Assessments of Selected Weapon Programs
Observations on Defense Acquisition Performance (GAO-17-333SP)

Desirée E. Cunningham, Senior Defense Analyst

April 2017

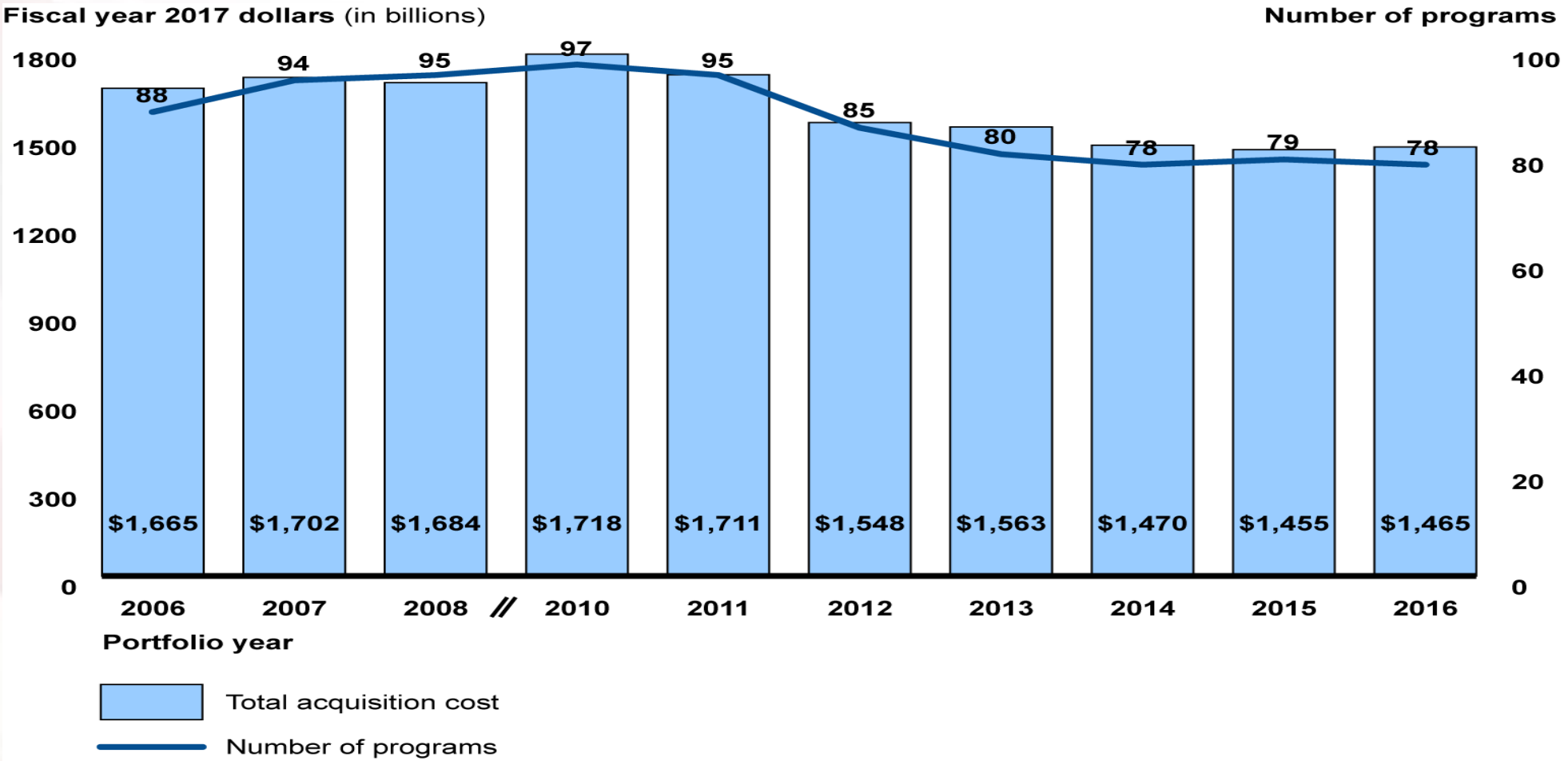


Sources: (Left to Right) Patriot Advanced Capability-3 Missile Segment Enhancement, U.S. Army; VH-92A Presidential Helicopter Replacement, 2016 Sikorsky Aircraft Corporation, a Lockheed Martin Company; Next Generation Operational Control System, U.S. Air Force; and F-35 Lightning II, 2016 Lockheed Martin.

Introduction

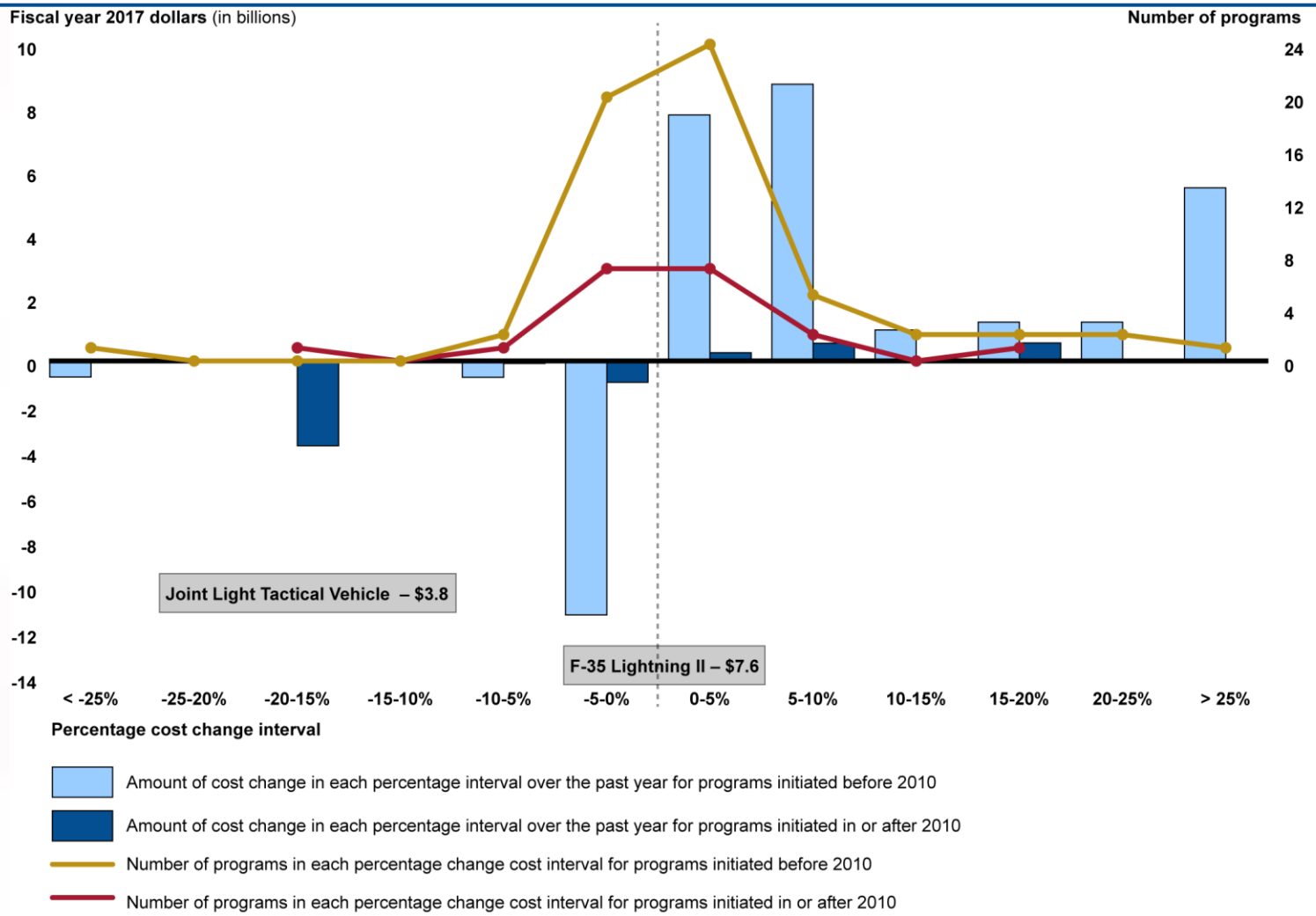
- In our March 2017 report, we assessed defense programs' performance in three areas:
  1) cost and schedule outcomes
  2) use of acquisition reforms and initiatives, and
  3) use of knowledge-based best practices.
- Our 2017 report updates several of our **previous observations**, including:
  - the magnitude and type of cost and schedule changes for current programs,
  - "buying power" gains and losses, and
  - programs' use of knowledge-based best practices.
- **New observations** in our 2017 report cover:
  - the cost performance of programs started before versus after acquisition reforms,
  - the intervals in the acquisition cycle where cost growth occurs,
  - the extent to which operational testing informs initial operational capability, and
  - implementation of certain acquisition reform initiatives.

