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The Rational Unified Process® and the Capability Maturity Model® – Integrated Systems/Software Engineering

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Topics

- Goals and Purpose
- CMMI Overview
- RUP Overview
- RUP to CMMI Mapping
- Lessons Learned

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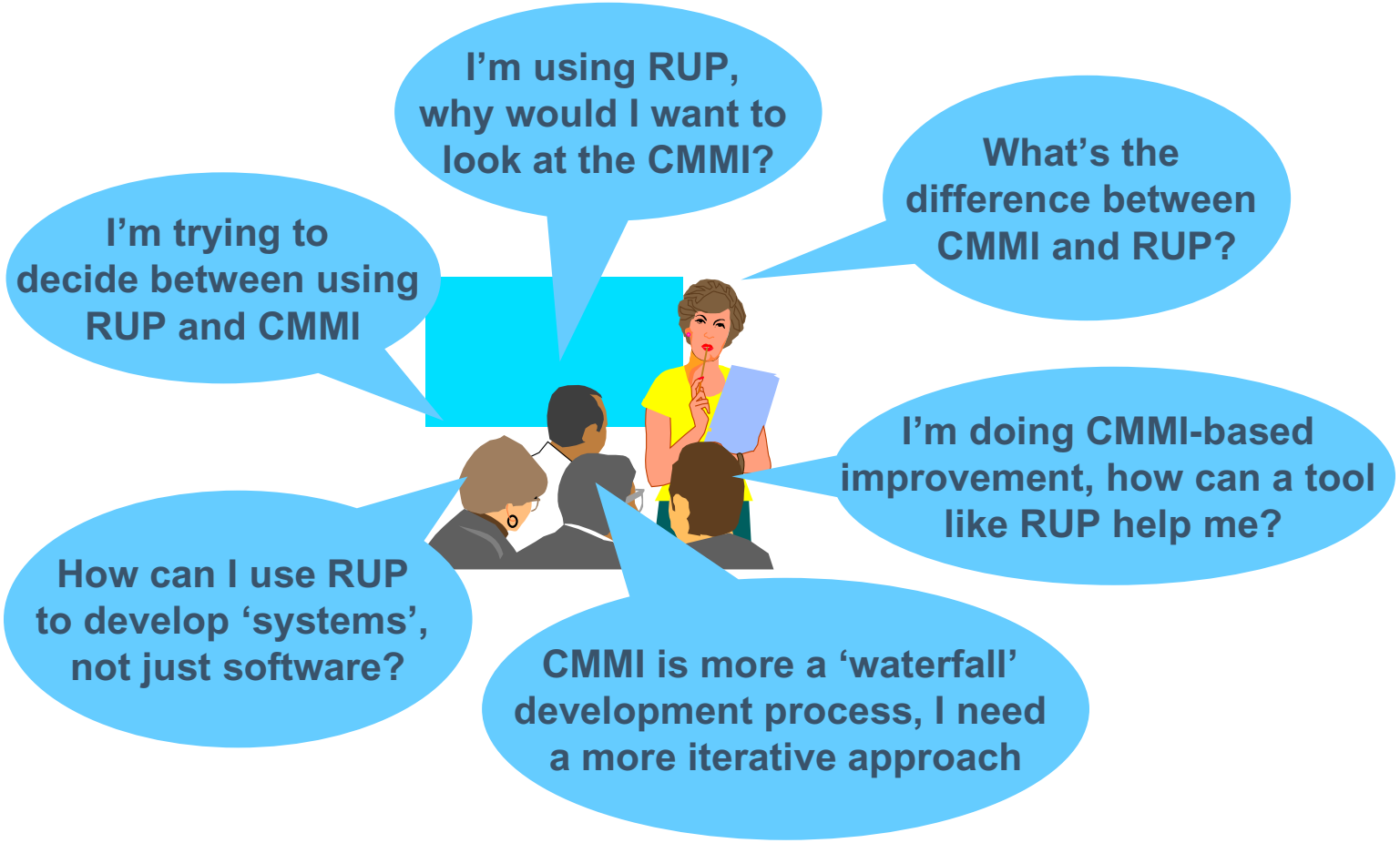
What We've Heard



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Our Approach

- Plan
  - Set comparison objectives
  - Select review team
  - Identify the RUP/CMMI authoritative source and constituent elements to be used in the comparison
  - Determine comparison information to capture
- Train review team on CMMI
- Determine how RUP supports CMMI
- Determine how CMMI supports RUP
- Report the results
  - Develop this tutorial
  - Develop a detailed Technical Report (~Aug 01)

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Tutorial Goals

Explore commonalities between RUP and CMMI

Identify differences between RUP and CMMI

Recommend improvements in RUP and CMMI to strengthen both

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Intended Audience

Organizations engaged in CMMI-based improvement considering using RUP

Organizations using RUP who are considering CMMI-based improvement

Appraisal teams using CMMI as a “yardstick” for organizations or projects using RUP

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Topics

Goals and Purpose

CMMI Overview

RUP Overview

RUP to CMMI Mapping

Lessons Learned

What Is CMMI?

A framework of the key process elements for a system development

- structured collection of processes proven through experience

An integrated view of process improvement across multiple disciplines

- sets process improvement goals and priorities
- provides guidance for quality processes
- provides a yardstick for assessing current practices

Based on concepts and approaches pioneered by Crosby, Deming, Juran, Humphrey, et. al

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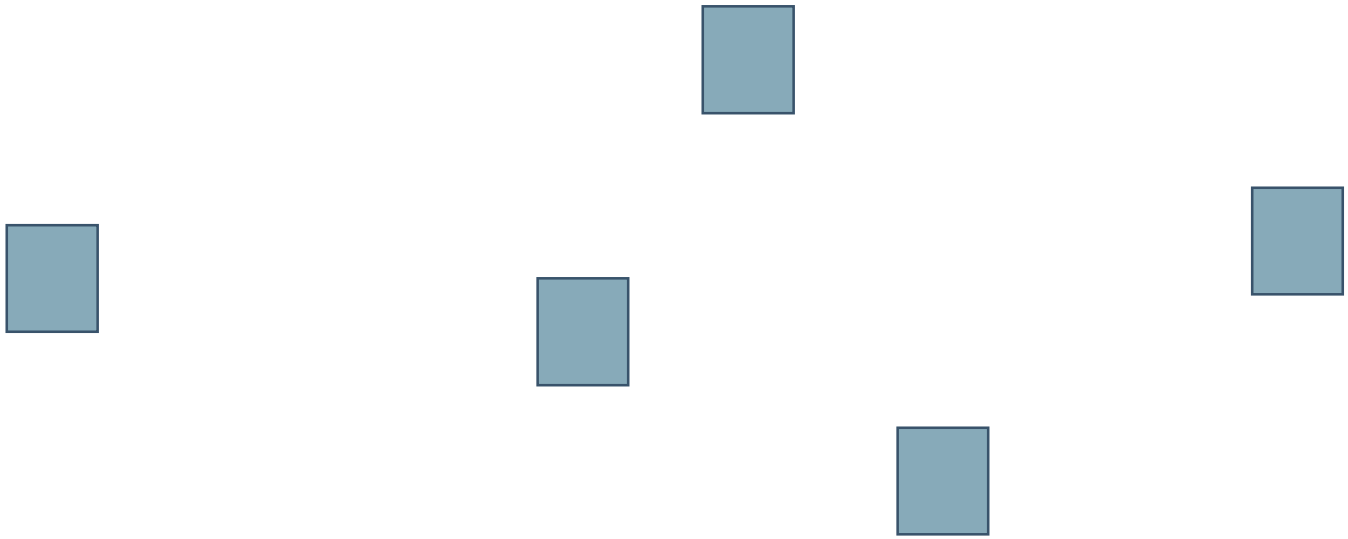
Elements of an Effective Process -1



