



Using Parametric Software Estimates During Program Support Reviews

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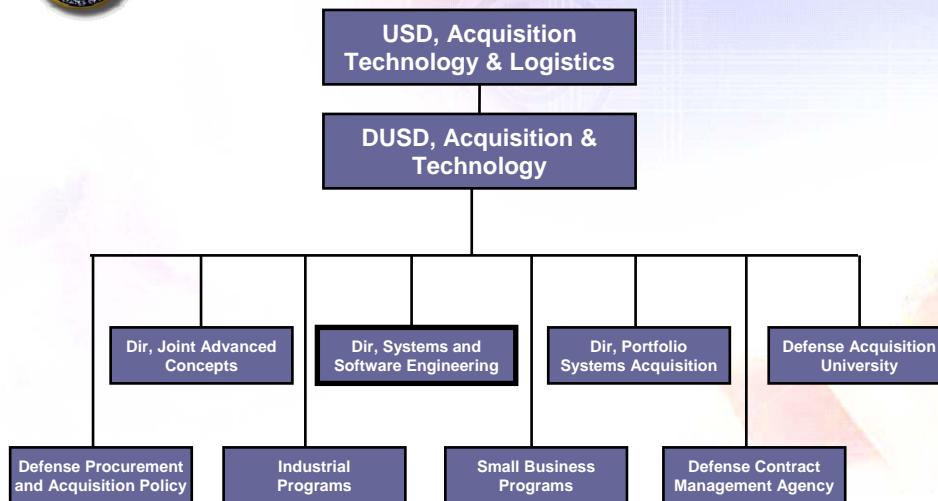
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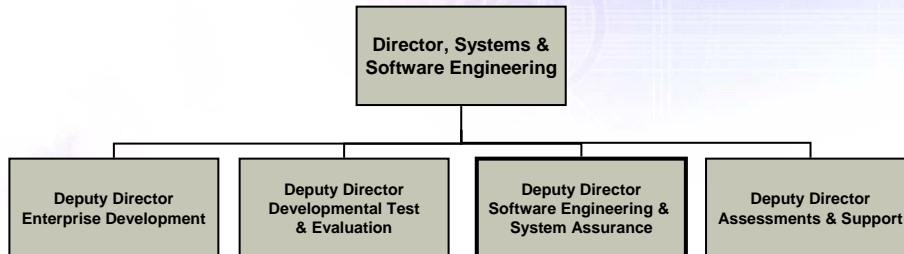


OUSD (AT&L) Organization May 2006





Systems and Software Engineering



Analysis of Program Failure



- Acquisition cost growth over 11 years (SAR data FY 1995–2005):
 - Estimation changes: \$201B
 - Engineering changes: \$147B
 - Schedule changes: \$70B
- Over the past 10 years, DoD systems have experienced a 33% cost growth due to “RDT&E mistakes”
- DoD IOT&E results, FY2001-2006
 - 29 systems; mix of ACAT II, 1C, 1D across 3 Services
 - Approx. 50% were deemed “Not Suitable”, or partially NS
 - Approx. 33% were deemed “Not Effective”, or partially NE
- Specific Causes of Program Failure (Systemic Root Cause Analysis findings)

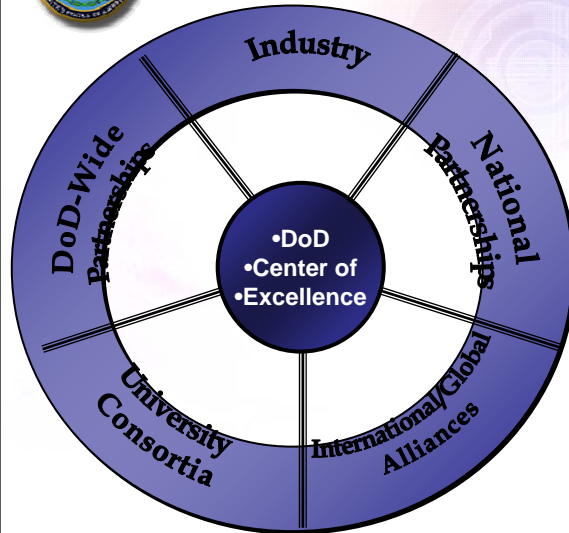
We do not Start Programs Right

- Insufficient requirements analysis and definition at program initiation
- Lack of rigorous SE approach
- Optimistic/realistic reliability growth – not a priority during development
- Inadequate software architectures, design/development discipline, and organizational competencies

