



# CMMI<sup>SM</sup> — How Will It Change The Industry?

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**November 2000**

**Sponsored by the U.S. Department of Defense  
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# Acknowledgments

**Slides and ideas stolen liberally from other members of the CMMI Product Team:**

- **Thanks are due in particular to Dave Kitson, Joe Jarzombek, Gene Miluk, David White, and Dave Zubrow.**
- **Special thanks also are due to Khaled El Emam, Terry Rout, Angela Tuffley, and the members of the CMMI Test and Evaluation IPT.**

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# Today's Talk

## **CMMI Background**

## **Impact of process improvement: a brief review**

## **The product suite**

## **Test and evaluation in CMMI**



# Today's Talk



## CMMI Background

- Purpose and scope
- Integrating the source models & methods
- Development & review process
- Transition to CMMI

**Impact of process improvement: a brief review**

**The product suite**

**Test and evaluation in CMMI**





# The CMMI Project

**Sponsored by the US Department of Defense and  
the National Defense Industrial Association (NDIA)**

## **Collaborative endeavor**

- **Industry**
- **Government**
- **Software Engineering Institute**

## **Over 100 people involved**

- **Product (Development) Team**
- **Steering Group**
- **Stakeholder reviewers from selected government  
and industry organizations**



# CMMI Benefits

**Efficient, effective assessment and improvement across multiple process disciplines in an organization**

**Reduced training and assessment costs**

**A common, integrated vision of improvement for all elements of an organization**

**A means of representing new discipline-specific information in a standard, proven process improvement context**



# CMMI Source Models

**Capability Maturity Model for Software V2,  
draft C (SW-CMM V2C)**

**EIA Interim Standard 731, System Engineering  
Capability Model (SECM)**

**Integrated Product Development Capability Maturity  
Model, draft V0.98 (IPD-CMM)**

■ ■ ■

**“Reference documents” include ISO/IEC 12207 and  
ISO/IEC 15504**



# Model Metrics

<u>Release</u>	<u>FAs</u>	<u>PAs/ Themes*</u>	<u>Goals/ Practices**</u>	<u>Activities/ Practices**</u>	
SW-CMM V1.1		18	52	316	
SW-CMM V2C		19	62	318	
EIA/IS 731		19	38 77	139 383	701
IPD-CMM V0.98		23	60	865	
CMMI V0.1 SE/SW		27	149	550	
CMMI V0.2 SE/SW		24	80	528	
CMMI V1.0 SE/SW		22	70	417	

\* Ratable components

\*\* Key to implementation effort



# CMMI Design Goals

**Integrate the source models, eliminate inconsistencies, reduce duplication**

**Reduce the cost of implementing model-based process improvement**

**Increase clarity and understanding**

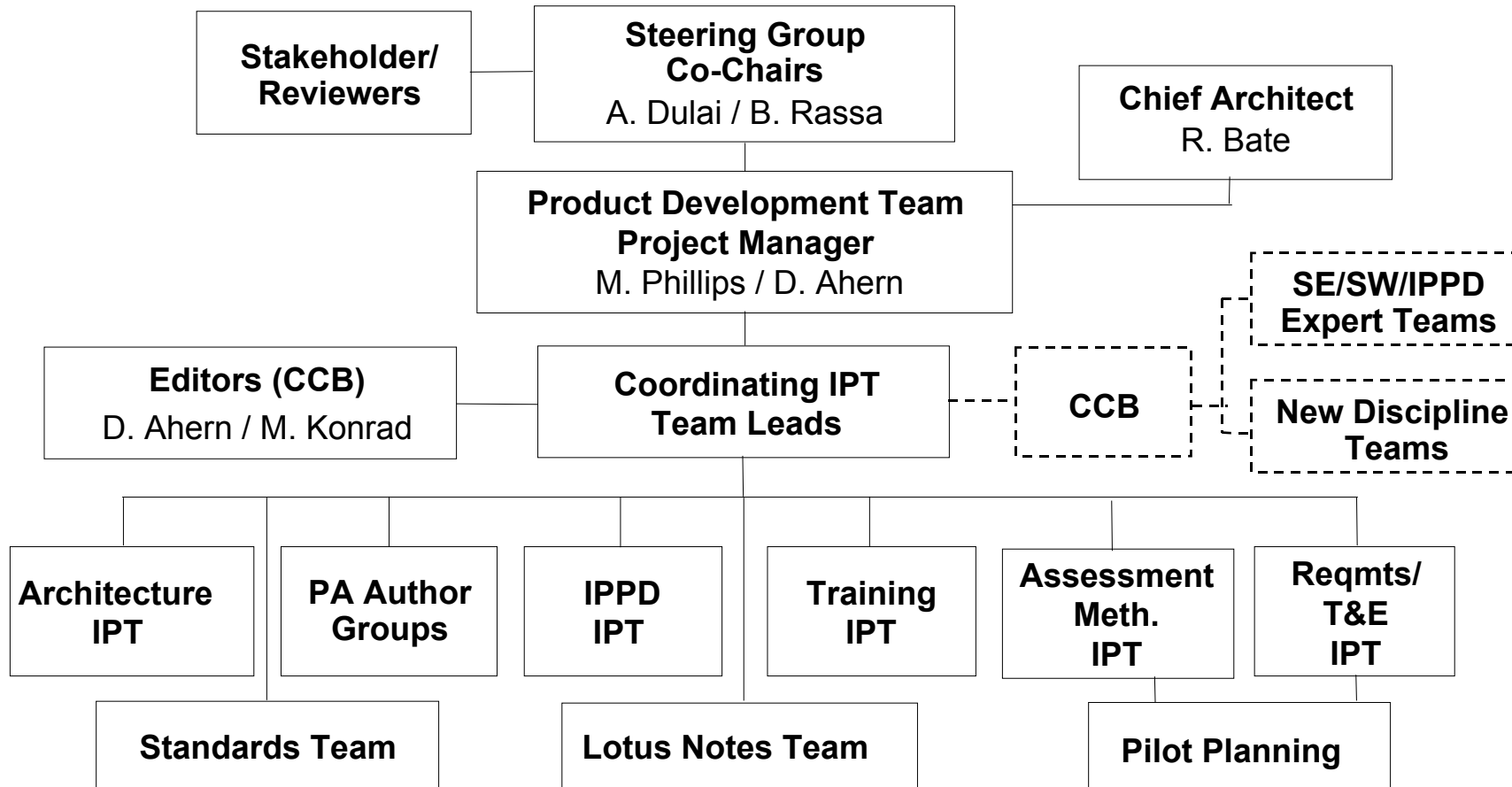
- **Common terminology**
- **Consistent style**
- **Uniform construction rules**
- **Common components**

**Assure consistency with ISO/IEC 15504**

**Be sensitive to impact on legacy efforts**



# Development & Review Process



IPT = integrated product team



# CMMI Schedule

<b>August 12, 2000</b>	<b>Released CMMI-SE/SW V1.0 for initial use</b>
<b>August 16, 2000</b>	<b>Released CMMI-SE/SW/A to stakeholders for review</b>
<b>Oct 2000 for initial use</b>	<b>Released CMMI-SE/SW/IPPD V1.0</b>
<b>Nov 2000</b>	<b>Release CMMI-SE/SW/A for initial piloting</b>
<b>Fall 2001</b>	<b>Publish models V1.1</b>
<b>Fall 2003</b>	<b>Complete sunset period for precursor models</b>



# CMMI Transition Plan

## Development Phase

- Development of CMMI products
- Verification and validation of CMMI products

## Transition Phase

- Approval of initial CMMI products for public release
- Evidence of sufficient use
- Transition planning to help organizations use CMMI products

## Sustainment Phase

- Upkeep and continuous improvement of the product suite
- Additional evidence of adoption and use



