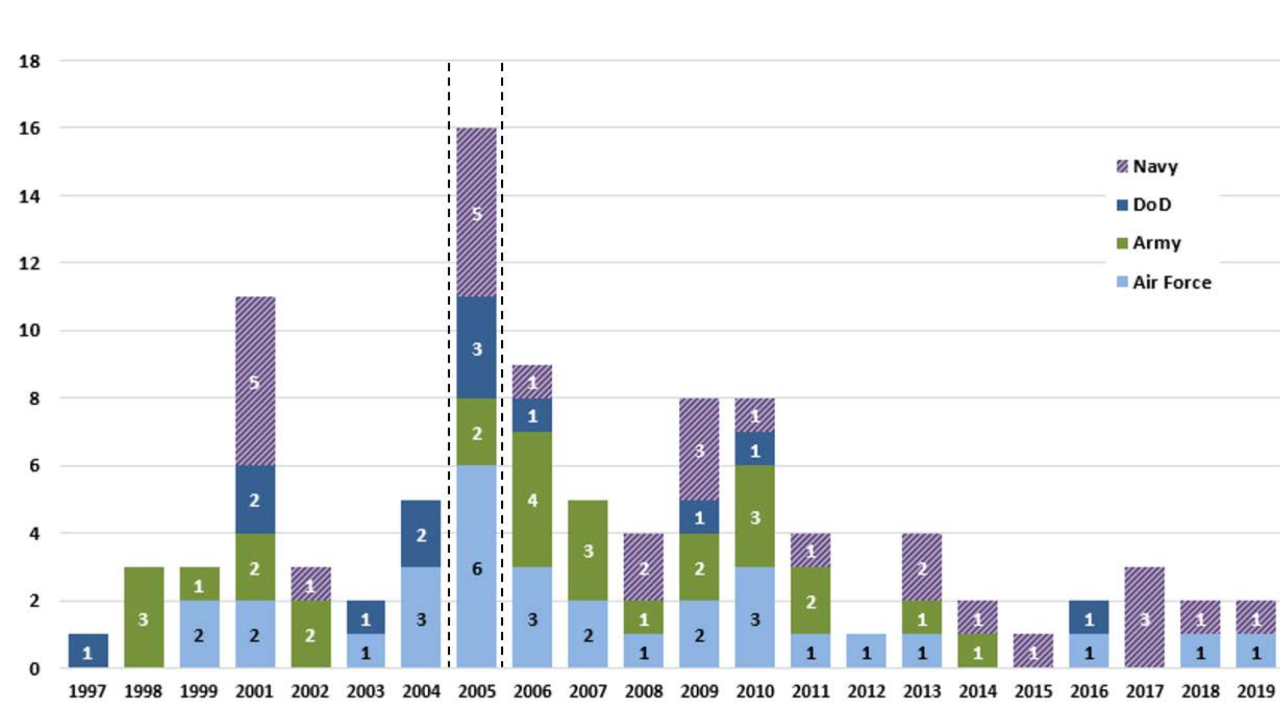


NOTE: The criteria for breaches were changed in NDAA 2006, so the counts before 2005 are different than those since 2006. 2005 was a transition year and is not comparable to the years before or after the enactment of the 2006 NDAA. Breaches are determined using "base- year" dollars (i.e., adjusting for inflation). This plot includes the number of breaches in each annual SAR cycle, which nominally equates to calendar year but may include updates early in the following calendar year from the President's Budget Request. Breaches in different years for different thresholds or baselines for the same program are included in each respective year. If a program reported both a significant and critical breach in the same year, only one breach is shown here. Nunn-McCurdy breaches are decreasing, with critical Nunn-McCurdy breaches decreasing at a faster rate than significant Nunn-McCurdy breaches since 2006. The critical Nunn-McCurdy breach trend line (red) is statistically significant while there is no trend in significant breaches from 2006–2019(the blue line). This suggests that the Department is doing a better job at preventing critical breaches since 2006. There is also a statistically significant downward trend in the combined number of critical and significant breaches.

2.1 Breaches by Component

One measure of acquisition program cost performance is the Nunn-McCurdy breach rate by DoD Component. In this analysis, "DoD" programs are programs categorized as such in the SARs, which include joint programs and programs (such as Chem Demil) overseen by an organization other than the Air Force, Army, or Navy.[7] Figure 1and 2 show significant and critical Nunn-McCurdy breach numbers year-by-year from 1997 through 2018. Figure 1 shows Nunn-McCurdy breaches by severity, whereas Figure 2 shows Nunn-McCurdy breaches by service. These charts align with the DoD official breach list (Table 1). The Air Force's SDB II and the Navy's AGM-88E AARGM programs are the two 2019 breaches.

Figure 2. Nunn-McCurdy Significant and Critical Breaches by DoD Component (SAR Years 1997–2019)



NOTE: The criteria for breaches were changed in NDAA 2006, so the counts before 2005 are different than those since 2006. 2005 was a transition year and is not comparable to the years before or after the enactment of the 2006 NDAA. Breaches are determined using "base- year" dollars (i.e., adjusting for inflation). This plot includes the number of breaches in each annual SAR cycle, which nominally equates to calendar year but may include updates early in the following calendar year from the President's Budget Request. Breaches in different years for different thresholds or baselines for the same program are included in each respective year. If a program reported both a significant and critical breach in the same year, only one breach is shown here.

[7] This analysis attributed programs to the same DoD Component as USD(AT&L) (2016). Additionally, the following Navy programs released their first SAR in 2016 or 2017: AAG, ACV 1.1, IRST, NGJ Inc 1, OASuW Inc 1 (LRASM), T-AO 205 Class, and SSBN 826. The following Army programs released their first SAR in 2016 or 2017: M88A2 HERCULES, CH-47F Block II, and CIRCM. The following Air Force programs released their first SAR in 2016: B-2 DMS-M, F-15 EPAWSS, and MGUE Inc 1.

Table 2 summarizes a different analysis of Nunn-McCurdy breaches by DoD Component. Here we do not "double count" programs that have breached multiple times. This allows us to get a sense of the tendency of programs to breach within each DoD Component. All breaches are listed regardless of cause. If a program had both a significant and a critical breach, it was included only in the "programs with critical breach" column.

Historically, about a third of MDAPs had at least a significant cost breach (and conversely, about two-thirds of the MDAPS have cost growth below 15 percent). Also, almost two-thirds of programs that breach at any level had a critical breach (i.e., fewer remain at the significant level), except for Army programs, which are more evenly split between significantly and critically breaching programs.

Table 2. Nunn-McCurdy Breach Rate by DoD Component (SAR Years 1997–2019)

Component	Total # Programs	# Programs that Ever Breached	Breach Rate	# Programs with at Most a Significant Breach	# Programs with a Critical Breach
DoD	12	6	50%	1	5
Army	61	18	30%	8	10
Navy	74	23	31%	9	14
Air Force	65	18	28%	5	13
Total	**212**	**65**	**31%**	**23**	**42**

NOTE: The analysis used DoD's December 31, 2019 official list of Nunn-McCurdy breaches. If a program had both a significant and critical breach, it was included only in the "# Programs with a Critical breach" column. Breaches are determined using "base-year" dollars (i.e., adjusted for inflation). This table includes all DoD programs that released a SAR with funding information during the time period and does not control for program maturity.

2.2 Breaches by Commodity

Table 3 below summarizes Nunn-McCurdy breaches by commodity.[8] As above, we do not "double count" programs that have breached multiple times. This allows us to compare the types of programs that have poor cost-growth performance (as evidenced by crossing any Nunn-McCurdy threshold) to those that have never breached during this period. All breaches are listed regardless of cause. If a program had both a significant and a critical breach, it was included only in the "programs with critical breach" column.

Table 3. Fraction of MDAPs by Commodity Type with Any Nunn-McCurdy Breach (SAR Year 1997–2018)

Commodity Type	Total # of Programs	# of Programs That Ever Breached	Breach Rate	# of Programs with at Most a Significant Breach	# of Programs With At Least One Critical Breach
Chem Demilitarization	4	4	100%	1	3
Space Launch	1	1	100%	—	1
Helicopter	20	10	50%	5	5
Fixed-Wing Aircraft	29	10	34%	3	7
Satellite	15	5	33%	1	4
UAV	7	2	29%	—	2
Munition/Missile	34	10	29%	4	6
Ship/Submarine	23	6	26%	3	3
C4ISR	57	13	23%	4	9
Ground Vehicle	14	3	21%	2	1
Missile Defense	8	1	13%	—	1
Total	**212**	**65**	**31%**	**23**	**42**

NOTE: The table compares number of programs that have crossed any Nunn-McCurdy threshold to those that have never crossed a threshold. Breaches are determined using "base-year" dollars (i.e., adjusted for inflation). This table includes all DoD programs that released a SAR with funding information during the time period and does not control for program maturity.

[8] This analysis uses the same commodity types as USD(AT&L) (2016).

3. Cost-Growth Performance: Development

3.1 Program Development Funding Growth: Cumulative

We now examine MDAP development cost-growth performance at the program level, using RDT&E funding growth as the metric (rather than PAUC or APUC). Program "cost" is synonymous with the total amount of funding because it reflects the prices paid on contracts as well as program execution costs. Generally, RDT&E must be funded regardless of how many units are produced. In that sense, they are a fixed cost regardless of quantity for the DoD to arrive at the point where it can procure and field a capability. Thus, for RDT&E, we track total funding growth rather than by unit produced to avoid confusing the effects of even small quantity changes with growth in RDT&E. Since we measure growth compared to initial baselines, this measure can show significant increases when a program originally was planned to involve little RDT&E but received even modest additions to address changing threats or operational needs. Still, this approach provides a means for measuring total RDT&E funding control relative to original plans.

A primary reason for systematically measuring our performance is to determine objectively if we are improving. On the one hand, recent programs and contracts naturally have less cost and schedule growth because they are newer and have had less time to realize any growth. On the other hand, waiting until they are complete will take many years—sometimes decades.

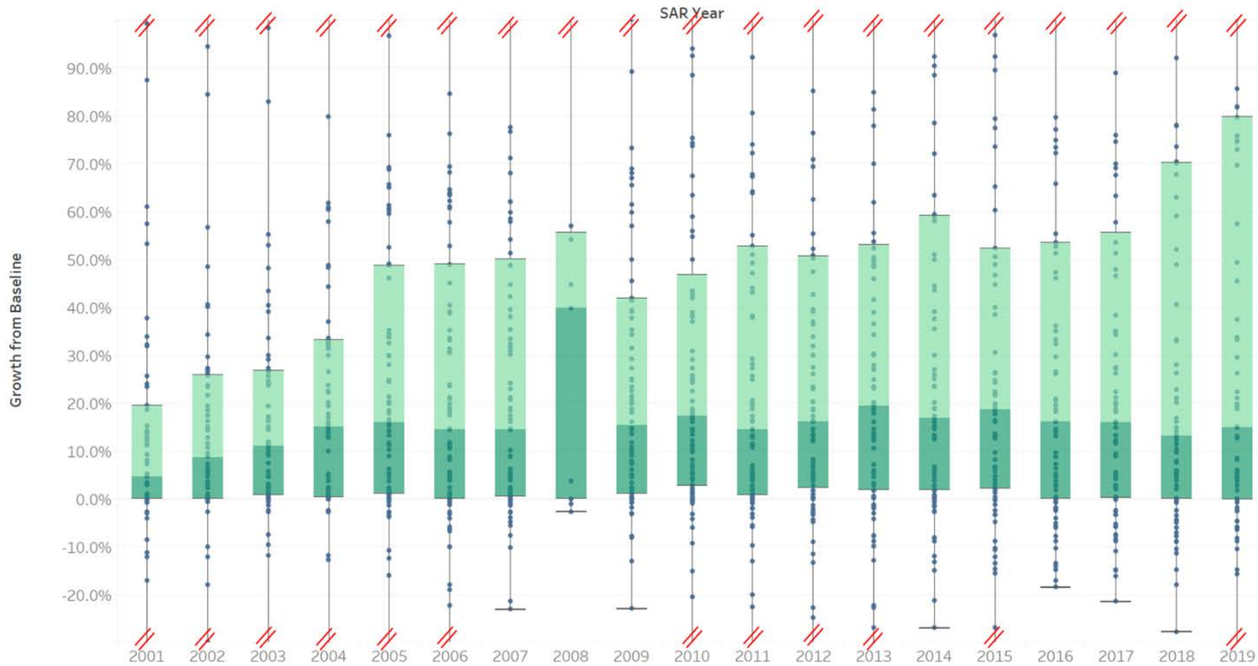
Rather than wait for the completion of programs before measuring their performance, we take the middle ground of controlling for immature programs in this set of analyses. The cost analysis community generally has found that programs and contracts with large cost or schedule growth will begin reflecting it in their estimates by the time they have executed about 30 percent of their originally planned schedule. Thus, analyses in this report that control for maturity exclude newer programs that have not yet reached this point. This, of course, is not the final word, but it does allow us to reflect much of the anticipated performance problems and get a reasonable sense of recent performance.

