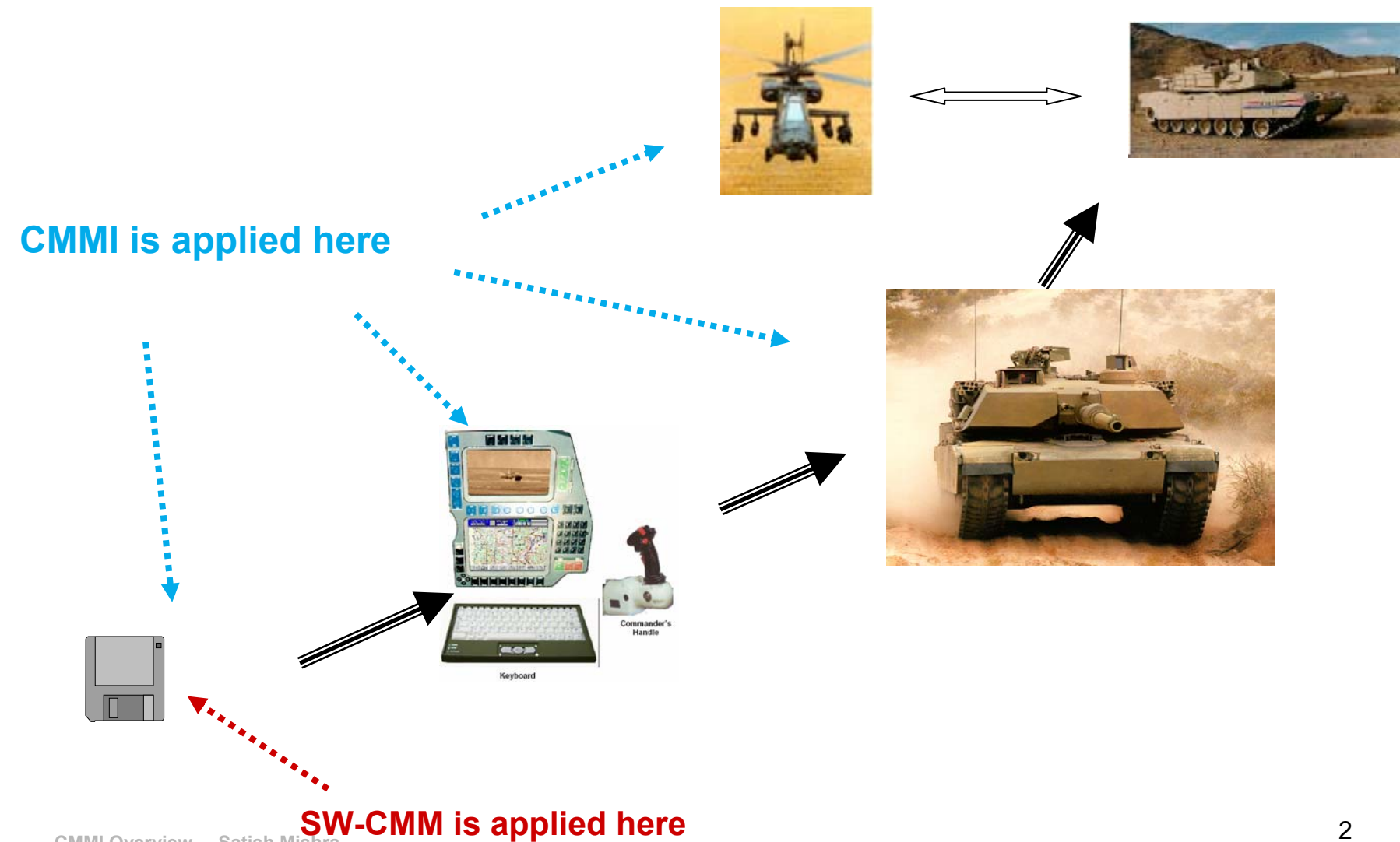


CMMI Overview

Satish Mishra

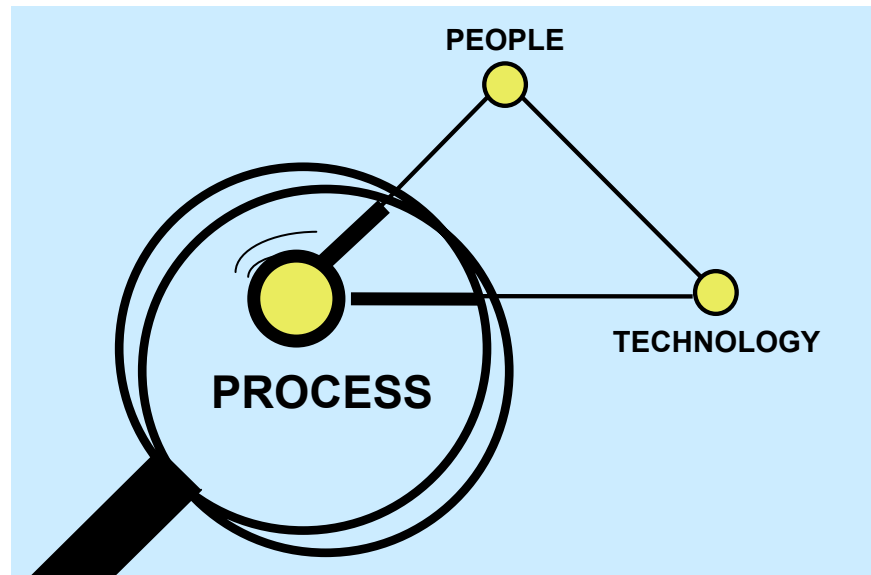
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Focus of CMMI



Quality Leverage Points

Everyone realizes the importance of having a motivated, quality work force but...



Major determinants of product cost, schedule, and quality

- **...even our finest people can't perform at their best when the process is not understood or operating "at its best."**

Why Focus on Process?

- **Process provides a constructive, high-leverage focus...**
 - **as opposed to a focus on people**
 - » Your work force, on the average, is as “good” as it is trained to be.
 - » Working harder is not the answer.
 - » Working smarter, through process, is the answer.
 - **as opposed to a focus on technology**
 - » Technology applied without a suitable roadmap will not result in significant payoff.
 - » Technology provides the most benefit in the context of an appropriate process roadmap.

Underlying Premise of Process Improvement



“The quality of a product is largely determined by the quality of the process that is used to develop and maintain it.”

Categories of Process Improvement Benefits



- **Process improvement benefits fall into eight general categories:**
 - **improved schedule and budget predictability**
 - **improved cycle time**
 - **increased productivity**
 - **improved quality (as measured by defects)**
 - **increased customer satisfaction**
 - **improved employee morale**
 - **increased return on investment**
 - **decreased cost of quality**

What is a CMM?

