



# Enhancing Performance Management via Metrics

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**ODDR&E/Systems Engineering**

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# Mission Context



Director, Systems Engineering  
Steve Welby

## Systems Analysis

### “Weapon Systems Acquisition Reform Act of 2009”

S.454-10; d.(1): The development and tracking of detailed measurable performance criteria as part of the systems engineering master plans...

S.454-10; d.(3): A system for storing and tracking information relating to the achievement of the performance criteria and objectives specified...

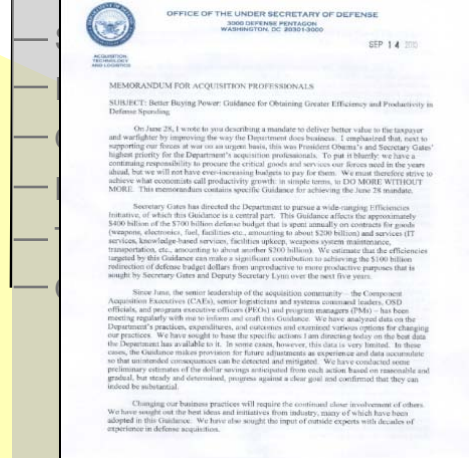
S.454-12; SEC. 103.b.(4): Evaluating the utility of performance metrics used to measure the cost, schedule, and performance of [MDAPS], and making such recommendations ...to improve such metrics.

## Major Program Support James Thompson

- Program Support Reviews
- Systems Engineering Plans
- Program Technical Auditing
- OIPT/DAB/DSAB Support
- DAES Database Analysis and Support
- Performance Measurement
- Systemic Root Cause Analysis

## Mission Assurance

### AT&L Memo, 14SEP2010 Subject: Better Buying Power: Guidance for Greater Efficiency and Productivity in Defense Spending



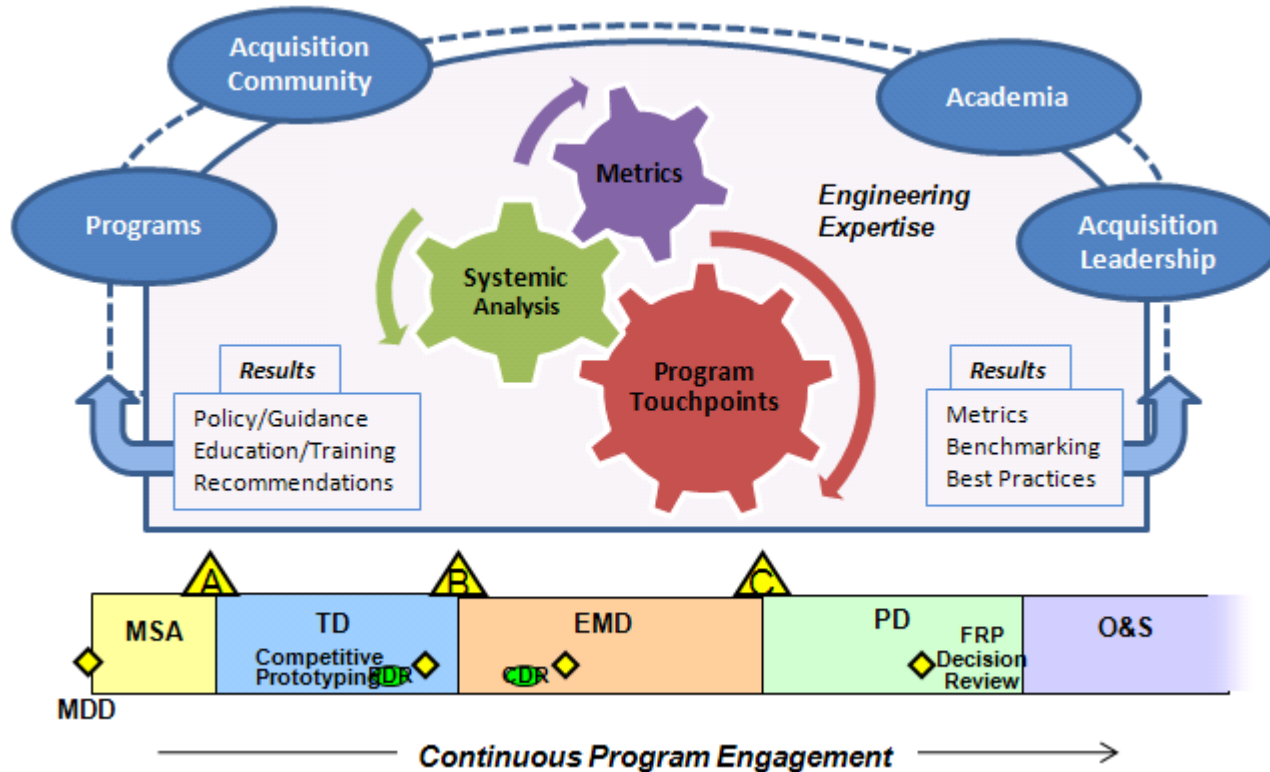
*“...Set shorter program timelines and manage to them...”*

*“...remain cognizant of our programs’ progress...and identify problems quickly...”*

ability  
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HSI)  
ment  
essment