We do not Manage Programs Right

- Insufficient trade space
- Insufficient risk management
- Inadequate IMP, IMS, EVMS
- Most programs lack quantifiable entrance/exit criteria
- Maturing “suitability” (e.g., RAM) is not always a priority

Establishing a DoD Engineering Center of Excellence



DoD Engineering Center of Excellence

- Support Acquisition Success
- Improve State-of-the-Practice of Engineering
- Leadership, Outreach and Advocacy
- Foster Resources to Meet DoD Needs

Elements of a DoD Strategy for Software



- Support Acquisition Success
 - Ensure effective and efficient software solutions across the acquisition spectrum of systems, SoS and capability portfolios
- Improve the State-of-the-Practice of Software Engineering
 - Advocate and lead software initiatives to improve the state-of-the-practices through transition of tools, techniques, etc.
- Leadership, Outreach and Advocacy
 - Implement at Department and National levels, a strategic plan for meeting Defense software requirements
- Foster Software Resources to meet DoD needs
 - Enable the US and global capability to meet Department software needs, in an assured and responsive manner

Promote World-Class Leadership for Defense Software Engineering



Getting Started – What are we Doing?



- Identifying software issues, needs
 - Software Industrial Base Study
 - NDIA Top Software Issues Workshop
 - Defense Software Strategy Summit
- Creating opportunities, partnerships
 - Established network of Government software POCs
 - Chartered the NDIA Software Committee and Expert Panel
 - Information exchanges with Government, Academia, and Industry
- Executing focused initiatives
 - Providing software support to acquisition programs
 - Foundational assessment of software policy/guidance
 - Study of Software/SE integration
 - Software Engineering reference curriculum
 - Engineering for System Assurance
 - SoS Systems Engineering Guide
 - CMMI Integrity, CMMI-ACQ, CMMI Guidebook
 - Early Systems/Software Engineering



Top Software Issues*



1. The impact of requirements upon software is not consistently quantified and managed in development or sustainment. **“Requirements”**
2. Fundamental system engineering decisions are made without full participation of software engineering. **“SE/SW Integration”**
3. Software life-cycle planning and management by acquirers and suppliers is ineffective. **“Sustainment”**
4. The quantity and quality of software engineering expertise is insufficient to meet the demands of government and defense industry. **“Human Capital”**
5. Traditional software verification techniques are costly and ineffective for dealing with the scale and complexity of modern systems. **“Testing”**
6. There is a failure to assure correct, predictable, safe, secure execution of complex software in distributed environments. **“Assurance”**
7. Inadequate attention is given to total lifecycle issues for COTS/NDI impacts on lifecycle cost and risk. **“COTS”**

* NDIA Top Software Issues Workshop
August 2006

Driving Technical Rigor Back Into Programs "Program Support Reviews"



- Program Support Reviews provide insight into a program's technical execution focusing on:
 - SE as envisioned in program's technical planning
 - T&E as captured in verification and validation strategy
 - Risk management - integrated, effective and resourced
 - Milestone exit criteria as captured in Acquisition Decision Memo
 - Acquisition strategy as captured in Acquisition Strategy Report
- Independent, cross-functional view aimed at providing risk-reduction recommendations

The PSR reduces risk in the technical and programmatic execution of a program

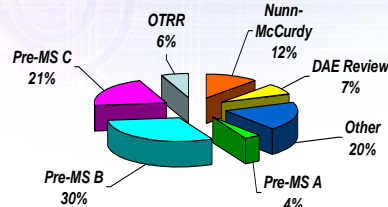
Program Support Review Activity

(since March 2004)

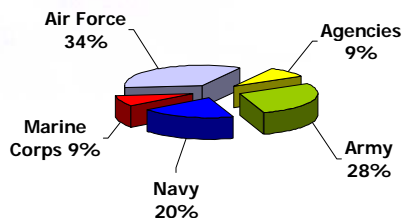


- PSRs/NARs completed: 48
- AOTRs completed: 11
- Nunn-McCurdy Certification: 10
- Participation on Service-led IRTs: 2
- Technical Reviews: 12
- Reviews planned for FY08:
 - PSRs/NARs: 21
 - AOTRs: 2
 - Nunn-McCurdy: 2