The 2016 Portfolio's Total Acquisition Cost Flattened Out

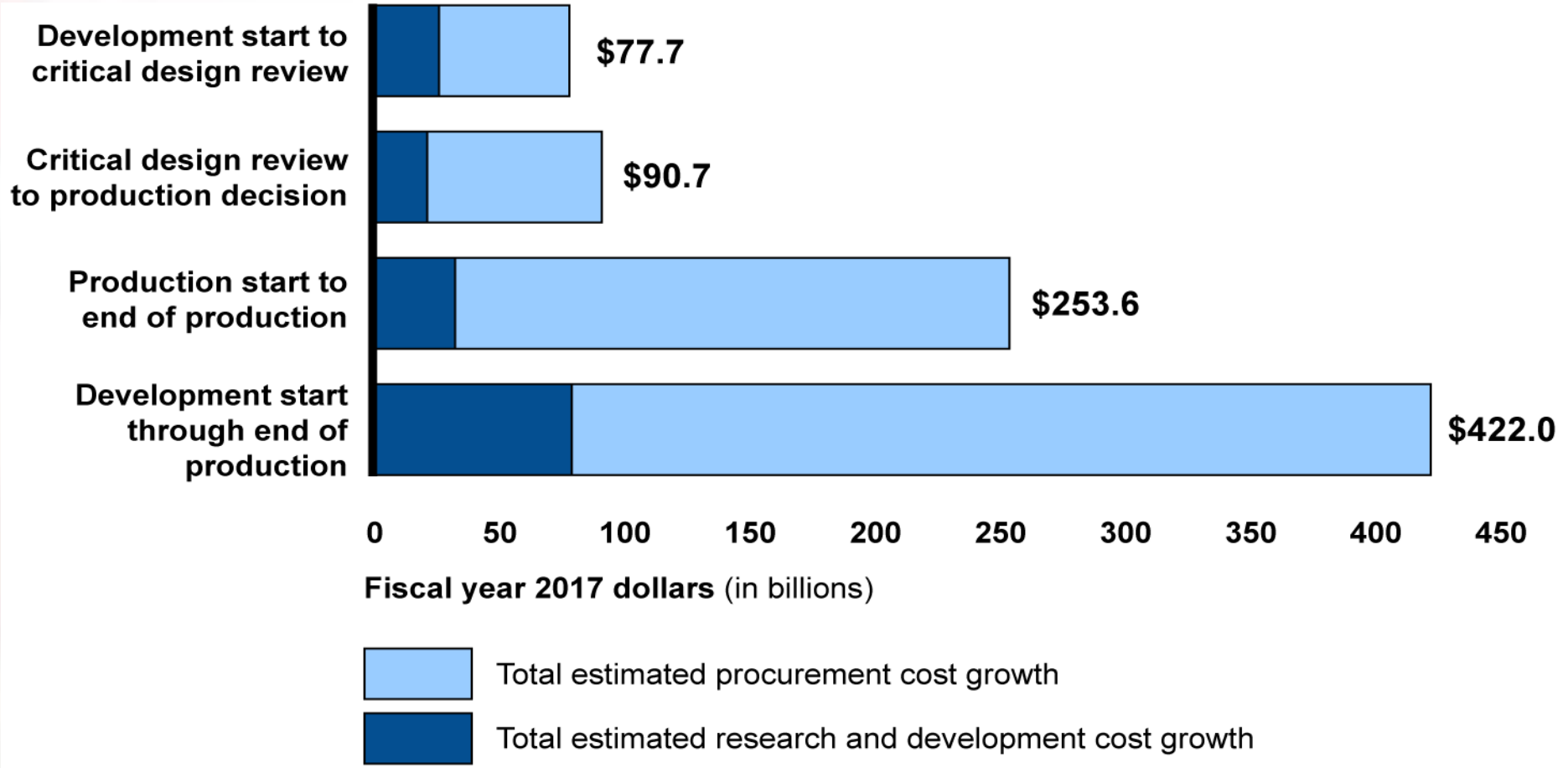


Source: GAO analysis of Department of Defense data. | GAO-17-333SP

Cost Changes in Programs Started Before and After 2010 Share a Similar Profile



Programs Incur Most of Their Cost Growth during Production

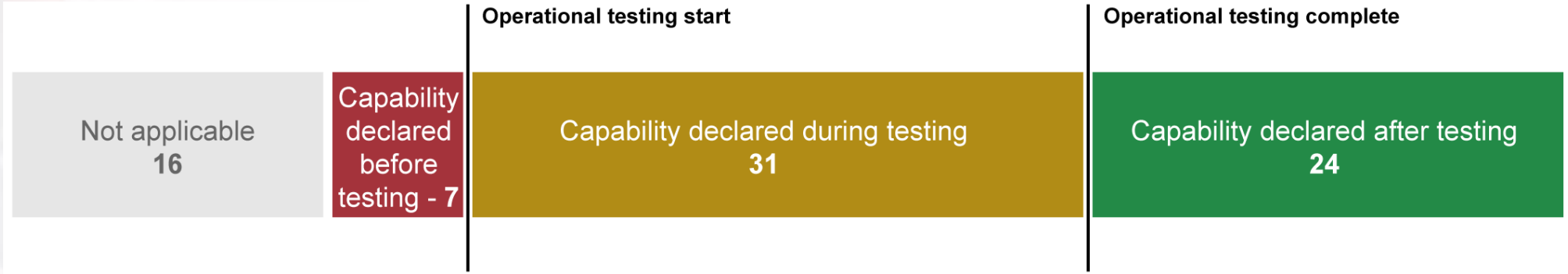


Source: GAO analysis of Department of Defense data. | GAO-17-333SP

The portfolio realized a buying power gain of $10.7 billion

	Number of programs	GAO calculated cost change due to quantity changes	Actual procurement cost change	GAO calculated cost change not attributable to quantity changes
Programs that gained buying power	**33**	**1.8**	**-15.1**	**-16.9**
Procurement cost decreased with no quantity change	24	0.0	-13.6	-13.6
Quantity increased with less cost increase than anticipated	6	3.4	1.5	-2.0
Quantity decreased with more cost decrease than anticipated	3	-1.7	-3.1	-1.4
Programs that lost buying power	**40**	**14.6**	**20.7**	**6.2**
Procurement cost increased with no quantity change	25	0.0	2.6	2.6
Quantity increased with more cost increase than anticipated	12	15.8	19.2	3.4
Quantity decreased with less cost decrease than anticipated	3	-1.2	-1.1	0.2
No change in buying power	5	0.0	0.0	0.0
Portfolio totals	**78**	**16.3**	**5.6**	**-10.7**

Almost Half of Programs Declare Initial Capability Before Completing Operational Testing



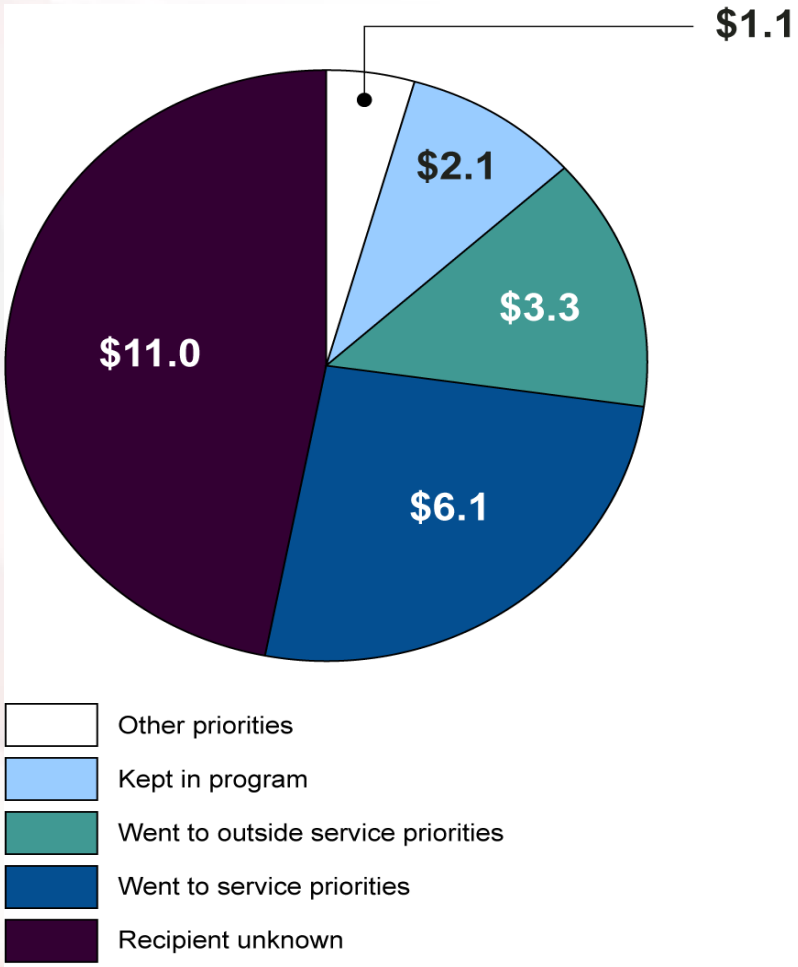
Source: GAO analysis of Department of Defense data. | GAO-17-333SP

- Initial operational test and evaluation (IOT&E) is to evaluate a system's effectiveness and suitability.
- DOD's TEMP Guide notes that initial operational capability (IOC) is usually determined by the service.
- Consequently, programs can declare IOC on the basis of full, partial, or no IOT&E.
- Programs declaring IOC prior to completing full IOT&E risk finding deficiencies that may need to be corrected, which could add to a program's cost and schedule.

Reforms & Initiatives: 70 Percent of Programs Have an Affordability Constraint

- Affordability constraints are cost caps intended to force prioritization of requirements, enable cost trades, and ensure that unaffordable programs do not enter the acquisition process.
- Of the 54 current and future programs we assessed, 38 have established an affordability constraint while 16 have not.
- We found that all but one current program that conducted an analysis and set a constraint reported being on track to remain within their constraints.
- While the effectiveness of these constraints has yet to be widely tested, we observed that the current programs we assessed with established affordability constraints had a lower average amount of cost growth from their initial estimates compared to programs without a constraint.

