RDA CHIEF SYSTEMS ENGINEER

ASN (RD&A) Initiatives to Improve Integration of Software Engineering into Defense Acquisition Related Systems Engineering

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- The MITRE Corporation

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Outline

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- ASN (RD&A) CHSENG initiatives to strengthen DON capabilities in acquiring Software Intensive Systems (SIS)
  - Software Process Improvement Initiative (SPII) as a basis for integrating software Into Systems Engineering (SE)
- Highlights of recent efforts
  - Focus Teams
  - Software Acquisition Guidebook
- Key software-related activities for the way ahead
  - Software Metrics
  - Probability of Program Success (PoPS) at the Gate Reviews
  - Software-informed Systems Engineering Technical Reviews (SETRs)
  - Software-infused Work Breakdown Structure (WBS)
  - Bringing it all together – Software activity-based structures

Introduction

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- ASN (RD&A) policy memo (15-May-06) established SPII, led by CHSENG; created five Focus Teams:
  - Software Acquisition Management (SAM)
  - Software Systems Engineering (SSE)
  - Software Development Techniques (SWDEV)
  - Business Implications (BI)
  - Human Resources (HR)
- Focus Teams: 2 years of surveys, interviews, and research
  - Led to an array of microproducts
  - Microproducts distilled into overarching Guidebook
  - CHSENG formed a Horizontal Integration Team (HIT) to facilitate coordination and integration across Focus Teams
  - Guidebook provides basis for HIT way-forward activities

Focus Teams

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- *Software Acquisition Management (SAM)*
  - Responsible for overall acquisition management practices
  - Developed a tailorable acquisition organizational structure with clearly defined roles and responsibilities
  - Developed “As-Is” and “To Be” reports, helping to document current acquisition practice and to lay out future direction
- *Software Systems Engineering (SSE)*
  - Responsible for integrating software engineering events and products into traditional systems engineering practices
  - Conducted cross-SYSCOM survey to identify where PORs have problems in lack of software planning/coordination and/or robust policy/guidance specific to SIS acquisition/development
  - Developed a tailorable set of software metrics, resulting in ASN (RD&A) policy memo of 22-Jul-08

Focus Teams 2

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- *Software Development (SWDEV)*
  - Responsible for evaluating current and emerging software development methodologies and their supporting standards
  - Developed report on understanding positive and negative attributes of methodologies and determining how standards could be applied to Navy software development and acquisition
- *Business Implications (BI)*
  - Responsible for examining acquisition and contracting strategies and practices
  - Developed the “Software Process Improvement Initiative Contract Language” in ASN (RD&A) policy memo of 17-Nov-06
  - Developed SPII guidance for implementing the contract language – promulgated by ASN (RD&A) memo of 13-Jul-07

Focus Teams 3

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- *Human Resources (HR)*
  - Responsible for defining the required skills and capabilities needed by government software acquisition and engineering professionals
  - Produced the “Role Based, Right Fit Training Report” that identified a required set of training courses tailored to the respective roles and responsibilities of software acquisition and engineering professionals

Guidebook

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- *Guidebook for Acquisition of Naval Software Intensive Systems*, Version 1.0 (September 2008)
  - Available at - http://acquisition.navy.mil/rda/home/organizations/dasns/rda_cheng
  - Provides amplifying guidance for ASN (RD&A) policy and other key software topics
    - Establishes IEEE/EIA Std 12207 as the standard software acquisition life cycle framework
    - Defines a set of core software metrics and provides specific guidance for applying them
    - Provides contract solicitation and source selection guidance, including sample Sections L and M language
    - Describes required content for offeror's Software Development Plan (SDP)
    - Addresses the need for a software process IPT and a shared development environment
    - Provides guidance for requirements development and risk management
    - Presents "Role Based, Right Fit Training" based functional disciplines and how to align necessary competencies with training

Horizontal Integration Team (HIT)

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- Current core HIT Members (other than Authors)
  - Brenda Zettervall - BZ Consulting, Inc.
  - Jim Dietz - The MITRE Corp.
  - Cathy O'Hagan - Strategic Insight Ltd.
  - Marty Smart - Strategic Insight Ltd.
  - Jennifer Shirley - Strategic Insight Ltd.
- Modified Value Stream Analysis (VSA) used to refine and prioritize work activities for FY09, based on
  - SPII results
  - Recommendations from recent DON SE initiatives involving
    - SE Practices and Human Resources
    - Program Health (including adoption of PoPS)
    - Technology Protection and Defense Industrial Base (DIB) Security
    - DoDI 5000.2 updates for "early" SE

VSA-Based Priorities

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- Software
  - Metrics
  - Human Resources
  - SETRs
  - WBS
  - Cost Estimating
  - Requirements Management
  - Risk Management
- Assurance
  - Software Assurance
  - Safety
  - Systems Assurance
  - Supplier Assurance
  - Information Assurance (IA)
- RTP
  - Damage Assessment Management Office (DAMO)
  - RTP ESC (Includes PPP and Anti-Tamper)
  - DIB-IA
  - Cyber Security

Initial Work on SW Infusion

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- Initial key activities selected to advance integration of software engineering into acquisition-related SE
  - Guidance for the required set of core software metrics
  - Infusion of software metrics into Probability of Program Success (PoPS) to support the Gate Reviews
  - The argument for software-informed SETRs and software-infused WBSs
  - HR (competencies and training) will both contribute to preventing program office performance gaps and provide a remediation path to close gaps that have been identified in review processes

Core Software Metrics

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- The four required core metrics
  - Software Size/Stability
  - Software Cost/Schedule
  - Software Quality
  - Software Organization
- All metrics to be provided during key phases of the system acquisition lifecycle

ID	Phase	Milestone-Related Period
I	Concept Development	Pre-Concept Decision (CD)
II	Concept Refinement	Post-CD, Leading to Milestone (MS)-A
III	Technology Development	Post MS-A, Leading to MS-B
IV	System Development and Demonstration (SDD) (System Integration)	Post MS-B, Leading to Design Readiness Review (DRR)
V	SDD (System Demonstration)	Post DRR, Leading to MS-C
VI	Production and Deployment	Post MS-C, Leading to Full Rate Production (FRP) Decision
VII	Operations and Support	Post FRP Decision Review