Figure 3 shows total cumulative RDT&E funding growth over original MS B baseline for each year's MDAP portfolio.[9] This is the most conservative measure, since it ignores any revised baselines set after Nunn-McCurdy breaches. For each analysis, we first show the main portion of the distribution (between −30 percent and +100 percent growth) followed by a table showing the top five outliers for each year. The boxes show the inner-quartiles between the 25th percentile and then 75th percentile. Medians are the lines within each box. Plots that extend off the y-axis scale are indicated with red double-slashes. Please note that 2008 should be considered an outlier because not all active programs submitted SARs that year (due to a new Presidential administration). However, we include the few SARs that were submitted in 2008 for transparency. Notably, the data show considerable (and sometimes seemingly conflicting) differences between the medians and the averages (arithmetic means). This is because the data are highly skewed, and a single but very large outlier can have a large effect on the mean while not affecting the median.[10] In these cases, the best measure of central tendency is the median.

[9] Analysis was generally done at the subprogram level. Notable exceptions include the F-35 program for which the aircraft and engine data were combined as they were in USD(AT&L) (2016) and the Chem Demil-ACWA program for which the Pueblo and Blue Grass subprograms, which began filing separate SARs in 2017, were combined to provide continuity.

[10] Part of the skewing in the distribution of cost change is the mathematical boundary on cost change because cost cannot decrease more than 100 percent but can increase more than 100 percent.

Figure 3. Development Cumulative Cost Growth:
Growth Over Original MS B Baseline of Active MDAP Planned Total (From Start to Completion)
RDT&E Funding: Program Basis (Controlled for Maturity; SAR Years 2001–2019)



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Count (RDTE C..	67	66	69	72	78	89	87	11	92	96	90	85	81	82	79	83	82	83	80
Median (RDTE ..	4.62%	8.68%	11.02%	15.01%	16.03%	14.42%	14.52%	39.83%	15.34%	17.34%	14.48%	16.14%	19.48%	16.80%	18.66%	16.09%	15.94%	13.15%	14.93%
IQR (RDTE Cum..	19%	26%	26%	33%	47%	49%	50%	56%	41%	44%	52%	48%	51%	57%	50%	53%	54%	70%	79%

NOTES: This shows total RDT&E funding growth independent of procurement funding and quantity changes; it reflects any work-content changes. These are percentage changes after adjusting for inflation from the original MS B baseline of actual past and estimated future funding as reported in each program's latest SAR.[11] We use the first SAR present in the Defense Acquisition Management Information Retrieval (DAMIR) system within the Defense Acquisition Visibility Environment (DAVE) dated after the program achieved MS B as the original MS baseline. Relatively new programs that have not completed at least 30 percent of their original EMD schedule are not shown. Boxes show first quartile, median, and third quartile; bars show first and third quartiles, minimum, and maximum. The IQR is the difference between the 75th and 25th percentiles.

Cost growth up to and including 2019 has been statistically flat since the earlier years of 2001–2003, when the set of MDAPs active at that time had lower total RDT&E funding growth at the median.[12]

[11] For all of the development cost growth analyses, we adjusted for inflation using RDT&E deflators in the FY21 Green Book from the Under Secretary of Defense (Comptroller), Table 5-5, p. 60-61.

[12] We used a Mann-Whitney test with a significance cutoff of 0.05 to compare the full "program basis" distributions (excluding immature programs) for each pair of years.

Figure 4. Development Cumulative Cost Growth:
Five Largest Outliers by Year (Controlled for Maturity; SAR Years 2001–2019)

	1	2	3	4	5
2019	C-130J (3091.5%)	GMLRS/GMLRS AW (1167.7%)	AIM-9X Blk II (255.9%)	MIDS (193.0%)	NSSL (191.8%)
2018	C-130J (3138.3%)	GMLRS/GMLRS AW (1132.1%)	AIM-9X Blk II (348.9%)	NSSL (190.1%)	MIDS (174.7%)
2017	C-130J (2930.9%)	GMLRS/GMLRS AW (1166.7%)	AIM-9X Blk II (234.4%)	MIDS (168.0%)	Chem Demil-ACWA [Pueblo (PCAPP)] (161.0%)
2016	C-130J (2834.0%)	GMLRS/GMLRS AW (1179.8%)	AIM-9X Blk II (194.4%)	MIDS (164.0%)	UH-60M Black Hawk (160.9%)
2015	C-130J (2889.4%)	GMLRS/GMLRS AW (861.4%)	SBIRS High [Baseline (GEO 1-4, HEO 1-2, and Ground)] (229.3%)	AIM-9X Blk II (211.8%)	UH-60M Black Hawk (160.9%)
2014	C-130J (2902.1%)	MH-60S (849.4%)	GMLRS/GMLRS AW (840.8%)	RQ-4A/B Global Hawk (251.4%)	SBIRS High [Baseline (GEO 1-4, HEO 1-2, and Ground)] (229.2%)
2013	C-130J (3016.0%)	MH-60S (849.4%)	GMLRS/GMLRS AW (840.1%)	RQ-4A/B Global Hawk (251.2%)	SBIRS High [Baseline (GEO 1-4, HEO 1-2, and Ground)] (229.1%)
2012	C-130J (3110.6%)	MH-60S (865.1%)	GMLRS/GMLRS AW (778.4%)	RQ-4A/B Global Hawk (235.2%)	SBIRS High [Baseline (GEO 1-4, HEO 1-2, and Ground)] (230.3%)
2011	C-130J (3317.0%)	MH-60S (858.2%)	GMLRS/GMLRS AW (783.7%)	RQ-4A/B Global Hawk (237.8%)	SBIRS High [Baseline (GEO 1-4, HEO 1-2, and Ground)] (232.1%)
2010	C-130J (3131.9%)	MH-60S (807.6%)	GMLRS/GMLRS AW (718.9%)	RQ-4A/B Global Hawk (314.0%)	SBIRS High [Baseline (GEO 1-4, HEO 1-2, and Ground)] (240.9%)
2009	C-130J (3435.1%)	MH-60S (793.8%)	GMLRS/GMLRS AW (745.1%)	RQ-4A/B Global Hawk (250.8%)	SBIRS High [Baseline (GEO 1-4, HEO 1-2, and Ground)] (217.8%)
2008	MH-60S (675.5%)	H-1 Upgrades (161.1%)	AEHF [AEHF SV 1-4] (57.0%)	Chem Demil-ACWA [Pueblo (PCAPP)] (54.0%)	FBCB2 (44.8%)
2007	C-130J (3548.9%)	MH-60S (675.5%)	GMLRS/GMLRS AW (587.9%)	RQ-4A/B Global Hawk (231.4%)	SBIRS High [Baseline (GEO 1-4, HEO 1-2, and Ground)] (185.8%)
2006	C-130J (3613.8%)	MH-60S (665.8%)	GMLRS/GMLRS AW (596.3%)	RQ-4A/B Global Hawk (239.4%)	SBIRS High [Baseline (GEO 1-4, HEO 1-2, and Ground)] (164.6%)
2005	C-130J (2242.6%)	MH-60S (641.4%)	GMLRS/GMLRS AW (433.6%)	RQ-4A/B Global Hawk (202.7%)	SBIRS High [Baseline (GEO 1-4, HEO 1-2, and Ground)] (173.4%)
2004	C-130J (2254.3%)	MH-60S (651.1%)	GMLRS/GMLRS AW (445.1%)	SBIRS High [Baseline (GEO 1-4, HEO 1-2, and Ground)] (155.2%)	UH-60M Black Hawk (145.9%)
2003	C-130J (2011.7%)	GMLRS/GMLRS AW (461.4%)	MH-60S (448.2%)	RQ-4A/B Global Hawk (157.7%)	SBIRS High [Baseline (GEO 1-4, HEO 1-2, and Ground)] (120.7%)
2002	C-130J (2078.7%)	MH-60S (447.7%)	RQ-4A/B Global Hawk (139.5%)	SBIRS High [Baseline (GEO 1-4, HEO 1-2, and Ground)] (120.9%)	GMLRS/GMLRS AW (112.1%)
2001	GMLRS/GMLRS AW [Launcher] (1194.4%)	MH-60S (267.6%)	GMLRS/GMLRS AW (113.2%)	CVN 68 [CVN-77] (106.8%)	SBIRS High [Baseline (GEO 1-4, HEO 1-2, and Ground)] (99.1%)

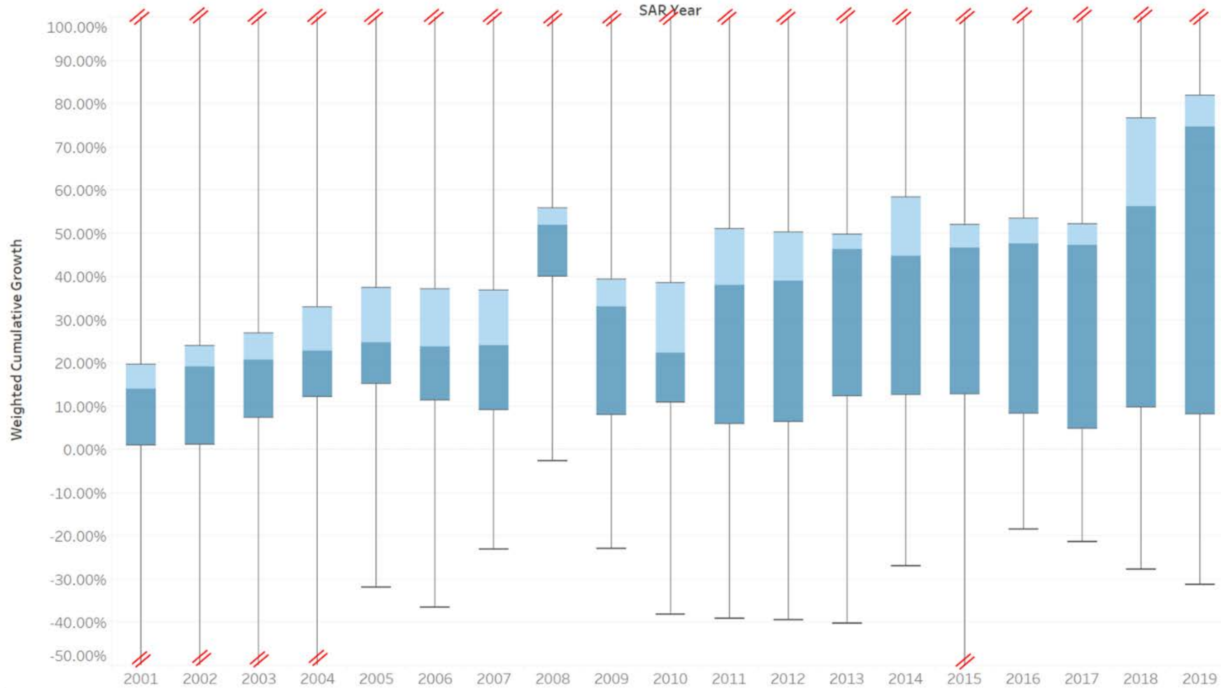
All of the outliers have very large growth percentages but are not representative of the overall MDAP portfolio. These extreme growths are not due to measurement error and so were not excluded from the analysis. Still, they do skew the aggregate data, which is an important fact for determining how to measure and discuss funding growth across a program population. Similar skewing is observed in various complex commercial projects (see, for example, Flyvbjerg et al., 2002).

Understanding why a program may exhibit such a large percentage increase in RDT&E funding requires an individual examination of each case. For example, in Figure 4, the C-130J remains the highest outlier since 2002. This program originally was envisioned as a non-developmental aircraft acquisition with a negligible RDT&E effort planned. Several years into the program, a decision was made to install the Global Air Traffic Management system, adding several hundred million dollars to development and causing the total development funding growth to climb towards 3,000 percent. This is an example of a major change in the program rather than poor execution, although significant program changes like this are not necessarily the reason for all extreme cases of funding growth.

In contrast to the results on a program basis, Figure 5 shows results on a dollar basis (i.e., weighted by program size in dollars).[13] As with the other analyses in this section, we controlled for maturity by removing programs that had not executed at least 30 percent of their original EMD schedule. Here, median growth has been trending upwards since 2001. In other words, larger programs (in terms of spending) have systematically larger total RDT&E funding growth, and that growth has been increasing. The F-35, for example, constitutes about 26 percent of the dollars in the current MDAP portfolio and thus has a large effect when weighted by program size (dollar basis). As the F-35 total RDT&E funding growth is above the median of the rest of the portfolio, it pulls the dollar-weighted median upwards. Also remember that here we are measuring growth against the original MS B baselines independent of any revised original baselines (due to program reconfigurations from Nunn-McCurdy breaches).

[13] We weighted each program's development cost growth by the size of the program's actual and planned RDT&E funding.