# OUSD(AT&L) Systems Engineering Major Program Support Directorate



## Program Touchpoints:

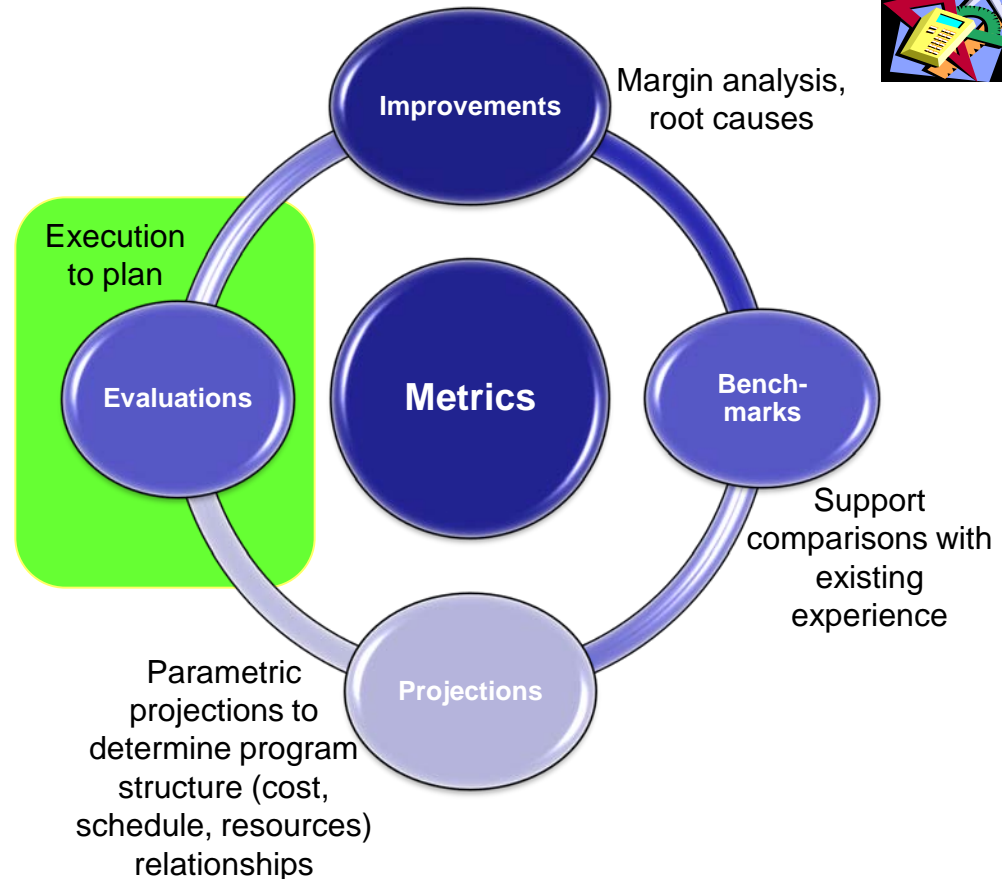
- Program Support Reviews (PSR), SE Working Integrated Product Teams (WIPT), Technical Reviews, SEP Reviews, PDR/CDR Assessments
- Integrating IPT (IIPT), Overarching IPT (OIPT)
- Defense Acquisition Board (DAB), Defense Acquisition Executive Summary (DAES), Nunn McCurdy Reviews



# SE Metrics Goals

## “What we are trying to achieve”

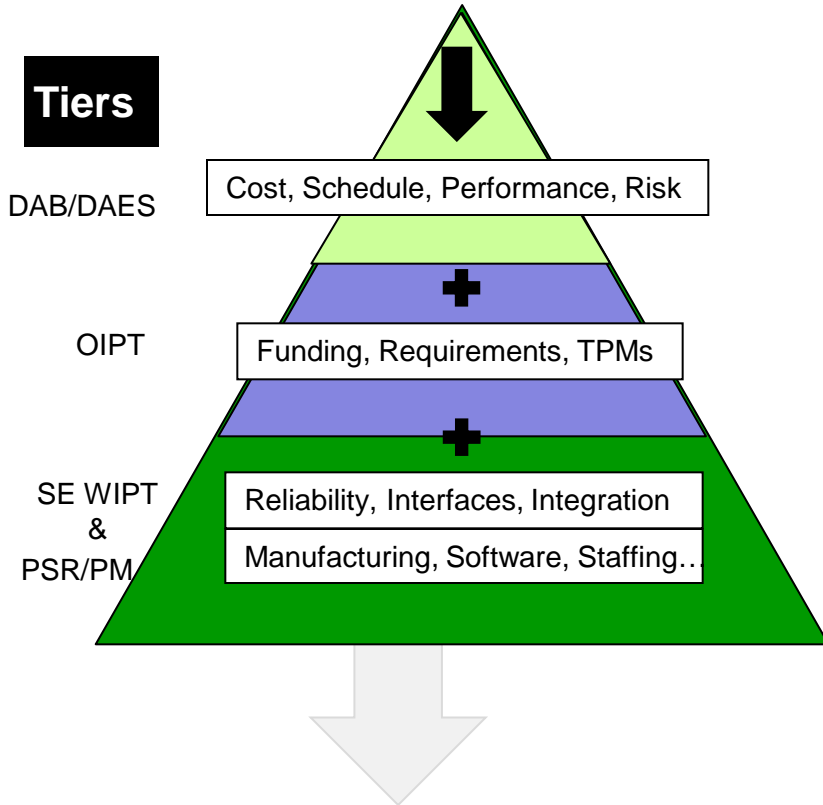
- Emphasize quantitative understanding consistent with Industry practice of system engineering
- Make visible relationships between system/equipment design objectives and performance
- Harness and use existing information for timely and better decisions at the appropriate levels



