

*Distributed and Outsourced Software Engineering*

## *The CMMI Model*

## *SEI Trademarks and Service Marks*

- <sup>SM</sup> CMM Integration SCAMPI are service marks of Carnegie Mellon University
- <sup>®</sup> Capability Maturity Model, Capability Maturity Modeling, CMM, and CMMI are registered in the U.S. Patent & Trademark Office

# *Agenda*

- **Why CMMI?**
- What is CMMI?
- Where does it come from and fit into?
- How does it look like?

# CMMI Experiences

- SEI collects quantitative measures of CMMI performance improvement

Performance Category	Median Improvement
Cost	34%
Schedule	50%
Productivity	61%
Quality	48%
Customer Satisfaction	14%
ROI	4.0 : 1
CMU/SEI-2006-TR-004. Data from 35 organizations.	

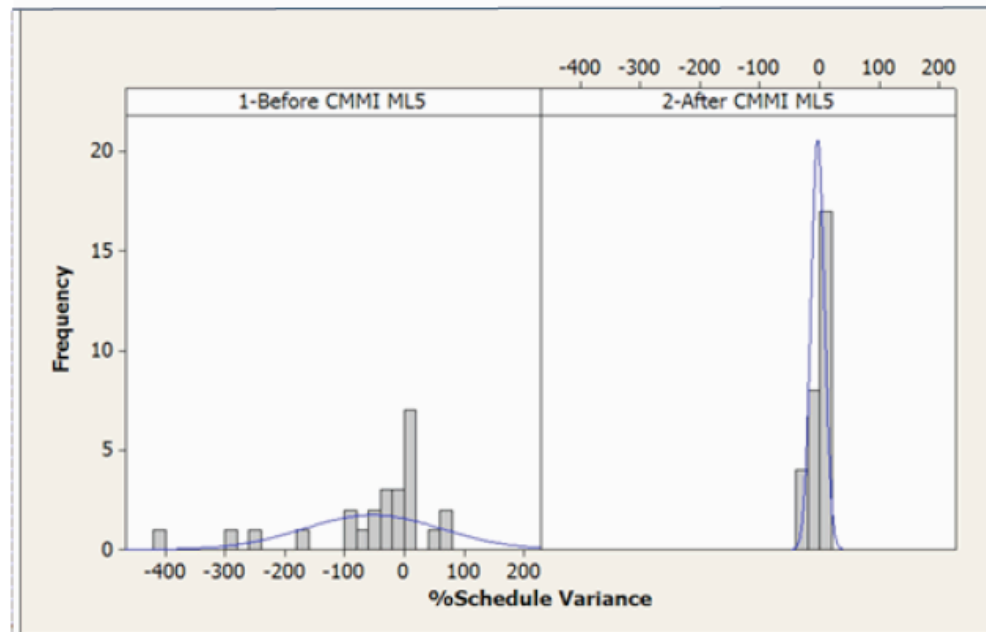
- Technical Report

<http://www.sei.cmu.edu/pub/documents/06.reports/pdf/06tr004.pdf>

## CMMI Experiences

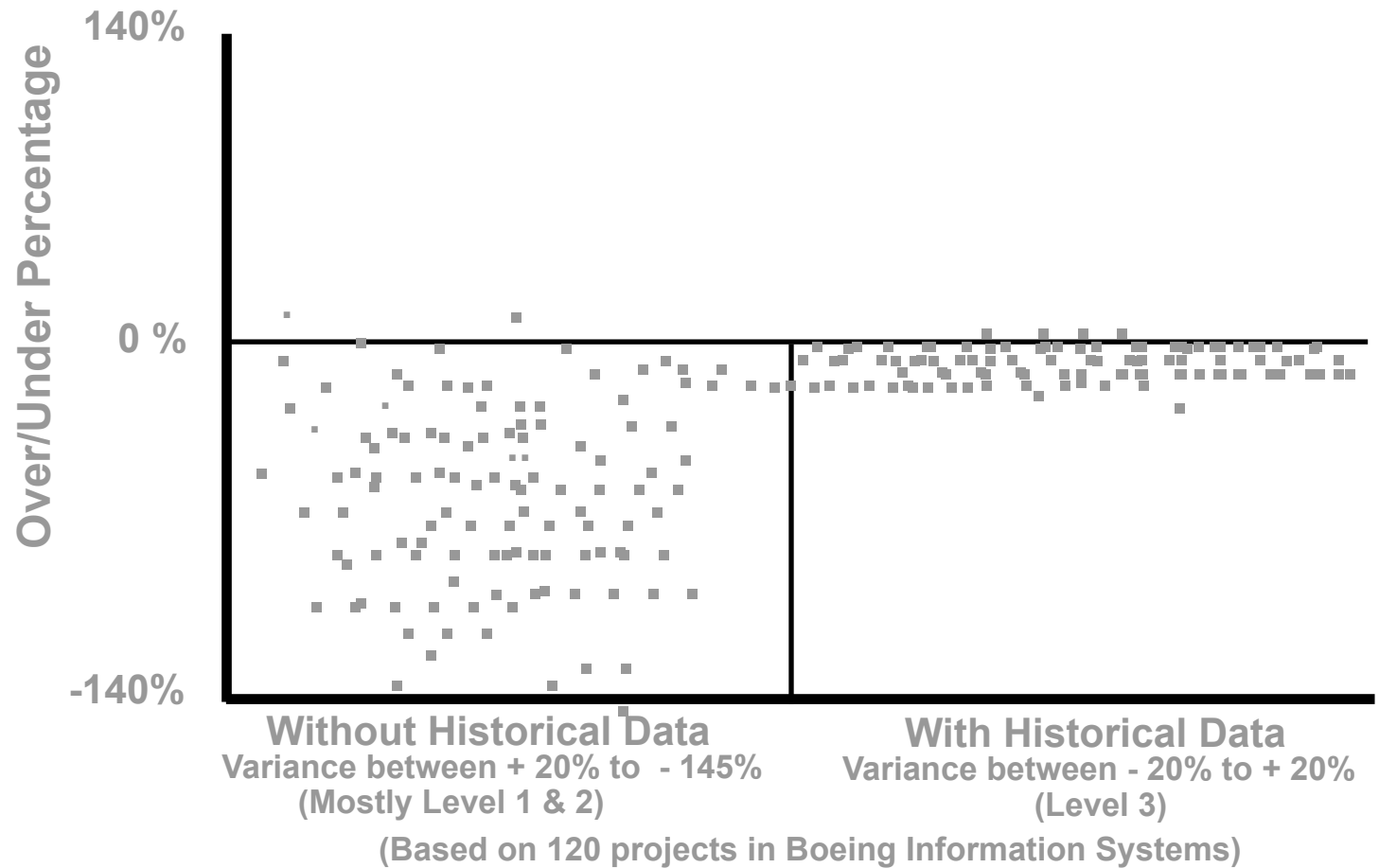
# Example Benefit -2

The Software Maintenance Group at Warner Robins Air Logistics Center, a maturity level 5 organization, significantly reduced schedule variance.