Reforms & Initiatives: Programs Are Identifying and Realizing "Should-cost" Savings

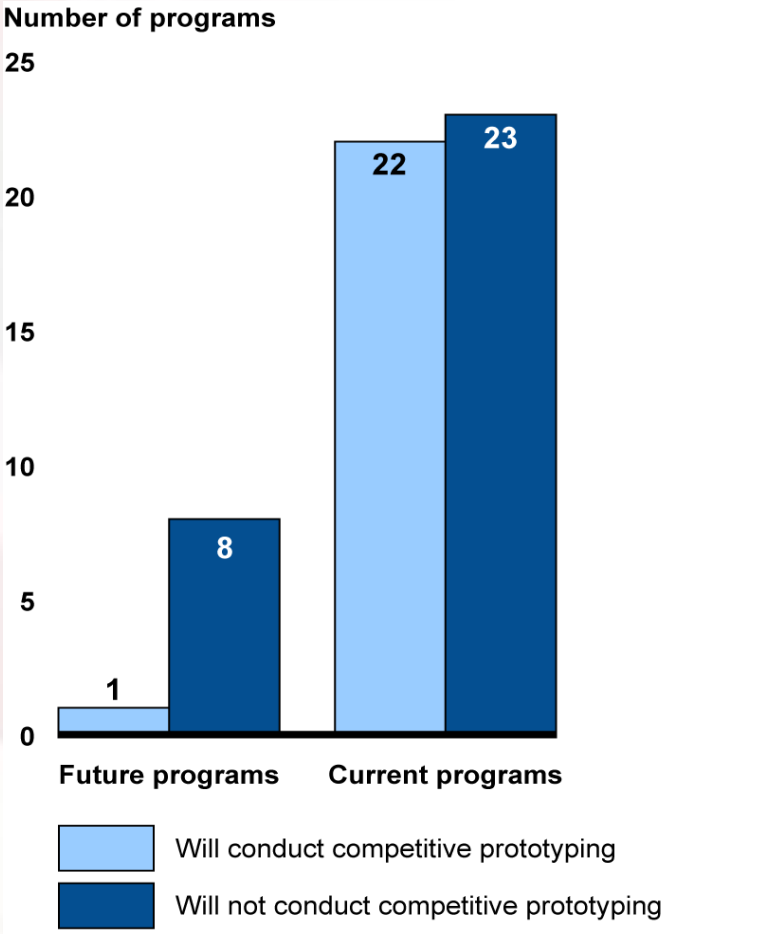


Source: GAO analysis of Department of Defense data. | GAO-17-333SP

"Should-Cost" analyses result in a cost estimate to be used as a management tool to control and reduce cost.

- Programs reported $23.6 billion in realized "should-cost" savings.
- programs could account for the recipient of almost half, or $11 billion, of these savings.
- $178 million of savings realized were used to offset budget cuts required by sequestration.

Reforms & Initiatives: Use of Competitive Prototyping and Other Measures Mixed



Source: GAO analysis of Department of Defense data. | GAO-17-333SP

	For the 9 future programs	For the 45 current programs	Total
Number of programs planning to promote competition	3	38	41
Throughout the Acquisition life cycle	1	15	16
Only prior to the start of system development	0	7	7
Only after the start of system development	2	16	18
Number of programs taking no actions to promote competition	6	7	13

One Program Began Development With a Match Between Resources and Requirements

Knowledge-based practices at system development start	Columbia Class SSBN	F-15 EPAWSS	IFPC Inc 2-I Block 1	PAR	Other 41 programs ●	Other 41 programs ○	Other 41 programs ––
Demonstrate all critical technologies are very close to final form, fit, and function within a relevant environment (TRL 6)	○	●	––	––	23	11	7
Demonstrate all critical technologies are in form, fit, and function within an operational environment (TRL 7)	○	○	––	––	3	29	9
Complete system functional review and system requirements review before system development start	○	●	●	○	15	25	1
Completed preliminary design review before system development start	●	●	●	○	19	21	1
Constrain system development phase to 6 years or less	––	●	●	––	27	6	8

● Practice implemented ○ Practice not implemented ––– Practice not applicable or information not available

Source: GAO analysis of Department of Defense data. | GAO-17-333SP

Future Programs Do Not Consistently Plan to Follow Best Practices

	Development start	Projected to demonstrate all critical technologies in an operational environment	Projected to complete all systems engineering reviews	Plan to constrain system development
Long Range Precision Fires	TBD	---	O	●
T-AO 205 John Lewis Class Fleet Oiler	06/2017	●	●	●
P-8A Poseidon Multi-Mission Maritime Aircraft Increment 3	NA	---	O	---
MQ-25 Stingray Unmanned Air System	05/2018	---	O	●
Joint Surveillance Target Attack Radar System Recapitalization	10/2017	---	O	●
Improved Turbine Engine Program	TBD	O	O	●
Amphibious Ship Replacement	TBD	---	O	●
Advanced Pilot Training	12/2017	---	O	●
Weather Satellite Follow-on	06/2018	O	●	●

● Implementation planned, O No implementation planned, —- Practice to be determined

At Critical Design Review, No Programs Met All Best Practices

Knowledge-based practices at critical design review	AMPV	CIRCM	OASuW Inc 1	VH-92A	Other 31 programs ●	Other 31 programs ○	Other 31 programs ——
Demonstrate all critical technologies in an operational environment	●	○	○	——	6	19	6
Release at least 90 percent of drawings	●	●	●	●	10	16	5
Test an early system-level integrated prototype	○	●	○	○	5	19	7
Establish a reliability growth curve	●	●	——	●	21	6	4
Identify key product characteristics	●	——	●	●	27	0	4
Identify critical manufacturing processes	●	——	●	●	25	1	5
Conduct producibility assessments to identify manufacturing risks for key technologies	●	——	●	——	24	2	5
Complete failure modes and effects analysis	●	●	●	●	24	1	6

● Practice implemented ○ Practice not implemented —— Practice not applicable or information not available

Source: GAO analysis of Department of Defense data. | GAO-17-333SP

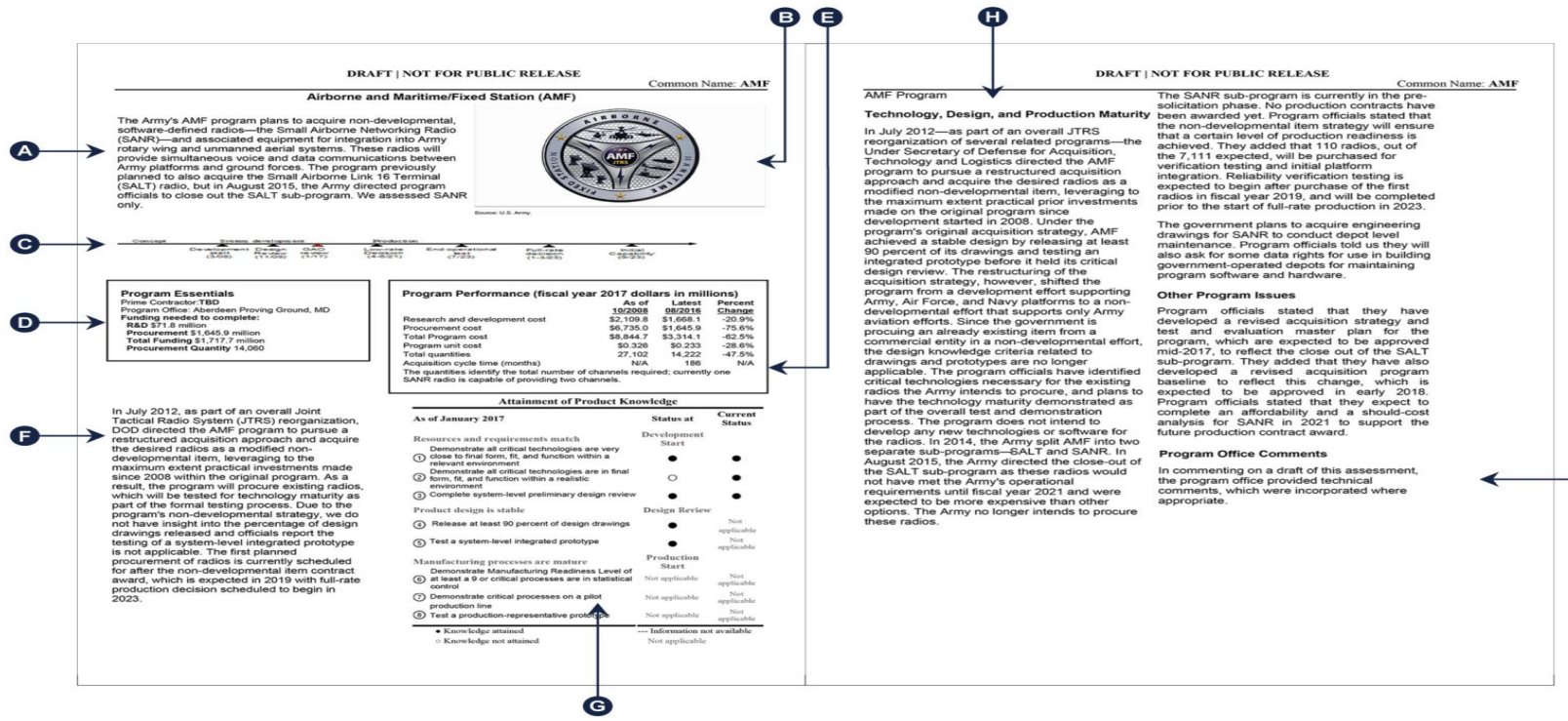
Two of Three Programs Did Not Test a Production-Representative Prototype

Knowledge-based practices at production start	F-22 Inc 3.2 B	KC-46A	OASuW Inc 1	For the 15 non-shipbuilding programs that have reached this juncture[b] ●	○	––
Demonstrate all critical technologies in an operational environment	●	●	●	9	3	3
Release at least 90 percent of drawings	●	●	●	7	4	4
Demonstrate manufacturing process capabilities are in control	○	○	○	1	11	3
Demonstrate critical processes on a pilot production line	○	●	––	8	4	3
Test a production-representative prototype in its intended environment	○	●	○	6	7	2

● Practice implemented ○ Practice not implemented ––– Practice not applicable or information not available

Source: GAO analysis of Department of Defense data. | GAO-17-333SP

Example of an Individual Program Assessment



DRAFT | NOT FOR PUBLIC RELEASE

Common Name: AMF

Airborne and Maritime/Fixed Station (AMF)

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

Source: U.S. Army.