**"To measure is to know."  
"If you can not measure it, you can not improve it."  
Lord William Kelvin (1824-1907)**

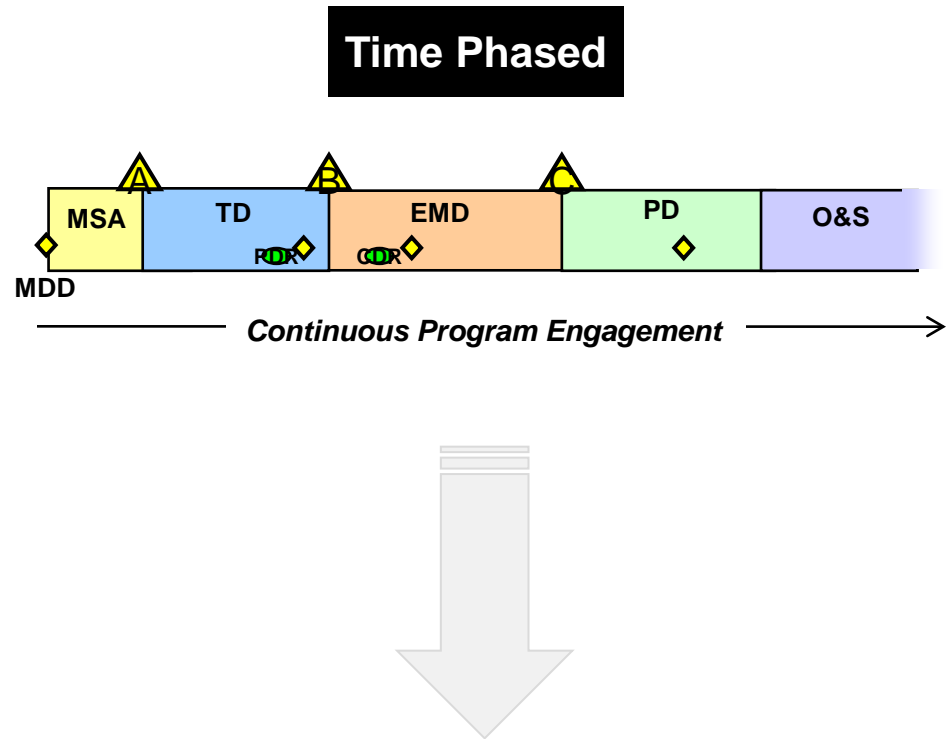


# Tiered and Time Phased Measures



## Information needs vary by Tier

- Summary and roll-up information at highest tier
- Greater engineering detail and number of metrics provided at lowest tier



## Metric relevancy based on lifecycle phase and events

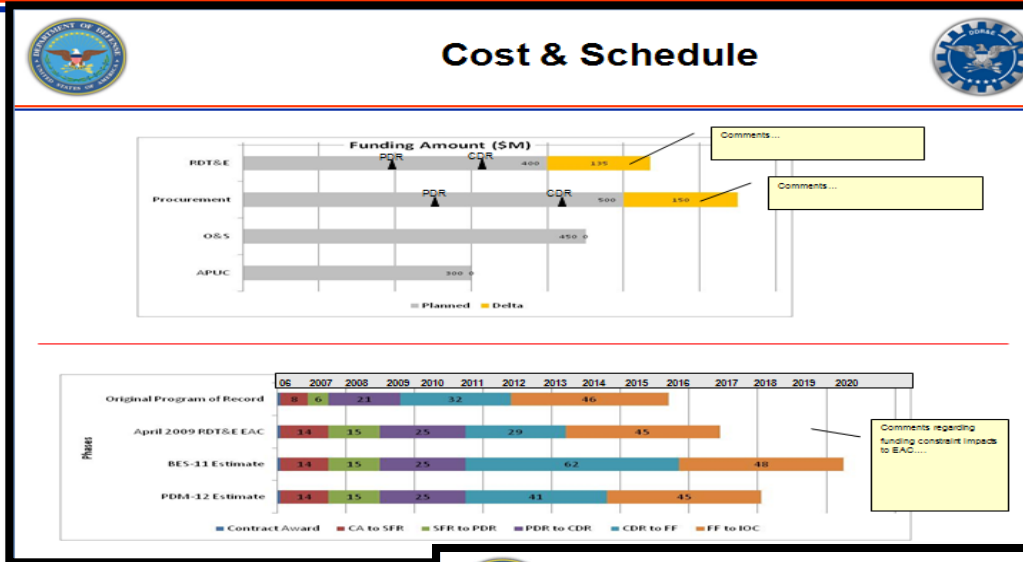
- E.g. T&E metrics prevalent later
- Decisions based on time cycles (e.g. DAES every 3 months)



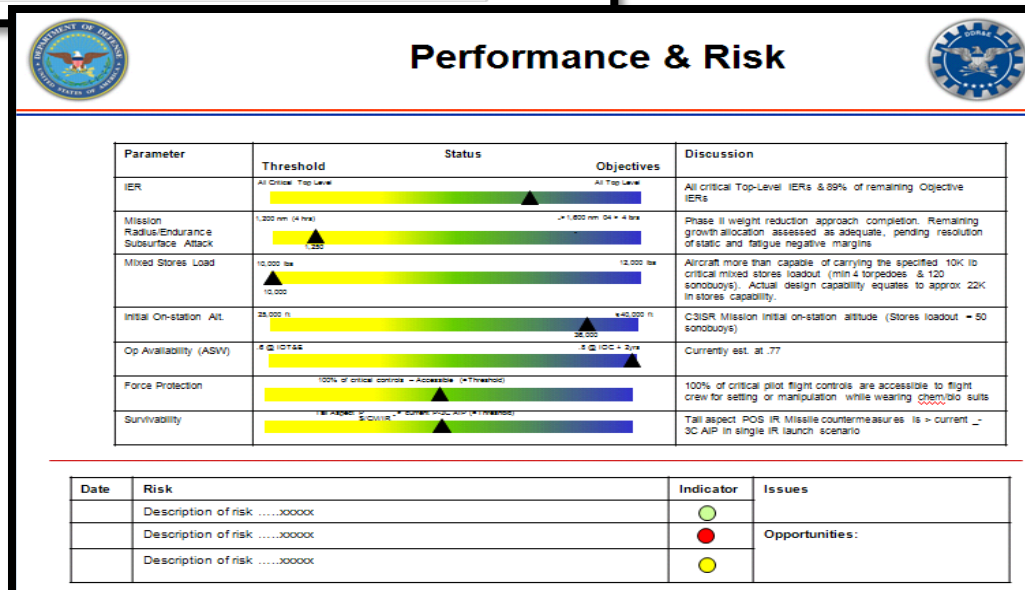
# Top Tier: Senior Leadership Level



Sample Metrics



1. Top level understanding of program status
2. Execution to plan
3. Key risks
4. Adequacy of path forward to resolve risks/issues