= CMMI Key Elements

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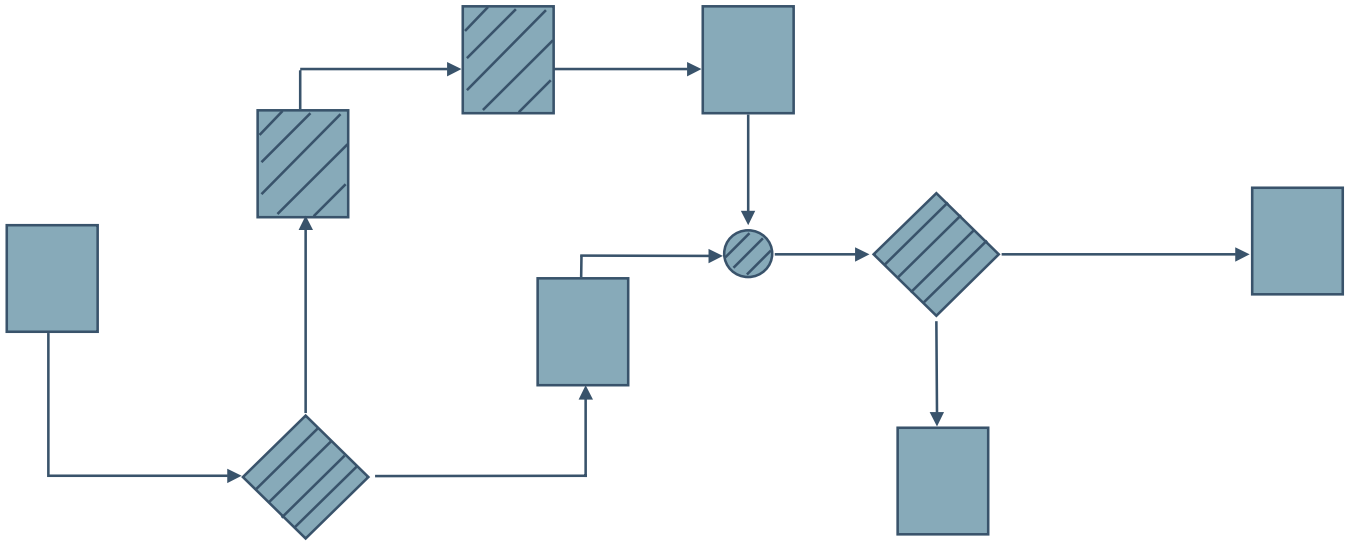
Elements of an Effective Process -2



= CMMI Key Elements

= Your Project's Additional Elements

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Capability and Maturity

Process capability pertains to an individual process

- Knowing the process capabilities of a collection of processes has implications for organizational maturity

Organizational maturity pertains to a set of processes

- Being at a particular level of organizational maturity has process capability implications for multiple processes

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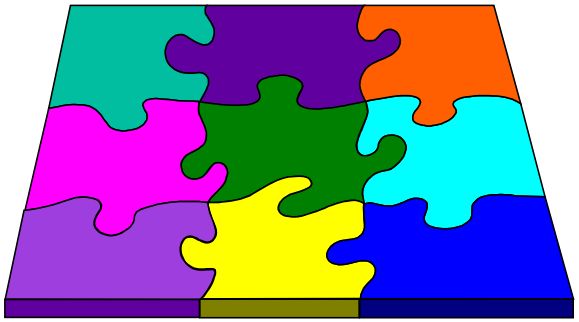
CMMI Model Representations

Two approaches to process improvement

- process capability
- organizational maturity



CMMI models support each approach with a *representation*

- process capability approach ==> **continuous** representation
- organizational maturity approach ==> **staged** representation

Which representation to use is based on the purpose of the improvement task

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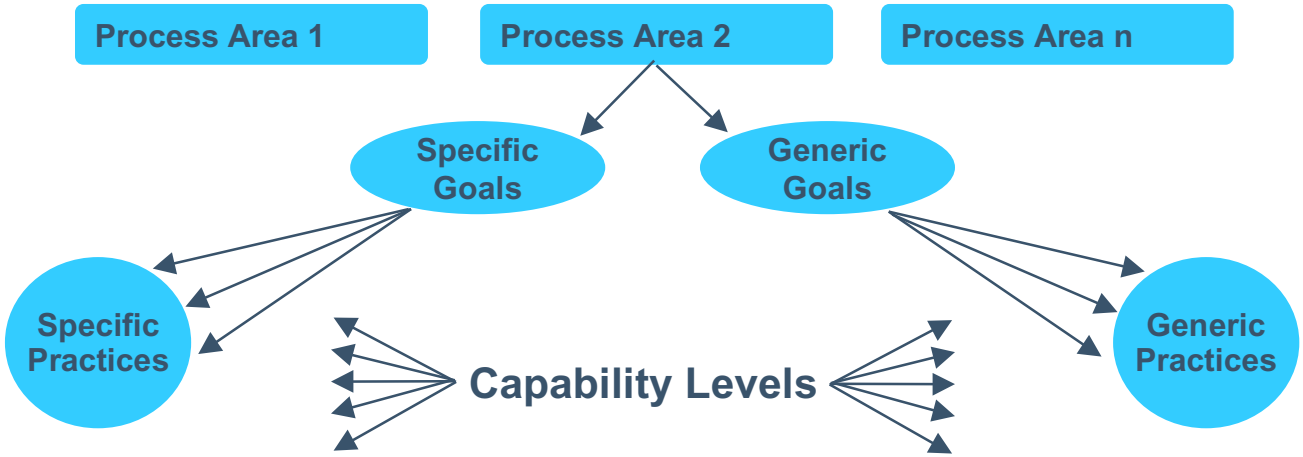
CMMI Model Components



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Continuous Representation Structure

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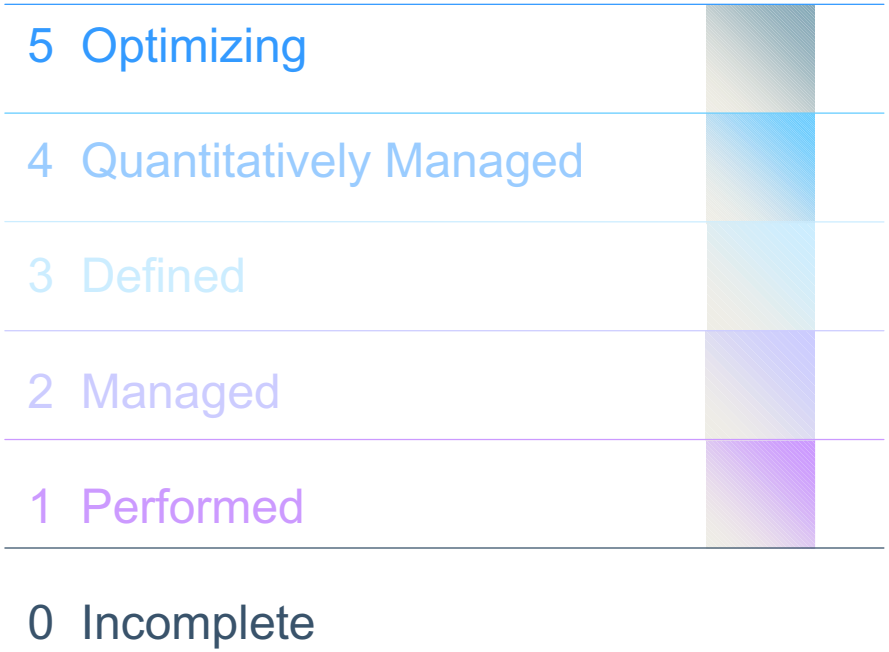
Capability Levels

A capability level is

- A well-defined evolutionary plateau describing the capability of any Process Area
- A layer in the foundation for continuous process improvement



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

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Topics

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RUP Overview*

RUP to CMMI Mapping

Lessons Learned

*Material based on *The Rational Unified Process; An Introduction*, Philippe Kruchten, Second Edition. Addison-Wesley, 2000

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What is RUP?

A software engineering process based on best practices in modern software development

- A disciplined approach to assigning and managing tasks and responsibilities in a development organization
- Focused on high-quality software that meets the needs of its end users within a predictable schedule and budget

A process framework that can be tailored to specific organization or project needs

A process product developed and marketed by Rational Software with an interactive knowledge base integrated with tools

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Key Aspects of RUP

Risk-driven process

- Risk management integrated into the development process
- Iterations are planned based on high priority risks

Use-case driven development

- Use cases express requirements on the system's functionality and model the business as context for the system
- Use cases are defined for the intended system and are used as the basis of the entire development process

Architecture-centric design activities

- Architecture is the primary artifact to conceptualize, construct, manage, and evolve the system
- Consists of multiple, coordinated views (or models) of the architecture

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RUP Basic Principles

Develop Software Iteratively

- Driven by early risk identification and mitigation
- Each iteration results in an executable release

Manage Requirements

- Requirements inherently dynamic across the system's life

Use Component-Based Architecture

- Architectures that are resilient to change are essential

Visually Model Software

- Promotes consistency and unambiguous communication of development information

Continuously Verify Software Quality

- Identify defects early, objective measure of project status

Control Changes to Software

- Create and release a tested baseline at the end of each iteration

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RUP Architecture

RUP produces a software generation

- A generation extends from idea to retirement of a single version of the system

Static Structure

- Describes the process in terms of who is doing what, how, and when

Dynamic Structure

- Describes the process in terms of how the process rolls out over time
- Expressed in terms of iterations, phases, and milestones

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Static Process Elements

Worker (who)
A role that defines the individuals or a team that should carry out the work

