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Effects of System Prototype Demonstrations on DoD Weapon Systems Development

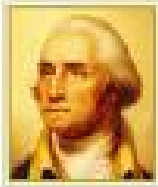
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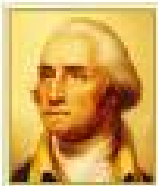
Problem Statement

*The inability of DoD programs to sufficiently reduce technology risk **prior to entering formal systems development** has over the past 5 years contributed to a 13% cost growth in weapon systems acquisition and a 17% increase in cycle time for initial operational capability.^[1]*

- GAO analysis of Major Defense Acquisition Programs (MDAPs) (2007 – 2012) indicates need for additional reform in the acquisition of weapon systems
 - Avg acquisition cost increased → **38%** *(Since program first full estimates)*
 - Avg cycle time (for IOC) increased → **37%**

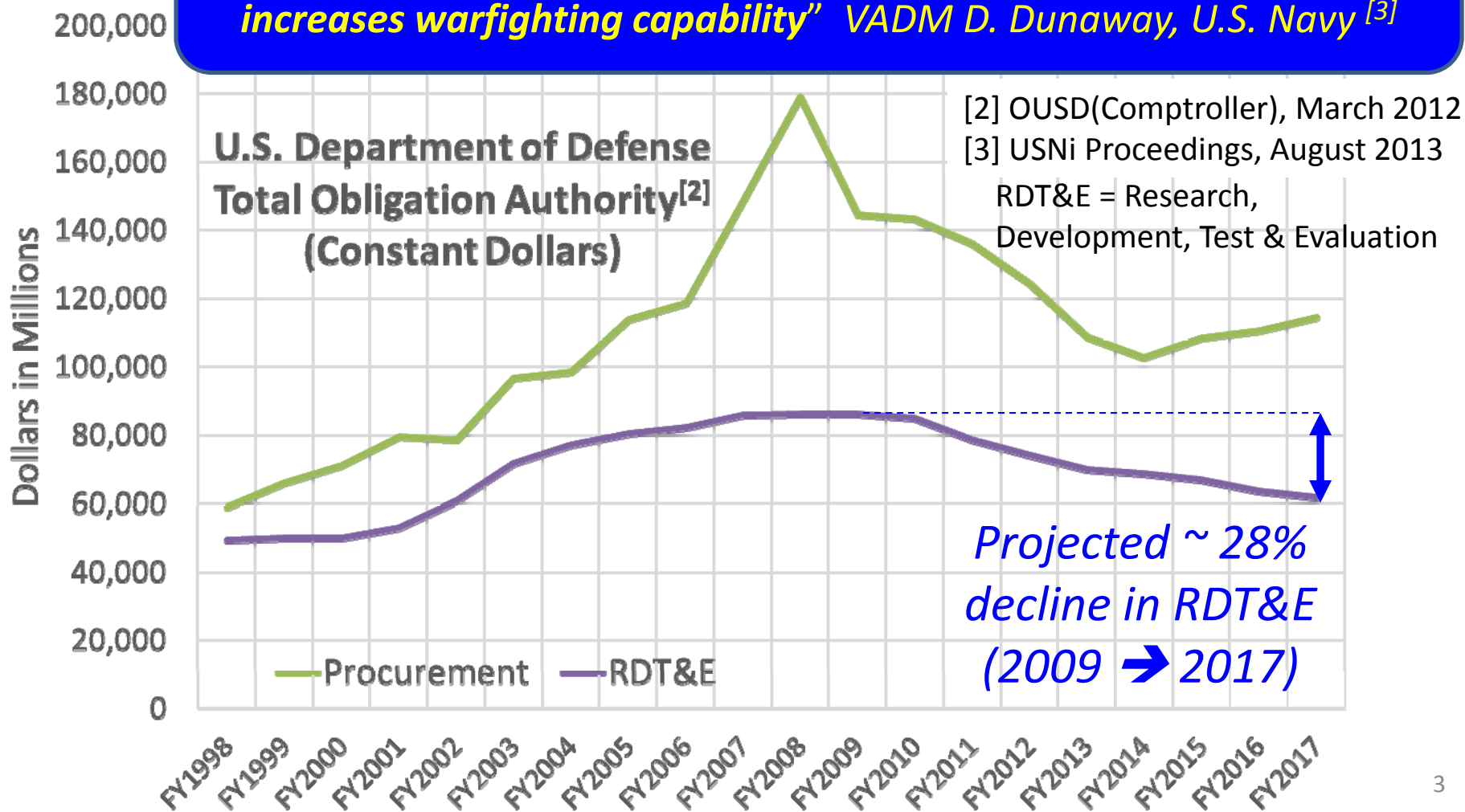
MDAP is an ACAT I program with either:

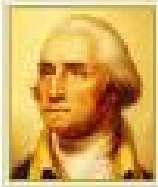
- Est. RDT&E ≥ \$365M (FY2000 dollars); or
- Est. Production ≥ \$2.19B (FY2000 dollars)



RDT&E Budget Continues Decline

“In the face of decreasing budgets, rapidly evolving threats, and a shift in national defense strategy ... , *it’s imperative that every dollar spent increases warfighting capability*” VADM D. Dunaway, U.S. Navy [3]





Research Objective & Focus

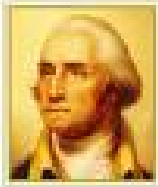
Conceptual Research Objective

- Establish a framework to measure the effects that ***early system prototype demo's*** have on weapon systems development

System prototype demo's in Technology Development → EMD Program Performance

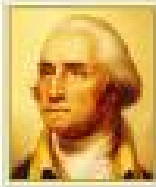
Elements to be Addressed

- Return-on-Investment for reducing technology risk
- Impact on technology maturity of enabling critical technologies
- Impact on requirements definition & system allocated baseline
- Impact on achieving system design maturity



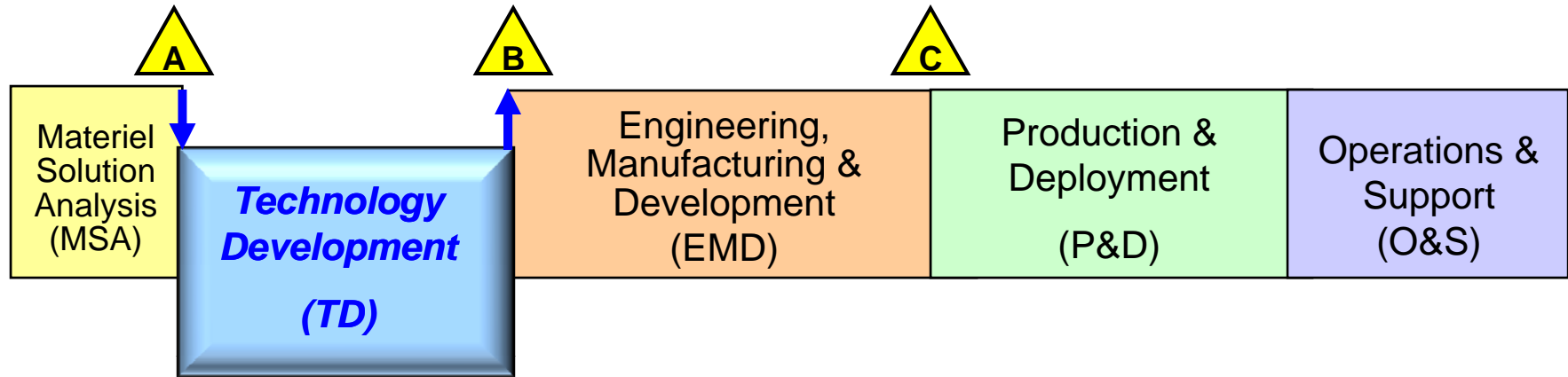
Technology Development Guidance (Key Historical Events)

