Fall 2013

Analysis of US Government Accounting Office Reports: Management Practices in US Space Weapon Programs

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Analysis of U.S. Government Accounting Office Reports: Management Practices in U.S. Space Weapon Programs

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4 December 2013

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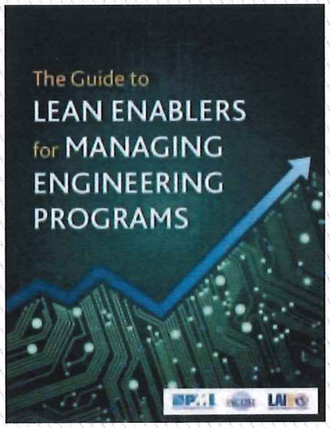
Introduction

- Determine the effectiveness of DoD space weapon programs' management and leadership using data from GAO reports

- This study will supplement data mining efforts for Dr. Bohdan Oppenheim's space program research, which will map Lean Enablers described in *The Guide to Lean Enablers for Managing Engineering Programs*, J. Oehmen et al, ed., PMI-INCOSE-MIT, 2012
  - *Lean Enablers* jointly developed by aerospace experts using the *Lean Thinking* concepts (PMI-INCOSE-MIT study)



DoD: Department of Defense
MIT: Massachusetts Institute of Technology
GAO: U.S. Government Accounting Office
PMI: Program Management Institute
INCOSE: International Council of Systems Engineering

Objectives

- Review GAO reports to mine data related to the leadership and management of U.S. space weapon programs
  - Ten major acquisition programs selected based on development date

SBIRS	GPS IIF	GPS III	GPS OCX	JMS
MUOS	AEHF	SBSS	NPOESS	PTSS

- Compare GAO's weapon acquisition best practices with DoD practices in acquiring U.S. space weapon systems

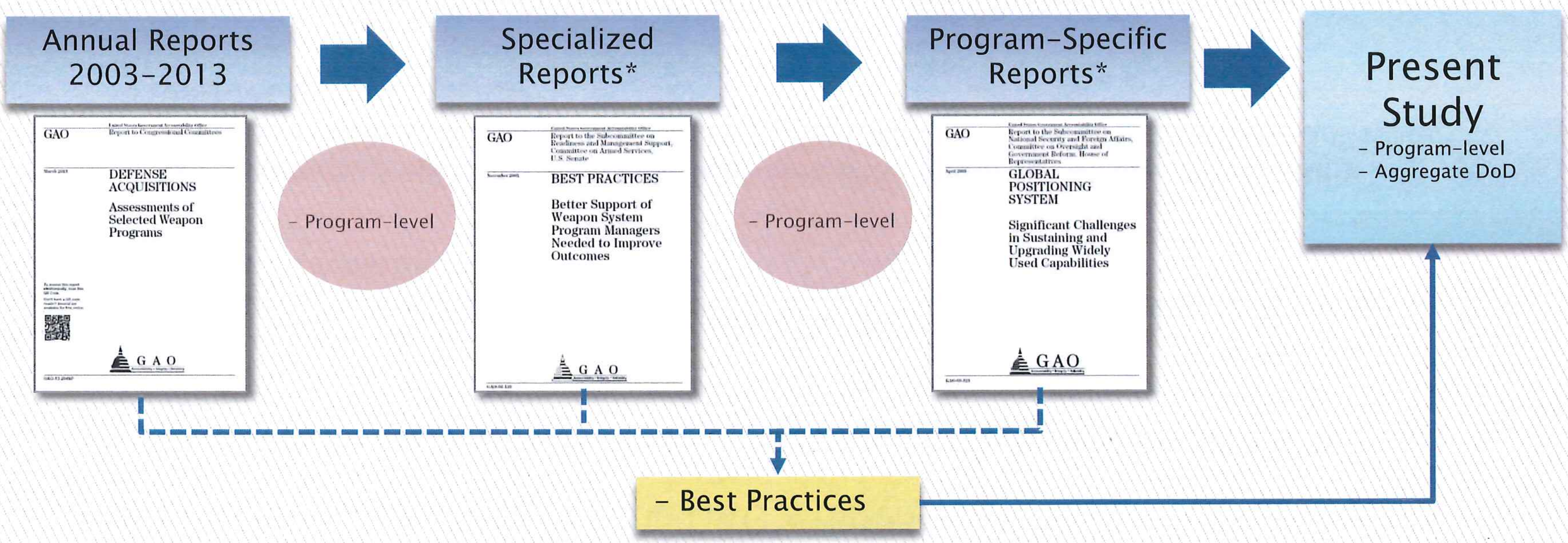
- List the applicable Lean Enablers

- Observe effects of the 2009 DoD acquisition reform in U.S. space programs

DoD: Department of Defense GAO: U.S. Government Accounting Office

Methodology
(1 of 2)

- Data extracted from GAO and SAR reports and other open sources



*Reviewed specialized/program-specific result when available

DoD: Department of Defense
SAR: Selected Acquisition Report

GAO: U.S. Government Accounting Office

Methodology (2 of 2)

- Used the following subset of the GAO's defense acquisition best practices*

1. Performance requirements: Prevent cost and schedule overruns with requirements stability
2. DoD program manager tenure: Reduce DoD program management turnover during system development
3. Government workforce composition: Size DoD program offices adequately (manpower and technical expertise) to perform program management activities and technical oversight
4. Systems engineering: Execute disciplined, knowledge-based processes during product development
5. Support from top DoD leadership: Ensure an executable business case is delivered to DoD program managers and hold DoD program managers accountable for successful outcomes

*GAO, Best Practices: Better Support of Weapon System Program Managers Needed to Improve Outcomes, GAO-06-110, (Washington, D.C., November 31, 2005)

DoD: Department of Defense

GAO: U.S. Government Accounting Office

Assumption

- GAO reports contain accurate data and analysis

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Limitations

- GAO reports analyze aggregate DoD performance and provide high-level overview of programmatic issues
  - Program-specific management shortfalls generally not addressed in GAO reports
  - When program-specific management information not available, the program's performance was mapped to GAO's best practices
- GAO reports generally do not analyze a specific program unless requested by Congress or a Committee
- Study does not evaluate raw data
- Study does not include Missile Defense Agency cost, schedule or performance data

DoD: Department of Defense GAO: U.S. Government Accounting Office TRL: Technology Readiness Level

DoD Portfolio Overview

- DoD weapon system acquisition tracked as high-risk by GAO (1990)*
- Overall improvement in 2012 DoD acquisition performance+
  - Buying power (reduction in acquisition unit cost) increased by 60%
  - Programs implementing affordability requirements increased by 70%
  - 90% of programs performed "should-cost" analysis; savings: 25% realized, 49% anticipated
- DoD's 2012 weapon system portfolio contained 86 programs (10% reduction)+
  - Program cancellation or restructuring (lowest portfolio number in 5 years)

	2000	2005	2007	2012
Number of Programs	75	91	95	86
Total Cost	$790 Billion	$1.5 Trillion	$1.6 Trillion	$1.6 Trillion
Avg. Schedule Delay to IOC	16 months	17 months	21 months	27 months

*GAO, Defense Acquisition: Assessment of Selected Weapon Programs, GAO-05-301, (Washington, D.C., March 31, 2005)

+GAO, Defense Acquisition: Assessment of Selected Weapon Programs, GAO-13-249SP, (Washington, D.C., March 31, 2013)

Lean Enablers Matched to Select Programs Summary

42 Lean Enablers or Sub-enablers applicable to one or more programs

Lean Enabler	Number of programs that would benefit from the Enabler
2.3.6	1
2.4	7
2.4.1	5
2.4.10	4
2.4.12	1
2.4.2	3
2.4.3	1
2.4.4	2
2.4.6	5
2.4.7	1
2.6	1
3.1	3
3.2	1
3.2.2	2
3.3	4
3.4	9
3.4.2	1
3.4.3	1
3.10	7
3.10.6	3
3.10.7	4
3.10.9	1
3.10.11	1

Lean Enabler	Number of programs that would benefit from the Enabler
4.1	8
4.1.2	1
4.2	4
4.2.2	3
4.2.3	2
4.2.5	1
4.2.6	2
4.3	2
4.3.1	1
4.3.3	1
4.4	3
4.4.1	3
4.4.2	3
4.6.4	1
4.8.5	1
5.2	3
6.5	8
6.6	6
6.6.6	2

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Space Based Infrared Systems (SBIRS) (1 of 5)

Program description

- Infrared intelligence, surveillance and reconnaissance
- Replace Defense Support Program

Missions*	DSP	SBIRS	STSS
Missile Warning	Primary	Primary	Inherent
Missile Defense		Primary	Primary
Technical Intelligence		Primary	Inherent
Battlespace Awareness		Primary	Inherent

Program details+

- **Lead DoD Agency:** Air Force
- **Prime Contractor:** Lockheed Martin Space Systems
- **Original total program cost:** $4.7 billion
- **Current total program cost:** $18.8 billion (300% growth)
- **Original quantity:** 5
- **Current quantity:** 6
- **Original schedule:** 2002 (1st sat.); 2006 (final)
- **Current schedule:** 2011 (1st sat.); 2018 (final)
- **# Technologies below TRL 6 at dev. start:** 3 of 3
- **# Nunn-McCurdy breach:** 4

Concept — System Development — Production

- Development start (1996)
- Design review and production decision (2001)
- First Satellite launch (2011)
- Second satellite delivery (2012)
- Third satellite delivery (2015)
- Fourth satellite delivery (2016)

*GAO, Space Based Infrared System High Program and its Alternative, GAO-07-1088R, (Washington, D.C., September 12, 2007)

+GAO, Space Acquisitions: DoD is Overcoming Long-standing Problems, but Faces Challenges to Ensuring its Investments are Optimized, GAO-13-508T, (Washington, D.C., April 24, 2013)

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Space Based Infrared Systems (SBIRS) (2 of 5)

Best Practice : Prevent cost and schedule overruns with requirements stability

- SBIRS program development began with unclear system-level requirements*
  - 94 system-level requirement modified & 16 requirements added after CDR (2001)*
- Requirement refinement process was ad hoc without clear direction of program priorities*
  - High-level requirements not well-defined nor decomposed (prior to 2005)
  - 4 ORD requirements not be met under approved design
- Production began with 50% of expected drawings
  - 39 design modifications to first infrared sensor (for hosted payload)
  - 2 design modifications to first SBIRS satellite
  - 34 contract actions - added/clarified requirements ($203.8 million)
- First and second hosted payloads accepted without meeting all program requirements
  - Subsequent hosted payload design modified for future IR sensors

*GAO, Defense Acquisition: Despite Restructuring, SBIRS High Program Remains at Risk of Cost and Schedule Overruns, GAO-04-48, (Washington, D.C., October 2003)

Space Based Infrared Systems (SBIRS) (2 of 5)

Best Practice : Prevent cost and schedule overruns with requirements stability

- SBIRS program dev… *
  - 94 syst… CDR (2001)*
- Requiremen… …gram priorities*
  - High-… …005)
  - 4 ORD…
- Production…
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  - 2 design modifications to first SBIRS satellite
  - 34 contract actions - added/clarified requirements ($203.8 million)
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Lean Enablers

- ❑ 2.4.3
- ❑ 2.4.4
- ❑ 2.4.6
- ❑ 2.4.10
- ❑ 2.4.12

*GAO, Defense Acquisition: Despite Restructuring, SBIRS High Program Remains at Risk of Cost and Schedule Overruns, GAO-04-48, (Washington, D.C., October 2003)

Space Based Infrared Systems (SBIRS) Lean Enablers

- 2.4.3 If the customer lacks the expertise to develop clear requirements, issue a contract to a proxy organization with towering experience and expertise to sort out and mature the requirements, including personal accountability

- 2.4.4 Prevent careless insertion of mutually competing and conflicting requirements, excessive number of requirements, standards, and rules to be followed in the program, for example mindless "cut-and-paste" of requirements from previous programs