Program Essentials
Prime Contractor: TBD
Program Office: Aberdeen Proving Ground, MD
Funding needed to complete:
R&D $71.6 million
Procurement $1,645.9 million
Total Funding $1,717.7 million
Procurement Quantity 14,060

Program Performance (fiscal year 2017 dollars in millions)

	As of 10/2008	Latest 08/2016	Percent Change
Research and development cost	$2,109.8	$1,668.1	-20.9%
Procurement cost	$6,735.0	$1,645.9	-75.6%
Total Program cost	$8,844.7	$3,314.1	-62.5%
Program unit cost	$0.326	$0.233	-28.6%
Total quantities	27,102	14,222	-47.5%
Acquisition cycle time (months)	N/A	186	N/A

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

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

Attainment of Product Knowledge

As of January 2017	Status at Development Start	Current Status
Resources and requirements match		
① Demonstrate all critical technologies are very close to final form, fit, and function within a relevant environment	●	●
② Demonstrate all critical technologies are in final form, fit, and function within a realistic environment	○	●
③ Complete system-level preliminary design review	●	●
Product design is stable	Design Review	
④ Release at least 90 percent of design drawings	●	Not applicable
⑤ Test a system-level integrated prototype	●	Not applicable
Manufacturing processes are mature	Production Start	
⑥ Demonstrate Manufacturing Readiness Level of at least a 9 or critical processes are in statistical control	Not applicable	Not applicable
⑦ Demonstrate critical processes on a pilot production line	Not applicable	Not applicable
⑧ Test a production-representative prototype	Not applicable	Not applicable

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

DRAFT | NOT FOR PUBLIC RELEASE

Common Name: AMF

AMF Program

Technology, Design, and Production Maturity

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

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

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

Other Program Issues

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

Program Office Comments

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

- **A** Program description
- **B** Illustration or photo of system
- **C** Schedule timeline identifying key dates for the program including the start of development, major design reviews, production decisions, and planned operational capability
- **D** **Program Essentials** Programmatic information including the prime contractor, program office location, and funding needed to complete
- **E** **Program Performance** Cost and schedule baseline estimates and the latest estimate provided as of January 2017
- **F** Brief summary describing the program's implementation of knowledge-based acquisition practices and its current status
- **G** **Attainment of Product Knowledge** Depiction of selected knowledge-based practices and the program's progress in attaining that knowledge
- **H** Assessment of program's technology, design, and production maturity, as well as other program issues
- **I** **Program Office Comments** General comments provided by the cognizant program office

Source: GAO analysis. | GAO-17-333SP

Back up Slides

Individual Program Assessments

One Page (12)	Two Pagse (43)		
APT	3DELRR	F-35	MGUE
DDG 51	ACV	FAB-T CPT	MQ-4C Triton
Frigate	AMDR	G/ATOR	MQ-8 Fire Scout
ITEP	AMF JTRS	GPS III	NGJ
JSTARS Recap	AMPV	IAMD	OASuW
LRPF	B-2 DMS	IFPC 1-I Blk 1	OCX
LX(R)	CH-53K	JAGM	PAC-3 MSE
MQ-25	CIRCM	JLTV	SDB II
P-8A Inc 3	CRH	JPALS	Space Fence
PAR	CVN 78	JTRS HMS	SSBN 826
T-AO 205	DDG 1000	KC-46A	SSC
WSF-M	EELV	LCS	VH-92A
	EPS	LCS MM	WIN-T
	F-15 EPAWSS	LHA 6	
	F-22 3.2B	M109A	

Early Systems Engineering Positions Programs for Success

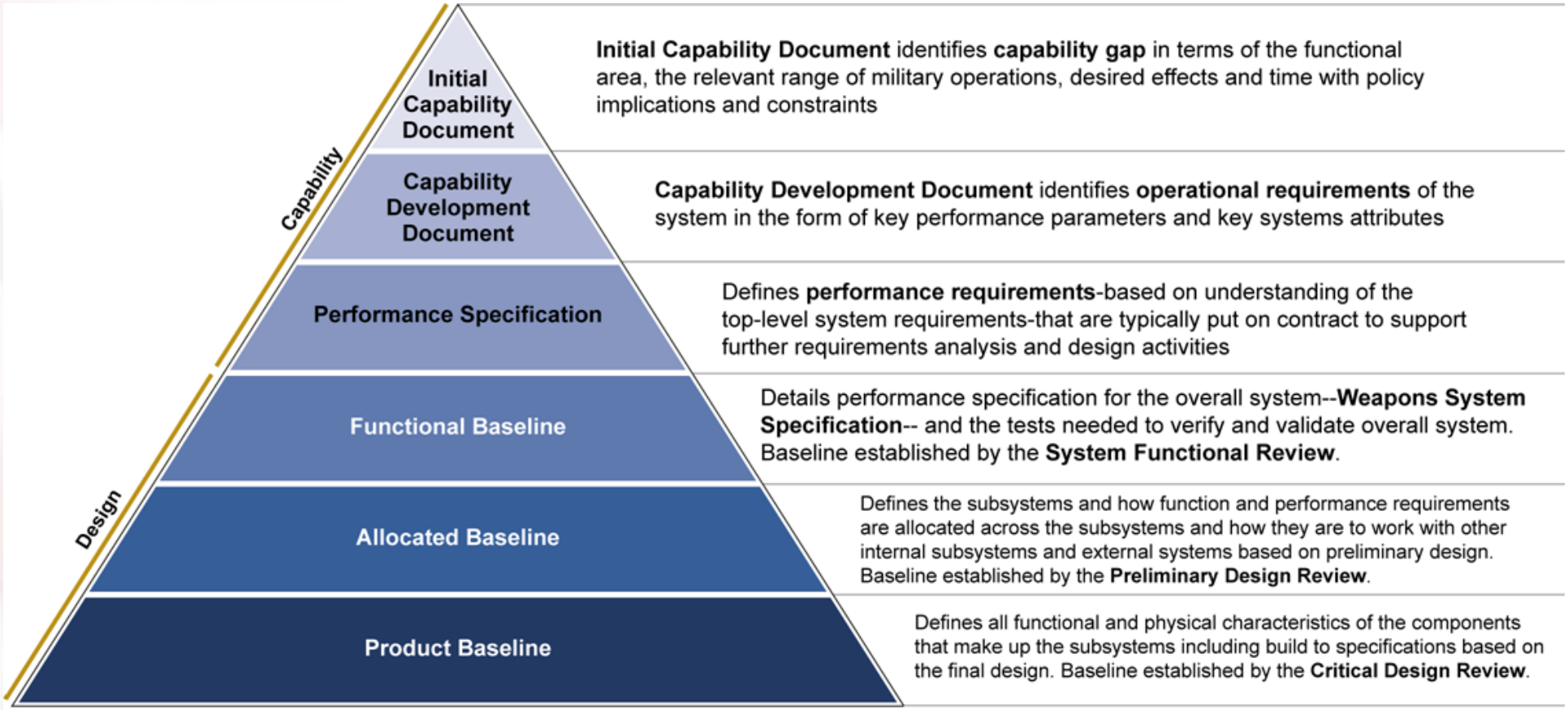
Travis J. Masters, Assistant Director
U.S. Government Accountability Office
Acquisition and Sourcing Management Team