Activity (how)
Describes a piece of work a worker performs

Artifact (what)
A piece of information that is produced, modified, or used by an activity

Workflow (when)
Specifies when a set of related *activities* is performed, by which *workers*, producing some *artifact*, which provides some observable value to the project

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RUP Workflows - 1

Project Management	• Plan an iterative process • Decide duration and content of an iteration
Business Modeling	• Understand the organization structure and dynamics in which a system is to be deployed
Requirements	• Capture and manage requirements • Design a user interface focused on users needs and goals
Analysis and Design	• Translate requirements into a specification that describes how to implement the system

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RUP Workflows - 2

Implementation	• Create, assemble, and integrate components and subsystem into an executable system
Test	• Assess product quality
Configuration and Change Management	• Track and maintain the integrity of evolving project assets
Environment	• Support the development organization with processes and tools
Deployment	• Turn the finished software product over to its users

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Additional Static Elements

Guidelines

- Rules, recommendations, techniques, or heuristics to support activities and artifacts

Templates

- Models of artifacts that can be used to create the artifact
- Usually associated with a tool

Concepts

- Discussions on particular concepts (e.g., iteration, risk) associated with the process

Tool mentors

- Show how to perform a set of process steps using a specific tool

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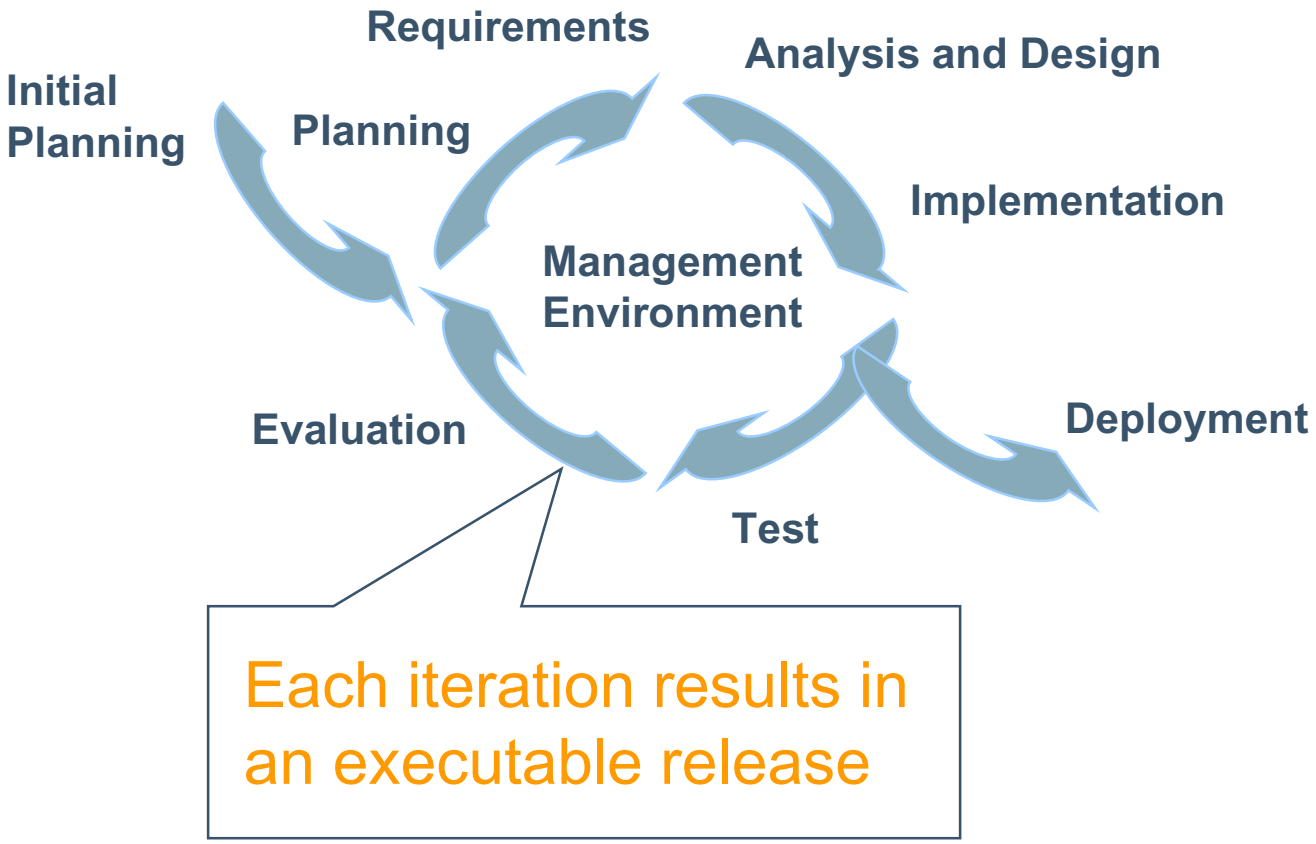
Dynamic Element: Iterations



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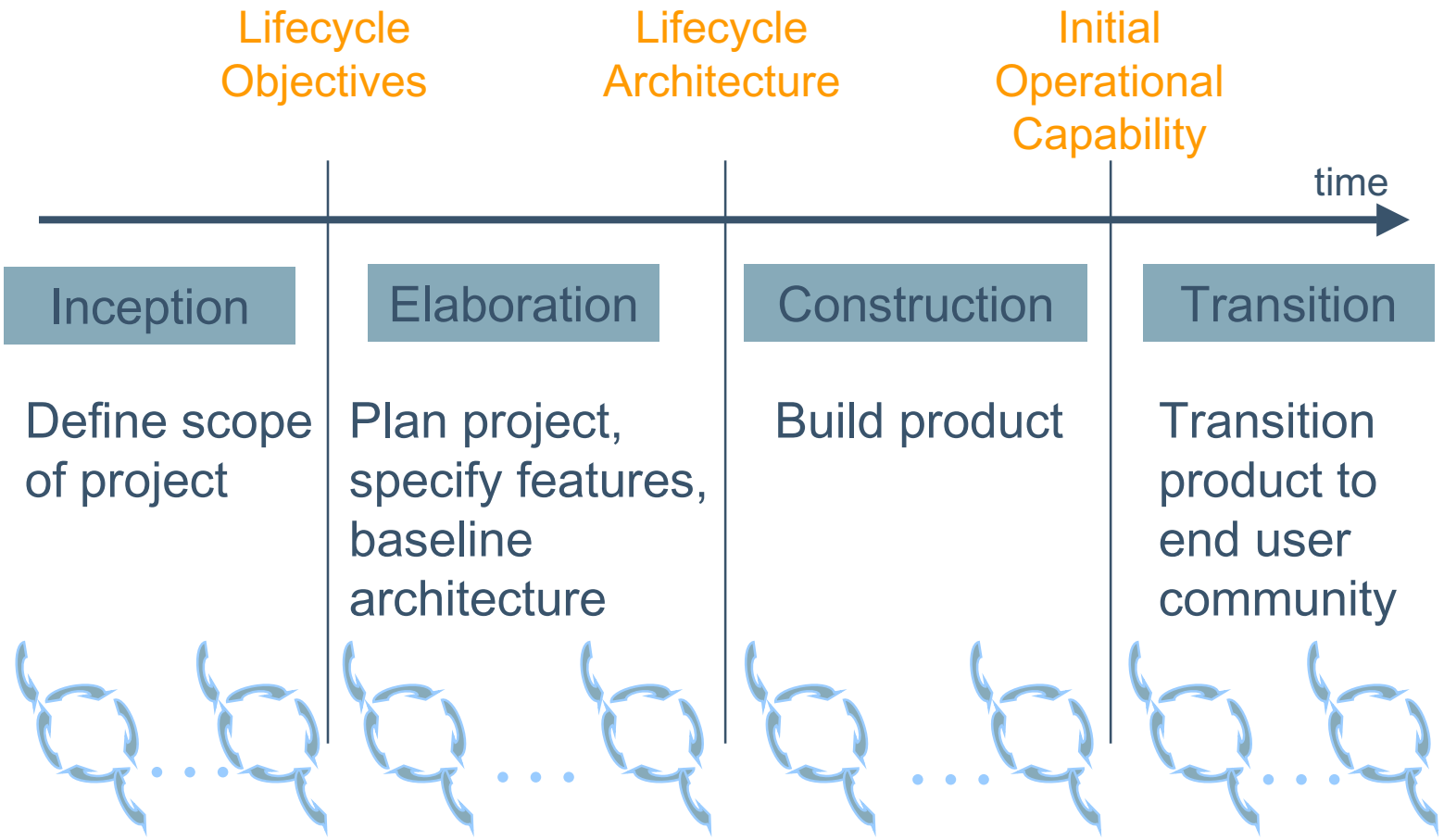
Dynamic Elements: Phases and Milestones



