Informing Data Driven Decisions

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for Systems Engineering

17th PSM Measurement Users' Group

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Making Decisions

Leadership and Culture

Knowledge/ Information

Indicators

Risks

Systems Engineering *leadership*,
and the *expertise* of our <u>people</u> make the difference.

Measuring Progress to Plan

In God we trust….all others, bring data…

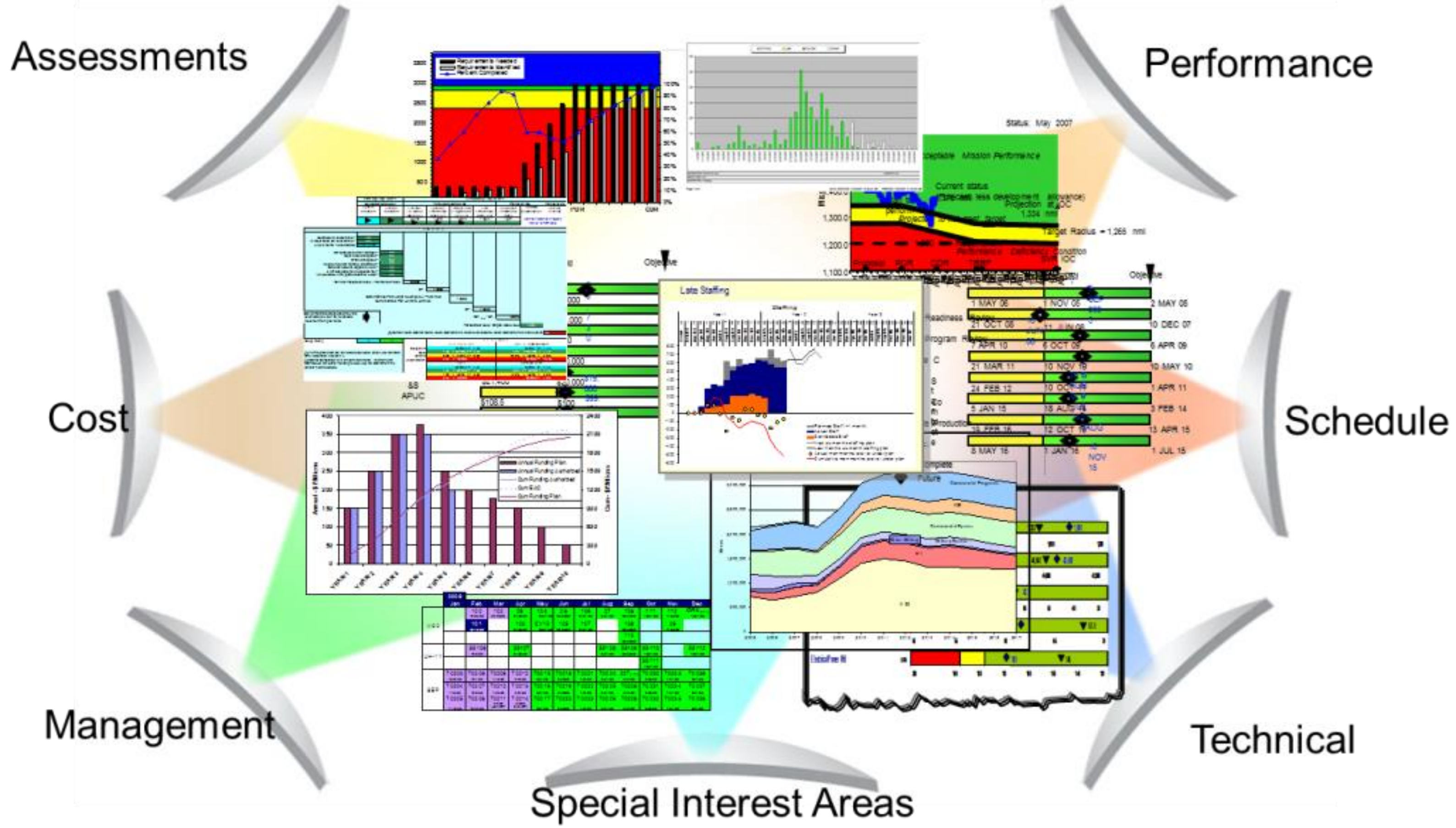
W. Edwards Deming

Sign outside office of The Honorable Frank Kendall,
Under Secretary of Defense for Acquisition, Technology and Logistics

Agenda

- Why do we measure?
- When and What do we Measure
- Approach
- Analysis and Insight
- How are we doing?
- Challenges
- Path Forward

Why do We Measure?
Program Insights, Knowledge & Inflection Points



- Tailored by phase -

Why Do We Measure
Law, Policy, and Guidance

Public Law 111-23, May 22, 2009: Weapon Systems Acquisition Reform Act

- 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.

DoDI 5000.02 (January 2015) Enclosure 3 (Systems Engineering)

- Para 6, Encl 3: 6. TECHNICAL PERFORMANCE MEASURES AND METRICS. The Program Manager will use technical performance measures and metrics to assess program progress. Analysis of technical performance measures and metrics, in terms of progress against established plans, will provide insight into the technical progress and risk of a program

Systems Engineering Plan Outline, 20 April 2011

SYSTEMS ENGINEERING PLAN (SEP) OUTLINE

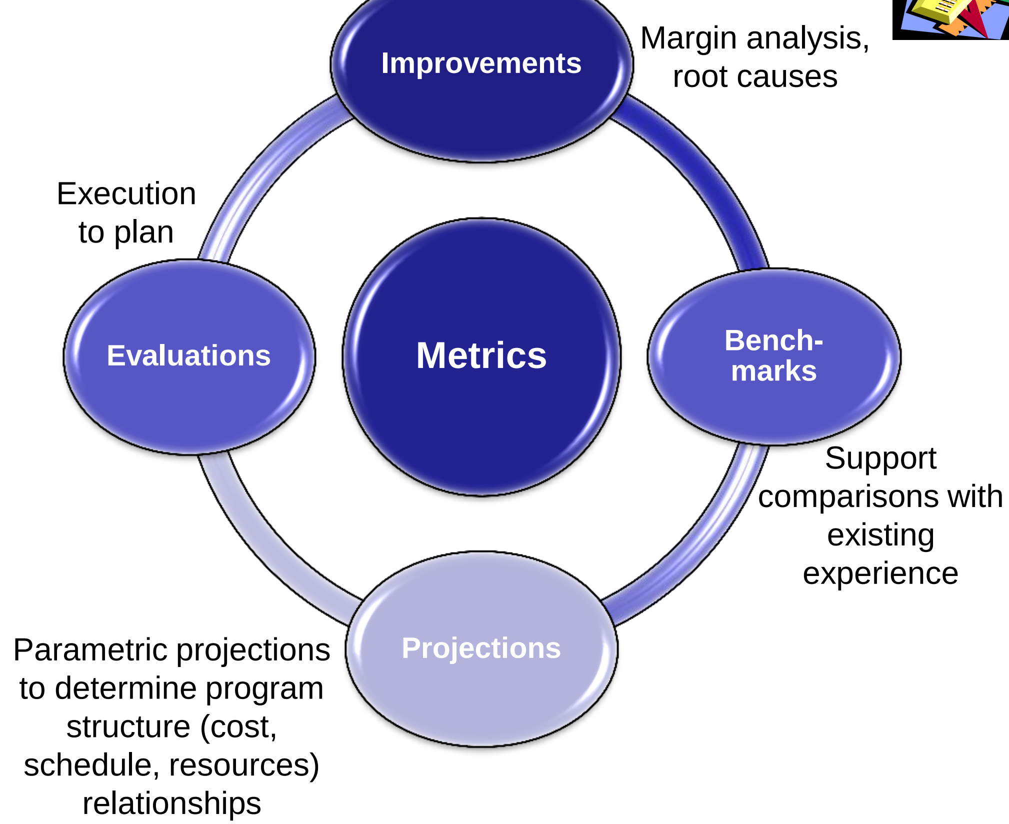
20 April 2011

- Directs programs to present their strategy for identifying, prioritizing, and selecting metrics for monitoring and tracking program SE activities and performance
- **Section 3.6 – "<u>Technical Performance Measures and Metrics</u>"**
  - Provides an overview of measurement planning and metrics selection process
  - Include approach to monitor execution-to-plan and identification of roles, responsibilities, and authorities
  - Minimum set of TPMs and intermediate goals and plan to achieve them with dates
  - Examples include TPMs in areas of software, reliability, manufacturing, integration, & test

Performance measures are foundational to PM and DASD(SE) missions.

SE Metrics Goals
"What we are trying to achieve"

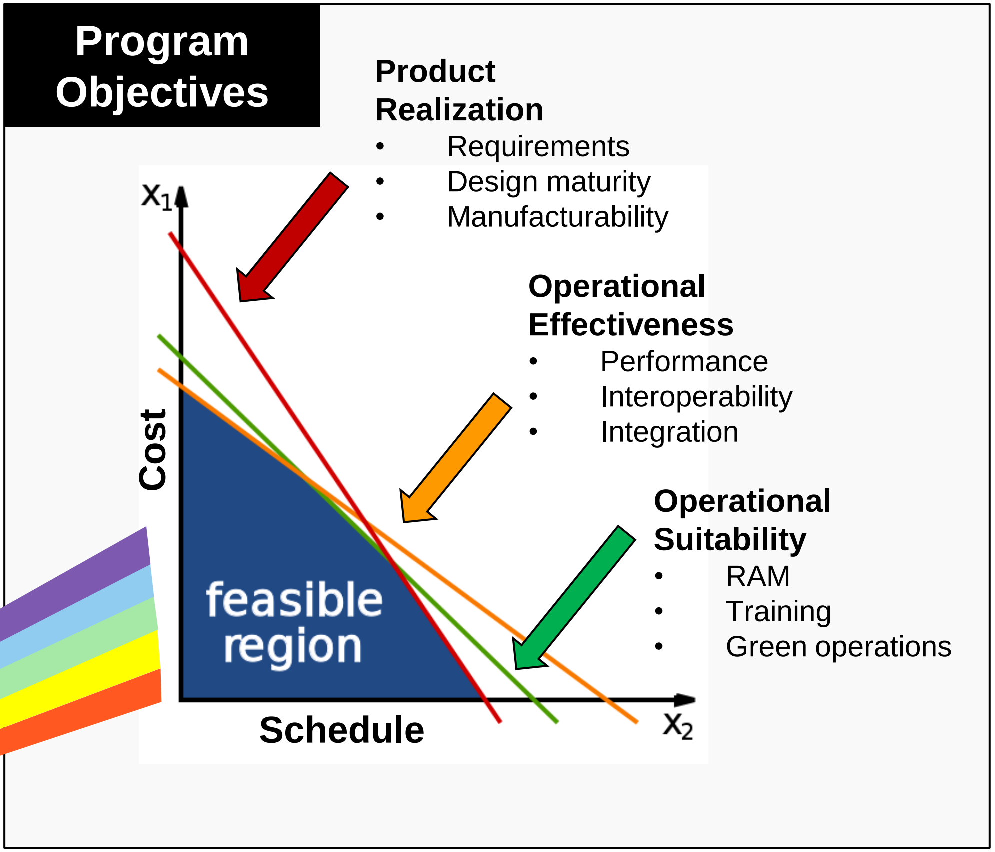
- Emphasize quantitative understanding consistent with Industry practice of systems engineering
- Make visible relationships between system/equipment design objectives and performance
- Provide foundation for planning, monitor execution
- Inform leaders of technical risks, opportunities, and their impacts at major decisions
- Harness and use existing information for timely and better decisions at the appropriate levels
- Enable data-driven decisions

