An Introduction to CMMI

The CMMI Model
SEI Trademarks and Service Marks

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Agenda

- Why CMMI?
- What is CMMI?
- Where does it come from and fit into?
- How does it look like?
- What can you achieve?
**Improved Schedule and Budget Predictability**

*Results: Boeing Effort Estimation*

- Without Historical Data: Variance between +20% to -145% (Mostly Level 1 & 2)
- With Historical Data: Variance between -20% to +20% (Level 3)

(Based on 120 projects in Boeing Information Systems)

Improved Cycle Time

Project Cycle Times

Source: Software Engineering Div., Hill AFB, Published in Crosstalk May 1999
Increased Productivity and Quality

Productivity Rate and Quality Performance
* For Software Programs

Error Rate Per KLOC
Productivity Rate SLOC per Person Day
Level 2
Level 3
Level 4

Productivity Increased By 80% As Error Rates Decreased

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Why Base Your Organization’s Process Improvement Success on the CMMI?

First and foremost the emphasis is on developing processes and changing cultures to show a measurable benefit for the organization’s business objectives and vision.

Provides a framework from which to organize and prioritize engineering, people, and business activities.

Supports the coordination of multi-disciplined activities that may be required to successfully build a product or application.

Adds “Engineering Systems Thinking” back into building systems.
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CMMI Model

Integrates systems and software disciplines into one process improvement framework.

Provides a framework for introducing new disciplines as needs arise.

CMMI-SE/SW/IPPD/SS, V1.1
- Systems Engineering
- Software Engineering
- Integrated Product and Process Development
- Supplier Sourcing

Describes the WHAT? Not the HOW?
Bridging the Divide

- Systems engineering and software engineering processes are integrated.
- Integrates systems and software disciplines into one process improvement framework.
- Provides a framework for introducing new disciplines as needs arise.


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The CMM Explosion

The first CMM (CMM v1.0) was developed for software and released in August 1991.

Based on this success and the demand from other interests CMMs were developed for other disciplines and functions:

- Systems Engineering
- People
- Integrated Product Development
- Software Acquisition
- Software Quality Assurance
- Measurement
- Others......
World of Standards

http://www.software.org/quagmire/

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Fundamental Processes for Engineering a System

EIA - 632

Processes for Engineering A System

- **Acquisition and Supply**
  - Supply Process
  - Acquisition Process

- **Technical Management**
  - Planning Process
  - Assessment Process
  - Control Process

- **System Design**
  - Requirements Definition Process
  - Solution Definition Process

- **Product Realization**
  - Implementation Process
  - Transition to Use Process

- **Technical Evaluation**
  - Systems Analysis Process
  - Requirements Validation Process
  - System Verification Process
  - End Products Validation Process

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ISO 9001:2000 vs CMMI
ISO 9001:2000 vs CMMI

ISO 9001:2000

- No explicit requirements for
  - Institutionalization
  - Creating and maintaining organizational process assets
    - Organizational Measurement Repository
    - Database of good and best practices
- Misses details for the following process areas
  - Organizational Training (Lvl 3)
  - Risk Management (Lvl 3)
  - Decision Analysis and Resolution (Lvl 3)
  - Organization Process Performance (Lvl 4)
  - Quantitative Project Management (Lvl 4)
  - Organization Innovation and Deployment (Lvl 5)
  - Causal Analysis (Lvl 5)
The Support of CMMI to ISO 9001:2000

Organizations at the CMMI Maturity Level 3 will be ready for ISO 9001:2000 registration with minor adjustments.

Organizations registered as ISO 9001:2000 compliant will require additional effort to reach the CMMI Level 2 or 3.