Status Reporting Based on Metrics

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- Examples of basic and general usage of metrics:
  - Scope creep and software stability based on software size metrics/trends
  - Software cost and schedule variances, trends, and performance indexes
  - Software defects, trouble reports, and other quality trends
  - Software personnel staffing actuals vs. planned, including training and turnover metrics

Software Size/Stability Metric

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Phase	I	II	III	IV	V	VI	VII
Baseline/ Basis of Metric	Concept expectation of %-age of system functionality to be delivered by SW (vice, e.g., HW)	Concept expectation of %-age of system functionality to be delivered by SW (vice, e.g., HW)	SW Size Estimates	SW Size Baseline	SW Stability	SW Stability	SW Stability
Who Collects Measure-ments	Program Office	Program Office	Program Office / Bidders	SW developer/ integrator	SW developer/ integrator	SW developer/ integrator	Program Office / SW developer/ integrator
Who Analyzes	Program Office	Program Office	Program Office	Program Office / SW developer/ integrator	SW developer/ integrator	SW developer/ integrator	Program Office
Metric	%-age of functionality in SW	%-age of functionality in SW	Estimated SLOC, FP, or Req'ts.	ESLOC, FP, or Req'ts.	ESLOC, FP, or Req'ts.	ESLOC, FP, or Req'ts.	ESLOC, FP, or Req'ts.
Use of Metrics	Risk, Lessons Learned	Risk, Lessons Learned, Concept Selection	Risk, Lessons Learned, Source Selection	Risk, Lessons Learned, Performance	Risk, Lessons Learned, Performance	Risk, Lessons, Learned, Performance	Risk, Performance , Lessons Learned, Database/ Archival

Software Cost/Schedule Metric

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Phase	I	II	III	IV	V	VI	VII
Baseline/ Basis of Metric	SW related IERs, SDXs	SW related IERs, SDXs	Actual SW cost & schedule data	Actual SW cost & schedule data	Actual SW cost & schedule data	Actual SW cost & schedule data	Actual SW cost & schedule data
Who Collects Measure-ments	Sponsors & Advocates	Sponsors & Advocates	Program Office /SW developer/ integrator	Program Office / SW developer/ integrator	Program Office / SW developer/ integrator	Program Office / SW developer/ integrator	Program Office / SW developer/ integrator
Who Analyzes	Sponsors & Advocates	Sponsors & Advocates	Program Office	Program Office	Program Office	Program Office	Program Office
Metric	# IERs/SDXs produced by SW	# IERs/SDXs produced by SW	Cost/Schedule Variance/ Performance index	Cost/Schedule Variance/ Performance index	Cost/ Schedule Variance/ Performance index	Cost/ Schedule Variance/ Performance index	Cost/ Schedule Variance/ Performance index
Use of Metrics	Risk, Lessons Learned	Risk, Lessons Learned	Risk, Lessons Learned	Risk, Performance , Lessons Learned	Risk, Performance , Lessons Learned	Risk, Performance , Lessons Learned	Risk, Performance Lessons Learned

Software Quality Metric

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Phase	I	II	III	IV	V	VI	VII
Baseline/ Basis of Metric	SW related IERS & SDXs	SW related IERS & SDXs	Defects per SLOC	Defects per SLOC, Defects per system interface	Defects per SLOC, Defects per system interface, Defects per system interface	Defects per SLOC, Defects per system interface, Defects per system interface	Defects per SLOC, Defects per system interface, Defects per system interface
Who Collects Measure-ments	Sponsors & Advocates	Sponsors & Advocates	Program Office / SW developer/ integrator	Program Office / SW developer/ integrator	Program Office / SW developer/ integrator	User/Tester	User/Tester
Who Analyzes	Sponsors & Advocates	Sponsors & Advocates	Program Office	Program Office	Program Office	Program Office	Program Office
Metric	% SW generated IERs/SDXs	% SW generated IERs/SDXs	Qty performance index/ variance	Qty performance index/ variance	Qty performance index/ variance	Qty performance index/ variance	Qty performance index/ variance
Use of Metrics	Risk, Lessons Learned	Risk, Lessons Learned	Risk, Lessons Learned	Risk, Performance , Lessons Learned	Risk, Performance , Lessons Learned	Risk, Performance , Lessons Learned	Risk, Performance , Lessons Learned

Software Organization Metric

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Phase	I	II	III	IV	V	VI	VII
Baseline/ Basis of Metric	Effort/KSA	Effort/KSA	Effort/KSA/Turnover	Effort/KSA/ Turnover	Effort/KSA/ Turnover	Effort/KSA/ Turnover	Effort/KSA/ Turnover
Who Collects Measure-ments	Program Office	Program Office	Program Office / Bidders	Program Office / Contractor	Program Office / Contractor	Program Office / Contractor	Program Office / Contractor
Who Analyzes	Program Office	Program Office	Program Office	Program Office / SW developer/ integrator	Program Office / SW developer/ integrator	Program Office / SW developer/ integrator	Program Office / SW developer/ integrator
Metric	Planned # of people or planned # of labor hours, KSA	# of people or # of labor hours/actual trng vs required trng	# of people or # of labor hours/actual trng vs required trng/# of people lost & gained	# of people or # of labor hours/actual trng vs required trng/# of people lost & gained	# of people or # of labor hours/actual trng vs required trng/# of people lost & gained	# of people or # of labor hours/actual trng vs required trng/# of people lost & gained	# of people or # of labor hours/actual trng vs required trng/# of people lost & gained
Use of Metrics	Risk, Lessons Learned	Risk, Lessons Learned	Risk, Lessons Learned, Source Selection	Risk, Lessons Learned	Risk, Lessons Learned	Risk, Lessons Learned	Risk, Lessons Learned

Infusion Into PoPS for Gate Reviews

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- Mapping of software metrics-related timeline phases to Gate Reviews

Lifecycle Phases	SECNAVNOTE 5000
I: Concept Development	Gate 1
II: Concept Refinement	Gates 2 & 3
III: Technology Development	Gates 4 & 5
IV: System Development	Gate 6
V: System Demonstration	Gate 6 (Phase 2)
VI: Production & Deployment	Gate 6 (Phase 3)
VII: Operations & Support	Gate 6 (Phase 4)