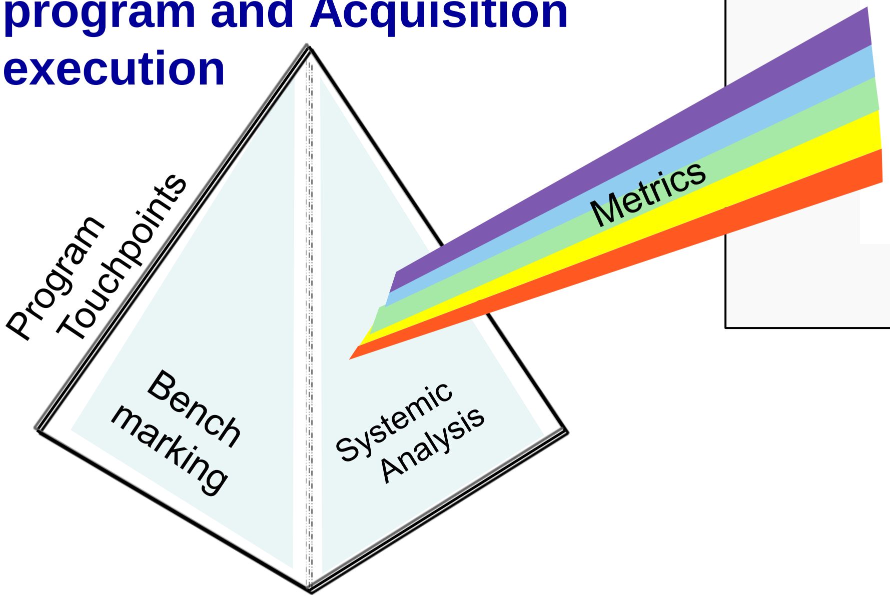


Focus on Program Objectives

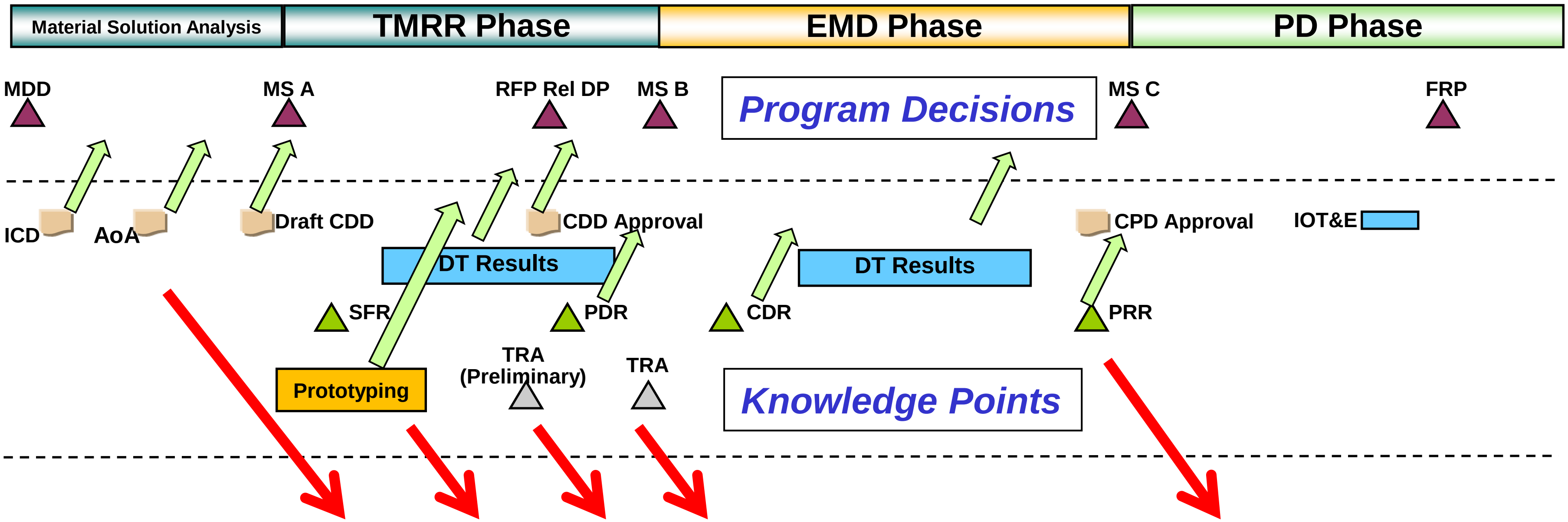
Metrics / Measures

- **Tailored for program objectives**
- **Combined with relevant context**
- **Transformed into useful decision aids to enhance program and Acquisition execution**





Decisions
Knowledge Points and Off-Ramps



Off-ramp Decisions / Branches / Sequels

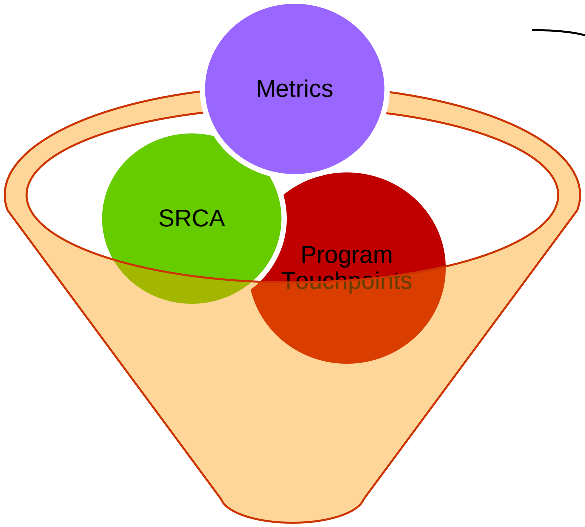
- Requirements
- Technologies
- Design decisions
- Specification changes
- Supplier changes

= knowledge point

= off-ramp decision

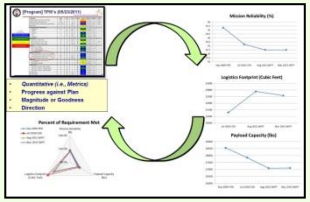
Planning for knowledge and information with which to make off-ramp or branch/sequel decisions based on that knowledge

SE Metrics Approach

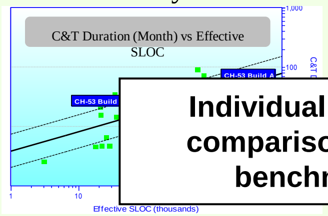


Information to Inform Decision Making

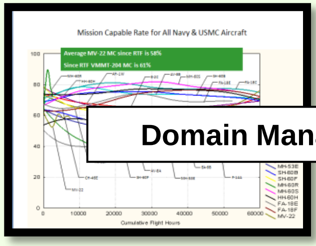
Performance to Plan



AT&L History



Individual program comparison versus benchmarks



Domain Management

Systemic Root Cause Analysis

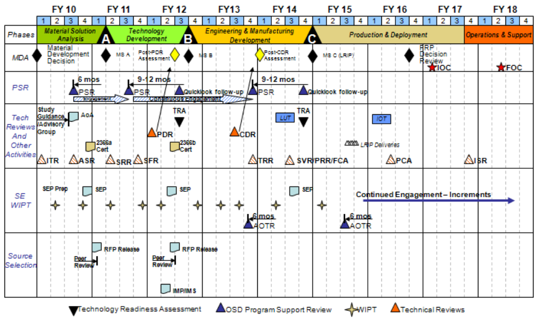
Rank	Systemic Finding	% Reviews
	Staffing – 50%, 4 (%of reviews, # of Systemic Findings)	
1	Marginal program office staffing	31
12	Program Office has clear lack of acquisition or specialized expertise	17
	Management – 77%, 17	
2	Progress is impeded by lack of good communications between Govt and contractors	24
9	Risk management tools and methodology are not sufficient	18
	Systems Engineering – 34%, 2	
3	Program has in	
10	Incomplete or	
	Verification –	
4	Test schedule	
14	Testing is incon	
	Budget – 20%,	
5	Current progra	
	Requirements	
6	Requirements	
7	Requirements are vague, poorly stated, or not defined	20
8	Requirements creep	18
	Schedule – 44 %, 4	
13	Program does not have an IMS or does not have a current IMS	17
	Reliability –34%, 4	
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

Performance Across Programs

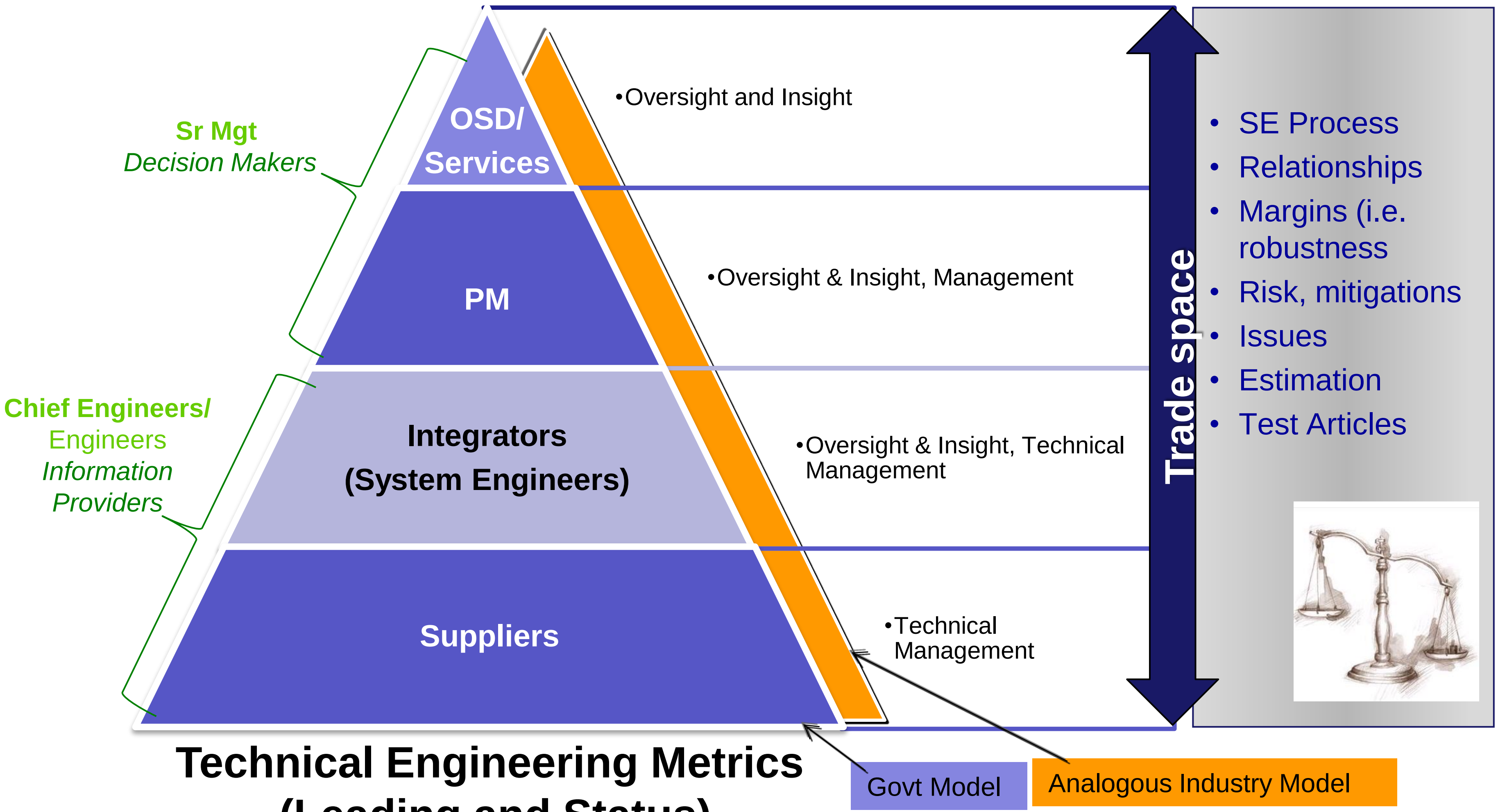
Information to Inform…

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

Feedback thru continuous program engagement



Metrics Framework

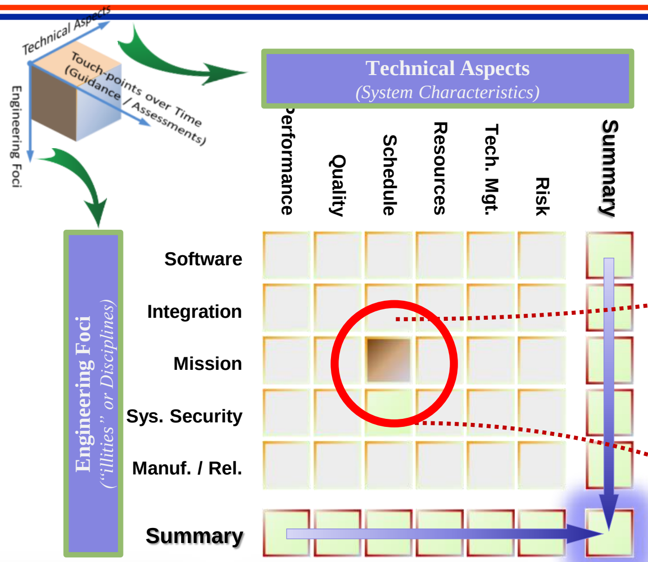


Technical Engineering Metrics (Leading and Status)