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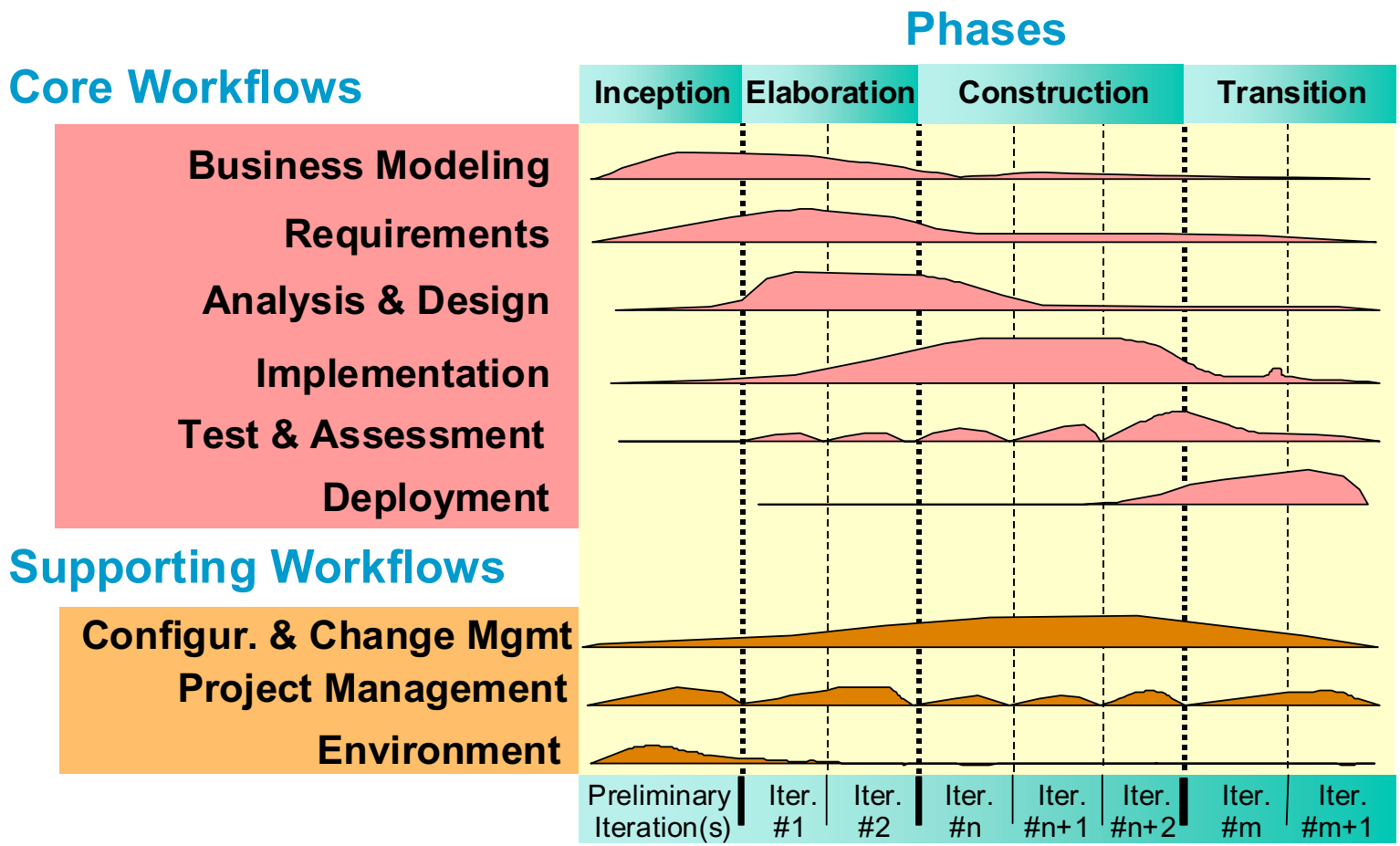
Static and Dynamic Process Structure



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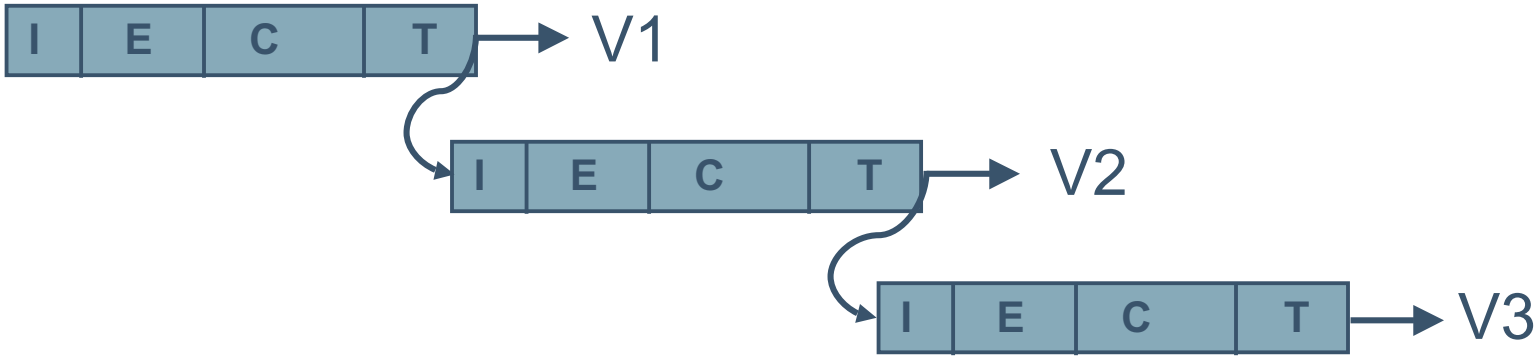
System Evolution

- Four phases form one *development cycle* and produce a *generation* of the system
- Significant user enhancement, business or mission changes, or technology changes trigger a new generation



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Topics

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RUP Overview

RUP to CMMI Mapping

- Project Management
- Engineering
- Support
- Process Management
- Generic Practices

Lessons Learned

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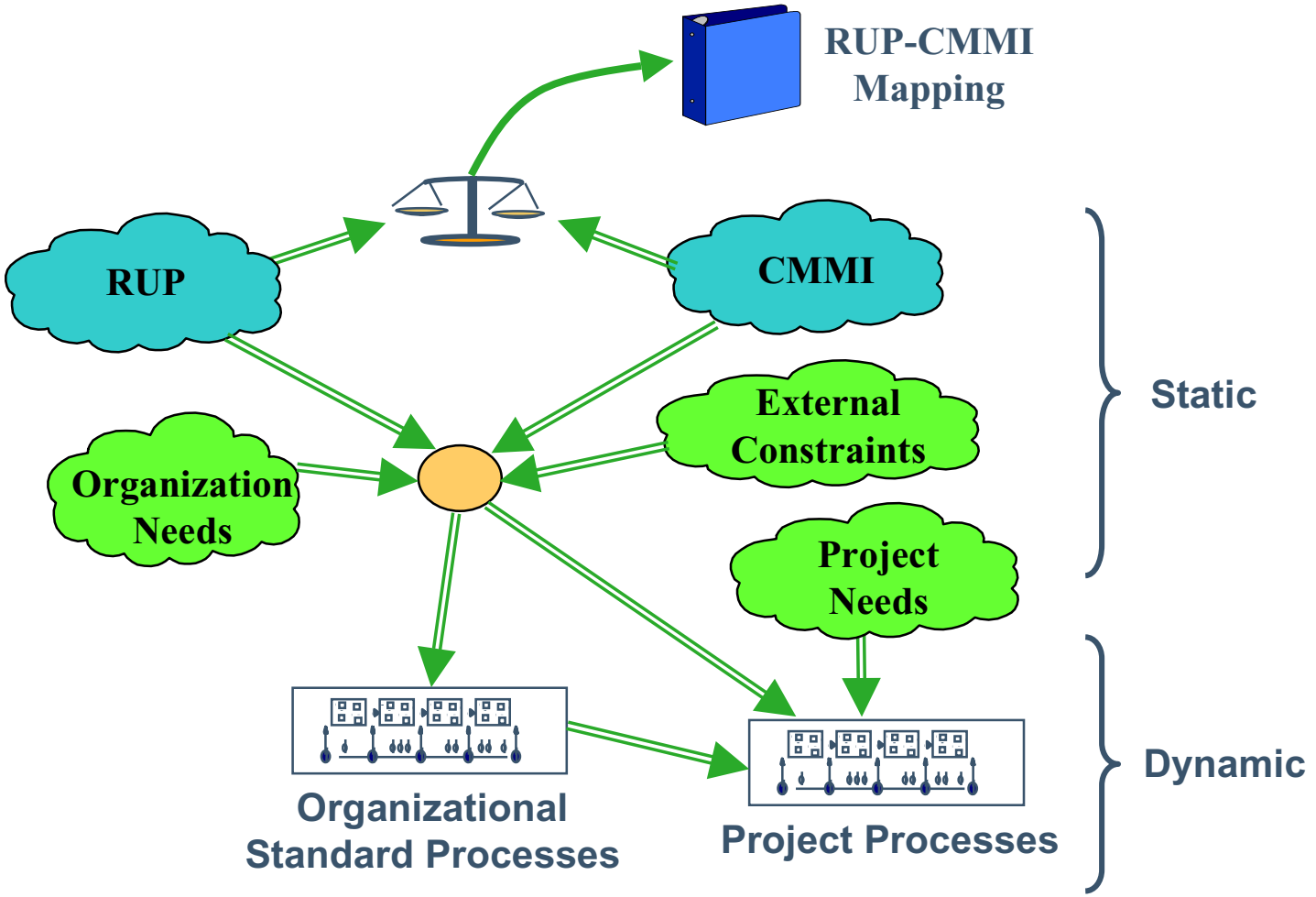
Comparing Static Representations