Figure 5. Development Cumulative Cost Growth (Weighted by Program Size in Dollars): Growth Over Original MS B Baseline of Active MDAP Planned Total (From Start to Completion) RDT&E Funding: Dollar Basis (Controlled for Maturity; SAR Years 2001–2019)

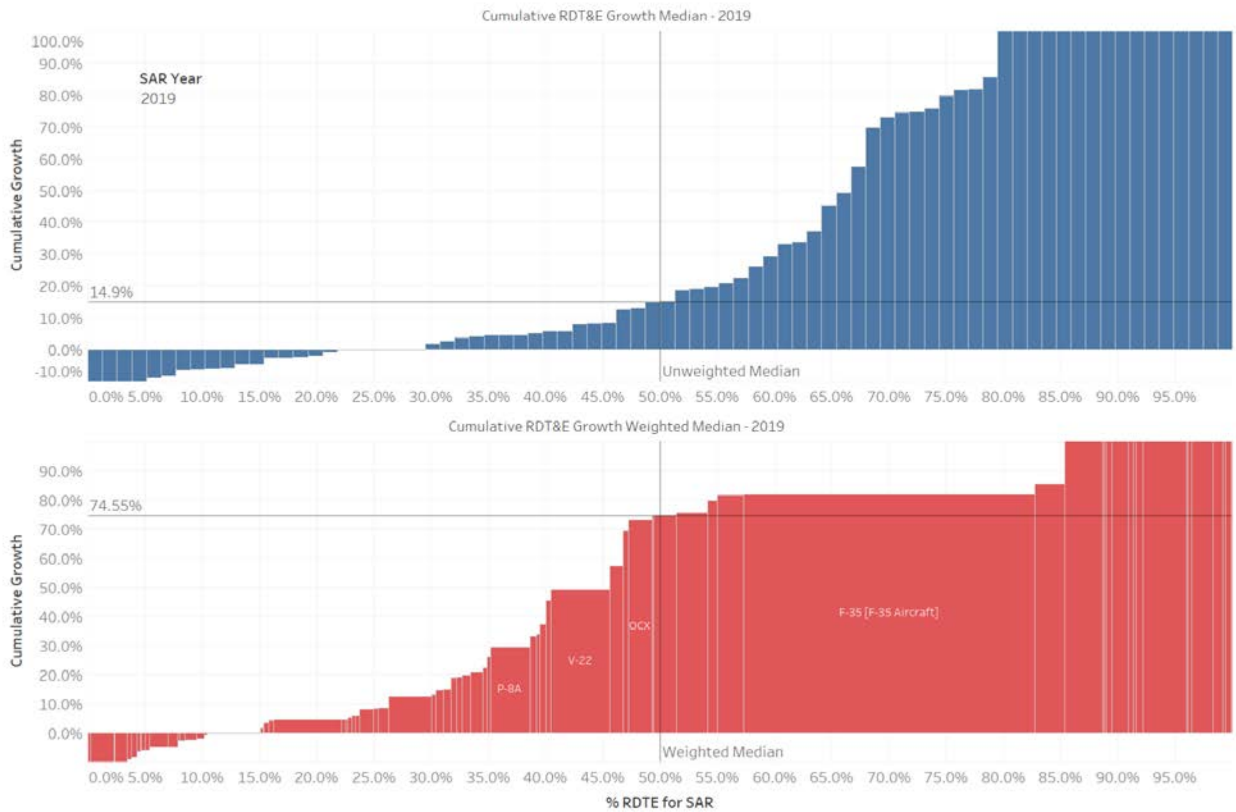


	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Median (RDTE..	13.89%	19.03%	20.67%	22.69%	24.67%	23.77%	24.06%	51.93%	32.93%	22.29%	37.98%	38.86%	46.20%	44.67%	46.58%	47.59%	47.30%	56.13%	74.55%
IQR	18.8%	23.0%	19.5%	20.8%	22.2%	25.7%	27.7%	15.8%	31.4%	27.6%	45.1%	43.8%	37.5%	45.7%	39.1%	45.1%	47.3%	67.0%	73.8%

NOTES: This shows total RDT&E funding growth independent of procurement funding and quantity changes; it reflects any work-content changes. These are percentage changes after adjusting for inflation from the original MS B baseline of actual past and estimated future funding as reported in each program's latest SAR. We use the first SAR present in the DAVE/DAMIR system dated after the program achieved MS B as the original MS baseline. Relatively new programs that have not completed at least 30 percent of their original EMD schedule are not shown. Boxes show first quartile, median, and third quartile; bars show first and third quartiles, minimum, and maximum. The IQR is the difference between the 75th and 25th percentiles.

To illustrate the difference between the median (14.9%) and weighted median (74.6%) for the 2019 SARs, the top chart on Figure 6 shows the 80 programs included in our RDT&E growth analysis, weighted equally. However, when each program's bar width is relative to the program's RDT&E funding, we see that larger programs 'push' the median higher. The program with the most RDT&E funding, the F-35, takes up about 26 percent of all RDT&E funding.

Figure 6. Development Cumulative Cost Growth:
Growth Over Original MS B Baseline of Active MDAP Planned Total (From Start to Completion)
Program Basis vs. Dollar Basis (2019)

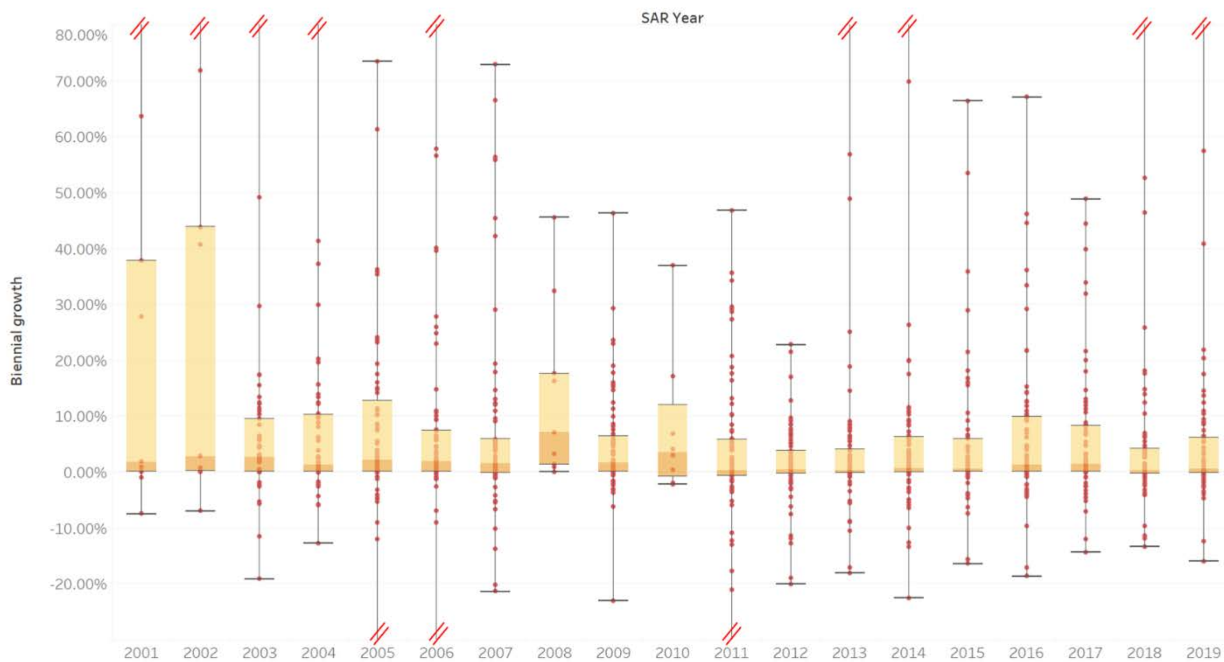


3.2 Program Development Funding Growth: Biennial

While examining total RDT&E funding from each program's original baseline estimate is important to capture the overall growth since inception, it may not be the best choice for gaining insight into recent cost-growth management. When we analyze a program from inception, we are forced to carry all growth until the program or phase of the program ceases to be active. Programs currently executing well but that had a one-time increase in the distant past can appear to be poor performers in the long term. Therefore, we also measure biennial changes in total planned and actual RDT&E funding.

Figure 7 shows the "marginal" cost growth when examining biennial changes in total (past plus planned) RDT&E funding growth on a program basis. The biennial growth increased slightly from 0.22% in 2018 to 0.47% in 2019. Figure 9 shows an increase from 3.65% in 2018 to 4.27% in 2019 for biennial cost growth when programs are weighted by size in dollars. This suggests that larger programs are experiencing higher biennial cost growth than smaller programs of late. The 2019 results (p-value= 0.322) are not statistically different from 2018 on a program basis.[14]

Figure 7. Development Biennial Cost Growth: Biennial Change in Active MDAP Planned Total (From Start to Completion) RDT&E Funding: Program Basis (Controlled for Maturity; SAR Years 2001–2019)



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Count (RDTE ..	9	9	54	56	59	64	70	9	72	8	77	70	70	71	66	67	64	70	69
Median (RDTE..	1.78%	2.80%	2.62%	1.24%	2.18%	1.83%	1.50%	7.08%	1.66%	3.48%	0.20%	0.40%	0.24%	0.69%	0.55%	1.26%	1.42%	0.22%	0.47%
IQR (RDTE Bie..	38%	44%	9%	10%	13%	7%	6%	16%	6%	10%	7%	4%	4%	6%	6%	10%	8%	4%	6%

NOTE: This figure shows biennial changes in total RDT&E funding growth independent of procurement funding and quantity changes; it reflects any work-content changes. These are percentage changes after adjusting for inflation from the original MS B baseline of actual past and estimated future funding as reported in each program's latest SAR. Relatively new programs that have not completed at least 30 percent of their original EMD schedule are not shown. Boxes show first quartile, median, and third quartile; bars show first and third quartiles, minimum, and maximum. The IQR is the difference between the 75th and 25th percentiles.

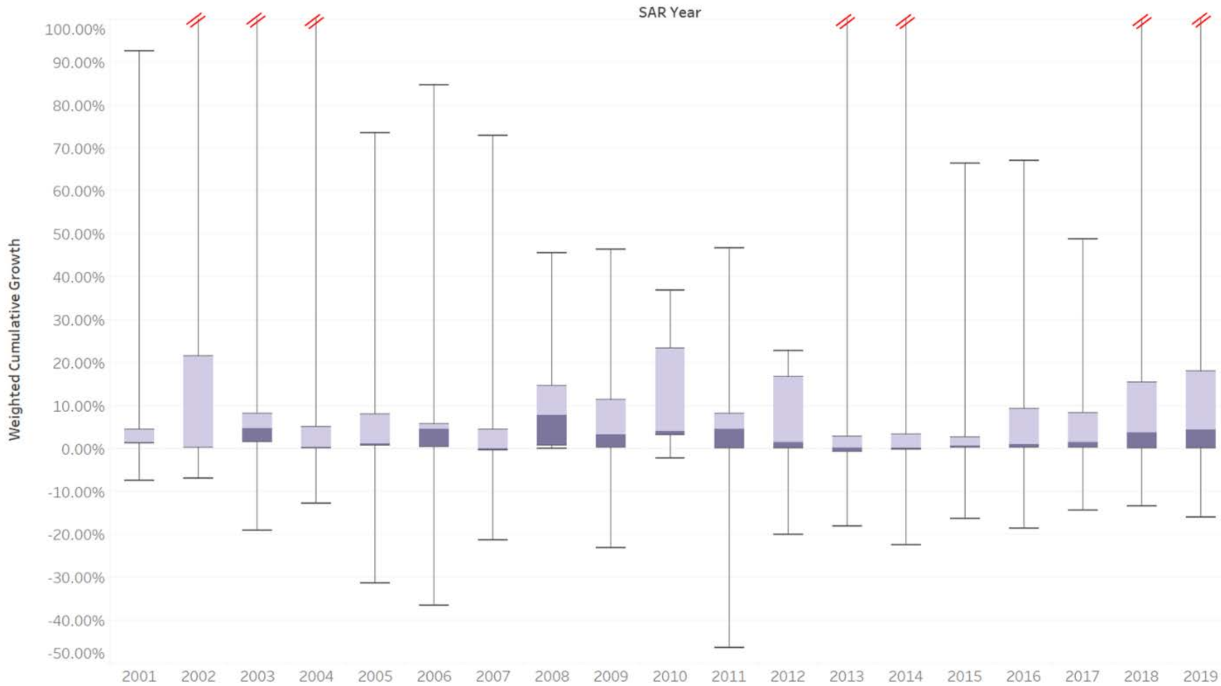
[14] We used a Mann-Whitney test with a significance cutoff of 0.05 to compare the biennial "program basis" distributions (excluding immature programs) for 2016 to 2018 and 2017 to 2019.

Figure 8 shows the five largest programs with biennial changes in planned and actual RDT&E funding, controlling for program maturity. This includes outliers that are off the chart in Figure 7. Note the high turnover in the largest biennial changes in RDT&E growth. This indicates that these programs are experiencing RDT&E growth in bursts rather than consistently high growth over time.