  - See Backup slides for overview/description of each Gate Review and policy memos for use of PoPS methodology at Gate Reviews

Weighting of Core Metrics Across Gates

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Core Metric	*Gate 1 / Ph I: Concept Development*	*Gate 2 / Ph II: Concept Refinement*	*Gate 3 / Ph II: Concept Refinement*	*Gate 4 / Ph III: Technology Development*	*Gate 5 / Ph III: Technology Development*	*Gate 6 / Ph IV: System Development*	*Gate 6 Phase 2 / Ph V: System Demon-stration*	*Gate 6 Phase 3 / Ph VI: Production & Deployment*	*Gate 6 Phase 4 / Ph VII: Operations & Support*
Size/ Stability	10%	10%	10%	20%	30%	25%	30%	30%	30%
Organ-ization	50%	40%	50%	40%	30%	25%	15%	15%	15%
Cost / Schedule	30%	40%	30%	25%	25%	25%	30%	30%	30%
Quality	10%	10%	10%	15%	15%	25%	25%	25%	25%
TOTAL	100%	100%	100%	100%	100%	100%	100%	100%	100%

Gate 1 Criteria Weights

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Core Metric	Weight	Criteria Statement	Weight
Size/Stability	10%	1.1 AoA guidance directs developing a projection of the percentage of total functionality provided by software for each alternative; this may require assumptions, which are to be described	100%
Organization	50%	1.2 Staffing is adequate (availability, skills, experience, certifications) to select alternatives for software and to conduct software planning activities	100%
Cost/ Schedule	30%	1.3 Software cost estimates range has been developed to address potential capability alternatives	80%
		1.4 AoA guidance directs inclusion of software cost estimates (including rationale for cost estimate approach and involvement of relevant stakeholders to include requirements stakeholders)	20%
Quality	10%	1.5 Requirement to identify Information Exchange Requirements (IERs) and data exchange requirements is addressed in AoA planning	100%

Meets all elements of criteria statement

Partially meets elements of criteria statement

Does not address criteria statement

Gate 2 Criteria Weights

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Core Metric	Weight	Criteria Statement	Weight
Size/Stability	10%	1.1 Preliminary estimate and justification of the percentage of total system functionality to be provided by software for the selected alternative has been produced.	100%
Organization	40%	1.2 Staffing is adequate (availability, skills, experience, certifications) to address software considerations in developing the CONOPS and CDD and to conduct related software planning activities.	50%
		1.3 Plan exists to investigate Program Office software manpower requirements (e.g. staff phasing, skills, certifications, training and experience).	50%
Cost/ Schedule	40%	1.4 AoA software cost estimates for the preferred alternative are within the previously established range, or acceptable justification for a waiver is provided.	80%
		1.5 Plans have been developed to incorporate appropriate software cost estimating activities across the acquisition timeline, including identification of and involvement by relevant stakeholders.	20%
Quality	10%	1.6 Plan exists to investigate software engineering tools, techniques and processes.	50%
		1.7 Requirement to identify Information Exchange Requirements (IERs) and data exchange requirements has been addressed in AoA planning and is being addressed in developing the CONOPS and CDD.	50%

Meets all elements of criteria statement

Partially meets elements of criteria statement

Does not address criteria statement

Gate 3 Criteria Weights

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Core Metric	Weight	Criteria Statement	Weight
Size/Stability	10%	1.1 Refined estimate and justification of the percentage of total system functionality to be provided by software for the selected alternative have been produced; the justification is related to and reflects the CONOPS and CDD that were developed.	40%
		1.2 A preliminary identification (with supporting context information) of the percentage of total software that will be new development vs. Commercial Off The Shelf (COTS)/Government Off The Shelf (GOTS)/Non-Developmental Items (NDI)/open source has been produced.	60%
Organization	50%	1.3 Staffing is adequate (availability, skills, experience, certifications) to address software in the CDD approval and the SDS development efforts, and to conduct related software planning activities (e.g., ensuring that projected SW components, together with other system elements specified in the SDS, will satisfy the CDD).	30%
		1.4 Software staff are participating in selection of KPP/KSA threshold/objective values and development of architectural descriptions/views.	40%
		1.5 The planned investigation of Program Office software manpower requirements (required at Gate 2) has been conducted and approved.	30%

Meets all elements of criteria statement

Partially meets elements of criteria statement

Does not address criteria statement

Gate 3 Criteria Weights 2

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Core Metric	Weight	Criteria Statement	Weight
Cost/ Schedule	30%	1.6 Software cost estimating activities are on or ahead of schedule; Stakeholders are involved (as appropriate).	60%
		1.7 Software schedule reflects the industry accepted development and integration time for the percentage of total functionality of the system and complexity of the software for similar systems.	40%
Quality	10%	1.8 The planned investigation of Program Office software engineering tools, techniques, and processes (required at Gate 2) has been conducted and approved.	50%
		1.9 Requirement to identify Information Exchange Requirements (IERs) and data exchange requirements has been addressed in developing the CONOPS and CDD.	50%

Meets all elements of criteria statement

Partially meets elements of criteria statement

Does not address criteria statement

Gate 4 Criteria Weights

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Core Metric	Weight	Criteria Statement	Weight
Size/Stability	20%	1.1 Refined estimate and justification of the percentage of total system functionality to be provided by software have been developed in association with the SDS.	40%
		1.2 Refined estimate and justification of the percentage of total software that will be new development versus Commercial Off The Shelf (COTS)/Government Off The Shelf (GOTS)/Non-Developmental Items (NDI)/open source have been developed in association with the SDS.	40%
		1.3 Preliminary estimates and justification of the percentage of total software that are associated with software safety and software security have been completed.	20%
Organization	40%	1.4 Staffing is adequate (availability, skills, experience, training and certifications) to address software-related SDS requirements and to provide software-related requirements in the RFP.	40%
		1.5 Software staff are validating KPP/KSA threshold/objective values and architectural descriptions/views.	30%
		1.6 Execution of Program Office staffing plan is on or ahead of schedule.	30%