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Caveats

We are not assessing the Rational Unified Process

A project or organization is expected to tailor RUP to meet specific project needs

We are not comparing the results of tailoring either RUP or CMMI for an actual project or organization

Tailoring decisions could augment or deteriorate the results of our comparison

These comparisons are subjective: reasonable people may come to different conclusions

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Sources for Our Comparison

Rational Unified Process, version 2000.02.10

- all process elements (workflows, workflow details, activities, artifacts, guidelines, templates)

Capability Maturity Model – Integrated for Systems and Software Engineering (CMMI-SE/SW), Continuous Representation, Version 1.02, December 2000

- all Process Areas
- Specific Goals within each Process Area
- Specific Practices within each goal
- Generic Practices

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Capturing our Results

RUP to CMMI

- **HIGH**: reviewers found a high degree of synergy between CMMI practices and RUP
- **MEDIUM**: reviewers were able to find some support for the CMMI practice
- **LOW**: reviewers had to stretch what we saw in RUP to support the CMMI practice, there were no mechanisms to support the practice, or the practice was outside the scope of RUP

CMMI to RUP

- To be provided in a technical report (approximately ~Aug 01)

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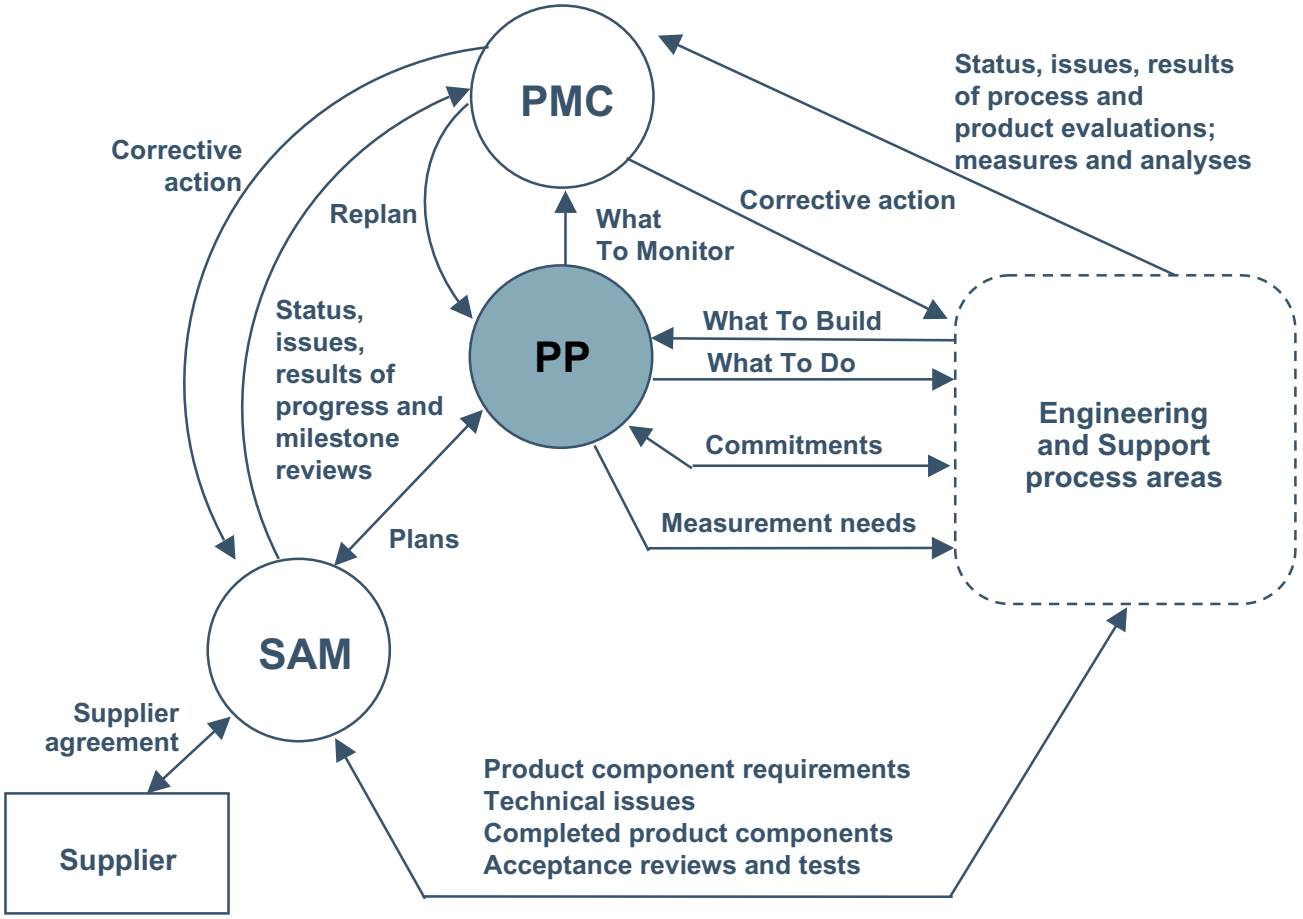
CMMI Basic Project Management



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Project Planning: Overview

CMMI

Purpose

Establish and maintain plans that define project activities.

RUP

Workflow

Project Management, Environment

Synergy

- RUP provides adequate support mechanisms
- RUP does not provide assistance in sizing non-software project attributes (e.g., labor, machinery, materials)

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Project Planning: Mapping -1

CMMI	RUP
SG 1: Establish Estimates Estimates of project planning parameters are established and maintained.	Workflow: Project Management WD: Conceive New Project WD: Develop Software Development Plan
SG 2: Develop a Project Plan A project plan is established and maintained as the basis for managing the project.	Workflow: Project Management WD: Conceive New Project WD: Develop Software Development Plan Workflow: Environment WD: Prepare Environment for Project WD: Prepare Environment for an Iteration

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Project Planning: Mapping -2

CMMI

SG 3: Obtain Commitment to the Plan

Commitments to the project plan are established and maintained.

RUP

Workflow: Project Management

WD: Develop Software Development Plan

Project Planning: Synergy

Specific Goal	Specific Practice
Establish Estimates	• Estimate the Scope of the Project (H) • Establish Estimates of Project Attributes (M) • Define Project Life Cycle (H) • Determine Estimates of Effort and Cost (H)
Develop a Project Plan	• Establish the Budget and Schedule (H) • Identify Project Risks (H) • Plan for Data Management (M) • Plan for Project Resources (M) • Plan for Needed Knowledge and Skills (H) • Plan Stakeholder Involvement (H) • Establish the Project Plan (H)
Obtain Commitment to the Plan	• Review Subordinate Plans (H) • Reconcile Work and Resource Levels (M) • Obtain Plan Commitment (H)

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Project Planning: Detail Example

SP1.2-1: Establish and document estimates of the attributes of the work products and tasks.

RUP Elements:
Workflow: Project Management
Workflow Detail: Develop Software Development Plan
Activity: Plan Phases and Iterations

Comments: RUP provides guidance on sizing a software effort. Sizing by analogy and sizing by analysis is discussed. RUP does not provide assistance in sizing non-software project attributes (i.e. labor, machinery, materials, and methods that will be required by the project).

