From Performance-Based Earned Value℠ (PBEV℠) to the Capability Maturity Model-Integrated (CMMI℠)

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Northrop Grumman Integrated Systems

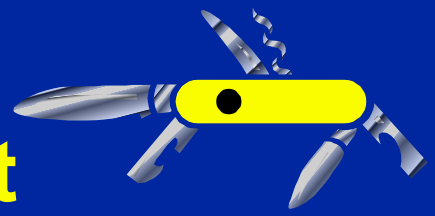
Agenda

- Earned Value Management (EVM), the Integrator
- CMMI to SW-CMM℠
- Performance-Based Earned Value
- Mapping of the CMMI (CMMI-SE/SW/IPPD, V1.1)
  - To Technical Performance Measurement (TPM)
  - To the EVM Industry Standard
  - To the Project Management Institute Guide to the Project Management Body of Knowledge (PMBOK®)
- Cost Savings Opportunity
- Process Improvement During Transition to the CMMI
- CMMI Change Requests Submitted
- Conclusion

Integrated : "I" in CMMI and IPPD

EVM Is the Primary Project Management Tool...

That Integrates the Technical, Schedule, and Cost Parameters of the Contract.



Best Metrics for Early Warning.

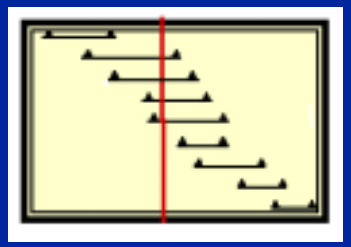
External Industry Benchmarks

- ANSI/EIA 748-1998, "Guidelines for EVM Systems" (Standard)
  - OUSD (Acquisition and Technology)
    - D. Czelusniak, 1997: Only Technique Proven to Effectively INTEGRATE Cost, Schedule and Technical Performance Management
    - J. Gansler, 1999 (Adopted for Defense):
      - Best Management Practice
      - INTEGRATED PROJECT MANAGEMENT
- PMBOK®, ANSI/PMI 99-001-2000
- Practical Software and Systems Measurement (PSM)

Integrated Project Planning

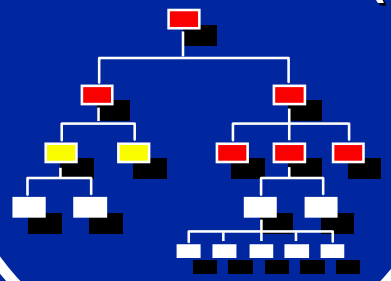
CMMI/EVM

COST

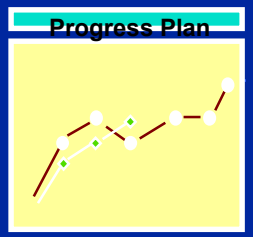


SCHEDULE

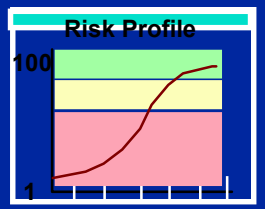
WBS(a)



REQUIREMENTS, TPM



RISK



a: Work Breakdown Structure

Comparison of CMMI to SW-CMM: EVM

- Improved coverage of goals and practices to:
  - Integrate project planning parameters:
    - Cost
    - Schedule
    - Technical performance
  - Establish measurement objectives
  - Establish precise, quantifiable measures
  - Use earned value as an integrating metric for cost, schedule and technical performance
- Measurement elevated to a separate process area

Performance Measurement Baseline (PMB)

CMMI: Project Monitoring & Control

CMMI SPECIFIC PRACTICE	CMMI SUBPRACTICE, CLARIFICATION	SW-CMM SW PROJECT TRACKING & OVERSIGHT
1.1 Monitor project *planning parameters:* • *Attributes of work products* • *Cost (Budget),* schedule	• Compare actual values to plan • Identify significant deviations	Activities 6, 8, 9: • Cost *estimates and work completed* • Schedule activities • Technical activities

CMMI: Measurement & Analysis

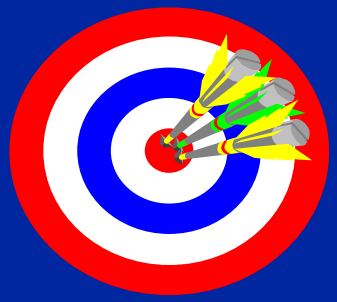
CMMI SPECIFIC PRACTICE	CMMI SUBPRACTICE, CLARIFICATION	SW-CMM QUANTITATIVE PROCESS MANAGEMENT
1.2 Specify Measures to address the measurement objectives	• Precise • *Quantifiable* • Derived examples: – *Earned Value* – *Schedule performance index* • Specify *operational definitions* for measures	Activity 4, Measurement data: • Size, cost, schedule • Quality measurements • Test coverage