# Today's Talk

## CMMI Background



## Impact of process improvement: a brief review

## The product suite

## Test and evaluation in CMMI



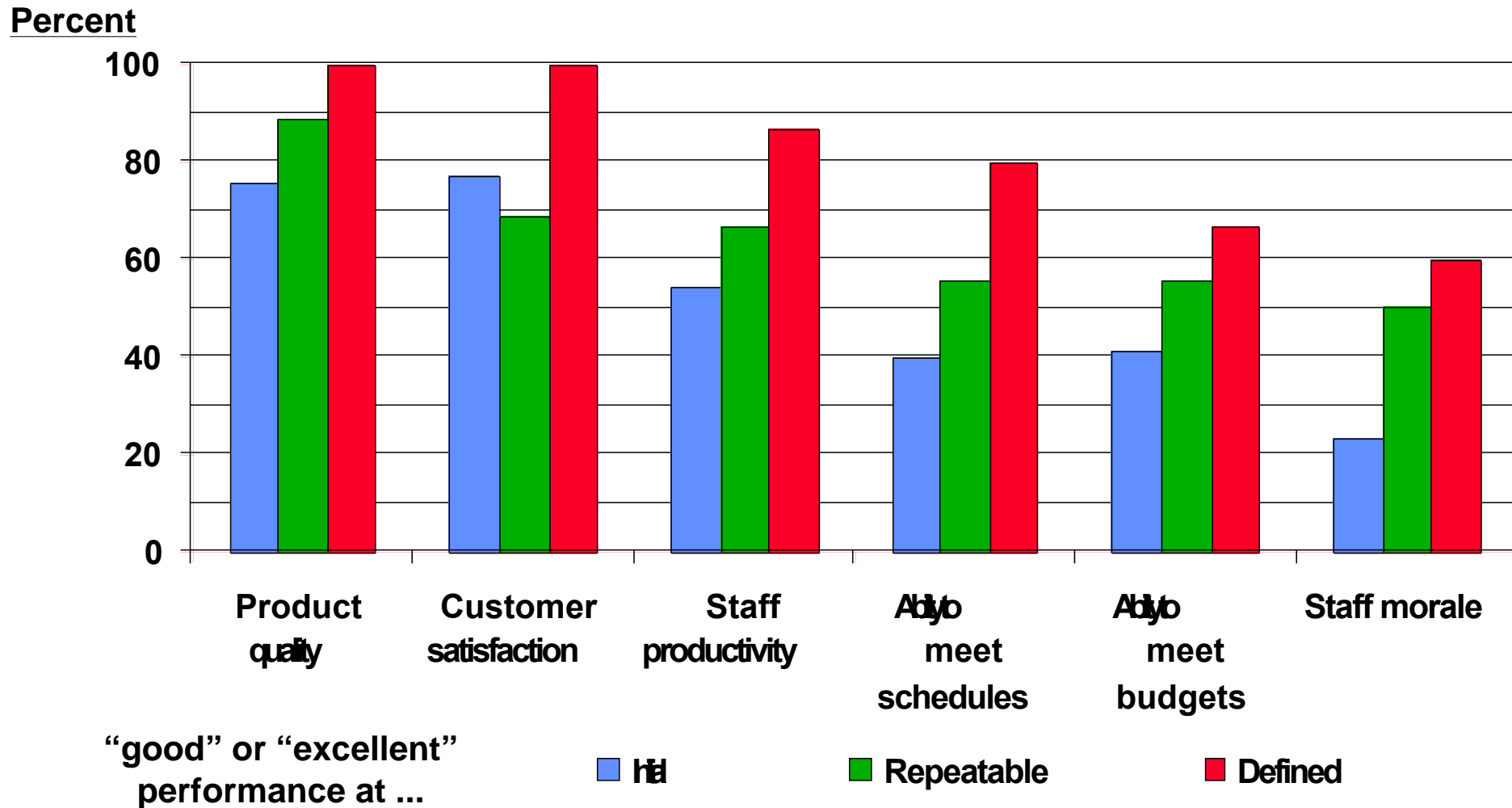
# Impact of Process Improvement

**Process capability can, and often does, result in improved organizational performance**

- **Numerous case studies demonstrate improvements in productivity, product quality, & return on investment**
  - **E.g., improvements in cycle time, defect density, and productivity, and benefit-to-cost ratios in the range of 4.0:1 to 8.8:1 [Herbsleb 94]**
- **Similar results from studies comparing many projects or organizations**
  - **Comparing measures of process capability with schedule, budget, product quality, and other performance metrics [E.g., Harter 00, Krishnan 99, Clark 97, Lawlis 95, Goldenson 95]**



# For Example...





# Select Bibliography – 1

Clark, Bradford K. *The Effects of Software Process Maturity on Software Development Effort*, PhD Dissertation, Computer Science Department, University of Southern California, August 1997.

Dunaway, Donna K.; Goldenson, Dennis R.; Monarch, Ira A.; & White, David M. *How Well is CBA IPI Working?* User feedback presented at SEPG98, Chicago, Illinois, March 1998.

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# Select Bibliography -2

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# Today's Talk

## CMMI Background

## Impact of process improvement: a brief review



### The product suite

- Framework & architecture
- Integrated models
- Measurement in CMMI
- Appraisal methods and training
- Relation to ISO/IEC 15504

## Test and evaluation in CMMI



# **CMMI Framework**

**Architecture instantiated in Lotus Notes**

**Generates CMMI models for specified disciplines**

- **Common, shared, and discipline specific process areas**

**In either staged or continuous representations**

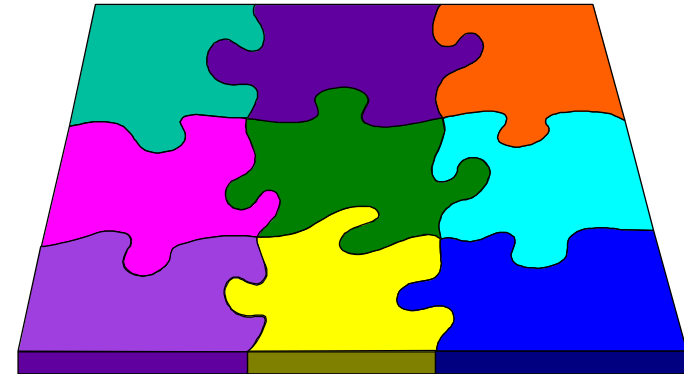
**Capable of generating training and appraisal documents**



# CMMI Model Representations

An organization may choose to approach process improvement from either the

- process capability approach
- organizational maturity approach



CMMI models support each approach with a *representation*

- process capability approach - continuous representation
- organizational maturity approach - staged representation



# Comparing the Two Representations

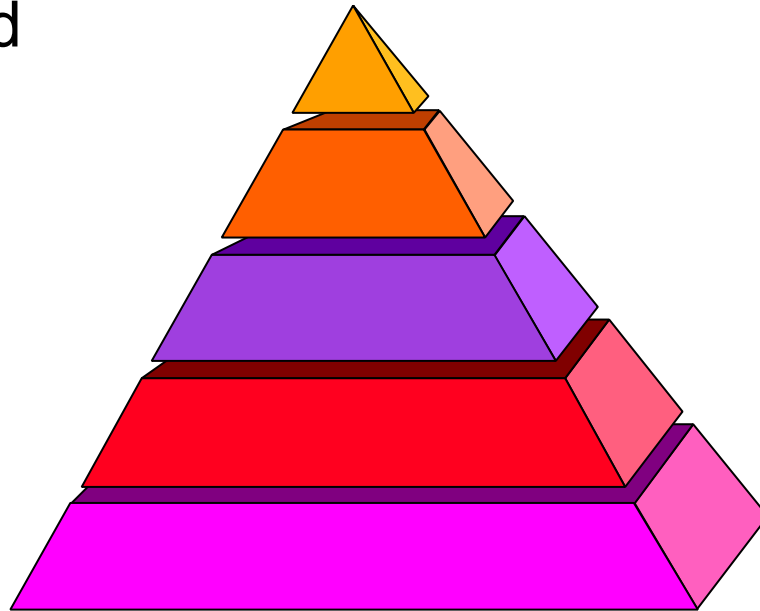
**Both representations provide the same essential content but organized in different ways**

**Thus providing different ways of implementing process improvement to achieve business goals**



# Staged Representation

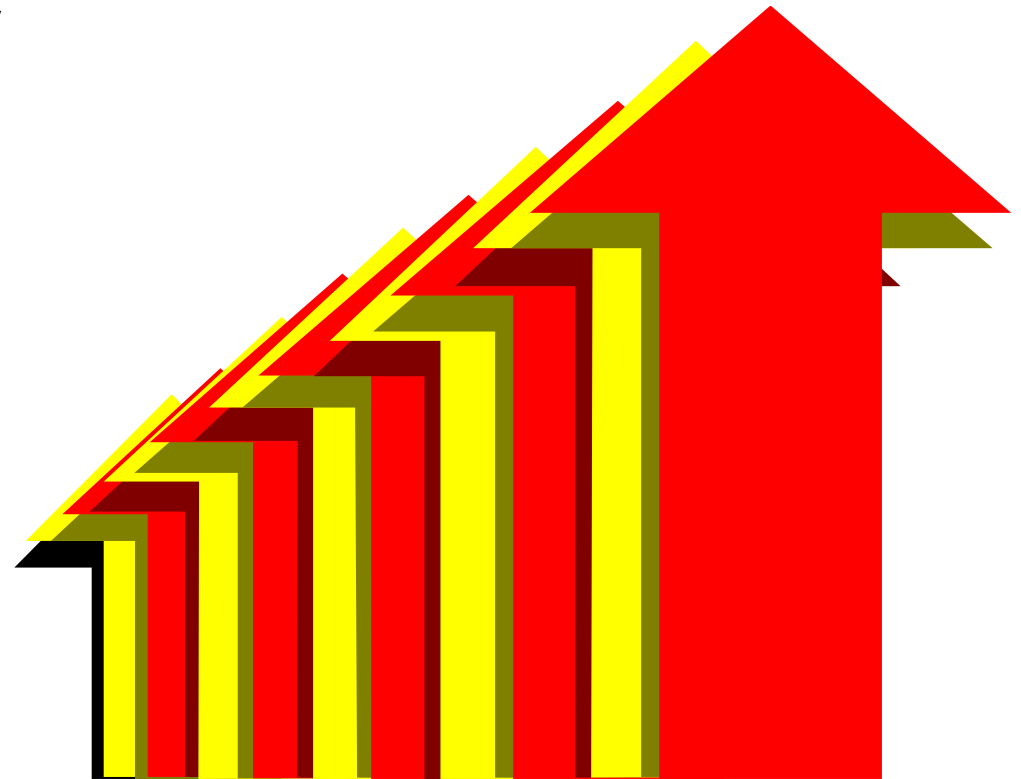
Provides a pre-defined roadmap for organizational improvement based on grouping & ordering of processes and associated organizational relationships