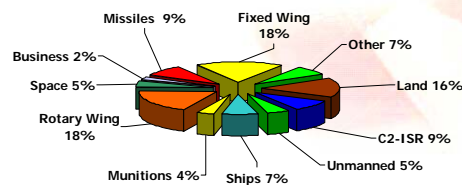
Decision Support Reviews



Service-Managed Acquisitions



Programs by Domain Area





DoD Software Performance: What We're Seeing*



- Software issues are significant contributors to poor program execution
 - Schedule realism (compressed, overlapping)
 - Software requirements not well defined, traceable, testable
 - Immature architectures, COTS integration, interoperability, obsolescence (electronics/hardware refresh)
 - Software development processes not institutionalized, planning documents missing or incomplete, reuse strategies inconsistent
 - Software test/evaluation lacking rigor and breadth
 - Lessons learned not incorporated into successive builds
 - Software risks/metrics not well defined, managed

*Based on over 60 program reviews over the past 3 ½ years



Software Engineering and System Assurance (SSA) Role



- SSA produced software estimates to support several PSR teams in 2007
 - Program A: SSA was asked to assess software schedule feasibility prior to MS B
 - Program B: Significant software issues
- Opportunity for SSA to support program decision making by providing software estimates
 - Estimation activities aimed at gauging overall program feasibility and quantifying magnitude of top program risks
 - Focus on support for engineering vs. budgeting decisions



Program A



- PSR of aircraft program with ambitious schedule
 - Three years (36 months) from Milestone B to LRIP
 - Modifications needed to meet U.S. requirements
- Developed three software estimates
 - Software size (SLOC) estimates provided by program office
 - Re-estimated both new and reused code
 - » Based on reuse and code growth
 - » Estimates for optimistic, typical, and pessimistic were identified as “Min”, “Mid”, and “Max”
 - Used three parametric models
 - » COCOMO II, SLIM, and SEER-SEM
 - Most input parameters set at nominal



Program A



- Estimation & Feasibility Analysis
 - Given an adjusted code size (ASIZE) of 918K to 1590K SLOCs
 - A range of 5375 to 9571 person months should be expected over a 62 to 74 calendar month schedule

COCOMO II	Min	Mid	Max
ASize (KSLOC)	918	1,204	1590
Effort (PM)	5375	7147	9571
Duration (CM)	62	68	74

- All three models forecasted 65 to 68 months (assuming a 50% confidence-level)
- Result:
 - Analysis revealed existing acquisition strategy was not feasible
 - Service added more schedule to acquisition strategy
 - DUSD(A&T) estimates change in acquisition strategy saved \$5 billion



Program B



- Major subcontractor with significant software content did not use any parametric estimating tool
 - Firm Fixed Price subcontract
- At one point there was a substantial conflict on estimates between major subcontractor and prime, related to requirements
 - One portion of software grew from ~250KSLOC to 863KSLOC (3.5x), reflecting “shall not degrade current capability” requirement
- Increase in software engineering staff by 57 percent (40 people) over 9 month period
 - Based on schedule, contractor should be drawing down software staff
- Significant variation in code estimates during review



Program B

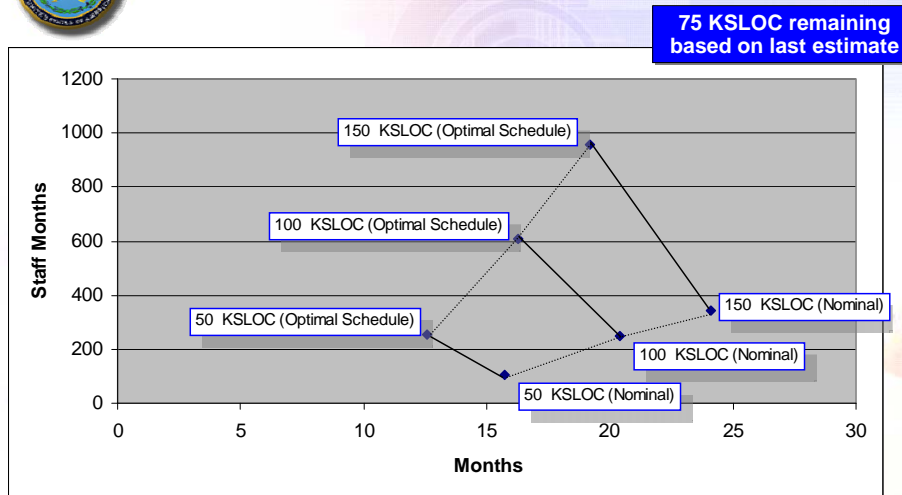


Changes in SLOC estimates...