Degree of Synergy: **Medium**

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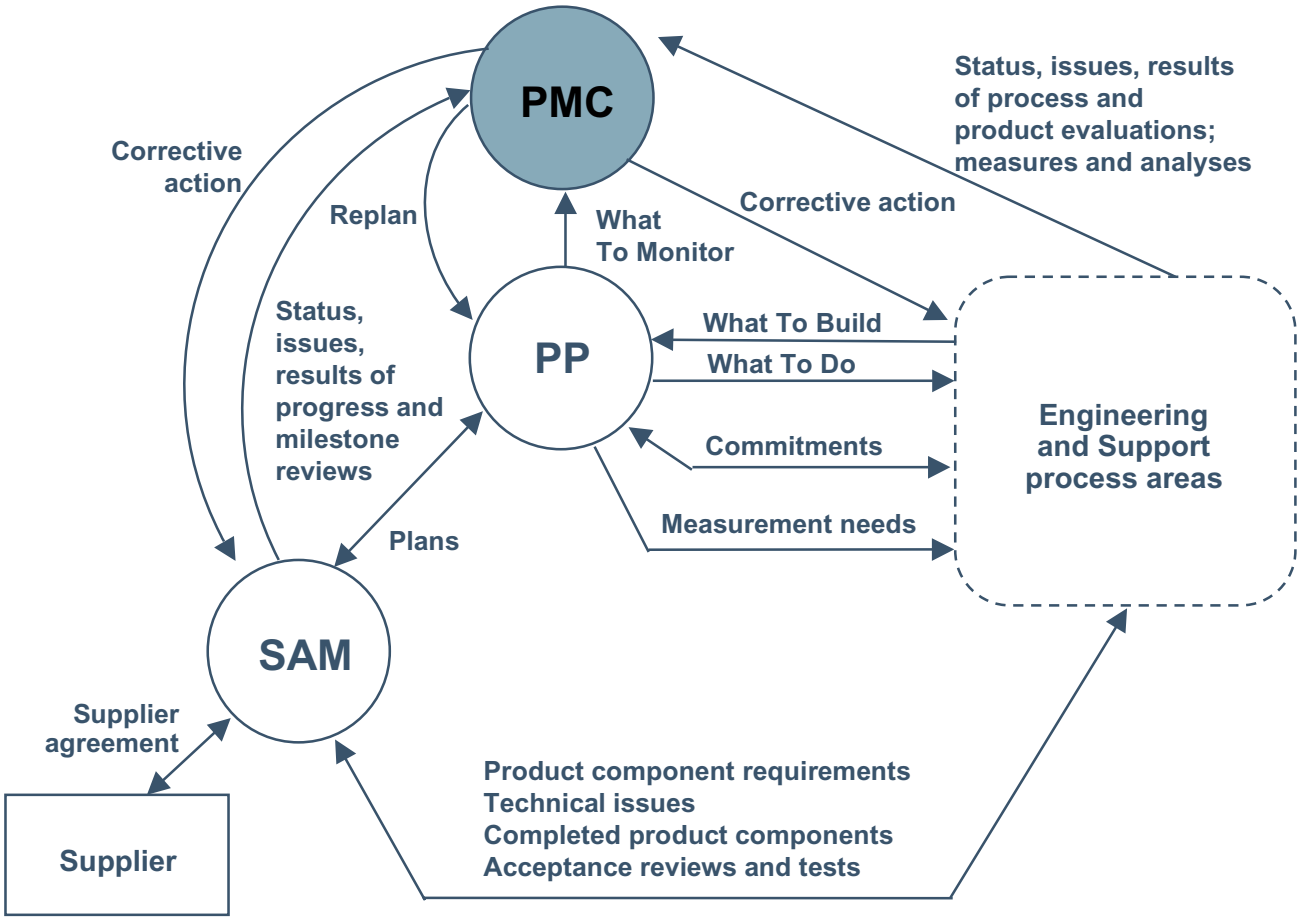
CMMI Basic Project Management



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Project Monitor and Control: Overview

CMMI

Purpose

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

RUP

Workflow

Project Management

Synergy

- RUP provides strong mechanisms to help monitor a project
- Project's using RUP should make sure data management is explicitly addressed

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Project Monitor and Control: Mapping

CMMI	RUP
SG 1: Monitor Project Against Plan Actual performance and progress of the project is monitored against the project plan.	Workflow: Project Management WD: Monitor and Control Project Workflow: Configuration Management
SG 2: Manage Corrective Action to Closure Corrective actions are managed to closure when the project's performance or results deviate significantly from the plan.	Workflow: Project Management WD: Monitor and Control Project

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Project Monitor and Control: Synergy

Specific Goal	Specific Practice
Monitor Project Against Plans	• Monitor Project Planning Parameters (H) • Monitor Commitments (M) • Monitor Project Risks (H) • Monitor Data Management (M) • Monitor Stakeholder Interactions (H) • Conduct Progress Reviews (H) • Conduct Milestone Reviews (H)
Manage Corrective Actions to Closure	• Analyze Issues (H) • Take Corrective Actions (H) • Manage Corrective Actions (H)

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Project Monitor and Control: Detail Example

SP1.4-1 Monitor the management of project data.

RUP Components:
Workflow: Configuration Management

Comments: Although not required, managing project data could be called out in the Configuration Management Plan.

Degree of Synergy: **Medium**

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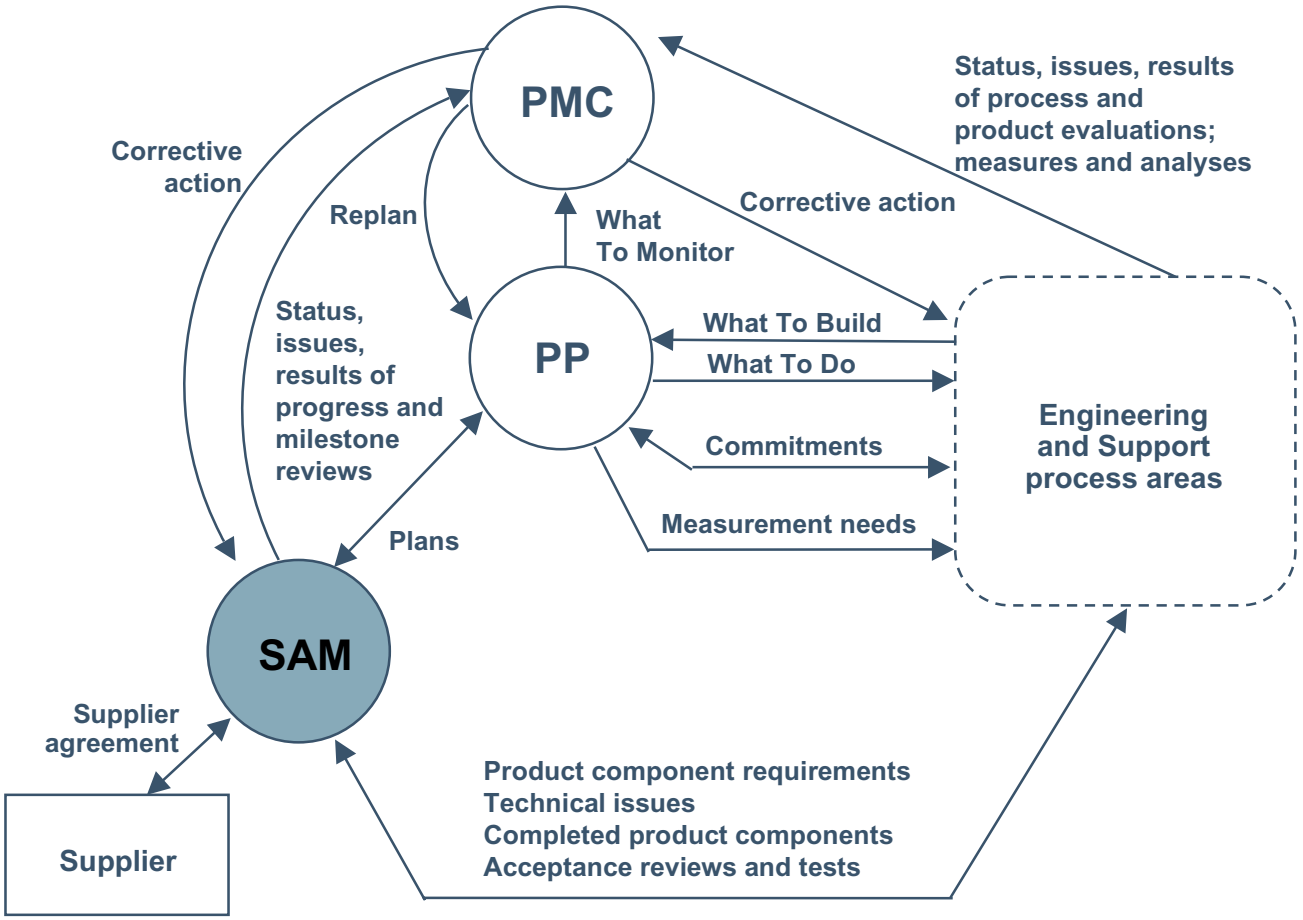
CMMI Basic Project Management



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Supplier Agreement Management: Overview

CMMI

Purpose

Manage the acquisition of products and services from suppliers external to the project for which there exists a formal agreement.