Figure 8. Development Biennial Cost Growth:
Five Largest Outliers by Year (Controlled for Maturity; SAR Years 2001–2019)

	1	2	3	4	5
2019	LPD 17 (124.29%)	ACV FoV (57.42%)	JASSM [JASSM-ER] (40.72%)	NSSL (21.82%)	F-35 [F-35 Aircraft] (20.26%)
2018	LPD 17 (132.21%)	AIM-9X Blk II (52.50%)	IDECM [IDECM Block 4] (46.37%)	NSSL (25.69%)	JASSM [JASSM-ER] (18.06%)
2017	IDECM [IDECM Block 4] (48.80%)	JASSM [JASSM-ER] (44.34%)	OCX (39.71%)	MQ-4C Triton (33.86%)	GMLRS/GMLRS AW (31.76%)
2016	JASSM [JASSM-ER] (66.98%)	NSSL (46.12%)	OCX (44.52%)	GMLRS/GMLRS AW (36.03%)	MQ-4C Triton (33.29%)
2015	NSSL (66.33%)	AIM-9X Blk II (53.35%)	MQ-8 Fire Scout (35.77%)	NMT (28.89%)	OCX (21.39%)
2014	AIM-9X Blk II (140.38%)	MQ-8 Fire Scout (69.79%)	JPALS (26.20%)	NMT (19.97%)	NSSL (19.83%)
2013	AIM-9X Blk II (103.30%)	JPALS (56.78%)	MQ-9 Reaper (48.78%)	MQ-8 Fire Scout (25.03%)	E-2D AHE (18.84%)
2012	F-35 [F-35 Aircraft] (22.76%)	MIDS (21.46%)	E-2D AHE (16.91%)	FAB-T [FAB- T] (12.66%)	WIN-T Inc 3 (9.66%)
2011	AH-64E Remanufacture (46.71%)	STRYKER (35.48%)	HMS [HMS Radios] (34.21%)	FAB-T [FAB- T] (29.52%)	RMS (29.11%)
2010	Chem Demil-ACWA [Pueblo (PCAPP)] (36.86%)	MH-60S (17.04%)	CHEM DEMIL-CMA [CHEM DEMIL- CMA] (6.78%)	AEHF [AEHF SV 1-4] (4.01%)	H-1 Upgrades (2.94%)
2009	Patriot/MEADS CAP [Missile] (46.27%)	LHA 6 (29.22%)	WGS (23.52%)	GMLRS/GMLRS AW (22.85%)	JTRS GMR (18.87%)
2008	CHEM DEMIL-CMA [CHEM DEMIL- CMA] (45.49%)	ARH (32.37%)	H-1 Upgrades (17.54%)	AEHF [AEHF SV 1-4] (16.17%)	C-5 RERP (7.08%)
2007	Chem Demil-ACWA [Pueblo (PCAPP)] (72.84%)	SSDS [SSDS MK 2 P3I] (66.37%)	NAVSTAR GPS [USER EQUIPMENT] (56.20%)	C-130J (55.77%)	CHEM DEMIL-CMA [CHEM DEMIL- CMA] (45.28%)
2006	WIN -T (84.57%)	C-130J (57.75%)	JTN (56.47%)	RQ-4A/B Global Hawk (40.05%)	NPOESS (39.48%)
2005	UH-60M Black Hawk (73.42%)	NPOESS (61.26%)	WGS (36.22%)	MIDS (35.80%)	MH-60S (35.25%)
2004	GMLRS/GMLRS AW (157.01%)	UH-60M Black Hawk (133.43%)	WGS (41.24%)	MH-60S (37.13%)	MIDS (29.86%)
2003	C-130J (2011.70%)	GMLRS/GMLRS AW (163.32%)	MH-60S (49.12%)	WGS (29.61%)	CEC (17.37%)
2002	MH-60S (146.30%)	CVN 68 [CVN-77] (71.71%)	MH-60R (43.77%)	FBCB2 (40.56%)	B-1B CMUP [Computer Upgrade] (2.80%)
2001	CVN 68 [CVN-77] (92.59%)	MH-60S (63.53%)	FBCB2 (37.74%)	MH-60R (27.69%)	F/A-18E/F (1.78%)

Figure 9. Development Biennial Cost Growth (Weighted by Program Size in Dollars): Biennial Change in Active MDAP Planned Total (From Start to Completion) RDT&E Funding: Dollar Basis (Controlled for Maturity; SAR Years 2001–2019)



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
IQR	3.2%	21.4%	6.6%	5.0%	7.2%	5.3%	4.9%	13.8%	11.2%	20.2%	8.1%	16.6%	3.5%	3.5%	2.5%	9.0%	8.0%	15.2%	17.8%
Median (RDTE..	1.43%	0.07%	4.60%	0.23%	1.09%	4.42%	0.00%	7.74%	3.20%	3.92%	4.41%	1.48%	0.11%	0.17%	0.52%	0.95%	1.39%	3.65%	4.27%

NOTE: This figure shows biennial changes in total RDT&E funding growth independent of procurement funding and quantity changes; it reflects any work-content changes. These are percentage changes after adjusting for inflation from the original MS B baseline of actual past and estimated future funding as reported in each program's latest SAR. Relatively new programs that have not completed at least 30 percent of their original EMD schedule are not shown. Boxes show first quartile, median, and third quartile; bars show first and third quartiles, minimum, and maximum. The IQR is the difference between the 75th and 25th percentiles.

4. Cost-Growth Performance: Production

We now examine cost-related performance in production. Again, we are not using PAUC as a measure because the following approach allows us to better control for the biasing effect of any quantity changes.

4.1 Program Procurement Cost Growth (Quantity Adjusted): Cumulative

The following figures summarize the unit procurement funding growth across the MDAP portfolio from the original MS B baseline. These analyses use recurring unit flyaway funding data reported in the SARs and are adjusted for quantity changes since the MS B baseline. As with the development funding analysis, we exclude relatively immature programs that have not executed at least 30% of their original EMD schedule.

These program-level data are for measures that (unlike PAUC and APUC) are fully adjusted for any changes in procurement quantity. The results help compare procurement unit costs at the current quantities, extrapolating data if baseline quantities have been reduced or increased. This approach provides a way of comparing what the units would have cost at the current quantity by, essentially, measuring the shift in the procurement cost-versus-quantity curve from planned to actual.[15] In other words, we measure changes in procurement cost at the currently planned quantity to be purchased and assume that the original cost-quantity curve can be extrapolated to the current quantity. This approach allows us to examine on a unit basis the cost of the capability to acquire those units regardless of whether we increased or decreased quantity. Of course, quantity decreases may be due to unit-cost increases, and this approach will show such cost increases.

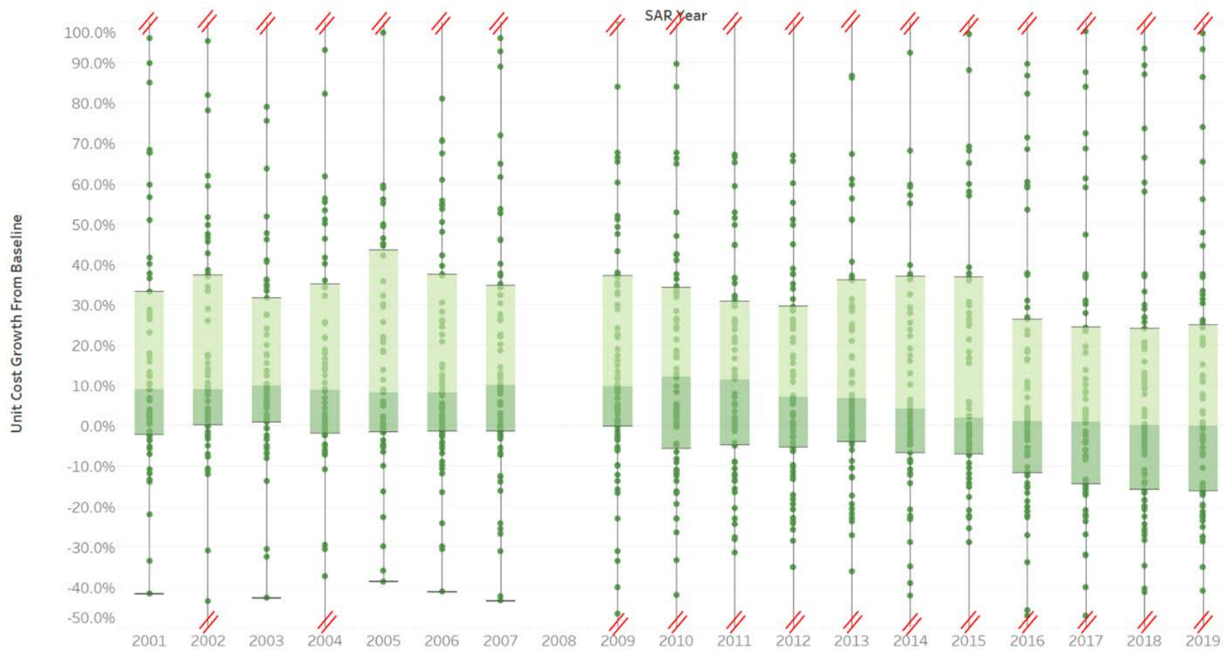
Similar to the prior RDT&E results, growth distributions in production are highly skewed, with arithmetic means higher than the medians. The overall magnitudes of production funding growth are not nearly as large as those for RDT&E. There also is considerable variability in the production funding growth across the MDAP portfolio.

To provide continuity, we combined the F-35 aircraft and engine data as we did for the development cost growth analysis.[16] Aside from the F-35, however, we continue to focus the analysis at the subprogram level.

[15] This basic approach for quantity adjustment is one of the standard techniques employed by the cost analysis community—see, for example, the discussions in Hough (1992), Arena et al. (2006, pp. 5–6), and Younossi et al. (2007, pp. 13-14).
[16] Starting in 2011, the SARs separated the F-35 aircraft and engine data to comply with statutory requirements.

Figure 10 shows quantity-adjusted procurement cumulative unit-funding growth over the original MS B baseline for each year's MDAP portfolio on a program basis (controlled for program maturity).[17] Median growth for 2019 remained near 0% —the lowest value measured in the analysis period. Overall, the growth throughout the portfolio has been statistically lower in 2016–2019 than any of the years from 2001–2010 (excluding 2008, which had too few SARs to provide a sufficient sample), and growth in 2019 was statistically lower than every year before 2014.[18]

Figure 10. Procurement Cumulative Cost Growth:
Growth Over Original MS B Baseline of Active MDAP Planned Total (From Start to Completion)
Quantity-Adjusted Unit-Procurement Recurring-Flyaway Funding:
Program Basis (Controlled for Maturity; SAR Years 2001–2019)



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Median (Procur..	8.9%	9.0%	9.9%	8.8%	8.2%	8.2%	10.0%	166.7%	9.7%	12.0%	11.5%	7.2%	6.7%	4.2%	2.0%	1.2%	0.9%	0.0%	-0.1%
Count (Procure..	65	66	68	68	70	81	79	1	84	84	77	77	74	74	73	78	78	77	75
IQR (Procurem..	34.3%	37.2%	30.8%	36.4%	44.4%	38.9%	36.0%	0.0%	37.1%	39.3%	35.6%	34.8%	38.8%	43.1%	43.9%	38.1%	38.5%	39.9%	41.1%

NOTE: The figure shows growth in unit recurring flyaway funding after adjusting for quantity changes; it is independent of RDT&E funding but reflects any work-content changes. These are percentage changes after adjusting for inflation and any quantity changes from the original MS B baseline of actual past and estimated needed future funding as reported in the programs' latest SARs.[19] Relatively new programs that have not completed at least 30 percent of their original EMD schedule are not included. Boxes show first quartile, median, and third quartile; bars show first and third quartiles, minimum, and maximum. The IQR is the difference between the 75th and 25th percentiles.

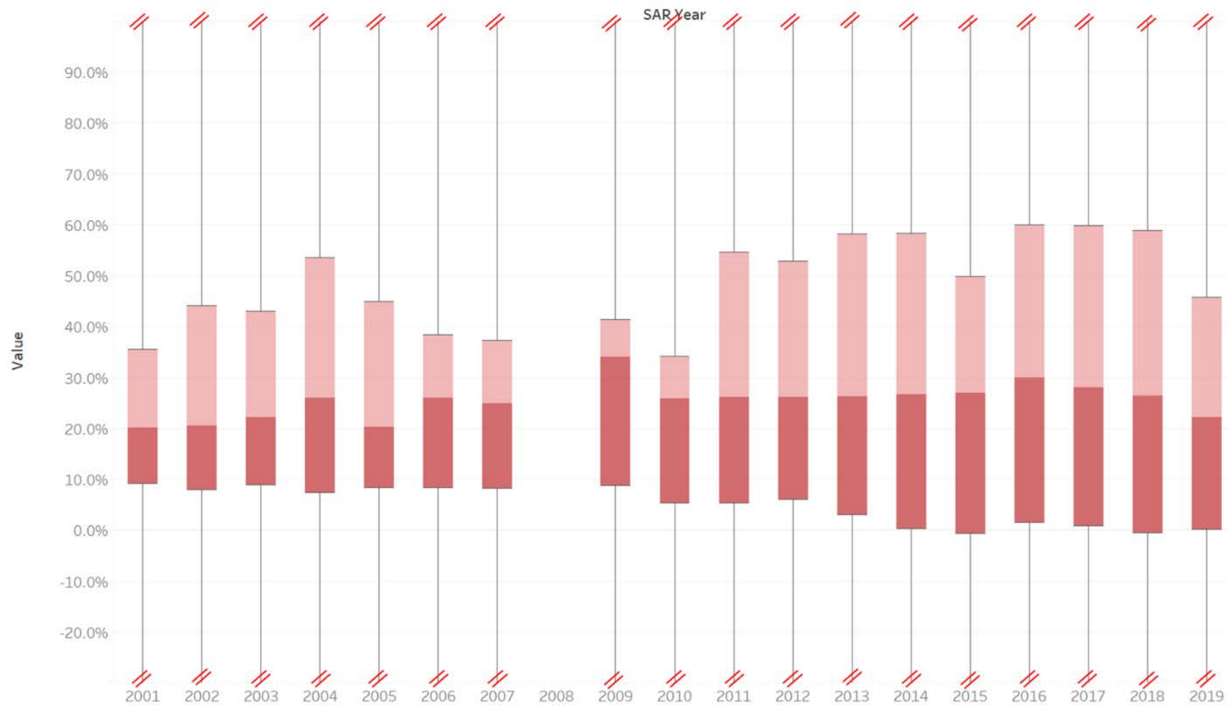
[17] We used the earliest post-MS B learning curve data available in DAVE/DAMIR as the baseline, regardless of whether it came from an APB, a SAR, or a SAR baseline.