CSCI	Supplier	Original	NM Review	2 wks. later	New	Reuse	Complete %	Test coverage to-date	DR's/Problem reports
1	A	40,000	374,739	293,844	201,144	49,700	75%	68%	47
2	B	27,000	50,363	50,363	40,363	10,000	90%	85%	0
3	A	20,000	38,962	38,962	38,962	0	71%	60%	5
4	C	325,000	415,249	401,732	131,821	269,811	98%	98%	1
5									5
6									0
7	D	65,000	283,255	25,467	18,367	7,100	82%	60%	0
8	C	33,000	373,587	100,129	68,129	32,000	99%	99%	0
9	E	15,000	7,879	7,879	2,000	5,879	100%	100%	1
10	F	114,000	218,609	218,609	16,409	202,200	99%	95%	0
11	G	26,000	25,622	34,544	8,922	25,622	100%	100%	2
12	H	6,000	16,580	16,580	15,580	1,000	100%	100%	2
13	H	2,000	34,806	34,806	17,206	17,600	100%	100%	0
14	I	33,000	42,355	42,355	31,655	10,700	99%	97%	1
15	G	15,000	126,238	119,626	6,433	113,193	100%	100%	0
16	K	23,000	26,404	26,404	2,604	23,800	91%	91%	1
17	L	7,000	12,500	12,500	1,000	11,500	100%	100%	1
18	C	1,000	29,121	29,121	25,621	3,500	100%	100%	7
19	M	NA	100	1,000	1,000	Unavail	100%	100%	0
20	C	NA	2,600	2,600	400	2,200	81%	43%	0
		752,000	2,078,969	1,413,521					



Program B Schedule Estimates



Time from Detailed Requirements Complete Through End of Developmental Testing



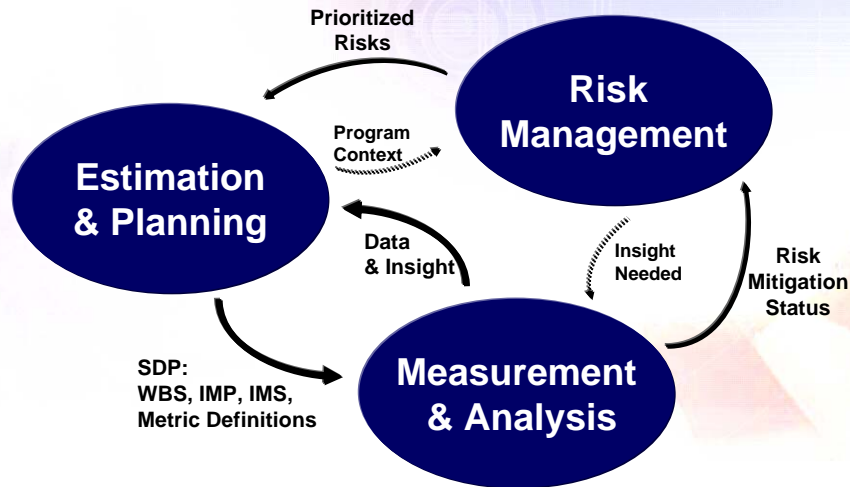
Program B



- Estimation and Feasibility Analysis
 - Contractor appears to be driven to meet schedules versus costs
 - » Significant increase in effort for minimal schedule savings
 - Uncertainty in scope of remaining software development
 - » Need to develop firmer size estimates
- Recommendations
 - PMO reach a decision on unstable requirements to prevent further code growth – in or out
 - Program office bring in parametric estimating consultant to review contractor's estimates for most volatile software components
- Result
 - Acquisition Decision Memorandum requires Service to conduct software review



Integrating Management Indicators



SSA Software Initiatives



- Measurement, Analysis, and (Size, Effort/Cost, Schedule → Risk) Estimation
 - Work Breakdown Structure Study
 - » Focus: Recommendations for update of MIL-HDBK-881A
 - » Execution: Partnering with DCMA, ARA, NII, PA&E/CAIG and using NDIA expert panel
 - Earned Value Management Study
 - » Focus: Recommendations for update of EVM Guidebook
 - » Execution: Partnering with AS, DCMA, ARA, NII, PA&E
 - Pilot of EVM/SW Metric
 - » Focus: Development of cost controls for software component of program
 - » Execution: Partnering with DCMA, ARA, NII, PA&E/CAIG, Contractors
 - Cost Estimation
 - » Focus: Software considerations for cost estimation
- Software Quality Attributes
 - Possible studies
 - » Focus: SW Quality attributes issues, data
 - » Execution: NDIA Panel

Questions/Discussion



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