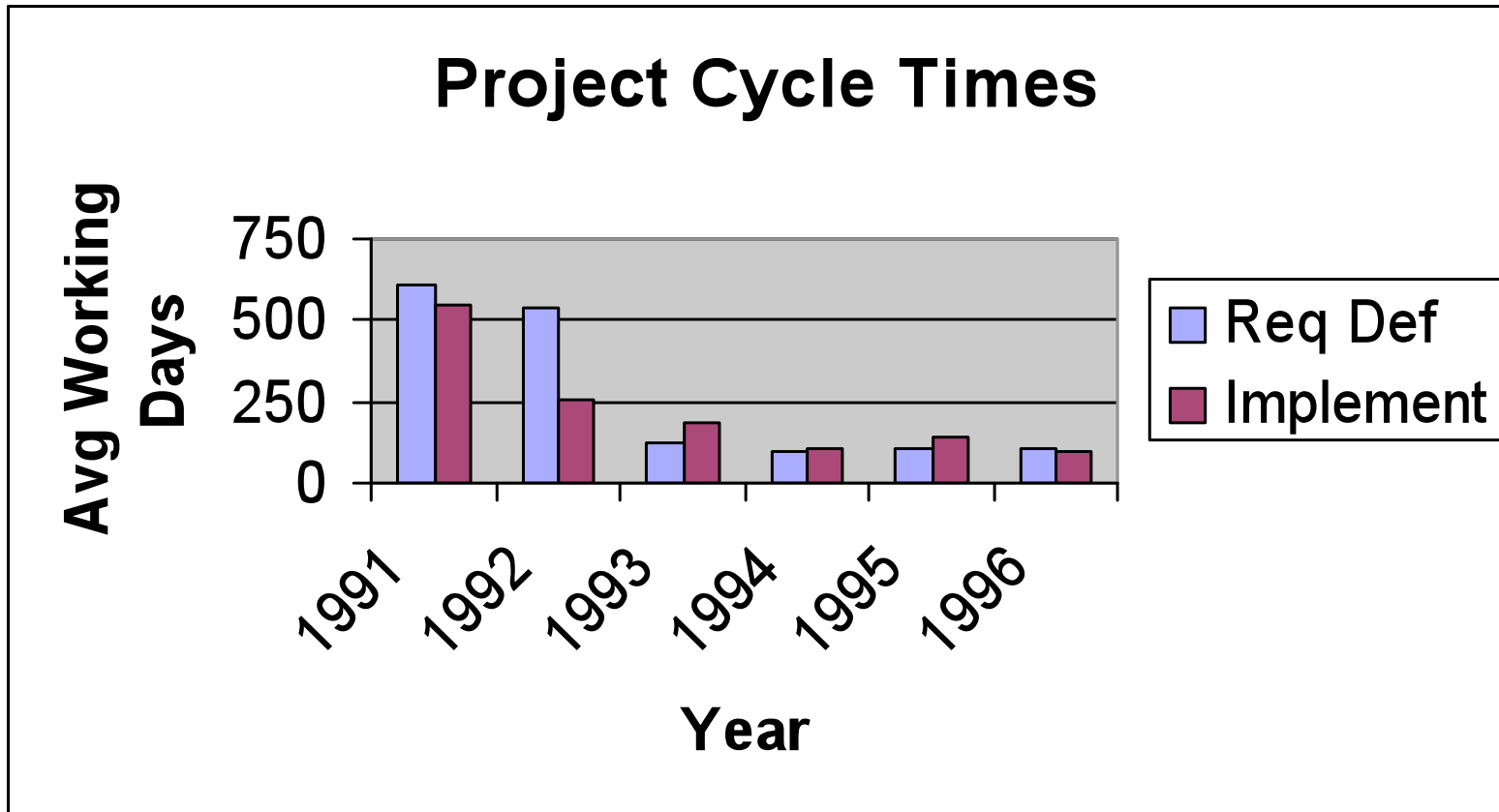
# Improved Schedule and Budget Predictability

## Results: Boeing Effort Estimation



Reference: John D. Vu. "Software Process Improvement Journey: From Level 1 to Level 5."  
7th SEPG Conference, San Jose, March 1997.