Date	Source	Significance
1970	Fitzhugh Commission	✓ Increased use of prototypes and design competition “Fly-Before-You-Buy”
1986	Packard Commission	✓ Prototypes before full-scale development ✓ Early demos of tech feasibility & operational utility
2006 & 2008	NDAA (U.S.C. 2366b)	✓ All critical technologies demo in relevant environment ***Technology Maturity is Law *** TRL 6
2007	USD(AT&L), Prototyping & Competition (Young)	✓ Competing teams w/ system prototypes through Milestone B
2009	WSARA	✓ Competitive prototype demos prior to EMD ✓ Preliminary Design Review prior to MS-B
2011	USD(AT&L), Improve Milestone Effect. (Kendall)	✓ Pre-EMD Review w/ pre-TRA as entry criteria
2012	USD(AT&L), Better Buying Power 2.0 (Kendall)	✓ Promote effective competition ✓ Focus TD Phase on true risk reduction

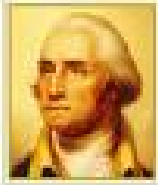


Technology Development

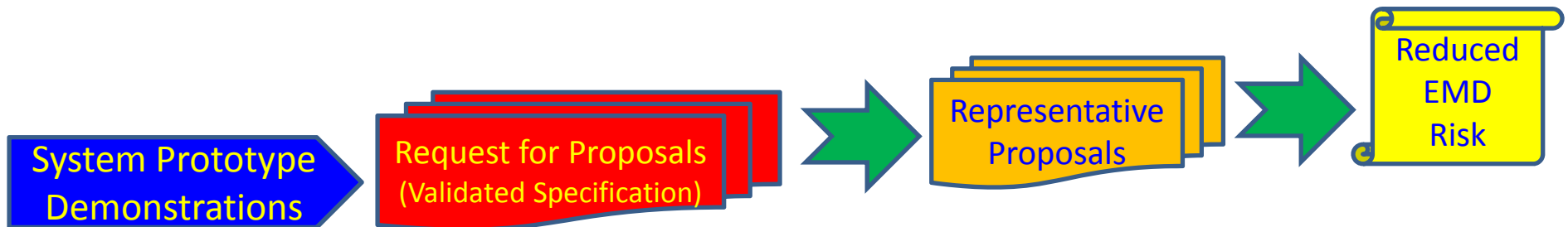
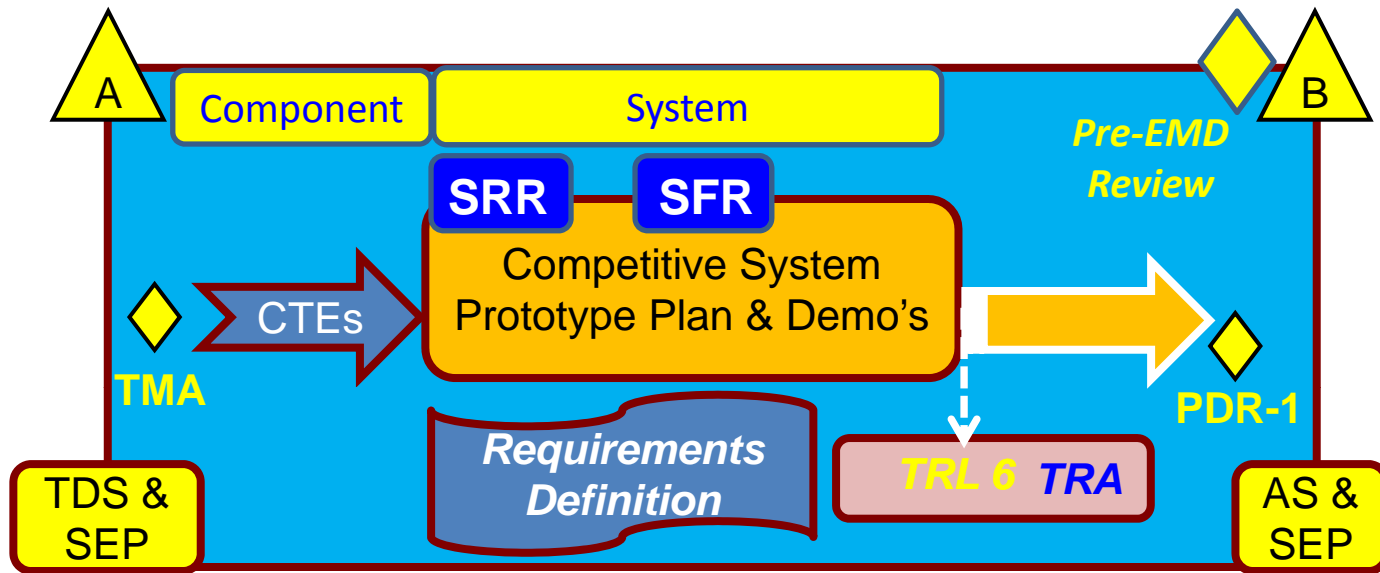
“Key Enabler to Reducing Technology Risk”