[18] We used a Mann-Whitney test with a significance cutoff of 0.05 to compare the "program basis" distributions (excluding immature programs). We did not correct for multiple testing.

[19] For the procurement cost growth analyses, we adjusted for inflation using procurement deflators in the FY21 Green Book from the Under Secretary of Defense (Comptroller), Table 5-5, p. 60-61.

Figure 11 shows results on a dollar basis (i.e., weighted by program size in dollars).[20] Unlike on a program basis, cost growth on a dollar basis has been hovering near 25% in recent years. This indicates that larger programs (in terms of procurement spending) have systematically larger unit procurement cost growth than smaller programs.

Figure 11. Procurement Cumulative Cost Growth (Weighted by Program Size in Dollars): Growth Over Original MS B Baseline of Active MDAP Planned Total (From Start to Completion) Quantity-Adjusted Unit-Procurement Recurring-Flyaway Funding: Dollar Basis (Controlled for Maturity; SAR Years 2001–2019)



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Median (Weig..	20.1%	20.5%	22.1%	25.9%	20.2%	26.0%	24.8%	166.7%	34.0%	25.8%	26.1%	26.1%	26.3%	26.7%	27.0%	30.0%	28.0%	26.4%	22.1%
IQR	26.3%	36.1%	34.1%	46.0%	36.6%	30.0%	29.1%	0.0%	32.7%	28.8%	49.3%	46.9%	55.2%	58.0%	50.5%	58.5%	59.0%	59.4%	45.6%

NOTE: The figure shows growth in unit recurring flyaway funding after adjusting for quantity changes; it is independent of RDT&E funding but reflects any work-content changes. These are percentage changes after adjusting for inflation and any quantity changes from original the MS B baseline of actual past and estimated needed future funding as reported in the programs' latest SARs. Relatively new programs that have not completed at least 30 percent of their original EMD schedule are not included. Boxes show first quartile, median, and third quartile; bars show first and third quartiles, minimum, and maximum. The IQR is the difference between the 75th and 25th percentiles.

[20] We weighted each program's unit procurement cost growth by the size of the program's actual and planned recurring unit flyaway funding.

Figure 12 shows the top five outliers for each year since 2001. This chart is also controlled for program maturity.

Figure 12. Procurement Cumulative Cost Growth Outliers
Growth Over Original MS B Baseline of Active MDAP Planned Total (From Start to Completion)
Quantity-Adjusted Unit-Procurement Recurring-Flyaway Funding:
Program Basis Outliers (Controlled for Maturity; SAR Years 2001–2019)

	1	2	3	4	5
2019	NSSL (297.9%)	GMLRS/GMLRS AW (166.0%)	H-1 Upgrades (159.4%)	MQ-8 Fire Scout (97.2%)	CVN 78 [EMALS] (93.2%)
2018	NSSL (307.1%)	GMLRS/GMLRS AW (163.6%)	H-1 Upgrades (161.0%)	CVN 78 [EMALS] (93.3%)	MQ-8 Fire Scout (89.2%)
2017	NSSL (304.5%)	CH-47F (177.5%)	GMLRS/GMLRS AW (166.8%)	H-1 Upgrades (160.6%)	CVN 78 [EMALS] (97.6%)
2016	NSSL (302.0%)	AEHF [AEHF SV 1-4] (235.6%)	GMLRS/GMLRS AW (179.9%)	CH-47F (177.5%)	H-1 Upgrades (159.9%)
2015	NSSL (307.8%)	SBIRS High [Baseline (GEO 1-4, HEO 1-2, and Ground)] (267.0%)	AEHF [AEHF SV 1-4] (258.5%)	CH-47F (178.0%)	JPALS (176.8%)
2014	NSSL (314.5%)	SBIRS High [Baseline (GEO 1-4, HEO 1-2, and Ground)] (274.5%)	AEHF [AEHF SV 1-4] (257.7%)	JPALS (182.3%)	GMLRS/GMLRS AW (181.4%)
2013	NSSL (329.3%)	SBIRS High [Baseline (GEO 1-4, HEO 1-2, and Ground)] (297.4%)	AEHF [AEHF SV 1-4] (249.2%)	GMLRS/GMLRS AW (188.6%)	CH-47F (177.8%)
2012	NSSL (357.9%)	SBIRS High [Baseline (GEO 1-4, HEO 1-2, and Ground)] (325.9%)	AEHF [AEHF SV 1-4] (255.4%)	GMLRS/GMLRS AW (175.8%)	CH-47F (174.5%)
2011	SBIRS High [Baseline (GEO 1-4, HEO 1-2, and Ground)] (327.5%)	AEHF [AEHF SV 1-4] (278.7%)	CH-47F (174.1%)	GMLRS/GMLRS AW (170.2%)	H-1 Upgrades (153.5%)
2010	SBIRS High [Baseline (GEO 1-4, HEO 1-2, and Ground)] (362.0%)	AEHF [AEHF SV 1-4] (292.1%)	CH-47F (181.4%)	GMLRS/GMLRS AW (165.9%)	H-1 Upgrades (158.0%)
2009	SBIRS High [Baseline (GEO 1-4, HEO 1-2, and Ground)] (290.3%)	AEHF [AEHF SV 1-4] (280.2%)	H-1 Upgrades (181.8%)	CH-47F (176.4%)	GMLRS/GMLRS AW (165.7%)
2008	H-1 Upgrades (166.7%)				
2007	SBIRS High [Baseline (GEO 1-4, HEO 1-2, and Ground)] (392.2%)	NPOESS (279.1%)	CH-47F (170.8%)	GMLRS/GMLRS AW (165.5%)	EFV (112.7%)
2006	SBIRS High [Baseline (GEO 1-4, HEO 1-2, and Ground)] (478.6%)	NPOESS (277.1%)	GMLRS/GMLRS AW (191.6%)	NSSL (186.6%)	CH-47F (165.0%)
2005	SBIRS High [Baseline (GEO 1-4, HEO 1-2, and Ground)] (482.2%)	NPOESS (230.5%)	CH-47F (144.4%)	NSSL (132.0%)	GMLRS/GMLRS AW (119.5%)
2004	SBIRS High [Baseline (GEO 1-4, HEO 1-2, and Ground)] (156.0%)	CH-47F (139.1%)	NSSL (134.3%)	GMLRS/GMLRS AW (93.0%)	H-1 Upgrades (82.2%)
2003	CH-47F (116.0%)	NSSL (110.4%)	GMLRS/GMLRS AW (79.0%)	H-1 Upgrades (75.5%)	NAS (74.5%)
2002	ATACMS-BAT [ATACMS BLK II/IIA] (129.0%)	H-1 Upgrades (95.2%)	GMLRS/GMLRS AW (81.8%)	GBS (78.1%)	ATACMS-BAT [BAT/BAT P3I] (61.9%)
2001	ATIRCM/CMWS [ATIRCM/ CMWS] (225.8%)	CH-47F (96.0%)	ATACMS-BAT [ATACMS BLK II/IIA] (89.8%)	GBS (84.9%)	ATACMS-BAT [BAT/BAT P3I] (68.3%)

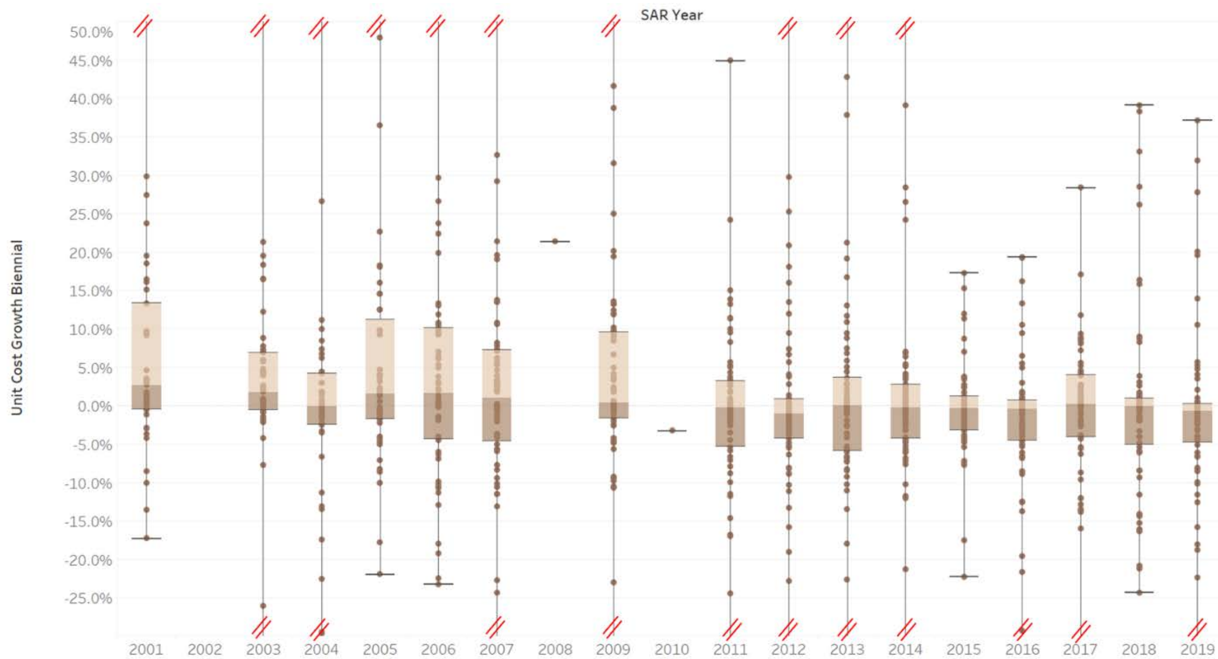
NOTE: This shows growth in unit recurring flyaway funding after adjusting for quantity changes; it is independent of RDT&E funding but reflects any work-content changes. These are percentage changes after adjusting for inflation and any quantity changes from the original MS B baseline of actual past and estimated needed future funding as reported in the programs' latest SARs. Relatively new programs that have not completed at least 30 percent of their original EMD schedule are not included.

4.2 Program Procurement Cost Growth (Quantity Adjusted): Biennial

Figure 13 shows biennial changes in total quantity-adjusted unit procurement funding (actual and planned), controlling for program maturity. The periods ending 2018-2019 have statistically lower biennial growth than the periods ending 2001–2009.[21] Biennial growth since 2011 has been fairly steady, hovering near 0 percent.

Figure 14 shows biennial changes in total quantity- adjusted unit procurement funding, but on a dollar basis.[22] On a dollar basis, the median growth from 2017 to 2019 was -0.5%, a slight decrease from the -0.1% median growth from 2015 to 2017.

Figure 13. Biennial Procurement Cost Growth: Biennial Change in Active MDAP Planned Total (From Start to Completion) Quantity-Adjusted Unit-Procurement Recurring-Flyaway Funding: Program Basis (Controlled for Maturity; SAR Years 2001–2019)



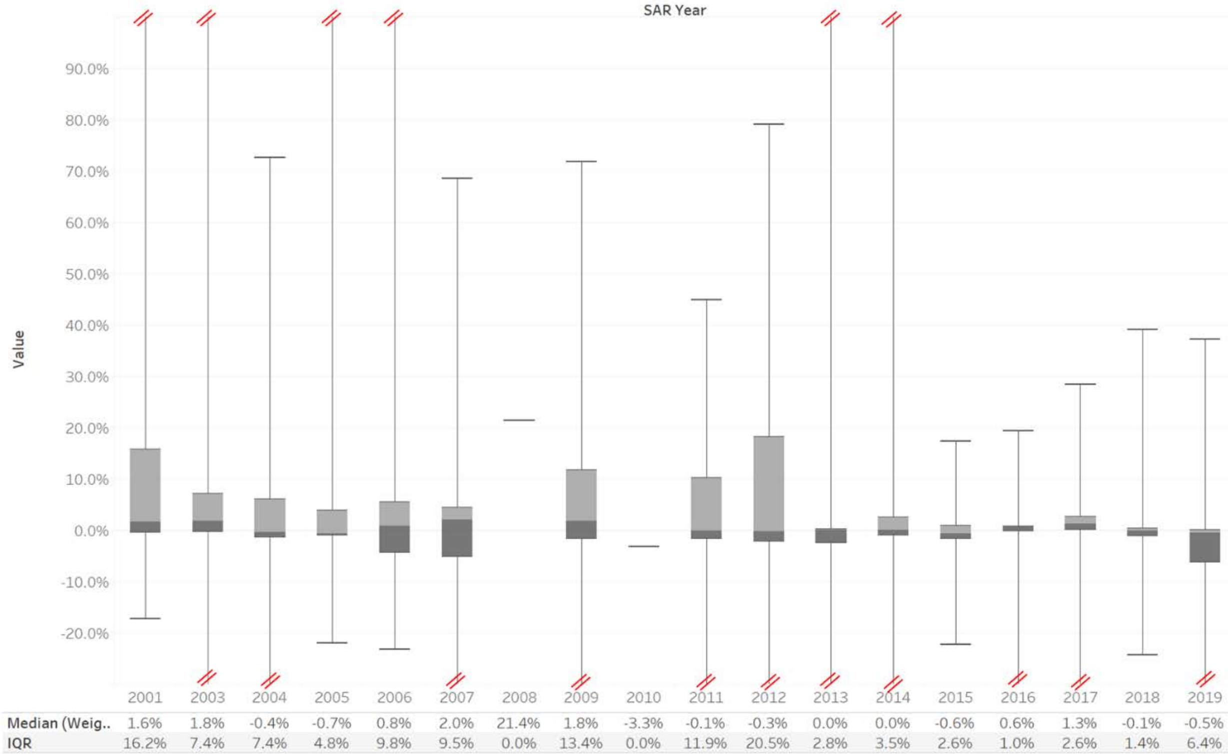
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Median (Procu..	2.7%		1.8%	-0.1%	1.6%	1.6%	1.0%	21.4%	0.4%	-3.3%	-0.2%	-1.0%	0.0%	-0.2%	-0.3%	-0.4%	0.2%	-0.1%	-0.7%
Count (Procure..	41	0	49	50	48	58	64	1	65	1	65	65	65	66	64	63	63	67	67
IQR (Procurem..	13.8%		7.5%	6.3%	12.2%	14.3%	11.5%	0.0%	11.3%	0.0%	8.5%	5.1%	9.5%	7.0%	4.2%	5.3%	8.1%	6.1%	5.0%

NOTE: This shows biennial changes in unit recurring flyaway funding after adjusting for quantity changes; it is independent of RDT&E funding but reflects any work-content changes. These are percentage changes after adjusting for inflation and any quantity changes from original MS B baseline of actual past and estimated needed future funding as reported in the programs' latest SARs. Relatively new programs that have not completed at least 30 percent of their original EMD schedule are not included. Boxes show first quartile, median, and third quartile; bars show first and third quartiles, minimum, and maximum. The IQR is the difference between the 75th and 25th percentiles.