Data-Driven Decisions at Every Level

Framework for a Single Systems' Engineering Engagement

Matrix of Engineering Specialties and Technical Aspects

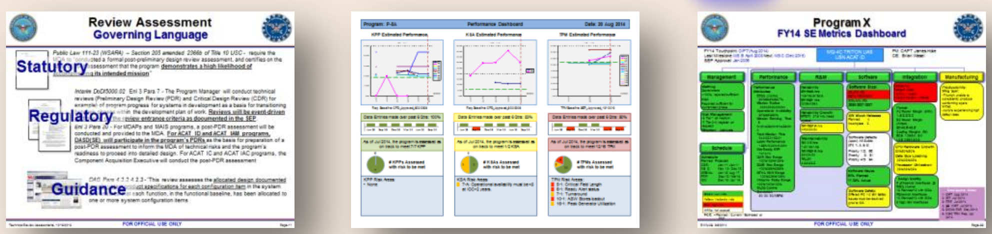


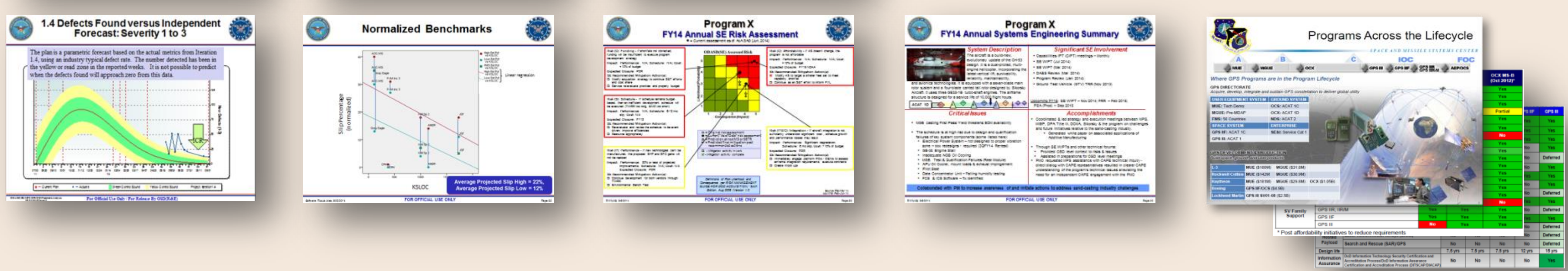
Typical Content in each Cell

Varies depending on aspect and focus

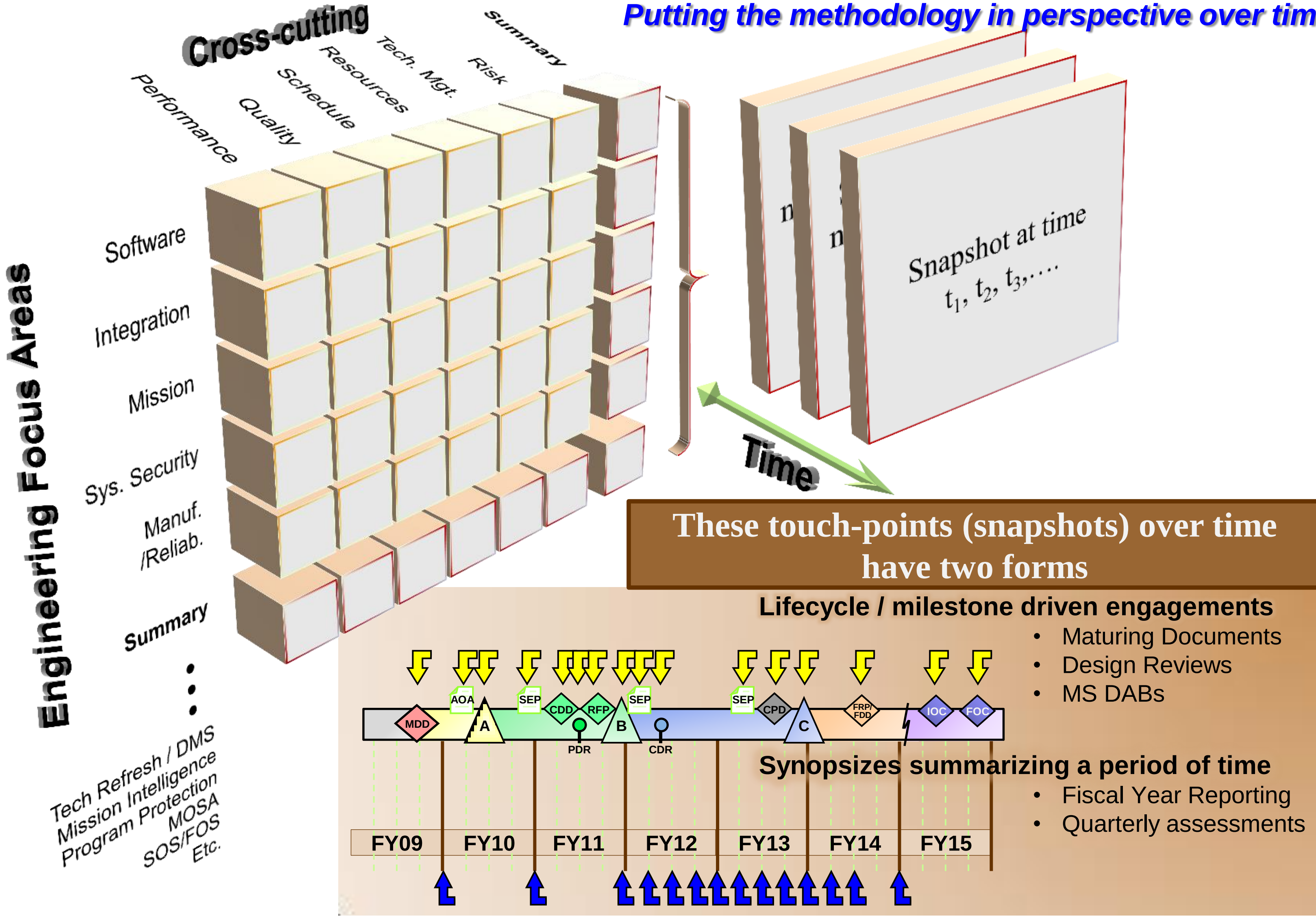
Mentoring Guidance and Assessment Content

- Overarching Statute/ Policy
- Plans / Goals / Req.
- Measures and Metrics
- Benchmarks
- Trends
- Dashboards
- PMO Interaction
- Gathered Evidence of Status
- Assessment Narrative
- Recommendations





Systems' Engineering Touch-points over Time



Flow and Trace of Measures

AoA	CDD/CPD	SEP (Developers)		TEMP (Testers)	
MoEs MoPs	**KPPs, KSAs, (Thresh/Obj)**	**TPMs**	**Threshold/ Objective**	**MOEs / MOPs**	**CTPs (Threshold criteria)**
CCIR time SOA net-ready TST time TST Dissemina-tion	Net-Ready KPP Ref: CDD 6.4	Implemented community of interest Services exposed to external customers	70%/100%	1-9: CCIR Time 2-5: PED Visibility 3-10: IERs& KIPS *3-12: SOA Net Ready 3-21: IA Protection Risk 2-2: TST time 2-4: TST Dissemination 2-10: SITREP>FrOB 2-15: Order urgent 2-16: Order normal 3-21: IA protection risk 3-22: IA response risk 3-23: IA detection risk	• Normal Operations <15 minutes transmitted to units/assets • Visibility of 95% PED nodes status • IERs: 100% critical IERs; KIPS: address all GIG Architecture KIPS • Identified standard: Risk is low with no additional protection controls needed • <3 minutes re-plan initiation to planning completion; order changes transmitted <1 min after plan completion; replanning 25 concurrent missions 1. DISR mandated GIG IT standards & profiles identified in the TV-1 2. DISR mandated GIG KIPS identified in the KIP declaration table 3. NCOW RM Enterprise Services 4. Information assurance requirements including availability, integrity, authentication, confidentiality, non repudiation, and issuance of an order ty the designating authority 5. Operationally effective information exchanges: mission critical performance, information assurance attributes, data correctness, data availability and correctness.
		Services exposed internally through vertical integration	Ability to expose services in support of vertical integration of mission application sub-systems		
		Services consumed through horizontal mission threads	Ability to consume services in support of horizontal integration of mission applications in a net-centric way		
		Services Exposure Verification and tracking sheet	Number of services exposed to external systems to comply with net-centric service strategy		

Traceability between AoA, Requirements, SEP, and TEMP

Individual TPMs Evaluated using SMART Criteria

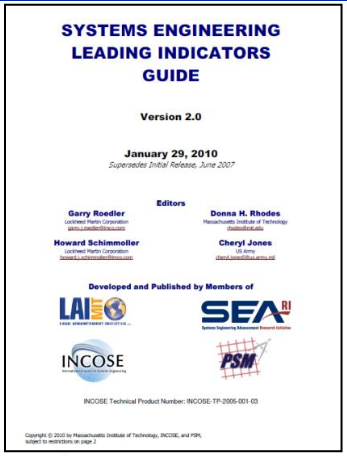
Assessment Rubric

	Specific	Measurable	Achievable	Relevant	Timely
Definition	Metric or Measure can be interpreted only one way	Metric or Measure can be represented by a number obtained from counting, analysis or instrumentation	Metrics or Measures have defined goals at key acquisition events	Metrics or Measures tied to prgram requirement, KPP/KSA, risk, or key PM process.	Metrics or Measures are collected frequently enough and in time to act on the data. Measure provides early indicator of shortfalls.
Strongly Disagree	• Ambiguous Term • No definition provided	• Unmeasurable concept	• No desired values identified • Multiple interpretations of reported values	• Measure has no tie to program requirements	• Measured only at end of project
Disagree	• Overloaded term without definition / equation	• Non-deterministic value, and/or subjective	• No desired values identified	• Measure is tangentially related to program requirements	• Measured too late to act on the information
Neutral	• Unknown	• Unknown	• Desired value defined only at program completion	• Unknown	• Marginally acceptable frequency and latency • Measure/Metric is a lagging indicator
Agree	• Measure clearly understood, without disagreement within PMO • Equation not provided	• Result is subjective and/or non-deterministic, but based on a published ruleset (e.g. this assessment rubric)	• Desired value for measure defined for each acquisition milestone	• Beneficial measure, but not related to Requirement, KPP/KSA or PM key process	• Measured only at acquisition milestones and System Engineering Technical Reviews • Provides prompt warning of shortfalls
Strongly Agree	• Measure clearly understood outside PMO • Equation provided	• Result is deterministic and objective (e.g. given a common set of inputs, the result will be repeated)	• Threshold and objective values defined for each acquisition milestone	• Measure tied to KPP, requirement or risk • Measure is a project management key process	• Measured frequently enough and in time to act on data (e.g. monthly CDRL) • Provides early warning of shortfalls