- Purpose: *Reduce technology risk, determine and mature technologies ... and perform **system level prototype demos** of critical technologies in a relevant environment (TRL 6)*
 - *Technology maturity* is a major indicator of design complexity, adequacy of requirements, and an indicator to program risk
 - *System prototype demonstrations* play a pivotal role to implementing and achieving a successful program Technology Development Strategy
 - *“Competitive” system prototype demonstrations* provide an added dimension or multiplier through the perceived incentive of competition

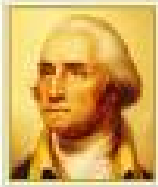


Defense Acquisition Management System "Technology Development Phase" [4]



CTE = Critical Technology Element
PDR = Preliminary Design Review
SFR = System Functional Review
TDS = Technology Development Strategy
TRA = Technology Readiness Level

EMD = Engineering, Manufacturing & Development
SEP = Systems Engineering Plan
SRR = System Requirements Review
TMA = Technology Maturity Assessment
TRL = Technology Readiness Level



CTEs → System Prototype → Demonstration ^{[5][6][7]}

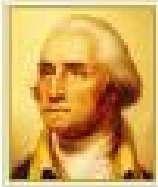
- **Critical Technology Element (CTE):** Technologies required to meet operational requirements that are considered either new or novel or poses major technological risk
- **System Prototype:** Integrated components that are representative of the actual system
 - Very close to form, fit, and function
 - A physical or virtual model (Hardware/Software)
- **System Prototype Demonstration:** Tests to show technical or manufacturing feasibility or military utility of a technology or process, concept, end item, or system
 - Venues include: Laboratory; dynamic platform; high fidelity live, virtual, and/or constructive simulations; and physics based modeling
 - Used to reduce technological risk and uncertainty of fully integrated system
 - Benefits include: technology maturity, requirements refinement, design stability, and improved program performance (cost & schedule)

[5] DoD 2009 TRA Deskbook

[6] DoD Acquisition Guidebook

[7] OSD 2011 TRA Guidebook

WSARA = Weapon Systems Acquisition Reform Act of 2009



System Prototype Demonstrations “Relevant Environment → TRL 6”



Source: U.S. Army.



Source: U.S. Air Force.



Source: U.S. Navy.



Source: U.S. Air Force.



Source: U.S. Navy.



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Source: U.S. Navy.



Source: U.S. Navy.

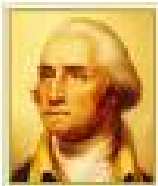
Relevant environment varies dependent upon system performance requirements and worse case (threshold) mission relatable scenarios

