CMMI for Development

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Software CMM v2 Release Halted

In October 1997, SEI's sponsor, the Office of the Under Secretary of Defense for Acquisition and Technology, directed that the Software CMM Version 2 release be halted in favor of work on CMM Integration.

One of the source documents for CMMI is Software CMM v2C.

CMM "Integration"

Capability Maturity Model Integration originally addressed

- **software engineering**
  - **Software CMM v2 Draft C**
- **systems engineering**
  - **EIA/IS 731 (Systems Engineering Capability Model)**
- **integrated process and product development**
  - **Integrated Product Development CMM v0.98**
  - **IPPD disappeared between CMMI-DEV v1.2 and v1.3**
  - **"IPPD" and "integrated process and product development" do not appear in v1.3**
- **sourcing selection (acquisition)**
  - **inferentially Software Acquisition CMM v1**
  - **acquisition was spun back out as a separate constellation: CMMI for Acquisition**

Two Perspectives

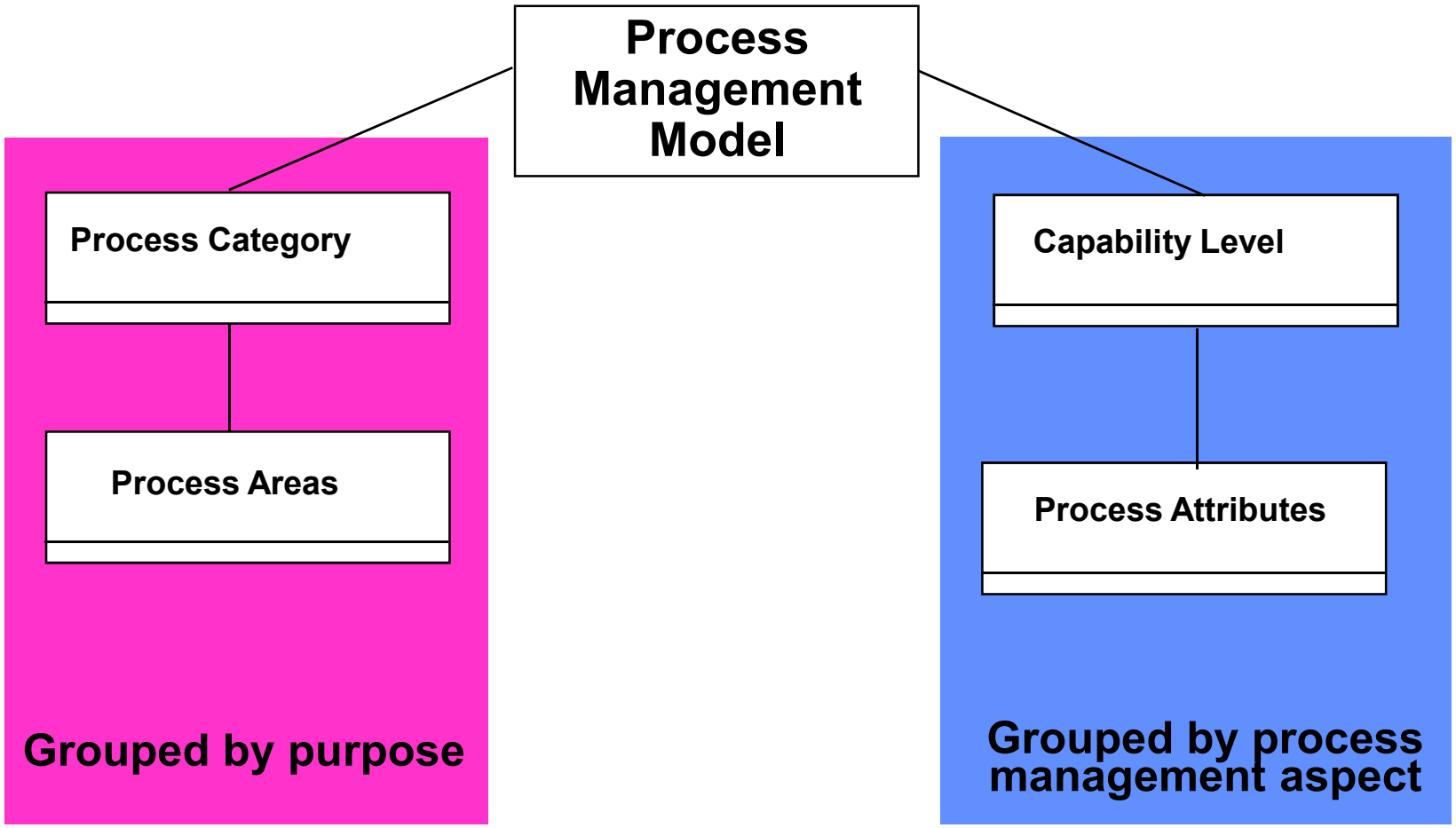
A "staged" architecture, e.g., the Software CMM