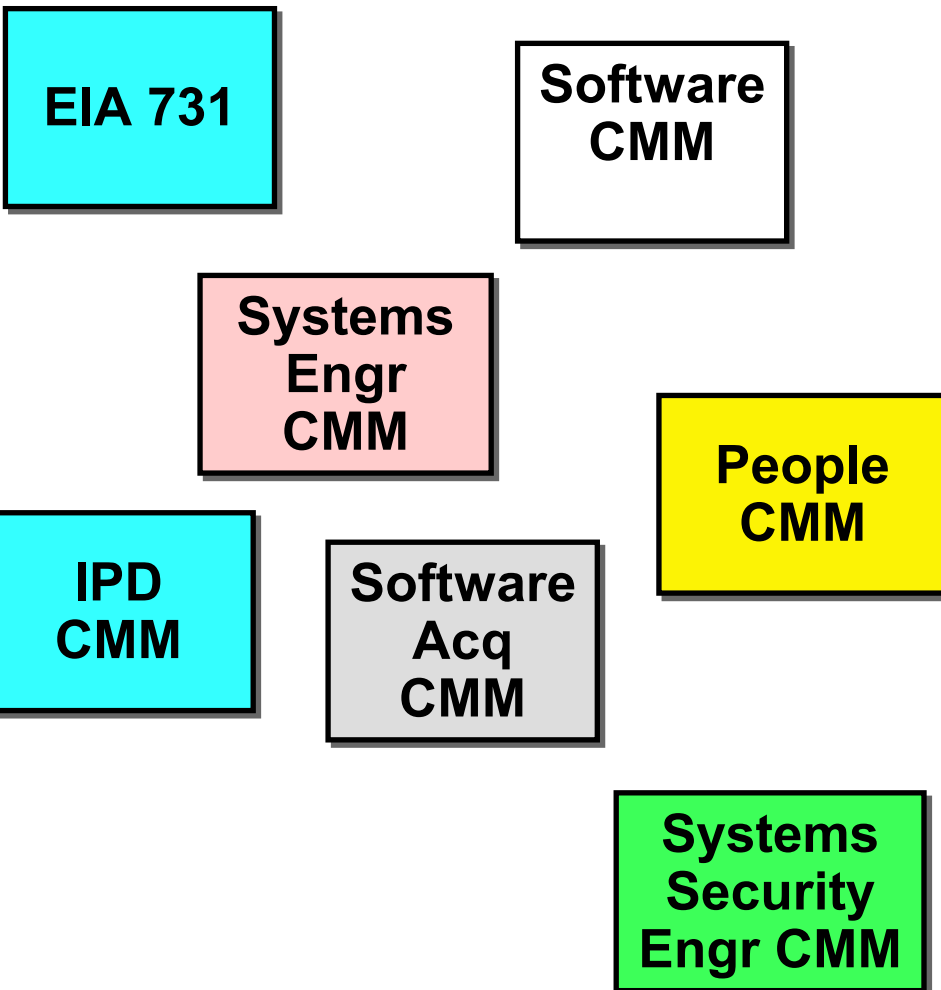
- ***Capability Maturity Model:***

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)**

So Many Models, So Little Time

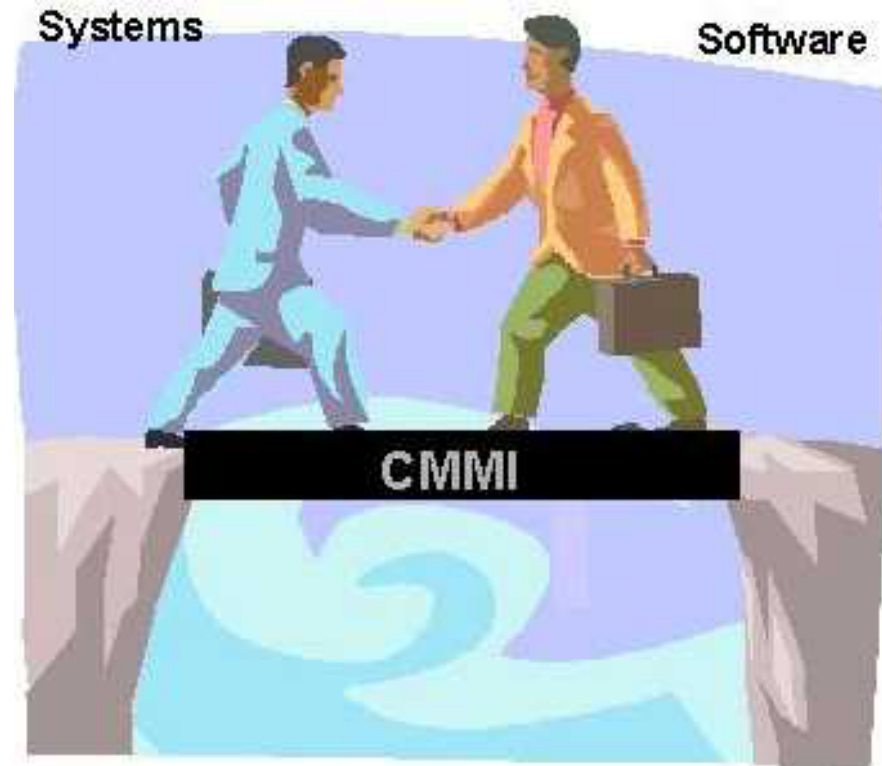


- Different structures, formats, terms, ways of measuring maturity
- Causes confusion, especially when using more than one model
- Hard to integrate them in a combined improvement program
- Hard to use multiple models in supplier selection

Bridging the Divide

CMMI:

- **Integrates systems and software disciplines into one process improvement framework.**
- **Provides a framework for introducing new disciplines as needs arise.**



The Next Step Is CMM Integration

- **The CMM Integration Project was formed to**
 - **build an initial set of integrated models**
 - **improve best practices from source models based on lessons learned**
 - **establish a framework to enable integration of future models**
 - **create an associated set of appraisal and training products**
- **Collaborative endeavor (over 100 people involved)**
 - **Industry**
 - **Government**
 - **Software Engineering Institute (SEI)**

Enterprise-Wide Improvement

- **CMMI enables organizations that want to pursue process improvement in multiple functional areas to do so with less additional investment for each additional function.**
 - **CMMI supports process integration and product improvement.**
 - **CMMI integrates multiple disciplines into one process-improvement framework.**
 - **CMMI provides a framework for introducing new disciplines as needs arise.**

Bodies of Knowledge Captured in CMMI Models

- **An organization selects the bodies of knowledge most relevant to achieving its business objectives. Bodies of knowledge* available in CMMI models include**
 - **software engineering(sw)**
 - **systems engineering(se)**
 - **integrated product and process development (IPPD)**
 - **supplier sourcing (SS)**
- ***Each body of knowledge related to product or process development in CMMI is considered a discipline.**

Software Engineering (SW)

- **SW covers the development of software systems**
- **SW focus on applying systematic, disciplined, and quantifiable approaches to the**
 - **development,**
 - **operation**
 - **maintenance**

System Engineering (SE)

- **Systems engineering covers the development of total systems, which may or may not include software**
- **Systems engineers focus on transforming customer needs, expectations, and constraints into product solutions and supporting these product solutions throughout the life of the product**

Integrated Product & process development (IPPD)



- **IPPD is a systematic approach that achieves a timely collaboration of relevant stakeholders throughout the life of the product to better satisfy customer needs, expectations, and requirements**

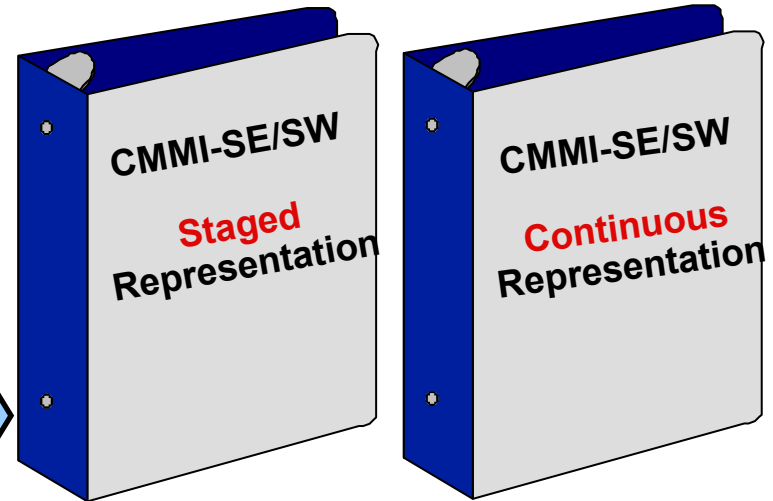
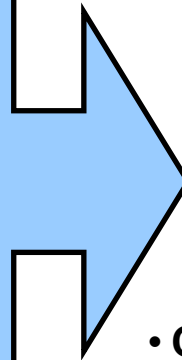
Supplier sourcing (SS)

- **As work efforts become more complex, projects may use suppliers to perform functions or add modifications to products that are specifically needed by the project. When those activities are critical, the project benefits from enhanced source analysis and from monitoring supplier activities before product delivery**

CMMI Models

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)



- Combined System Engineering / Software Engineering model
- Can be applied to:
 - Just the software engineering projects in an organization
 - Just the system engineering projects in an organization
 - Both
 - IPPD/SS can be used in either/both

Understanding CMMI Representations

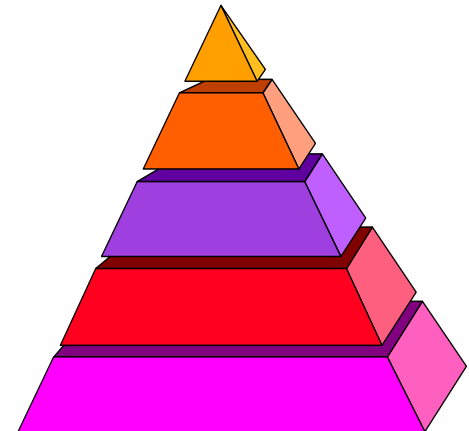


- There are two types of representations in the CMMI models:
 - staged
 - continuous
- A **representation** allows an organization to pursue different improvement objectives
- The organization and presentation of the data are different in each representation. However, the content is the same.