SMART* Criteria used to Evaluate TPMs

*Commonly attributed to Peter Drucker; first-known use of the term occurs in November 1981 issue of *Management Review* by George T. Doran

Technical Measures and Attributes


SYSTEMS ENGINEERING
LEADING INDICATORS
GUIDE

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Editors

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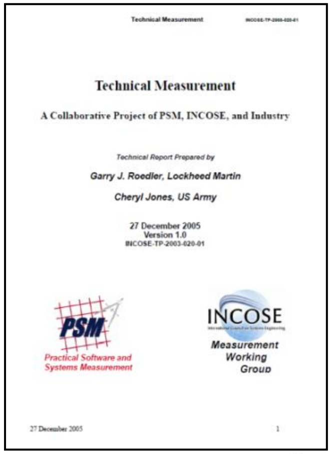
Technical Measurement

A Collaborative Project of PSM, INCOSE, and Industry

Technical Report Prepared by

Garry J. Roedler, Lockheed Martin

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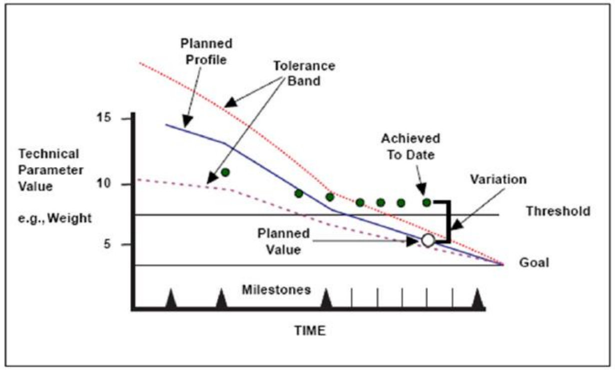
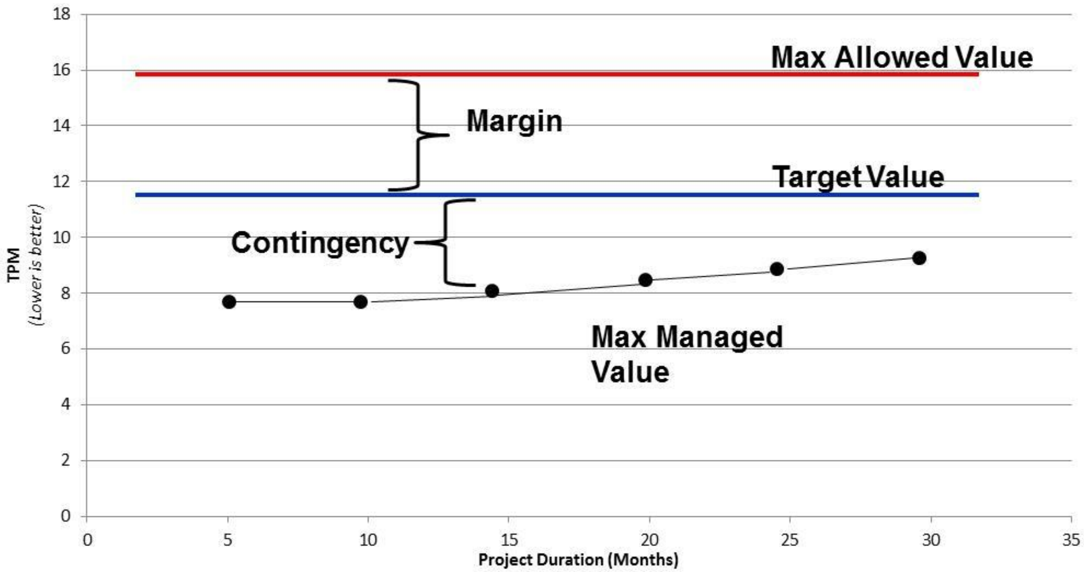
27 December 2005
Version 1.0
INCOSE-TP-2003-020-01

PSM — Practical Software and Systems Measurement

INCOSE — Measurement Working Group

27 December 2005 — 1





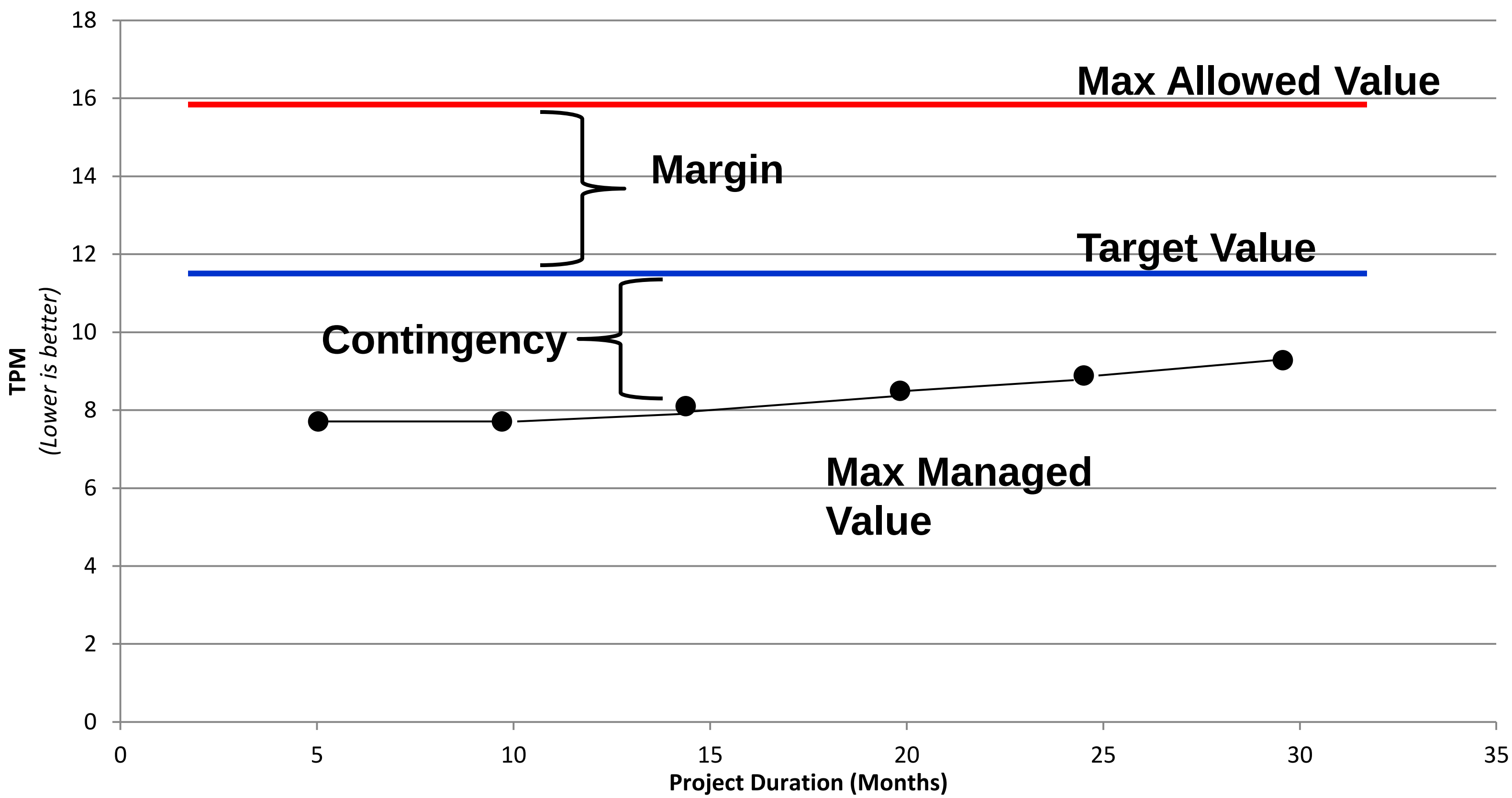
Attributes

a. Achieved-to-date	e. Planned Profile
b. Current Estimate	f. Tolerance Band
c. Milestone	g. Threshold
d. Planned Value	h. Variance(s)

Margin – difference between the maximum allowed value and the target value

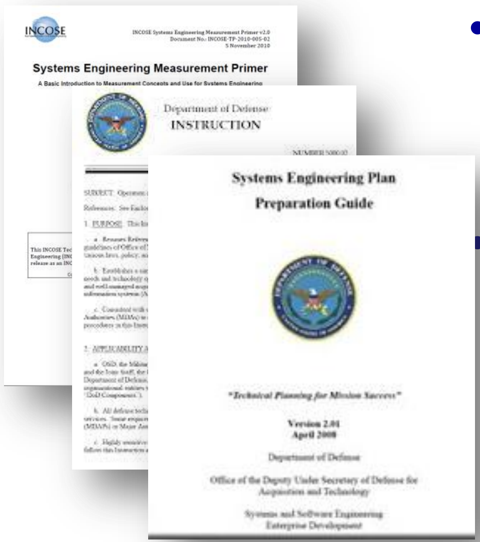
Contingency – difference between the maximum managed value and the target value, dependent on uncertainty, maturity, variability, and risk.

Measure Contingency and Margin



Margin – difference between the maximum allowed value and the target value
Contingency – difference between the maximum managed value and the target value, dependent on uncertainty, maturity, variability, and risk.

What do we measure?