RUP

Workflow

none

Synergy

- RUP does not explicitly deal with managing work from external suppliers to the project
- RUP's QA Plan, CM Plan, and Software Development Plan have sections labeled for supplier and subcontractor control

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Supplier Agreement Management: Mapping

CMMI	RUP
SG 1: Establish Supplier Agreements Agreements with the suppliers are established and maintained.	Workflow: none Outside of the scope of RUP
SG 2: Satisfy Supplier Agreements Agreements with the suppliers are satisfied by both the project and the supplier	Workflow: none Outside of the scope of RUP

Supplier Agreement Management: Synergy

Specific Goal	Specific Practice
Establish Supplier Agreements	• Analyze Needs and Requirements Determined by the Project (L) • Select Suppliers (L) • Establish Supplier Agreements (L)
Satisfy Supplier Agreements	• Acquire COTS Products (L) • Execute the Supplier Agreement (L) • Conduct Acceptance Testing (L) • Transition Products (L)

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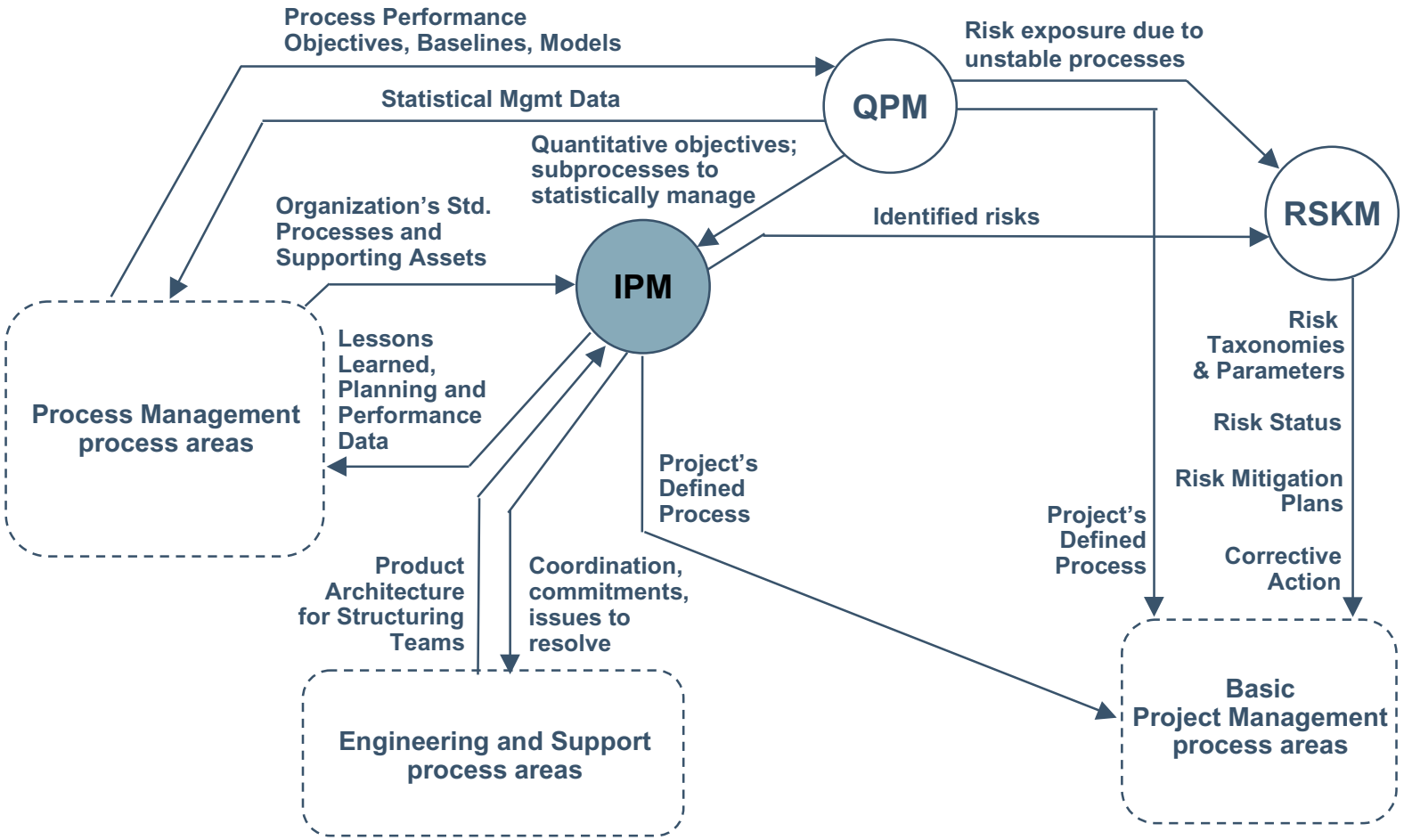
CMMI Advanced Project Management



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Integrated Project Management: Overview

CMMI

Purpose

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.

RUP

Workflow

Project Management, Environment

Synergy

- RUP encourages developing integrated plans
- RUP supports tailoring for project unique needs through the development case artifact

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Integrated Project Management: Mapping

CMMI	RUP
SG 1: Use the Project's Defined Process The project is conducted using a defined process that is tailored from the organization's set of standard processes.	Workflow: Environment WD: Prepare Environment for Project/Iteration Workflow: Project Management WD: Develop Software Development Plan WD: Monitor and Control Project
SG 2: Coordinate and Collaborate with Relevant Stakeholders Coordination and Collaboration of the project with relevant stakeholders is conducted.	Workflow: Project Management WD: Close-out Phase

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Integrated Project Management: Synergy

Specific Goal	Specific Practice
Use the Project's Defined Process	• Establish the Project's Defined Process (M) • Use Organizational Assets for Planning Project Activities (M) • Integrate Plans (M) • Manage the Project Using the Integrated Plans (H) • Contribute to the Organization's Process Assets (H)
Coordinate and Collaborate with Relevant Stakeholders	• Manage Stakeholder Involvement (H) • Manage Dependencies (L) • Resolve Coordination Issues (H)

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Integrated Project Management: Detail Example

SP1.1-1 Establish and maintain the project's defined process.

RUP Components:
Workflow: Environment
Workflow Detail: Prepare Environment for Project/Iteration

Comments: Using RUP, a project would assess the current software development organization and select the processes and tools to support the project. This is less formal than having an “organizational standard process” comprised of a suite of lifecycles and processes to choose from complete with tailoring guidelines.

Degree of Synergy: **Medium**

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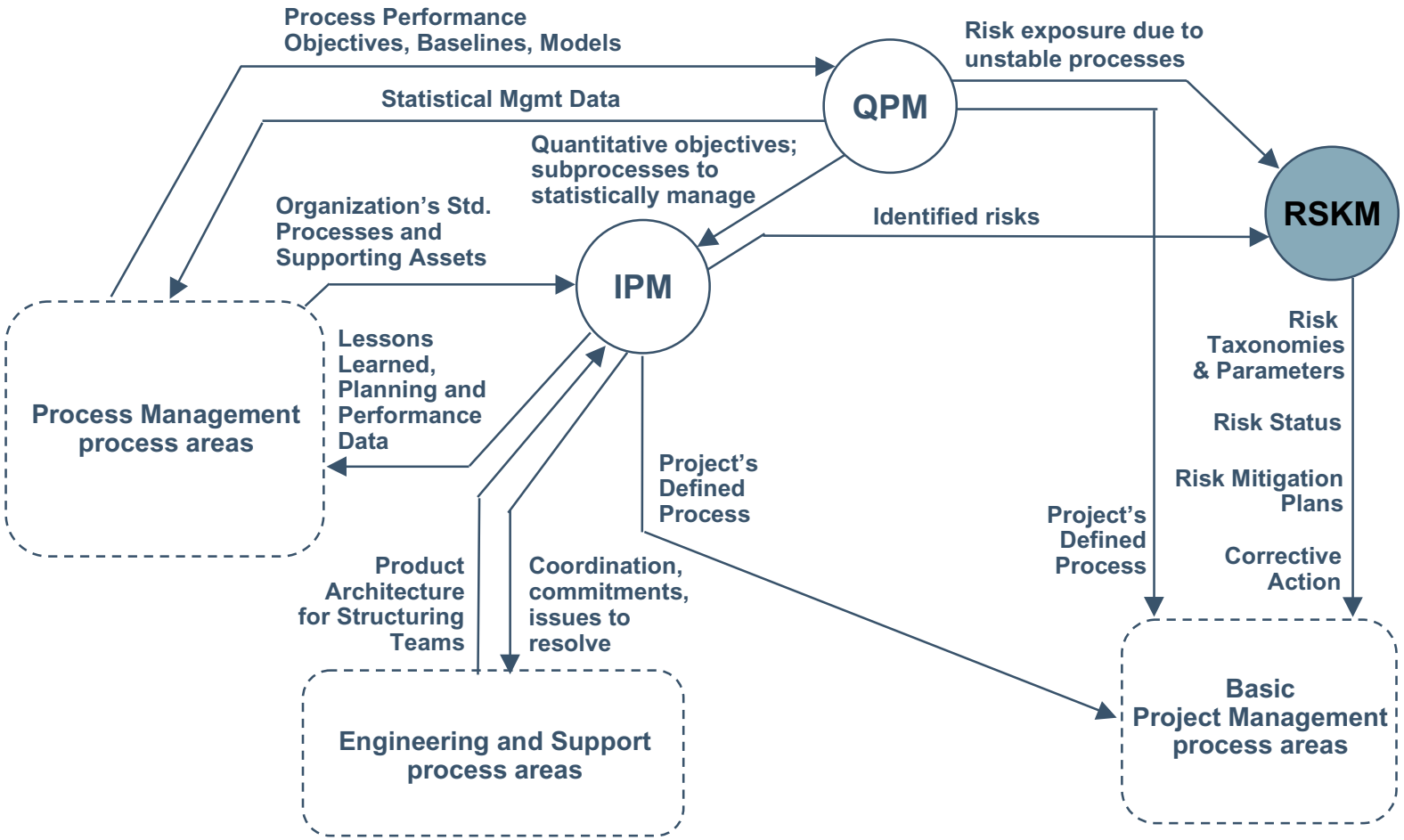
CMMI Advanced Project Management