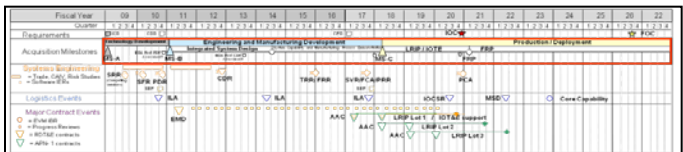




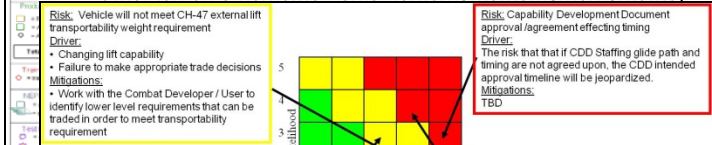
# Mid Tier: Principal Managers

Sample Metrics

- Top level findings and recommendations
- Metric summaries across wider breadth of engineering and management areas
- Insights on PM incorporation of recommendations
- Positive observations



Schedule



Risks

**SAMPLE Investment Program Funding & Quantities**  
 (\$ in Millions / Then Year)

RD&E	Prior	FY10	FY11	FY12	FY13	FY14	FY15	FY11-15	To Comp	Prog Total
Prior \$ (PB 10)	106.4	6.7	17.2	7.1	0.0	0.0	0.0	24.3	0.0	137.4
Current \$ (PB 11)	106.4	5.0	1.2	6.9	16.9	7.1	3.0	35.1	0.0	146.5
Delta \$ (Current - Prior)	0.0	(1.7)	(16.0)	(0.2)	16.9	7.1	3.0	10.8	0.0	9.1
Required \$	110.0	7.0	17.0	7.0	0.0	5.0	10.0	39.0	0.0	156.0
Delta \$ (Current - Required)	(3.6)	(2.0)	(15.8)	(0.1)	16.9	2.1	(7.0)	(3.9)	0.0	(9.9)

Cost

**Table 1.4.1-1 MOE/MOS**  
 Measures of Effectiveness and Suitability

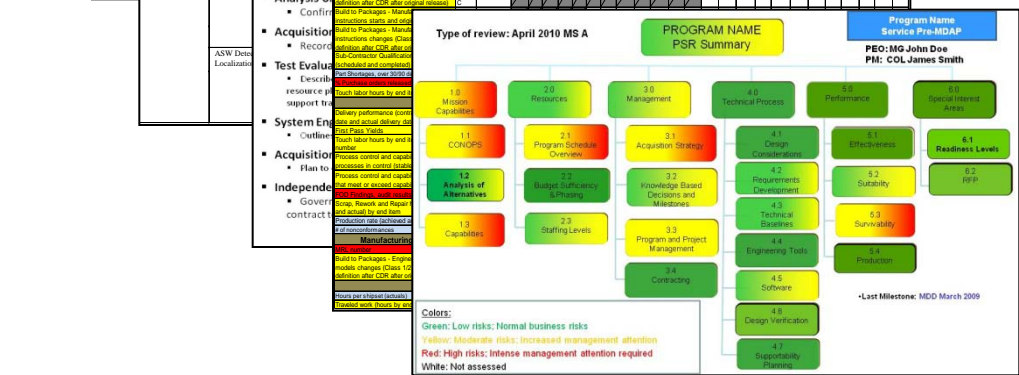
COI	Characteristic	Parameter	CPD Threshold	CPD Objective	CPD Reference
Prior \$ (PSW)	ASW Aircraft Performance	Mission Radius/Endurance - Subsurface Attack (per flight profile CPD Appendix)	EFFECTIVENESS	≥ 1,600 nm / 2.4-hr on-sta	6.1 Table 6-1
Current \$				**KPP 1,200 NM / 4-hr on-station	
Delta				Conditions:	
Required					
Delta					

T&E

**MS A Documents**

- MDA Program Certification (10 USC 2366a)
  - MDA certifies that statutory programmatic requirements have been met
- Program Protection Plan
  - Comp...
- Technology
  - Appro...
  - and execu...
  - Include...
- Analysis of
  - Confir...
- Acquisition
  - Record...
- Test Evaluat
  - Describ...
  - resource p...
  - support Te...
- System Eng
  - Outvie...
- Acquisition
  - Plan to...
- Govern
  - independe...
- Govern
  - contract...

Documentation Status



Manufacturing

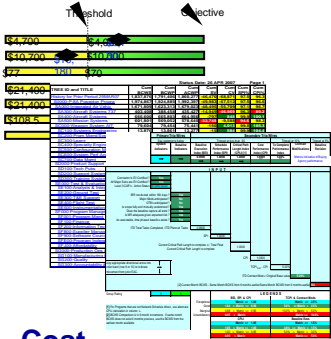
PSR Scorecard



# Lower Tier: Working Level

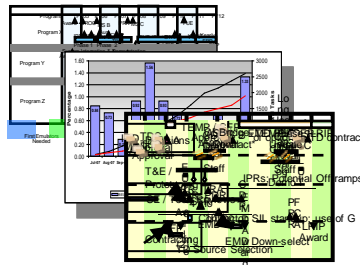


## Sample Metrics



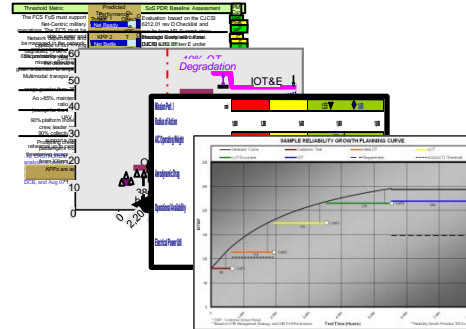
### Cost

- EVMS Dashboard
- CPI-SPI
- Variances
- Burn rate
- Management Reserve



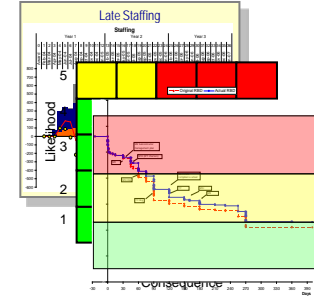
### Schedule

- Tier 1
- Critical path
- Schedule risk assessment
- Late starts/finishes
- FoS/SoS schedules