Meets all elements of criteria statement

Partially meets elements of criteria statement

Does not address criteria statement

Gate 4 Criteria Weights 2

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Core Metric	Weight	Criteria Statement	Weight
Cost/ Schedule	25%	1.7 Software cost estimating activities (to include planning for software lifecycle support costs) are on or ahead of schedule; Stakeholders are involved (as appropriate).	40%
		1.8 Program Office has tailored the Software Development Plan (SDP), including Work Breakdown Structure (WBS) software elements, for inclusion in the RFP.	40%
		1.9 Schedule reflects the industry accepted development and integration time for the percentage of total functionality of the system and complexity of the software for similar systems.	20%
Quality	15%	1.10 The approved Program Office software engineering tools, techniques and processes (see Gate 3) are in place and are included in the SDS (as appropriate).	50%
		1.11 Initial estimates for software defects have been identified.	50%

Meets all elements of criteria statement

Partially meets elements of criteria statement

Does not address criteria statement

Gate 5 Criteria Weights

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Core Metric	Weight	Criteria Statement	Weight
Size/Stability	30%	1.1 Government preliminary software size baseline has been identified and includes: ▪ Expected percentage of total system functionality to be provided by software ▪ Percentage of total software that is expected to be new development ▪ Expected size of newly developed, reused, and modified software (Equivalent Source Lines of Code [ESLOC], Function Points [FP], or requirements)	50%
		1.2 RFP addresses required metrics for software size and stability, including selection criteria for: ▪ Percentage of total system functionality to be provided by software ▪ Estimate and justification of the percentage of total software that will be new development or Commercial Off The Shelf (COTS)/Government Off The Shelf (GOTS)/Non-Developmental Items (NDI)/open source ▪ Software size estimates and justification (to include software safety and software security) ▪ Software baseline requirements, including expected growth and trend metrics for software stability, and the use of metrics for forecasting ▪ Weighting factors for source selection	50%
Organization	30%	1.3 Execution of the Program Office staffing plan is on or ahead of schedule (to include source selection).	30%
		1.4 RFP addresses requirements for software organization including: ▪ Manpower requirements (including staff phasing metrics, skills and certifications required, training plans) ▪ Training metrics (actual training vs. required by plan), and required experience) ▪ Turnover metrics	70%

Meets all elements of criteria statement

Partially meets elements of criteria statement

Does not address criteria statement

Gate 5 Criteria Weights 2

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Core Metric	Weight	Criteria Statement	Weight
Cost/ Schedule	25%	1.5 Software cost estimating activities (to include planning for software lifecycle support costs; Integrated Development Environment [IDE]; access to software development data; software metric evidence and artifacts, etc.) are on or ahead of schedule. ▪ Cost estimates have been completed for critical SDS elements (e.g., software safety and software security); RFP selection criteria address these expectations.	40%
		1.6 RFP includes required metrics for tracking software cost/schedule against an approved baseline, including cost and schedule variances and cost and schedule performance indices.	40%
		1.7 Schedule reflects the industry accepted development and integration time for the percentage of total functionality of the system and complexity of the software for similar systems.	20%
Quality	15%	1.8 RFP addresses requirements for developer software engineering tools.	50%
		1.9 RFP includes required metrics for software quality, including defect “density” metrics and trends (e.g., defects per Source Lines of Code [SLOC], defects per unit, defects per interface).	50%

Meets all elements of criteria statement

Partially meets elements of criteria statement

Does not address criteria statement

Gate 6 Criteria Weights
(Post IBR – CDR)

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Core Metric	Weight	Criteria Statement	Weight
Size/Stability	25%	1.1 Size baseline has been established using either Equivalent Source Lines of Code (ESLOC), Function Points (FP), or requirements and identifies acceptable variations over time.	50%
		1.2 A process to collect and assess size metric has been established and is being used.	40%
		1.3 Contract modifications are traced to size.	10%
Organization	25%	1.4 Organization metrics baselines are established including software staff labor hours, needed or fulfilled training, and key software personnel turnover (gain/loss).	50%
		1.5 Process is executing, collecting and assessing the metrics, comparing actuals vs. planned trend lines, and identifying and communicating risk. ▪ Predicted trend lines are established for: hours per sampling period, training completed, and key software personnel arrivals and departures ▪ Software organization metrics definitions and actuals include starting points of activities and tasks ▪ Software organization metrics are sensitive enough to highlight risk issues such as: lack of training, lack of skilled software staff, key software personnel are late (compared to task start), or experiencing high turnover rate	50%

Meets all elements of criteria statement

Partially meets elements of criteria statement

Does not address criteria statement

Gate 6 Criteria Weights
(Post IBR – CDR) 2

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Core Metric	Weight	Criteria Statement	Weight
Cost/ Schedule	25%	1.6 Software cost and schedule baselines have been developed and acceptable variances have been identified.	50%
		1.7 Software is reflected in Work Breakdown Structure (WBS)/Earned Value Management System (EVMS)/equivalent artifacts in sufficient detail to trace to cost and schedule elements.	50%
Quality	25%	1.8 Acceptable software quality definitions (e.g., defect, class of defects) and boundaries (including defect "density" (e.g., defects per SLOC, defects per unit, defects per interface)) have been established and agreed between acquirer and developer.	10%
		1.9 Software quality baselines have been identified and agreed between acquirer and developer.	30%
		1.10 Process to collect and assess quality metric has been established and is being used.	30%
		1.11 Process for defect remediation has been developed (if appropriate, accounts for builds at differing maturities with potentially different classes of defects).	30%

Meets all elements of criteria statement

Partially meets elements of criteria statement

Does not address criteria statement

Gate 6 Criteria Weights (Phase 2)
(Post CDR – PRR)