Physical, logical, data, security & user environments

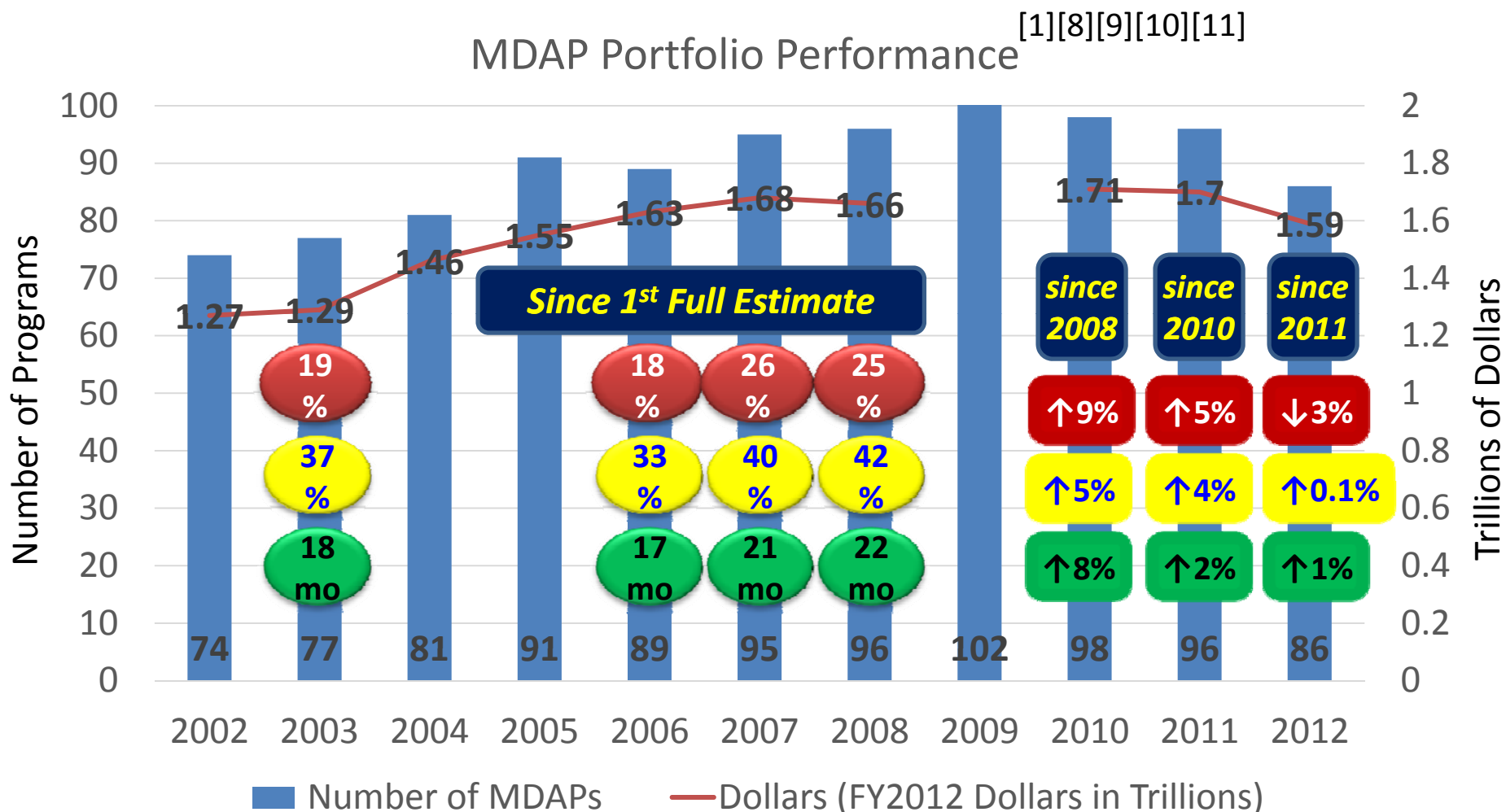


Source: U.S. Air Force.

- System prototype demo must address worse case mission relevant environment to minimize technology risk to EMD



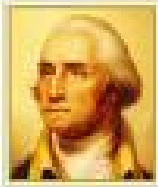
DoD Major Defense Acquisition Programs (MDAPs) Portfolio