- 2.4.6 Insist that a single person is in charge of the entire program requirements to assure consistency and efficiency throughout

- 2.4.10 Require an independent mandatory review of the program requirements, concept of operation, and other relevant specifications of value for clarity, lack of ambiguity, lack of conflicts, stability, completeness, and general readiness for contracting and effective program execution

Space Based Infrared Systems (SBIRS) (3 of 5)

Best Practice :
Reduce DoD program management turnover during system development

- SBIRS DoD program manager historical timelines not available in GAO reports
- Prime contractor program manager tenure restructured in 2002
  - Prevent uncontrolled changes to the baseline*
  - Vice Presidents assigned to major functional areas

*GAO, Defense Acquisition: Despite Restructuring, SBIRS High Program Remains at Risk of Cost and Schedule Overruns, GAO-04-48, (Washington, D.C., October 2003)

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Space Based Infrared Systems (SBIRS) (3 of 5)

Best Practice : Reduce DoD program management turnover during system development

- SBIRS DoD
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Lean Enablers

- ❑ 4.4 The top-level program management (e.g., program management office) overseeing the program must be highly effective
- ❑ 4.4.1 Program management staff turnover and hiring rates must be kept low

*GAO, Defense Acquisition: Despite Restructuring, SBIRS High Program Remains at Risk of Cost and Schedule Overruns, GAO-04-48, (Washington, D.C., October 2003)

Space Based Infrared Systems (SBIRS) (4 of 5)

Best Practice :
Execute disciplined, knowledge-based processes during product development

- Development started with 3 of 3 immature critical technologies*
- Program lacked basic systems engineering practices*
  - 2002 Independent Review Team (IRT)
- Flawed initial SE resulted in SBIRS sensor and satellite integration issues

*GAO, Defense Acquisition: Despite Restructuring, SBIRS High Program Remains at Risk of Cost and Schedule Overruns, GAO-04-48, (Washington, D.C., October 2003)

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Space Based Infrared Systems (SBIRS) (4 of 5)

Best Practice : Execute disciplined, knowledge-based processes during product development

- Developm
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Lean Enablers

- ❑ 3.4 Ensure up-front that capabilities exist to deliver program requirements
- ❑ 3.10 Manage technology readiness levels and protect program from low-TRL delays
- ❑ 4.1 Use systems engineering to coordinate and integrate all engineering activities in the program

*GAO, Defense Acquisition: Despite Restructuring, SBIRS High Program Remains at Risk of Cost and Schedule Overruns, GAO-04-48, (Washington, D.C., October 2003)

Space Based Infrared Systems (SBIRS) (5 of 5)

Best Practice :
Ensure an executable business case is delivered to DoD program managers and hold DoD program managers accountable for successful outcomes

- Program manager experienced funding instability
  - 1998 DoD delayed satellite launch to fund other priorities
  - Contractor stopped work →lost technical expertise
  - Added 25-60 months delay for re-planning*
- Total System Performance Responsibility; inflexible to incentivize contractor
- GAO cannot calculate cost associated with weak program management*

*GAO, Defense Acquisition: Despite Restructuring, SBIRS High Program Remains at Risk of Cost and Schedule Overruns, GAO-04-48, (Washington, D.C., October 2003)

Space Based Infrared Systems (SBIRS) (5 of 5)

Best Practice :
Ensure an executable business case is delivered to DoD program managers and hold DoD program managers accountable for successful outcomes

- Program
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Lean Enablers

- ❑ 3.10.7 Provide stable funding for technology development and maturation. This will support a steady, planned pipeline of new technologies to be inserted into the program
- ❑ 5.2 Establish effective contracting vehicles in the program that support the program in achieving the planned benefits and create effective pull for value

*GAO, Program Remains at Risk of Cost and Schedule Overruns, GAO-04-48, (Washington, D.C., October 2003)

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Global Positioning System (GPS) IIF (1 of 6)

Program description	Program details*
- Space-based radio positioning, navigation, and time distribution system - Designed to upgrade timing and navigation accuracy and add a new L5 signal for civilian use*	**Lead DoD Agency:** Air Force **Prime Contractor:** Boeing **Original total program cost:** $729 million **Current total program cost:** $2.6 billion (257% growth) **Original quantity:** 19 **Current quantity:** 12 **Original schedule:** 2006 (1st sat.) **Actual schedule:** 2010 (1st sat.) **# Technologies below TRL 6 at dev. start:** 0+ **# Nunn-McCurdy breach:** 1 (min.)

Concept — System Development — Production

Development start (2000)
Design review (2001)
Production decision (2002)
First Satellite Available for launch (2010)

*OSD, Selected Acquisition Report: NAVSTAR Global Positioning System, DD-A&T(Q&A)823-166, (Washington, D.C., December 31, 2012)

+GAO, Defense Acquisition Assessment of Selected Weapon Programs, GAO-07-406SP, (Washington, D.C., March 2007)

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Global Positioning System (GPS) IIF (2 of 6)

Best Practice :
Prevent cost and schedule overruns with requirements stability

- Requirements added after development start → delayed launch (4 years)
- Design modifications resulted in technical issues and cost overruns*
  - New civilian and military GPS signals and flexible power
  - Redesigned L1 transmitter

*GAO, GPS: Significant Challenges in Sustaining and Upgrading Widely Used Capabilities, GAO-09-325, (Washington, D.C., April 2009)

Global Positioning System (GPS) IIF (2 of 6)

Best Practice :
Prevent cost and schedule overruns with requirements stability

– Requirem

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Lean Enablers

- ❑ 2.4
- ❑ 2.4.1
- ❑ 2.4.2
- ❑ 2.4.3
- ❑ 2.4.4
- ❑ 2.4.6
- ❑ 2.4.7
- ❑ 2.4.10
- ❑ 2.4.12

*GAO, GPS: Significant Challenges in Sustaining and Upgrading Widely Used Capabilities, GAO-09-325, (Washington, D.C., April 2009)

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Global Positioning System (GPS) IIF
Lean Enablers

- ❑ 2.4 Develop high-quality program requirements among customer stakeholders before bidding and execution process begins
- ❑ 2.4.1 Ensure that the customer-level requirements defined in the request for proposal or contracts are truly representative of the need: stable, complete, crystal clear, de-conflicted, free of wasteful specifications and as simple as possible
- ❑ 2.4.2 Use only highly experienced people and expert institutions to write program requirements, RFPs, and contracts
- ❑ 2.4.3 If the customer lacks the expertise to develop clear requirements, issue a contract to a proxy organization with towering experience and expertise to sort out and mature the requirements, including personal accountability
- ❑ 2.4.4 Prevent careless insertion of mutually competing and conflicting requirements, excessive number of requirements, standards, and rules to be followed in the program, for example mindless "cut-and-paste" of requirements from previous programs

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Global Positioning System (GPS) IIF Lean Enablers

- 2.4.6 Insist that a single person is in charge of the entire program requirements to assure consistency and efficiency throughout

- 2.4.7 Require personal and institutional accountability of the reviewers of requirements until program success is demonstrated

- 2.4.10 Require an independent mandatory review of the program requirements, concept of operation, and other relevant specifications of value for clarity, lack of ambiguity, lack of conflicts, stability, completeness, and general readiness for contracting and effective program execution

- 2.4.12 Use a clear decision gate that reviews the maturity of requirements, the trade-offs between top-level objectives, as well as the level of remaining requirements risks before detailed formal requirements or a request for proposal is issued

Global Positioning System (GPS) IIF (3 of 6)

**Best Practice:
Reduce DoD program management turnover during system development**

- Seven different DoD program managers (1996-2009); first 5 served 1 year*
- Diffused leadership contributed to poor performance
- Lacked single responsibility to synchronize all capability and user equipment*

*GAO, GPS: Significant Challenges in Sustaining and Upgrading Widely Used Capabilities, GAO-09-325, (Washington, D.C., April 2009)

Global Positioning System (GPS) IIF (3 of 6)

Best Practice:
Reduce DoD program management turnover during system development

- Seven diff

Lean Enablers

- ❑ 4.4 The top-level program management (e.g., program management office) overseeing the program must be highly effective
- ❑ 4.4.1 Program management staff turnover and hiring rates must be kept low

*GAO, GPS: Significant Challenges in Sustaining and Upgrading Widely Used Capabilities, GAO-09-325, (Washington, D.C., April 2009)

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Global Positioning System (GPS) IIF (4 of 6)

Best Practice :
Size DoD program offices adequately (manpower and technical expertise) to perform program management activities and technical oversight

- Specific manpower numbers not available
- Increased military and civilian personnel at contractor's facility in 2006^

^GAO, GPS: Significant Challenges in Sustaining and Upgrading Widely Used Capabilities, GAO-09-325, (Washington, D.C., April 2009)

*GAO, DoD Faces Challenges in Fully Realizing Benefits of Satellite Acquisition Process, GAO-12-563T, (Washington, D.C., March 21, 2012)

+GAO, Defense Acquisition Assessment of Selected Weapon Programs, GAO-07-406SP, (Washington, D.C., March 2007)

Global Positioning System (GPS) IIF (4 of 6)

Best Practice :
Size DoD program offices adequately (manpower and technical expertise) to perform program management activities and technical oversight

- Specific m

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Lean Enablers

- ❑ 4.3.3 Ensure that the competency, technical knowledge and other relevant domain knowledge of the program manager and the other key members of the program team are on par with the technical complexity of the program
- ❑ 4.4.2 Invest heavily in skills and intellectual capital; engage people with deep knowledge of the product and technology

^GAO, G
Upgradi
(Washington, D.C., April 2009)

(Washington, D.C., March 21, 2012)

(Washington, D.C., March 2007)

Global Positioning System (GPS) IIF (5 of 6)

Best Practice :
Execute disciplined, knowledge-based processes during product development

- TSPR resulted in relaxed specifications and inspections of the contractor
- Contractor had poor quality manufacturing process^
- Manufacturing issues identified as root-cause of an on-board failure*
  - Cost to replace atomic clocks on remaining satellites ~$2.6 billion
- Concurrent development and production → cost and schedule delays+

^GAO, GPS: Significant Challenges in Sustaining and Upgrading Widely Used Capabilities, GAO-09-325, (Washington, D.C., April 2009)

*GAO, DoD Faces Challenges in Fully Realizing Benefits of Satellite Acquisition Process, GAO-12-563T, (Washington, D.C., March 21, 2012)

+GAO, Defense Acquisition Assessment of Selected Weapon Programs, GAO-07-406SP, (Washington, D.C., March 2007)

Global Positioning System (GPS) IIF (5 of 6)

Best Practice : Execute disciplined, knowledge-based processes during product development

- TSPR resu

Lean Enablers

- 3.4 Ensure up-front that capabilities exist to deliver program requirements
- 3.10 Manage technology readiness levels and protect program from low-TRL delays and cost overruns
- 4.6.4 Use gated process for validating, planning, and execution of the program and leverage functional expertise at these gates

^GAO, GPS: Significant Challenges in Sustaining and Upgrading Widely Used Capabilities, GAO-09-325, (Washington, D.C., April 2009)

'GAO, DoD Faces Challenges in Fully Realizing Benefits of Satellite Acquisition Process, GAO-12-563T, (Washington, D.C., March 21, 2012)

+GAO, Defense Acquisition Assessment of Selected Weapon Programs, GAO-07-406SP, (Washington, D.C., March 2007)

Global Positioning System (GPS) IIF (6 of 6)

Best Practice :
Ensure an executable business case is delivered to DoD program managers and hold DoD program managers accountable for successful outcomes

- Government unable to influence multiple contract mergers^
  - GPS production moved to three different facilities
  - Disrupted workforce and lost engineering expertise