- **focuses on building organizational capability**
- **identifies the vital few issues to focus on**
- **describes a roadmap for process improvement**

A "continuous" architecture, e.g., ISO 15504

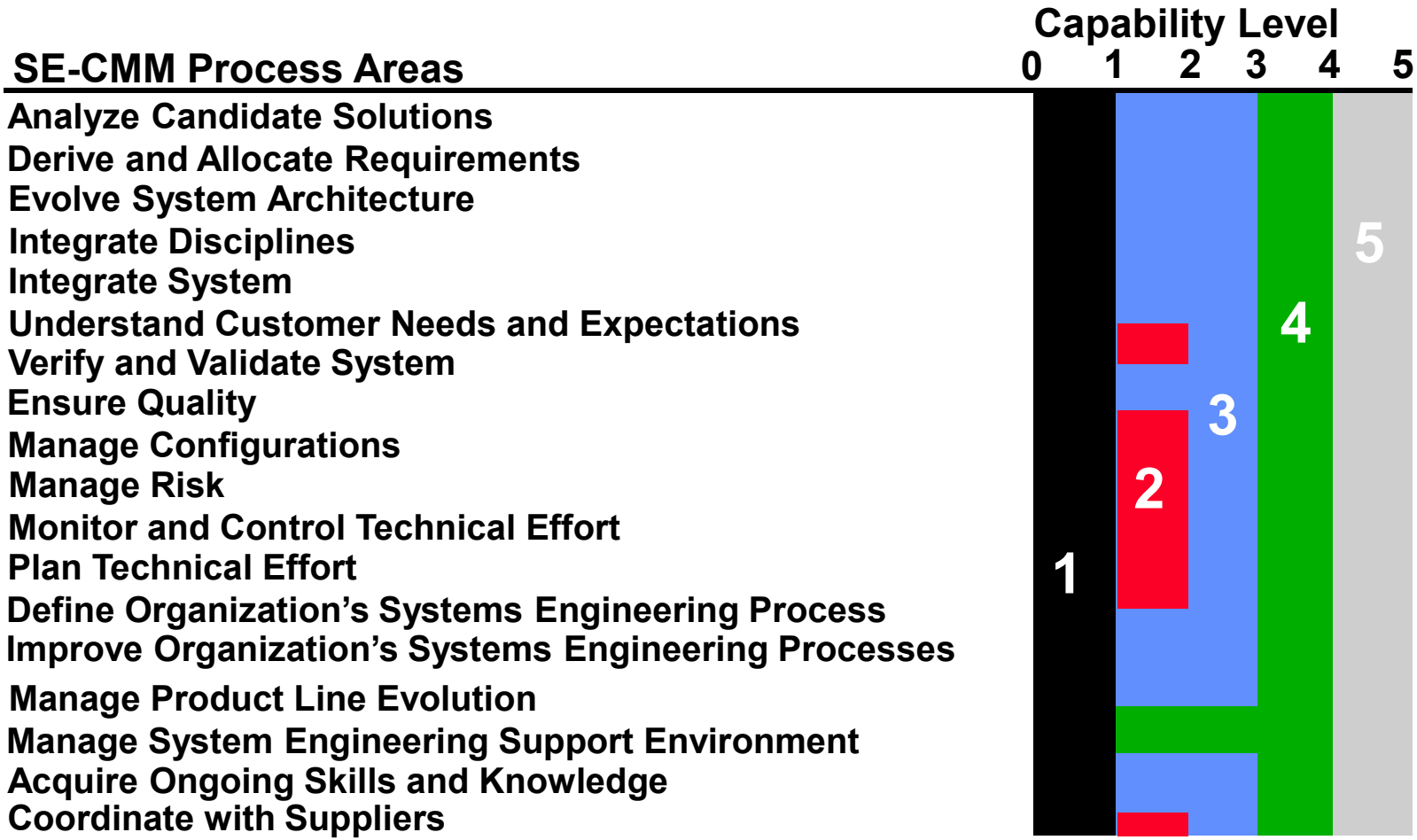
- **focuses on building process capability**
- **provides a reference model for rating processes**
- **describes the terrain of process management**

ISO 15504 Continuous Architecture



Mapping Maturity Levels Onto Systems Engineering CMM v1.1

(Paulk 1999)



Capability Dimension

Generic practices or process attributes

Six capability levels

- **level 0 = incomplete**
- **level 1 = performed**
- **level 2 = managed**
- **level 3 = established**
- **level 4 = predictable**
- **level 5 = optimizing**

1995 ISO/IEC 15504-2

Capability Level 1: Performed-Informally

Common Feature 1.1: Performing Base Practices

- GP 1.1.1 Perform the process.