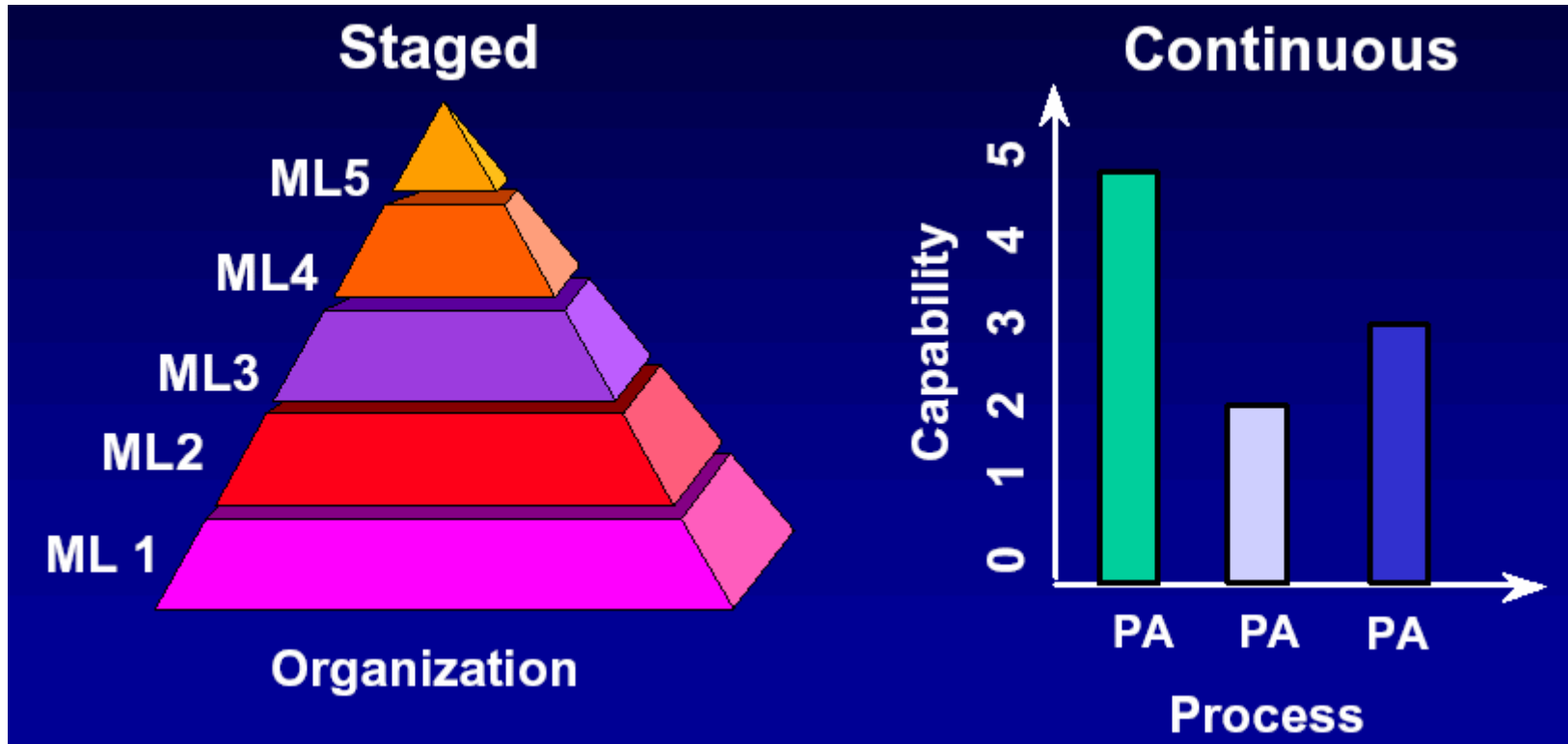
Staged Representation

- **Provides a proven sequence of improvements, each serving as a foundation for the next**
- **Permits comparisons across and among organizations by the use of maturity levels**
- **Provides an easy migration from the SW-CMM to CMMI**
- **Provides a single rating that summarizes appraisal results and allows comparisons among organizations**

Indicates maturity of an organization's standard process -- to answer, "What is a good order for approaching improvement across the organization?"



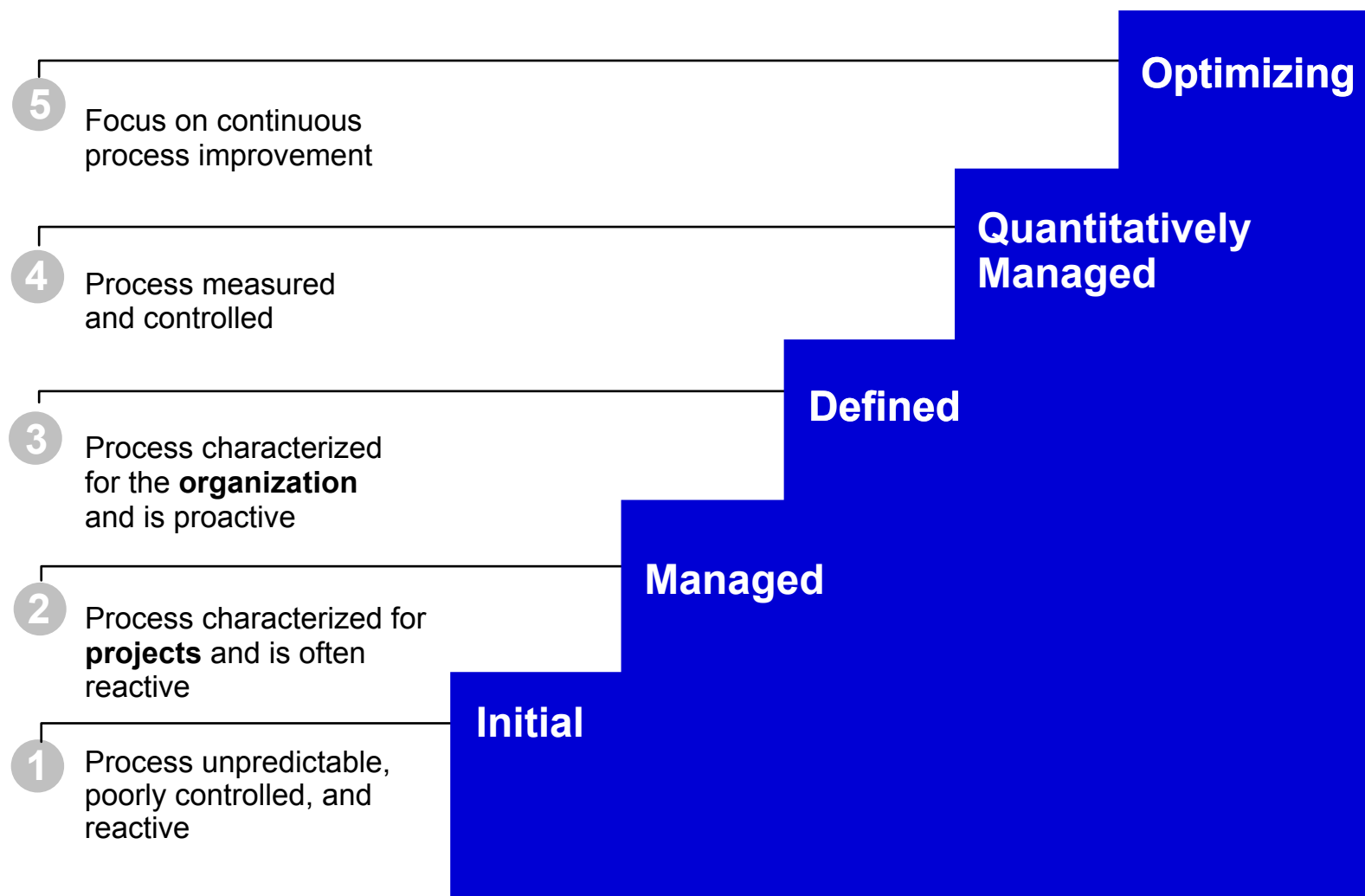
CMMI Model Representations



Maturity Levels

- A **maturity level** is a well-defined evolutionary plateau of process improvement.
- There are five maturity levels.
- Each level is a layer in the foundation for continuous process improvement using a proven sequence of improvements, beginning with basic management practices and progressing through a predefined and proven path of successive levels.