- Lacked management continuity and accountability^

- Funding diverted from ground programs to pay for space segment issues*

^GAO, GPS: Significant Challenges in Sustaining and Upgrading Widely Used Capabilities, GAO-09-325, (Washington, D.C., April 2009)

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Global Positioning System (GPS) IIF (6 of 6)

Best Practice :
Ensure an executable business case is delivered to DoD program managers and hold DoD program managers accountable for successful outcomes

- Governm
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Lean Enablers

- ❑ 4.1.2
- ❑ 4.2
- ❑ 4.2.1
- ❑ 4.2.2
- ❑ 4.2.3
- ❑ 4.2.6
- ❑ 5.2
- ❑ 6.5

^GAO, G
Upgradi
(Washington, D.C., April 2009)

Global Positioning System (GPS) IIF Lean Enablers

- 4.1.2 Maintain team continuity between phases to maximize experiential learning, including pre-proposal and proposal phases

- 4.2 Ensure clear responsibility, accountability, and authority (RAA) throughout the program from initial requirements definition to final delivery

- 4.2.1 Nominate a permanent, experienced program manager fully responsible and accountable for success of the entire program life cycle, with complete authority over all aspects of the program (business and technical)

- 4.2.2 Ensure continuity in the program manager position and avoid personnel rotation

- 4.2.3 Define and clearly communicate the program manager's RAA across all stakeholders

Global Positioning System (GPS) IIF Lean Enablers

- 4.2.6 Develop a process to ensure the timely and flawless coordination, interface, and hand-off (if needed) of RAA among relevant program stakeholders and execution teams throughout the program life cycle

- 5.2 Establish effective contracting vehicles in the program that support the program in achieving the planned benefits and create effective pull for value

- 6.5 Use change management effectively to continually and proactively align the program with unexpected changes in the program's conduct and the environment

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Global Positioning System (GPS) III (1 of 5)

Program description	Program details*
• Next generation of GPS satellites • Expected to provide enhanced capabilities including a new signal for civilian users, anti-jam capabilities, and compatibility with the European Galileo satellite navigation system signal • Incremental capability IIIA, IIIB, and IIIC; this study only addresses GPS IIIA	• **Lead DoD Agency:** Air Force • **Prime Contractor:** Lockheed Martin • **Original total program cost:** $4.1 billion • **Current total program cost:** $4.2 billion (2% growth) • **Original quantity:** 8 • **Current quantity:** 8 • **Original schedule:** 2013 (1st sat.) • **Current schedule:** 2015 (1st sat.) • **# Technologies below TRL 6 at dev. start:** 0+ • **# Nunn-McCurdy breach:** 0

Concept — System Development — Production

- Development start (2008)
- Design review (2010)
- Production decision (2011)
- First Satellite Available for launch (2015)
- Start operational test (2016)

*GAO, Space Acquisitions: DoD is Overcoming Long-standing Problems, but Faces Challenges to Ensuring its Investments are Optimized, GAO-13-508T, (Washington, D.C., April 24, 2013)

+GAO, Defense Acquisition Assessment of Selected Weapon Programs, GAO-13-249SP, (Washington, D.C., March 2013)

Global Positioning System (GPS) III (2 of 5)

Best Practice : Prevent cost and schedule overruns with requirements stability

- Concerted effort to prevent change in scope or requirements
  - USD AT&L mandated no scope, performance, requirement changes*
- Planned for incremental development
  - First system not as technically challenging*
- Larger satellite than GPS IIF required to accommodate future GPS IIIB & IIIC*
  - Increase new military signal by a factor of 10

*GAO, GPS: Significant Challenges in Sustaining and Upgrading Widely Used Capabilities, GAO-09-325, (Washington, D.C., April 2009)

Global Positioning System (GPS) III
(2 of 5)

Best Practice :
Prevent cost and schedule overruns with requirements stability

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Lean Enablers

- ❑ 2.4 Develop high-quality program requirements among customer stakeholders before bidding and execution process begins
- ❑ 2.4.1 Ensure that the customer-level requirements defined in the request for proposal (RFP) or contracts are truly representative of the need: stable, complete, crystal clear, de-conflicted, free of wasteful specifications, and as simple as possible
- ❑ 2.4.2 Use only highly experienced people and expert institutions to write program requirements, RFPs, and contracts
- ❑ 2.4.6 Insist that a single person is in charge of the entire program requirements to assure consistency and efficiency throughout

*GAO,
and Up
325, (Washington, D.C., April 2009)

Global Positioning System (GPS) III (3 of 5)

Best Practice :
Size DoD program offices adequately (manpower and technical expertise) to perform program management activities and technical oversight

- Filled critical contracting and engineering positions with difficulty*
  - Manpower numbers not listed in GAO reports

*GAO, GPS: Significant Challenges in Sustaining and Upgrading Widely Used Capabilities, GAO-09-325, (Washington, D.C., April 2009)

Global Positioning System (GPS) III
(3 of 5)

Best Practice :
Size DoD program offices adequately (manpower and technical expertise) to perform program management activities and technical oversight

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Lean Enablers

- ❑ 4.3.1 Groom an exceptional program manager with advanced skills to lead the development, the people, and ensure program success

- ❑ 4.3.3 Ensure that the competency, technical knowledge and other relevant domain knowledge of the program manager and the other key members of the program team are on par with the technical complexity of the program

- ❑ 4.4.2 Invest heavily in skills and intellectual capital; engage people with deep knowledge of the product and technology

- ❑ 6.6.6 Develop sufficient risk management skills in the program and provide adequate resources

*GAO,
and Up
325, (W

Global Positioning System (GPS) III (4 of 5)

Best Practice : Execute disciplined, knowledge-based processes during product development

- "Back-to-basics" approach to system development*
  - Military standards for satellite quality
  - Conducted multiple design reviews
  - Implemented improved risk management process
  - Conducted various trade studies
  - Incremental capability approach
- Dual launch initiative to support tow satellite on one launch vehicle*

*GAO, GPS: Significant Challenges in Sustaining and Upgrading Widely Used Capabilities, GAO-09-325, (Washington, D.C., April 2009)

Global Positioning System (GPS) III
(4 of 5)

Best Practice :
Execute disciplined, knowledge-based processes during product development

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Lean Enablers

- ❑ 3.4 Ensure up-front that capabilities exist to deliver program requirements
- ❑ 3.10 Manage technology readiness levels and protect program from low-TRL delays and cost overruns
- ❑ 4.1 Use systems engineering to coordinate and integrate all engineering activities in the program
- ❑ 6.5 Use change management effectively to continually and proactively align the program with unexpected changes in the program's conduct and the environment
- ❑ 6.6 Proactively manage uncertainty and risk to maximize benefit

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Global Positioning System (GPS) III (5 of 5)

Best Practice :
Ensure an executable business case is delivered to DoD program managers and hold DoD program managers accountable for successful outcomes

- Air Force delayed program start a year to fund other programs*
- Under Secretary of Defense for Acquisition and Technology and Logistics*
  - GPS III funding commitment
  - Directed no changes to requirement or scope
  - Conducted independent assessment of preliminary design review
- Program using a "back-to-basics" program development approach*
  - Shifting risk earlier in the acquisition phase
  - Stringent parts and materials requirement

*GAO, GPS: Significant Challenges in Sustaining and Upgrading Widely Used Capabilities, GAO-09-325, (Washington, D.C., April 2009)

Global Positioning System (GPS) III (5 of 5)

Best Practice :
Ensure an executable business case is delivered to DoD program managers and hold DoD program managers accountable for successful outcomes

- Air Force

Lean Enablers

- 3.10.7 Provide stable funding for technology development and maturation. This will support a steady, planned pipeline of new technologies to be inserted into the program
- 4.2 Ensure clear responsibility, accountability, and authority (RAA) throughout the program from initial requirements definition to final delivery
- 5.2 Establish effective contracting vehicles in the program that support the program in achieving the planned benefits and create effective pull for value

*GAO, and Upgrading Widely Used Capabilities, GAO-09-325, (Washington, D.C., April 2009)

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Global Positioning System (GPS) OCX (1 of 5)

Program description*	Program details+

- GPS Operational Ground Control System (OCX) will replace the legacy GPS ground control system
- Expected to deliver reliable and secure position and timing information to military and civilian users
- Required to operate GPS III satellite and use of GPS IIF specialized military signal
- GPS program experienced significant imbalance between space and ground capabilities

- **Lead DoD Agency:** Air Force
- **Prime Contractor:** Raytheon
- **Original total program cost:** $2,891.3 million
- **Current total program cost:** $3,694.9 million (28% growth)
- **Original quantity:** 1(2 increments)
- **Current quantity:** 1 (3 increments)
- **Original schedule:** 2013 (Block 0); 2014 (Block 1)
- **Current schedule:** 2015 (Block 0); 2016 (Block 1)
- **# Technologies below TRL 6 at dev. start:** 14 of 14+
- **# Nunn-McCurdy breach:** N/A at least one

Concept — System Development — Production

- Program start (2007)
- Preliminary design review (2011)
- Development start (2012)
- Production decision (2015)
- Initial capability Block I (2016)

*GAO, Space Acquisitions: DoD is Overcoming Long-standing Problems, but Faces Challenges to Ensuring its Investments are Optimized, GAO-13-508T, (Washington, D.C., April 24, 2013)

+GAO, Defense Acquisition Assessment of Selected Weapon Programs, GAO-11-233SP, (Washington, D.C., March 2011)

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Global Positioning System (GPS) OCX (2 of 5)

Best Practice : Prevent cost and schedule overruns with requirements stability

- GPS ground segment deferred requirements to fund space segment issues*
- Legacy ground system unable to process certain GPS IIF signals*
- Experienced significant requirement instability during the development phase*
- Contractor underestimated complexity of information assurance requirements

Function or capability enabled	Original ground control program/version	Current or future ground control program/version	Amount of delay (in months)
GPS IIR-M satellites (first launch in 2005 & currently being launched)			
Command & telemetry for IIA & IIR and satellites, and use of additional signals	OCS Version 5.0 September 2005	OCS Version 5.2.1 September 2007	24
Command & telemetry for IIRM & IIF satellites	OCS Version 5.0 September 2005	AEP Version 5.2.2 March 2008	30
Selective Availability Anti-Spoofing Module	OCS Version 5.0 September 2005	AEP Version 5.5 September 2009	48
Second civil signal (L2C)	OCS Version 6 September 2007	OCX Block I or II September 2012/September 2013	60-72
Military code (M-code)	OCS Version 6 September 2007	OCX Block I or II September 2012/September 2013	60-72
GPS IIF satellites (first launch planned for November 2009)			
Third civil signal (L5)	OCS Version 6 September 2007	OCX Block I or II September 2012/September 2013	60-72

Source: GPS program office.

GAO, Space Acquisitions: DoD is Overcoming Long-standing Problems, but Faces Challenges to Ensuring its Investments are Optimized, GAO-13-508T, (Washington, D.C., April 24, 2013)

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Global Positioning System (GPS) OCX (2 of 5)

Best Practice : Prevent cost and schedule overruns with requirements stability

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Lean Enablers

- 2.4 Develop high-quality program requirements among customer stakeholders before bidding and execution process begins
- 3.10.7 Provide stable funding for technology development and maturation. This will support a steady, planned pipeline of new technologies to be inserted into the program
- 6.5 Use change management efficiently to continually and proactively align the program with unexpected changes in the program's conduct and the environment
- 6.6 Proactively manage uncertainty and risk to maximize program benefit

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508T, (Washington, D.C., April 24, 2013)

2013

Source: GPS program office.