Capability Level 2: Planned-and-Tracked

Common Feature 2.1: Planning Performance

- GP 2.1.1 Allocate resources.
- GP 2.1.2 Assign responsibilities.
- GP 2.1.3 Document the process.
- GP 2.1.4 Provide tools.
- GP 2.1.5 Ensure training.
- GP 2.1.6 Plan the process.

Common Feature 2.2: Disciplined Performance

- GP 2.2.1 Use plans, standards, and procedures.
- GP 2.2.2 Do configuration management.

Common Feature 2.3: Verifying Performance

- GP 2.3.1 Verify process compliance.
- GP 2.3.2 Audit work products.

Common Feature 2.4: Tracking Performance

- GP 2.4.1 Track with measurement.
- GP 2.4.2 Take corrective action.

Capability Level 3: Well-Defined

Common Feature 3.1: Defining a Standard Process

- GP 3.1.1 Standardize the process.
- GP 3.1.2 Tailor the standard process.

Common Feature 3.2: Performing the Defined Process

- GP 3.2.1 Use a well-defined process.
- GP 3.2.2 Perform peer reviews.
- GP 3.2.3 Use well-defined data.

Capability Level 4: Quantitatively-Controlled

Common Feature 4.1: Establishing Measurable Quality Goals

- GP 4.1.1 Establish quality goals.

Common Feature 4.2: Objectively Managing Performance

- GP 4.2.1 Determine process capability.
- GP 4.2.2 Use process capability.

Capability Level 5: Continuously-Improving

Common Feature 5.1: Improving Organizational Capability

- GP 5.1.1 Establish process effectiveness goals.
- GP 5.1.2 Continuously improve the standard process.

Common Feature 5.2: Improving Process Effectiveness

- GP 5.2.1 Perform causal analysis.
- GP 5.2.2 Eliminate defect causes.
- GP 5.2.3 Continuously improve the defined process.

Comparing CMMI Capability and Maturity Levels

Level	Continuous Representation Capability Levels	Staged Representation Maturity Levels
0	Incomplete	---
1	Performed	Initial
2	Managed	Managed
3	Defined	Defined
4	---	Quantitatively Managed
5	---	Optimizing

CMMI-DEV v1.3

	Process Management	Project Management	Engineering	Support
ML5	Organizational Performance Management			Causal Analysis and Resolution
ML4	Organizational Process Performance	Quantitative Project Management		
ML3	Organizational Process Focus Organizational Process Definition Organizational Training	Integrated Project Management Risk Management	Requirements Development Technical Solution Product Integration Verification Validation	Decision Analysis and Resolution
ML2		Project Planning Project Monitoring and Control Requirements Management Supplier Agreement Management		Configuration Management Process and Product Quality Assurance Measurement and Analysis

CMMI-DEV v1.3

Level	Process Characteristics	Process Areas
5 Optimizing	*Focus is on quantitative continuous process improvement*	Causal Analysis & Resolution Organizational Performance Management
4 Quantitatively Managed	*Process is measured and controlled*	Organizational Process Performance Quantitative Project Management
3 Defined	*Process is characterized for the organization and is proactive*	Requirements Development Technical Solution Product Integration Verification Validation Organizational Process Focus Organization Process Definition Organizational Training Integrated Project Management Risk Management Decision Analysis & Resolution
2 Managed	*Process is characterized for projects and is often reactive*	Requirements Management Project Planning Project Monitoring & Control Supplier Agreement Management Product & Process Quality Assurance Configuration Management Measurement & Analysis
1 Initial	*Process is unpredictable, poorly controlled, and reactive*	

Required, Expected, and Informative

Specific and generic goals are required to satisfy a process area / capability level / maturity level.

- **52 Specific Goals**

Specific and generic practices are expected.

- **alternative practices could be implemented that are equally effective in achieving the intent of the associated goals**

- **177 Specific Practices**

Supplementary information, subpractices, etc., are informative.

- **650 page CMMI-DEV book (Chrissis 2011)**

A Performed Process and the Level 1 Generic Practice

A performed process is a process that accomplishes the work necessary to satisfy the specific goals of a process area.