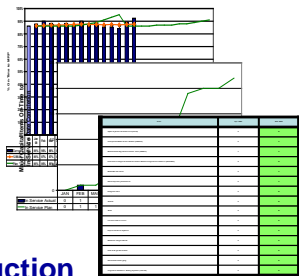
### Performance

- KPP/KSA progress
- TPMs
- Reliability growth curve
- TRLs



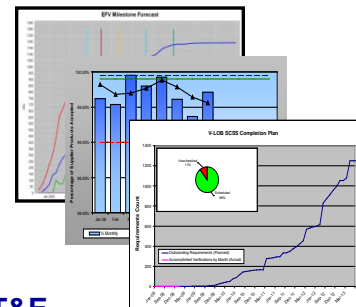
### Management

- Staffing
- Risk cube and Burn-down curve
- Exit criteria



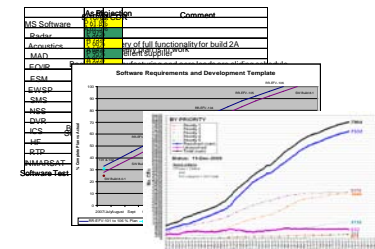
### Production

- Build-to-Package completions
- Traveled work
- Supplier/Subcontractor Quality tests
- Scrap, Rework and Repair hours
- First pass yields
- Touch labor hours
- Etc.