Global Positioning System (GPS) OCX (3 of 5)

Best Practice : Reduce DoD program management turnover during system development

- GPS OCX program manager tenure not specifically addressed in GAO reports*
- GPS ground user equipment development led by multiple program managers*
- Development efforts not synchronized (ground, space, and user equipment)*
- Diffused leadership → reduced ability to use space systems enhancements*

*GAO, Space Acquisitions: DoD is Overcoming Long-standing Problems, but Faces Challenges to Ensuring its Investments are Optimized, GAO-13-508T, (Washington, D.C., April 24, 2013)

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Global Positioning System (GPS) OCX (3 of 5)

Best Practice :
Reduce DoD program management turnover during system development

- GPS OCX

Lean Enablers

- ❑ 4.4 The top-level program management (e.g., program management office) overseeing the program must be highly effective
- ❑ 4.4.1 Program management staff turnover and hiring rates must be kept low

*GAO, Space Acquisitions: DoD is Overcoming Long-standing Problems, but Faces Challenges to Ensuring its Investments are Optimized, GAO-13-508T, (Washington, D.C., April 24, 2013)

Global Positioning System (GPS) OCX (4 of 5)

Best Practice :
Execute disciplined, knowledge-based processes during product development

- Experienced code development issues; lack of systems engineering processes*
  - 2012 rework caused 2-4 month delay (systems engineering tasks)*
- Air Force aligned GPS III launch with delivery of GPS OCX
  - GPS III launch delayed to May 2015 to meet GPS OCX block 0 delivery*
  - Current GPS ground segment cannot process GPS III data
  - Block 0 only capable of basic GPS III command and control

*GAO, Space Acquisitions: DoD is Overcoming Long-standing Problems, but Faces Challenges to Ensuring its Investments are Optimized, GAO-13-508T, (Washington, D.C., April 24, 2013)

Global Positioning System (GPS) OCX (4 of 5)

Best Practice :
Execute disciplined, knowledge-based processes during product development

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- ❑ 4.1 Use systems engineering to coordinate and integrate all engineering activities in the program
- ❑ 6.5 Use change management efficiently to continually and proactively align the program with unexpected changes in the program's conduct and the environment
- ❑ 6.6 Proactively manage uncertainty and risk to maximize program benefit

*GAO, Space Acquisitions: DoD is Overcoming Long-standing Problems, but Faces Challenges to Ensuring its Investments are Optimized, GAO-13-508T, (Washington, D.C., April 24, 2013)

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Global Positioning System (GPS) OCX (5 of 5)

Best Practice :
Ensure an executable business case is delivered to DoD program managers and hold DoD program managers accountable for successful outcomes

- Fragmented leadership contributed to disconnects in the delivery of related systems as well as delays in the development of architectures*
- Lack of single authority to synchronize procurements and fielding deliveries*

Satellites and Ground Control
Single Program Executive Officer

User Equipment
Multiple Program Executive Officers

*GAO, Space Acquisitions: DoD is Overcoming Long-standing Problems, but Faces Challenges to Ensuring its Investments are Optimized, GAO-13-508T, (Washington, D.C., April 24, 2013)

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Global Positioning System (GPS) OCX (5 of 5)

Best Practice :
Ensure an executable business case is delivered to DoD program managers and hold DoD program managers accountable for successful outcomes

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Lean Enablers

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- ❑ 4.3

*GAO, Space Acquisitions: DoD is Overcoming Long-standing Problems, but Faces Challenges to Ensuring its Investments are Optimized, GAO-13-508T, (Washington, D.C., April 24, 2013)

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Global Positioning System (GPS) OCX Lean Enablers

- 4.1.2 Maintain team continuity between phases to maximize experiential learning, including pre-proposal and proposal phase

- 4.2 Ensure clear responsibility, accountability, and authority (RAA) throughout the program from initial requirements definition to final delivery

- 4.2.1 Nominate a permanent, experienced program manager fully responsible and accountable for success of the entire program life cycle, with complete authority over all aspects of the program (business and technical)

- 4.2.2 Ensure continuity in the program manager position and avoid personnel rotation

- 4.2.6 Develop a process to ensure the timely and flawless coordination, interface, and handoff (if needed) of the RAA among relevant program stakeholders and execution teams throughout the program life cycle

- 4.3 For every program, use a program manager role to lead and integrate the program from start to finish

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Mobile User Objective System (MUOS) (1 of 4)

Program description*	Program details+

- Communication system expected to provide a worldwide, multiservice population of mobile and fixed-site terminal users with increased narrowband communications capacity and improved availability for small terminal users
- Replace the Ultra High Frequency (UHF) Follow-on (UFO) satellite systems currently in operations
- Both space and ground segments

- **Lead DoD Agency:** Navy
- **Prime Contractor:** Lockheed Martin Space Systems
- **Original total program cost:** $6.9 billion
- **Current total program cost:** $7.3 billion (6% growth)
- **Original quantity:** 6
- **Current quantity:** 6
- **Original schedule:** 2010 (1st sat.); 2014 (Final)
- **Current schedule:** 2012 (1st sat.); 2016 (Final)
- **# Technologies below TRL 6 at dev. start:** 1 of 9^
- **# Nunn-McCurdy breach:** 0

Concept — System Development — Production

- Program start (2002)
- Development start (2004)
- Design review (2007)
- Production decision (2008)
- First launch (2012)
- End Operational test (2014)
- Final Capability (2016)

*GAO, Space Acquisitions: DoD is Overcoming Long-standing Problems, but Faces Challenges to Ensuring its Investments are Optimized, GAO-13-508T, (Washington, D.C., April 24, 2013)

+GAO, Defense Acquisition Assessment of Selected Weapon Programs, GAO-13-294SP, (Washington, D.C., March 2013)

^GAO, Defense Acquisition Assessment of Selected Weapon Programs, GAO-05-301, (Washington, D.C., March 2005)

Mobile User Objective System (MUOS) (2 of 4)

Best Practice :
Prevent cost and schedule overruns with requirements stability

- GAO reports did not indicate significant growth in MUOS requirements
- Significant growth in spacecraft size (preliminary CDR and CDR)*
- More than 90% of MUOS's capability under utilized
  - Requires compatible user terminals*
  - User terminal not expected until 2014

*GAO, Space Acquisitions: Government and Industry Partners Face Substantial Challenges in Developing New DoD Space Systems, GAO-09-648T, (Washington, D.C., April 2009)

*GAO, Space Acquisitions: DoD is Overcoming Long-standing Problems, but Faces Challenges to Ensuring its Investments are Optimized, GAO-13-508T, (Washington, D.C., April 24, 2013)

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Mobile User Objective System (MUOS) (2 of 4)

Best Practice : Prevent cost and schedule overruns with requirements stability

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Lean Enablers

- ❑ 3.2 Actively architect and manage the program enterprise to optimize its performance as a system
- ❑ 4.1 Use systems engineering to coordinate and integrate all engineering activities in the program
- ❑ 4.2 Ensure clear responsibility, accountability, and authority (RAA) throughout the program from initial requirements definition to final delivery
- ❑ 4.2.2 Ensure continuity in the program manager position and avoid personnel overruns

*GAO, Space Acquisitions: Government and Industry Partners Face Substantial Challenges in Developing New DoD Space Systems, GAO-09-648T, (Washington, D.C., April 2009)

*GAO, Space Acquisitions: DoD is Overcoming Long-standing Problems, but Faces Challenges to Ensuring its Investments are Optimized, GAO-13-508T, (Washington, D.C., April 24, 2013)

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Mobile User Objective System (MUOS) (3 of 4)

Best Practice : Execute disciplined, knowledge-based processes during product development

- Attempted to mature critical technologies prior to development start*
- 8 of 9 critical technologies matured at start of development^
- 90% of drawings contractually required; 95% drawings at CDR+
- Compressed launch schedule (2.7 years shorter than UHF program)^
- Discovered design flaws late in production; UHF reflectors redesigned to mitigate signal interference and structural hardware bonding issuesµ
- Ground software high-risk; ground segment cost increased about 51%µ

*GAO, Space Acquisitions: Government and Industry Partners Face Substantial Challenges in Developing New DoD Space Systems, GAO-09-648T, (Washington, D.C., April 2009)

+GAO, Space Acquisitions: DoD is Overcoming Long-standing Problems, but Faces Challenges to Ensuring its Investments are Optimized, GAO-13-508T, (Washington, D.C., April 24, 2013)

^GAO, Defense Acquisition Assessment of Selected Weapon Programs, GAO-05-301, (Washington, D.C., March 2005)

µGAO, Defense Acquisition Assessment of Selected Weapon Programs, GAO-10-388SP, (Washington, D.C., March 2013)

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Mobile User Objective System (MUOS) (3 of 4)

Best Practice : Execute disciplined, knowledge-based processes during product development

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Lean Enablers

- ❑ 3.3 Pursue multiple solution sets in parallel
- ❑ 3.4 Ensure up-front that capabilities exit to deliver program requirements
- ❑ 3.10 Manage technology readiness levels and protect program from low-TRL delays and cost overruns
- ❑ 6.5 Use change management efficiently to continually and proactively align the program with unexpected changes in the program's conduct and the environment

[a]GAO Indu Chal Systems, GAO-09-648T, (Washington, D.C., April 2009)

GAO-13-508T, (Washington, D.C., April 24, 2013)

[b]GAO, Defense Acquisition Assessment of Selected Weapon Programs, GAO-10-388SP, (Washington, D.C., March 2013)

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Mobile User Objective System (MUOS) (4 of 4)

Best Practice :
Ensure an executable business case is delivered to DoD program managers and hold DoD program managers accountable for successful outcomes

- Executed technical lessons learned and best practices^
- Space segment cost increased 48% because of additional labor required to address issues related to satellite design complexity, satellite weight, satellite component test anomalies, and subsequent rework^
- Delayed user capability and fielding user equipment due to test issues*
    - User equipment managed by a separate program

*GAO, Space Acquisitions: DoD is Overcoming Long-standing Problems, but Faces Challenges to Ensuring its Investments are Optimized, GAO-13-508T, (Washington, D.C., April 24, 2013)

+GAO, Defense Acquisition Assessment of Selected Weapon Programs, GAO-13-294SP, (Washington, D.C., March 2013)

^GAO, Space Acquisitions: Government and Industry Partners Face Substantial Challenges in Developing New DoD Space Systems, GAO-09-648T, (Washington, D.C., April 2009)

Mobile User Objective System (MUOS) (4 of 4)

Best Practice :
Ensure an executable business case is delivered to DoD program managers and hold DoD program managers accountable for successful outcomes

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Lean Enablers

- ❑ 3.2.2 Set up a single, co-located organization to handle the entire systems engineering and architecting for the entire effort throughout the life cycle, in order to increase RAA
- ❑ 4.2.3 Define and clearly communicate the program manager's RAA across all stakeholders
- ❑ 4.2.6 Develop a process to ensure the timely and flawless coordination, interface, and hand-off (if needed) or RAA among relevant program stakeholders and execution teams throughout the program life cycle
- ❑ 6.6 Proactively manage uncertainty and risk to maximize benefit

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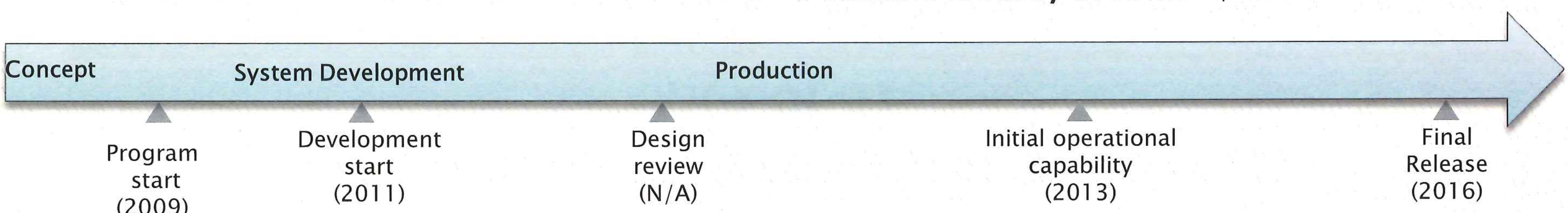
Joint Space Operations Mission System (JMS) (1 of 4)