- The CMMI path leverages the investment an organization may have in ISO 9001.
- Provides additional benefits especially in institutionalizing the engineering discipline.
- Takes an organization to the quantitative management level of process improvements.
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Comparing Model Representations

- For an established set of process areas across an organization
- For a single process area or a set of process areas
CMMI Model Structure

**Staged**

- **Maturity Levels**
  - Process Area 1
  - Process Area 2
  - Process Area n

- **Specific Goals**
  - Specific Practices
  - Generic Practices

- **Generic Goals**
  - Ability to Perform
  - Directing Implementation
  - Commitment to Perform
  - Verifying Implementation

**Continuous**

- **Capability Levels**
  - Specific Practices
  - Generic Practices

- **Specific Goals**
  - Specific Practices
  - Generic Practices

- **Generic Goals**
**Structure of the CMMI Staged Representation**

- **Commitment to Perform**: creates policies and secures sponsorship for process improvement efforts
- **Ability to Perform**: ensures that the project and/or organization has the resources it needs to pursue process improvement
- **Directing Implementation**: collects, measures, and analyzes data related to processes
- **Verification**: verifies that the projects and/or organization’s activities conform to requirements, processes, and procedures
Model Terminology

Establish and Maintain

This phrase connotes a meaning beyond the component terms; it includes documentation and usage.

Work product

The term “work product” is used throughout the CMMI Product Suite to mean any artifact produced by a process. These artifacts can include files, documents, parts of the product, services, processes, specifications, and invoices.

Planned Process

A process that is documented both by a description and a plan. The description and plan should be coordinated, and the plan should include standards, requirements, objectives, resources, assignments, etc.
Model Terminology -2

**Performed Process**

A process that accomplishes the needed work to **produce identified output** work products using identified input work products. The specific goals of the process area are satisfied.

**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.

**Defined Process**

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 work products, measures, and other **process-improvement information** to the organizational process assets.
## Generic Practices

<table>
<thead>
<tr>
<th>Level</th>
<th>Generic Goals</th>
<th>Generic Practices</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Institutionalize a Managed Process</td>
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<tr>
<td></td>
<td></td>
<td>GP 2.2 Plan the Process</td>
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<tr>
<td></td>
<td></td>
<td>GP 2.3 Provide Resources</td>
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<tr>
<td></td>
<td></td>
<td>GP 2.4 Assign Responsibility</td>
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<tr>
<td></td>
<td></td>
<td>GP 2.5 Train People</td>
</tr>
<tr>
<td></td>
<td></td>
<td>GP 2.6 Manage Configurations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>GP 2.7 Identify and Involve Relevant Stakeholders</td>
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<tr>
<td></td>
<td></td>
<td>GP 2.8 Monitor and Control the Process</td>
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<tr>
<td></td>
<td></td>
<td>GP 2.9 Objectively Evaluate Adherence</td>
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<tr>
<td></td>
<td></td>
<td>GP 2.10 Review Status with Higher Level Mgmt</td>
</tr>
<tr>
<td>3</td>
<td>Institutionalize a Defined Process</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>GP 3.2 Collect Improvement Information</td>
</tr>
</tbody>
</table>
Staged Representation
The Maturity Levels

1. Process unpredictable, poorly controlled and reactive
2. Process characterized for projects and is often reactive
3. Process characterized for the organization and is proactive
4. Process measured and controlled
5. Focus on process improvement

- Performed
- Managed
- Defined
- Quantitatively Managed
- Optimizing
## Process Areas by Maturity Level

<table>
<thead>
<tr>
<th>Level</th>
<th>Focus</th>
<th>Process Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 Optimizing</td>
<td>Continuous process improvement</td>
<td>Organizational Innovation and Deployment, Causal Analysis and Resolution</td>
</tr>
<tr>
<td>4 Quantitatively Managed</td>
<td>Quantitative management</td>
<td>Organizational Process Performance, Quantitative Project Management</td>
</tr>
<tr>
<td>2 Managed</td>
<td>Basic project management</td>
<td>Requirements Management, Project Planning, Project Monitoring and Control, Supplier Agreement Management, Measurement and Analysis, Process and Product Quality Assurance, Configuration Management</td>
</tr>
<tr>
<td>1 Performed</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Continuous Representation
CMMI-SE/SW/IPPD/SS Continuous

- Organizational Process Focus
- Organizational Process Definition
- Organizational Training
- Organizational Process Performance
- Organizational Innovation and Deployment

- Project Planning
- Project Monitoring and Control
- Supplier Agreement Mgmt.
- Integrated Project Mgmt.
- Risk Management
- Quantitative Project Mgmt.
- Integrated Supplier Mgmt.
- Integrated Teaming
- Integrated Project Mgmt. for IPPD

- Requirements Management
- Requirements Development
- Technical Solution
- Product Integration
- Verification
- Validation