GG 1 Achieve Specific Goals

GP 1.1 Perform Specific Practices

A Managed Process

A managed process is a performed process that is

- **planned and executed in accordance with policy;**
- **employs skilled people having adequate resources to produce controlled outputs;**
- **involves relevant stakeholders;**
- **is monitored, controlled, and reviewed; and**
- **is evaluated for adherence to its process description.**

Level 2 Generic Practices

GG 2 Institutionalize a Managed Process

GP 2.1 Establish an Organizational Policy
GP 2.2 Plan the Process
GP 2.3 Provide Resources
GP 2.4 Assign Responsibility
GP 2.5 Train People
GP 2.6 Control Work Products
GP 2.7 Identify and Involve Relevant Stakeholders
GP 2.8 Monitor and Control the Process
GP 2.9 Objectively Evaluate Adherence
GP 2.10 Review Status with Higher Level Management

CMMI-DEV v1.3 ML2

Requirements Management	**REQM**
Project Planning	**PP**
Project Monitoring & Control	**PMC**
Supplier Agreement Management	**SAM**
Process & Product Quality Assurance	**PPQA**
Configuration Management	**CM**
Measurement & Analysis	**MA**

Requirements Management

Manage the requirements of the project's products and product components and to ensure alignment between those requirements and the project's plans and work products.

Specific Goals

1) **Manage requirements.**

Project Planning

Establish and maintain plans that define project activities.

Specific Goals

1) **Establish estimates.**
2) **Develop a project plan.**
3) **Obtain commitment to the plan.**

Project Monitoring & Control

Provide an understanding of the project's progress so that appropriate corrective actions can be taken when the project's performance deviates significantly from the plan.

Specific Goals

1) **Monitor the project against the plan.**
2) **Manage corrective action to closure.**

Supplier Agreement Management

Manage the acquisition of products and services from suppliers.

Specific Goals

1) **Establish supplier agreements.**
2) **Satisfy supplier agreements.**

Process & Product Quality Assurance

Provide staff and management with objective insight into processes and associated work products.

Specific Goals

1) **Objectively evaluate processes and work products.**
2) **Provide objective insight.**

Note that product quality assurance, as described in PPQA, is against applicable process descriptions, standards, and procedures. It is not against requirements. Practices in the Verification process area ensure that specified requirements are satisfied.

Configuration Management

Establish and maintain the integrity of work products using configuration identification, configuration control, configuration status accounting, and configuration audits.

Specific Goals

1) **Establish baselines.**
2) **Track and control changes.**
3) **Establish integrity.**

CMMI-DEV v1.3 Support – Level 2 MA

Measurement & Analysis

Develop and sustain a measurement capability used to support management information needs.

Specific Goals

1) **Align measurement and analysis activities.**
2) **Provide measurement results.**

A Defined Process and the Level 3 Generic Practices

A defined process is a managed process that is

- **tailored from the organization's set of standard processes according to the organization's tailoring guidelines;**
- **has a maintained process description; and**
- **contributes process related experiences to the organizational process assets.**

GG 3 Institutionalize a Defined Process

GP 3.1 Establish a Defined Process

GP 3.2 Collect Process Related Experiences

CMMI-DEV v1.3 ML3

Requirements Development	**RD**
Technical Solution	**TS**
Product Integration	**PI**
Verification	**VER**
Validation	**VAL**
Organizational Process Definition	**OPD**
Organizational Process Focus	**OPF**
Organizational Training	**OT**
Integrated Project Management	**IPM**
Risk Management	**RSKM**
Decision Analysis & Resolution	**DAR**

Requirements Development

Elicit, analyze, and establish customer, product, and product component requirements.

Specific Goals

1) **Develop customer requirements.**
2) **Develop product requirements.**
3) **Analyze and validate requirements.**

Technical Solution

Select, design, and implement solutions to requirements. Solutions, designs, and implementations encompass products, product components, and product-related lifecycle processes either singly or in combination as appropriate.

Specific Goals

1) **Select product component solutions.**
2) **Develop the design.**
3) **Implement the product design.**

Product Integration

Assemble the product from the product components, ensure that the product, as integrated, behaves properly (i.e., possesses the required functionality and quality attributes), and deliver the product.

Specific Goals

1) **Prepare for product integration.**
2) **Ensure interface compatibility.**
3) **Assemble product components and deliver the product.**

Verification

Ensure that selected work products meet their specified requirements.

Specific Goals

1) **Prepare for verification.**
2) **Perform peer reviews.**
3) **Verify selected work products.**

Note that IEEE 610-1990 defined verification as "The process of evaluating a system or component to determine whether the products of a given development phase satisfy the conditions imposed at the start of that phase."