CMMI: Integrated Project Management for IPPD

CMMI SPECIFIC PRACTICE	CMMI SUBPRACTICE, CLARIFICATION	SW-CMM INTEGRATED SW MANAGEMENT
1.4 Manage the Project Using the Integrated Plans	• Integrated plans • Track planning parameters using measurable thresholds that trigger investigations • Align performance with current and projected needs, objectives, requirements	Activity 4, Project Management, does *not* address: • Integrated plans • Measurable planning parameters and thresholds

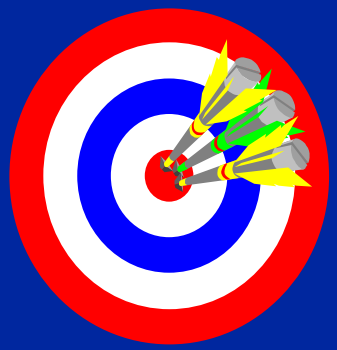
Performance-Based EV

- PBEV: Fusion of EVM and Requirements Management
  - Identify Key Requirements With Biggest Impact on Cost, Schedule, Functionality, Technical Performance and Risk
- Eliminate Waste: Reduce Cost of Using EVM
- Select Effective Measures of Schedule and Progress
  - PMB Tied to Requirements
    - Rapid Integration of Project Scope Changes
  - Progress of Work Products: Not Support Tasks
    - Requirements Development
    - Technical Solution
    - Requirements Management
    - Validation
    - Verification
    - Measurement & Analysis
  - Tie EV to TPM Results



PBEV

- Ban Discrete Planning of Non-Technical Tasks
  - No EV for Meetings, Reviews, Recurring Reports
- Manage Costs, Not Schedule, of Level of Effort Tasks
  - Allocate Support Budget to Discrete Work Packages It Supports
- Reduce Number of Work Packages in EVM System



Requirements Development Work Products

- SP 1.2: Customer Requirements
- SP 2.1: Product and product-component requirements
  - Derived Requirements
  - Product Requirements
  - Product-component Requirements
- SP 2.3: Interface Requirements
- SP 3.2: Required Functionality
  - Functional Architecture
  - Activity diagrams and use cases
  - Object-oriented analysis with services identified

Requirements Development Work Products

- SP 3.3: Analyze requirements
  - Key Requirements
  - TPMs
- SP 3.5: Validate requirements
  - Record of analysis methods and results

Technical Solution Work Products

- SP 1.2:
  - Product Component Operational Concepts, Scenarios and Environments
  - Use Cases
- SP 1.3 Product-component Selection Decisions
- SP 2.2 Technical Data Package
  - Allocated Requirements
  - Product-component description
  - Key product characteristics
  - Required physical characteristics and constraints
  - Interface requirements
  - Material requirements
  - (continued, next slide)

Technical Solution Work Products

- SP 2.2 Technical Data Package (continued)
  - Verification criteria used to ensure requirements have been achieved
  - Conditions of use (environments) and operating/usage scenarios, modes and states for operations, support, training, and verifications
- SP 2.3 Comprehensive Product-component Interface
  - Interface Design Specifications
  - Interface Control Documents
  - Interface Specification Criteria
- SP 3.1: Implemented Design
- SP 3.2 Product Support Documentation
  - Training Materials, User's Manual, Maintenance Manual, Online Help

Other Work Products

- Requirements Management
  - Requirements traceability matrix
- Validation
  - Validation results
  - Validation cross-reference matrix
- Verification
  - Exit and entry criteria for work products
  - Verification results
- Measurement and Analysis
  - Specifications of base and derived measures

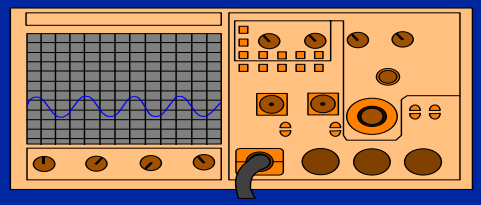
Practical Software and Systems Measurement

PSM Common Issue Areas:

Schedule and Progress
Resources and Cost
Product Size and Stability
Product Quality
Process Performance
Technology Effectiveness
Development Performance
Customer Satisfaction