April 2017

Requirements Lay the Foundation for a Program Business Case

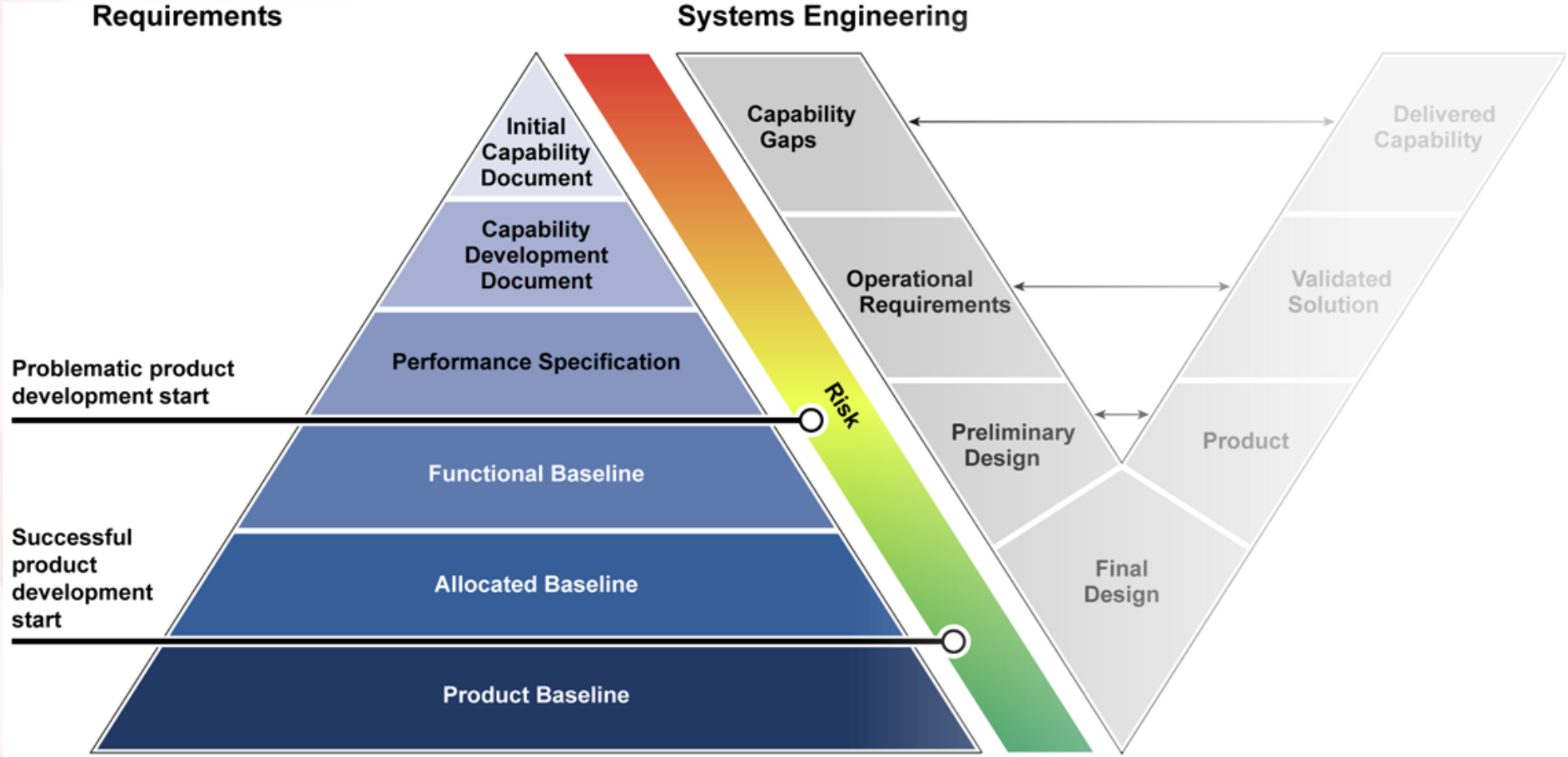
- Capability requirements exist that warrant a materiel solution consistent with national military strategy priorities.
- Capability requirements have been decomposed into design requirements through systems engineering.
- The materiel developer has the resources—including mature technologies and design knowledge—necessary to meet the design requirements and ultimately the capability requirements.
- The materiel developer has a knowledge-based product development and production plan with reasonable cost and schedule estimates.
- Funding is available to fully resource the product development and production plan.

What Requirements?



Source: GAO analysis of Department of Defense policy and guidance. | GAO-17-77

Relationship among Requirements, Systems Engineering, and Program Risk



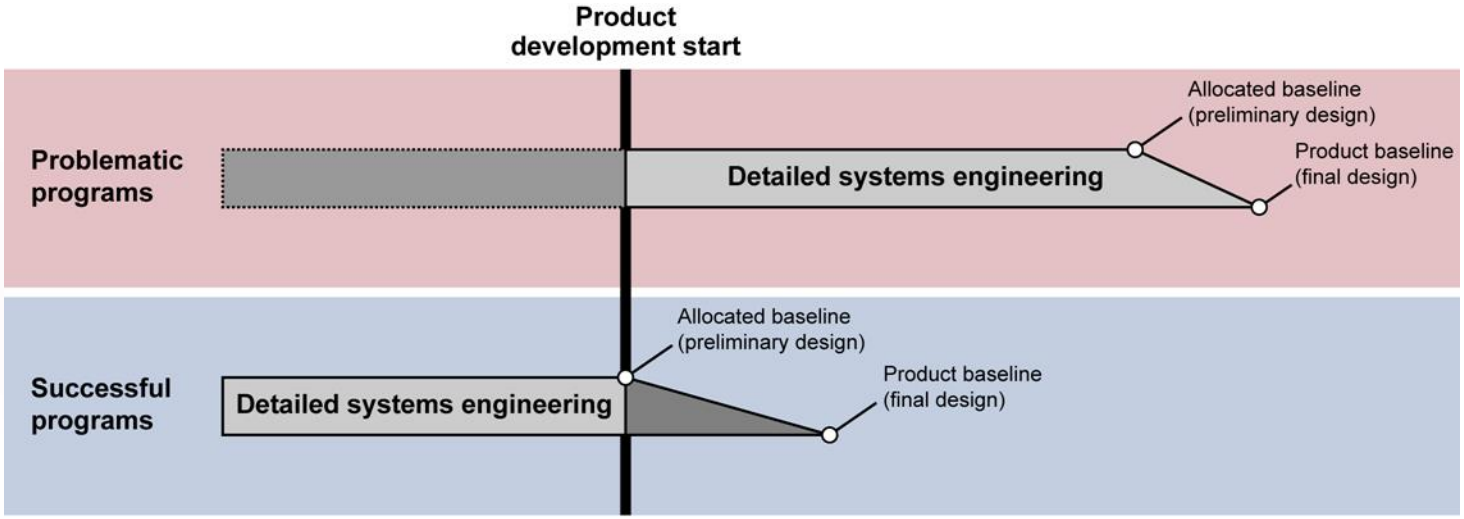
Source: GAO analysis of Department of Defense policy, guidance and selected programs. | GAO-17-77

Identifying and Meeting the Challenges Posed by Capability Requirements

- Four factors frame the challenge posed by capability requirements
  - **Acquisition Approach** – do the requirements lend themselves to an incremental or single-step development approach?
  - **Technology Status** – are key technologies available and sufficiently mature, or do the requirements demand significant changes to the form, fit, or function of existing technologies or the invention of new technologies?
  - **Design Maturity** – can the requirements be met with a modified version of an existing system (operational or prototype), or will a new and unprecedented design be needed?
  - **Program Interdependency** – do the requirements lend themselves to a largely standalone solution or will a "system of systems" likely be needed?

Systems Engineering is key To Understanding Whether and How the Challenge Can Be Met

- Challenging requirements don't have to become acquisition problems.
- Detailed systems engineering analysis done before product development can help programs understand and account for risks.
- Risks can not all be avoided, but they must be understood, acknowledged, and adequately resourced if carried into development.



Source: GAO analysis of Department of Defense guidance and selected program data. | GAO-17-77

General Findings of Nine Program Case Studies

- Three programs began with less challenging requirements and conducted early, robust systems engineering to achieve an executable business cases. Their outcomes have been good.

- Three programs began with slightly greater requirements challenges, but the early systems engineering analysis they did allowed them to understand and plan for the associated risks. They have experienced moderate cost and schedule growth.

- Three programs began with highly challenging requirements and conducted The bulk of the detailed systems engineering after development started. They have encountered significant cost and schedule problems.

Case Study Programs and Outcomes

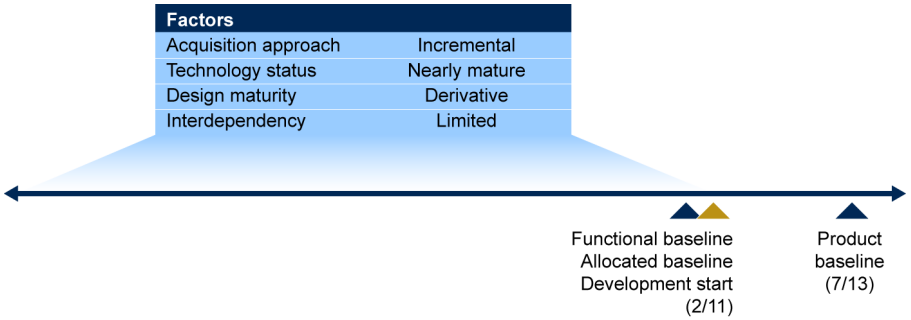
(Then-year dollars in millions)

Program	Initial estimate	Current estimate	Percent change	Acquisition cycle time growth since initial estimates (in months)
KC-46A Tanker Modernization Program	$7,149.6	$6,259.6	-12%	14
Joint Light Tactical Vehicle	$1,009.8	$948.9	-6%	19
Small Diameter Bomb Increment I	$381.3	$367.7	-4%	-1
Paladin Integrated Management/M109A7 Family of Vehicles	$1,041.7	$1,098.6	5%	2
P-8A Poseidon Multi-mission Maritime Aircraft Increment I	$6,975.5	$7,940.4[a]	14%	4
Global Positioning System III	$2,512.0	$3,018.6	20%	n/a
CH-53K Heavy Lift Replacement Helicopter	$4,366.4	$6,598.3	51%	51
F-35 Lightning II Program	$34,400.0	$55,133.0	60%	62
Integrated Air and Missile Defense	$1,672.5	$2,632.9	62%	22

Source: GAO analysis of DOD data.
Note: Acquisition cycle time is calculated from the start of product development to initial operational capability. We could not calculate acquisition cycle times for the first increment of the Global Positioning III program because initial operational capability will not occur until satellites from a future increment are fielded. For the P-8A Increment I current estimate, we used the P-8A budget estimate from February 2016 to separate increment I cost from increment II.