Validation

Demonstrate that a product or product component fulfills its intended use when placed in its intended environment.

Specific Goals

1) **Prepare for validation.**
2) **Validate product or product components.**

Note that validation is against "intended use.. in its intended environment" rather than against the requirements. IEEE 610-1990 defined validation as "The process of evaluating a system or component during or at the end of the development process to determine whether it satisfies specified requirements."

Organizational Process Focus

Plan, implement, and deploy organizational process improvements based on a thorough understanding of current strengths and weaknesses of the organization's processes and process assets.

Specific Goals

1) **Determine process improvement opportunities.**
2) **Plan and implement process actions.**
3) **Deploy organizational process assets and incorporate experiences.**

Organizational Process Definition

Establish and maintain a usable set of organizational process assets, work environment standards, and rules and guidelines for teams.

Specific Goals

1) **Establish organizational process assets.**

The process assets include:

- **Standard Processes**
- **Lifecycle Model Descriptions**
- **Tailoring Criteria and Guidelines**
- **Measurement Repository**
- **Process Asset Library**
- **Work Environment Standards**
- **Rules and Guidelines for Teams**

Organizational Training

Develop skills and knowledge of people so they can perform their roles effectively and efficiently.

Specific Goals

1) **Establish an organizational training capability.**
2) **Provide training.**

CMMI-DEV v1.3 Project Management – Level 3 IPM

Integrated Project Management

Establish and manage the project and the involvement of the relevant stakeholders according to an integrated and defined process that is tailored from the organization's set of standard processes.

Specific Goals

- **Use the project's defined process.**
- **Coordinate and collaborate with relevant stakeholders.**

Risk Management

Identify potential problems before they occur so that risk handling activities can be planned and invoked as needed across the life of the product or project to mitigate adverse impacts on achieving objectives.

Specific Goals

1) **Prepare for risk management.**
2) **Identify and analyze risks.**
3) **Mitigate risks.**

Decision Analysis & Resolution

Analyze possible decisions using a formal evaluation process that evaluates identified alternatives against established criteria.

Specific Goals

1) **Evaluate alternatives.**

CMMI-DEV v1.3 ML4
Quantitatively Managed

Organizational Process Performance	**OPP**
Quantitative Project Management	**QPM**

Organizational Process Performance

Establish and maintain a quantitative understanding of the performance of selected processes in the organization's set of standard processes in support of achieving quality and process performance objectives, and to provide process performance data, baselines, and models to quantitatively manage the organization's projects.

Specific Goals

1) **Establish performance baselines and models.**

Quantitative Project Management

Quantitatively manage the project to achieve the project's established quality and process performance objectives.

Specific Goals

1) **Prepare for quantitative management.**
2) **Quantitatively manage the project.**

CMMI-DEV v1.3 ML5
Optimizing

Causal Analysis & Resolution **CAR**

Organizational Performance Management **OPM**

Organizational Performance Management

Proactively manage the organization's performance to meet its business objectives.

Specific Goals

1) **Manage business performance.**
2) **Select improvements.**
3) **Deploy improvement.**

CMMI-DEV v1.3 Support – Level 5 CAR

Causal Analysis & Resolution

Identify causes of selected outcomes and take action to improve process performance.

Specific Goals

1) **Determine causes of selected outcomes.**
2) **Address causes of selected outcomes.**

"Defects" in CMMI v1.2 became "selected outcomes."

CMMI Complexity

From Joe Zec's review of Practical Insight into CMMI: The Look and Feel of a Successful Implementation by Tim Kasse (2004), published in ASQ Software Quality Professional, June 2005, page 42.

"One thing the book unintentionally reveals is the enormous complexity of the CMMI. The number of process areas, goals, and practices is truly staggering. One can't help but wonder if the CMMI is in danger of collapsing under its own weight. But this is all the more reason to add a book like this to one's reference shelf."

Outside the Scope of CMMI

Currently three constellations

- **Development**
- **Services**
- **Acquisition**

Other useful CMMs include

- **People**
- **Systems Security Engineering**
- **…**

Various frameworks capture knowledge beyond the scope of CMMI as well as implementation oriented concerns.

Beyond CMMI

M.C. Paulk and M.D. Konrad, "Software Horizons: What's Beyond CMMI?" Software Engineering Process Group (SEPG) North America Conference, March 2012.

- **attention chain for knowledge work**
- **growth mindset**
- **team performance**
- **expert intuition**
- **rational decision making**
- **creativity, innovation, and weird ideas that work**
- **high reliability organizations**
- **Constantine's organizational paradigms**
- **Hofstede's national cultures model**
- **…**

Questions and Answers