Note: See final slide for references to PSM and to paper, "Practical Software Measurement, PBEV" in CrossTalk

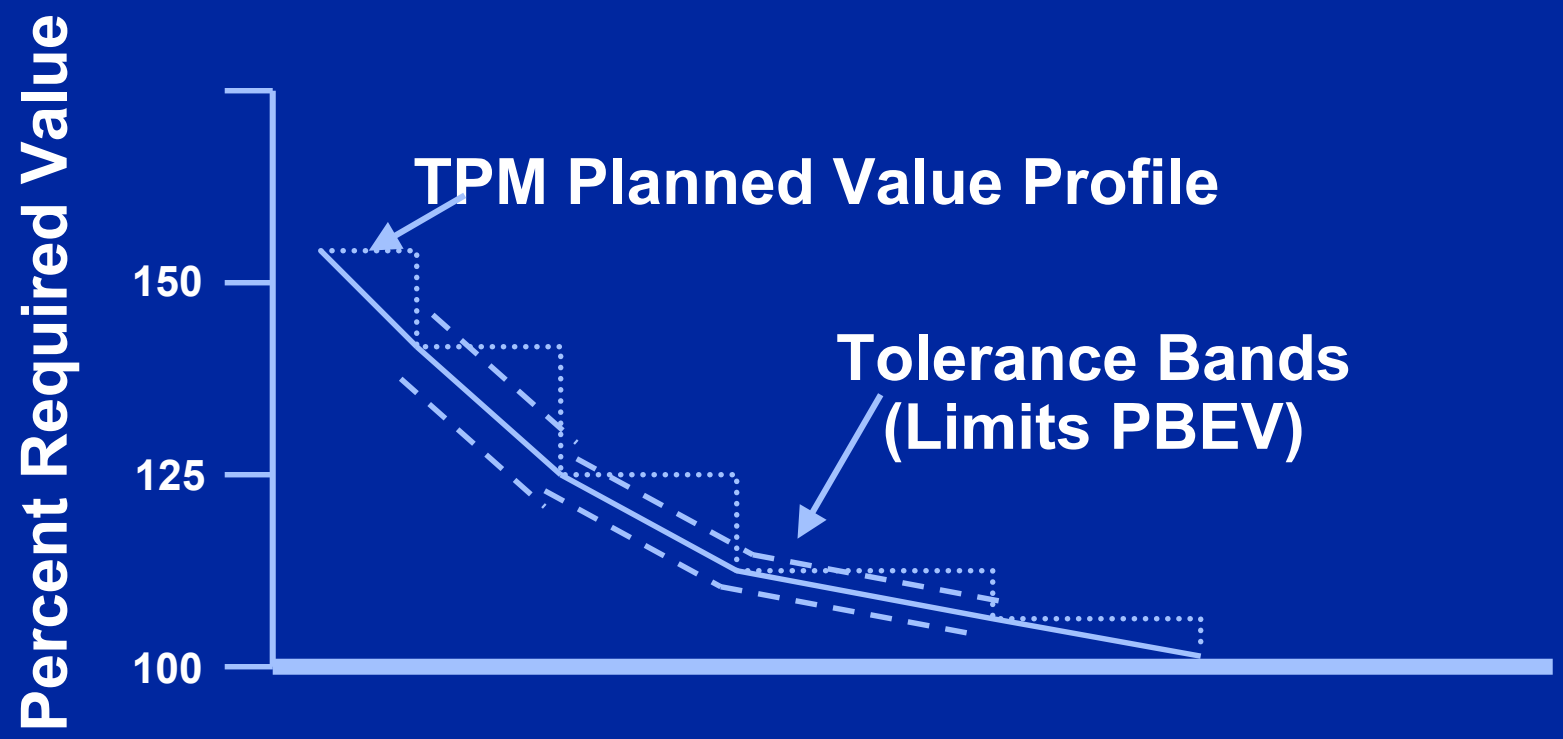
Technical Performance Measurement



- DoD 5000.2-R, Para. 5.2
  - Performance Metrics to Measure:
    - Technical Development and Design,
    - Actual vs. Planned
    - Meeting System Requirements
  - Performance Metrics Traceable to Performance Parameters Identified by Operational User
- Systems Engineering Capability Model (EIA/IS-731)
  - Predict Future Value of Key Technical Parameters
    - Of the End System
    - Based on Current Assessments of the Systems That Make up That End System
- Performance-Based Contracting