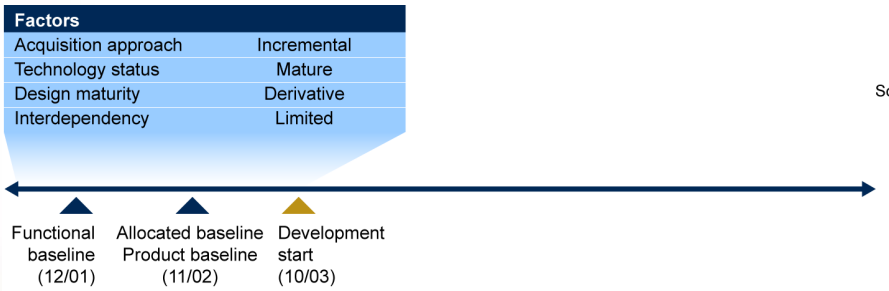
Programs with Little Risk and Better Outcomes

KC-46A Tanker Modernization



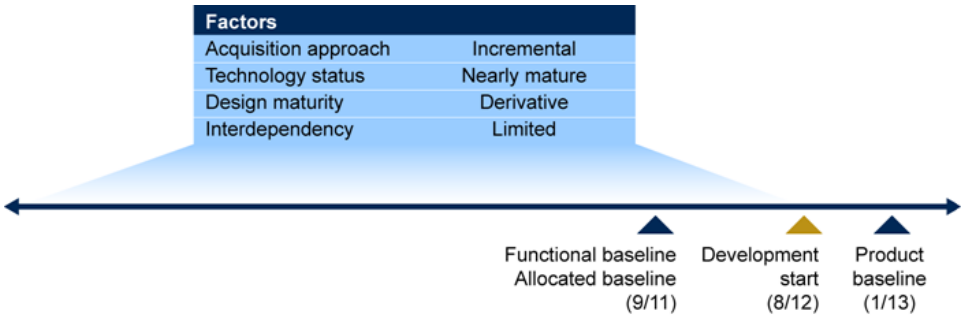
Source: GAO analysis of Department of Defense data. | GAO-17-77

Small Diameter Bomb Increment I



Source: GAO analysis of Department of Defense data. | GAO-17-77

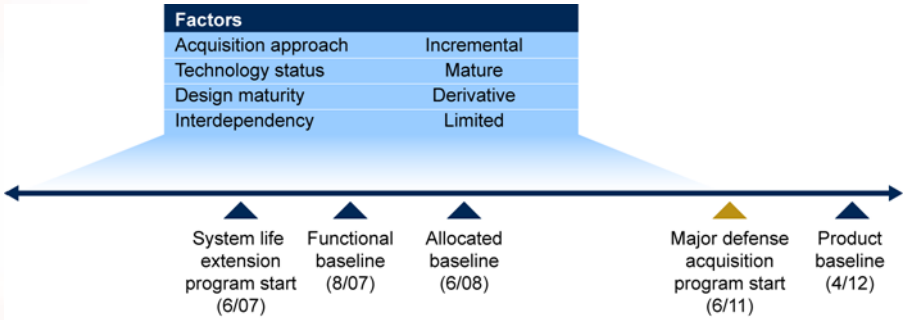
Joint Light Tactical Vehicle



Source: GAO analysis of Department of Defense data. | GAO-17-77

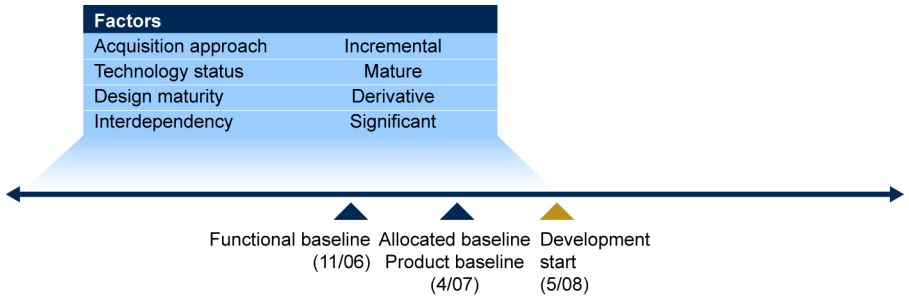
Programs with Moderate Risk and Some Cost and Schedule Growth

Paladin Integrated Management



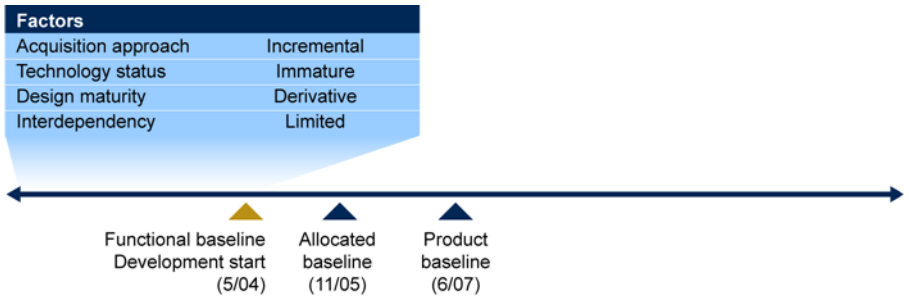
Source: GAO analysis of Department of Defense data. | GAO-17-77

Global Positioning System III



Source: GAO analysis of Department of Defense data. | GAO-17-77

P-8A Poseidon Multi-Mission Maritime Aircraft Increment I

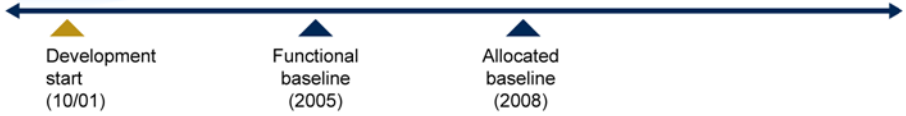


Source: GAO analysis of Department of Defense data. | GAO-17-77

Programs with High Risk and Significant Cost and Schedule Growth

F-35 Lightning II

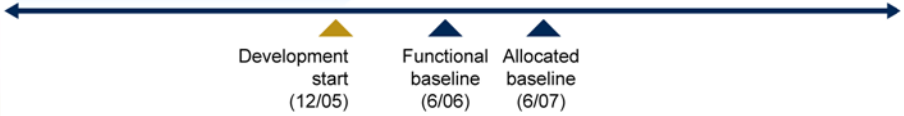
Factors	
Acquisition approach	Single step
Technology status	Immature
Design maturity	New
Interdependency	Limited



ırce: GAO analysis of Department of Defense data. | GAO-17-77

CH-53K Heavy Lift Replacement Helicopter

Factors	
Acquisition approach	Single step
Technology status	Immature
Design maturity	New
Interdependency	Limited



Source: GAO analysis of Department of Defense data. | GAO-17-77

Integrated Air and Missile Defense

Factors	
Acquisition approach	Incremental
Technology status	Nearly mature
Design maturity	New
Interdependency	Significant

Source: GAO analysis of Department of Defense data. | GAO-17-77

Misaligned Budget and Acquisition Processes Pose Challenges to Oversight

- Current DOD budget processes and mechanisms require Congress to make funding decisions well in advance of the decision to begin product development.

- At the time of the budget decision many of the elements of a business case are still in draft and not available to Congress to inform their decisions.

- Information like that in a Systems Engineering Plan could provide useful insights about requirements risks and remaining systems engineering analyses to Congress as it considers funding a program.

Early Insights Into Systems Engineering Status Can Enhance Oversight

- Providing Congress with information on the challenges posed by requirements (the factors) and the status of systems engineering analysis when a funding request is made, would provide useful insight into risks facing a proposed program and could allow for more robust budget deliberations.

Source: GAO analysis of Department of Defense data. | GAO-17-77

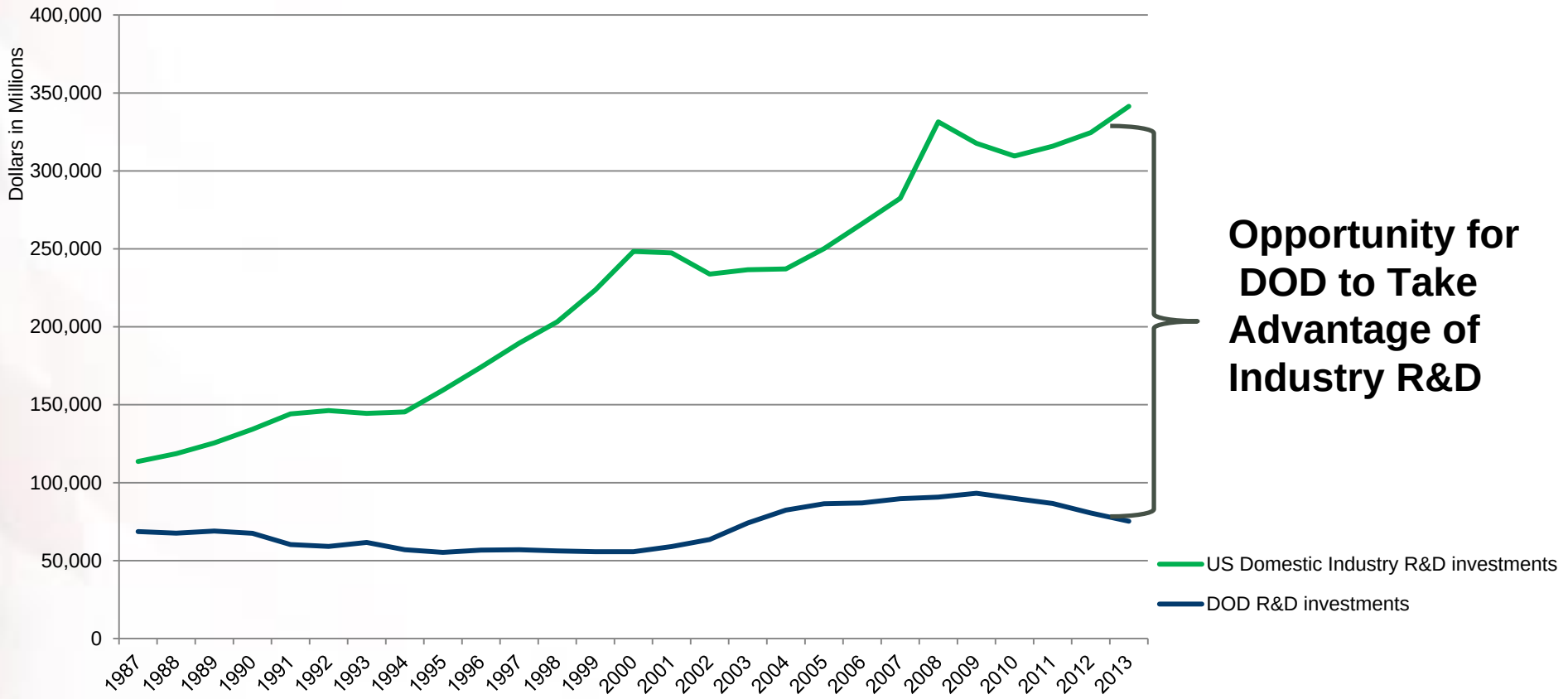
Acquisition Reform: Encouraging Non-Traditional Companies to Do Business With DOD