## Improved Cycle Time

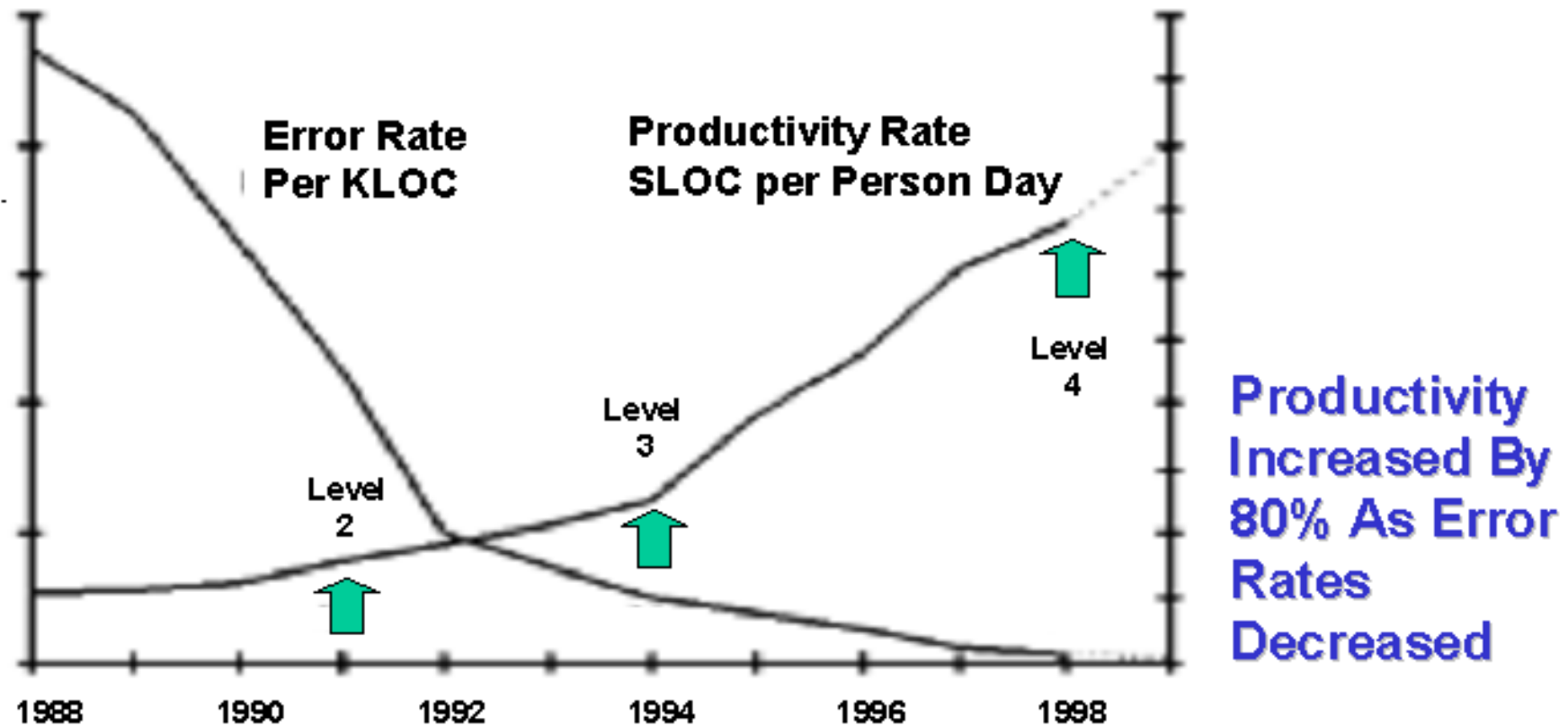


Source: Software Engineering Div., Hill AFB, Published in Crosstalk May 1999

## *Increased Productivity and Quality*

### **Productivity Rate and Quality Performance**

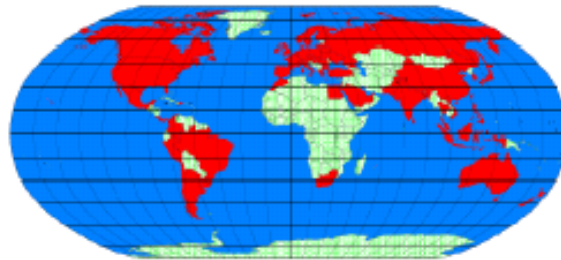
**\* For Software Programs**





# CMMI Adoption

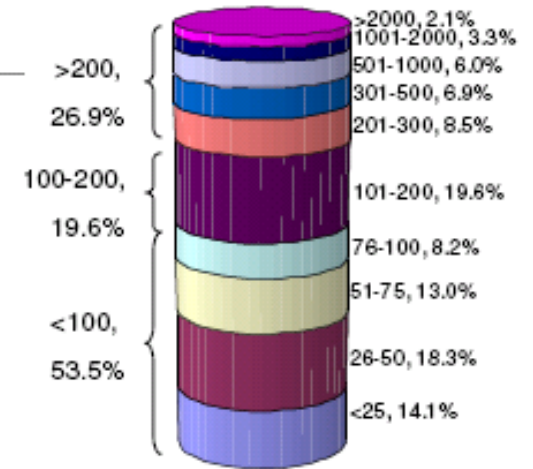
CMMI appraisals are conducted worldwide...



	USA		Non-USA	
	Qty	%	Qty	%
Commercial In-House	318	32.5%	2207	90.9%
Contractor for Military/Government	555	56.7%	163	6.7%
Military/Government Agency	106	10.8%	57	2.3%
	979	100.0%	2427	100.0%

...in small and large organizations and projects

Organization Size (Employees)



(3407 organizations reporting)

...in a wide range of business domains

## Services (69.2%)

- Engineering and Management Services
  - Public Administration
- Transportation and Utilities
- Finance, Insurance, Real Estate
  - Health Services
- Retail/Wholesale Trade

## Manufacturing (17.6%)

- Electronic and Electric Equipment
  - Industrial Machinery
- Instruments and Related Products
  - Transportation Equipment
  - Other Mfg Industries

Based on primary Standard Industrial Classification (SIC) codes reported in CMMI-based appraisals.

...at all levels of process maturity

	Commercial In-House	Contractor for Military/Government	Military/Government Agency
No Rating Given	6.3%	9.6%	23.3%
Initial (ML1)	0.9%	1.7%	1.9%
Managed (ML2)	29.1%	31.9%	44.9%
Defined (ML3)	50.4%	45.1%	25.8%
Quantitatively Managed (ML4)	3.4%	1.5%	0.6%
Optimizing (ML5)	9.9%	11.1%	3.7%
	(2525 orgs)	(718 orgs)	(163 orgs)

Source: SEI Process Maturity Profile, March 2009.

<http://www.sei.cmu.edu/appraisal-program/profile/>

## *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

# *Agenda*

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- **What is CMMI?**
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- How does it look like?

## *Models*

- “All models are wrong, but some are useful.”  
George Box
- Simplified approximations of reality that provide insight.

## *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:
  - It is not a ready-made scheme or template for describing processes
  - It contains no methods for the processes

## *Bridging the Divide: CMM-I (Integrated)*

- Integrates systems and software disciplines into one process improvement framework.
- Foreseen for Hardware / Software / System Development



# *Agenda*

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

## *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.....



# The CMMI Framework

The CMMI Framework is the structure that organizes the components used in generating models, training materials, and appraisal methods.

The CMMI Product Suite is the full collection of models, training materials, and appraisal methods generated from the CMMI Framework.

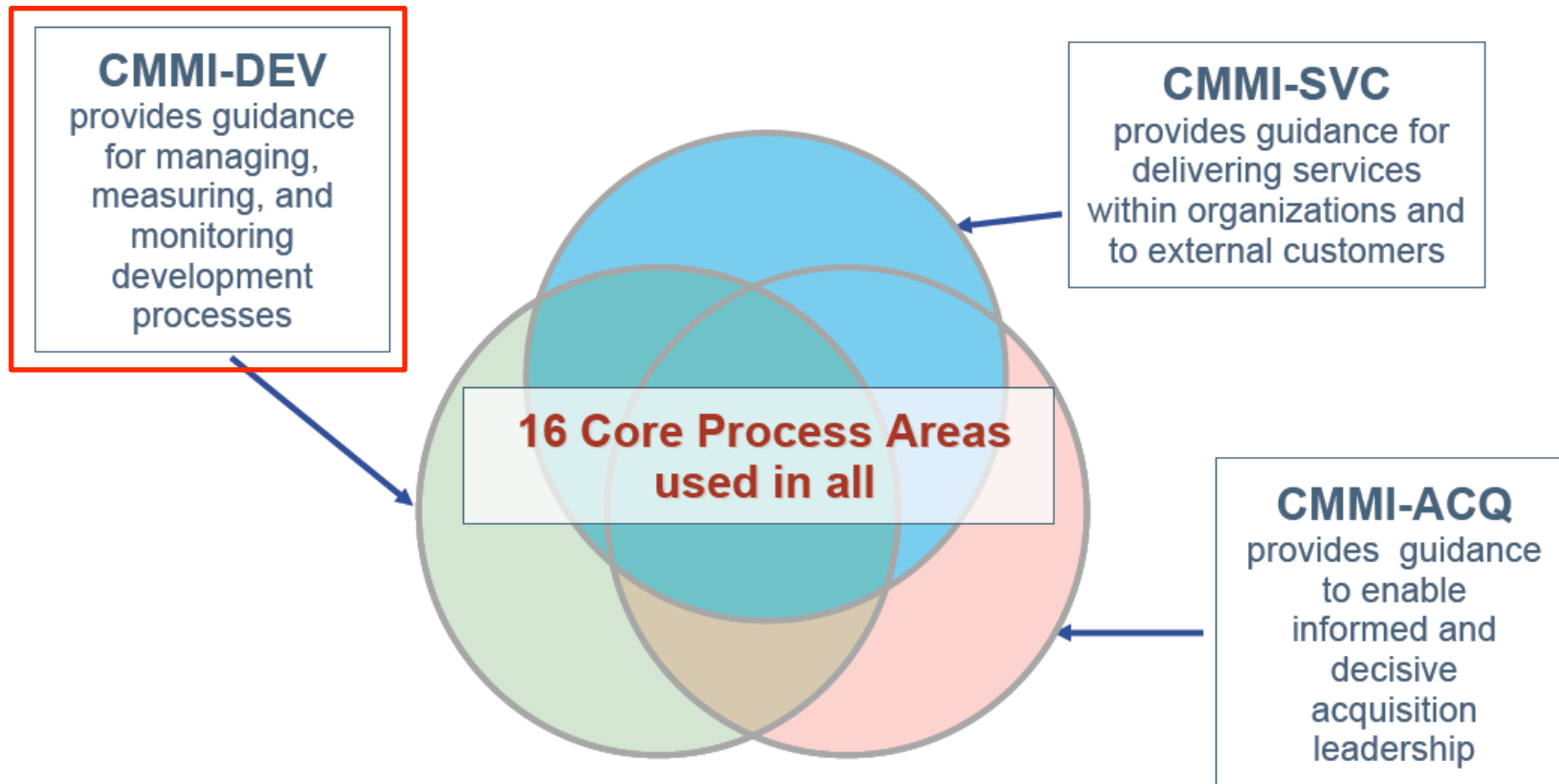
The components in the CMMI Framework are organized into groupings, called **constellations**, which facilitate construction of approved models.