[21] We used a Mann-Whitney test with a significance cutoff of 0.05 to compare the "program basis" distributions (excluding immature programs). We did not correct for multiple testing. Due to the low number of SARs available in 2000 and 2008, we did not consider the periods 2000-2002, 2006-2008, or 2008-2010.

[22] We weighted each program's procurement growth by the size of the program's actual and planned recurring unit flyaway funding.

Figure 14. Biennial Procurement Cost Growth (Weighted by Program Size in Dollars): Biennial Change in Active MDAP Planned Total (From Start to Completion) Quantity-Adjusted Unit-Procurement Recurring-Flyaway Funding: Dollar Basis (Controlled for Maturity; SAR Years 2001–2019)



NOTE: This chart shows biennial changes in unit recurring flyaway funding after adjusting for quantity changes; it is independent of RDT&E funding but reflects any work-content changes. These are percentage changes after adjusting for inflation and any quantity changes from the original MS B baseline of actual past and estimated needed future funding as reported in the programs' latest SARs. Relatively new programs that have not completed at least 30 percent of their original EMD schedule are not included. Boxes show first quartile, median, and third quartile; bars show first and third quartiles, minimum, and maximum. The IQR is the difference between the 75th and 25th percentiles.

Figure 15 identifies the five largest biennial funding-growth programs for each year.

Figure 15. Biennial Procurement Cost Growth Outliers: Biennial Change in Active MDAP Planned Total (From Start to Completion) Quantity-Adjusted Unit-Procurement Recurring-Flyaway Funding: Program Basis Outliers (Controlled for Maturity; SAR Years 2001–2019)

	1	2	3	4	5
2019	JASSM [JASSM-ER] (37.1%)	CIRCM (31.9%)	SDB II (27.7%)	OASuW Inc 1 (LRASM) (20.1%)	JAGM (19.6%)
2018	JASSM [JASSM-ER] (38.3%)	CIRCM (33.1%)	JAGM (28.5%)	FAB-T [FAB-T FET] (26.1%)	LCS MM (16.3%)
2017	FAB-T [FAB-T FET] (28.4%)	SSC (17.0%)	G/ATOR (11.7%)	AWACS Blk 40/45 Upgrade (9.4%)	HMS [HMS Radios] (8.9%)
2016	SDB II (19.3%)	MQ-4C Triton (19.2%)	AWACS Blk 40/45 Upgrade (16.1%)	SSC (13.3%)	DDG 1000 (10.5%)
2015	JPALS (17.3%)	MQ-8 Fire Scout (15.3%)	DDG 1000 (12.0%)	SDB II (11.3%)	MIDS (8.7%)
2014	JPALS (253.9%)	MQ-8 Fire Scout (57.5%)	G/ATOR (39.1%)	AH-64E Remanufacture (28.4%)	WIN-T Inc 2 (26.5%)
2013	JPALS (171.3%)	AH-64E Remanufacture (42.8%)	MQ-8 Fire Scout (37.8%)	HMS [HMS Radios] (21.2%)	CH-53K (19.1%)
2012	HMS [HMS Radios] (79.0%)	B-2 EHF Inc 1 (29.7%)	MQ-9 Reaper (25.2%)	F-35 [F-35 Aircraft] (20.8%)	CH-53K (18.0%)
2011	HMS [HMS Radios] (44.9%)	FAB-T [FAB- T] (24.2%)	GPS III (15.0%)	MQ-9 Reaper (13.9%)	Excalibur (13.2%)
2010	H-1 Upgrades (-3.3%)				
2009	B-2 RMP (71.8%)	AEHF [AEHF SV 1-4] (65.7%)	MQ-8 Fire Scout (41.6%)	H-1 Upgrades (38.7%)	JASSM [JASSM Baseline] (31.5%)
2008	H-1 Upgrades (21.4%)				
2007	C-130 AMP (68.5%)	EFV (64.3%)	NPOESS (32.6%)	JTRS GMR (21.3%)	Excalibur (19.6%)
2006	NPOESS (279.1%)	SBIRS High [Baseline (GEO 1-4, HEO 1-2, and Ground)] (135.9%)	C-130 AMP (92.1%)	EFV (29.7%)	GMLRS/GMLRS AW (26.6%)
2005	NPOESS (283.7%)	SBIRS High [Baseline (GEO 1-4, HEO 1-2, and Ground)] (230.4%)	UH-60M Black Hawk (47.9%)	TACTOM (36.4%)	WGS (22.9%)
2004	NSSL (72.6%)	CH-47F (62.7%)	TACTOM (52.2%)	UH-60M Black Hawk (26.9%)	RQ-4A/B Global Hawk (13.7%)
2003	NSSL (90.6%)	B-1B CMUP [Computer Upgrade] (21.3%)	JASSM [JASSM Baseline] (19.5%)	TACTOM (18.3%)	JPATS (16.5%)
2001	ATIRCM/CMWS [ATIRCM/ CMWS] (107.3%)	MH-60R (72.0%)	CHEM DEMIL-CMA [NSCMD] (38.2%)	NAS (33.2%)	Trident II Missile (29.8%)

NOTE: This shows biennial changes in unit recurring flyaway funding after adjusting for quantity changes; it is independent of RDT&E funding but reflects any work-content changes. These are percentage changes after adjusting for inflation and any quantity changes from the original MS B baseline of actual past and estimated needed future funding as reported in the programs' latest SARs. Relatively new programs that have not completed at least 30 percent of their original EMD schedule are not included.

5. Schedule Performance: Development

Warfighting capabilities must not only have the needed technical performance but must be delivered in a timely fashion to address operational threats. Cycle time—the time between the identification of a need and fielding of a capability—therefore continues to be an area of primary concern.

We measure cycle time and schedule growth in various ways to gain insight into schedule-related performance. As we did with the cost growth analyses, we focus the analysis at the subprogram level. In some analyses (see Table 4 and Figure 15), we include only MDAPs that have already achieved the metric's endpoint (i.e., IOC). In other analyses (see Figure 16), we consider MDAPs before they have achieved their endpoint. Ongoing programs might experience additional schedule growth before reaching their endpoints, so analyzing ongoing programs throughout time might provide insight into recent trends. We also measure planned versus actual cycle time differences in both years and percentages. The latter provides perspective on the relative magnitude of the change compared to the total length. Note, however, that percent scales differ below and above zero. The lowest negative value is −100 percent, while the largest positive value is theoretically (but not practically) infinity. Thus, −10 percent and +10 percent are not true inverses, and statistics such as the arithmetic mean (average) can be misleading when both negative and positive percent values are present in the distribution.

MDAP Cycle Time: MS B or MS C to IOC

We analyzed planned and actual cycle times for the 94 MDAP subprograms that reported achieving IOC (or a similar benchmark) in the SARs issued since 1997. Table 4 summarizes the average portfolio cycle time for these MDAPs. When an MDAP started reporting at Milestone B, we measured cycle time from Milestone B. Similarly, when an MDAP started reporting at Milestone C, we measured cycle time from Milestone C. Not included in this analysis are some MDAPs with complicated schedules that lacked clear or consistent program start or IOC-related dates, as well as MDAPs whose earliest development or production APB came more than two years after the program's start.[23]

Cycle times for the programs that achieved IOC grew across the portfolio by about 29 percent (18 months for a nominal 5-year program) compared to original plans. Programs that started at MS C had less schedule growth on average than those that started at MS B (14% versus 35%), which is to be expected. Programs that start at MS C are further along in their program's life and should expect less volatility in their schedules. While programs that started at MS C were shorter on average than those that started at MS B (actual cycle time of 4.0 years versus 7.7 years), some programs that started at MS B are among the shortest overall. The six longest programs all began at MS B and included Engineering, Manufacturing, and Development (EMD).

Of note, the planned cycle times reported since the 2017 data [OUSD(A&S), 2019] for the combined MS B

[23] The initial dataset contained 242 subprograms for which DAVE/DAMIR contained at least one development or production baseline and at least one SAR issued between 1997 and 2018. Of those, the analysis considered 93 to have achieved IOC either because the program's most recent SAR (or the most recent SAR that reported on the IOC MS) was dated after that SAR's current IOC estimate or because the program's final SAR (as a result of being 90% expended and/or 90% delivered) indicated that the program would meet their IOC Current Estimate. The analysis considered the 37 programs that had not yet obtained IOC but issued a 2018 SAR containing current estimates for both program start and IOC to be working towards IOC. The analysis excluded 52 of the original 242 programs because the earliest development or production APB in DAVE/DAMIR was dated more than two years after the program started. The analysis excluded an additional 15 programs because they did not contain an identifiable program start milestone. The analysis considered the remaining 41 programs to have been reorganized or cancelled prior to obtaining IOC.

and MS C programs have been much more aggressive (shorter) than those reported in the 2016 PDAS report [USD(AT&L), 2016], but the actuals are lower at the median (but the same at the mean). In other words, it appears that the plans in recent years have been more aggressive (i.e., with the recent emphasis on reducing schedules) with some success in lowering actual cycle time. Thus, while the growth compared to plans was much higher than those reported in 2016, there has been some success in lowering the actual median cycle time from 7.6 years to 6.2 years. Therefore, the higher cycle time growths below appear to be a function of more aggressive planning than of increasing cycle times (at least at the median).

As for the shortest and longest programs reported below, they align with the 2018 data. F-35 Aircraft was updated from 13.7 to 13.8 due to differences in rounding.

Table 4. Average Portfolio Cycle Time (from MS B or C to IOC) for MDAPs Past IOC (1997–2019 SARs)

		Median *(years)*	Mean *(years)*	Count *(n)*	IQR *(years)*	Standard Deviation *(years)*	Min *(years)*	Max *(years)*
All Programs	**Planned**	**4.9**	**5.2**	94	3.4	2.4	0.8	12.3
	Actual	**6.2**	**6.7**	94	5.1	3.7	0.7	21.2
MS B Start	**Planned**	**5.6**	**5.7**	70	2.7	2.2	1.0	12.3
	Actual	**7.4**	**7.7**	70	4.1	3.7	0.8	21.2
MS C Start	**Planned**	**3.1**	**3.5**	24	1.6	1.9	0.8	7.6
	Actual	**3.3**	**4.0**	24	2.9	2.2	0.7	8.3

6 Shortest Programs	Started at	Actual Cycle Time *(years)*
JOINT MRAP	MS C	0.7
LCS MM	MS B	0.8
UH-72 LUH	MS C	0.9
JTN	MS B	1.1
CEC	MS B	1.3
MQ-1C Gray Eagle	MS C	1.8

6 Longest Programs *[subprogram]*	Started at	Actual Cycle Time *(years)*
V-22	MS B	21.2
ATIRCM/CMWS [ATIRCM QRC]	MS B	14.8
F-22	MS B	14.5
AEHF [AEHF SV 1-4]	MS B	13.8
F-35 [F-35 Aircraft]	MS B	13.8
C-5 RERP	MS B	12.3

