Lecture 7: CMMI

(based in part on material by Dr. Peter Kolb)
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® Capability Maturity Model, Capability Maturity Modeling, CMM, and CMMI are registered in the U.S. Patent & Trademark Office
The plan for performing the organizational process focus process, which is often called `the process-improvement plan,' differs from the process action plans described in specific practices in this process area. The plan called for in this generic practice addresses the comprehensive planning for all of the specific practices in this process area, from the establishment of organizational process needs all the way through to the incorporation of process-related experiences into the organizational process assets.
Boeing results

Improved cycle time

Project Cycle Times

Source: Software Engineering Div., Hill AFB, Published in Crosstalk May 1999
Increased productivity and quality
CMMI goals

Emphasis on developing processes and changing culture for measurable benefit to organization’s business objectives

Framework from which to organize and prioritize engineering, people, and business activities

Supports coordination of multi-disciplined activities required to build successful product or application

Adds “Engineering Systems Thinking”
What is a CMM?

Capability Maturity Model:
A reference model of mature practices in a specified discipline, used to assess a group’s capability to perform that discipline

CMMs differ by

- Discipline (software, systems, acquisition, etc.)
- Structure (staged versus continuous)
- How Maturity is Defined (process improvement path)
- How Capability is Defined (institutionalization)

NOT:

- Ready-made scheme or template for describing processes
- Methods for the processes
Bridging the divide

Integrates systems and software disciplines into one process improvement framework.

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

Provides a framework for introducing new disciplines as needs arise.
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…….
The world of standards
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)
Support of CMMI for 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.
Model Representations

...for an established set of process areas across an organization

Software Engineering, lecture 7+8: CMMI
## Management visibility by maturity level

<table>
<thead>
<tr>
<th>Level</th>
<th>Process Characteristics</th>
<th>Management Visibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 Optimizing</td>
<td>Focus is on continuous quantitative improvement</td>
<td>Out</td>
</tr>
<tr>
<td>4 Quantitatively Managed</td>
<td>Process is measured and controlled</td>
<td>Out</td>
</tr>
<tr>
<td>3 Defined</td>
<td>Process is characterized for the organization and is proactive</td>
<td>Out</td>
</tr>
<tr>
<td>2 Managed</td>
<td>Process is characterized for projects and is often reactive</td>
<td>Out</td>
</tr>
<tr>
<td>1 Initial</td>
<td>Process is unpredictable, poorly controlled, and reactive</td>
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</table>

- Process is unpredictable, poorly controlled, and reactive
- Process is characterized for the organization and is proactive
- Process is characterized for projects and is often reactive
- Process is measured and controlled
- Process is unpredictable, poorly controlled, and reactive
- Focus is on continuous quantitative improvement
Capability levels are cumulative

Because capability levels build upon one another, there can be no gaps.
Structure of the CMMI Staged Representation

Commitment to Perform: creates policies and secures sponsorship for process improvement
Ability to Perform: ensures that project/organization has needed resources for improvement
Directing Implementation: collects, measures, and analyzes data related to processes
Verification: verifies that activities meet requirements, processes, procedures
Generic goals

**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
Institutionalization involves implementing practices that

- Ensure the process areas are effective, repeatable and long lasting
- Provide needed infrastructure support
- Ensure processes are defined, documented, understood
- Enable organizational learning to improve the processes
CMMI 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.
CMMI terminology

Performed Process (Capability Level 1)
- 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 (Capability Level 2)
- 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 (Capability Level 3)
- 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.
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
## 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><strong>Continuous process improvement</strong></td>
<td>Organizational Innovation and Deployment&lt;br&gt;Causal Analysis and Resolution</td>
</tr>
<tr>
<td>4 Quantitatively Managed</td>
<td><strong>Quantitative management</strong></td>
<td>Organizational Process Performance&lt;br&gt;Quantitative Project Management</td>
</tr>
<tr>
<td>3 Defined</td>
<td><strong>Process standardization</strong></td>
<td>Requirements Development&lt;br&gt;Technical Solution&lt;br&gt;Product Integration&lt;br&gt;Verification&lt;br&gt;Validation&lt;br&gt;Organizational Process Focus&lt;br&gt;Organizational Process Definition&lt;br&gt;Organizational Training&lt;br&gt;Integrated Project Management&lt;br&gt;Integrated Supplier Management&lt;br&gt;Risk Management&lt;br&gt;Decision Analysis and Resolution&lt;br&gt;Organizational Environment for Integration&lt;br&gt;Integrated Teaming</td>
</tr>
<tr>
<td>2 Managed</td>
<td><strong>Basic project management</strong></td>
<td>Requirements Management&lt;br&gt;Project Planning&lt;br&gt;Project Monitoring and Control&lt;br&gt;Supplier Agreement Management&lt;br&gt;Measurement and Analysis&lt;br&gt;Process and Product Quality Assurance&lt;br&gt;Configuration Management</td>
</tr>
<tr>
<td>1 Performed</td>
<td></td>
<td></td>
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</tbody>
</table>
The purpose of Integrated Supplier Management is to proactively identify sources of products that may be used to satisfy the project’s requirements and to manage selected suppliers while maintaining a cooperative project-supplier relationship.
Examples