- **Two Types of Measurements***
  - Process: Quantitative Process Management (QPM)
  - Product: Technical Performance Measures (TPM)
- **Measurements are used to:**
  1. Provide early detection of performance risk & issues
  2. Track technical maturity - forecast values to achieve
  3. Control system design - visibility into actual vs. planned

*Source: *INCOSE Systems Engineering Primer*

Quantitative Process Management	Technical Performance Measures
How far have you progressed in developing the product?	**How well does your product do what it is supposed to do?**
(e.g., schedule, requirements)	***(e.g., throughput, CPU/memory use)***

Tailor Domain- & Lifecycle-Appropriate Performance Measures

Quantitative Process Measures

Software
Demographics
Effort
Productivity, Agile Velocity
Schedule
Staff
Test

Staffing *
Quantity
Effort Hours
Experience
Turnover Rate

Schedule *

Requirements Management

Cost
Affordability
Resources
Dollars/Funding
CPI

Risk Management
Exposure
Burndown

Production
Build-to-Package Completions
Traveled Work
Supplier/Sub Quality Tests
Scrap, Rework and Repair Hours
Touch Labor Hours
Yield

Technology Maturity

Manufacturing

Design/ Development

Architecture
% DoDAF drawings complete
Quality Attributes
Flexibility, Stability

Integration
COTS/GOTS/NDI Components
Interface Definition
Interface Verification
Interface Stability

System Assurance

Infrastructure

Product TPMs

Software
Defects
Quality
Size

System Performance
Accuracy | Lethality
Bandwidth
System Latency
System Throughput
System Response Time
Utilization—Data bus, CPU, Memory
SWAP-C | Range

System Quality *

Reliability
unscheduled reboots
Time between reboots (MTBCF)
Time to reboot (MTRCF)
MTBF, MTTF

Mission Performance
Mission Thread &
End-to-End Performance
e.g. Probability of Detection

Net Ready KPP
Network Management
Time to enter network
Time to exchange data

User Acceptance
User questionnaire scores
User acceptance scores

Supportability/ Maintainability
Maintainability Characteristics
Mean time to repair

Legend

Category
Sub-category 1
Sub-category 2
…
Sub-category N

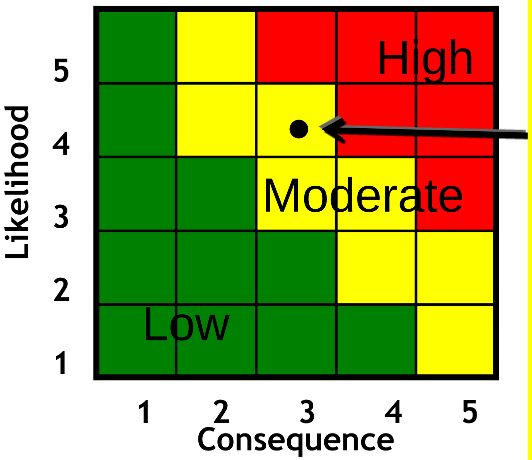
MDAP-centric

Included on SRDR

* Staffing, Quality & Schedule are also included in the Software Category

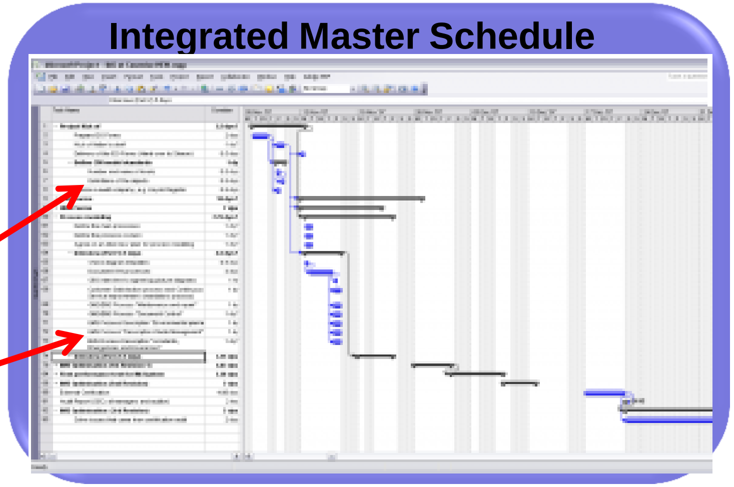
Risk Analysis, Tracking, and Mitigation

Risk Reporting Matrix

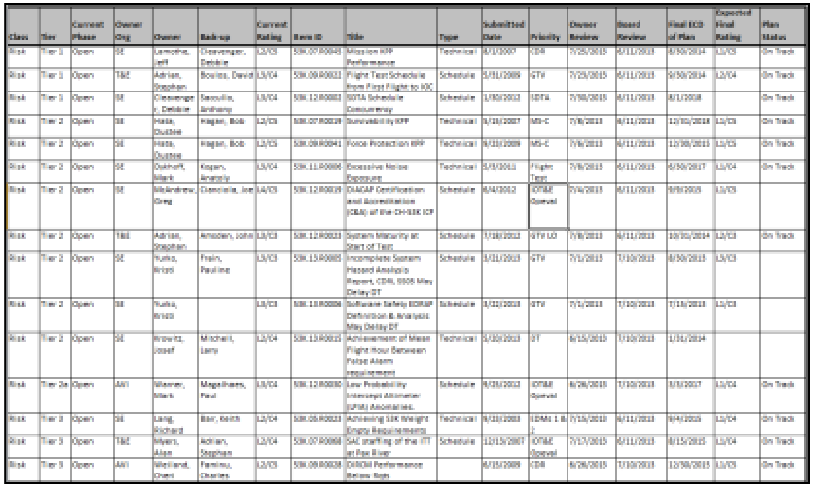


- Risk ID Number: 99
- Risk Driver:
- Cost Impacts:
  - RDT&E: $ or %
  - Production: $ or %
  - O&M: $ or %
- Schedule Impacts:
  - Months:
- Performance Impacts:
  - Only Y% KSA performance
- Risk Mitigation Actions:
  - Activity 1:
  - Activity 2:
  - Cost: $
- Closure Date:

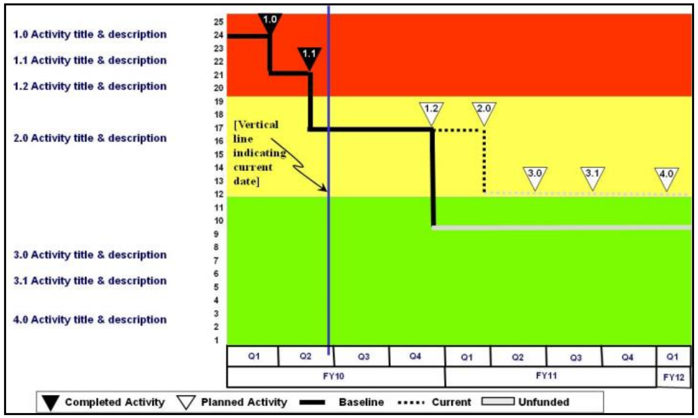
Capture Mitigation Activities in IMS



Track Risks in a Risk Register



Monitor/Measure Risk Burndown



Sample Metrics Collected, Normalized, and Modeled

- **Metrics are captured as reported by the Program (as Program Artifacts)**
  - Identify internal inconsistencies within Program metrics
  - Identify data gaps, and omissions
  - Data validation is necessary to conduct analysis
- **Metrics are normalized to enable parametric modeling and benchmark analyses**
  - Normalization provides ability use parametric models to assess feasibility
  - Software development effort assessed based on probability of success
- **Data compiled into historical repository to support benchmark analyses**
  - Normalized data allows for benchmarking
  - Unified data set provides ability to assess software performance across portfolios of programs

Example A/Pre-MS B: "Trade Space"

Program Office received trade space analysis

Enabled the program office to select initial planning options in the feasible trade space

Scenario Comparison (80% Assurance)

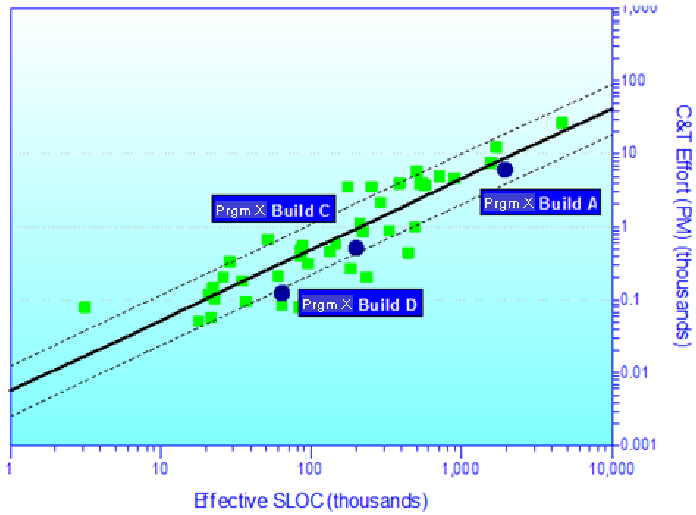
Scenario Assumptions	ESLOC	Cost	Schedule	PI	Remarks
Program Plan	--	$25M	60 mo	--	Program allocated $25M for software; 60 months schedule is not software driven.
1. Optimized Solution	**538K**	$76M	86 mo	12.1	Historical industry average; assumes no ESLOC growth; **cost overrun 300%; schedule adds 2.1 yrs**
2. Fixed Cost	538K	**$25M**	114 mo	12.1	Constrained to $25.2M budget; **schedule runs 4.5 yrs late**
3. Fixed Schedule	538K	$370M	**60 mo**	12.1	Constrained to 5-yr schedule; **cost is 14.7 times greater than total budgeted**
4. Typical Program Size Growth	**700K**	$105M	97 mo	12.3	Size growth (80% industry projects typically grow 30% from PDR to delivery); slightly improved productivity index assumed; **cost over 420% of budget; schedule takes 3 yrs longer**
5. Reduced Functionality	**216K**	$25M	58 mo	12.1	Limited functionality/size with budget and schedule constrained
6. Increased	538K	$25.2M	60 mo	**16.0**	Increased PI (2 standard deviations higher than
7. Increased Productivity/ Size	**700K**	$39M	62 mo	**16.0**	Increased PI (only 2.2% of industry has achieved that PI)

XXX *= Value constrained (held constant) in scenario run*
PI = Productivity Index, to include environmental factors for efficiency
ESLOC = Effective Logical Source Lines of Code

Interrelationships among size, effort, staffing, duration, and productivity allow decision-makers to see the impact of existing program constraints

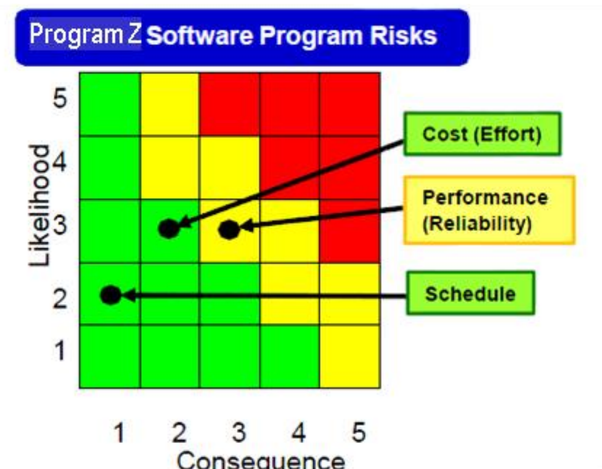
Example MS B: Plan Feasibility

- Similar AT&L projects shown in green
- **Program X Builds in blue**
- Plot provides solid center line of AT&L project and 1 standard deviation dotted line
- View all four views concurrently to gain insight:
  - Size vs Effort
  - Size vs Staffing
  - Size vs Productivity parameter
  - Size vs Schedule



Scatter plot shows feasibility of planned builds compared to other similar AT&L programs

Risk areas identified based on statistical distance from historical program performance



Although consistent with AT&L projects, potential risk due to large size and increased defects, impacting reliability and, to lesser degree, schedule (fixing instead of coding).