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Core Metric	Weight	Criteria Statement	Weight
Size/Stability	30%	1.1 Process to collect and assess size metric is being used; size trending and actuals vs. planned size are being tracked, analyzed, and reported.	50%
		1.2 Size variations are within tolerance or justification and waiver has been approved.	50%
Organization	15%	1.3 Process to collect and assess organization metric is being used; organization trend lines (hours per sampling period, training complete, and key software personnel arrivals and departures, comparing actuals vs. planned) are being tracked, analyzed, and reported.	50%
		1.4 Organization metrics are within tolerance or justification and waiver has been approved.	50%
Cost/ Schedule	30%	1.5 Standard process to collect and assess cost/schedule metric is being used; cost/schedule variances, trends and performance indices are being tracked, analyzed and reported.	50%
		1.6 Cost/schedule metrics are within tolerance or justification and waiver has been approved.	50%
Quality	25%	1.7 Standard process to collect and assess quality metric is being used; quality variances, trends and performance indices are being tracked, analyzed and reported.	50%
		1.8 Quality metrics are within tolerance or justification and waiver has been approved. Process for defect remediation is being used and defects have been eliminated to within acceptable limits.	50%

Meets all elements of criteria statement

Partially meets elements of criteria statement

Does not address criteria statement

Gate 6 Criteria Weights (Phase 3)
(Post PRR – Milestone C)

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Core Metric	Weight	Criteria Statement	Weight
Size/Stability	30%	1.1 Process to collect and assess size metric is being used; size trending and actuals vs. planned size are being tracked, analyzed, and reported.	50%
		1.2 Size variations are within tolerance or justification and waiver has been approved.	50%
Organization	15%	1.3 Process to collect and assess organization metric is being used; organization trend lines (hours per sampling period, training complete, and key software personnel arrivals and departures, comparing actuals vs. planned) are being tracked, analyzed, and reported.	50%
		1.4 Organization metrics are within tolerance or justification and waiver has been approved.	50%
Cost/ Schedule	30%	1.5 Standard process to collect and assess cost/schedule metric is being used; cost/schedule variances, trends and performance indices are being tracked, analyzed and reported.	50%
		1.6 Cost/schedule metrics are within tolerance or justification and waiver has been approved.	50%
Quality	25%	1.7 Standard process to collect and assess quality metric is being used; quality variances, trends and performance indices are being tracked, analyzed and reported.	50%
		1.8 Quality metrics are within tolerance or justification and waiver has been approved. Process for defect remediation is being used and defects have been eliminated to within acceptable limits.	50%

Meets all elements of criteria statement

Partially meets elements of criteria statement

Does not address criteria statement

Gate 6 Criteria Weights (Phase 4)
(Post Milestone C – FRP)

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Core Metric	Weight	Criteria Statement	Weight
Size/Stability	30%	1.1 Process to collect and assess size metric is being used; size trending and actuals vs. planned size are being tracked, analyzed, and reported.	50%
		1.2 Size variations are within tolerance or justification and waiver has been approved.	50%
Organization	15%	1.3 Process to collect and assess organization metric is being used; organization trend lines (hours per sampling period, training complete, and key software personnel arrivals and departures, comparing actuals vs. planned) are being tracked, analyzed, and reported.	50%
		1.4 Organization metrics are within tolerance or justification and waiver has been approved.	50%
Cost/ Schedule	30%	1.5 Standard process to collect and assess cost/schedule metric is being used; cost/schedule variances, trends and performance indices are being tracked, analyzed and reported.	50%
		1.6 Cost/schedule metrics are within tolerance or justification and waiver has been approved.	50%
Quality	25%	1.7 Standard process to collect and assess quality metric is being used; quality variances, trends and performance indices are being tracked, analyzed and reported.	50%
		1.8 Quality metrics are within tolerance or justification and waiver has been approved. Process for defect remediation is being used and defects have been eliminated to within acceptable limits.	50%

Meets all elements of criteria statement

Partially meets elements of criteria statement

Does not address criteria statement

Metrics – Next Steps

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- Required core metrics must be refined
  - To provide more detailed prescriptions with focused baseline-and-trend techniques, for each metric in each phase
    - To underpin better senior-level visibility (PoPS), balanced by flow-up from technical visibility (SETR)
  - To support cost estimating and EVM analysis via appropriate granularity of phased software work packages in the WBS
    - To identify specific tasks (with clear staffing and scheduling obligations) for effective monitoring of software cost and schedule