Program description*	Program details+

- JMS will provide space situational awareness-knowledge and characterization of space objects and the space command and control
- Designed to replace the Space Defense Operations Center (SPADOC)
- Space Fence dependent on JMS functionality

- **Lead DoD Agency:** Air Force
- **Prime Contractor:** Sys. Program Office Integrator
- **Original total program cost:** N/A
- **Current total program cost:** N/A
- **Original quantity:** 1
- **Current quantity:** 1
- **Original schedule:** 2012; 2014 (Final)
- **Current schedule:** 2013 (IOC); 2016 (Final)
- **# Technologies below TRL 7 at dev. start:** N/A
- **# Nunn-McCurdy breach:** N/A



*GAO, Space Acquisitions: Development and Oversight Challenges in Delivering Improved Space Situational Awareness Capabilities, GAO-11-545, (Washington, D.C., May 2011)

+DOD, Systems Engineering FY2012 Annual Report, (Washington, D.C., March 2013)

Joint Space Operations Mission System (JMS) (2 of 4)

Best Practice : Prevent cost and schedule overruns with requirements stability

- Data integration top risk (numerous heterogeneous, net-centric sources)*
- Complex requirements postponed to later releases
- Information assurance requirements at multiple security level

*GAO, Space Acquisitions: Development and Oversight Challenges in Delivering Improved Space Situational Awareness Capabilities, GAO-11-545, (Washington, D.C., May 2011)

Joint Space Operations Mission System (JMS) (2 of 4)

Best Practice :
Prevent cost and schedule overruns with requirements stability

- Data integr
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Lean Enablers

- ❑ 2.4 Develop high-quality program requirements among customer stakeholders before bidding and execution process begins
- ❑ 2.4.2 Use only highly experienced people and expert institutions to write program requirements, RFP, and contracts
- ❑ 2.4.6 Insist that a single person is in charge of the entire program requirements to assure consistency and efficiency throughout
- ❑ 2.4.10 Require an independent mandatory review of the program requirements, concept of operation, and other relevant specifications of value for clarity, lack of ambiguity, lack of conflicts, stability, completeness, and general readiness for contracting and effective program execution

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Joint Space Operations Mission System (JMS) (3 of 4)

Best Practice :
Size DoD program offices adequately (manpower and technical expertise) to perform program management activities and technical oversight

- Shortage of systems engineering personnel within program office*
- Development start delayed 6 months due to lack of SE documentation
- Concerted effort to hire system engineers and contractor support (2010)
  - 83% of required positions (133 of 160 positions)
- Augmented staff → Space and Naval Warfare Systems Center (SPAWAR) team+

*GAO, Space Acquisitions: Development and Oversight Challenges in Delivering Improved Space Situational Awareness Capabilities, GAO-11-545, (Washington, D.C., May 2011)

+DOD, Systems Engineering FY2012 Annual Report, (Washington, D.C., March 2013)

Joint Space Operations Mission System (JMS) (3 of 4)

Best Practice :
Size DoD program offices adequately (manpower and technical expertise) to perform program management activities and technical oversight

- Shortage

Lean Enablers

- 4.4.2 Invest heavily in skills and intellectual capital; engage people with deep knowledge of the product and technology
- 4.8.5 Promote standardized skill sets with careful training and mentoring, rotations, strategic assignments, and assessments of competencies
- 6.6.6 Develop sufficient risk management skills in the program and provide adequate resources

*GAO, Space Acquisitions: Development and Oversight Challenges in Delivering Improved Space Situational Awareness Capabilities, GAO-11-545, (Washington, D.C., May 2011)

+DOD, Systems Engineering FY2012 Annual Report, (Washington, D.C., March 2013)

Joint Space Operations Mission System (JMS) (4 of 4)

Best Practice :
Execute disciplined, knowledge-based processes during product development

- Program did not follow "knowledge-based" approach*
  - Incremental approach not implemented
  - Entered development with immature critical technologies (TRL 6)
- Experienced interoperability and capability degradation issues*
  - Limited operational capability/degradation (2011 test report)
  - Tool design, data inconsistencies, and need for additional development
- Increment 2 delivery delayed due to aggressive schedule*

*GAO, Space Acquisitions: Development and Oversight Challenges in Delivering Improved Space Situational Awareness Capabilities, GAO-11-545, (Washington, D.C., May 2011)

+DOD, Systems Engineering FY2012 Annual Report, (Washington, D.C., March 2013)

Joint Space Operations Mission System (JMS) (4 of 4)

Best Practice : Execute disciplined, knowledge-based processes during product development

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Lean Enablers

- ❑ 3.3 Pursue multiple solution sets in parallel
- ❑ 3.4 Ensure up-front that capabilities exist to deliver program requirements
- ❑ 3.10 Manage technology readiness levels and protect program from low-TRL delays and cost overruns
- ❑ 4.1 Use systems engineering to coordinate and integrate all engineering activities in the program
- ❑ 6.5 Use change management efficiently to continually and proactively align the program with unexpected changes in the program's conduct and the environment

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Space Based Space Surveillance Block 10 (SBSS) (1 of 3)

Program description +	Program details+
• SBSS Block 10 replaced the Midcourse Space Experiment/ Space Based Visible sensor satellite • De-scoped from SBIRS • Single satellite and associated command, control, communications and ground processing equipment	• **Lead DoD Agency:** Air Force • **Prime Contractor:** Ball Aerospace Boeing, Northrop Grumman Mission System • **Original total program cost:** $332 million* • **Current total program cost:** $922 million* (178% growth) • **Original quantity:** 1 • **Current quantity:** 1 • **Original schedule:** 2007 • **Actual schedule:** 2010 • **# Technologies below TRL 6 at dev. start:** 5 of 5+ • **# Nunn-McCurdy breach:** 0

Concept — System Development — Production

- Program start (2002)
- Development start (2003)
- Design review (2006)
- Satellite launch (2010)
- Initial Operations (2012)

*GAO, Defense Acquisition Assessment of Selected Weapon Programs, GAO-11-233SP, (Washington, D.C., March 2011)

+GAO, Defense Acquisition Assessment of Selected Weapon Programs, GAO-10-388SP, (Washington, D.C., March 2010)

Space Based Space Surveillance Block 10 (SBSS) (2 of 3)

Best Practice : Prevent cost and schedule overruns with requirements stability

- Cost and schedule increase due to requirement instability*
  - Change in complex sensor design (program's largest cost driver)
  - Late development contract award
  - Launch vehicle type change (from a Delta II to a Minotaur IV)
- 2006 IRT concluded baseline estimate not executable*
  - Assembly, integration and test were high risk; program later restructured
  - Overstated requirements; restructuring relaxed requirements
- Joint Space Operations Center Mission System (JMS) process SBSS data*

*GAO, Space Acquisitions: Development and Oversight Challenges in Delivering Improved Space Situational Awareness Capabilities, GAO-11-545, (Washington, D.C., March 2011)

Space Based Space Surveillance Block 10 (SBSS) (2 of 3)

Best Practice :
Prevent cost and schedule overruns with requirements stability

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Lean Enablers

- 2.4 Develop high-quality program requirements among customer stakeholders before bidding and execution process begins
- 2.4.2 Use only highly experienced people and expert institutions to write program requirements, RFP, and contracts
- 2.4.6 Insist that a single person is in charge of the entire program requirements to assure consistency and efficiency throughout
- 3.4.3 Ensure that planners and cost estimators are held responsible for their estimates during the execution of the program. Minimize the risk of wishful thinking

*GAO, Space Acquisitions: Development and Oversight Challenges in Delivering Improved Space Situational Awareness Capabilities, GAO-11-545, (Washington, D.C., March 2011)

Space Based Space Surveillance Block 10 (SBSS) (3 of 3)

Best Practice : Execute disciplined, knowledge-based processes during product development

- Development began with 0 of 5 critical technologies mature (2003)*
- 74% drawings available (vs. 90%) at CDR+
- Experienced major design changes → complex sensor design^

^GAO, Space Acquisitions: Development and Oversight Challenges in Delivering Improved Space Situational Awareness Capabilities, GAO-11-545, (Washington, D.C., March 2011)

*GAO, Defense Acquisition Assessment of Selected Weapon Programs, GAO-10-388SP, (Washington, D.C., March 2010)

+GAO, Defense Acquisition Assessment of Selected Weapon Programs, GAO-09-326SP, (Washington, D.C., March 2009)

Space Based Space Surveillance Block 10 (SBSS) (3 of 3)

Best Practice :
Execute disciplined, knowledge-based processes during product development

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Lean Enablers

- ❑ 3.10.9 Perform robust system architecting and requirements analysis to determine technology needs and current technology readiness levels
- ❑ 3.10.11 Utilize independent technical reviews to confirm a capability to deliver and integrate any new technology that could delay the program or cause schedule overruns
- ❑ 3.10.6 Remove show-stopping research and unproven technology from the critical path of large programs. Issue separate development contracts, staff with co-located experts, and include it in the risk mitigation plan. Reexamine for integration into the program after significant progress has been made or defer to future systems

*GAO,
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Space
11-545, (Washington, D.C., March 2011)

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Advanced Extremely High Frequency (AEHF) (1 of 5)

Program description *

- Replenish existing Milstar system with higher-capacity, survivable, jam-resistant, worldwide, secure communication capabilities for strategic and tactical users
- Terminals used to transmit and receive communications are acquired separately by each military service

Program details+

- **Lead DoD Agency:** Air Force
- **Prime Contractor:** Lockheed Martin
- **Original total program cost:** $5,657.8 million
- **Current total program cost:** $14,372 million* (155% growth)
- **Original quantity:** 5
- **Current quantity:** 6
- **Original schedule:** 2007 (1st sat.)
- **Current schedule:** 2010 (1st sat.)
- **# Technologies below TRL 6 at dev. start:** 11 of 14
- **# Nunn-McCurdy breach:** 3

Concept — System Development — Production

- Program start (1999)
- Development start (2001)
- Design review (2004)
- Production decision (2004)
- First launch (2010)

*GAO, Defense Acquisition Assessment of Selected Weapon Programs, GAO-13-294P, (Washington, D.C., March 2013)

+GAO, Defense Acquisition Assessment of Selected Weapon Programs, GAO-04-391, (Washington, D.C., March 2004)

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Advanced Extremely High Frequency (AEHF) (2 of 5)

Best Practice :
Prevent cost and schedule overruns with requirements stability

- Modified requirements after Critical Design Review
  - Security requirements
  - Manufacturing issues related to critical cryptological equipment[+]
- Design for remaining satellites will not change[*]
  - Part obsolescence / 4-year gap to production

[+] GAO, Defense Acquisition Assessment of Selected Weapon Programs, GAO-04-391, (Washington, D.C., March 2004

[*] GAO, Space Acquisitions: DOD is Overcoming Long-Standing Problems but Faces Challenges Ensuring Its Investments Are Optimized, GAO-13-508T, (Washington, D.C., 2013)

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Advanced Extremely High Frequency (AEHF) (2 of 5)

Best Practice : Prevent cost and schedule overruns with requirements stability

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Lean Enablers

- ❑ 2.4 Develop high-quality program requirements among customer stakeholders before bidding and execution process begins
- ❑ 2.4.2 Use only highly experienced people and expert institutions to write program requirements, RFP, and contracts
- ❑ 2.4.6 Insist that a single person is in charge of the entire program requirements to assure consistency and efficiency throughout
- ❑ 2.4.10 Require an independent mandatory review of the program requirements, concept of operations, and other relevant specifications of value for clarity, lack of ambiguity, lack of conflicts, stability, completeness, and general readiness for contracting and effective program execution

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Advanced Extremely High Frequency (AEHF) (3 of 5)

Best Practice :
Execute disciplined, knowledge-based processes during product development