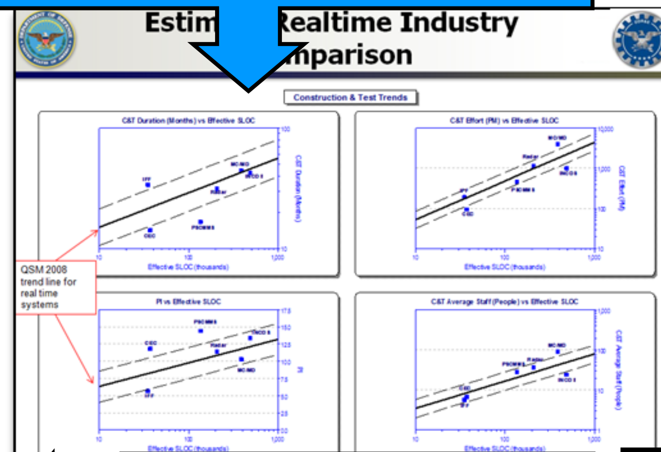
Example MS C: Software Maturity Modeling

1 Reconstruct current/adjusted plan using actual reported metrics

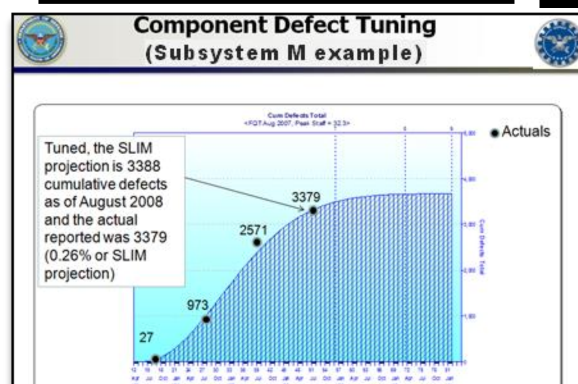
SLIM-Estimate Reconstruction

Component Name	ESLOC	Rqts. Start Date	FQT Completion Date	Peak Staffing	PI
Subsystem 1	135,000	11/2005	08/2007	37.0	14.4
Subsystem 2	486,690	04/2004	12/2008	32.3	13.4
Subsystem 3	207,600	04/200[illegible]	[illegible]007	49.0	11.4

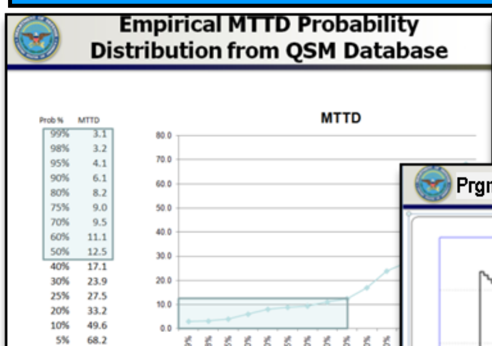
2 Compare and quantify performance to date with similar programs

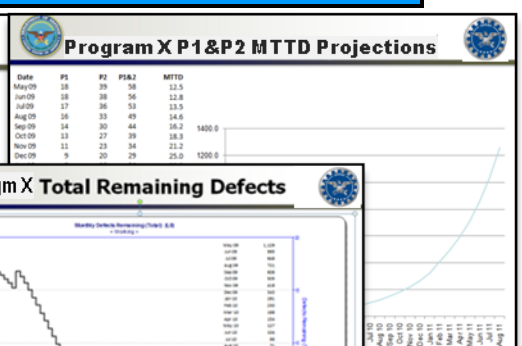


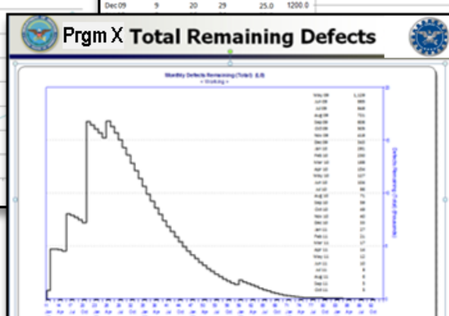
3 Using reported defects, calibrate model



4 Forecast if acceptable software maturity will be achieved by release date compared to similar programs



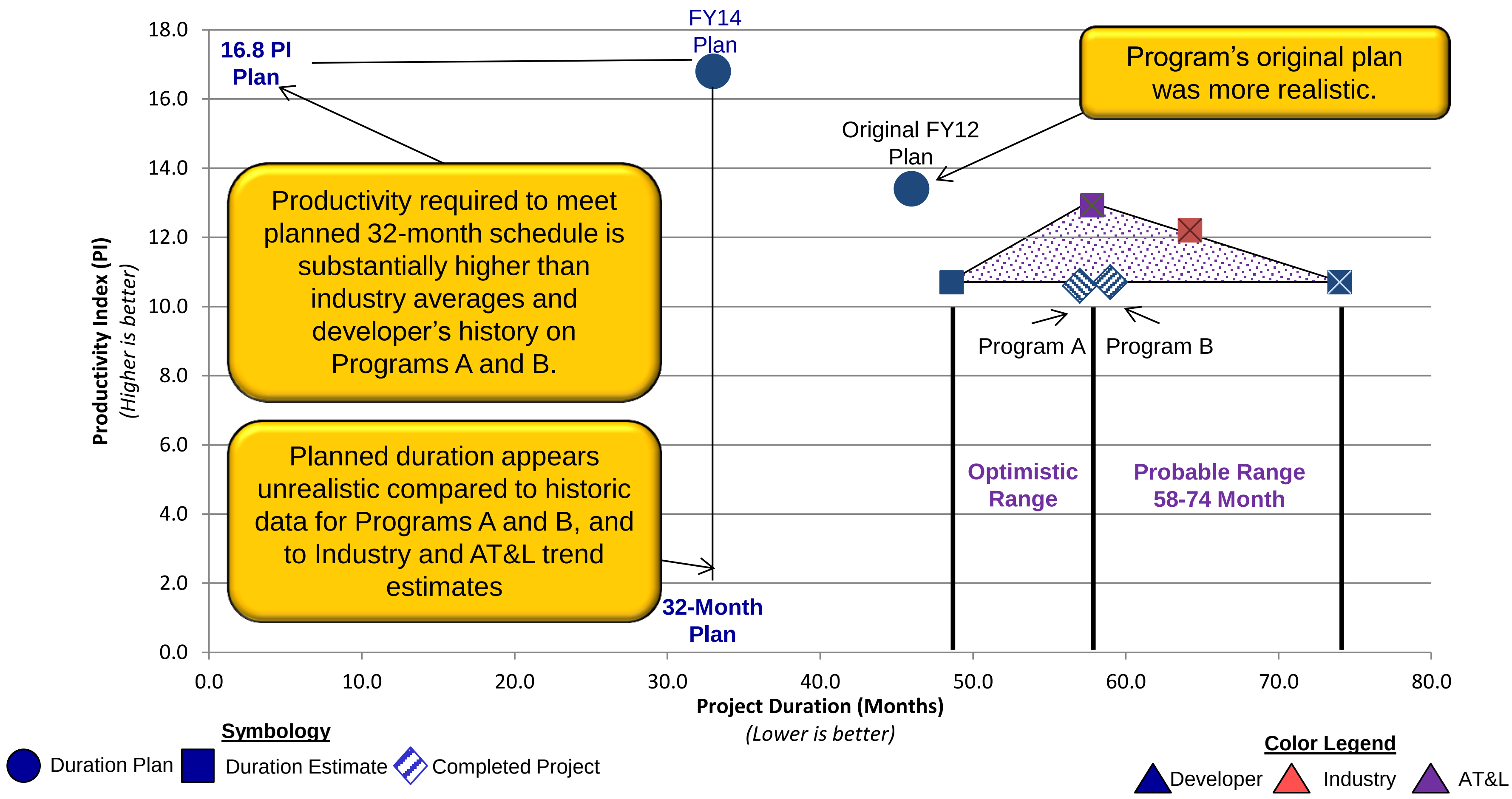




How We are Doing
Performance Measurement Shortfalls

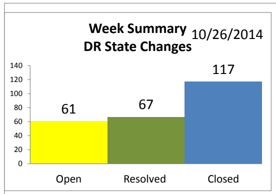
- **Systemic issues identified in 2015 report to Congress**
  - Lack of sufficient **predictive metrics** and **quantitative management**
- **Lack of end-to-end performance measurement, developer/tester disconnect and insufficient integration testing**
- **Sample of other observations**
  - Not enough TPMs;
  - No threshold / objective values;
  - Measuring too late; Limited ability to influence program;
  - Too expensive to collect
  - No mission performance metrics;
  - Exclusively focused on “Product” measures;
  - NR KPP unmeasurable
  - Transparency/Warehousing
  - Heisenberg Effect

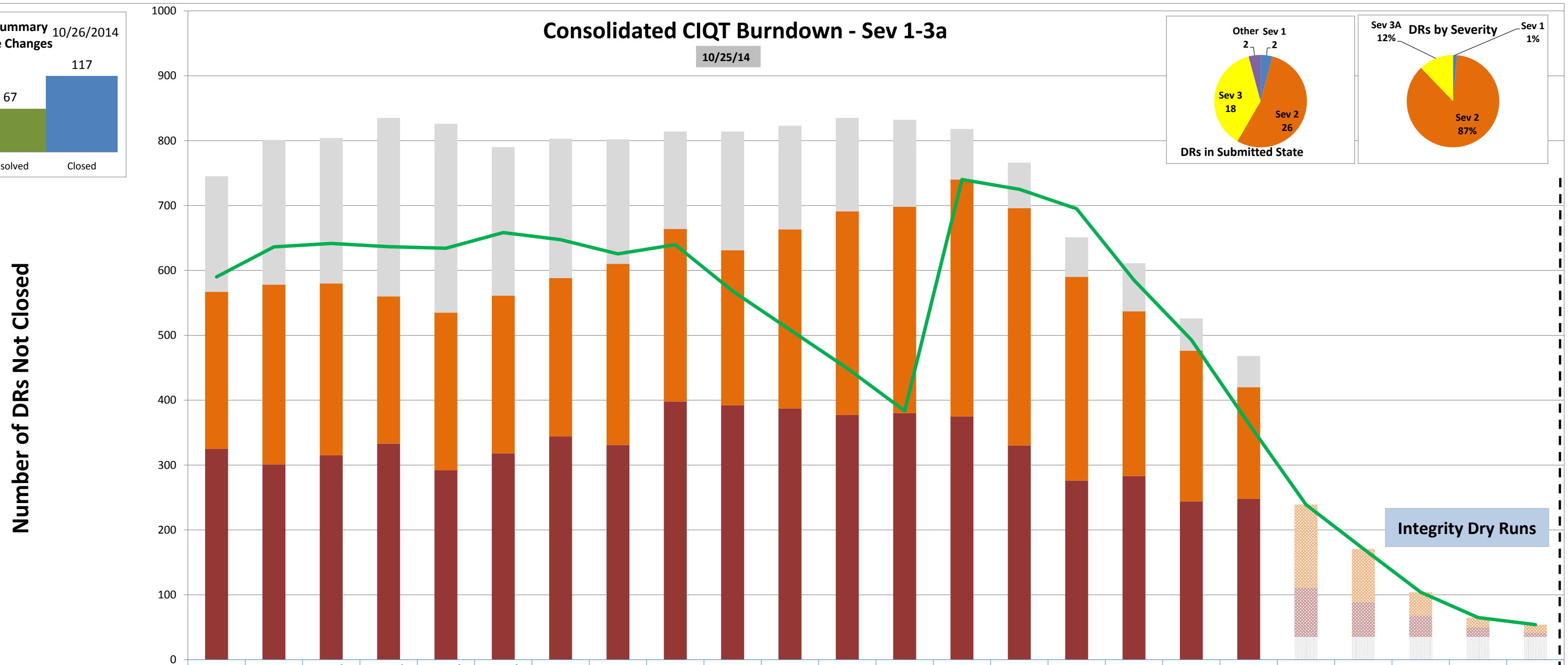
Estimated Schedule Durations for a Software Development Effort



DASD(SE) uses software benchmarks for industry and from our historical engagements to help inform decisions makers.