Cheryl K. Andrew, Assistant Director
U.S. Government Accountability Office
Acquisition and Sourcing Management Team

April 2017

Evolution of Acquisition Reform

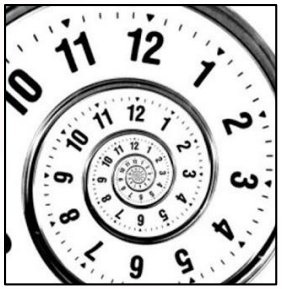
Research and Development Spending Trend



Aspects of DOD's Acquisition Process that Cause Challenges for Commercial Companies

Complex Acquisition Environment

Budget Uncertainty



Contracting timelines

Inexperienced Workforce

Intellectual property rights

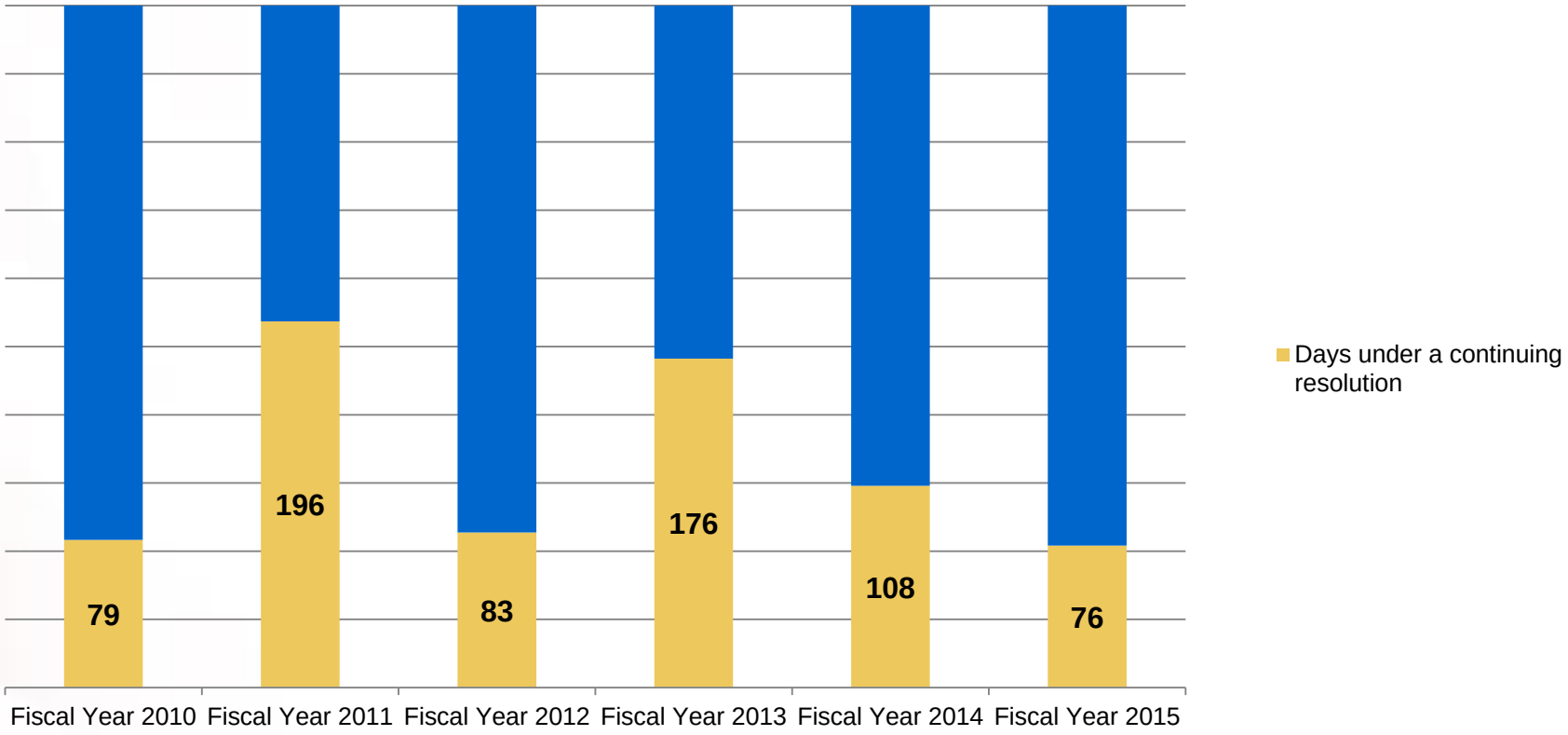
Contract terms and conditions

Government-specific business systems

Complex Acquisition Environment

- Multiple decision-makers
- Security Clearances
- High Barriers to Entry

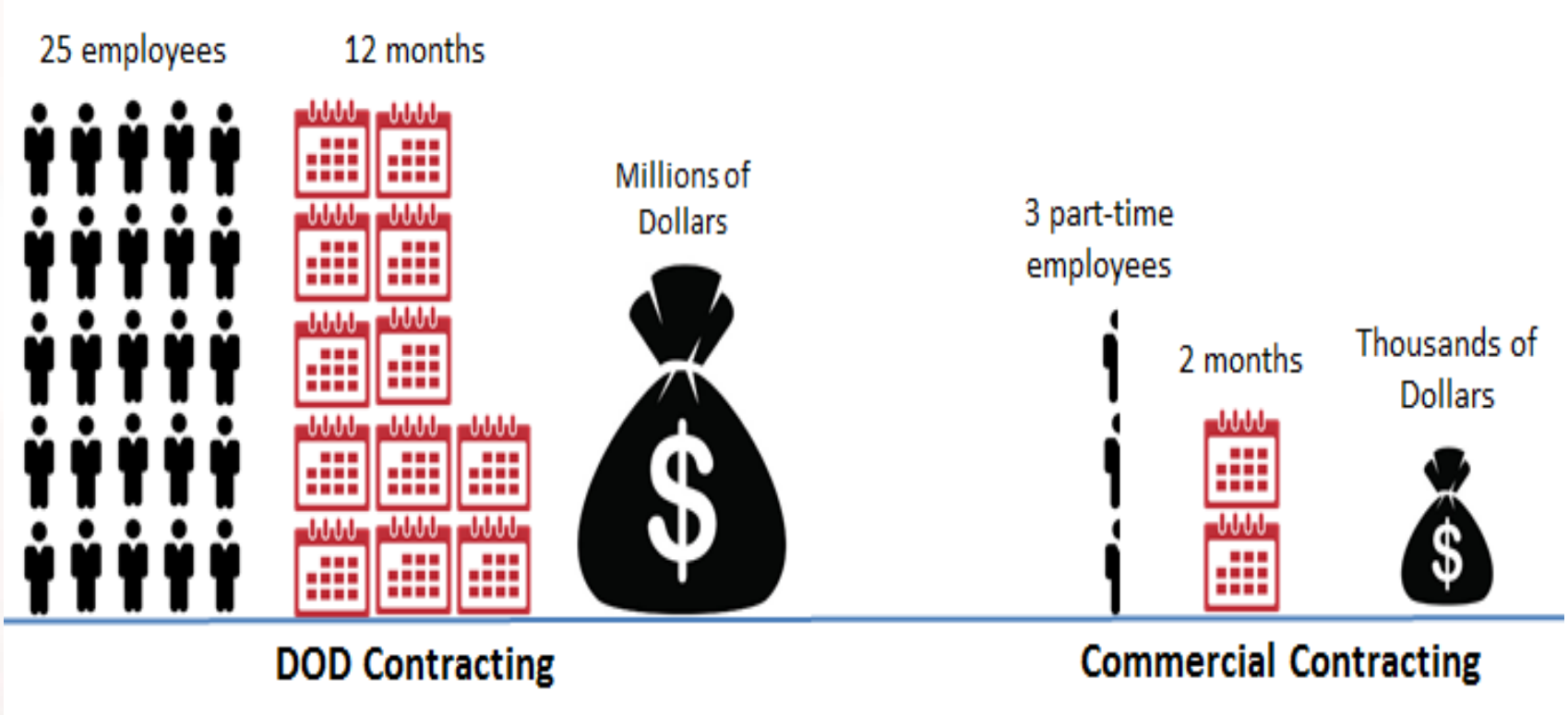
DOD Budget Uncertainty



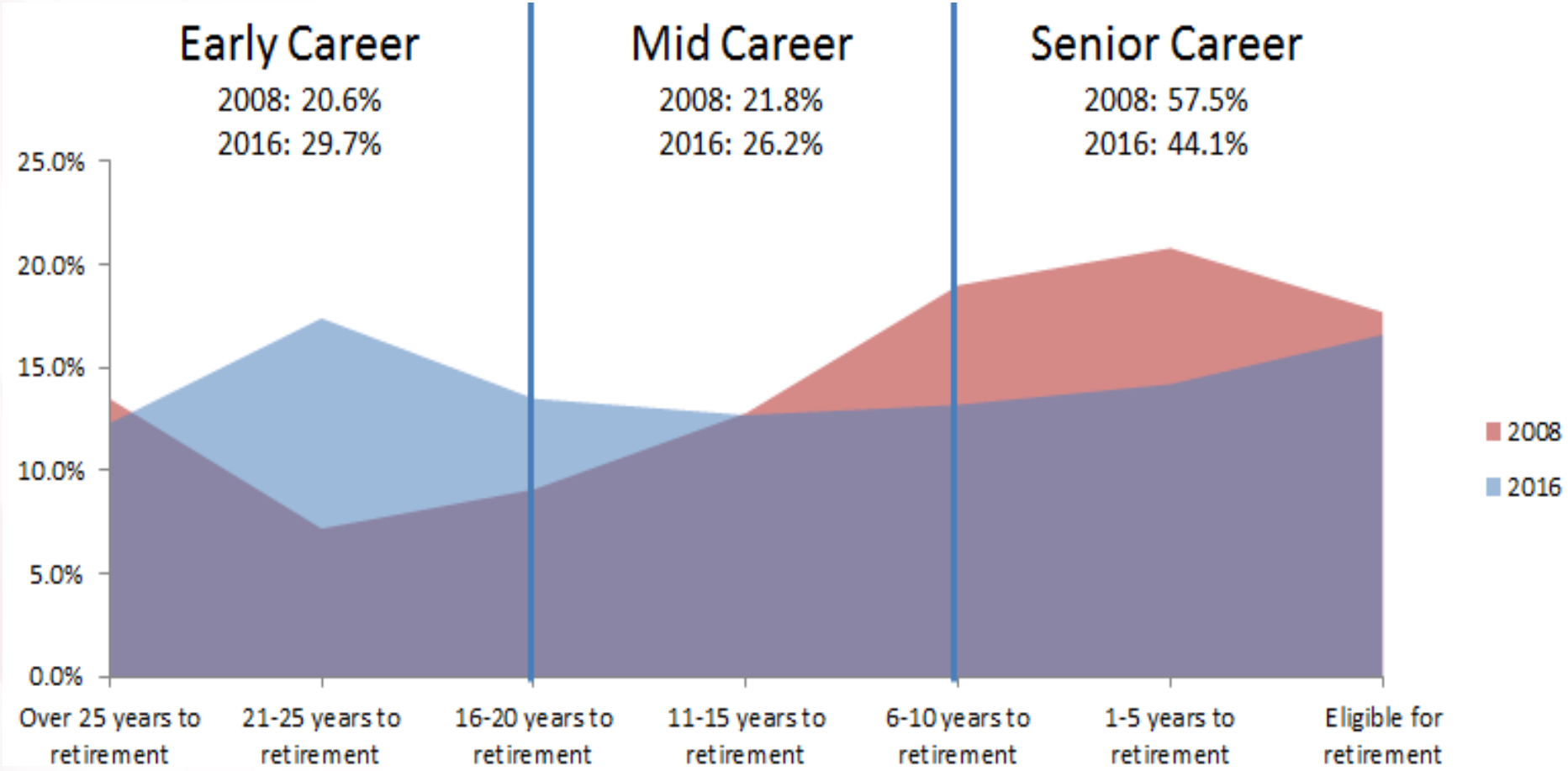
Example of Army Contract Timelines

Dollar Value	Procurement Administrative Lead Time	
	Competitive Contracts	Non-Competitive Contracts
<$25,000	55	55
$25,000-<$1 million	75	100
$1 million - < $50 million	180	250
$50 million - $250 million	600	520
$250 million - $1 billion	630	550
>$500 million	Did not provide	610
>$1 billion	700	Did not provide

Competing for DOD and Commercial Contracts



Change in DOD Contracting Workforce Demographics (Comparison of FY 2008 and 2016 data)



Aspects of DOD's Acquisition Process that Deter Companies from Developing Products for DOD's Use

Intellectual property rights

Contract terms and conditions

Government-specific business systems

Congressional Legislation Aimed at Simplifying Acquisition Procedures

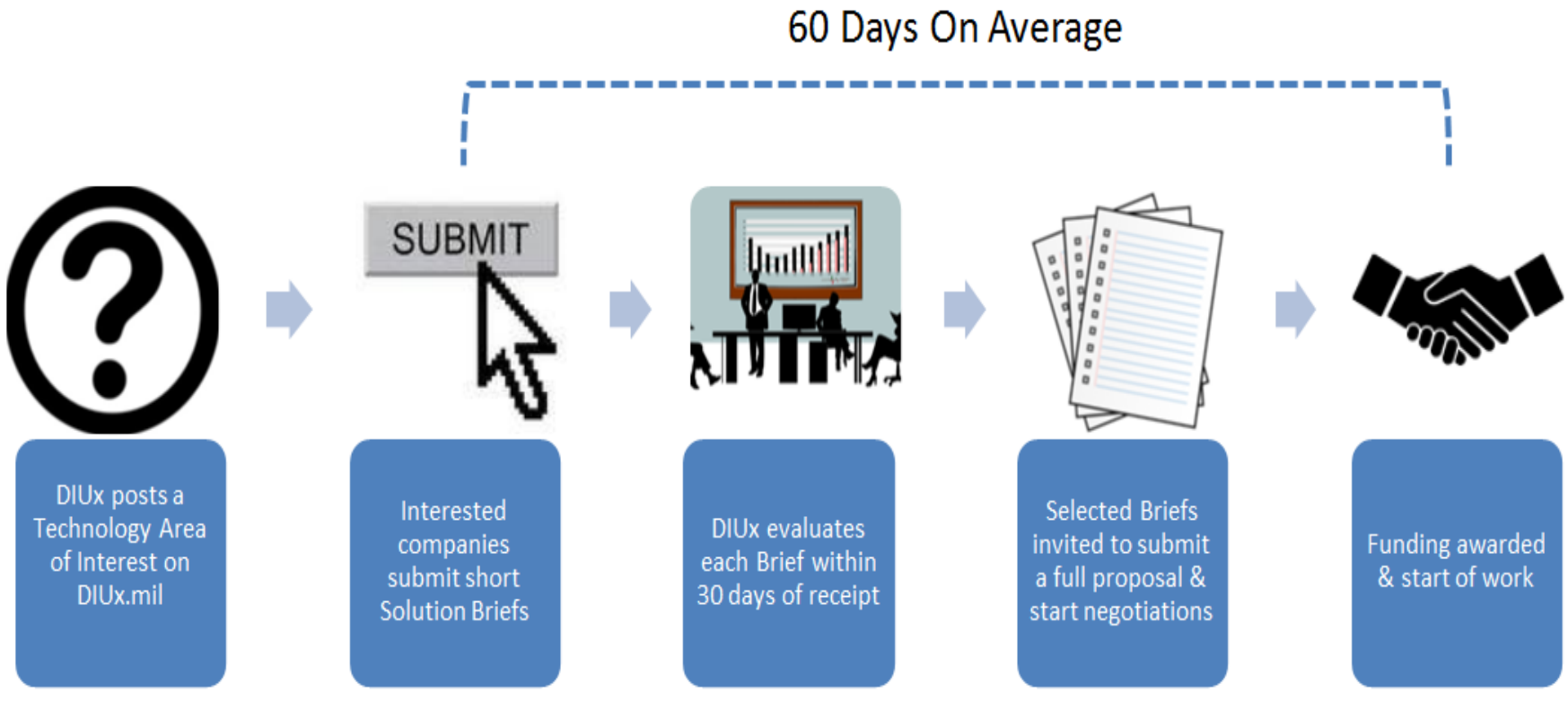