# Continuous Representation

**Provides maximum flexibility for organizations to choose which processes to emphasize for improvement**



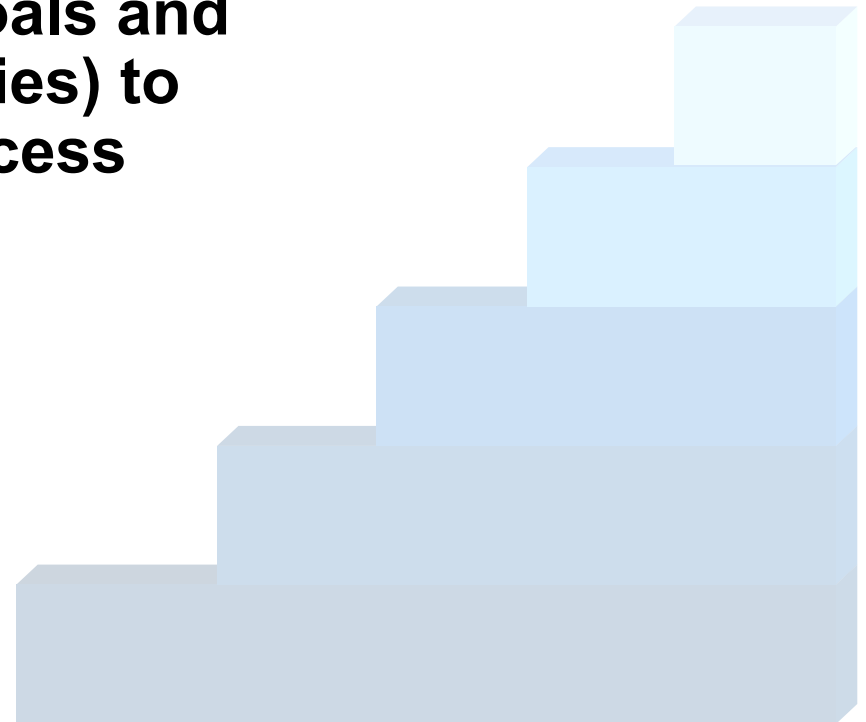


# Staged Representations

**Process Areas are grouped into stages (maturity levels) from 2 to 5**

**Each Process Area contains goals and implementing practices (activities) to achieve the purpose of the process area**

**For a Process Area at a given stage, institutionalization practices (common features) are integral to the process area**



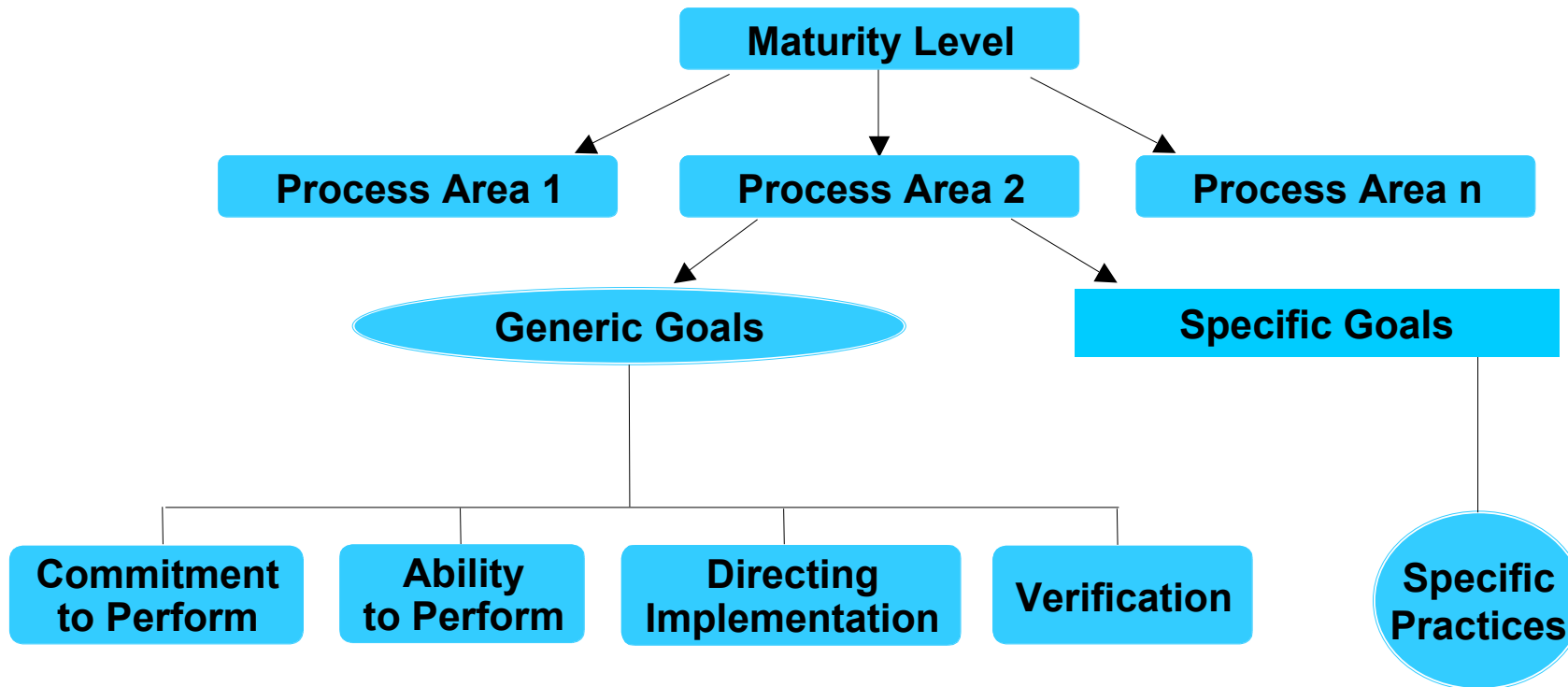


Level	Focus	Process Areas
5 Optimizing	<i>Continuous Process Improvement</i>	Organizational Innovation and Deployment Causal Analysis and Resolution
4 Quantitatively Managed	<i>Quantitative Management</i>	Organizational Process Performance Quantitative Project Management
3 Defined	<i>Process Standardization</i>	Requirements Development Technical Solution Product Integration Verification Validation Organizational Process Focus Organizational Process Definition Organizational Training Integrated Project Management Risk Management Decision Analysis and Resolution
2 Managed	<i>Basic Project Management</i>	Requirements Management Project Planning Project Monitoring and Control Supplier Agreement Management Measurement and Analysis Process and Product Quality Assurance Configuration Management
1 Initial		





# Structure of the CMMI Staged Representation





# Continuous Representations

**A Process Area contains specific goals and practices to achieve the purpose of the process area**

- **Some of these practices may reside at higher Capability Levels (advanced practices)**