- Configuration Mgmt.
- Process and Product Quality Assurance
- Measurement & Analysis
- Decision Analysis and Resolution
- Causal Analysis and Resolution
- Organizational Environment For Integration
Basic Project Management

PP: Project Planning

PMC: Project Monitoring & Control

SAM: Supplier Agreement Mgmt

PP
- What to build
- What to do
- Plans
- Status, issues, results of progress and milestone reviews

PMC
- What to monitor
- Corrective action
- Replan

SAM
- Supplier agreement
- Corrective action

Engineering and Support process areas
- Status, issues, results of process and product evaluations; measures and analyses
- Measurement needs
- Product component requirements, technical issues, completed product components, acceptance reviews and tests
- Commitments

Supplier
Engineering

RD: Requirements Development
TS: Technical Solution
REQM: Requirements Mgmt
VER: Verification
PI: Product Integration
VAL: Validation
CMMI Process Areas for R&D Projects
Appraisal Requirements for CMMI (ARC) v1.1

- A guide to appraisal method developers

- Specifies the requirements for classes of appraisal methods
  - Class A: Full, comprehensive appraisal methods
  - Class B: Initial, incremental, self-appraisals
  - Class C: Quick-look

- Method developers can declare which class their method fits

- Implications of the desired class of appraisal
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<tr>
<th>Level</th>
<th>Process Characteristics</th>
<th>Management Visibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optimizing 5</td>
<td>Focus is on continuous quantitative improvement</td>
<td><img src="image1.png" alt="Diagram" /></td>
</tr>
<tr>
<td>Quantitatively Managed 4</td>
<td>Process is measured and controlled</td>
<td><img src="image2.png" alt="Diagram" /></td>
</tr>
<tr>
<td>Defined 3</td>
<td>Process is characterized for the organization and is proactive</td>
<td><img src="image3.png" alt="Diagram" /></td>
</tr>
<tr>
<td>Managed 2</td>
<td>Process is characterized for projects and is often reactive</td>
<td><img src="image4.png" alt="Diagram" /></td>
</tr>
<tr>
<td>Initial 1</td>
<td>Process is unpredictable, poorly controlled, and reactive</td>
<td><img src="image5.png" alt="Diagram" /></td>
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</table>
## Process Capability Prediction

<table>
<thead>
<tr>
<th>Level</th>
<th>Process Characteristics</th>
<th>Predicted Performance</th>
</tr>
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<tbody>
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<td>Optimizing</td>
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## People Implications of Process Maturity

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<th>Process Characteristics</th>
<th>People Implications</th>
</tr>
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<tr>
<td>Optimizing</td>
<td>Focus is on continuous quantitative improvement</td>
<td>Focus on &quot;fire prevention&quot;; improvement anticipated and desired, and impacts assessed</td>
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<tr>
<td>Quantitatively Managed</td>
<td>Process is measured and controlled</td>
<td>Sense of teamwork and inter-dependencies</td>
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<tr>
<td>Defined</td>
<td>Process is characterized for the organization and is proactive</td>
<td>Increased reliance on defined process; investment in people and process as corporate assets</td>
</tr>
<tr>
<td>Managed</td>
<td>Process is characterized for projects and is often reactive</td>
<td>Overreliance on experience of good people – when they go, the process goes</td>
</tr>
<tr>
<td>Initial</td>
<td>Process is unpredictable, poorly controlled, and reactive</td>
<td>Focus on &quot;fire fighting&quot;; effectiveness low – frustration high</td>
</tr>
<tr>
<td>Level</td>
<td>Process Characteristics</td>
<td>Results</td>
</tr>
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<td>-----------</td>
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For More Information About CMMI

Go to CMMI Website

- http://sei.cmu.edu/cmmi
- http://seir.sei.cmu.edu/seir/
- http://jo.sei.cmu.edu/pub/english.cgi/0/323123
- http://dtic.mil/ndia (first annual CMMI Conference)
- http://www.faa.gov/aio

Assistance for government organizations:

- SW-CMM v1.1 to CMMI v1.1 Mappings
- Software Technology Support Center
- OO-ALC/TI-3
- 7278 4th Ave
- Hill AFB, UT 84056-5705
- http://www.stsc.hill.af.mil