The Maturity Levels



Maturity Levels Should Not Be Skipped

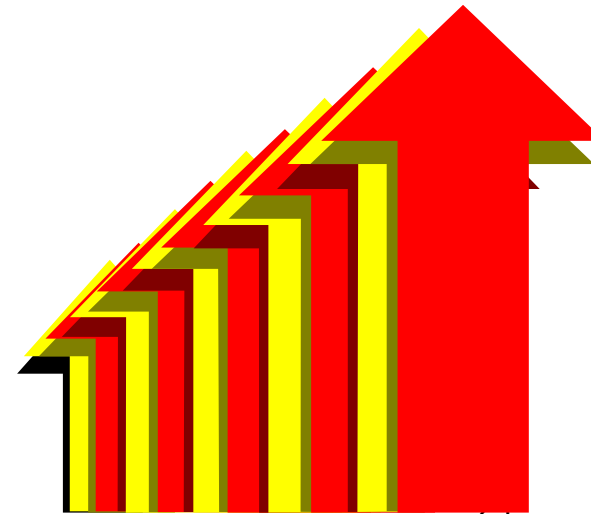


- **Each maturity level provides a necessary foundation for effective implementation of processes at the next level.**
 - **Higher level processes have less chance of success without the discipline provided by lower levels.**
 - **The effect of innovation can be obscured in a noisy process.**
- **Higher maturity level processes may be performed by organizations at lower maturity levels, with the risk of not being consistently applied in a crisis.**

Continuous Representation

- **Allows you to select the order of improvement that best meets your organization's business objectives and mitigates your organization's areas of risk**
- **Enables comparisons across and among organizations on a process-area-by-process-area basis**
- **Provides an easy migration from EIA 731 (and other models with a continuous representation) to CMMI**

Indicates improvement within a single process area -- to answer, "What is a good order for approaching improvement of this process area?"



Capability Levels

- A **capability level** is a well-defined evolutionary plateau describing the organization's capability relative to a process area.
- There are six capability levels.
- For capability levels 1-5, there is an associated generic goal.
- Each level is a layer in the foundation for continuous process improvement.
- Thus, capability levels are cumulative, i.e., a higher capability level includes the attributes of the lower levels.

The Capability Levels

5 Optimizing

4 Quantitatively Managed

3 Defined

2 Managed

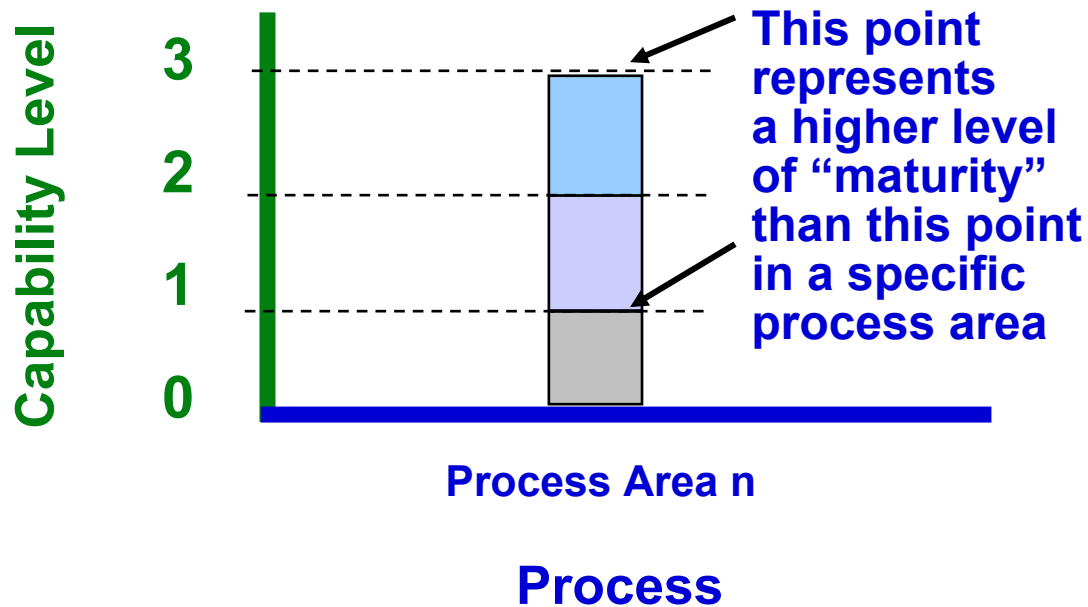
1 Performed

0 Incomplete



Representing Capability Levels for a Single Process Area

- The process area capability of an implemented process can be represented by a bar.



Relating Process Area Capability and Organizational Maturity

- **Organizational maturity** is the focus of the staged representation, whereas **process area capability** is the focus of the continuous representation.
- **Organizational maturity** and **process area capability** are similar concepts.
- The difference between them is that **organizational maturity** pertains to a set of process areas across an organization, while **process area capability** deals with a set of processes relating to a single process area or specific practice.

Comparison of Representations

Staged

- **Process improvement is measured using maturity levels.**
- **Maturity level** is the degree of process improvement across a predefined set of process areas.
- **Organizational maturity** pertains to the “maturity” of a set of processes across an organization

Continuous

Process improvement is measured using **capability levels**.

Capability level is the achievement of process improvement within an individual process area.

Process area capability pertains to the “maturity” of a particular process across an organization.

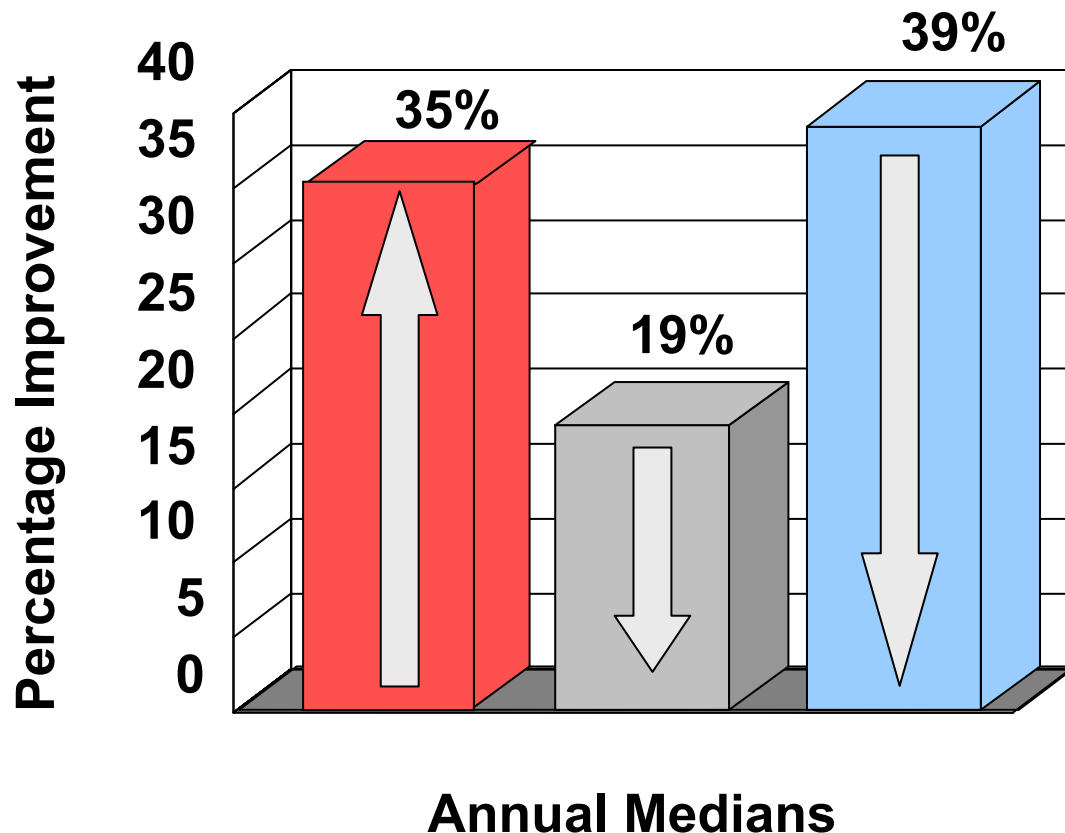
Advantages of Each Representation

- Staged
 - **Provides a roadmap for implementing**
 - groups of process areas
 - sequencing of implementation
 - **Familiar structure for those transitioning from the Software CMM**
- Continuous
 - **Provides maximum flexibility for focusing on specific process areas according to business goals and objectives**
 - **Familiar structure for those transitioning from EIA 731**

CMMI in a Nutshell

- **A CMMI model provides a structured view of process improvement across an organization**
- **CMMI can help**
 - **set process improvement goals and priorities**
 - **provide guidance for quality processes**
 - **provide a yardstick for appraising current practices**

Improvements from Adopting Software CMM



Savings vs. cost of software process improvement (median) 5:1

- **Productivity (increase)**
- **Time to market (reduction)**
- **Post-release defect reports (reduction)**

Benefits of Continuing Process Improvement



- **SEI Software CMM Level 5: For the Right Reasons***
 - Defects are now nearly all found and fixed before testing begins.
 - Defects escaping into the field have been reduced from 11% to practically 0%.
 - Programs consistently reach customer satisfaction and performance targets.
 - Peer reviews increase total project costs by 4%, but reduced rework during testing by 31%. R.O.I. is 7.75:1.