Technical Performance Plan

with Tolerance Bands



CMMI PROCESS AREAS and TPM

PROCESS AREA	SPECIFIC PRACTICE (SP)	TPM REFERENCE
REQUIREMENTS DEVELOPMENT	2.1 Establish Product Requirements 3.3 Analyze Requirements	Technical parameters TPMs
TECHNICAL SOLUTION	2.2 Tech. Data 2.3 Design Interface	Functionality, performance Critical parameters
VERIFICATION	3.1 Verify against 3.2 Analyze results	Requirements Compare to TPMs
RISK MANAGEMENT	2.1 Identify Risks	Performance
SUPPLIER AGREEMENT MANAGEMENT	2.2 Execute Agreement	Monitor tech. performance
MEASUREMENT & ANALYSIS	1.1 Measurement Objectives 1.2 Specify Measures	Source: Tech. Needs Base on quality

CMMI Levels and EVM

LEVEL	PROCESS AREAS
4 Quantitatively Managed	*Quantitative Project Management*
3 Defined	*Requirements Development* *Technical Solution* *Verification* *Validation* *Integrated Project Management for IPPD* *Risk Management*
2 Managed	*Requirements Management* *Project Planning* *Project Monitoring & Control* *Supplier Agreement Management* *Measurement & Analysis*

SPs Mapped to EVM Standard

PROCESS AREA	SPECIFIC PRACTICE	SUBPRACTICE, CLARIFICATION	STANDARD GUIDELINE
Integrated Project Management for IPPD	1.3 Integrate Plans	• Integrate other plans with project plan • Incorporate into plan definitions of measures and measurement activities	2.1.c. Provide for integration of planning, scheduling, budgeting, work authorization, cost processes..and WBS

Note: 26 Specific Practices within 11 Process Areas (Levels 3 and 4) map to 17 EVM Standard Guidelines

SPs Mapped to EVM Standard

PROCESS AREA	SPECIFIC PRACTICE	SUBPRACTICE, CLARIFICATION	STANDARD GUIDELINE
Require-ments Management	1.4 Bidirectional Traceability of Requirements (Among require-ments, project plans, intermediate and final and work products	•For each level of product decomposition •For impact of requirements changes on project plans, activities, work products •Work Product: Requirements traceability matrix	2.1.a. Define WBS for internal management control 2.5.a. Incorporate changes in timely manner, recording effects of changes on budgets and schedules

SPs Mapped to EVM Standard

PROCESS AREA	SPECIFIC PRACTICE	SUBPRACTICE, CLARIFICATION	STANDARD GUIDELINE
Requirements Development	3.3 Analyze Requirements	• Identify key requirements... influence cost, schedule, functionality, risk, performance • Identify TPMs	2.2.b. Identify physical products, milestones, tech. performance goals..measure progress

SPs Mapped to EVM Standard

PROCESS AREA	SPECIFIC PRACTICE	SUBPRACTICE, CLARIFICATION	STANDARD GUIDELINE
Measure-ment & Analysis	1.1 Establish Measurement Objectives derived from information needs and objectives 1.2 Specify Measures: Precise Quantifiable	•Sources: –Project plans –Monitoring performance •Base Measures •Derived Measures (EV, SPI) •Operational Definitions	2.2.b. Identify physical products, milestones, tech. performance goals..measure progress

SPs Mapped to EVM Standard

PROCESS AREA	SPECIFIC PRACTICE	SUBPRACTICE, CLARIFICATION	STANDARD GUIDELINE
Project Monitoring & Control	1.1 Monitor project planning parameters	• Progress vs. schedule • Cost • Attributes of work products and tasks	2.4.a: Compare EV with time-phased budget and actual cost
	2.2 Take corrective actions	Determine actions needed	2.4.e: Managerial actions 2.4.f: Estimate at Completion 2.5.e: Changes to the PMB

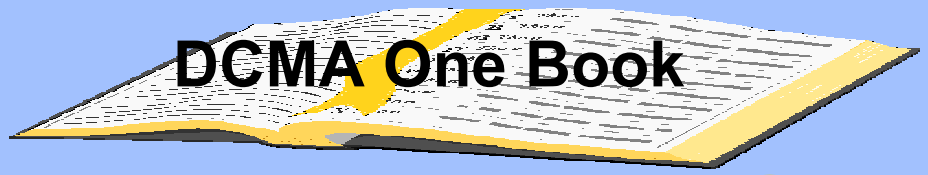
SPs Mapped to PMBOK®

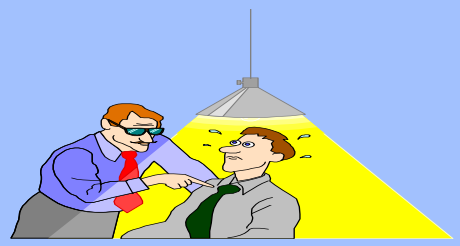
PROCESS AREA	SPECIFIC PRACTICE	SUBPRACTICE, CLARIFICATION	PMBOK Guide
Integrated Project Management for IPPD	1.3 Integrate Plans	• Integrate other plans with project plan • Incorporate into plan definitions of measures and measurement activities	4.1.2.4 EVM, technique used to integrate project's scope, schedule, and resources and to measure and report project performance