- 11 of 14 AEHF critical technologies were mature at development start[+]
- ~60 of design drawings presented at Critical Design Review[+]
- Unsynchronized critical external deliveries
  - 2004 launch delayed → payload key cryptographic equipment delayed
- System-level test uncovered design or workmanship issues on 6 components[*]
  - 5 of those components required to be removed from the spacecraft
  - 1 component required a software fix
  - Required second environment testing (re-work)

[+] GAO, Defense Acquisition Assessment of Selected Weapon Programs, GAO-04-391, (Washington, D.C., March 2004)

[*] GAO, Defense Acquisition Assessment of Selected Weapon Programs, GAO-09-326SP, (Washington, D.C., March 2009)

[^] GAO, Space Acquisition: DOD Delivering New Generation of Satellites, but Space System Acquisition Challenges Remain, GAO-09-590ST, (Washington, D.C., 2009)

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Advanced Extremely High Frequency (AEHF) (3 of 5)

Best Practice : Execute disciplined, knowledge-based processes during product development

- 11 of 14 A…

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Lean Enablers

- ❑ 3.4 Ensure up-front that capabilities exist to deliver program requirements
- ❑ 3.10 Manage technology readiness levels and protect program from low-TRL delays and cost overruns
- ❑ 3.10.6 Remove show-stopping research and unproven technology from the critical path of large programs. Issue separate development contracts, staff with co-located experts, and include it in the risk mitigation plan. Re-examine for integration into the program after significant progress has been made or defer to future systems

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(Washington, D.C., 2009)

Advanced Extremely High Frequency (AEHF) (4 of 5)

Best Practice :
Execute disciplined, knowledge-based processes during product development

- First satellite had issues reaching its dedicated orbit
  - Blockage in a propellant line^
- Subsequent launch delayed due to issues during integration and testing*

+GAO, Defense Acquisition Assessment of Selected Weapon Programs, GAO-04-391, (Washington, D.C., March 2004)

*GAO, Defense Acquisition Assessment of Selected Weapon Programs, GAO-09-326SP, (Washington, D.C., March 2009)

^GAO, Space Acquisition: DOD Delivering New Generation of Satellites, but Space System Acquisition Challenges Remain, GAO-09-590ST, (Washington, D.C., 2009)

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Advanced Extremely High Frequency (AEHF) (4 of 5)

Best Practice :
Execute disciplined, knowledge-based processes during product development

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Lean Enablers

- ❑ 4.1 Use systems engineering to coordinate and integrate all engineering activities in the program
- ❑ 6.5 Use change management effectively to continually and proactively align the program with unexpected changes in the program's conduct and the environment
- ❑ 6.6 Proactively manage uncertainty and risk to maximize program benefit

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Advanced Extremely High Frequency (AEHF) (5 of 5)

Best Practice :
Ensure an executable business case is delivered to DoD program managers and hold DoD program managers accountable for successful outcomes

- Concurrent development of two critical path items+
  - Both critical path items developed and managed outside the program
- AEHF program first to apply changes to acquisition strategy in 2012^
  - Buy blocks of two or more satellites (economic order quantities)
  - Use of fixed-price contracting
  - Stable research and development investment
  - Evolutionary development
  - Stable requirements

+GAO, Defense Acquisition Assessment of Selected Weapon Programs, GAO-06-391, (Washington, D.C., March 2006)

^GAO, Space Acquisition: DOD Delivering New Generation of Satellites, but Space System Acquisition Challenges Remain, GAO-09-590ST, (Washington, D.C., 2009)

Advanced Extremely High Frequency (AEHF) (5 of 5)

Best Practice :
Ensure an executable business case is delivered to DoD program managers and hold DoD program managers accountable for successful outcomes

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Lean Enablers

- ❑ 3.2 Actively architect and manage the program enterprise to optimize its performance as a system
- ❑ 4.2 Ensure clear responsibility, accountability, and authority (RAA) throughout the program from initial requirements definition to final delivery

+GAO, Defense Acquisition Assessment of Selected Weapon Programs, GAO-06-391, (Washington, D.C., March 2006)

^GAO, Space Acquisition: DOD Delivering New Generation of Satellites, but Space System Acquisition Challenges Remain, GAO-09-590ST, (Washington, D.C., 2009)

National Polar-orbiting Operational Environmental Satellite System (NPOESS) (1 of 5)

Program description +	Program details+
• NPOESS was meant to merge NOAA and DoD satellites into a single national system • NPOESS program was meant to monitor the weather and environment through 2020	• **Lead DoD Agency:** National Oceanic and Atmospheric Administration, Air Force, NASA • **Prime Contractor:** Northrop Grumman System Tech • **Original total program cost:** $5,628.2 million* • **Current total program cost:** $13,161.5 million+ (133% growth) • **Original quantity:** 6 • **Current quantity:** Cancelled/restructured • **Original schedule:** 2008 (1st launch); 2011(Final) • **Current schedule:** Cancelled/restructured • **# Technologies below TRL 6 at dev. start:** 13 of 14+ • **# Nunn-McCurdy breach:** 2

Concept — System Development — Production

- Program start (1997)
- Development start / production decision (2002)
- Program Cancelled/restructured (2010)

*GAO, Defense Acquisition Assessment of Selected Weapon Programs, GAO-03-476, (Washington, D.C., May 2003)

+GAO, Defense Acquisition Assessment of Selected Weapon Programs, GAO-10-388SP, (Washington, D.C., March 2010)

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National Polar-orbiting Operational Environmental Satellite System (NPOESS) (2 of 5)

Best Practice : Prevent cost and schedule overruns with requirements stability

- Requirements from three agencies with different mission needs*
  - NOAA and DoD provided 50% of funding each
- Program removed 7 of 14 critical technologies (2007)+
  - Significantly reduced data collection capabilities
  - Revised program did not removed key performance parameters
  - Reduced system capability did not meet all critical requirements

*GAO, Defense Acquisition Assessment of Selected Weapon Programs, GAO-08-467SP, (Washington, D.C., March 2008)

+GAO, Polar-orbiting Satellites with Cost Increasing and Data Continuity at Risk, Improvements Needed in Tri-agency Decision Making, GAO-09-722T, (Washington, D.C., June 2009

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National Polar-orbiting Operational Environmental Satellite System (NPOESS) (2 of 5)

Best Practice : Prevent cost and schedule overruns with requirements stability

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Lean Enablers

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- ❑ 2.4.1
- ❑ 2.4.6
- ❑ 2.4.10
- ❑ 4.2.1
- ❑ 4.2.2
- ❑ 4.2.3
- ❑ 4.2.5
- ❑ 4.3

*GAO, Defense Acquisition Assessment of Selected Weapon Programs, GAO-08-467SP, (Washington, D.C., March 2008)

+GAO, Polar-orbiting Satellites with Cost Increasing and Data Continuity at Risk, Improvements Needed in Tri-agency Decision Making, GAO-09-722T, (Washington, D.C., June 2009

National Polar-orbiting Operational Environmental Satellite System (NPOESS)
Lean Enablers

- 2.4 Develop high-quality program requirements among customer stakeholders before bidding and execution process begins

- 2.4.1 Ensure that the customer-level requirements defined in the request for proposal (RFP) or contracts are truly representative of the need: stable, complete, crystal clear, de-conflicted, free of wasteful specifications, and as simple as possible

- 2.4.6 Insist that a single person is in charge of the entire program requirements to assure consistency and efficiency throughout

- 2.4.10 Require an independent mandatory review of the program requirements, concept of operations, and other relevant specifications of value for clarity, lack of ambiguity, lack of conflicts, stability, completeness, and general readiness for contracting and effective program execution

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National Polar-orbiting Operational Environmental Satellite System (NPOESS) Lean Enablers

- 4.2.1 Nominate a permanent, experienced program manager fully responsible and accountable for success of the entire program life cycle, with complete authority over all aspects of the program (business and technical)
- 4.2.2 Ensure continuity in the program manager position and avoid personnel rotation
- 4.2.3 Define and clearly communicate the program manager's RAA across all stakeholders
- 4.2.5 In the top-level program management team and decision making, the different roles (e.g., business and technical) must exhibit a high level of teamwork, understanding, and appreciation for the necessitates in each other's domain
- 4.3 For every program, use a program manager role to lead and integrate the program from start to finish

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National Polar-orbiting Operational Environmental Satellite System (NPOESS) (3 of 5)

Best Practice : Execute disciplined, knowledge-based processes during product development

- Development started with only 1 of 14 critical technologies mature*
- System redesigned in 2007 (removed 7 o 14 critical technologies)
- Poor workmanship led to development challenges with a key sensor+
- Lacked effective risk management; ineffective root-cause analysis
  - Poor contractor subcontractor oversight
  - Sensor development affected rest of program

*GAO, Defense Acquisition Assessment of Selected Weapon Programs, GAO-08-467SP, (Washington, D.C., March 2008)

+GAO, Polar-orbiting Satellites with Cost Increasing and Data Continuity at Risk, Improvements Needed in Tri-agency Decision Making, GAO-09-722T, (Washington, D.C., June 2009

National Polar-orbiting Operational Environmental Satellite System (NPOESS) (3 of 5)

Best Practice : Execute disciplined, knowledge-based processes during product development

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Lean Enablers

- ❑ 3.4 Ensure up-front that capabilities exist to deliver program requirements
- ❑ 3.10 Manage technology readiness levels and protect program from low-TRL delays and cost overruns
- ❑ 3.10.6 Remove show-stopping research and unproven technology from the critical path of large programs. Issue separate development contracts, staff with co-located expert, and include it in risk mitigation plan. Re-examine for integration into program after significant progress has been made or defer to future systems
- ❑ 4.1 Use systems engineering to coordinate and integrate all engineering activities in the program

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National Polar-orbiting Operational Environmental Satellite System (NPOESS) (4 of 5)

Best Practice :
Ensure an executable business case is delivered to DoD program managers and hold DoD program managers accountable for successful outcomes

- Tri-agency decision-making ineffective
  - DoD executive did not attend meetings nor delegated authority
  - Contradicted committee decisions
- Differentiating priorities made conflict resolution difficult

*GAO, Defense Acquisition Assessment of Selected Weapon Programs, GAO-06-391, (Washington, D.C., March 2006)

+GAO, Polar-orbiting Satellites with Cost Increasing and Data Continuity at Risk, Improvements Needed in Tri-agency Decision Making, GAO-09-722T, (Washington, D.C., June 2009

^*GAO, Defense Acquisition Assessment of Selected Weapon Programs, GAO-11-233SP, (Washington, D.C., March 2011)

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National Polar-orbiting Operational Environmental Satellite System (NPOESS) (4 of 5)

Best Practice :
Ensure an executable business case is delivered to DoD program managers and hold DoD program managers accountable for successful outcomes

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Lean Enablers

- ❑ 2.6 Actively minimize the bureaucratic, regulatory, and compliance burden on the program and subprojects
- ❑ 4.2 Ensure clear responsibility, accountability, and authority (RAA) throughout the program from initial requirements definition to final deliver

*GAO, Defense Acquisition Assessment of Selected Weapon Programs, GAO-06-391, (Washington, D.C., March 2006)

+GAO, Polar-orbiting Satellites with Cost Increasing and Data Continuity at Risk, Improvements Needed in Tri-agency Decision Making, GAO-09-722T, (Washington, D.C., June 2009

^*GAO, Defense Acquisition Assessment of Selected Weapon Programs, GAO-11-233SP, (Washington, D.C., March 2011)

National Polar-orbiting Operational Environmental Satellite System (NPOESS) (5 of 5)

Best Practice :
Ensure an executable business case is delivered to DoD program managers and hold DoD program managers accountable for successful outcomes

- Executive Committee did not aggressively manage risk+
  - Lacked rigorous documentation & tracking of action items
- Budget reduced to fund legacy meteorological satellite launch+
  - NPOESS funding reduced by $65 million in 2002
- Program disbanded in 2010 due to long-standing cost, schedule, and performance issues and management deficiencies+