Software-informed SETR / Software-infused WBS

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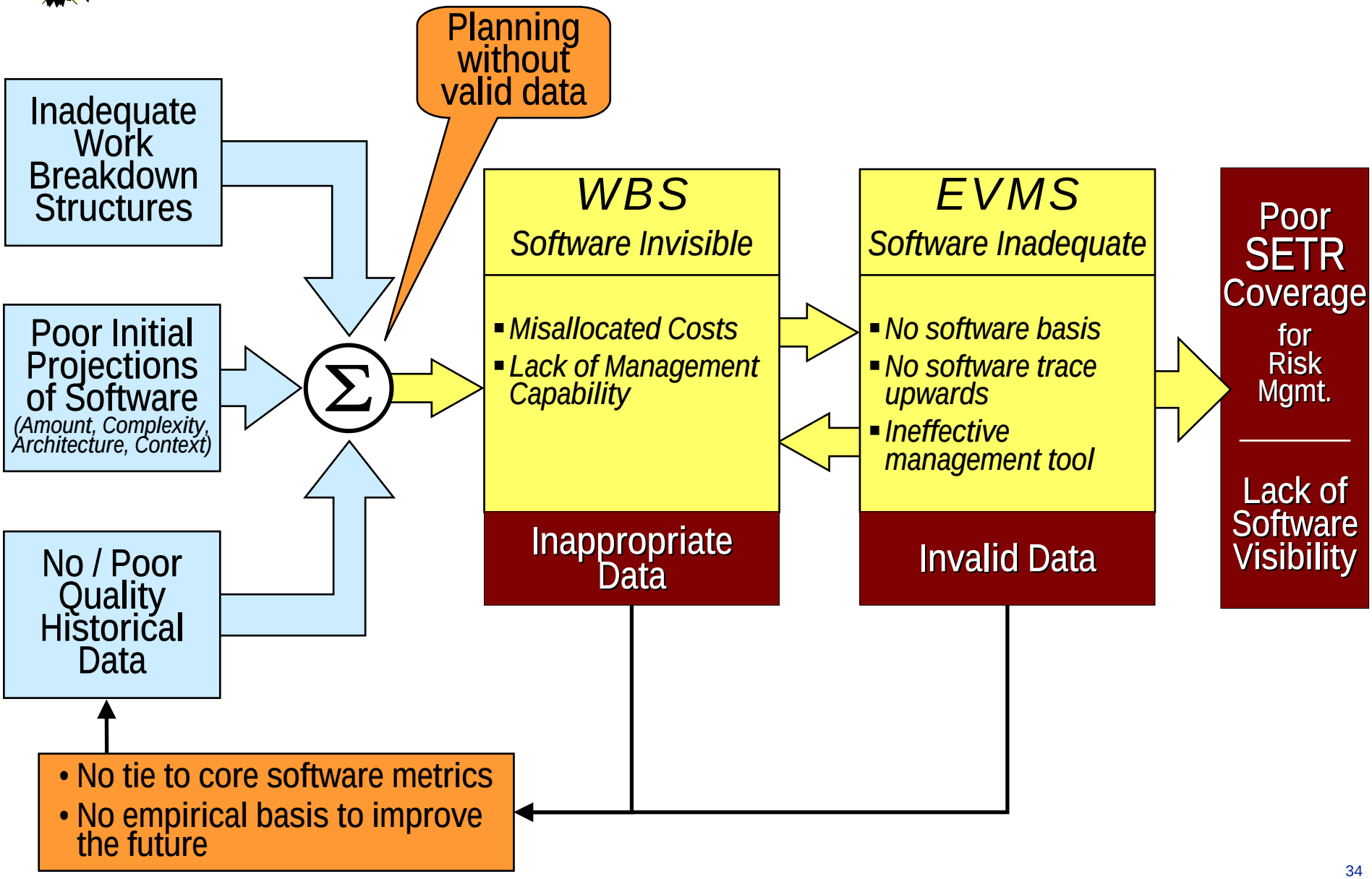
- The problems:
  - System WBSs are software-invisible (missing or deeply buried decomposition of software components and related activities)
  - Software status/indicators from lower-level software reviews are not adequately addressed, rolled up, and integrated into SETRs
  - Unaware programs haven't identified these issues as root causes of ineffective management and failures
- Resultant issues:
  - Software costs grow unobserved (with associated schedule slippages)
- Initial efforts:
  - Worked with SwCCWG (led by Chris Miller): Provided updates to MIL-HDBK-881 to address software infusion into the WBS
  - Work with Enterprise-level common SETR process agents to coordinate software support/input

"As-Is" Software Environment

RDA CHIEF SYSTEMS ENGINEER



Benefits of Software Infusion

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- A properly leveled WBS provides a realistic basis for accurate estimates and measurements of the required core metrics
- A software-informed SETR provides timely, consistent, and quantitative (metrics-based) software status for decision making
- Software infusion provides visibility to support software acquisition management control
  - To support software stability metrics in order to analyze software growth (both scope creep and legitimate volatility) vs. quality (defect removal)
  - To accurately capture the cost and schedule variances for timely re-planning and to facilitate coordinated risk mitigation activities
- Supports management tracking and related analysis efforts
  - Enhances evolution of the Integrated Master Plan (IMP) and Integrated Master Schedule (IMS)
  - Facilitates PoPS through inclusion in the SDS
- Contributes to valid databases for future use

"Should-Be" Software Environment

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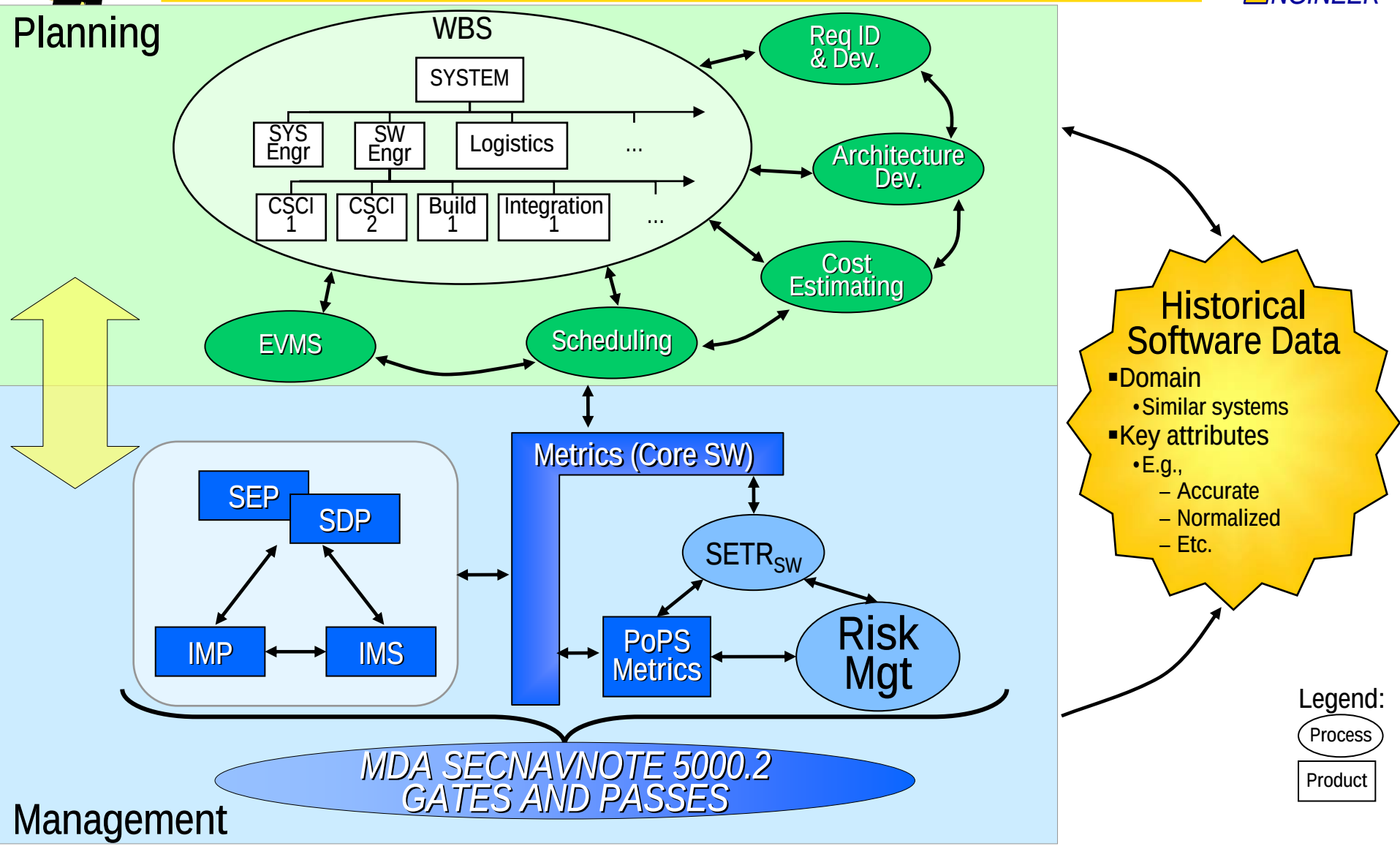