[1] GAO-13-294SP
[8] GAO-12-400SP
[9] GAO-11-233SP

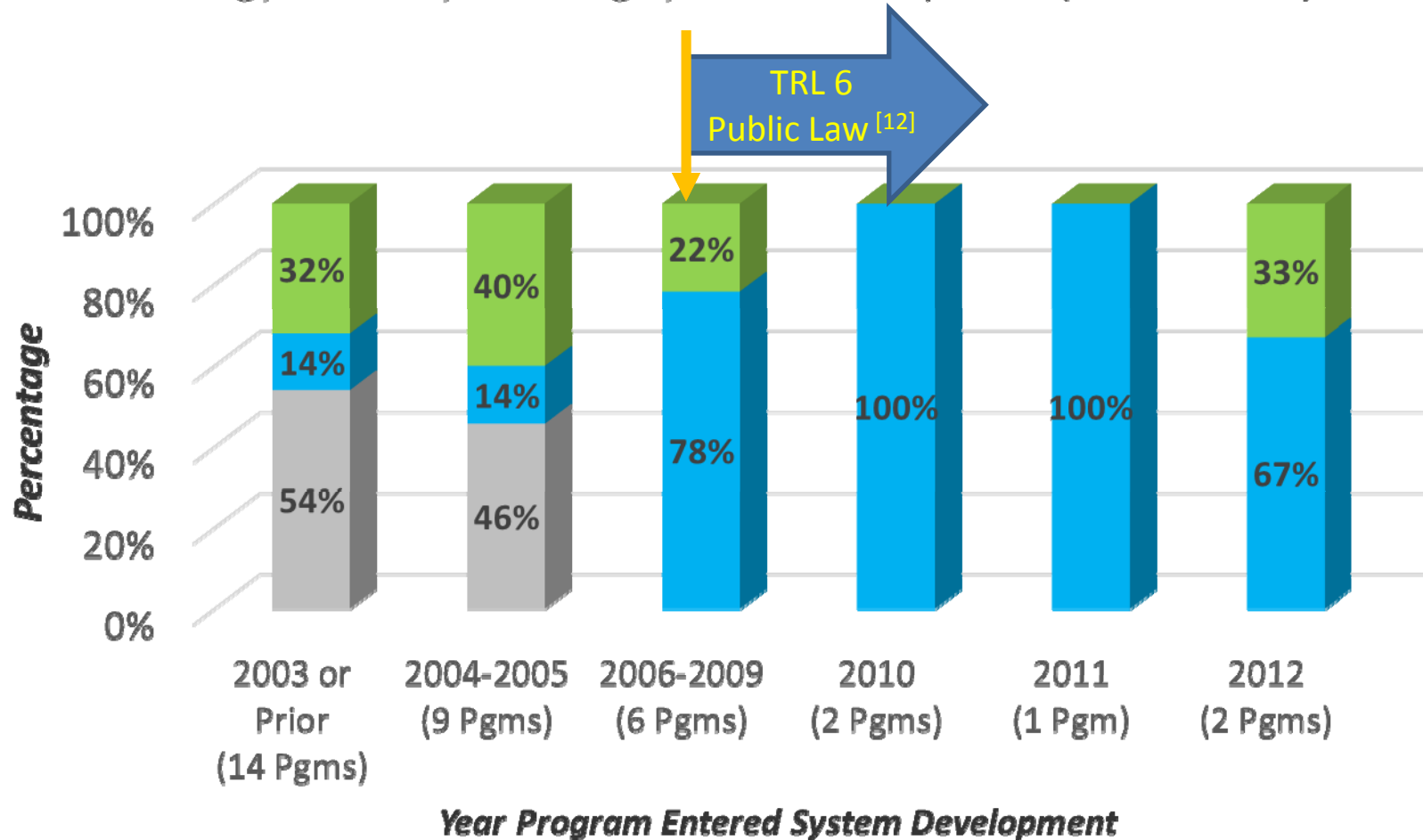
[10] GAO-09-326SP
[11] GAO-08-467SP

Red = Total Acquisition Cost Growth
Yellow = Research, Test, & Evaluation Cost Growth
Green = Total Cycle Time Growth



Technology Maturity (Driver for System Prototype Demo)

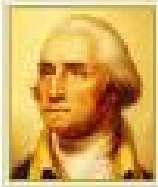
Technology Maturity Entering System Development (Milestone B) [1][8][9][13]



■ CTEs Immature (at least 1 < TRL 6) ■ CTEs Nearing Mature (TRL 6) ■ CTEs Mature (TRL 7)

[12] Public Law (U.S.C. 2366b) CTE = Critical Technology Element TRL = Technology Readiness Level 11

[13] GAO-10-388SP; [9] GAO-11-233SP; [8] GAO-12-400SP; [1] GAO-13-294SP



Technology Development Planning (PDR & Competitive Prototypes)

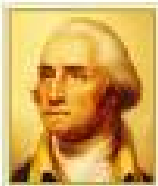
- Weapon Systems Acquisition Reform Act of 2009^[14]
**** Prior to entering EMD ****