*GAO, Defense Acquisition Assessment of Selected Weapon Programs, GAO-06-391, (Washington, D.C., March 2006)

+GAO, Polar-orbiting Satellites with Cost Increasing and Data Continuity at Risk, Improvements Needed in Tri-agency Decision Making, GAO-09-722T, (Washington, D.C., June 2009

^*GAO, Defense Acquisition Assessment of Selected Weapon Programs, GAO-11-233SP, (Washington, D.C., March 2011)

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National Polar-orbiting Operational Environmental Satellite System (NPOESS) (5 of 5)

Best Practice :
Ensure an executable business case is delivered to DoD program managers and hold DoD program managers accountable for successful outcomes

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Lean Enablers

- 3.1 Map the management and engineering value streams and eliminate non-value-added elements
- 5.2 Establish effective contracting vehicles in the program that support the program in achieving the planned benefits and create effective pull for value

*GAO, Defense Acquisition Assessment of Selected Weapon Programs, GAO-06-391, (Washington, D.C., March 2006)

+GAO, Polar-orbiting Satellites with Cost Increasing and Data Continuity at Risk, Improvements Needed in Tri-agency Decision Making, GAO-09-722T, (Washington, D.C., June 2009

^*GAO, Defense Acquisition Assessment of Selected Weapon Programs, GAO-11-233SP, (Washington, D.C., March 2011)

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Precision Tracking and Space Surveillance (PTSS) (1 of 3)

Program description *	Program details+

- Space-based infrared sensor system intended to provide persistent overhead tracking of ballistic missiles after boost and though the midcourse phase of flight
- PTSS' primary role was object characterization and discrimination+

- **Lead DoD Agency:** Missile Defense Agency
- **Prime Contractor:** Johns Hopkins University's Applied Physics Laboratory
- **Original total program cost:** Not available
- **Current total program cost:** Not available
- **Original quantity:** 26
- **Current quantity:** Cancelled
- **Original schedule:** N/A
- **Current schedule:** Cancelled
- **# Technologies below TRL 6 at dev. start:** N/A
- **# Nunn-McCurdy breach:** N/A

*GAO, Defense Acquisition Assessment of Selected Weapon Programs, GAO-13-294P, (Washington, D.C., March 2013)

+GAO, Defense Acquisition Assessment of Selected Weapon Programs, GAO-04-391, (Washington, D.C., March 2004)

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Precision Tracking and Space Surveillance (PTSS) (2 of 3)

Best Practice :
Prevent cost and schedule overruns with requirements stability

- Prototype program, new technology development
  - PTSS dependent on STSS data for risk reduction
- 2010 MDA Material Solution Analysis exit criteria assessed as low risk*
  - Development operational concept approved
  - Identified competitive alternative materiel solutions
  - Critical technology mature (or nearing maturity)
  - Funding approved for Technology Development Phase
- 2011 Defense Science Board (DSB) Task Force reported that PTSS was "too far away from the threat to provide useful discrimination data, does not avoid the need for persistent infrared (OPIR) coverage and is very expensive"^

*BMDS, BMDS Accountability Report (BAR) for 2010, declassified, 25 June 2010

+GAO, Defense Acquisition Assessment of Selected Weapon Programs, GAO-10-388SP, (Washington, D.C., March 2010)

^National Research Council of the National Academies, Letter from NRC Committee on an Assessment of Concepts and Systems for U.S. Boost Phase Missile Defense in Comparison to Other Alternatives, (Washington, D.C., April 30, 2012

Precision Tracking and Space Surveillance (PTSS) (2 of 3)

Best Practice :
Prevent cost and schedule overruns with requirements stability

- Prototyp

Lean Enablers

- ❑ 2.3.6 Create shared understanding of program content, goals, status, and challenges among key stakeholders
- ❑ 2.4 Develop high-quality program requirements among customer stakeholders before bidding and execution process begins
- ❑ 2.4.1 Assure that customer-level requirements defined in the request for proposal (RFP) or contracts are truly representative of the need; stable, complete, crystal clear, de-conflicted, free of wasteful specifications, and as simple as possible

*BMDS, BMDS Accountability Report (BAR) for 2010, declassified, 25 June 2010

+GAO, Defense Acquisition Assessment of Selected Weapon Programs, GAO-10-388SP, (Washington, D.C., March 2010)

^National Research Council of the National Academies, Letter from NRC Committee on an Assessment of Concepts and Systems for U.S. Boost Phase Missile Defense in Comparison to Other Alternatives, (Washington, D.C., April 30, 2012

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Precision Tracking and Space Surveillance (PTSS) (3 of 3)

Best Practice :
Execute disciplined, knowledge-based processes during product development

- Exited system concept phase without a robust analysis of alternatives (AOA)+
  - AoA aid in determining if concept achievable within baseline

Best Practice :
Ensure an executable business case is delivered to DoD program managers and hold DoD program managers accountable for successful outcomes

- 2013 DOD cancelled PTSS due to program's high-risk acquisition strategy and long-term affordability*

*GAO, Defense Acquisition Assessment of Selected Weapon Programs, GAO-13-294P, (Washington, D.C., March 2013)

+GAO, Missile Defense: Precision Tracking Space System Evaluation of Alternatives, GAO-13-747R, (Washington, D.C., 2013)

Precision Tracking and Space Surveillance (PTSS) (3 of 3)

Best Practice :
Execute disciplined, knowledge-based processes during product development

- Exited sys
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Lean Enablers

- 3.3 Pursue multiple-solution sets in parallel
- 3.4 Ensure up-front that capabilities exist to deliver program requirements
- 4.1 Use systems engineering to coordinate and integrate all engineering activities in the program
- 6.5 Use change management effectively to continually and proactively align the program with unexpected changes in the program's conduct and the environment
- 6.6 Proactively manage uncertainty and risk to maximize program benefit

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Select Program Summary (1 of 4)

Program	Contracting Agency	Contractor	Stable/Unstable Requirements	Stable/Unstable Funding	# TRL 6 or under at program start
SBIRS	Air Force	Lockheed Martin	Unstable	Unstable	3 of 3
GPS IIF	Air Force	Boeing	Unstable	Unstable	0
GPS III	Air Force	Lockheed Martin	Stable	Stable	0
GPS OCX	Air Force	Raytheon	Unstable	Unstable	14 of 14
MUOS	Navy	Lockheed Martin	Stable	Stable	1 of 9
JMS	Air Force	Multiple	Unstable	N/A	N/A
SBSS	Air Force	Boeing, Northrop Grumman	Unstable	Stable	5 of 5
AEHF	Air Force	Lockheed Martin	Unstable	Stable	11 of 14
NPOESS	Air Force, NOAA, NASA	Northrop Grumman	Unstable	Stable	13 of 14
PTSS	MDA	Johns Hopkins University's Applied Physics Laboratory	N/A	N/A	N/A

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Select Program Summary (2 of 4)

Program	Cost Final (in Billions)	Cost % Growth	Schedule Final	Schedule % Growth	Original Quantity	Final Quantity
SBIRS	18.8	300%	2018	120%	5	6
GPS IIF	2.6	257%	2014	133%	19	12
GPS III	4.2	2%	2015	40%	8	8
GPS OCX	3.695	28%	2015	50%	1	1
MUOS	7.3	6%	2012	20%	6	6
JMS	N/A	N/A	2013	50%	1	1
SBSS	0.922	178%	2010	60%	1	1
AEHF	14.372	154%	2010	150%	5	6
NPOESS	13.162	122%	Cancelled	Cancelled	6	0
PTSS	N/A	N/A	Cancelled	Cancelled	26	0

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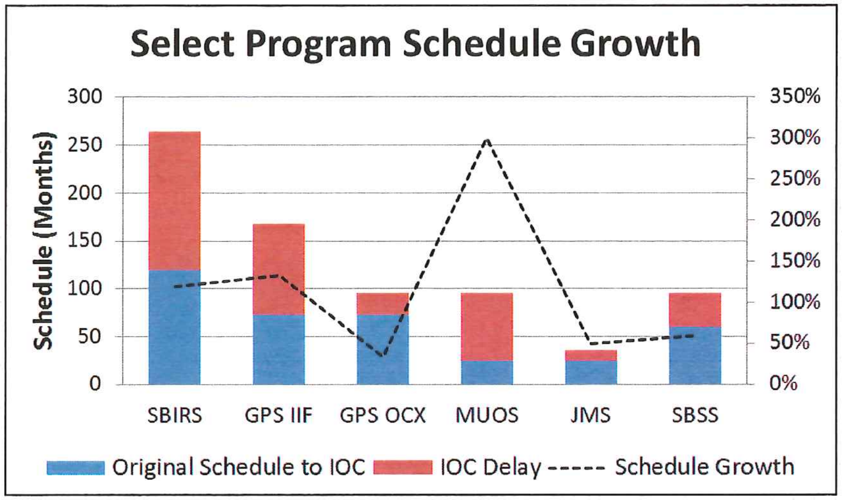
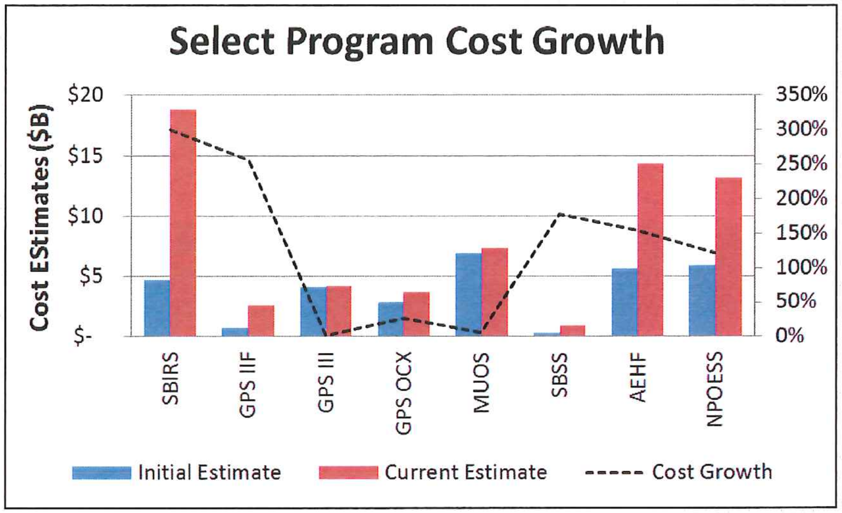
Select Program Summary (3 of 4)