CMM“I” – Improvement

- **The CMMI Product Suite provides a foundation for *enterprise-wide improvement* and adds**
 - new emphasis on products and services as well as process
 - emphasis on both process capability and organizational maturity
 - early emphasis on measurement and analysis
- **The CMMI model improves upon Software CMM V1.1 and Software CMM V2.0 Draft C.**

CMM“I” – Integration

- Provides expanded model scope for *integration*
 - Integrated Product Management
 - Integrated Supplier Management
 - Decision Analysis and Resolution
 - “Relevant Stakeholder” planning and execution
 - Inclusion of the Integrated Product and Process Development body of knowledge

Improving on the Software CMM

- **CMMI Models improve on the best practices in Software CMM Version 2.0 Draft C:**
 - **Incorporates 4+ additional years of learning**
 - **More explicitly links management and engineering activities to business objectives**
 - **Expands the scope of and visibility into the product life cycle and engineering activities to ensure the product or service meets customer expectations**
 - **Incorporates additional areas of best practice (e.g., measurement, risk management, bi-directional traceability in requirements management, decision analysis and resolution, and supplier management)**
 - **Captures more robust high-maturity practices**
 - **Addresses additional generic practices needed for institutionalization**
 - **More fully complies with relevant ISO standards**

CMMI Can Benefit You

- **CMMI provides**
 - **Efficient, effective assessment and improvement across multiple process disciplines in an organization**
 - **Improvements to best practices incorporated from the Software CMM**
 - **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 Product Suite

- **Models**

- **Disciplines**

- » Systems Engineering SE
 - » Software Engineering SW
 - » Integrated Product and Process Development (IPPD)
 - » Supplier Sourcing (SS)

- **Representations**

- » Staged
 - » Continuous

Available Models

- **The following CMMI Models exist:**
 - **SE/SW Staged**
 - **SE/SW Continuous**
 - **SE/SW/IPPD Staged**
 - **SE/SW/IPPD Continuous**
 - **SE/SW/IPPD/SS Staged**
 - **SE/SW/IPPD/SS Continuous**
 - **SW Staged**
 - **SW Continuous**

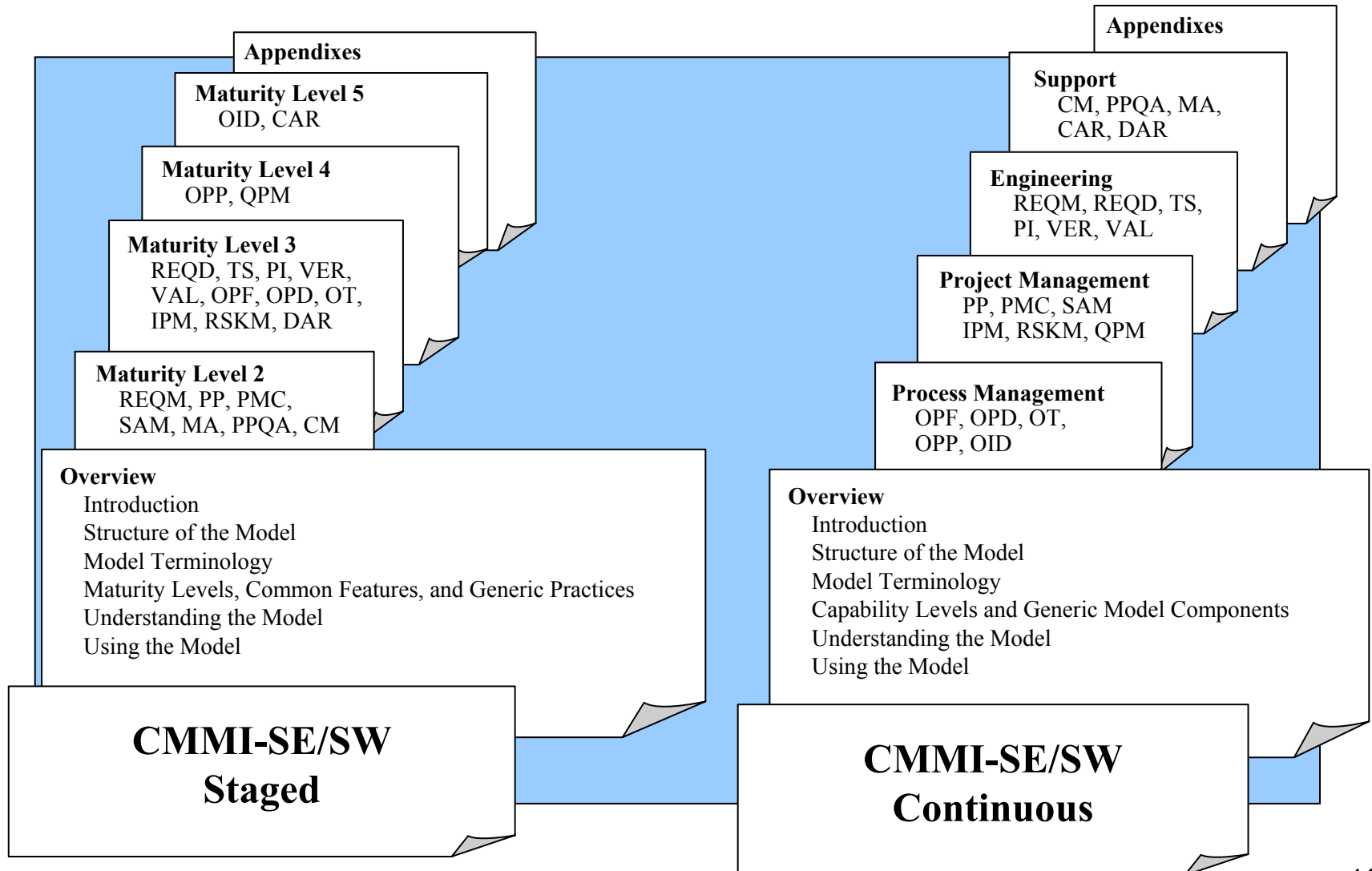
Selecting a Discipline to Use

- Different model versions exist
 - CMMI-SW -- CMMI-SE/SW/IPPD
 - CMMI-SE/SW -- CMMI-SE/SW/IPPD/SS
- You select which disciplines you wish to use, based on where you are trying to improve
- **Example** – A company which engineers and builds computer systems, by acquisition of COTS hardware and development of custom software, using integrated teams
 - Use CMMI-SW applied only to the software development
 - Use CMMI-SE/SW applied to the computer system and the software
 - Use CMMI-SE/SW/IPPD applied to the system, software, and use of teams
 - Use CMMI-SE/SW/IPPD applied to the system, software, teams, and COTS acquisition



CMMI Structure

one Model, Two Representations



Model Components

• Process Areas (PA)

– Specific Goals (SG)

» Specific Practices (SP)

- Typical Work Products
- Sub-practices
- Notes
- Discipline Amplifications
- References

Required

Expected

Informative

Informative

Informative

Informative

Informative

– Generic Goals (GG)

» Generic Practices (GP)

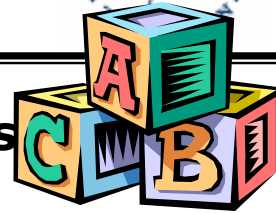
- Generic Practice Elaborations

Required

Expected

Informative

Practices



- Practices are the building blocks of the process areas
- Example - Project Planning Process Area
 - Specific Practice 1.1 - Establish a top-level work breakdown structure (WBS) to estimate the scope of the project.*
- To satisfy the required goals, you are expected to perform the practices
 - Most commercial and defense projects/organizations will implement as written
- You may perform equivalent practices if they have an equivalent effect toward satisfying the generic or specific goal
 - These are termed “alternative practices”
 - Less prevalent in CMMI than in SW-CMM, because the CMMI practices are at a slightly higher level of abstraction
 - “Equivalent” is a judgment call – discuss with your appraiser