SW Infused WBS Supports Effective Software Metrics and Program Management

The Way Ahead for SW Infusion

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- Expand leading edge of software infusion beginning with software activity-based structures
  - Map IEEE/EIA-12207 processes, activities, and tasks to the acquisition timeline
  - Identify/itemize related 12207 software activity-based constructs tied to SAM-101 informed phases of maturity
  - Integrate other model-based processes and best practices (such as those described in the CMMI®-ACQ)
    - System requirements allocation; SW requirements specification, refinement, management, and traceability
    - Software risk identification, assessment, prioritization, mitigation, tracking
  - Map the activities and tasks against the Defense Acquisition Management Framework of DoDI 5000.2 (and the elaborated guidance found in the DAG)
  - Harmonize the set of software activities across those being developed by the SYSCOMs

SW Infusion Into SETRs

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- Develop recommendations and guidance for inclusion of software into the SETR process
  - Objectives
    - Effectively demonstrate successful completion of required software tasks before proceeding beyond critical system-level events
    - Ensure a disciplined and systematic approach to software development, integration, and verification within the system-driven infrastructure
  - Background (…meanwhile)
    - ASN (RD&A) memo of 13-Jun-08 directed PEOs and respective SYSCOMs to develop a common SETR process across the DON
  - Approach
    - Merge the software activity packages against milestones represented by specific SETRs to inform the system-level reviews
    - Work with SESG representatives to coordinate software support/input to the documented Enterprise-level common SETR process

SW Infusion Into SETRs 2

RDA CHIEF SYSTEMS ENGINEER

- Software-infused SETR products will include:
  - Descriptions of expected software product maturity (development, procurement, and integration) for each SETR
  - Guidance in assessing successful completion of software tasks from an event-driven frame of reference
  - Software-related entry and exit criteria to augment SETR checklists
  - Guidance for identifying software issues and risks via the SETR, and for ensuring that risk mitigation is being addressed

The SW-Infused WBS and Beyond

RDA CHIEF SYSTEMS ENGINEER

- Related efforts that will be supported by developing the software activity packages
  - Refine and more clearly define specific options for required software metrics
  - Establish an approach to baseline metrics that will underpin the PoPS/Gate Reviews
  - Define the layers of software engineering details required for a software-infused WBS
  - Generate software work packages granular enough to manage and monitor software activity and risk
  - Provide guidance for scoping the size, schedule, staffing, and cost required to baseline each software work package
  - Convey methodology for using refined cost and schedule estimates to establish baselines and track software performance with EVM

Recommended Elements of SW-Infused WBS

RDA CHIEF SYSTEMS ENGINEER

- The WBS must contain a software functional allocation to the detail necessary to estimate costs, monitor performance metrics, and manage risks
- The software portion of the WBS should be decomposed to clearly separate and identify the capabilities (initial WBS) and functionality (refined WBS) to be provided by software
- Software should manifest in the WBS at the same high level as Systems Engineering to provide senior management visibility
- Computer software configuration items (CSCIs) should be elevated to the same level as software Builds and Integration

Program office and developer/integrator WBS's must be harmonized to ensure proper software coverage and visibility in both

The Future for Metrics

RDA CHIEF SYSTEMS ENGINEER

- Pilot the flow and trend of software metrics
  - Piloting the metrics data through a POR will help to coordinate metrics gathering mechanisms, analysis techniques, storage databases, flow of data to support reviews, continuity of collection, consistency of analysis, and usefulness of various trend analyses and forecasting techniques
  - Use of metrics by program offices, as evaluated throughout the SETR processes, up through the PoPS reporting at Gate Reviews, and into the ASN (RD&A) Dashboard, will uncover where Enterprise gaps exist
  - Defining the metrics “home database” and investigating the data-stream flow through the architecture of reports, including who owns and analyzes the data at the stops along the way, will provide updates to the requirements for the SDP, the SETRs, and the SEP

Acronyms (not called out elsewhere; in the order used)

RDA CHIEF SYSTEMS ENGINEER

- ASN – Assistant Secretary of the Navy
- RD&A – Research, Development, and Acquisition
- CHSENG – Chief Systems Engineer
- DON – Department of the Navy
- SYSCOM – Systems Command
- POR – Program of Record
- IEEE – Institute of Electrical & Electronics Engineers
- EIA – Electronic Industries Alliance
- IPT – Integrated Product Team
- SE – Systems Engineering
- DoDI – Department of Defense Instruction
- RTP – Research and Technology Protection
- ESC – Executive Steering Committee
- PPP – Program Protection Plan
- SW – Software
- ESLOC – Equivalent Source Lines of Code

Acronyms 2

- FP – Function Point
- IER – Information Exchange Requirement
- SDX – System Data Exchange
- KSA – Knowledge, Skills, and Abilities
- SECNAVNOTE – Secretary of the Navy Notice
- EVM – Earned Value Management
- SwCCWG – Software Cost Control Working Group
- MIL-HDBK – Military Handbook
- SDS – System Design Specification
- SAM-101 – Introduction to Software Acquisition Management
- CMMI®-ACQ – Capability Maturity Model Integration for Acquisition
- DAG – Defense Acquisition Guidebook
- PEO – Program Executive Officer
- SESG – Systems Engineering Steering Group
- SEP – Systems Engineering Plan