- During v1.2 development, CMMI-SE/SW/IPPD/SS was moved to the **CMMI for Development (CMMI-DEV)** constellation.
- Two new constellations have been commissioned by CMMI Steering Group:
  - **CMMI for Services (CMMI-SVC)**
  - **CMMI for Acquisition (CMMI-ACQ)**

## *Benefits from Using CMMI*

- Organization's activities are explicitly linked to its business objectives.
- Visibility into the organization's activities is increased to help to ensure that the product or service meets the customer's expectations.
- The teams learn from new areas of best practice (e.g., measurement, risk)
  
- CMMI is being adopted worldwide, including North America, Europe, Asia, Australia, South America, and Africa.

# Three Complementary Constellations



## *Organization-Wide Improvements through the Use of CMMI for Development*

- Better customer satisfaction
- Increased quality
- More accurate schedules
- Lower development costs
- Substantial return on investment
- Improved employee morale and reduced turnover



## *The Support of CMMI to ISO 9001:2000*

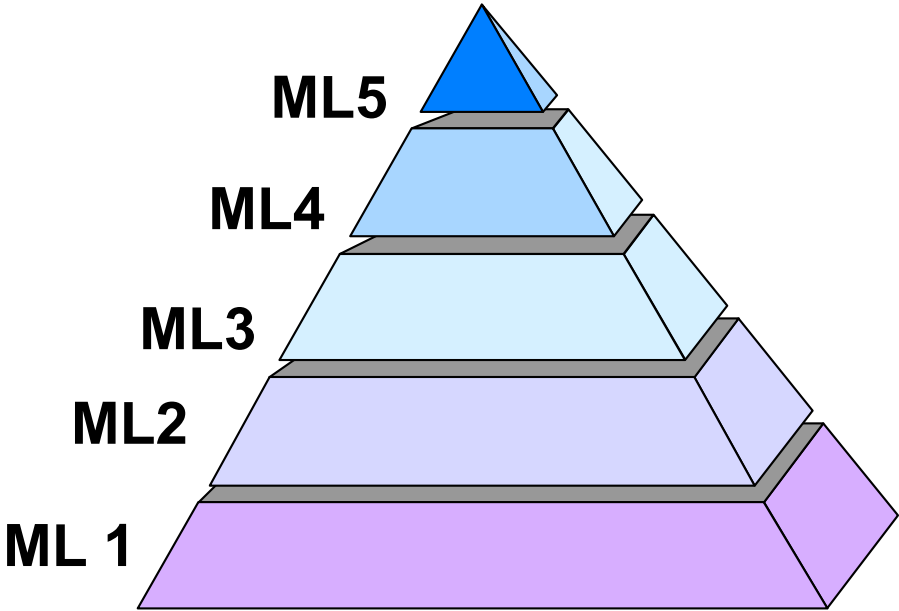
- Organizations at the CMMI Maturity Level 3 will be ready for ISO 9001:2000 registration with minor adjustments
- Organizations registered as ISO 9001:2008 compliant will require additional effort to reach the CMMI Level 2 or 3
  - ✦ The CMMI path leverages the investment an organization may have in 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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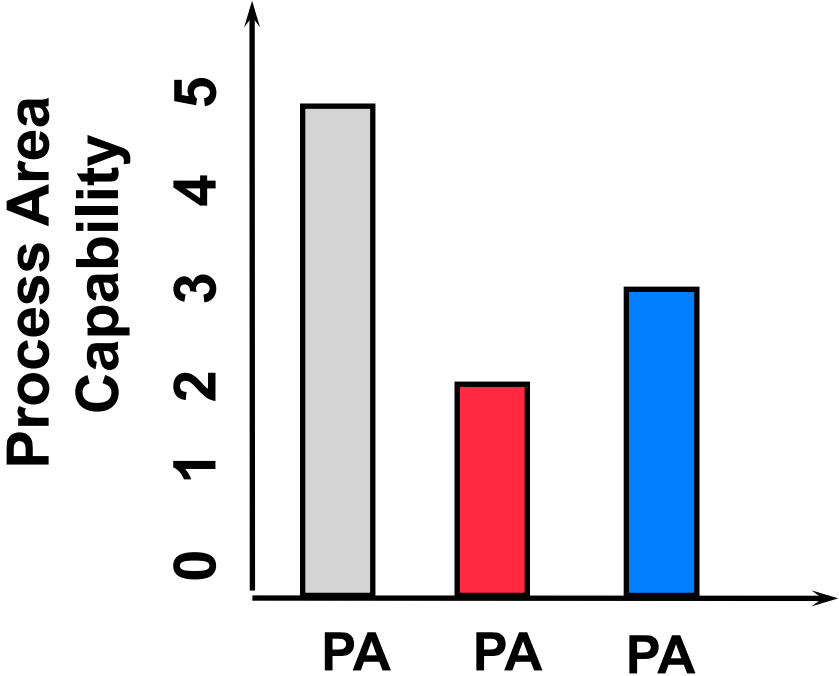
# Comparing Model Representations

## Staged



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

## Continuous

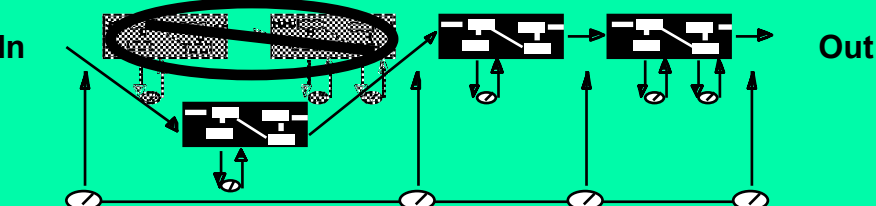
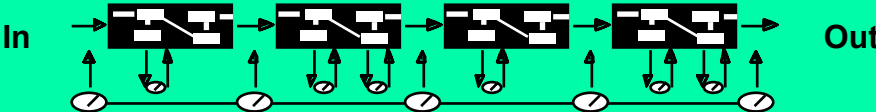
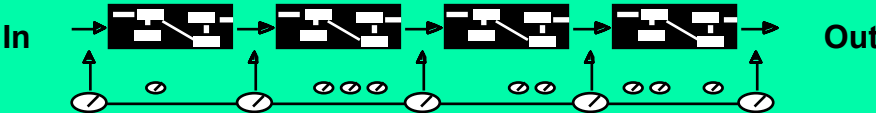
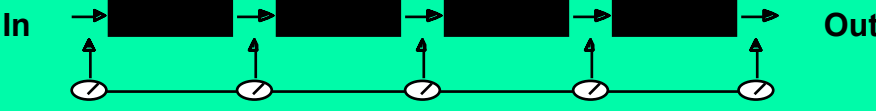
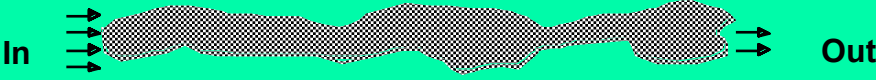