Program	# Nunn-McCurdy	Excessive Complexity	Main Issues	Lean Enablers
SBIRS	4	Yes	Immature technology Inadequate schedule/cost estimate Lack of discipline systems engineering	2.4.3, 2.4.4, 2.4.6, 2.4.10, 2.4.12, 3.4, 3.10 3.10.7, 4.1, 4.4, 4.4.1, 4.3, 5.2, 6.6.6
GPS IIF	At least 1	No	Diffused leadership Manufacturing disruption Unstable requirements Loss of expertise	2.4, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 2.4.4, 2.4.6, 2.4.7 2.4.10, 2.4.12, 3.4, 3.10, 3.10.7, 4.1.2, 4.2, 4.2.1 4.2.2, 4.2.3, 4.2.6, 4.4, 4.4.1, 4.4.2, 4.3.3, 4.6.4, 6.5
GPS III	0	No	Initial funding instability	2.4, 2.4.1, 2.4.2, 2.4.6, 3.4, 3.10, 3.10.7, 4.1, 4.2, 4.3.1, 4.3.3, 4.4.2, 5.2, 6.5, 6.6, 6.6.6
GPS OCX	N/A	Yes	Unstable funding Unstable requirements Unestimated complexity of information assurance	2.4, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 2.4.5, 2.4.6, 2.4.7, 2.4.8, 2.4.9, 2.4.10, 2.4.11, 2.4.12,4.1, 4.1.2, 4.2.1, 4.2.2, 4.2.6, 4.3, 4.4, 4.4.1, 6.5, 6.6, 8.10.7
MUOS	0	No	Manufacturing quality Underestimated software complexity	3.2, 3.3, 3.4, 3.10, 4.1, 4.2, 4.2.2, 6.5, 6.6
JMS	N/A	Yes	Information assurance complexity Integrating/Interoperability of IT systems	2.4, 2.4.1, 2.4.2, 2.4.10, 3.3, 3.4, 3.10, 4.1, 6.5, 6.6, 6.6.6
SBSS	0	No	Design modifications Requirement instability Change in launch vehicle (external)	2.4, 2.4.1, 2.4.2, 2.4.6, 3.4.2, 3.4.3, 3.10.9, 3.10.11, 3.10.6, 4.1, 6.5, 6.6
AEHF	3	No	Delivery delay of components (external) Workmanship Design issues	2.4, 2.4.1, 2.4.2, 2.4.6, 2.4.10, 3.2.2, 3.4, 3.10, 3.10.6, 4.1, 4.2, 6.5, 6.6,
NPOESS	2	Yes	Lacked single decision-maker Conflicting requirements Lacked disciplined systems engineering	2.4, 2.4.1, 2.4.6, 2.4.10, 2.6, 3.1, 3.4, 3.10., 3.10.6, 4.1, 4.2, 4.2.1, 4.2.2, 4.2.3, 4.2.5, 4.3, 5.2, 6.5, 6.6
PTSS	N/A	N/A	Long-term affordability	2.3.6, 2.4, 2.4.1, 3.3, 3.4, 4.1,6.5, 6.6,

Select Program Summary (4 of 4)

- Programs surveyed indicate common issues
  - Inadequate cost, schedule estimate
  - Unstable requirements
  - Immature critical technologies
  - Inadequate risk management
  - Software needs poorly understood
  - Unstable funding
  - Inadequate contract vehicle
  - Inadequate oversight
  - Unsynchronized deliveries
    - Space, ground, user equipment
  - Part obsolescence
- Average schedule overrun to IOC: 106%
- Average program cost overrun: 131%





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DoD Acquisition Performance Summary (1 of 5)

- Best Practice: unsettled requirements create cost & schedule overruns
  - Joint Requirements Oversight Council (JROC) inconsistently considered tradeoffs*
    - Agencies inconsistently provided quality resource estimates to the JROC
    - JROC inconsistently prioritized requirements and capability gaps
  - Programs experienced 72% cost increase compared to only 11% cost increase in programs that did not modify requirements*
  - Space program cost estimates in 2011 increased by 321% ($11.6 billion)*
    - 2012 estimates reflected overall decrease due to program cancellation/restructuring
- Programs attempted to satisfy all requirements in a single step, regardless of technology maturity required to achieve a capability*
  - Programs choose to maximize capability due to launch costs (ULA)

DoD requirement process is ineffective

*GAO, Space Acquisitions: DoD Faces Challenges in Fully Realizing Benefits of Satellite Acquisition Improvements, GAO-12-563T (Washington, D.C.: March 21, 2012)

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DoD Acquisition Performance Summary (2 of 5)

- Best Practice: Reduce DoD program management turnover during system development
  - DoD employs ~729 program managers (military and civilian)+
  - DoD policy states program managers must remain in a place until the completion of major milestone*
  - Average program system development duration in 2008: ~37 months*
  - Average DoD program manager tenure in 2008: ~17 months*
  - Short tenures may promote shortsightedness, challenge continuity, and reduce accountability for poor outcomes*
    - May incentivize DoD program mangers against implementing "knowledge-based acquisition" practices

Short tenures incentivize lack of "knowledge-based" decision-making

*GAO, Best Practices: Better Support of Weapon System Program Managers Needed to Improve Outcomes, GAO-06-110, (Washington, D.C., November 31, 2005)

+GAO, Defense Acquisitions: Assessment of Selected Weapon Programs, GAO-08-467SP, (Washington, D.C., March 31, 2008)

DoD Acquisition Performance Summary (3 of 5)

- Best Practice: Size DoD program offices adequately (manpower and technical expertise) to perform program management activities and technical oversight
  - ~48 percent of program office staff consist of contracting support*
    - DoD does not have the appropriate mix of staff and capabilities within its workforce to effectively manage programs*
  - Air Force Acquisition Improvement Plan to revitalize the acquisition workforce+
    - Increase number of authorized positions
    - Evaluate mix of military and civilian personnel
    - Establish training and experience objectives

Percentage of staff

	Program management	Administrative support	Business functions	Engineering and technical	Other	Total
Government	70	39	64	48	45	52
Support contractors	22	60	35	34	55	36
Other non-government[a]	8	1	1	18	1	12
Total non-government	30	61	36	52	56	48

Source: GAO analysis of DOD data.

Program offices not adequately staffed (skill sets lacking)

*GAO, Defense Acquisitions: Assessment of Selected Weapon Programs, GAO-08-467SP, (Washington, D.C., March 31, 2008)

+GAO, Space Acquisitions: DoD Faces Challenges in Fully Realizing Benefits of Satellite Acquisition Improvements, GAO-12-563T (Washington, D.C.: March 21, 2012)

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DoD Acquisition Performance Summary (4 of 5)

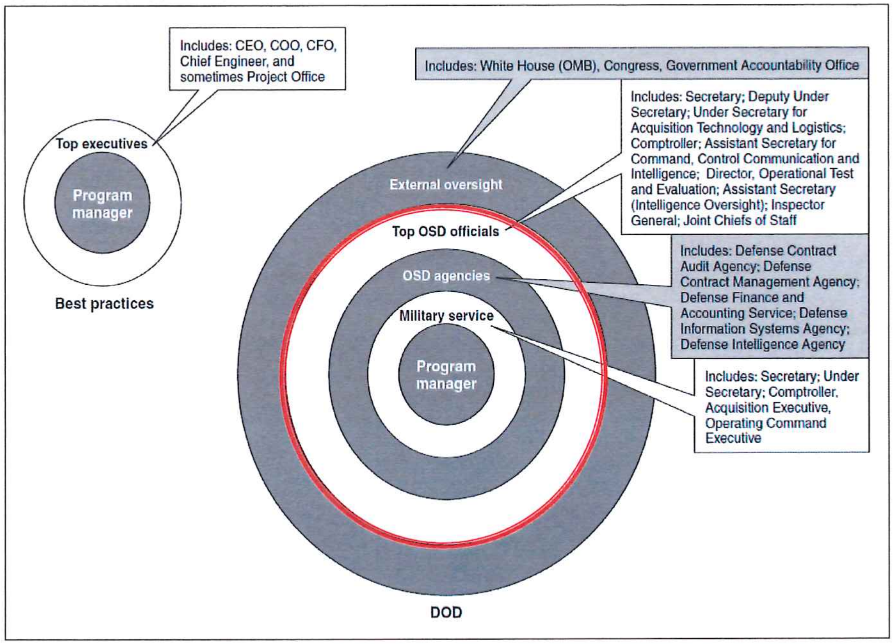
- Best Practice: Execute disciplined, knowledge-based processes during product development
  - 80% of programs conduct production and development activities concurrently*
    - No significant deviation from past reviews → Programs are moving through acquisition phases with high levels of risks
  - Ground systems and user equipment in major space programs are not optimally aligned leading to underutilization of enhanced on-orbit capability
  - 95% of software lines of code after system development
  - Quality problems discovered during development
    - Poor workmanship
    - Undocumented and untested manufacturing processes
    - Ineffective supplier management
    - Parts contamination
    - Poor part design and design complexity

*GAO, Defense Acquisition: Assessment of Selected Weapon Programs, GAO-13-249SP, (Washington, D.C., March 31, 2013)

+GAO, Defense Acquisition: Assessment of Selected Weapon Programs, GAO-10-388P (Washington, D.C.: March 31, 2010)

DoD Acquisition Performance Summary (5 of 5)

- Support from top DoD leadership
  - DoD programs begin without a business case, DoD program managers do not control requirements, budget (annual appropriation process), nor the tenure required to manage a specific program



Source: GAO.

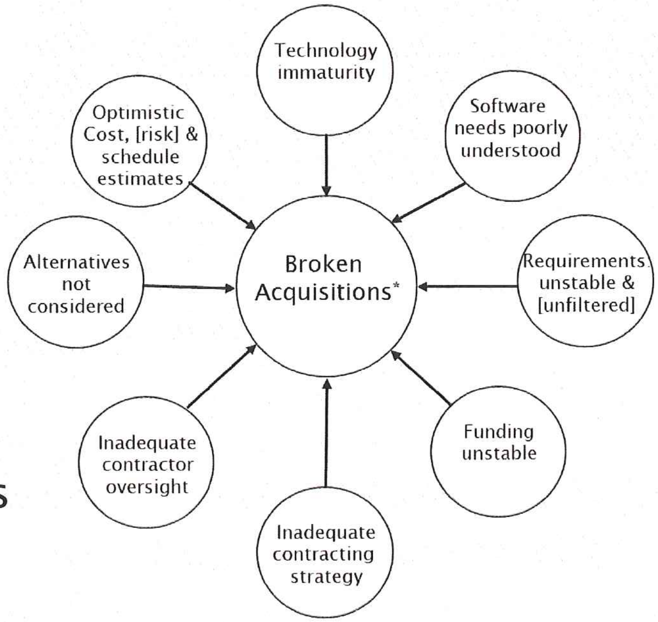
Under the current DoD management paradigm, it is nearly impossible to hold DoD program managers accountable

PM → RAA for both technical and business success of the program

*GAO, Best Practices: Better Support of Weapon System Program Managers Needed to Improve Outcomes, GAO-06-110, (Washington, D.C., November 31, 2005)

Reflection: Negative Influences that Can Cause Programs to Fail*

- GAO: 8 Factors for broken acquisitions
  - Starting more weapon programs than is affordable
  - Starting programs before assurance that capabilities can be achieved within available resources
  - Attempting to satisfy all requirements in a single step regardless of design challenges or technology maturity



Lean Enablers address every single one of the negative factors

*GAO, Space Acquisitions: DoD Faces Challenges in Fully Realizing Benefits of Satellite Acquisition Improvements, GAO-12-563T (Washington, D.C.: March 21, 2012)

Reflection:
Program Manager Ethical Perspective

- Legal and regulatory requirements: Right and wrong is clear
  - Standard of Ethical Conduct for Employees of the Executive Branch Joint Ethics Regulation (DoD 5500.7-R)

- Ethical dilemma: when right and wrong is not obvious
  - Effects not immediately recognized
    - Delaying risk for later phases of the program
    - Knowingly presenting unrealistic cost or schedule
    - Removing testing to recover schedule
    - Ignoring technical team concerns

Incentives caused by fiscal policy

Incentives caused by military program manager rotation

- Acquisition reform and fiscal policy give DoD program managers limited control over requirements and funding

Waste reduction is everyone's responsibility

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Reflection: Program-level Leadership and Management Issues

- Funding instability causes huge problems
- Most DoD program managers are military; rotations are disruptive
  - Incentive for short-term decision-making→ good vs. bad news
  - No real accountability for program success or failure
- Program manager does not control requirements
- Programs begin with unclear & unstable requirements
- Requirements may change due to long acquisition process
- Programs begin with immature critical technologies
- Development and production activities happen concurrently
- Space, ground, and user equipment program cycles unsynchronized

Poor program performance is a symptom of a broken acquisition process

Reflection: Personal Views

- Contract vehicles must be appropriate to program phase, i.e. development, production, sustainment
- Research and development must occur in separate phases
- Critical technologies must be matured before RFP
- Current program requirements too complex to be affordable
- Program Manager stability critical to success
- Revise acquisition strategy and incentives

Questions?

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