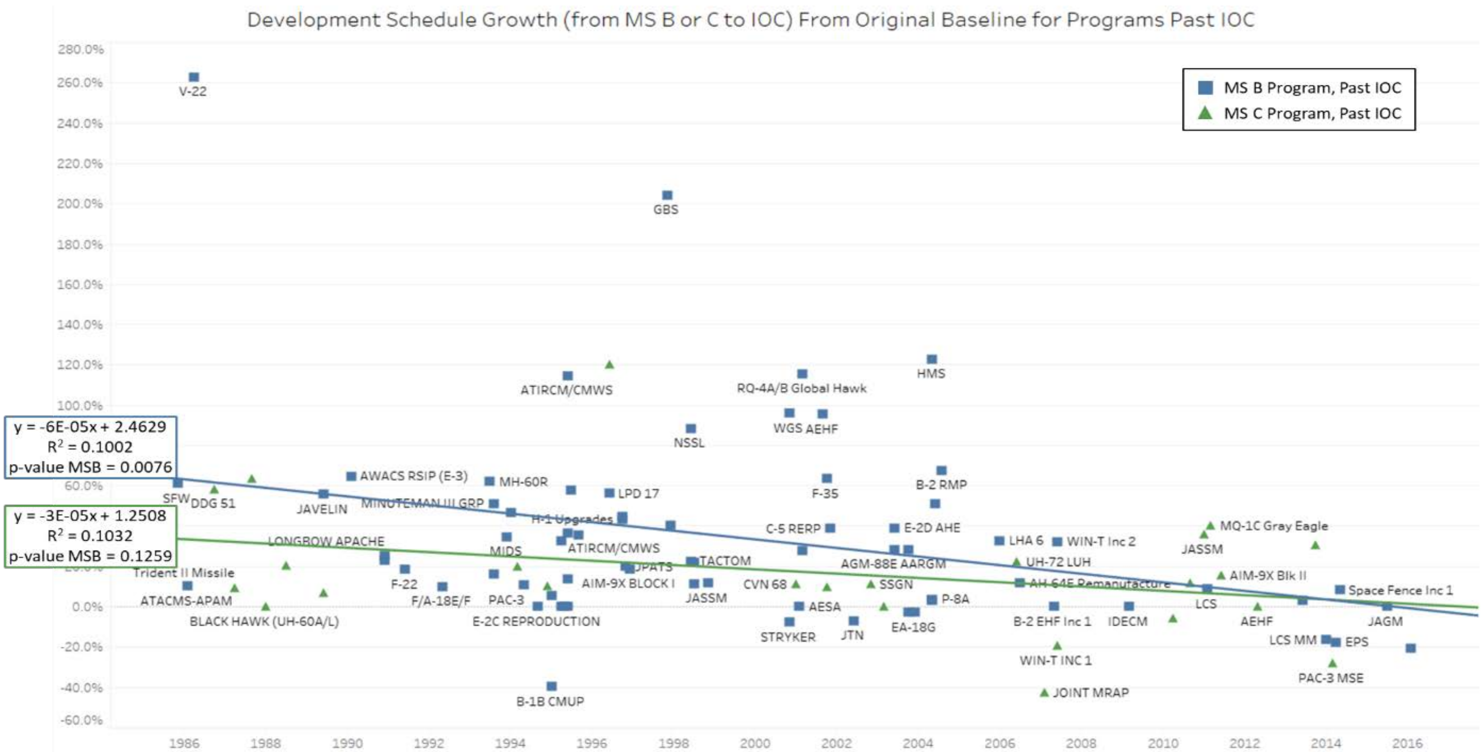
NOTE: The analysis used APBs as well as the 1997–2019 SARs. The analysis includes MDAPs with MS B or C dates as early as 1986. IOC dates range from March 1990 through December 2019. The planned cycle time is the time between the threshold values for program start (MS B or MS C as applicable) and IOC as reported in the earliest development or production APB in DAVE/DAMIR. The actual cycle time is the time between the current estimate for program start (MS B or MS C) and IOC as reported in the program's most recent SAR. For programs that did not identify program start or IOC milestones, the analysis used the most-equivalent milestones or excluded the program if equivalent milestones could not be identified.[24] A program was considered past IOC if the program's most recent SAR (or the most recent SAR that reported on the IOC MS) was dated after that SAR's current IOC estimate or if the program's final SAR (as a result of being 90% expended and/or 90% delivered) indicated that the program would meet their IOC Current Estimate[25] The IQR is the difference between the 75th and 25th percentiles. Program abbreviations are included in appendix A.

[24] When available, the analysis used MS B, MS II, MS C, or MS III as the program start milestone. When available, the analysis used the following milestones (shown in the order of preference) as the end of the development cycle: initial operational capability, first-unit equipped, first asset delivery, required assets available, or any delivery milestone whose name did not include "prototype," "EMD," "LRIP," or similar terms. When a program did not include any of the preferred milestones, we selected the most-equivalent milestone manually. We excluded 15 programs for which we could not identify a start milestone.

[25] Some programs (e.g., COBRA JUDY REPLACEMENT, AESA) were 90% expended and issued their final SAR before IOC.

Figure 15 plots percent growth in development schedule versus program start date for the 93 MDAPs (or MDAP subprograms) that reported achieving IOC (or a similar benchmark) in the SARs issued since 1997. There was a statistically significant trend in schedule growth as a function of program start date for MS B starts, but not for MS C starts.[26] This finding suggests recent programs that started at MS B and achieved IOC did not experience as much schedule growth as older programs. Reasons behind the trend are not discussed in this report but could prompt further investigation.

Figure 15. Development Schedule Growth (from MS B or C to IOC) From Original Baseline for 93 MDAPs Past IOC (1997–2019 SARs)



NOTE: This figure plots percent growth in development schedule versus program start date for the 94 MDAPs (or MDAP subprograms) that reported achieving IOC (or a similar benchmark) in the SARs issued since 1997. The metric compares the actual cycle time, the time between program start (MS B or MS C as applicable) and IOC as reported in the program's most recent SAR, with the planned (baseline) cycle time reported in the program's earliest development or production APB in DAVE/DAMIR. For programs that did not identify program start or IOC milestones, the analysis used the most-equivalent milestones. A program was considered past IOC if the most recent SAR was dated after the current IOC estimate or if the program was complete.[27] The analysis excluded programs whose earliest developmental or production APB in DAVE/DAMIR was dated more than two years after the program started (MS B or MS C) due to the concerns that the APB might reflect the schedule at the time the APB was issued, not the time the program started. Program abbreviations are included in appendix A.

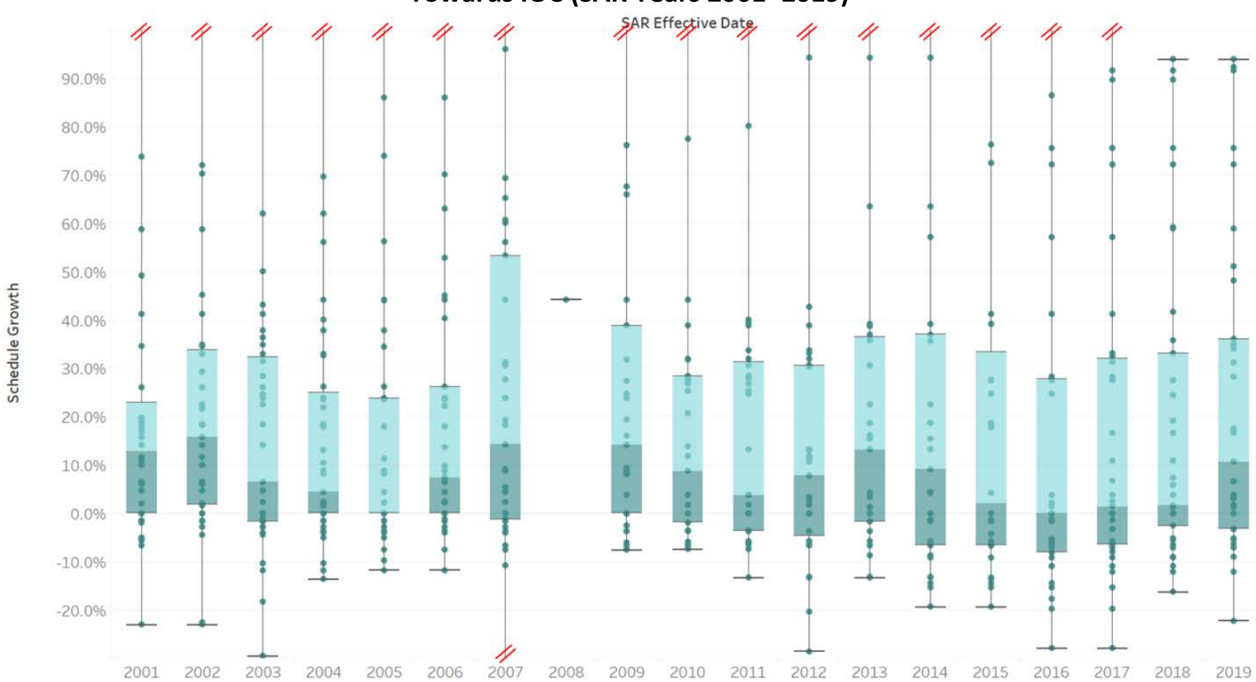
[26] We used a t-test with a significance cutoff of p=0.05 to assess whether the slope of the best affine model of percent schedule growth as a function of program start date was different from zero. We tested the MS B and MS C datasets separately.

[27] Some programs (e.g., COBRA JUDY REPLACEMENT, AESA) were 90% expended and issued their final SAR before IOC.

MDAP Schedule Growth: MS B or C to IOC

We also used SAR data to analyze the schedule growth of MDAPs working towards IOC. Figure 16 shows the distribution of schedule growth of the portfolio of active MDAP programs working towards or achieving IOC for each year.[28] Individual programs, of course, rotate in and out of the portfolio over time. The data for each year reflects the program managers' current estimates from the SARs; schedules may change in future years until the program achieves IOC. Median schedule growth is lowest in 2016, mainly due to a combination of programs with substantial schedule growth obtaining IOC (e.g., F-35, AEHF SV 1-4) and new programs starting (e.g., OASuW Inc 1, F-15 EPAWSS). The increase in median schedule growth in 2019 can be attributed to a combination of programs with minimal schedule growth obtaining IOC (AEHF SV 5-6, JAGM, F-22 Inc 3.2B Mod, and Space Fence Inc 1) and a small number of programs experiencing schedule growth of at least 30% (F-15 EPAWSS and B-2 DMS-M). However, there is no significant difference in schedule growth between any years evaluated.[29]

Figure 16. MDAP Schedule Growth (MS B or C to IOC From Original Baseline) for Active Programs Working Towards IOC (SAR Years 2001–2019)



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Count (Sched..	36	35	35	39	37	37	33	1	29	33	32	31	27	29	28	33	35	37	33
Median (Sche..	12.9%	15.7%	6.5%	4.4%	0.0%	7.4%	14.3%	44.2%	14.1%	8.8%	3.8%	7.8%	13.1%	9.1%	2.1%	0.0%	1.4%	1.6%	10.7%
IQR (Schedule..	21.2%	31.9%	33.9%	25.0%	23.8%	26.2%	54.5%	0.0%	38.8%	30.2%	34.5%	35.2%	38.0%	43.6%	37.0%	35.8%	38.3%	35.6%	39.2%

NOTE: This shows the changes in development schedule—program start (MS B or MS C) to IOC—for active programs working towards IOC. To emphasis recent changes, a program's schedule growth is not shown in the years after it achieves IOC. For each MDAP, the metric compares the schedule in each year's SAR to the schedule in the MDAP's first development or production APB in DAVE/DAMIR. Each program is weighted equally. For programs that did not identify program start or IOC milestones, the analysis used the most-equivalent milestones or excluded the program if equivalent milestones could not be identified. Programs are not included in years they did not issue SARs or issued SARs without current estimates for the program start and IOC milestones. The IQR is the difference between the 75th and 25th percentiles.

[28] The analogous analysis in USD(AT&L) (2016) examined all active MDAPs in each year, including those in post-IOC production. To increase the sensitivity to recent trends and to equalize the impact of programs with long and short production runs on the results, this analysis only includes an MDAP up to the year it obtains IOC.

[29] We used a Mann-Whitney test with a significance cutoff of 0.05 to compare the full distributions for each pair of years.

Appendix A: Program Name Acronyms

Program Acronym[30]	Definition	Component
AAG	Advanced Arresting Gear	Navy
ABRAMS UPGRADE	M1A2 Abrams Tank Upgrade	Army
ACS	Aerial Common Sensor	Army
ACV 1.1	Amphibious Combat Vehicle Phase 1 Increment 1	Navy
ADS (AN/WQR-3)	Advanced Deployable System	Navy
AEHF	Advanced Extremely High Frequency Satellite	Air Force
AGM-88E AARGM	Advanced Anti-Radiation Guided Missile	Navy
AH-64E New Build	Apache New Build	Army
AH-64E Reman	Apache Remanufacture	Army
AIM-9X Blk II	Air Intercept Missile, Block II (Sidewinder)	Navy
AIM-9X BLOCK I	Air Intercept Missile, Block I (Sidewinder)	Navy
AMDR	Air and Missile Defense Radar	Navy
AMF JTRS	Airborne & Maritime/Fixed Station Joint Tactical Radio System	Army
AMF JTRS SALT	Small Airborne Link 16 Terminal	Army
AMF JTRS SANR	Small Airborne Networking Radio	Army
AMPV	Armored Multi-Purpose Vehicle	Army
AMRAAM	AIM-120 Advanced Medium Range Air-to-Air Missile	Air Force
ARH	Armed Reconnaissance Helicopter	Army
ASDS	Advanced Seal Delivery System	Navy
ASIP	Airborne Signals Intelligence Payload	Air Force
ATACMS-APAM	Army Tactical Missile System-Anti-Personnel Anti-Materiel	Army
ATACMS-BAT	Army Tactical Missile System-Brilliant Anti-Tank	Army
ATIRCM/CMWS	Advanced Threat Infrared Countermeasure/Common Missile Warning System	Army
ATIRCM/CMWS QRC	Quick Reaction Capability	Army
AV-8B REMANUFACTURE	Harrier II Remanufacture	Navy
AWACS Blk 40/45 Upgrade	Airborne Warning and Control System Block 40/45 Upgrade	Air Force
AWACS RSIP (E-3)	Radar System Improvement Program	Air Force
B-1B CMUP	Conventional Mission Upgrade Program	Air Force
B-1B CMUP DSUP	Defensive Systems Upgrade	Air Force
B-1B CMUP JDAM	Joint Direct Attack Munition	Air Force
B-2 DMS-M	B-2 Defensive Management System - Modernization	Air Force
B-2 EHF Inc 1	Extremely High Frequency SATCOM and Computer Increment 1	Air Force
B-2 RMP	Radar Modernization Program	Air Force
B61 Mod 12 LEP TKA	Mod 12 Life Extension Program Tailkit Assembly	Air Force
BLACK HAWK (UH-60A/L)	Black Hawk Utility Helicopter	Army
BFVS A3 Upgrade	Bradley Fighting Vehicle Systems A3 Upgrade	Army
C-130 AMP	Avionics Modernization Program	Air Force
C-130J	Hercules Transport Aircraft	Air Force
C-17A	Globemaster III	Air Force
C-27J	Joint Cargo Aircraft	Air Force
C-5 AMP	Avionics Modernization Program	Air Force
C-5 RERP	Reliability Enhancement and Re-engining Program	Air Force
CANES	Consolidated Afloat Networks and Enterprise Services	Navy
CEC	Cooperative Engagement Capability	Navy
CGS (JSTARS GSM)	Common Ground Station (Formerly JSTARS CGS)	Army
CH-47F	Improved Cargo Helicopter	Army

[30] This table was adapted from USD(AT&L) (2016) and includes some programs that are not MDAPs.