### T&E

- Schedules
- CTPs
- MOE/S
- Retest
- Verification status



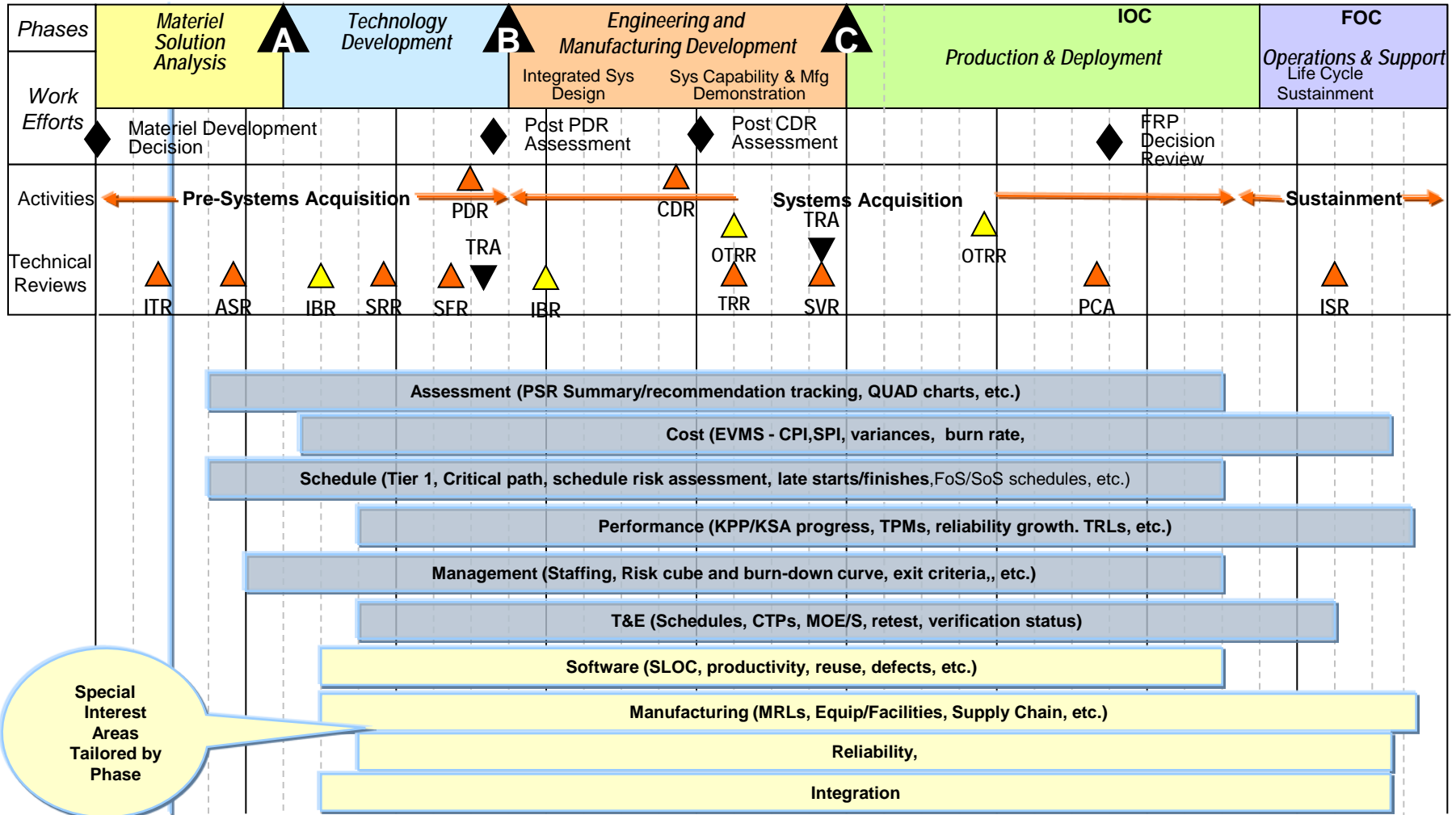
### Software

- SLOC
- Productivity
- Reuse
- Defects





# Time-based Metrics Related to Lifecycle Activities



Special Interest Areas Tailored by Phase



# Sample Metrics (Notional)



Manufacturing & Quality		Tiers	Requirement	Mat Sol Analysis	Technology Development								Engineering and Manufacturing Development					Production and Deployment											
		A/B/C	Planned	Actual	AoA	PSR	MS A	SRR	SFR	PDR	PSR	SE WIPT *	PMR *	DAES *	MS B	CDR	PRR	PSR	SE WIPT *	PMR *	DAES *	MS C	IoT&E	PSR	SE WIPT *	PMR *	DAES *	FRP	
Build to Pa models sta	Programatic Metrics	Tiers	Requirement	Mat Sol Analysis	Technology Development								Engineering and Manufacturing Development					Production and Deployment											
Build to Pa models cha		A/B/C	Planned	Actual	AoA	PSR	MS A	SRR	SFR	PDR	PSR	SE WIPT *	PMR *	DAES *	MS B	CDR	PRR	PSR	SE WIPT *	PMR *	DAES *	MS C	IoT&E	PSR	SE WIPT *	PMR *	DAES *	FRP	
Build to Pa models cha definition af	List date of last c event and next pl	Tiers	Requirement	Mat Sol Analysis	Technology Development								Engineering and Manufacturing Development					Production and Deployment											
Build to Pa instructions	Perform	A/B/C	Planned	Actual	AoA	PSR	MS A	SRR	SFR	PDR	PSR	SE WIPT *	PMR *	DAES *	MS B	CDR	PRR	PSR	SE WIPT *	PMR *	DAES *	MS C	IoT&E	PSR	SE WIPT *	PMR *	DAES *	FRP	
Build to Pa instructions definition af	KPPs (List value	Tiers	Requirement	Mat Sol Analysis	Technology Development								Engineering and Manufacturing Development					Production and Deployment											
Build to Pa instructions definition af	System Interfa application)	A/B/C	Planned	Actual	AoA	PSR	MS A	SRR	SFR	PDR	PSR	SE WIPT *	PMR *	DAES *	MS B	CDR	PRR	PSR	SE WIPT *	PMR *	DAES *	MS C	IoT&E	PSR	SE WIPT *	PMR *	DAES *	FRP	
Sub-Contr (scheduled	Internal Line Re (LRU) to LRU	Software	A/B/C	Planned	Actual	AoA	PSR	MS A	SRR	SFR	PDR	PSR	SE WIPT *	PMR *	DAES *	MS B	CDR	PRR	PSR	SE WIPT *	PMR *	DAES *	MS C	IoT&E	PSR	SE WIPT *	PMR *	DAES *	FRP
Part Shorta	Internal Comput Component (C	Software size	A/B/C	Planned	Actual	AoA	PSR	MS A	SRR	SFR	PDR	PSR	SE WIPT *	PMR *	DAES *	MS B	CDR	PRR	PSR	SE WIPT *	PMR *	DAES *	MS C	IoT&E	PSR	SE WIPT *	PMR *	DAES *	FRP
% Purchase	CSC to LRU	ESLOC	A/B/C	Planned	Actual	AoA	PSR	MS A	SRR	SFR	PDR	PSR	SE WIPT *	PMR *	DAES *	MS B	CDR	PRR	PSR	SE WIPT *	PMR *	DAES *	MS C	IoT&E	PSR	SE WIPT *	PMR *	DAES *	FRP
Touch labor	System Configu (WBS) to Extern Configuration It	Productivity	A/B/C	Planned	Actual	AoA	PSR	MS A	SRR	SFR	PDR	PSR	SE WIPT *	PMR *	DAES *	MS B	CDR	PRR	PSR	SE WIPT *	PMR *	DAES *	MS C	IoT&E	PSR	SE WIPT *	PMR *	DAES *	FRP
Delivery per date and ac	Mission Thread e.g., fusion, we	Software Grov Requirements	A	Planned	Actual	List parameter used, depends on application (MTBCF, MTBOMF, MTBSA, MTBEFF, or																							
First Pass	Applies to a	Code/Unit Tes	A	Planned	Actual	List parameter used, depends on application (MTBF, MTTF,																							
Process co processes	Number of integ laboratories	CSCI Integrati	A	Planned	Actual	Reliability Growth																							
Process co that meet o	Number interfac hardware/software	Cor	B	Planned	Actual	Mean Time Between Failure initial (MTBFI)																							
FOD Finding Scrap, Rew and actual)	Number of interf on/in target env the host platform	System Type	B	Planned	Actual	Status related to Metrics																							
Production	Integration prog (outstanding dis total number of	Reuse	C	Planned	Actual	Number of Failure Modes Identified																							
# of noncon	Peak Staffing	Defects - (Prio	C	Planned	Actual	Number of Failure Modes addressed																							
Manu	Effort Hours fo	Peak Staffing	C	Planned	Actual	Total failure rate identified																							
Build to Pa models cha definition af	Schedule durati	Effort Hours fo	C	Planned	Actual	% of failure rate addressed																							
Schedule Variat	Engineering res to integration (e	Duration (Star	C	Planned	Actual	Achieved versus planned progress on RGT																							
Hours per s	Type of system (e.g., aircraft, s	Reliability sta	C	Planned	Actual	Mean Time Between Failure Defect (MTTD)																							
Traveled wo	Types of Config being integrated	Status r	C	Planned	Actual	Mission Aborts (MTBMA)																							
	% Complete hours)	% Complete hours)	C	Planned	Actual	Mission Failures (MTBMF)																							
			C	Planned	Actual																								