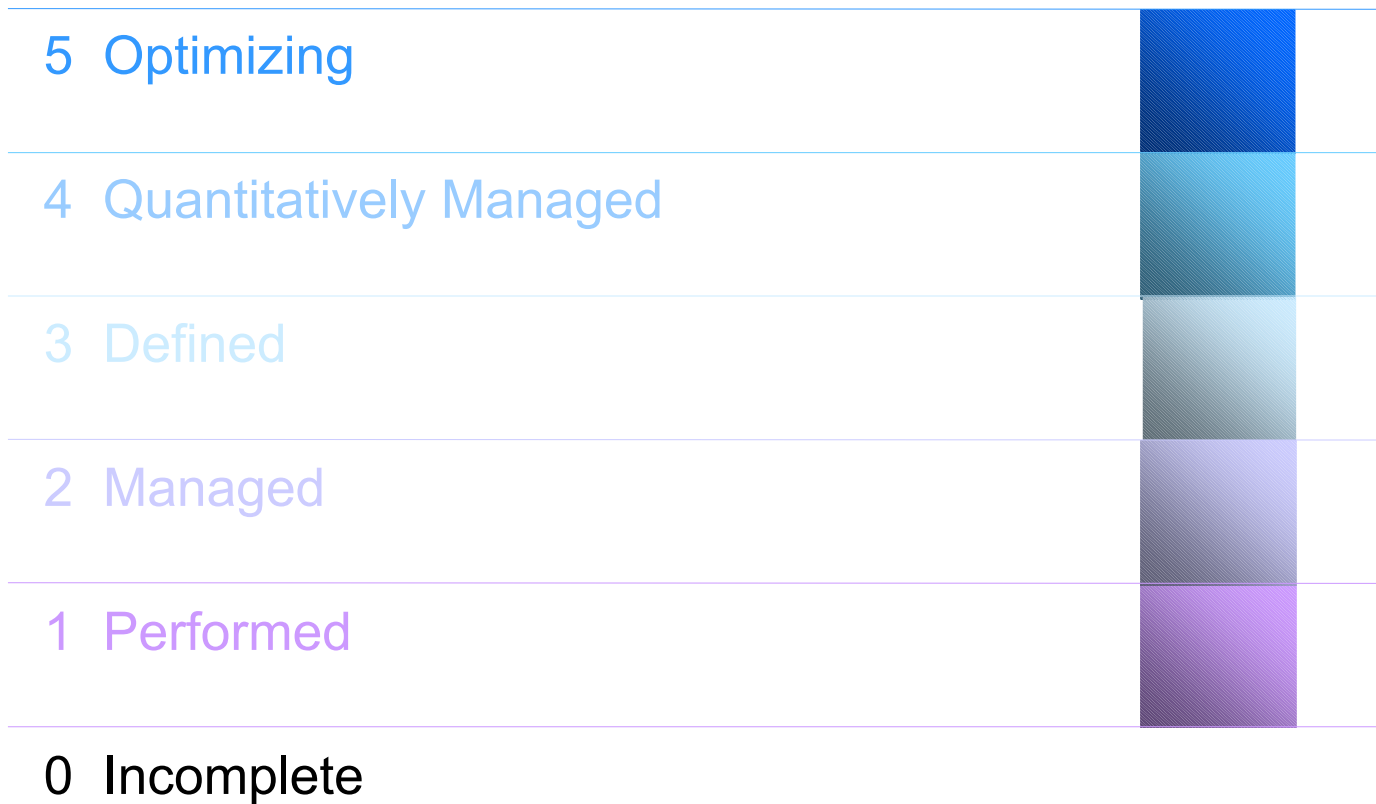
**Generic practices are grouped by goal to define Capability Levels**

- **The generic practices and goals are considered along with the specific goals and practices of any process area to attain a capability level for that process area**