Backup Slides

Overview/Description – Gate 1 Review

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- Grant authority for DoN initiated Initial Capabilities Document (ICD) that has completed Service review to be submitted to the Joint Staff (J-8)
  - Corresponding Capabilities-Based Assessment serves as the core input for the ICD
- Validate the proposed AoA guidance
- Authorize program to proceed to Concept Decision

Overview/Description – Gate 2 Review

RDA CHIEF SYSTEMS ENGINEER

- Occurs after completion of AoA and prior to program submitting MS-A documentation. It will:
  - Review AoA assumptions, analysis, cost estimates, conclusions and recommendations
  - Approve Service's preferred alternatives resulting from AoA analysis
  - Provide approval to develop a CDD and CONOPs with guidance and assumptions consistent with the preferred alternatives
  - Authorize a program to proceed to next event (i.e. Gate 3 when program initiation will be at MS-A or to MS-A when program initiation will be at MS-B)

Overview/Description – Gate 3 Review

RDA CHIEF SYSTEMS ENGINEER

- Grant authority for DoN-initiated CDD that has completed Service review to be submitted to J-8. It will:
  - Approve CONOPs – includes description for capability employment, sustainment, basing, training, and manning to support life cycle cost estimate
  - Validate that the SDS Development Plan addresses all required areas and serve as the input for follow-on Pass 2 Gates
  - Review program health for satisfactory cost, risks, and budget adequacy
  - Grant approval to continue with MS-A or MS B preps

Overview/Description – Gate 4 Review

RDA CHIEF SYSTEMS ENGINEER

- Approves the SDS and authorizes a program to proceed to Gate 5 or MS-B
  - SDS may be an attachment of the SDD Phase RFP
- Gate 4 may be combined with Gate 5 and or MS-B for ACAT IC, IAC, and selected ACAT II programs as determined by SECNAV or ASN (RD&A)

Overview/Description – Gate 5 Review

RDA CHIEF SYSTEMS ENGINEER

- Ensures that the Service has completed needed actions and recommends to the MDA approval of the release of the SDD RFP to industry as authorized by the Acquisition Strategy
  - Gate 5 and MS-B may be combined for ACAT IC, IAC, and selected ACAT II programs as determined by SECNAV or ASN (RD&A)

Overview/Description – Gate 6 Review

RDA CHIEF SYSTEMS ENGINEER

- Assess overall program health including readiness for production, the sufficiency of the SDS, EVMS, Program Management Baseline (PMB), and Integrated Baseline Review (IBR)
- Occurs following aware of the SDD contract and satisfactory completion of the IBR
- Follow-on Gate 6 reviews will be conducted to endorse or approve the Capability Production Document (CPD), review program health prior to and post MS-C and Full Rate Production Decision Review (FRP DR), and serve as forums for Configuration Steering Boards

PoPS Policy Memos

RDA CHIEF SYSTEMS ENGINEER

- PDASN (RDA) Memo dated Jan 19, 2008, subj: DON Decision to Utilize Probability of Program Success (PoPS) Approach to Assess Program Health During Gate Reviews
  - "PoPS provides identification of program issues not found in other reporting means and reduces ambiguity in existing methodologies. PoPS represents an opportunity for a consistent and repeatable means to assess and predict internal and external factors that affect program success. It was recognized the benefits of the PoPS approach was not limited to Gate Reviews. As PoPS can also be used for other progress reviews and potentially Milestone Decisions, we are encouraging the PMs to use this same methodology for all such reviews."
- PDASN (RDA) Memo dated Jan 19, 2008, subj: DON Interim Guidance for Probability of Program Success (PoPS) Implementation
  - "…all programs coming to Gate Reviews will utilize the standardized PoPS methodology…it is recommended that programs use an Integrated Product Team (IPT) approach for these assessments with an initial presumption that all criteria are "red", until quality objective evidence is applied that would then warrant a "yellow" or "green" rating."

Benefits of SW-Infused WBS

RDA CHIEF SYSTEMS ENGINEER

- The WBS must contain a software functional allocation to the detail necessary to estimate costs, monitor performance metrics, and manage risks associated with the software development and integration activities
- Software should manifest in the WBS at the same high level as Systems Engineering in order to provide senior management visibility to properly support software risk identification and mitigation
- The software portion of the WBS should be decomposed to clearly separate and identify the capabilities (initial WBS) and functionality (refined WBS) to be provided by software, as well as the related software processes and activities, in order to support software requirements allocation, development, management and traceability
- Computer software configuration items (CSCIs) should be elevated to the same level as software Builds, and the further breakdown of each should lead to key WBS elements supporting meaningful tracking and reporting of software status and progress, including measurement of size/stability and quality, in addition to cost and schedule
- A software-infused, properly-leveled WBS will provide the required basis for the four core software metrics, as follows:
  - It will underpin realistic analysis to support accurate:
    - Software organization requirements (staffing levels and KSA needed)
    - Software size estimates (lines of code and numbers of requirements)
    - Software effort estimates (to generate realistic software schedules and cost estimates)
    - Correct baselining of the software functionality and the details needed for an effective and accountable EVMS

Benefits of SW-Infused WBS 2

RDA CHIEF SYSTEMS ENGINEER

- It will provide visibility to support software acquisition management control:
  - Software work packages defined at the lower WBS levels will accurately capture the cost and schedule variances for timely re-planning and to facilitate coordinated risk mitigation activities
  - A clear mapping of software functionality to WBS elements will support software stability metrics in order to analyze software growth (both scope creep and legitimate volatility) vs. quality (defect removal)
  - The WBS-mapped requirements will support early and better peer review planning, leading to defect containment through disciplined analysis of functionality
  - The “early and better” focus will also support CPI identification and SA activity planning
- Other benefits:
  - A software-infused WBS indirectly supports and leads to sufficient software coverage in Systems Engineering Technical Reviews (SETRs)
  - A software-infused WBS enhances evolution of the Integrated Master Plan (IMP) and Integrated Master Schedule (IMS)
- The program office WBS must be harmonized with that of the developer/integrator to ensure proper software coverage and visibility in both
- A WBS with allocated subsystem components and associated decomposition of software functionality, together with accurate cost and schedule estimates, accurately captured software size and stability metrics, and well tracked changes, will lead to valid databases for future use