# Systemic Root Cause Analysis Top Negative Findings

Sep. 2010

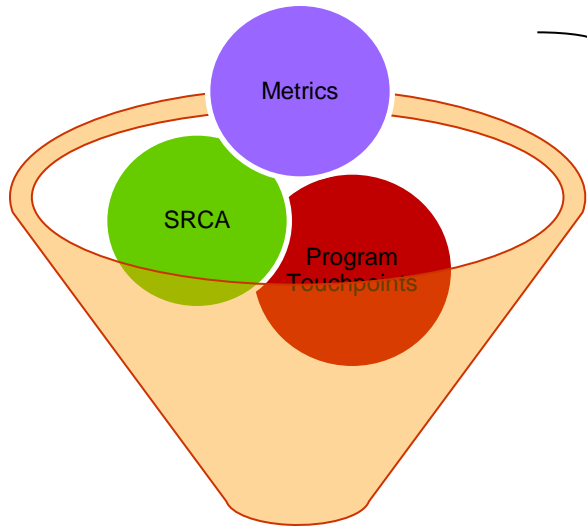


Rank	Systemic Finding	% Reviews
<b>Staffing – 50%, 4 (%of reviews, # of Systemic Findings)</b>		
1	Marginal program office staffing	31
12	Program Office has clear lack of acquisition or specialized expertise	17
<b>Management – 77%, 17</b>		
2	Progress is impeded by lack of good communications between Govt and contractors	24
9	Risk management tools and methodology are not sufficient	18
<b>Systems Engineering – 34%, 2</b>		
3	Program has inadequate system engineering process	23
10	Incomplete or missing a systems engineering plan (SEP)	17
<b>Verification – 35%, 4</b>		
4	Test schedule is aggressive/success oriented/ and highly concurrent	23
14	Testing is incomplete or inadequate	17
<b>Budget – 20%, 1</b>		
5	Current program budget is not sufficient to execute the proposed program	20
<b>Requirements – 54%, 6</b>		
6	Requirements are not stable	20
7	Requirements are vague, poorly stated, or not defined	20
8	Requirements creep	18
<b>Schedule – 44 %, 4</b>		
13	Program does not have an IMS or does not have a current IMS	17
<b>Reliability –34%, 4</b>		
18	Reliability is not progressing as planned or has failed to achieve requirements	14
26	Reliability test program is needed; Reliability growth program not in place	14
35	Reliability currently based on analytical predictions and won't be demonstrated until late in program	10

**Analyzed in conjunction with quantitative metrics results**



# SE Metrics Context



Information to Inform Decision Making



### AT&L History

**Individual program comparison versus benchmarks**

### Systemic Root Cause Analysis

Rank	Systemic Finding	% Reviews
1	Staffing - 50%, 4 (Not reviews, # of Systemic Findings)	31
10	Minimal program office staffing	17
12	Program Office has clear lack of acquisition or specialized expertise	17
13	Management - 72%, 17	17
2	Progress is impeded by lack of good communications between Govt and contractors	24
9	Risk management tools and methodology are not sufficient	18
3	Systems Engineering - 34%, 2	18
1	Program has:	
10	incomplete or	
4	Verification -	
14	Test schedule	
5	Testing is inop	
4	Budget - 20%	
7	Current prog	
4	Requirements	
7	Requirements	
8	Requirements	
11	Requirements	
13	Requirements	
18	Requirements	
20	Requirements	
35	Requirements	

**Performance Across Programs**

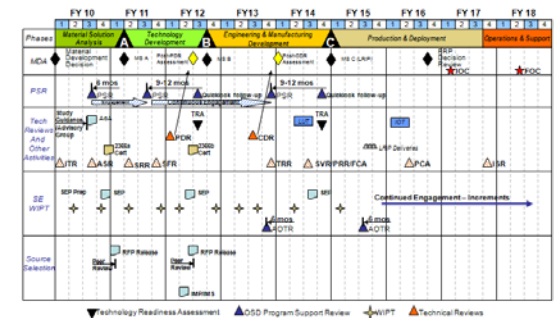
### Domain Management

Information to Inform...



- Policy/Guidance
- Education/Training
- Recommendations
- Metrics/Benchmarking
- Best Practices

Feedback thru continuous program engagement





# Conclusions



- **Corporately we need to...**

- Improve our ability to track Execution to Plan
- Provide better visibility to stakeholders
- Provide framework for accurate and timely issue identification/prediction

- **...in order to**

- Reduce cycle time and get required capability to warfighter quicker, more effectively and within budget





# For Additional Information



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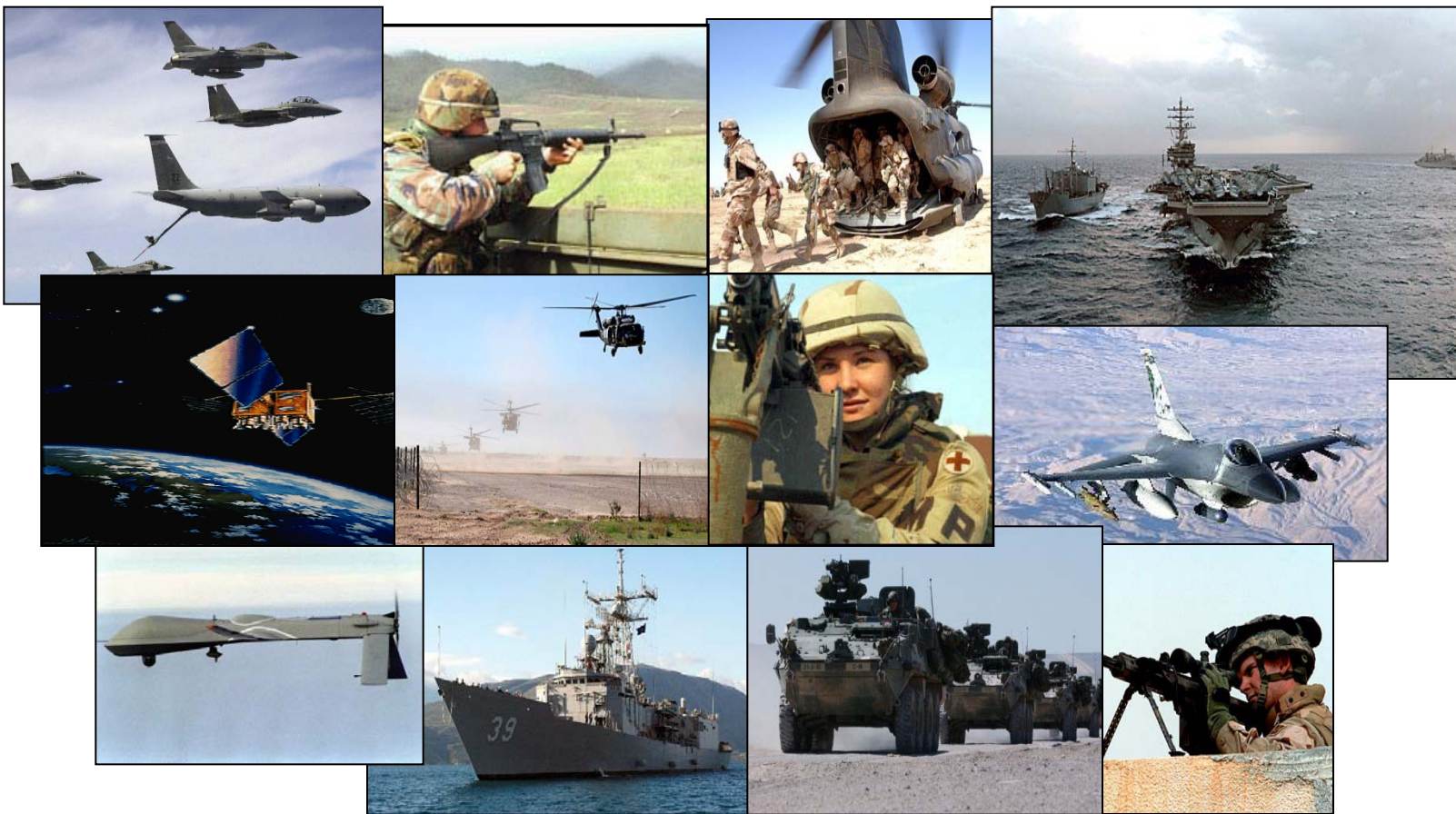
**Laura Dwinnell**