**The order in which Process Areas are addressed can follow a recommended staging**

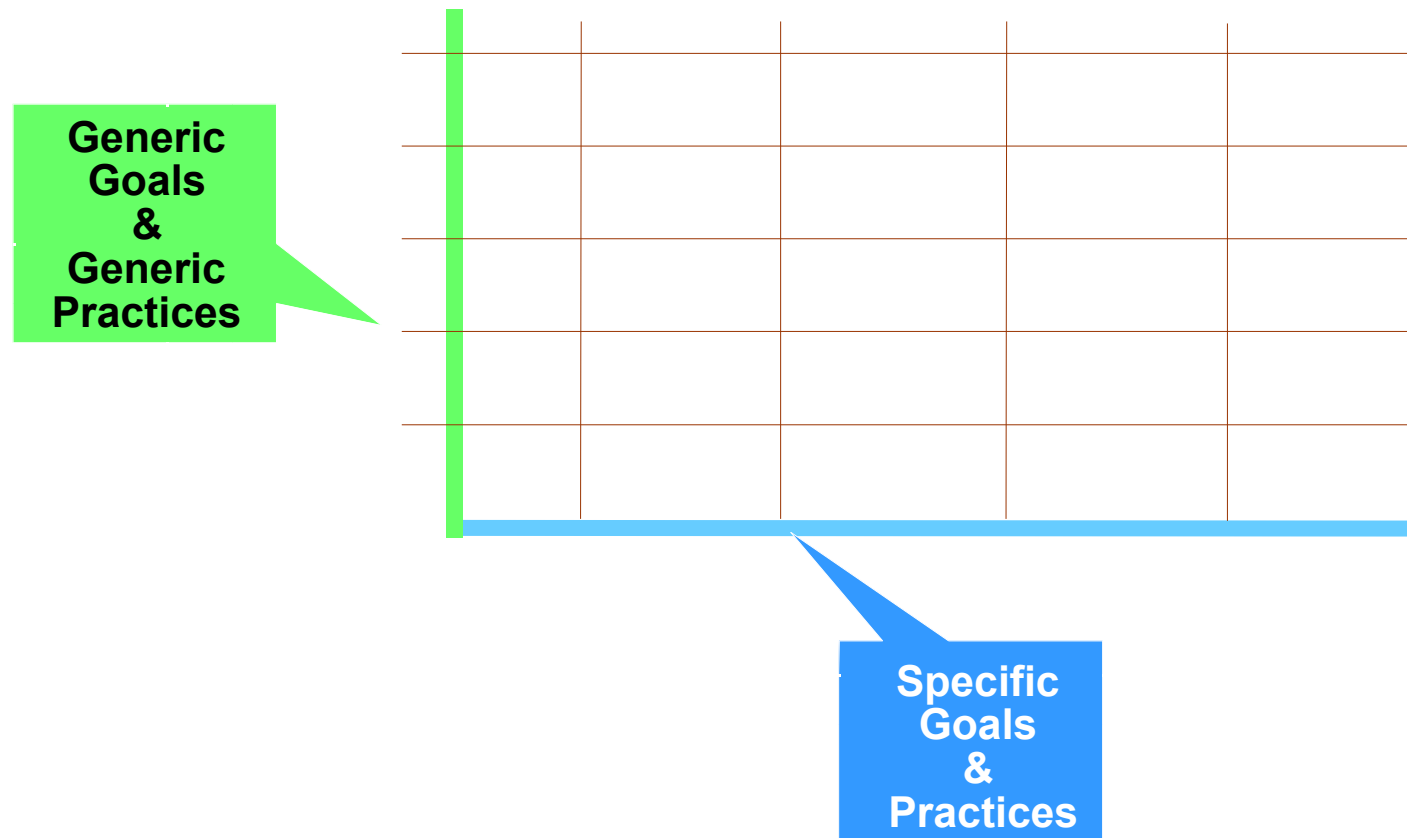


# Process Capability Levels



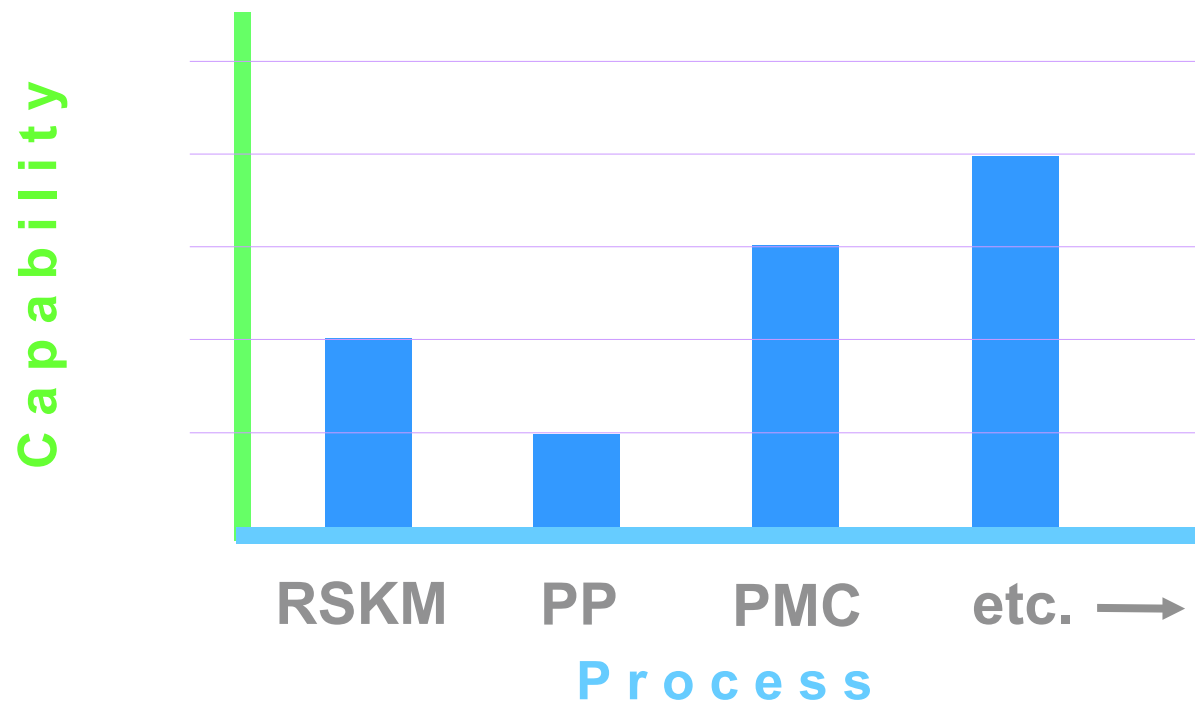


# Structure of the CMMI Continuous Representation





# An Example Organizational Process Maturity Profile





# **CMMI Process Area Contents**

**Purpose**

**Introductory Notes**

**Goals: Specific and Generic**

**Generic Practices**

**Specific Practices**

**Notes**

**Work Products**

**Subpractices**

**Amplifications**

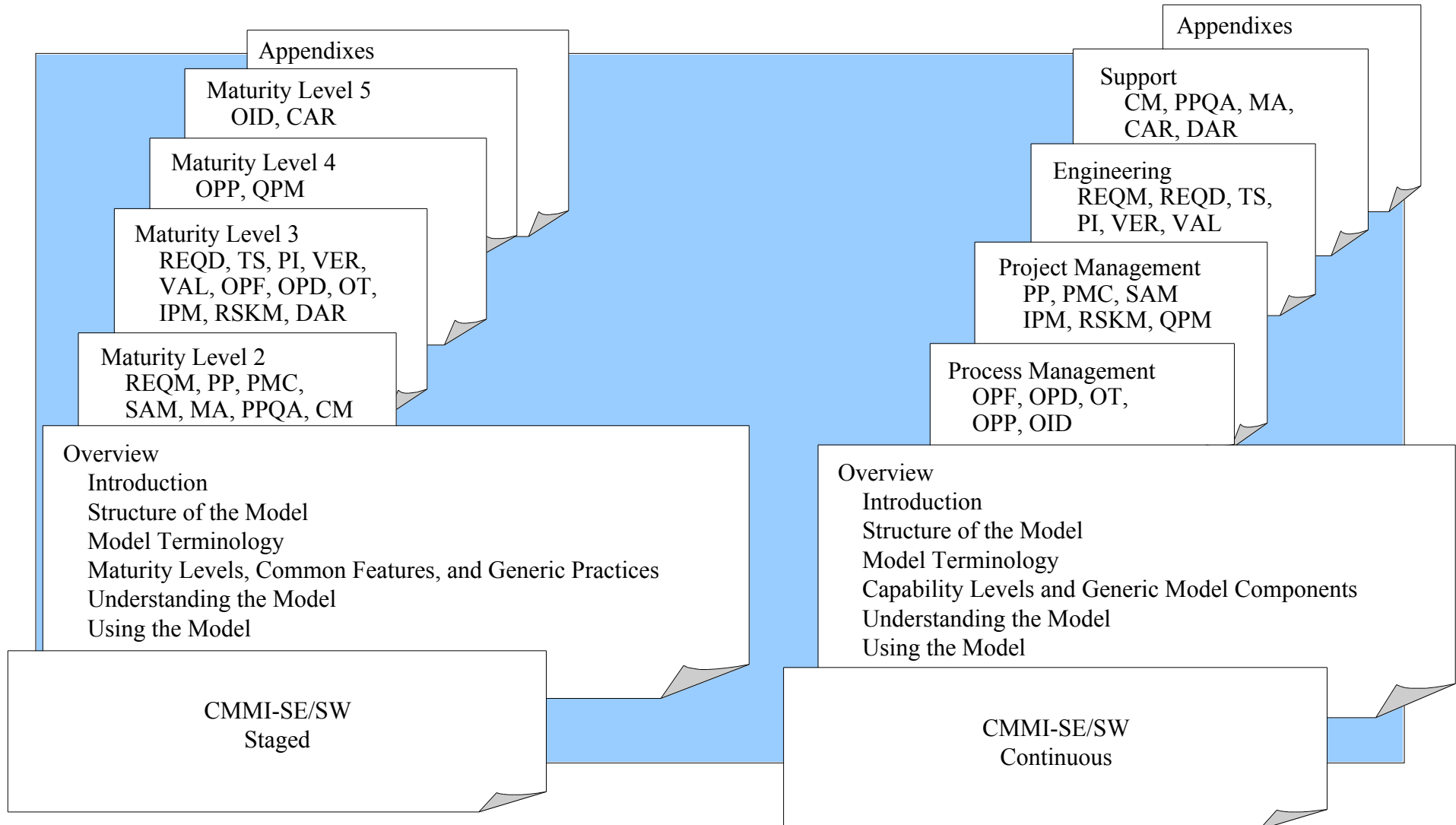
**Elaborations**



# Commonalities

**Both staged and continuous share ...**

- **Same process areas, goals, practices, and informative materials**
- **Elaborations of generic practices in process area context**
- **Amplifications by discipline**





# **CMMI-SE/SW Compared to SW-CMM v1.1**

**Organizations using SW-CMM v1.1 should be able to transition to CMMI by focusing on the following changes:**

- Measurement and Analysis at L2**
- Risk Management & Decision Analysis and Resolution at L3**
- Expansion of Software Product Engineering**
- Refocus of Measurement and Analysis CF to Directing Implementation CF**

**Most SW-CMM v2 Draft C updates have been incorporated**



# **CMMI-SE/SW Compared to SECM**

**EIA 731 users should be able to transition to the CMMI-SE/SW model by recognizing:**

- **Continuous representation (+ “equivalent” staged representation)**
- **Some lower-level differences**
- **Application of common SE/SW practices to SE community**

**Integrated Product and Process Development (IPPD) will be added.**

- **Integrated Team, and Organizational Environment for Integration**



# Methods and Training

## Assessment methods

- **Comprehensive SCAMPI**
  - (Standard CMMI Assessment Method for Process Improvement)
- **ARC (Assessment Requirements for CMMI) defines classess of CMMI assessment method**

## Training support

- **Course development and delivery**
- **Model and method**



# Classes of Assessment Methods

## **Class A:**

- **Comprehensive method**
- **Thorough model coverage**
- **Provides maturity level**

## **Class B:**

- **Less comprehensive, less expensive**
- **Initial, partial, self-assessment**
  - **Focus on areas needing attention**
- **No maturity level rating**

## **Class C:**

- **Quick look**
- **Checking for specific risk areas**
- **Inexpensive, little training needed**



# **Standard CMMI Assessment Method for Process Improvement (SCAMPI)**

**Based on CMM<sup>®</sup>-Based Appraisal for Process  
Improvement (CBA IPI) and EIA IS 731 Appraisal Method**

**Satisfies all ARC requirements**

**Must be led by authorized SCAMPI Lead Assessor**

**Tailorable to organization and model scope**

**Artifacts:**

- **SCAMPI Method Description**
- **CMMI Appraisal Questionnaire, work aids, templates**



# Value of Alternative Assessment Approaches

**CMMI models pose a challenge to current assessment methods given the:**

- **expanded (and expanding) model scope**
- **need for adequate rigor**
- **need for a reasonable-length on-site period**

**Alternative assessment methods may require changes to ARC**

**Linkage as part of “assessment product suite”**



# Coupling CMMI with the International SPICE trials

**Mapping and translation of CMMI**

**Pilot assessments in Australia first to produce  
15504 Process Profiles**

**Integrating future CMMI assessments with 5504  
trials**



# Mapping and Translation of CMMI to ISO/IEC 15504

**CMMI functional requirement 3.1.6: *The CMMI Product Suite shall be consistent and compatible with ISO/IEC 15504***



# Demonstration of Conformance

## For CMMI, v1.0 ...

- **To be completed in 4th quarter 2000**
- **Mapping of CMMI ISO/IEC 15504 TR, part 2**
  - **Currently dependent on informative materials**
  - **Many-to-one mappings from CMMI**
- **Mapping & translation being prepared collaboratively with Australian colleagues**

## For CMMI, v1.1 ...

- **Address 15504 mapping gaps identified in V1.0**
- **Publish demonstration of conformance as integral part of product suite**



# Risks in Establishing Conformance

## Mapping relationships is not a simple task

- **Lack of clarity and ambiguity remains in both 15504 and CMMI**
  - **Difficulty in mapping due to uncertainty in meaning of text**
- **Compounded by lack of familiarity by many mappers with both 15504 and CMMI**
  - **Insufficient contextual knowledge of one or the other**
- **Requires iterative validation cycle**



# Today's Talk

## CMMI Background

## Impact of process improvement: a brief review

## The product suite



## Test and evaluation in CMMI

- The results so far
- What's next?
- Coupling CMMI test and evaluation with the International SPICE trials