Specific Practices vs. Generic Practices



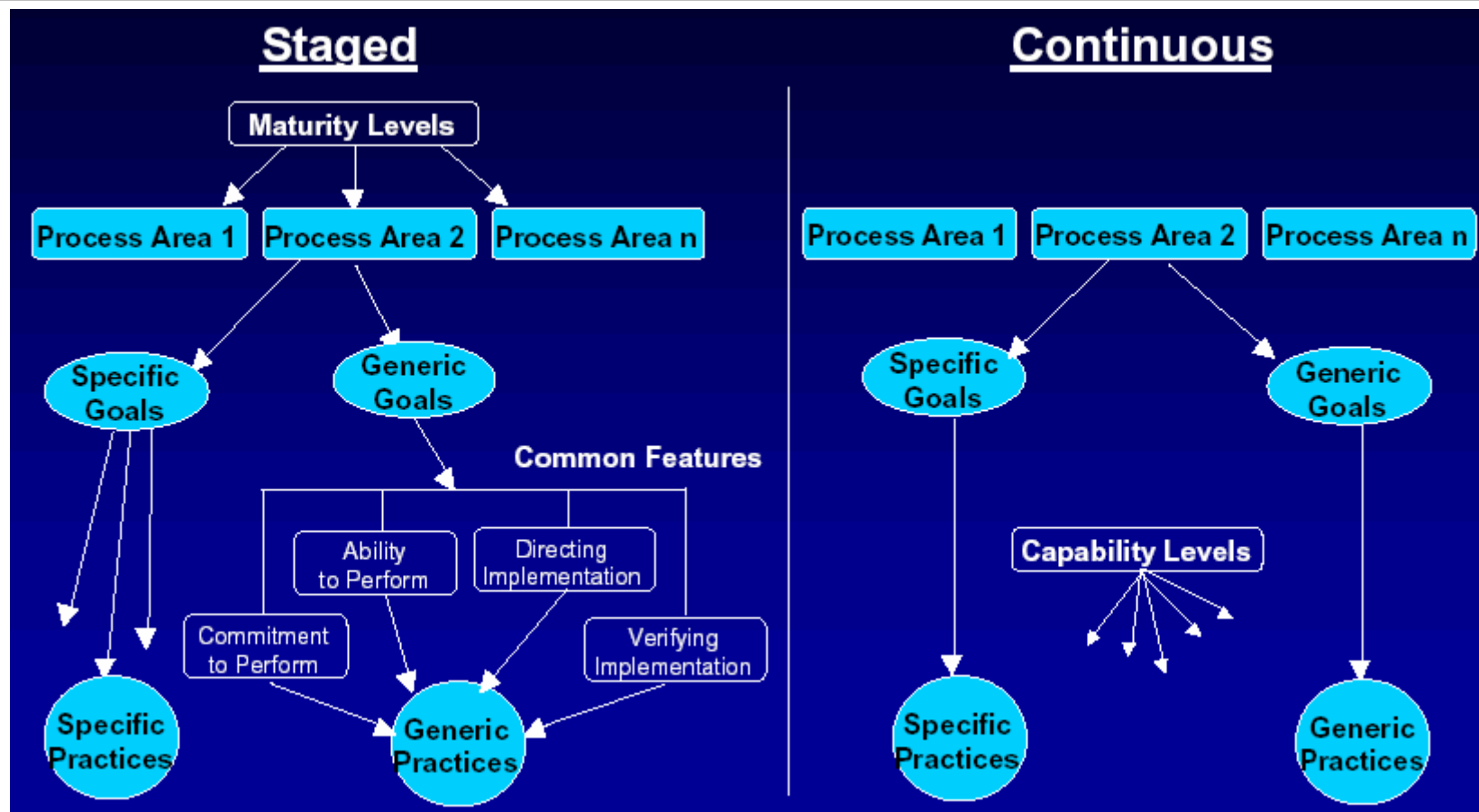
- Apply to a single process area
- Describe activities that implement the process area
- *Example – Requirements Mgmt.*

- **SG 1 Manage Requirements**
 - SP 1.1 Obtain an Understanding of Requirements
 - SP 1.2 Obtain Commitment to Requirements
 - SP 1.3 Manage Requirements Changes
 - SP 1.4 Maintain Bidirectional Traceability of Requirements
 - SP 1.5 Identify Inconsistencies between Project Work and Requirements

- Apply to all process areas
- Describe activities that institutionalize the process areas

- **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 Manage Configurations
 - 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
- **GG 3 Institutionalize a Defined Process**
 - GP 3.1 Establish a Defined Process
 - GP 3.2 Collect Improvement Information

CMMI Model Structure



Staged Representation: 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> (SS) (IPPD) (IPPD)	Requirements Development Technical Solution Product Integration Verification Validation Organizational Process Focus Organizational Process Definition Organizational Training Integrated Project Management Integrated Supplier Management Risk Management Decision Analysis and Resolution Organizational Environment for Integration Integrated Teaming
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		

Continuous Representation: Organization of Process Areas



Category	Process Area
Project Management	Project Planning Project Monitoring and Control Supplier Agreement Management Integrated Project Management (IPPD) Integrated Supplier Management (SS) Integrated Teaming (IPPD) Risk Management Quantitative Project Management
Support	Configuration Management Process and Product Quality Assurance Measurement and Analysis Causal Analysis and Resolution Decision Analysis and Resolution Organizational Environment for Integration (IPPD)
Engineering	Requirements Management Requirements Development Technical Solution Product Integration Verification Validation
Process Management	Organizational Process Focus Organizational Process Definition Organizational Training Organizational Process Performance Organizational Innovation and Deployment

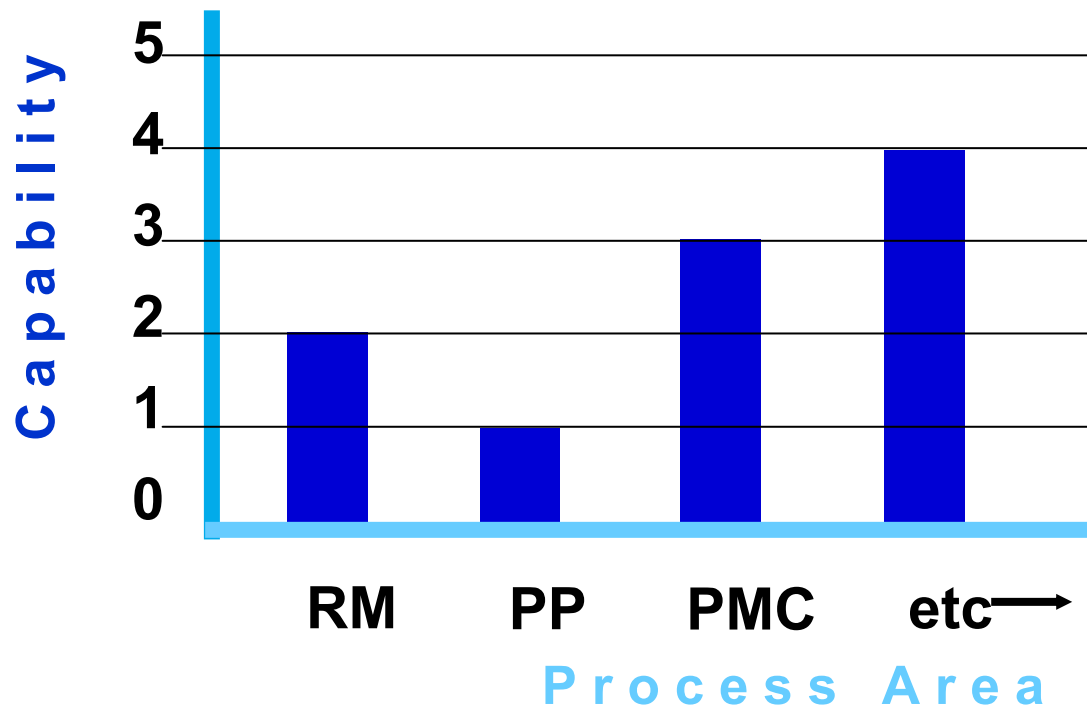
Process Area Capability Profile

A process area capability profile may be represented by a set of points in two dimensions.