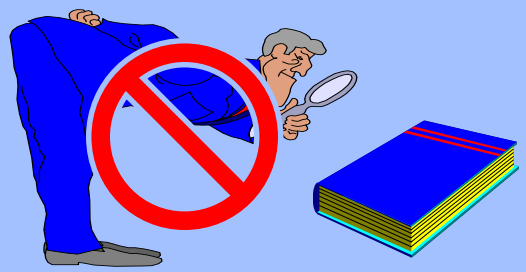
SPs Mapped to PMBOK

PROCESS AREA	SPECIFIC PRACTICE	SUBPRACTICE, CLARIFICATION	PMBOK Guide
Measure-ment & Analysis	1.1 Establish Measurement Objectives derived from information needs and objectives	• Sources: – Established management objectives – Project plans – Monitoring performance • Base Measures • Derived Measures (EV, SPI) • Operational Definitions	5.2.3.1 Project objectives – Quantifiable criteria that must be met for the project to be considered successful….. must include cost, schedule, and quality measures

Cost Savings: SCAMPI Appraisal Time







- Compliance With EVM Standard
- Assess EVM System Risk
- Joint Surveillance Agreement

Minimize On-site Interviews And Document Reviews:

Org. Maps SPs to its EVM Command Media and Shows Institutionalization

Process Improvement

Organization Uses EVM

- Improve and Standardize EVM Processes to Achieve CMMI Goals
  - Project Planning
  - Project Monitoring and Control
  - Supplier Agreement Management
  - Measurement and Analysis
  - Process & Product Quality Assurance
  - Organizational Training
  - Organizational Process Performance
  - Quantitative Project Management
  - Organizational Innovation & Deployment
  - Causal Analysis and Resolution