...for a single process area or a set of process areas (PA)

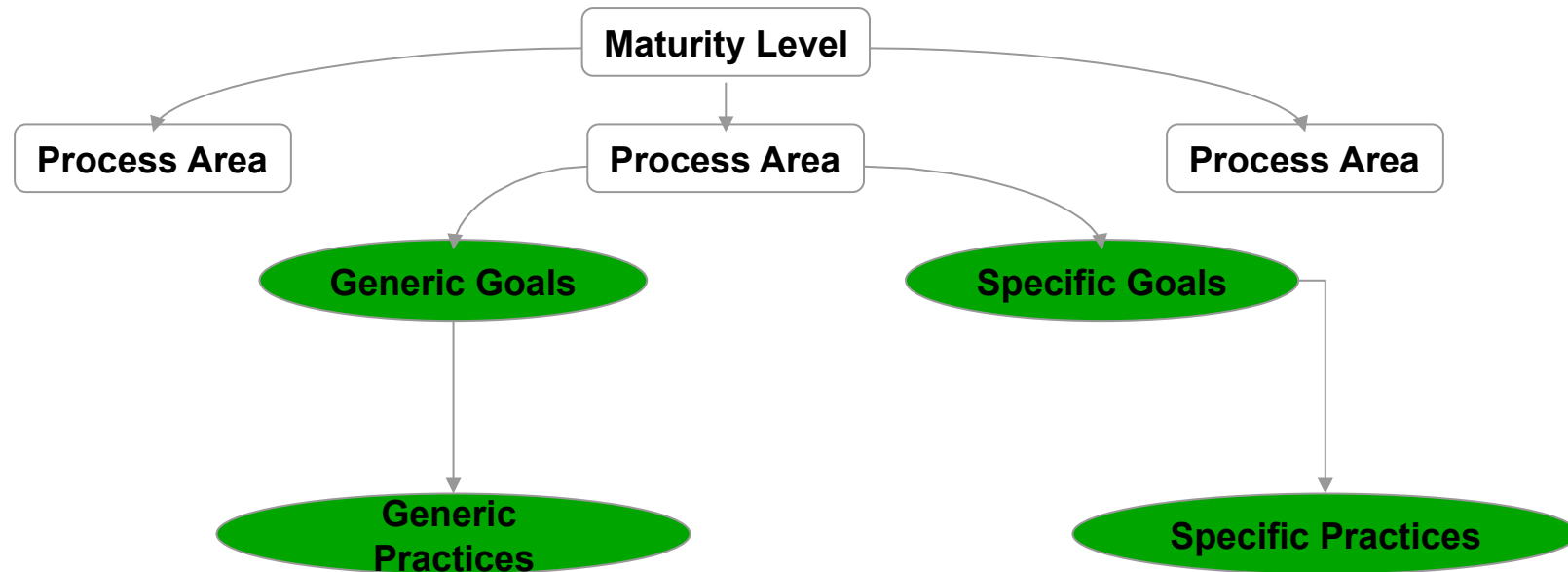


## *CMMI: Staged Representation*

# Management Visibility by Maturity Level

Level	Process Characteristics	Management Visibility
<p style="text-align: center; font-size: 2em;">5</p> <p style="text-align: center;"><b>Optimizing</b></p>	<p style="text-align: center;">Focus is on continuous quantitative improvement</p>	<p style="text-align: center;">In  Out</p>
<p style="text-align: center; font-size: 2em;">4</p> <p style="text-align: center;"><b>Quantitatively Managed</b></p>	<p style="text-align: center;">Process is measured and controlled</p>	<p style="text-align: center;">In  Out</p>
<p style="text-align: center; font-size: 2em;">3</p> <p style="text-align: center;"><b>Defined</b></p>	<p style="text-align: center;">Process is characterized for the organization and is proactive</p>	<p style="text-align: center;">In  Out</p>
<p style="text-align: center; font-size: 2em;">2</p> <p style="text-align: center;"><b>Managed</b></p>	<p style="text-align: center;">Process is characterized for projects and is often reactive</p>	<p style="text-align: center;">In  Out</p>
<p style="text-align: center; font-size: 2em;">1</p> <p style="text-align: center;"><b>Initial</b></p>	<p style="text-align: center;">Process is unpredictable, poorly controlled, and reactive</p>	<p style="text-align: center;">In  Out</p>

## Structure of the CMMI Staged Representation



**Generic Practices cover the following features:**

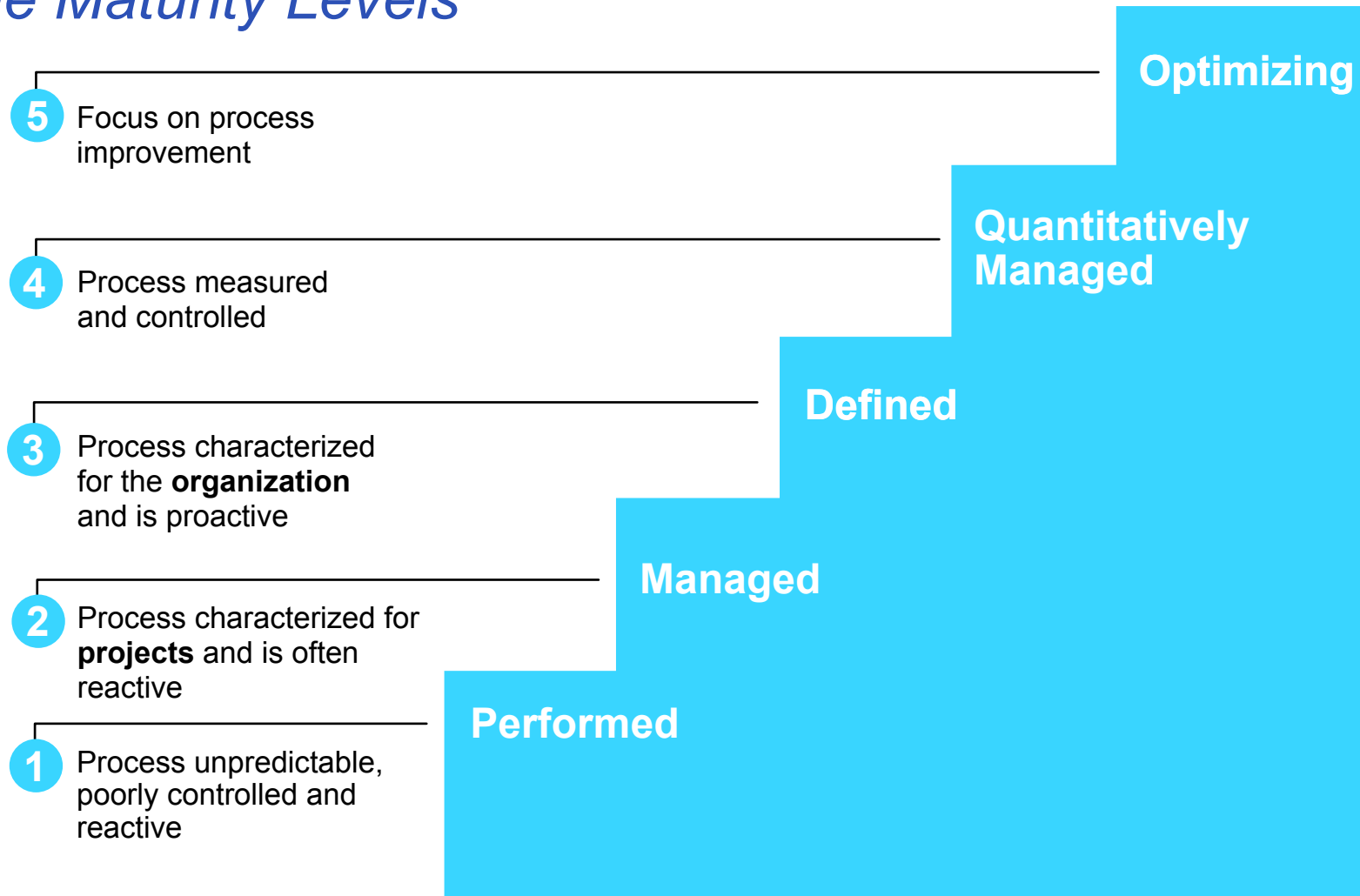
**Commitment to Perform:** creates policies and secures sponsorship for process improvement efforts