The purpose of Organizational Process Definition is to establish and maintain a usable set of organizational process assets.

(Organizational process asset: “Anything that the organization considers useful in attaining the goals of a process area. “)
Examples

The purpose of Organizational Process Focus is to plan and implement organizational process improvement based on a thorough understanding of the current strengths and weaknesses of the organization’s processes and process assets.
# Process capability prediction

<table>
<thead>
<tr>
<th>Level</th>
<th>Process Characteristics</th>
<th>Predicted Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Optimizing</strong></td>
<td>Focus is on continuous quantitative improvement</td>
<td></td>
</tr>
<tr>
<td><strong>Quantitatively</strong></td>
<td>Process is measured and controlled</td>
<td></td>
</tr>
<tr>
<td><strong>Managed</strong></td>
<td>Process is characterized for the organization and is proactive</td>
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The table above summarizes the characteristics and performance predictions for different levels of process capability in CMMI (Capability Maturity Model Integration). Each level describes the focus and control of a process, with corresponding performance analysis indicating the probability of achieving targets over time and cost.
## People implications

<table>
<thead>
<tr>
<th>Level</th>
<th>Process Characteristics</th>
<th>People Implications</th>
</tr>
</thead>
<tbody>
<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>
</tr>
<tr>
<td>Quantitatively Managed</td>
<td>Process is measured and controlled</td>
<td>Sense of teamwork and inter-depensities</td>
</tr>
<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>
</tbody>
</table>
## Risk implications

<table>
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<tr>
<th>Level</th>
<th>Process Characteristics</th>
<th>Results</th>
</tr>
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<tbody>
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*Patient, Quality, Productivity, Customer Satisfaction*
Specific and generic goals and practices

Capability Levels

- Generic Goals & Generic Practices
- Generic Goals & Generic Practices

Process Areas (PA)

1. Specific Goals & Practices
2. Specific Goals & Practices
3. Specific Goals & Practices
4. Specific Goals & Practices
5. Specific Goals & Practices
## Generic goals and practices

<table>
<thead>
<tr>
<th>Capability Level</th>
<th>Generic Goals</th>
<th>Generic Practices</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Achieve Specific Goals</td>
<td>GP 1.1 Perform Base Practices</td>
</tr>
<tr>
<td>2</td>
<td>Institutionalize a Managed Process</td>
<td>GP 2.1 Establish an Organizational Policy</td>
</tr>
<tr>
<td></td>
<td></td>
<td>GP 2.2 Plan the Process</td>
</tr>
<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>
</tr>
<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>
</tr>
<tr>
<td></td>
<td></td>
<td>GP 2.8 Monitor and Control the Process</td>
</tr>
<tr>
<td></td>
<td></td>
<td>GP 2.9 Objectively Evaluate Adherence</td>
</tr>
<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>GP 3.1 Establish a Defined Process</td>
</tr>
<tr>
<td></td>
<td></td>
<td>GP 3.2 Collect Improvement Information</td>
</tr>
<tr>
<td>4</td>
<td>Institutionalize a Quantitatively Managed Process</td>
<td></td>
</tr>
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</table>
Generic practices

The Generic Practices support institutionalization of critical practices for an organization to have a successful process improvement initiative:

- Processes will be **executed and managed consistently**
- Processes will **survive staff changes**
- Process **improvement** will be **related to business goals**
- The organization will **not** find itself continuously “reinventing the wheel”
- There will be the commitment to provide **resources** or infrastructure to support or improve the processes
- There will be historical basis for cost **estimation**
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
  ▪ http://www.stsc.hill.af.mil
CMMI

Defines goals and practices shown to be useful to the software industry

Primarily directed to large organizations

Focus on process: explicit, documented, reproducible, measurable, self-improving

Essential to outsourcing industry

Technology-neutral