Fiscal Year 2016 Provisions

- Codifies and expands Other Transaction Authority
- Requires DOD to identify and justify contract clauses applicable to commercial items acquisitions
- Requires DOD to develop commercial item determination expertise
- Limits DOD's ability to convert a commercial item acquisition to a FAR Part 15 negotiated procurement
- Established an advisory panel to study ways to streamline acquisition regulations

Fiscal Year 2017 Provisions

- Requires DOD to minimize the use of government-unique clauses
- Amends DFAR to include a list of defense-unique laws and contract clauses that are inapplicable to commercial item acquisitions
- Exempts non-traditional companies from establishing cost accounting systems
- Minimizes FAR Part 15 contract requirements in subcontracts
- Requires DOD to establish a personnel security program to quickly investigate and adjudicate security clearances

DIUx Uses Streamlined Process to Fund Innovative Projects



Other GAO Reviews that Will Provide Additional Perspectives on Challenges

- Commercial Item Determinations
- Contract Award Times
- Prototyping
- Defense Acquisition Workforce Development Fund (DAWDF)

GAO on the Web

Web site: http://www.gao.gov/

Congressional Relations

Katherine Siggerud, Managing Director, siggerudk@gao.gov
(202) 512-4400, U.S. Government Accountability Office
441 G Street, NW, Room 7125, Washington, DC 20548

Public Affairs

Chuck Young, Managing Director, youngc1@gao.gov
(202) 512-4800, U.S. Government Accountability Office
441 G Street, NW, Room 7149, Washington, DC 20548

Copyright