“Current” MDAPs (EMD) <i>(sample size = 40)</i>	2012 Portfolio^[1]	“Future” MDAPs (TD) <i>(sample size = 17)</i>
<p><i>Preliminary Design Review</i></p> <p>95% Conducted a PDR (38 programs)</p> <p>29% Conducted PDR prior to MS-B → 15% post WSARA → Avg 18 mo prior to MS-B</p> <p>71% Held/Plan PDR post MS-B → Avg 24 mo post CA</p>		<p><i>Preliminary Design Review</i></p> <p>59% Plan PDR prior to MS-B (10 programs)</p> <p>29% PDR unknown since MS-B is TBD</p> <p>12% Plan PDR post MS-B (waiver granted)</p> <p><i>Competitive Prototypes</i></p> <p>65% Competitive Prototypes Planned</p> <p>29% Seeking Waiver</p> <p>6% Undecided Strategy</p>

[1] GAO-13-294SP

[14] WSARA of 2009

CA = Contract Award

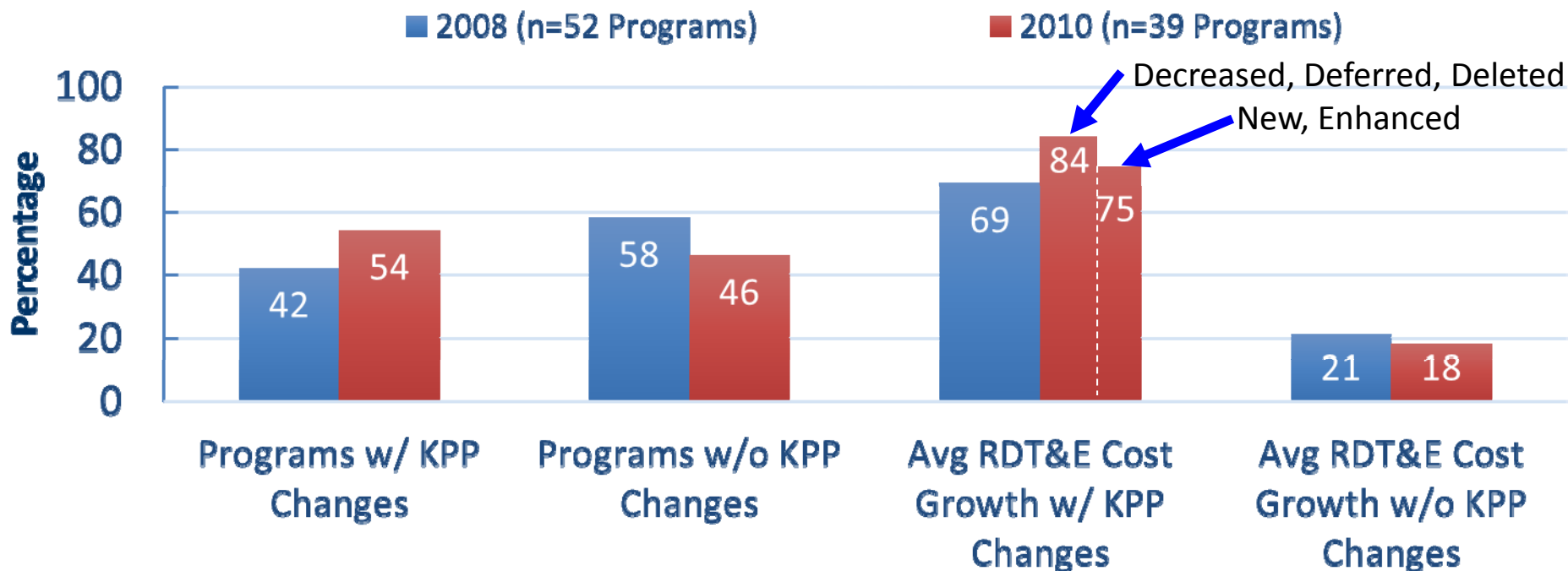


Impacts Due to Changing Requirements

[9] GAO-11-233SP

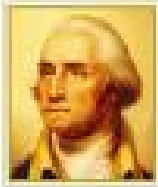
[10] GAO-09-326SP

Change in Key Program Performance (KPP) Requirements (Impact to Average Acquisition Cost Growth) [9][10]



	Avg Cycle Time Growth (months)	
	2008	2010
w/ KPP Changes	30	27 - 40
w/o KPP Changes	15	8