Process Improvement

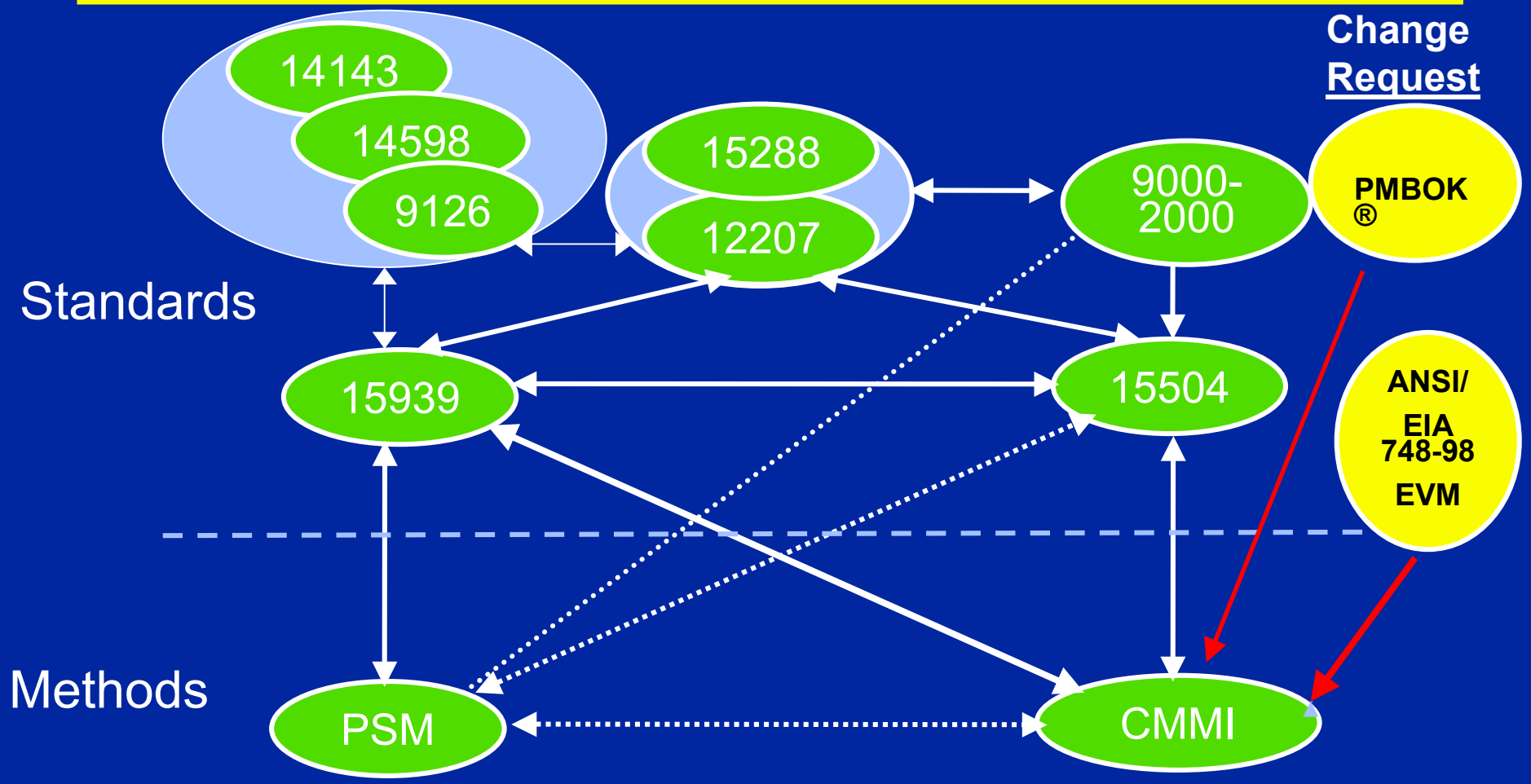
Implement EVM During Transition to CMMI

- Identify Strengths and Weaknesses of Current Processes Relative to EVM:
  - EVM Standard
  - PMBOK® Guide
- Commit to Process Improvement

Four Change Requests (CR) to CMMI

- EV:
  - References, Definitions From EVM Standard and PMBOK®
  - Clarification of EV Techniques and Terminology:
    - Differentiate Between Estimates and Budget
    - Identify Deviations Using Cost Performance Index (CPI) and Schedule PI
    - Differentiate Between Initial Development and Rework
    - Add TPM
- To Acquisition Model: Add Monitoring a Supplier's Project Management Process
- Add Critical Chain Schedule Management

Add EVM to Framework for Measurement

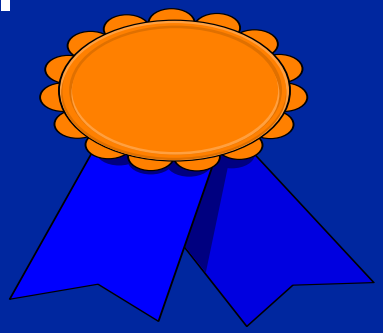


Practical Software Measurement (PSM) ver 3.1
Capability Maturity Model Integration (CMMI), ver 1.02
ISO 9126 -Software Product Quality
ISO 14598 - Evaluation of Software Products
ISO 14143 - Functional Size Measurement

ISO/IEC 15504, Information Technology – Software Process Assessment
ISO/EIC CD 15939, Information Technology – Software Measurement Process
ISO/EIC CD 15288, Information Technology – Life Cycle Management – System Life Cycle Processes
ISO/EIC 12207, Information Technology - Software Life Cycle Processes
ISO 9000:2000, Quality Management Systems

Conclusions

- EVM - the Only Technique Proven to Effectively INTEGRATE Cost, Schedule and Technical Performance Management
- Compliance With External Industry Benchmarks Indicates Achievement of CMMI SPs
  - Reduce Costs of Transition and Appraisal
- Use the Transition to CMMI To:
  - Improve EVM Processes or
  - Transition to EVM
- CMMI Models Should Be Revised to Better Clarify Ties to EVM



Contact and References

- Email: SolomonPBEV@msn.com
- Performance-Based Earned Value and PBEV are service marks of Paul Solomon
- CMMI and SW-CMM are service marks of Carnegie Mellon University
- Solomon, Paul J., "Practical Software Measurement, PBEV", CrossTalk, Vol. 14 No. 9, September 2001, www.stsc.hill.af.mil/crosstalk
- PMBOK®, Project Management Institute Guide to the Project Management Body of Knowledge, 2000 Edition
- PSM, U.S. Department of Defense and U.S. Army, Version 4.0b, www.psmsc.com