# Why Do Test & Evaluation for CMMI?

**Objectively evaluate product quality as delivered**

- **What works well or poorly?**

**Inform product revision & development choices**

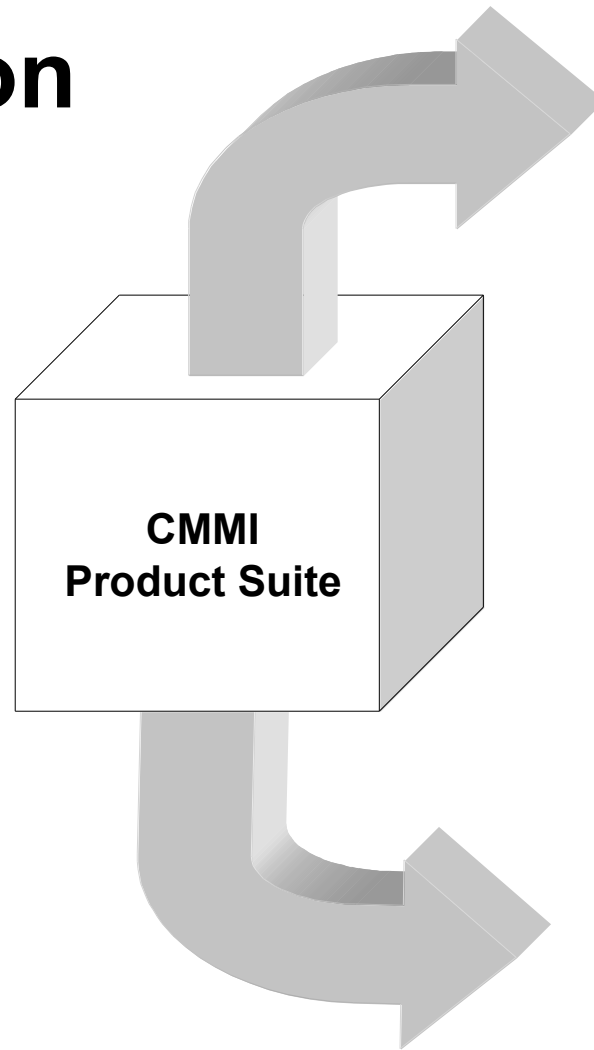
- **Continuing support for improvement of CMMI product suite during sustainment**

**Support transition and adoption of product suite**

- **Integrate test & evaluation into CMMI project management**



# Phase 1 Test & Evaluation



## Verification

**Does the CMMI Product Suite Meet Specifications?**

## Validation

**CMMI Product Suite:**

- Usability?
- Value Added?
- Correctness?
- Robustness?



# What Have We Learned So Far?

## Product value

- **Considerable value added reported by appraisers, sponsors, and other organizational participants**

## Areas for improvement

- **Recurring problems observed and reported by appraisers and organizational participants**
  - **Some addressed prior to release of v1.0**
  - **Others targeted for further improvement**

## Improvements to the product suite are helping

- **As seen in last of the initial pilots**



# Progress Made So Far?

**Improvements made during development and revision of the product suite**

**Verification that CMMI product suite satisfactorily meets its functional requirements**

- **Deployment risk analysis completed**
  - **Based on product inspections, test & evaluation**
  - **Risk items traceable to CMMI requirements (A-spec)**
  - **Rated for priority and severity**
- **Independent review of risk analysis prior to release of v1.0**



# How Was It Done? Inspection and Review

**Numerous change requests from external stakeholders and public review**

- **Documented in ...**
  - **PA revision logs**
  - **IPT working documents**
- **Used by PDT for product revision**

**Feedback from “focus groups” associated with training and other events**

**Inspection of product suite by PDT**

- **Delivered products**
- **Framework (implementation code & input content)**



# How Was It Done?

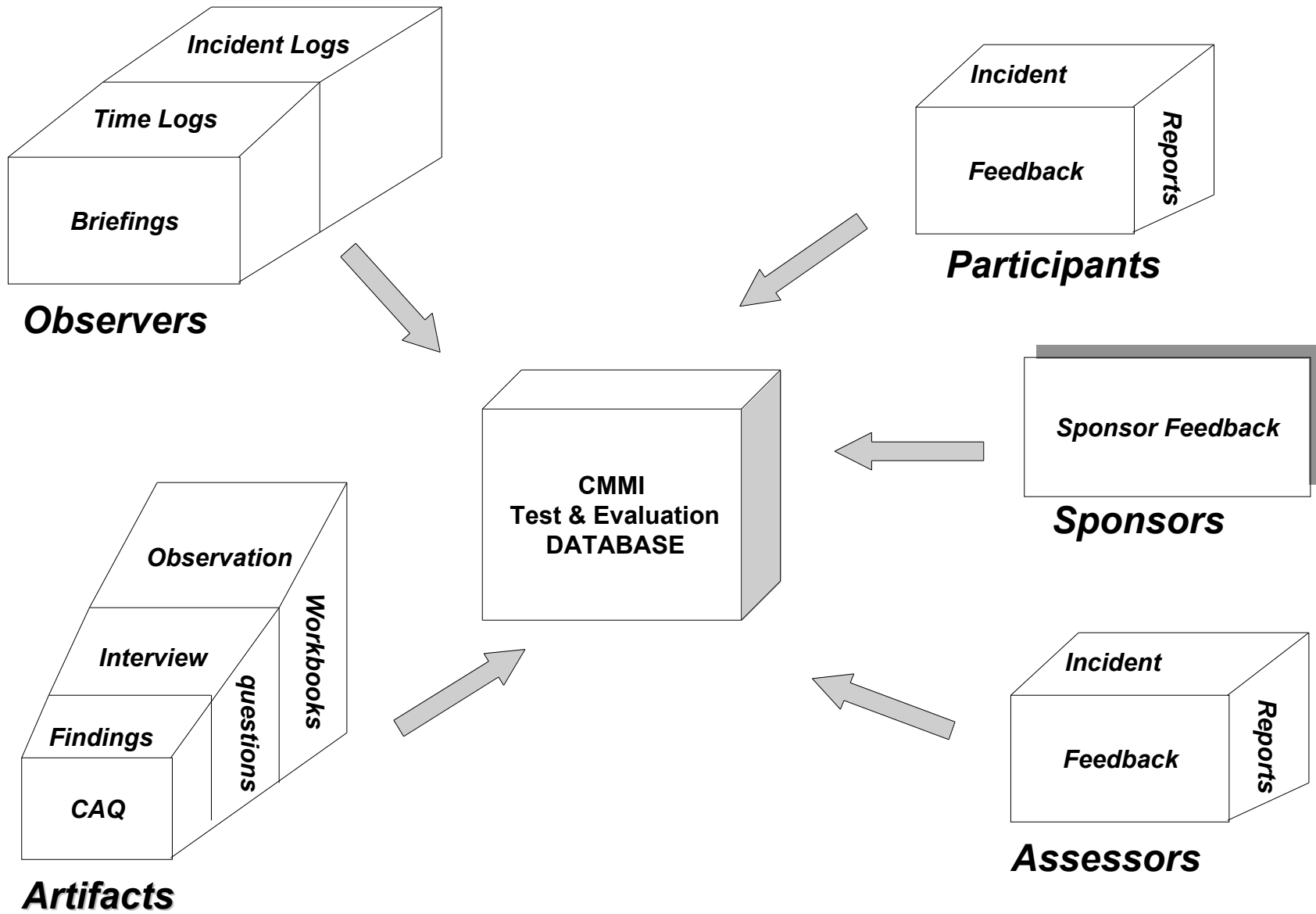
## Initial Pilot Appraisals

### **Eight “use cases” prior to release of v1.0**

- **Covering systems engineering and software disciplines, staged and continuous representations, varying organizational maturity**
- **Supported by observer teams using structured observation procedures**

### **Evidence collected includes**

- **Incident reports and briefings by observer teams**
- **Incident reports completed by appraisal team members**
- **End of appraisal feedback forms completed by appraisers and organization participants**
- **Assessment artifacts**





# What Changes Have Been Made?

**High risk items addressed prior to release of v1.0, e.g.**

- **Number of model practices reduced by ~15%**
  - **Combined with changes meant to improve clarity**
- **Enhanced method guidance, including ...**
  - **Appraisals using the continuous representation**
  - **Breadth first appraisal of generic practices**
  - **Similar change to CMMI Appraisal Questionnaire**
- **Automated tool support for consolidation of appraisal observations**
- **Improvements to CMMI Appraisal Questionnaire**
  - **Automated generation of response summaries**
  - **Guidance on completion, selecting respondents, and handling local organizational terminology**



# Observations from the Pilots -1

**Problems understanding intended meaning as written**

- **PA's**
- **Generic practices / common features**

**Apparent redundancy / confusion about linkage**

- **Among some PA's**
- **Between some PA's and GP's**

**Difficulty relating lower capability levels to higher maturity level PA's**

**Concern that some specific practices may not map well to their respective goals**



# Observations from the Pilots -2

## Difficulties encountered ...

- **Appraising generic practices/common features**
- **Applying rules of consolidation**
- **Scripting interview questions, “listen fors,” and “look fors”**
- **Crafting observations**
- **Mapping the model to the organization and its practices**
- **Integrating systems and software perspectives in some organizations**



# Observations from the Pilots -3

## Concerns with model terminology

### Inconsistent training delivery, e.g. ...

- **Abbreviated time**
- **Exercises rushed or omitted**
- **Varying use of reminders and other work aids**



# The Bottom Line About Appraisal Effort

**Initial pilots took considerable effort**

**And were judged worth the effort**



# Proposed Change in Focus for CMMI Test & Evaluation

## Phase 1:

- **Verification of functional requirements (A-spec) for CMMI product suite**

## Phase 2:

- **Validation and continuous improvement**
  - Model framework, architecture, & content
  - Appraisal method
  - Training
  - Long term impact & ROI of process improvement
- **Measuring performance to ...**
  - Aid in refining CMMI product suite
  - Provide valid, useful results to the community
- **Evaluating adoption strategies**