**FASI**

**(703) 602.0851 | Laura.Dwinnell.ctr@osd.mil**



# Systems Engineering: Critical to Program Success

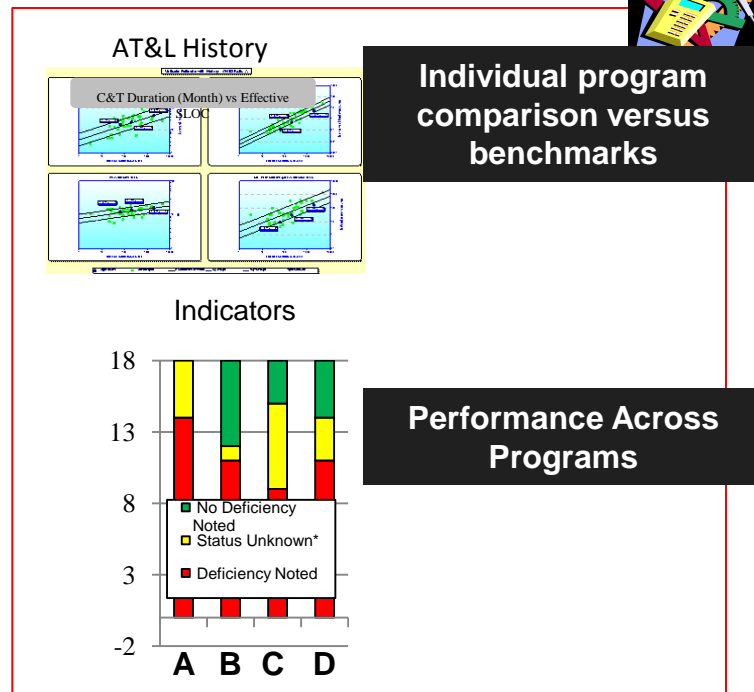
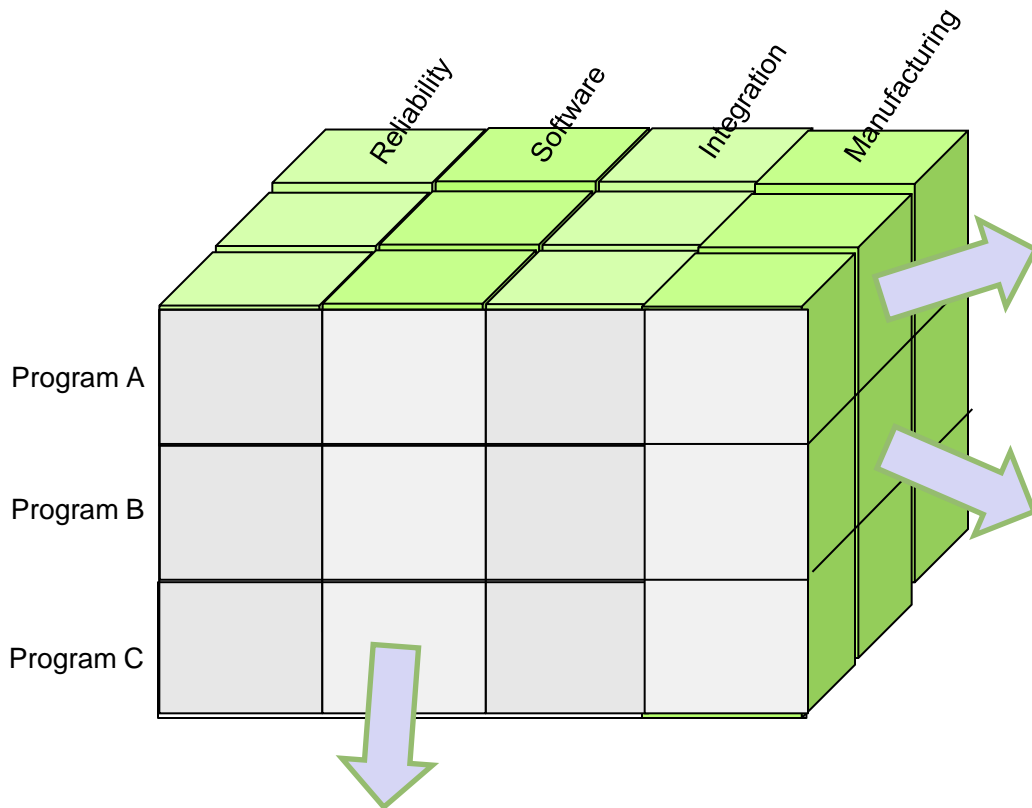


*Innovation, Speed, and Agility*

<http://www.acq.osd.mil/se>



# SE Products (in Progress)



Individual program comparison versus benchmarks

Performance Across Programs

Systemic Analysis

- Systemic Findings 2010; Example - Software**
- Software Development Plans do not exist, or lack needed information, outdated - 14% MDAP reviews conducted
  - Significant variation in software development estimates – 13%
  - Actual software reuse achieved significantly less than planned – 11%
  - Lack of metrics prevent accurate awareness of software activities in each development phase – 10%
  - Software requirements are ambiguous; not fully specified, developed and managed – 10%