**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

# The Maturity Levels



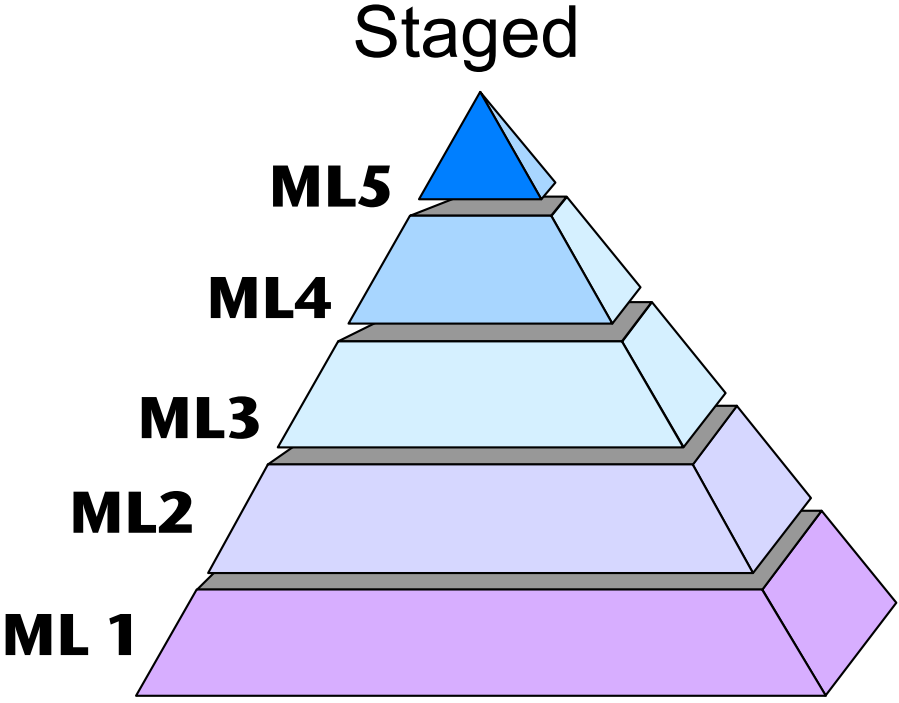
## Process Areas by Maturity Level

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 +IPPD Organizational Training Integrated Project Management Risk Management Decision Analysis and Resolution Organizational Environment for Integration
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 Performed		

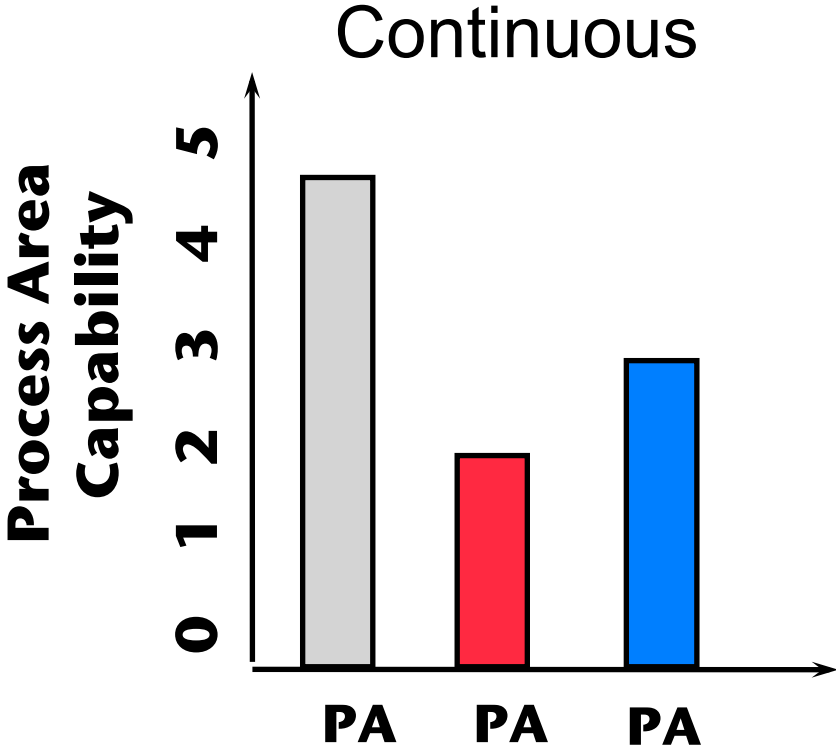
*Software Engineering for Outsourced & Offshore Development*