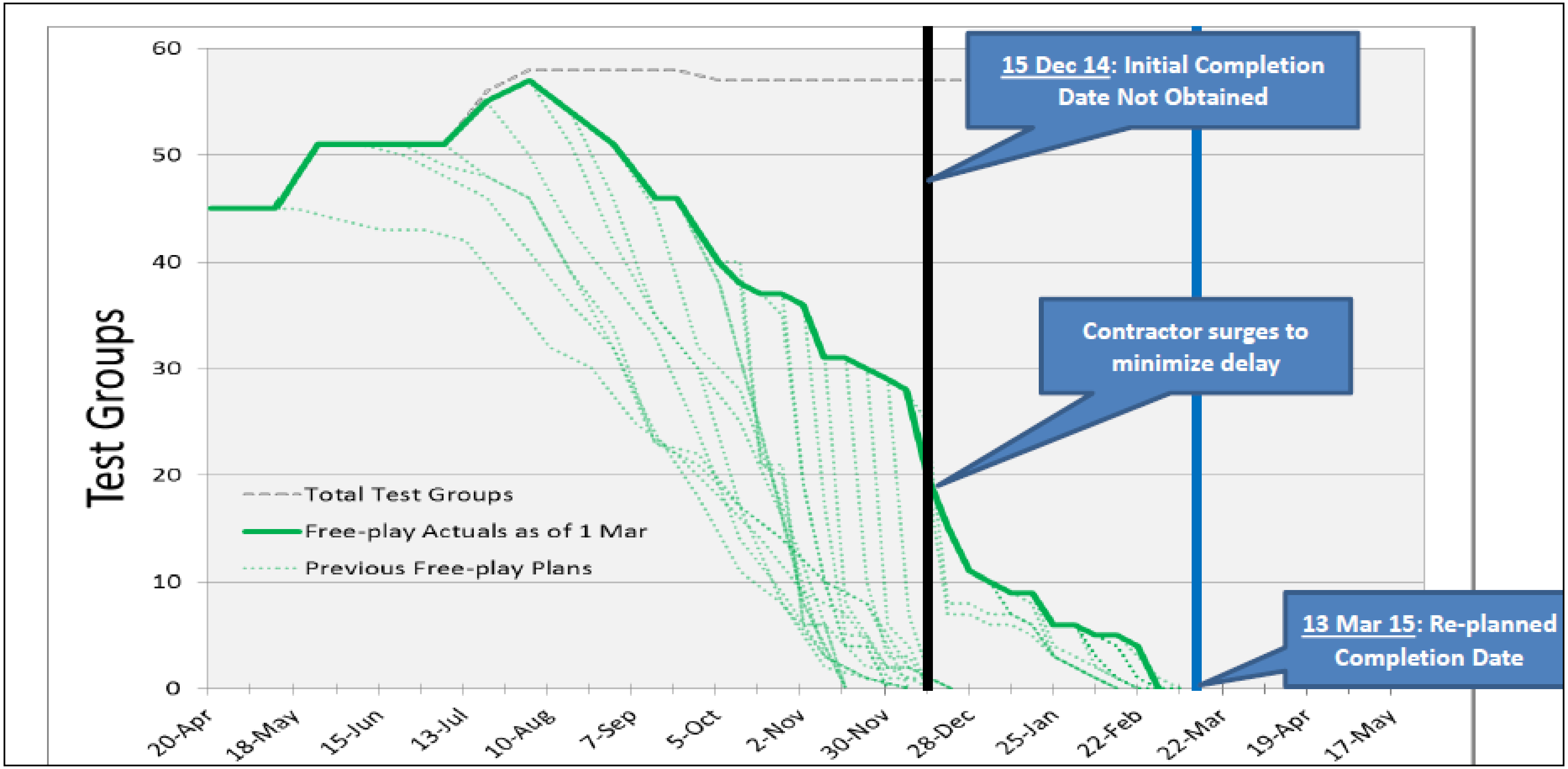
Sample Software Deficiency Burndown Optimism





	22-Jun	29-Jun	6-Jul	13-Jul	20-Jul	27-Jul	3-Aug	10-Aug	17-Aug	24-Aug	31-Aug	7-Sep	14-Sep	21-Sep	28-Sep	5-Oct	12-Oct	19-Oct	26-Oct	2-Nov	9-Nov	16-Nov	23-Nov	30-Nov
Predicted Resolved	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	282	194	128	82	36	15	12
Predicted Open	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	171	148	108	76	54	33	15	7
Predicted New DRs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	63	63	63	35	35	35	35	35
DRs in Submit State	178	223	224	275	291	229	215	192	150	183	160	144	134	78	70	61	74	50	48	0	0	0	0	0
Total Resolved	242	277	265	227	243	243	244	279	266	239	276	314	318	365	366	314	254	232	172	0	0	0	0	0
Total Open	325	301	315	333	292	318	344	331	398	392	387	377	380	375	330	276	283	244	248	0	0	0	0	0
Total Plan Backlog	590	636	642	637	634	658	647	626	640	568	509	449	384	740	725	695	585	493	364	239	171	104	65	54

Sample Metrics
Testing Optimism

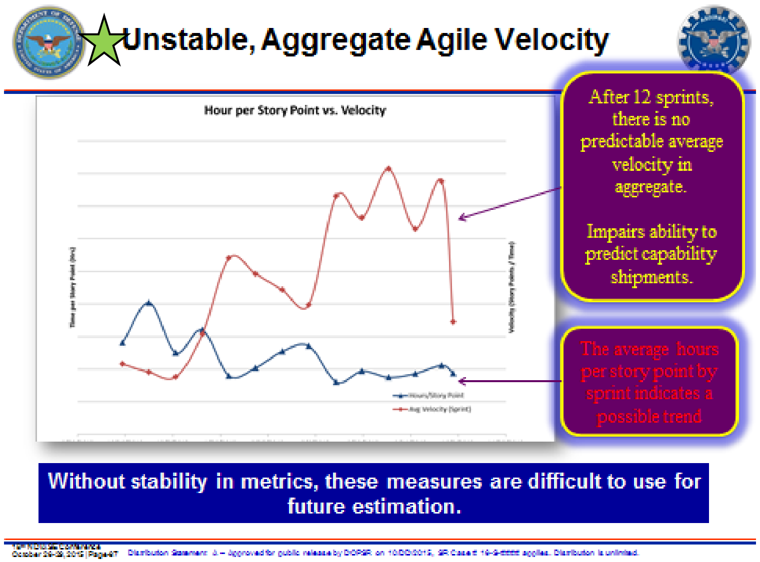


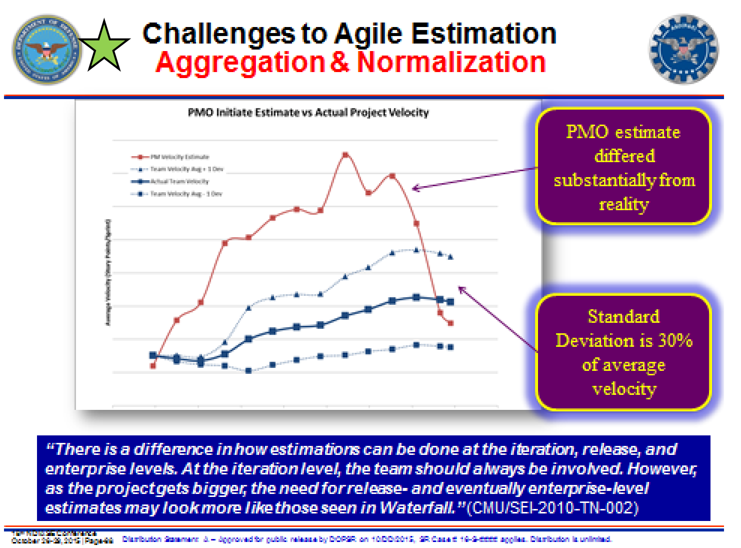
Sampling of Future Challenges

- Agile
- Software Maintenance
- Leading Indicators
- Schedule
- Integration Across Multiple Systems

Agile Metrics and Quantitative SW Engineering Vital for Predictable Delivery

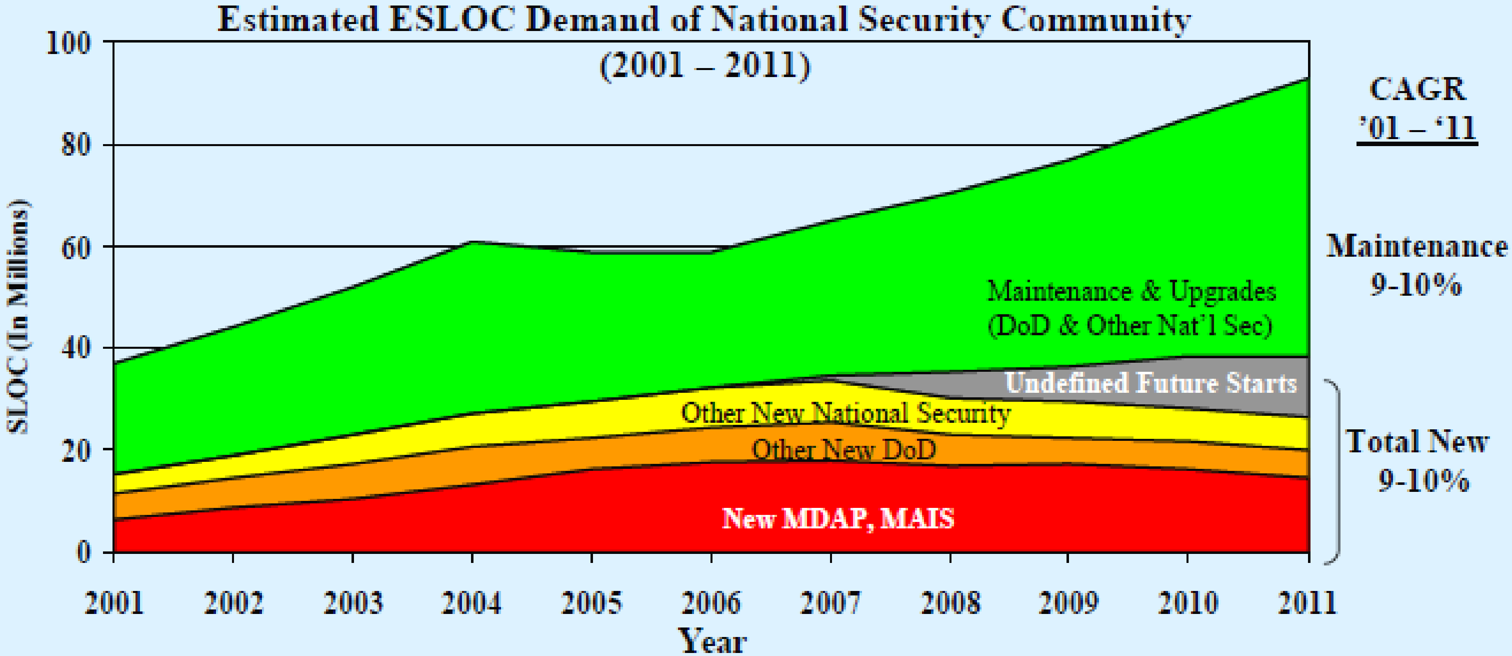
- **Meaning of SP (Done) must be understood**
  - Are system integration, DT & maturity factors baked in per Agile expectation
- ☆ **Predictability — how well do we estimate?**
  - Sustainable development; can we sustain delivery pace?
  - Ignoring "Yesterday's Weather" to plan; ignoring team-level metrics
- **Scaled metrics continued area of study — Normalization & Aggregation:**
  - Can safely monitor predictability, acceleration (& percentages) in aggregate
  - Can we meaningfully aggregate if the reference story is the same?
  - Aggregate velocity can hide Team velocity critical path risk
- **Daily, Sprint and Release cadence insights**
  - Sprint metrics optimized for team delivery;
  - At scale, measure effectiveness of synchronization and ability to deliver E2E thread
- **Lack of E2E Value Delivery — [does it] "Do Something" — Metric**





Demand for Software Maintenance

Estimated Demand for New and Maintenance Software: Maintenance Effort Growing as Fast as New Development



Note: No central or easily comparable sources of software maintenance and upgrade data found – even within Services. Need common software data collection process and repository to manage effectively.