# Phase 2 Approach

**Broad based feedback about the product suite**

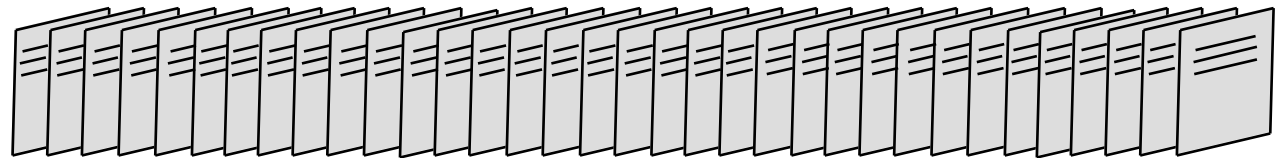
**In-depth studies focusing on critical issues**



# Phase 2 Strategy

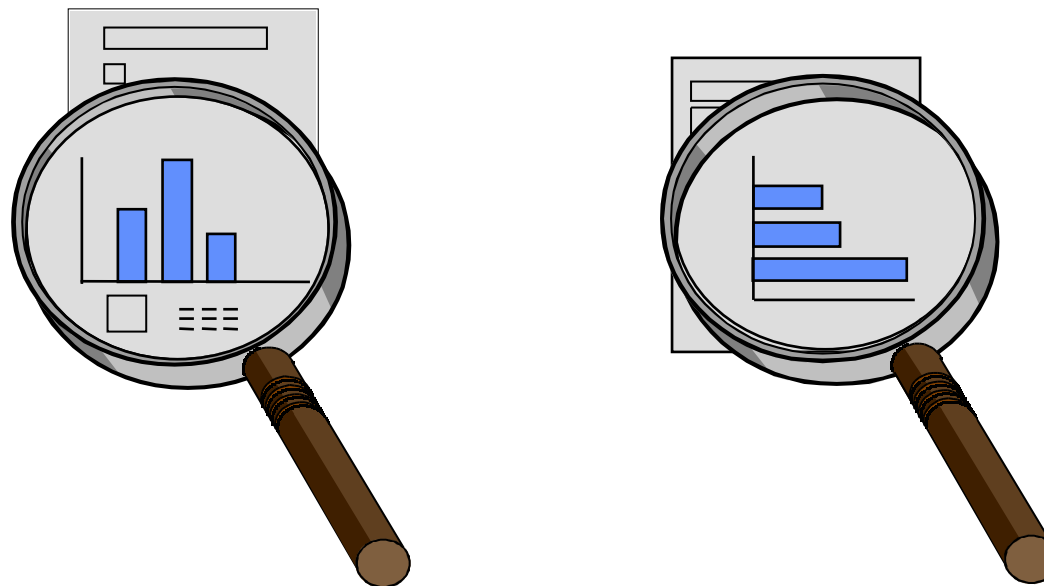
**Broad based community feedback on usage of products**

**Automated  
community  
based  
data collection**



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**Focused designed studies for identified critical Issues**





# Contact

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# Back Pocket Slides

**Follow here ...**



# Broad Based Feedback

**Standard feedback from many more cases ...**

- **Building on current CBA IPI & PAIS feedback & reporting mechanisms**
  - **Similar also to International SPICE trials of ISO/IEC 15504**
- **Provides more confidence in generalizability of results**
- **Supports more informative comparative analyses**
  - **E.g., by varying model scope, method activities, appraiser background, and organizational characteristics**

**CR's from public review**

- **From document review, test, & deployed use of CMMI v1.0**



# In-Depth Studies -1

## **In-depth pilot appraisals as necessary ...**

- **Need detailed cases on early use of v1.0**
- **Also important to get more detail as new disciplines are added, e.g., acquisition**
- **With emphasis on fidelity to enactment of the appraisal method**
  - **And commitment to clearly established processes**



# In-Depth Studies -2

**Custom designed studies and analyses as appropriate, including ...**

- **Pilot cases of process improvement beyond appraisals**
- **Ways of improving specific aspects of the product suite, e.g.**
  - **CMMI Appraisal Questionnaire**
  - **Other specific appraisal processes, activities, or tool support**
  - **Training design and delivery**
  - **Model structure and content**



# Sources of Data

- **Participants in CMMI appraisals**
- **Legacy users**
  - **731 and CMM**
- **Other experts, e.g.**
  - **iCMM and ISO/IEC 15504**
  - **SDCE and SCE**
- **Broader software and systems engineering communities, including non defense**



# Evolving Policy

**The CMMI Steering Group has established the schedule for the sunset period of the legacy models (i.e., SW-CMM V1.1, EIA IS 731) to be three years after release of the CMMI-SE/SW/IPPD Version 1.0 Product Suite.**

**A subsequent release, Version 1.1, is planned one year later to provide additional refinement and update based on the continuing CMMI pilot program.**



SW-CMM v1.1



CMMI -1

**LEVEL 2 (MANAGED)**

**Requirements Management**  
**Software Project Planning**  
**Software Project Tracking &**

**Software Subcontract Management**  
**Software Quality Assurance**  
**Assurance**

**Software Configuration Management**

**Requirements Management**  
**Project Planning**  
**Project Monitoring and Control Oversight**

**Supplier Agreement Management**  
**Process & Product Quality**

**Configuration Management**  
**Measurement and Analysis**



# SW-CMM v1.1 → CMMI -2

## LEVEL 3 (DEFINED)

Organization Process Focus  
Organization Process Definition  
Training Program  
Integrated Software Management

Organizational Process Focus  
Organizational Process Definition  
Organizational Training  
Integrated Project Management

Software Product Engineering

Risk Management  
Requirements Development

Technical Solution  
Product Integration

Intergroup Coordination  
Peer Reviews

Verification  
Validation  
Decision Analysis and Resolution






# SW-CMM v1.1 CMMI -3

## LEVEL 4 (QUANTITATIVELY MANAGED)

Quantitative Process Management  Organizational Process Performance  
Software Quality Management  Quantitative Project Management

## LEVEL 5 (OPTIMIZING)

Defect Prevention  Causal Analysis and Resolution  
Technology Change Management  Organizational Innovation and  
Process Change Management  Deployment



SW-CMM v1.1 Common Features	CMMI Common Features
Commitment to Performance	Commitment to Performance
Establish an Organizational Policy	Establish an Organizational Policy
Ability to Perform	Ability to Perform
Provide Resources	Plan the Process
Assign Responsibility	Provide Resources
Train People	Assign Responsibility
Activities Performed	Train People
Plan the Process	(Specific Practices)
Perform the Process	
Monitor and Control the Process	
	Directing Implementation
	Identify & Involve Rel. Stakeholders
	Manage Configurations
	Monitor and Control the Process
	Collect Improvement Information
Measurement & Analysis	Expanded in the Measurement and Analysis PA
Measure the Process	
Analyze the Measurements	
Verifying Implementation	Verifying Implementation
Review with Org. Management	Review Status w/ Higher Level Mgt
Review with Project Management	
Objectively Verify Adherence	Objectively Evaluate Adherence