*CMMI Model,  
Continuous Representation and Generic Goals and Practices*

# Comparing Model Representations



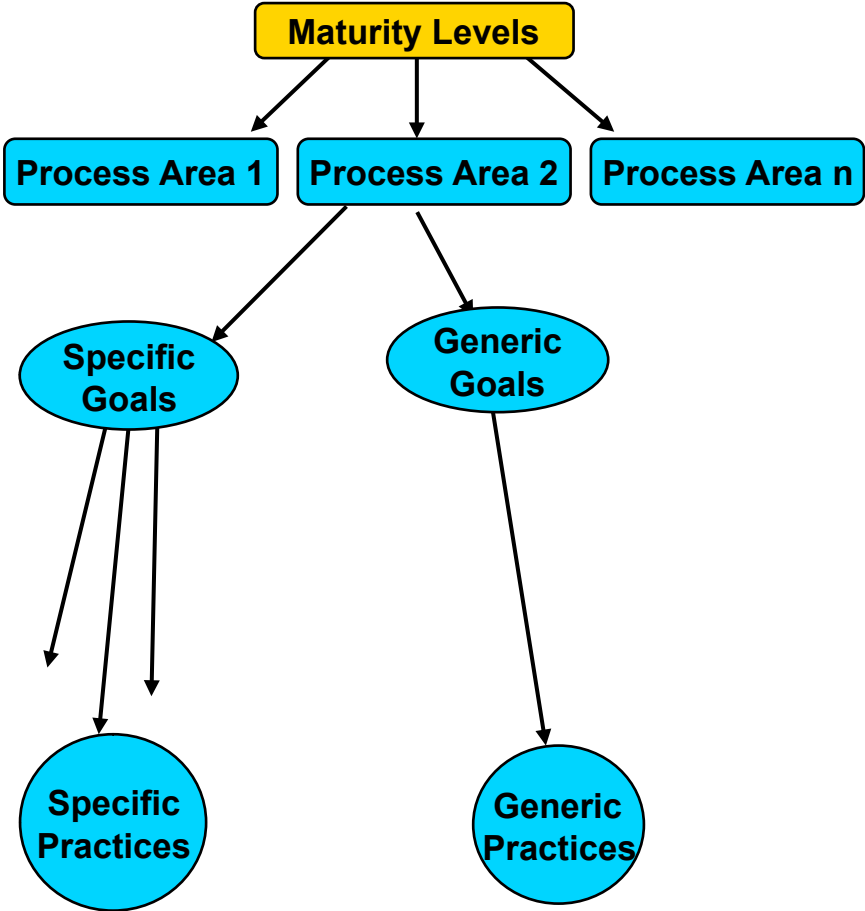
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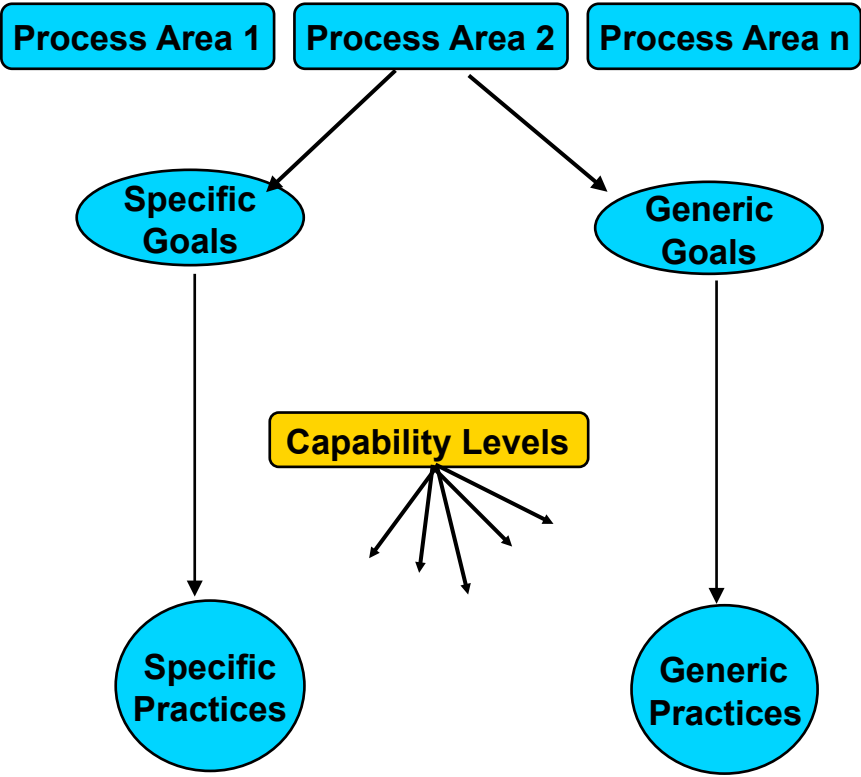
...for a single process area or a set of process areas