- the *process dimension*
 - »“What” you do
- the *capability dimension*
 - »“How well” you do it



An Example Process Area Capability Profile



SW-CMM V1.1 vs. CMMI V1.1

Key Process Areas (KPAs)

Process Areas (PAs)

LEVEL 5 OPTIMIZING

Defect Prevention
Technology Change Mgmt
Process Change Management

Causal Analysis and Resolution
Organizational Innovation & Deployment

LEVEL 4 MANAGED

Quantitative Process Mgmt
Software Quality Mgmt

Organizational Process Performance
Quantitative Project Management

Organization Process Focus
Organization Process Definition
Training Program
Integrated Software Mgmt

Organization Process Focus
Organization Process Definition
Organizational Training
Integrated Project Management

Software Product Engr

Risk Management
Requirements Development
Technical Solution
Product Integration

Intergroup Coordination
Peer Reviews

Verification
Validation
Decision Analysis and Resolution

LEVEL 3 DEFINED

Requirements Management
Software Project Planning
Software Project Tracking & Oversight
Software Subcontract Mgmt
Software Quality Assurance
Software Configuration Mgmt

Requirements Management
Project Planning
Project Monitoring and Control
Supplier Agreement Management
Product & Process Quality Assurance
Configuration Management
Measurement and Analysis

LEVEL 2 REPEATABLE

- **There are eight Project Management Process Areas.**
 - **Project Planning**
 - **Project Monitoring and Control**
 - **Integrated Project Management (IPPD)**
 - **Risk Management**
 - **Supplier Agreement Management**
 - **Quantitative Project Management**
 - **Integrated Supplier Management (SS)**
 - **Integrated Teaming (IPPD)**

PP - Capability Level 1

Project Planning

Specific Practices (CL1 - “Base Practices”)

- SP1.1-1: Estimate the Scope of the Project
- SP1.2-1: Establish Estimates of Work Product and Task Attributes
- SP1.3-1: Define Project Life Cycle
- SP1.4-1: Determine Estimates of Effort and Cost
- SP2.1-1: Establish Budget and Schedule
- SP2.2-1: Identify Project Risks
- SP2.3-1: Plan for Data Management
- SP2.4-1: Plan for Project Resources
- SP2.5-1: Plan for Needed Knowledge and Skills
- SP2.6-1: Plan Stakeholder Involvement
- SP2.7-1: Establish the Project Plan
- SP3.1-1: Review Plans that Affect the Project
- SP3.2-1: Reconcile Work and Resource Levels
- SP3.3-1: Obtain Plan Commitment

Generic Practices (CL1))

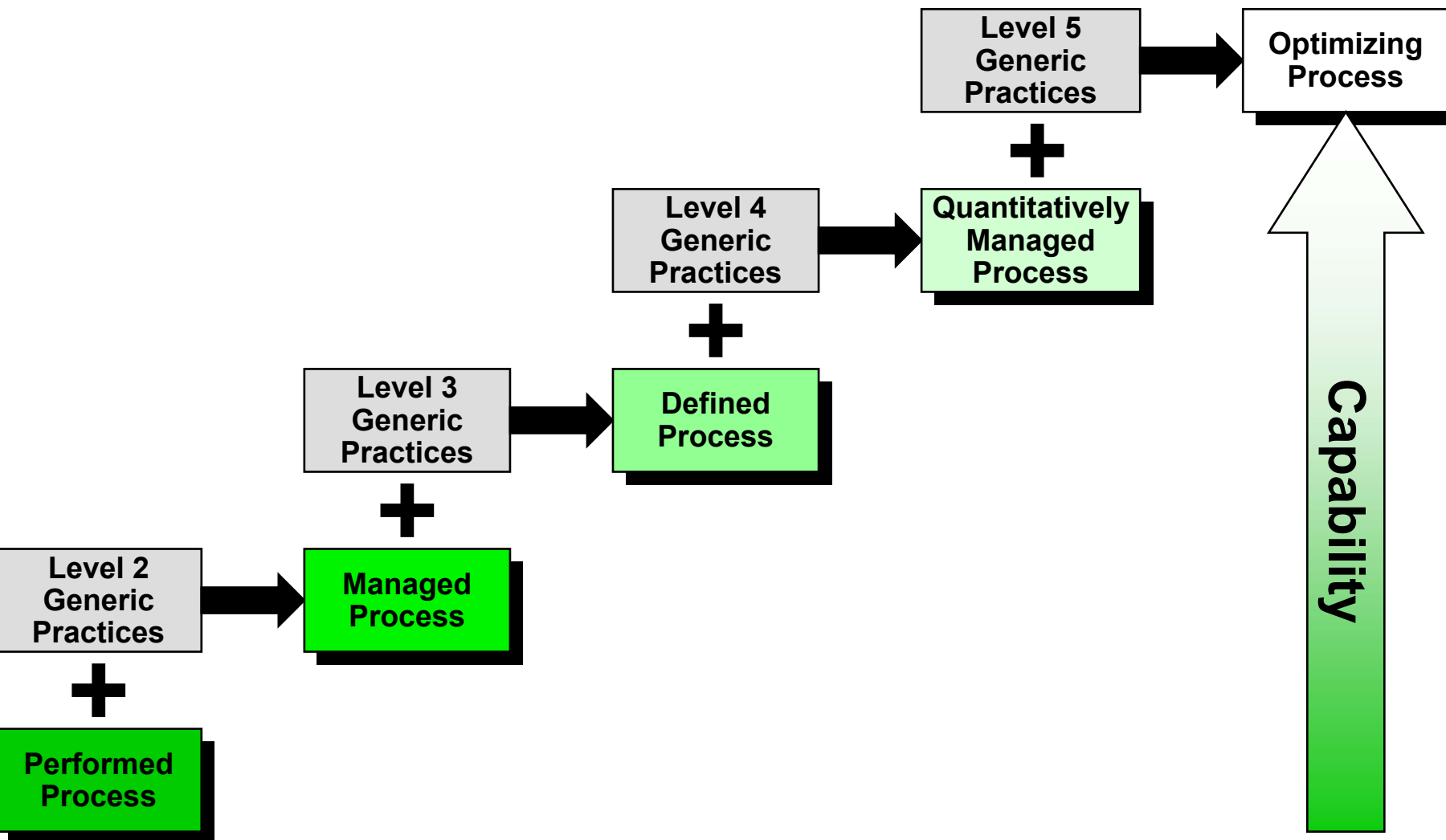
GP1.1: Perform Base Practices

If all of the base practices are performed,

Then, the associated Specific Goals and Generic Goal 1 are satisfied,

So, the Process Area is rated at Capability Level 1 (CL1) - Performed.

Building Process Capability



Support Process Areas

There are six Support Process Areas:

- **Configuration Management**
- **Process and Product Quality Assurance**
- **Measurement and Analysis**
- **Causal Analysis and Resolution**
- **Decision Analysis and Resolution**
- **Organizational Environment for Integration (IPPD)**

Understanding Support Processes

- **Support process areas cover the practices that support product development, maintenance, and acquisition.**
- **They provide essential processes used by all the CMMI process areas, and are typically used in the context of performing other processes.**

Engineering Process Areas

- **There are six Engineering Process Areas.**
 - **Requirements Management**
 - **Requirements Development**
 - **Technical Solution**
 - **Product Integration**
 - **Verification**
 - **Validation**

Process Management Process Areas

- **There are five Process Management Process Areas:**
 - **Organizational Process Focus**
 - **Organizational Process Definition**
 - **Organizational Training**
 - **Organizational Process Performance**
 - **Organizational Innovation and Deployment**

Understanding Process Management Process Areas



- **The process management PAs apply across the *organization* as a whole and provide details that support the Capability Level 3 Generic Goal.**
- **For selected PAs, the organization has standard processes, which individual projects tailor to their needs.**

About IPPD

Integrated Product and Process Development

- IPPD affects all process areas.
- IPPD is *not* a discipline like SE or SW.
- Rather, it is a way of doing business.
- IPPD is employed in conjunction with the CMMI disciplines (software and systems engineering).
- Implementation of IPPD shapes how you perform the work in these disciplines.