Program Acronym[30]	Definition	Component
CH-47F Block II	Improved Cargo Helicopter, Block II	Army
CH-53K	Heavy-Lift Replacement Helicopter	Navy
Chem Demil-ACWA	Chemical Demilitarization, Assembled Chemical Weapons	DoD
Chem Demil-CMA	Chemical Materials Agency	DoD
Chem Demil-CMA Newport	Chemical Materials Agency Newport	DoD
Chem Demil-CMA/CSD	Chemical Stockpile Disposal	DoD
Chem Demil-Legacy/NSCMP	Legacy/Non-Stockpile Chemical Materiel Project	DoD
CIRCM	Common Infrared Countermeasure	Army
COBRA JUDY REPLACEMENT	Cobra Judy Replacement	Navy
Comanche	Comanche Helicopter	Army
CRH	Combat Rescue Helicopter	Air Force
CVN 68	Nimitz Class Nuclear Aircraft Carrier	Navy
CVN 78	Gerald R. Ford Class Nuclear Aircraft Carrier	Navy
CVN 78/EMALS	Electromagnetic Aircraft Launching System	Navy
DCGS, Inc. 1	Distributed Common Ground System, Increment 1	Army
DDG 1000	Destroyer, guided-missile, Zumwalt class	Navy
DDG 51	Destroyer, guided-missile, Arleigh Burke class	Navy
DEAMS	Defense Enterprise Accounting and Management System	Air Force
DIMHRS	Defense Integrated Military Human Resources System	DoD
E-2C REPRODUCTION	E-2C Reproduction	Navy
E-2D AHE	Advanced Hawkeye Aircraft	Navy
EA-18G	Growler Aircraft	Navy
EA-6B ICAP III	Growler Aircraft, Improved Capability III	Navy
EELV	Evolved Expendable Launch Vehicle	Air Force
EFV	Expeditionary Fighting Vehicle	Navy
EPS	Enhanced Polar System	Air Force
ERM	Extended Range Munition	Navy
Excalibur	Excalibur Precision 155mm Projectiles	Army
F/A-18E/F	Super Hornet Aircraft, E/F variant	Navy
F-15 EPAWSS	Eagle Passive Active Warning Survivability System	Air Force
F-22	Raptor Advanced Tactical Fighter Aircraft	Air Force
F-22 Inc 3.2B Mod	Increment 3.2B Modernization	Air Force
F-35	Lightning II Joint Strike Fighter (JSF) Program	DoD
FAB-T	Family of Advanced Beyond Line-of-Sight Terminals	Air Force
FAB-T CPT	Command Post Terminal	Air Force
FAB-T FET	Force Element Terminal	Air Force
FBCB2	Force XXI Battle Command Brigade and Below Program	Army
FCS	Future Combat System	Army
FMTV	Family of Medium Tactical Vehicles	Army
G/ATOR	Ground/Air Task Oriented Radar	Navy
GBS	Global Broadcast Service	Air Force
GBSD	Ground Based Strategic Deterrent	Air Force
GCSS-A	Global Combat Support System, Army	Army
GMLRS AW	Guided Multiple Launch Rocket System/Alternative Warhead	Army
GPS III	Global Positioning System III	Air Force
H-1 Upgrades	Upgrades (4BW/4BN)	Navy
HC/MC-130 Recap	Recapitalization Aircraft	Air Force
HIMARS	High-Mobility Artillery Rocket System	Army
IAMD	Integrated Air and Missile Defense	Army
ICBM Fuze Mod	Intercontinental Ballistic Missile Fuze Modernization	Air Force
IDECM	Integrated Defensive Electronic Countermeasures	Navy
IFPC Inc 2-I Block 1	Indirect Fire Protection Capability, Increment 2, Intercept Block 1	Army
INCREMENT 1 E-IBCT	Increment 1 Early Infantry Brigade Combat Team	Army
IPPS-A	Integrated Personnel and Pay System, Army	Army
IRST	Infrared Search and Track	Navy
JAGM	Joint Air-to-Ground Missile	Army
JASSM	Joint Air-to-Surface Standoff Missile	Air Force
JASSM-ER	Extended Range	Air Force

Program Acronym[30]	Definition	Component
JAVELIN	Advanced Anti-Tank Weapon System, Medium	Army
JDAM	Joint Direct Attack Munition	Air Force
JHSV	Joint High-Speed Vessel	Navy
JLENS	Joint Land Attack Cruise Missile Defense Elevated Netted Sensor	Army
JLTV	Joint Light Tactical Vehicle	Army
JOINT COMMON MISSILE	Joint Common Missile	Army
JOINT MRAP	Joint Mine Resistant Ambush Protected Vehicle	Navy
JPALS	Joint Precision Approach and Landing System	Navy
JPATS	Joint Primary Aircraft Training System	Air Force
JSF	F-35 Joint Strike Fighter	DoD
JSOW	Joint Standoff Weapon	Navy
JTN	Joint Tactical Network	Army
JTRS GMR	Joint Tactical Radio System: Ground Mobile Radios	Army
JTRS HMS	Joint Tactical Radio System: Handheld, Manpack, and Small Form-	Army
KC-130J	Transport Aircraft	Navy
KC-46A	Tanker Modernization	Air Force
Land Warrior	Land Warrior	Army
LCS	Littoral Combat Ship	Navy
LCS MM	Littoral Combat Ship Mission Modules	Navy
LHA	Amphibious Assault Ship (General Purpose)	Navy
LHA 6	America Class Amphibious Assault Ship	Navy
LHD	Amphibious Assault Ship (Multi-Purpose)	Navy
LHD 1 [LHD]	Wasp Class Amphibious Assault Ship	Navy
LONGBOW APACHE	Longbow Apache AH-64D Helicopter	Army
LONGBOW HELLFIRE	Longbow Apache Precision Strike Missile System	Army
LMP	Logistics Modernization Program	Army
LPD 17	San Antonio Class Amphibious Transport Dock	Navy
LSD	Dock Landing Ship	Navy
LUH	Light Utility Helicopter	Army
M88A2 HERCULES	M88A2 Heavy Equipment Recovery Combat Utility Lift Evacuation	Army
MGUE Inc 1	Military Global Positioning System (GPS) User Equipment	Air Force
MH-60R	Multi-Mission Helicopter	Navy
MH-60S	Fleet Combat Support Helicopter	Navy
MHC 51	Coastal Mine Hunter	Navy
MIDS	Multifunctional Information Distribution System	Navy
MINUTEMAN III GRP [MMIII]	Minuteman III Guidance Replacement Program (GRP)	Air Force
MINUTEMAN III PRP	Minuteman III Propulsion Replacement Program (PRP)	Air Force
MOP GBU-57A/B	Massive Ordnance Penetrator Guided Bomb Unit	Air Force
MP-RTIP	Multi-Platform Radar Technology Insertion Program	Air Force
MPS	Mission Planning System	Air Force
MQ-1B UAS PREDATOR	Predator Unmanned Aircraft System	Air Force
MQ-1C Gray Eagle	Gray Eagle Unmanned Aircraft System	Army
MQ-4C Triton	Triton Unmanned Aircraft System	Navy
MQ-8 Fire Scout	Fire Scout Unmanned Aircraft System	Navy
MQ-9 Reaper	Reaper Unmanned Aircraft System	Air Force
MUOS	Mobile User Objective System	Navy
NAS	National Airspace System	Air Force
NAVSTAR GPS	NAVSTAR Global Positioning System	Air Force
Navy Area TBMD	Navy Area Theater Ballistic Missile Defense	Navy
NGJ Inc 1	Next Generation Jammer Mid-Band	Navy
NMT	Navy Multiband Terminal	Navy
NPOESS	National Polar-orbiting Operational Environmental Satellite	Air Force
OASuW Inc 1 (LRASM)	Offensive Anti-Surface Warfare Increment 1 (Long Range Anti-Ship Missile)	Navy
OCX	Next-Generation Operational Control System	Air Force
P-8A	Poseidon Multi-Mission Maritime Aircraft	Navy
PAC-3	Patriot Advanced Capability, variant 3	Army
PAC-3 MSE	Missile Segment Enhancement	Army
Patriot/MEADS CAP	Patriot/Medium Extended Air Defense System Combined	Army

Program Acronym[30]	Definition	Component
PIM	Paladin Integrated Management	Army
RMS	Remote Minehunting System	Navy
RQ-4A/B Global Hawk	Global Hawk Unmanned Aircraft System	Air Force
SADARM	Sense and Destroy Armor	Army
SBIRS Follow-On	Space-Based Infrared System Follow-On	Air Force
SBIRS High	Space-Based Infrared System High	Air Force
SBSS BLOCK 10	Space Based Space Surveillance Block 10	Air Force
SDB I	Small Diameter Bomb, Increment I	Air Force
SDB II	Small Diameter Bomb, Increment II	Air Force
SM 2	Standard Missile-2	Navy
SM-6	Standard Missile-6	Navy
Space Fence Inc 1	Space Fence Ground-Based Radar System, Increment 1	Air Force
SSBN 826	SSBN 826 COLUMBIA Class Submarine	Navy
SSC	Ship-to-Shore Connector Amphibious Craft	Navy
SSDS, MK 1	Ship Self-Defense System, Mark 1	Navy
SSDS, MK 2	Ship Self-Defense System, Mark 2	Navy
SSDS, MK 2 P3I	Ship Self-Defense System, Mark 2 Pre-Planned Improvement	Navy
SSGN	SSGN Ohio Class Conversion	Navy
SSN 21 / AN/BSY-2	SEAWOLF Class Nuclear Attack Submarine/Combat System	Navy
SSN 774	Virginia Class Submarine	Navy
STRATEGIC SEALIFT	Naval Transport Ship	Navy
STRYKER	Stryker Family of Vehicles	Army
T-45TS	Naval Undergraduate Jet Flight Training System (GOSHAWK)	Navy
TACTOM	Tactical Tomahawk RGM-109E/UGM-109E Missile	Navy
T-AKE	LEWIS and CLARK Class Dry Cargo/Ammunition Ship	Navy
T-AO 205 Class, T-AO(X)	John Lewis Class Fleet Oiler	Navy
TITAN IV	Space Booster	Air Force
TMIP-J	Theater Medical Information Program, Joint	DoD
Trident II Missile	Trident II (D-5) Sea-Launched Ballistic Missile UGM 133A	Navy
TSAT	Transformational Satellite Communications System	Air Force
TWS	Thermal Weapon Sight	Army
UH-60M Black Hawk	Black Hawk Helicopter	Army
V-22	Osprey Joint Services Advanced Vertical Lift Aircraft	Navy
VH-71	Presidential Helicopter Fleet Replacement	Navy
VH-92A	Presidential Helicopter	Navy
VTUAV	Vertical-Takeoff-and-Landing Tactical Unmanned Aerial Vehicle	Navy
WAS	Wide-Area Surveillance	Air Force
WGS	Wideband Global SATCOM	Air Force
WIN-T	Warfighter Information Network, Tactical	Army
WIN-T Inc 1	Warfighter Information Network, Increment 1	Army
WIN-T Inc 2	Warfighter Information Network, Increment 2	Army
WIN-T Inc 3	Warfighter Information Network, Increment 3	Army

Appendix B: Abbreviations

(See also the program names defined in Appendix A.)

ACAT—Acquisition Category

APB—Acquisition Program Baseline

APUC—Average Procurement Unit Cost

AT&L—Acquisition, Technology, and Logistics

C4ISR—Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance

CY—constant year

DAMIR—Defense Acquisition Management Information Retrieval

DAVE—Defense Acquisition Visibility Environment

DoD—Department of Defense

EMD—Engineering, Manufacturing and Development

FY—fiscal year

IQR—interquartile range

MDAP—Major Defense Acquisition Program

MS—Milestone

NDAA—National Defense Authorization Act

PAUC—Program Acquisition Unit Cost

PB—President's budget (request)

RDT&E—Research, Development, Test, and Evaluation

SAR—Selected Acquisition Report

USD—Under Secretary of Defense

U.S.C.—United States Code

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