# CMMI Model Structure

## Staged

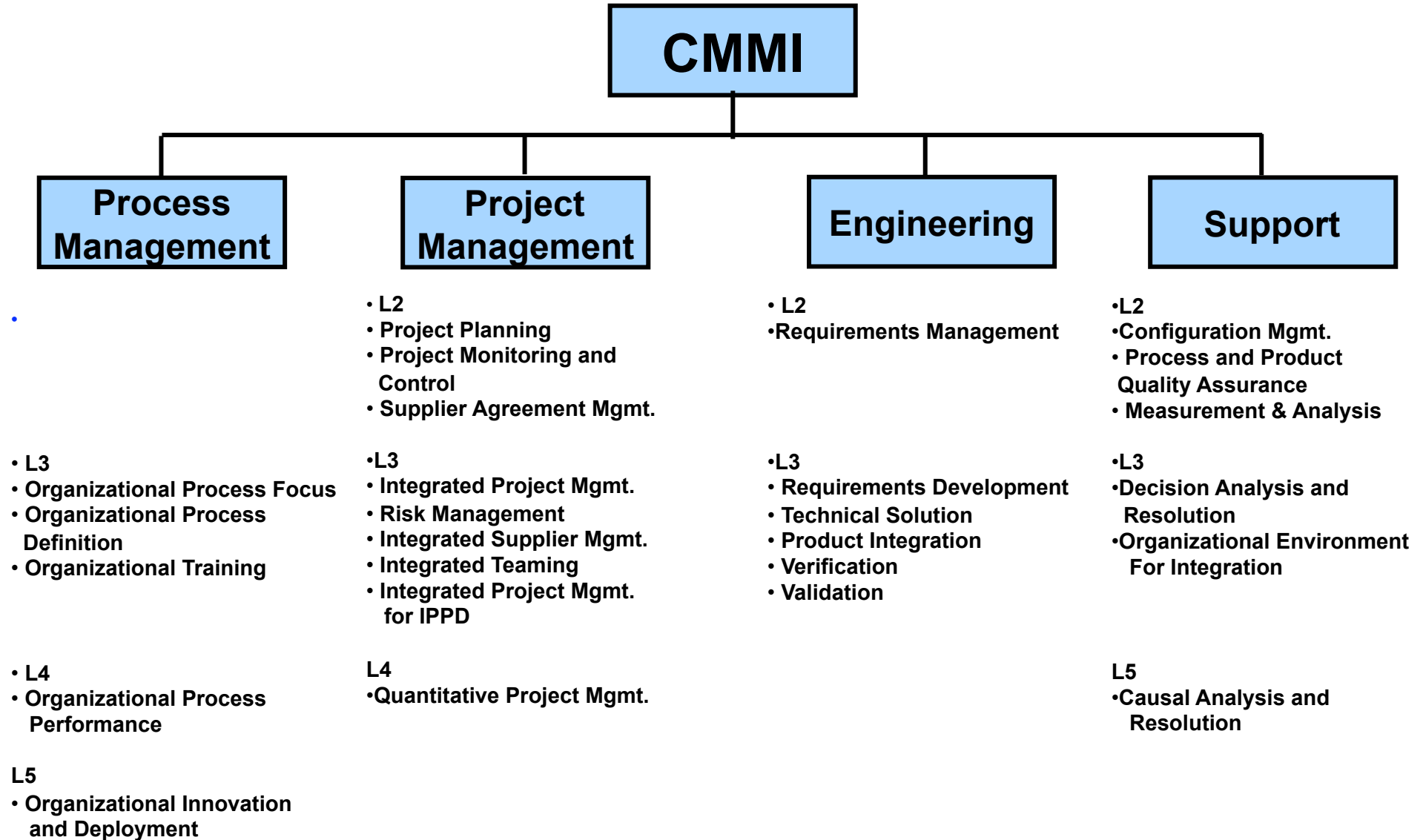


## Continuous





# CMMI-SE/SW/IPPD/SS Continuous

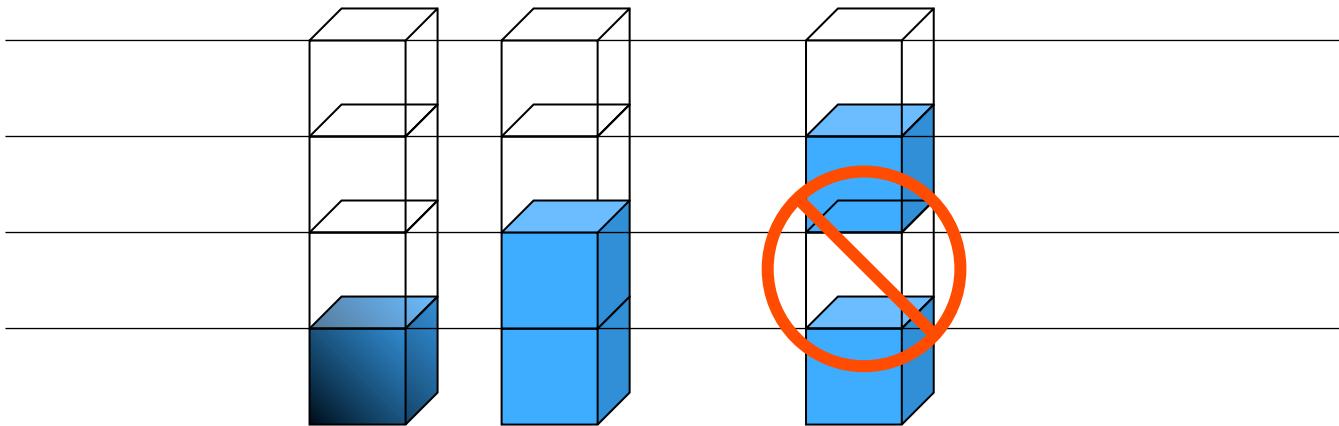


## *The Capability Levels*



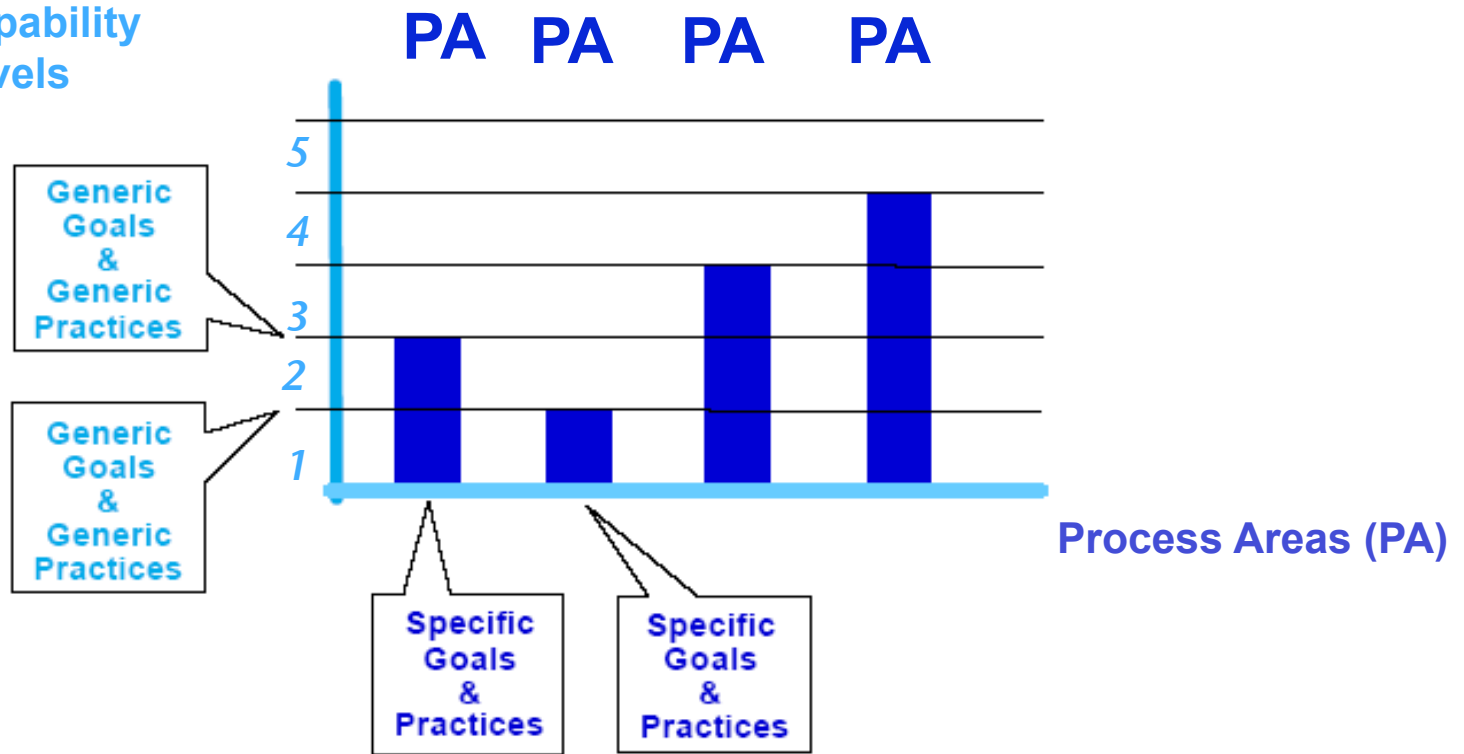
## Capability Levels are Cumulative

- Because capability levels build upon one another, there can be no gaps.



# Specific and Generic Goals and Practices

Capability Levels



# Generic Goals and Practices

## Capability

Level	Generic Goals	Generic Practices
1	<ul style="list-style-type: none"> <li>● Achieve Specific Goals</li> </ul>	<ul style="list-style-type: none"> <li>● GP 1.1 Perform Base Practices</li> </ul>
2	<ul style="list-style-type: none"> <li>● Institutionalize a Managed Process</li> </ul>	<ul style="list-style-type: none"> <li>● GP 2.1 Establish an Organizational Policy</li> <li>● GP 2.2 Plan the Process</li> <li>● GP 2.3 Provide Resources</li> <li>● GP 2.4 Assign Responsibility</li> <li>● GP 2.5 Train People</li> <li>● GP 2.6 Manage Configurations</li> <li>● GP 2.7 Identify and Involve Relevant Stakeholders</li> <li>● GP 2.8 Monitor and Control the Process</li> <li>● GP 2.9 Objectively Evaluate Adherence</li> <li>● GP 2.10 Review Status with Higher Level Mgmt</li> </ul>
3	<ul style="list-style-type: none"> <li>● Institutionalize a Defined Process</li> </ul>	<ul style="list-style-type: none"> <li>● GP 3.1 Establish a Defined Process</li> <li>● GP 3.2 Collect Improvement Information</li> </ul>
4	<ul style="list-style-type: none"> <li>● Institutionalize a Quantitatively Managed Process</li> </ul>	<ul style="list-style-type: none"> <li>● GP 4.1 Establish Quantitative Objectives for the Process</li> <li>● GP 4.2 Stabilize Sub-process Performance</li> </ul>
5	<ul style="list-style-type: none"> <li>● Institutionalize an Optimizing Process</li> </ul>	<ul style="list-style-type: none"> <li>● GP 5.1 Ensure Continuous Process Improvement</li> <li>● GP 5.2 Correct Root Causes of Problems</li> </ul>

# *Model Terminology -1*

## ● 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

## *Model Terminology -2*

- **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 -3

### ● 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



## *Generic Practices Summary*

- 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://www.sei.cmu.edu/library/abstracts/reports/06tr008.cfm>
  - <http://dtic.mil/ndia> (annual CMMI Conference)
  - <http://www.faa.gov/aio>
- ✦ Assistance for government organizations:
  - Software Technology Support Center
  - <http://www.stsc.hill.af.mil>