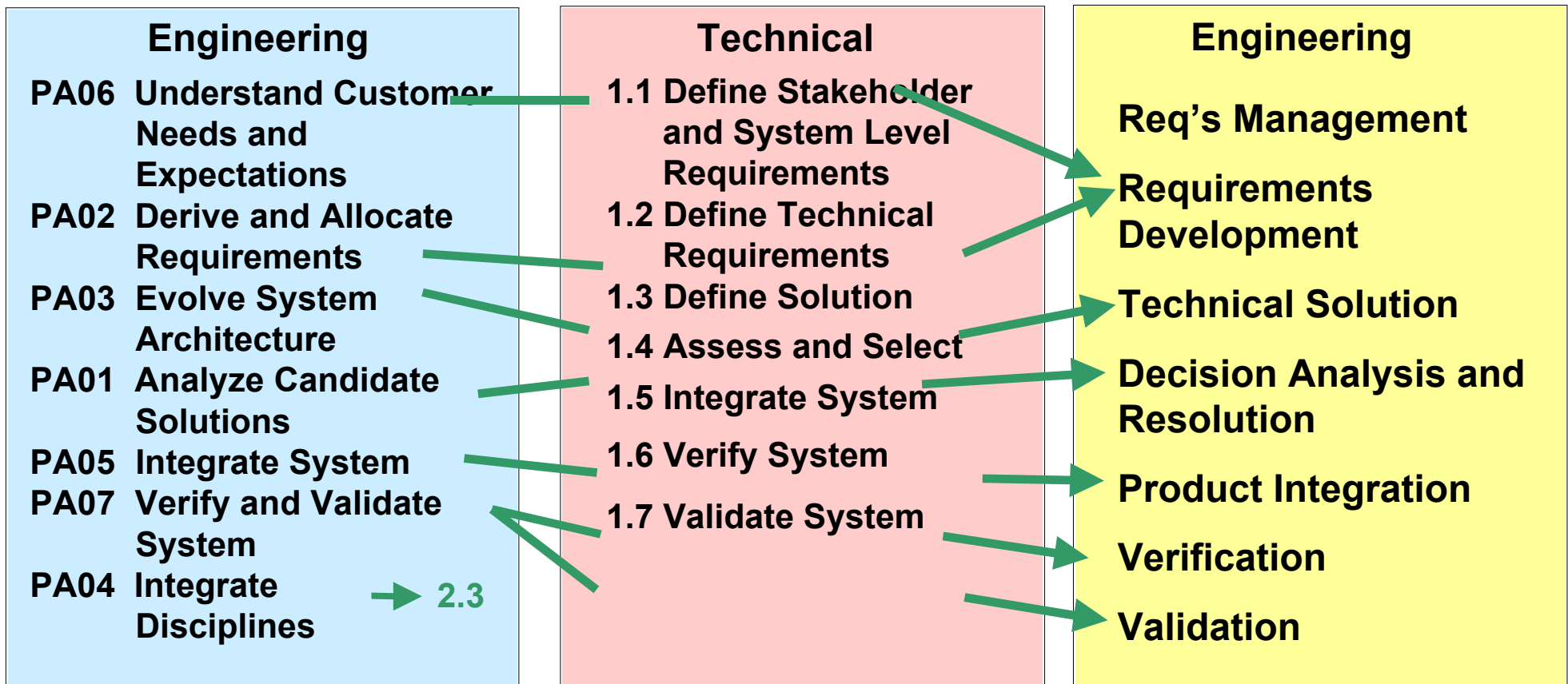


# Comparison of Elements -1

## SE-CMM

## SECM

## CMMI



This graphic courtesy of Software Productivity Consortium

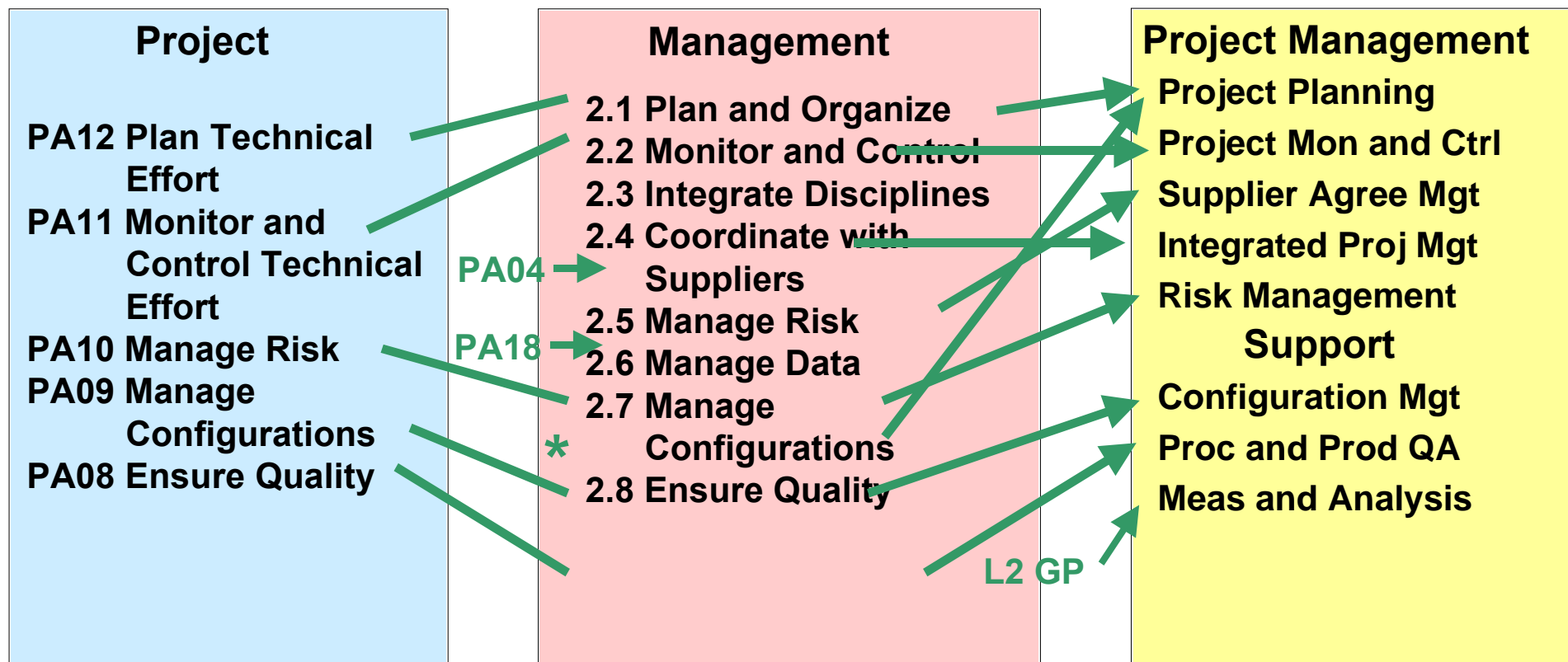


# Comparison of Elements -2

## SE-CMM

## SECM

## CMMI



\* Not in SE-CMM

This graphic courtesy of Software Productivity Consortium

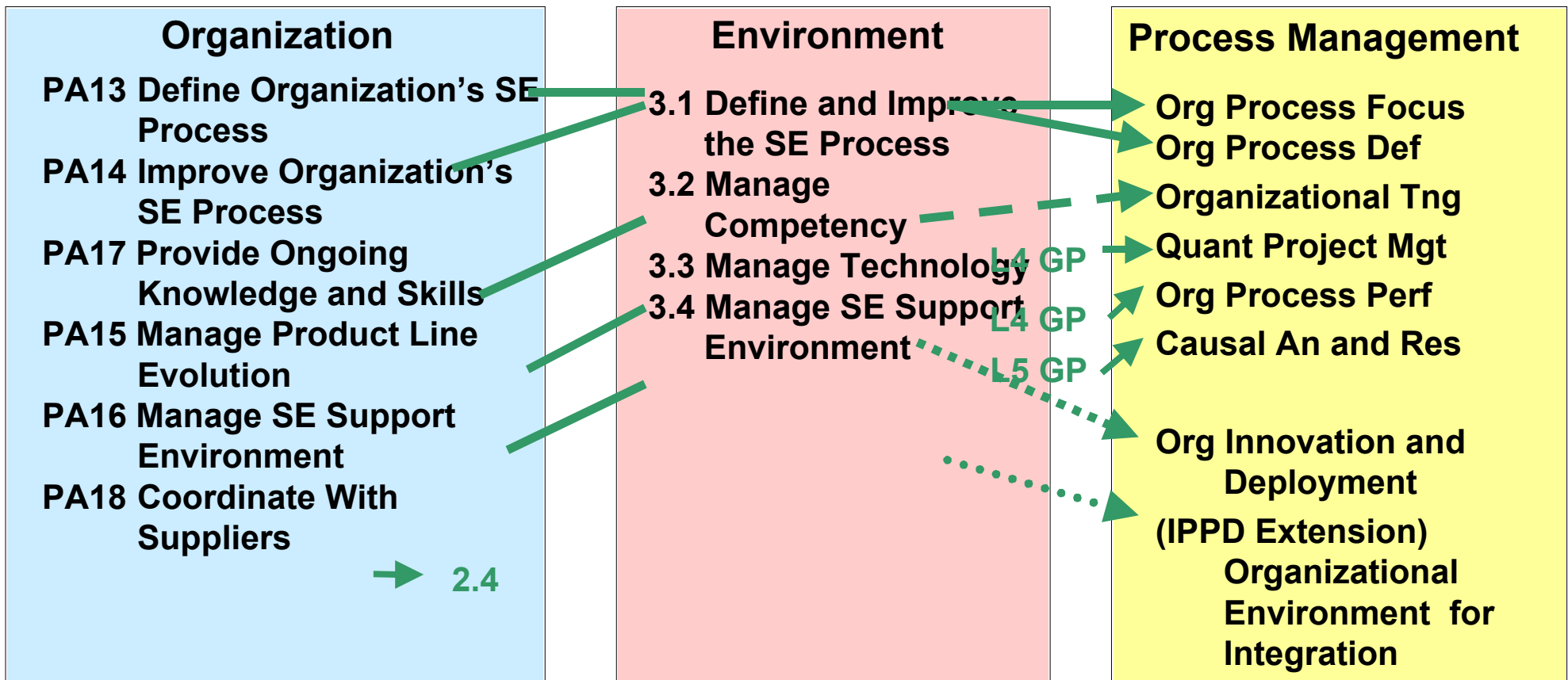


# Comparison of Elements -3

## SE-CMM

## SECM

## CMMI



This graphic courtesy of Software Productivity Consortium