19

Source: CARD data, Federal Procurement Database System, QSM, CSIS Analysis

Reference: Center for Strategic and International Studies, Defense-Industrial Initiatives Group, study in support of USD (AT&L)/AS, Oct 2006

Leading Indicators

Emerging Leading Indicators

Information Need	Specific Leading Indicator	Related Source Material
Requirements	Requirements Stability	SELI 3.1 Requirements Trends – Volatility
Requirements	Stakeholder Needs Met	SELI 3.4 Validation Trends, SELI 3.5 Verification Trends
Requirements Affordability	Requirements Tradeoff Impact	SELI 3.16 System Affordability Trends
Interfaces	Interface Trends	SELI 3.3 Interface Trends
Architecture	Critical Success Factor and/or Quality Attribute Requirements Satisfied by the Architecture	SELI 3.17 Architecture Trends
Staffing and Skills	Staffing and Skills Trends	SELI 3.11 Staffing and Skills Trends
Risk Management	Risk Trends	SELI 3.9 Risk Exposure Trends SELI 3.10 Risk Treatment Trends
Technical Performance Technical Maturity	TPM Summary (all TPMs)	SELI 3.13 Technical Measurement Trends
Technical Performance Technical Maturity	TPM Trend (specific TPM)	SELI 3.13 Technical Measurement Trends
Technical Maturity	Technology Readiness Level for each Critical Technology Element	SELI 3.8 Technology Maturity Trends

SELI: Systems Engineering Leading Indicators Guide

Information Needs Identified

Considered Most Important Based on Prioritization Determined by Workshop Participants

- Requirements
- Interfaces
- Staffing and Skills
- Technical Performance
- Technology Maturity
- Architecture
- Affordability
- Risk Management
- Manufacturability

Ranked Lower in Prioritization by Workshop Participants; not considered by breakout teams

- Testability
- Requirements Verification and Validation
- Defects and Errors
- System Assurance
- Process Compliance
- Work Product Progress
- Facility and Equipment
- Change Backlog
- Review Action Item Closure

Example: Requirements Stability

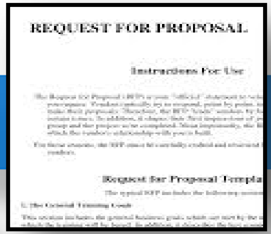
Measureable Concept	Is the SE effort driving towards stability in the system definition and size?
Leading Insight Provided	• Indicates whether the system definition is maturing as expected. • Indicates risks of change to and quality of architecture, design, implementation, verification, and validation. • Indicates schedule and cost risks. • May indicate future need for different level or type of resources/skills. • Indicates potential lack of understanding of stakeholder requirements that may lead to operational or supportability deficiencies.
Base Measures	Total Requirements at the end of the previous reporting period Requirements Changed during the current reporting period (Added, Modified, Deleted) Major Milestone Schedule Time Profile for Expected Requirements Stability
Derived Measures	Percent Requirements Changed = 100 * total requirement changes/Total Requirements Requirements Stability = 100 – Percent Requirements Changed
Decision Criteria	Investigate need for corrective action if the Stability is 10 percent below the expected level and/or the Stability trend for the last three reporting periods is moving toward the threshold.

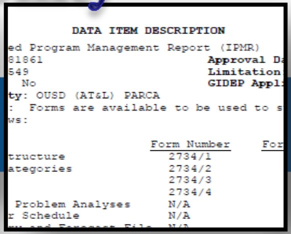
http://www.ndia.org/Divisions/Divisions/SystemsEngineering/Documents/Studies/NDIA%20System%20Develpopment%20Performance%20Measurement%20Report.pdf

Schedule Risk Analysis
FY15

Traceability

Early Program Planning and Development





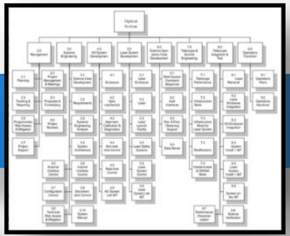
24% Increase in traceability between RFPs, SEPs & DIDs

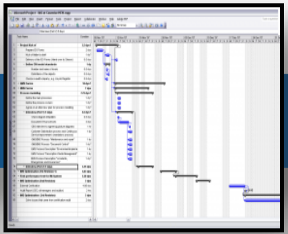
Influencing positive program outcomes through early program engagement and development planning

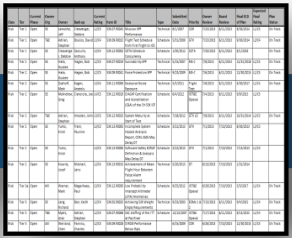
Building Bridges

Execution

Continuous Program Engagements







28% More programs influenced by MPS assessments in FY15

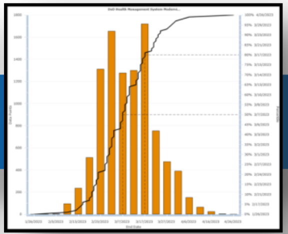
Improved program execution through 96 findings and recommendations!

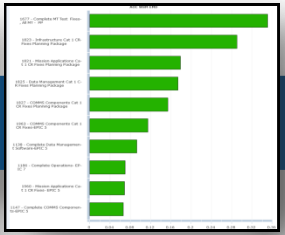
Bench-marking

Realism

Recurring Schedule Analysis

Schedule Health Assessment		Total Tasks	1375
		Complete Tasks	651
		Incomplete Tasks	724
		Baseline Count	655
		BEI Baseline Count	655
		Relationship Count	927
#	Metric	Goal	%
1	Logic	<5%	0.00%
2	Leads	0 tasks	1.62%
3	Lags	<5%	1.40%
4	Relationship Types	<10% non F-S (warn>0 non F-S)	0.97%
5	Hard Constraints	<5%	0.14%
6	High Float	<5%	51.66%
7	Negative Float	0 tasks	0.00%
8	High Duration	<5%	6.77%
9	Invalid Forecast and Actual Dates	0%	
10	Resources	0 improper assisgnments	100.00%
11	Missed Tasks	<5%	0.15%
12	Critical Path Test	0 days	Fail
13	Critical Path Length Index	>=.95	1.00
14	Baseline Execution Index	>=95%	0.99



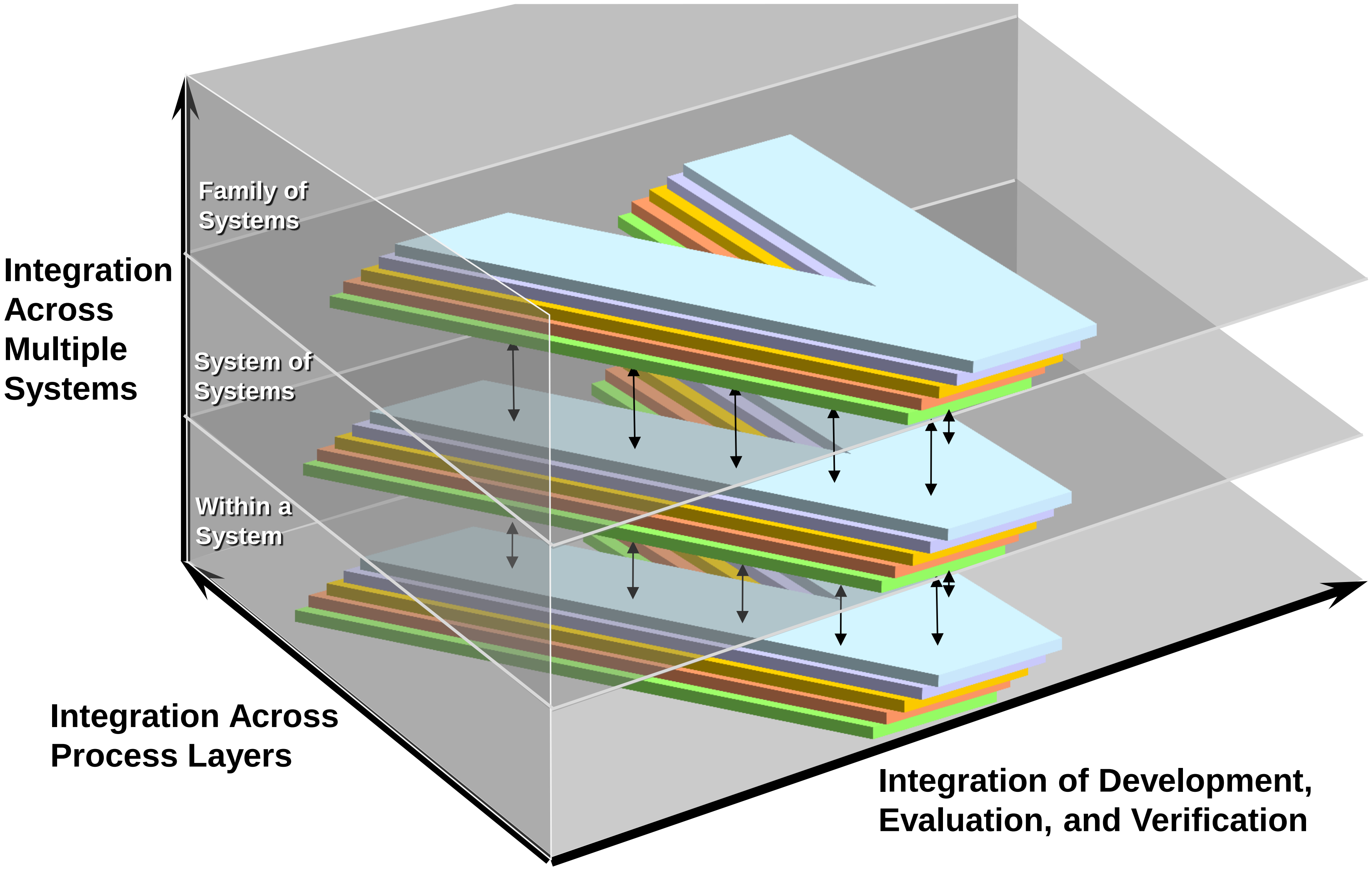


38% More deficiencies isolated in PSAs, PDRs, and CDRs

Improved program schedule realism and influenced decision-making!

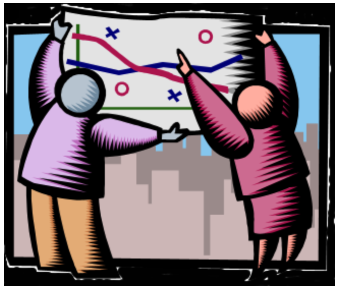
Lowering risk across all MDAP programs through a rigorous schedule risk assessment process

Integration Across Multiple Systems



Challenges for the Future: Making Metrics "Work"

- **Providing a common technical language, e.g., between customers and suppliers**
- **Selecting useful readily available metrics at all acquisition decision levels**
- **Using metrics to determine risk; role of benchmarking**
- **Characterize status; Establishing tolerance bands around the selected metric**
- **Prevent from becoming a numbers game**
- **Communicate findings and recommendations using simple relevant engineering terms backed by supporting engineering detail**



Metrics = Focus on Intended Outcomes

Summary

- **Actively plan and track performance to plan using TPMs to manage risks throughout the lifecycle**
  - Start early, think through the next phase in depth
  - Think through technical challenges and TPMs/metrics to help manage technical risks
  - Use the data to make informed cost and affordability decisions
  - Implement the plan – it isn't important if it isn't checked
- **DASD(SE) is committed to using a <u>quantitative SE approach</u> to:**
  - Mentor major PMOs and system developers; shape program plans; monitor execution
  - Inform DoD leadership of technical risks, opportunities, and impacts to schedule & performance at major decisions
  - Track time and cost for System and Software acquisition

Effective use of Measurement Provides Knowledge to inform Decisions

For Additional Information

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Questions?

Systems Engineering: Critical to Defense Acquisition










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