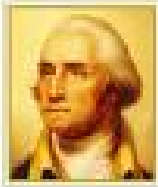
Better alignment w/ critical technologies (in TD) could improve program performance



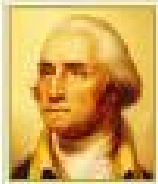
Concluding Remarks

- Today's economic environment requires smart & effective systems engineering to continue to meet the warfighter's needs and improve DoD buying power
- Pre-EMD system prototype demos can play a significant role in reducing technology risk for system development

Research will further analyze key attributes of system prototype demos for correlation and significance to program performance



Back-Up Slides

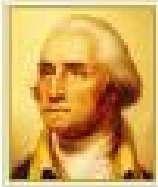


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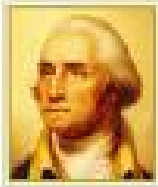
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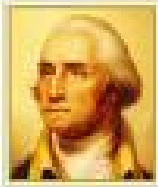
Acronyms

ACAT	Acquisition Category		MDAP	Major Defense Acquisition Program		SRR	System Requirements Review
AS	Acquisition Strategy		MSA	Materiel Solution Analysis		S&T	Science & Technology
CDD	Capability Development Document		NASA	National Aeronautics and Space Administration		TD	Technology Development
CTE	Critical Technology Element		O&S	Operations & Supportability		TDS	Technology Development Strategy
DoD	Department of Defense		P&D	Production & Deployment		TMA	Technology Maturity Assessment
EMD	Engineering, Manufacturing, and Development		PDR	Preliminary Design Review		TOA	Total Obligation Authority
GAO	Government Accounting Office		RDT&E	Research, Development, Test & Evaluation		TRA	Technology Readiness Assessment
ICD	Interim Capability Document		SEP	Systems Engineering Plan		TRL	Technology Readiness Level
IOC	Initial Operational Capability		SFR	System Functional Review		USC	United States Code
KPP	Key Performance Parameter		SRD	System Requirements Document		WSARA	Weapon Systems Acquisition Reform Act



References (1 of 2)

- [1] GAO (2013). Defense Acquisitions, Assessments of Selected Weapon Programs, GAO-13-294SP, U.S. Government Accountability Office, Washington, DC.
- [2] OUSD(Comptroller) (2012). National Defense Budget Estimates For FY2013.
- [3] USNi (2013). Creating Integrated Warfighting Capabilities, United State Naval Institute , Proceedings Magazine, 139(8)1, 60-65.
- [4] Department of Defense (2008). DoD Instruction 5000.02, Operation of the Defense Acquisition System, Washington, DC.
- [5] DoD (2009). Technology Readiness Assessment Desk book, Director of Defense Research & Engineering.
- [6] DoD (2013). Defense Acquisition Guidebook, Retrieved from Defense Acquisition University Defense Acquisition Guidebook website <https://acc.dau.mil>.
- [7] DoD (2011). Technology Readiness Assessment Guidance, Assistant Secretary of Defense for Research and Engineering.
- [8] GAO (2012). Defense Acquisitions, Assessments of Selected Weapon Programs, GAO-12-400SP , U.S. Government Accountability Office, Washington, DC.



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- [9] GAO (2011). Defense Acquisitions, Assessments of Selected Weapon Programs, GAO-11-233SP , U.S. Government Accountability Office, Washington, DC.
- [10] GAO (2009). Defense Acquisitions, Assessments of Selected Weapon Programs, GAO-09-326SP , U.S. Government Accountability Office, Washington, DC.
- [11] GAO (2008). Defense Acquisitions, Assessments of Selected Weapon Programs, GAO-08-467SP , U.S. Government Accountability Office, Washington, DC.
- [12] Public Law 109-163 (2006). NDAA FY2006 Public Law 109-163, § 801 (codified 10 U.S.C. § 2366b)
- [13] GAO (2010). Defense Acquisitions, Assessments of Selected Weapon Programs, GAO-10-388SP , U.S. Government Accountability Office, Washington, DC.
- [14] Public Law 111-23 (2009). Weapon Systems Acquisition Reform Act (WSARA) of 2009.