IPPD - Definition

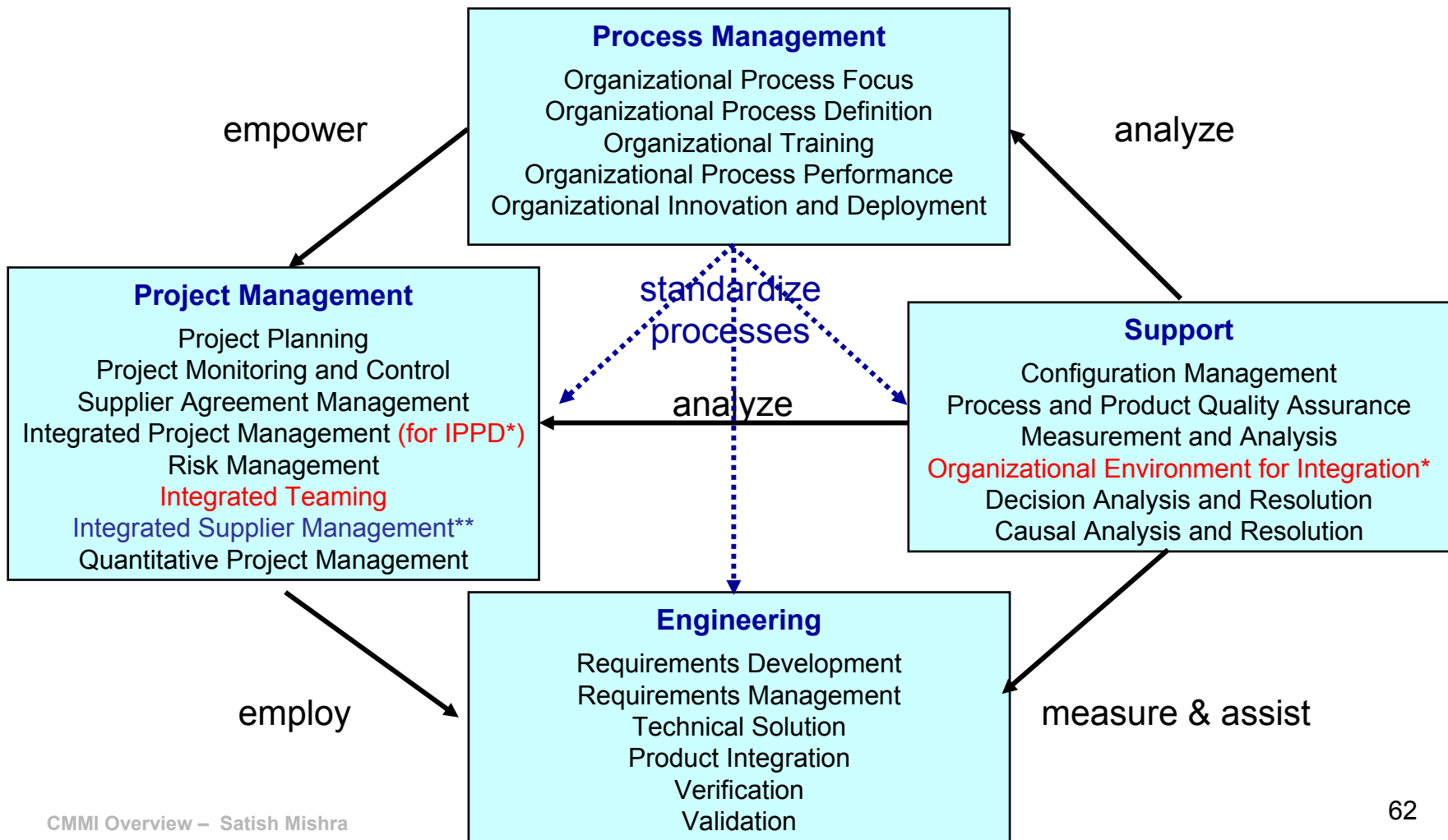
IPPD provides a systematic approach to product development that achieves a timely collaboration of relevant stakeholders throughout the product life cycle to better satisfy customer needs.

Scope of IPPD

CMMI SE/SW/IPPD adds to CMMI SE/SW:

- Two new process areas**
 - »Organizational Environment for Integration
 - »Integrated Teaming
- A revised Integrated Project Management (IPPD) process area (adds SG3 and SG4)**
- IPPD amplifications and references**
- New glossary definitions and acronyms**
- Overview material**

Process Areas Organized by Category



Summary

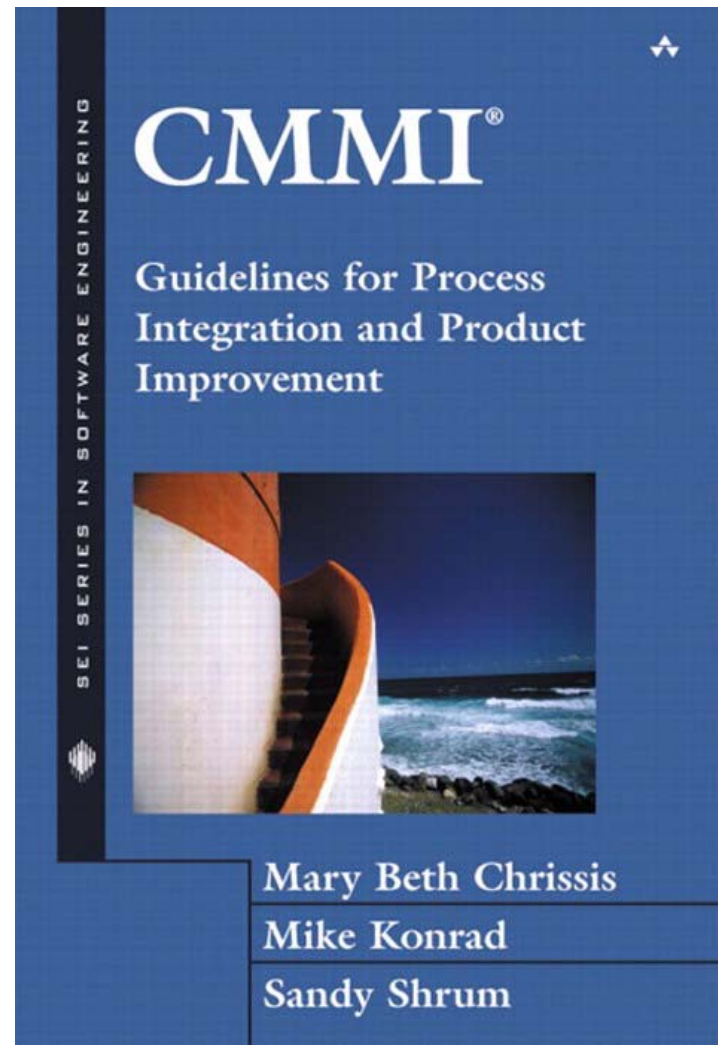
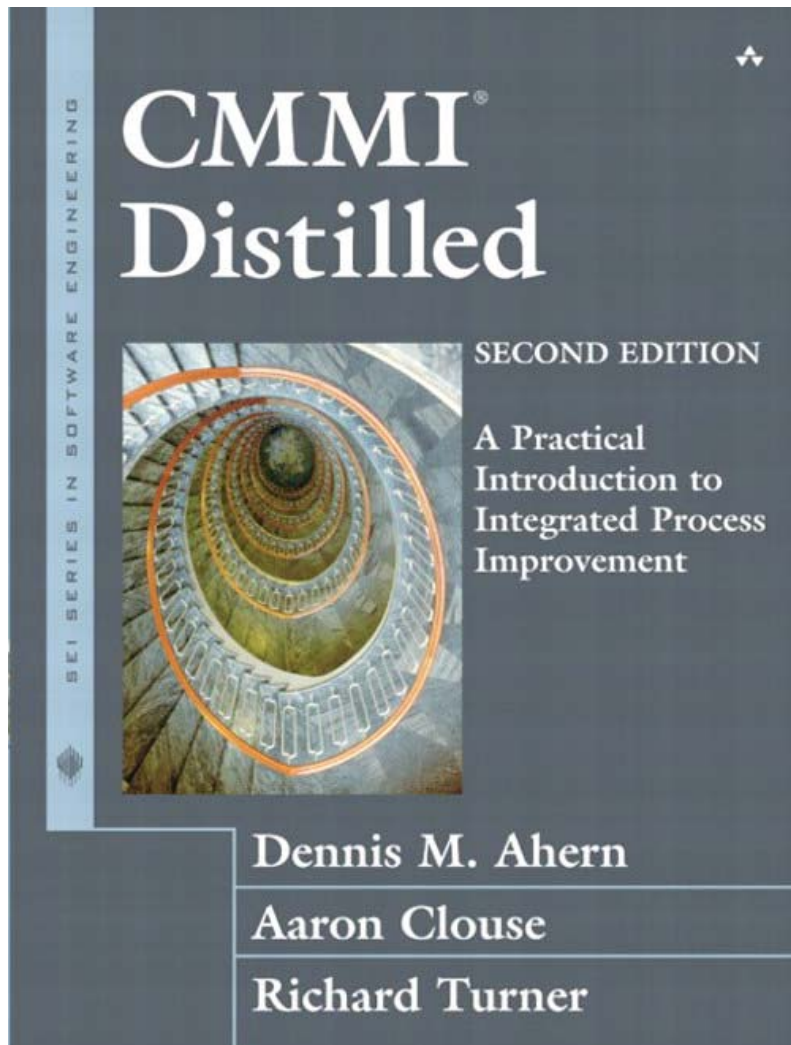
- **There is one CMMI Model with two representations, Staged and Continuous**
- **The material in both representations is the same just organized differently**
- **Each representation provides different ways of implementing processes**
- **Equivalent Staging provides a mechanism for relating Maturity Levels to Capability Levels**
- **The CMMI model should be applied using intelligence, common sense, and professional judgment**

For More Information About CMMI

–Go to CMMI Website

- » <http://sei.cmu.edu/cmmi>
- » <http://seir.sei.cmu.edu/seir/>
- » <http://www.ndia.org/> (annual CMMI Conference)
- » www.google.com

Further Reading



Thank you