Risk Management: Overview

CMMI

Purpose

Identify potential problems before they occur, so that risk-handling activities may be planned and invoked as needed across the life cycle to mitigate adverse impacts on achieving objectives.

RUP

Workflow

Project Management

Synergy

- RUP is a risk driven development process
- Activities are performed to mitigate the highest risks and tackle the hardest jobs first

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Risk Management: Mapping

CMMI	RUP
SG 1: Prepare for Risk Management Preparation for Risk Management is conducted.	Workflow: Project Management WD: Develop Software Development Plan
SG 2: Identify and Analyze Risks Risks are identified and analyzed to determine their relative importance.	Workflow: Project Management WD: Conceive New Project
SG 3: Mitigate Risks Risks are handled and mitigated, where appropriate, to reduce adverse impacts on achieving objectives.	Workflow: Project Management WD: Conceive New Project

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Risk Management: Synergy

Specific Goal	Specific Practice
Prepare for Risk Management	• Determine Risk Sources and Categories (H) • Define Risk Parameters (M) • Establish a Risk Management Strategy (M)
Analyze Risks	• Identify Risks (H) • Evaluate, Classify, and Prioritize Risks (H)
Mitigate Risks	• Develop Risk Mitigation Plans (H) • Implement Risk Mitigation Plans (H)

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Risk Management: Detail Example

SP2.1-1 Identify and document the risks.

RUP Components:
Workflow: Project Management
Workflow Detail: Conceive New Project
Activity: Identify and Assess Risks

Comments: RUP calls for identifying risks. The resulting artifact, the Risk List, documents the identified risks.

Degree of Synergy: **High**

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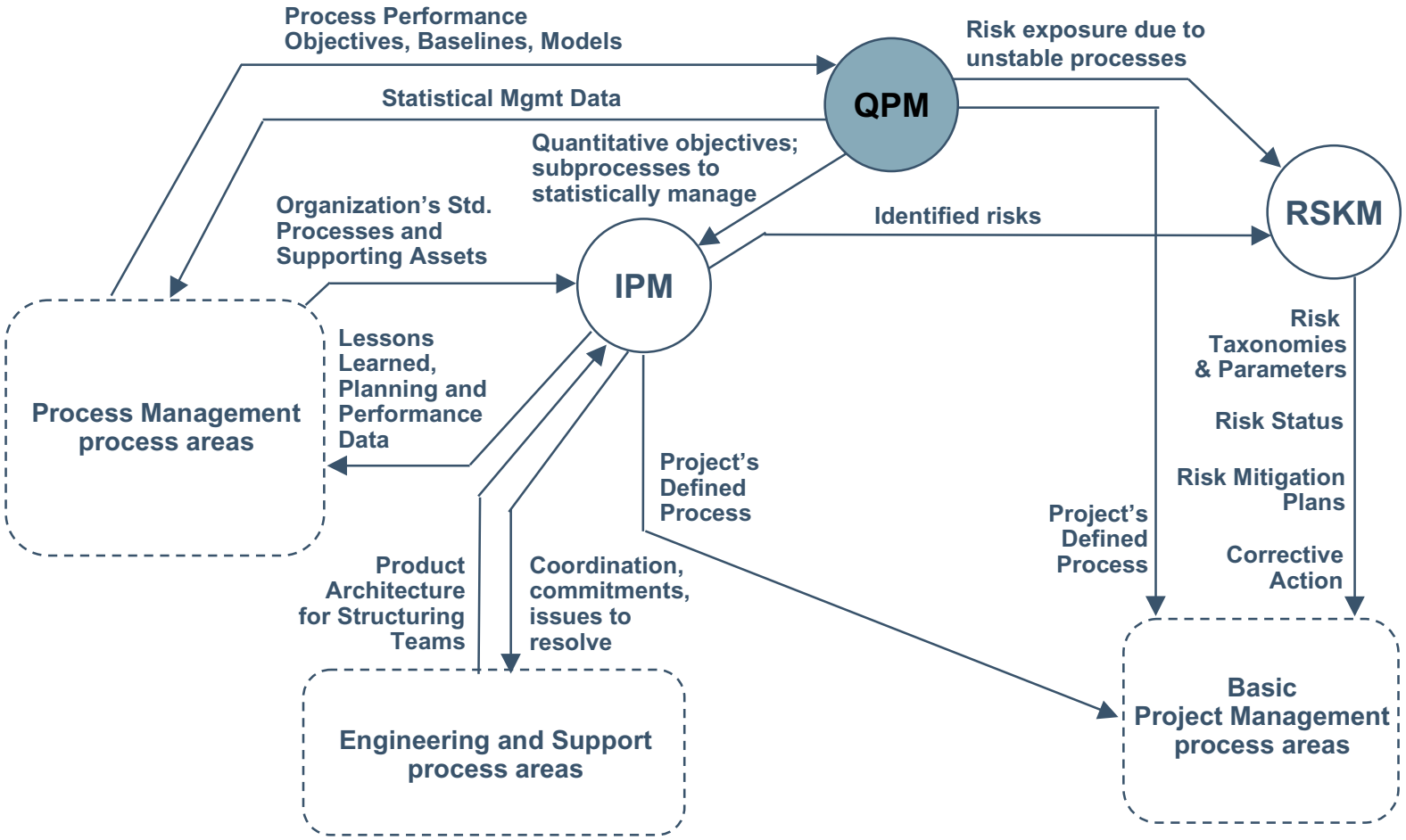
CMMI Advanced Project Management



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Quantitative Project Management: Overview

CMMI

Purpose

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

RUP

Workflow

Environment

Synergy

- Quantitatively managing the project's processes is outside the scope of RUP
- RUP provides some guidance on measures pertinent to RUP

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Quantitative Project Management: Mapping

CMMI	RUP
SG 1: Quantitatively Manage the Project The project is quantitatively managed using quality and process performance objectives.	Workflow: Environment WD: Prepare Environment for Project
SG 2: Statistically Manage Subprocess Performance The performance of selected subprocesses within the project's defined process is statistically managed.	Workflow: none

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Quantitative Project Management: Synergy

Specific Goal	Specific Practice
Quantitatively Manage the Project	• Establish the Project's Objectives (L) • Compose the Defined Process (M) • Select the Subprocesses to be Managed (L) • Manage Project Performance (L)
Statistically Manage Subprocess Performance	• Select Measures and Analytic Techniques (L) • Apply Statistical Methods to Understand Variation (L) • Monitor Performance of the Selected Subprocesses (L) • Record Statistical Management Data (L)

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Quantitative Project Management: Detail Example

SP1.2-1 Select the processes and process elements that comprise the project's defined process based on historical stability and capability data.

RUP Components:
Workflow: Environment
Workflow Detail: Prepare Environment for Project
Guidelines: Process Discriminates

Comments: While selection of processes and process elements aren't selected based on historical stability (meaning statistically understood), RUP provides guidelines to help projects select processes based on characteristics.

Degree of Synergy: **Medium**

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Lessons Learned

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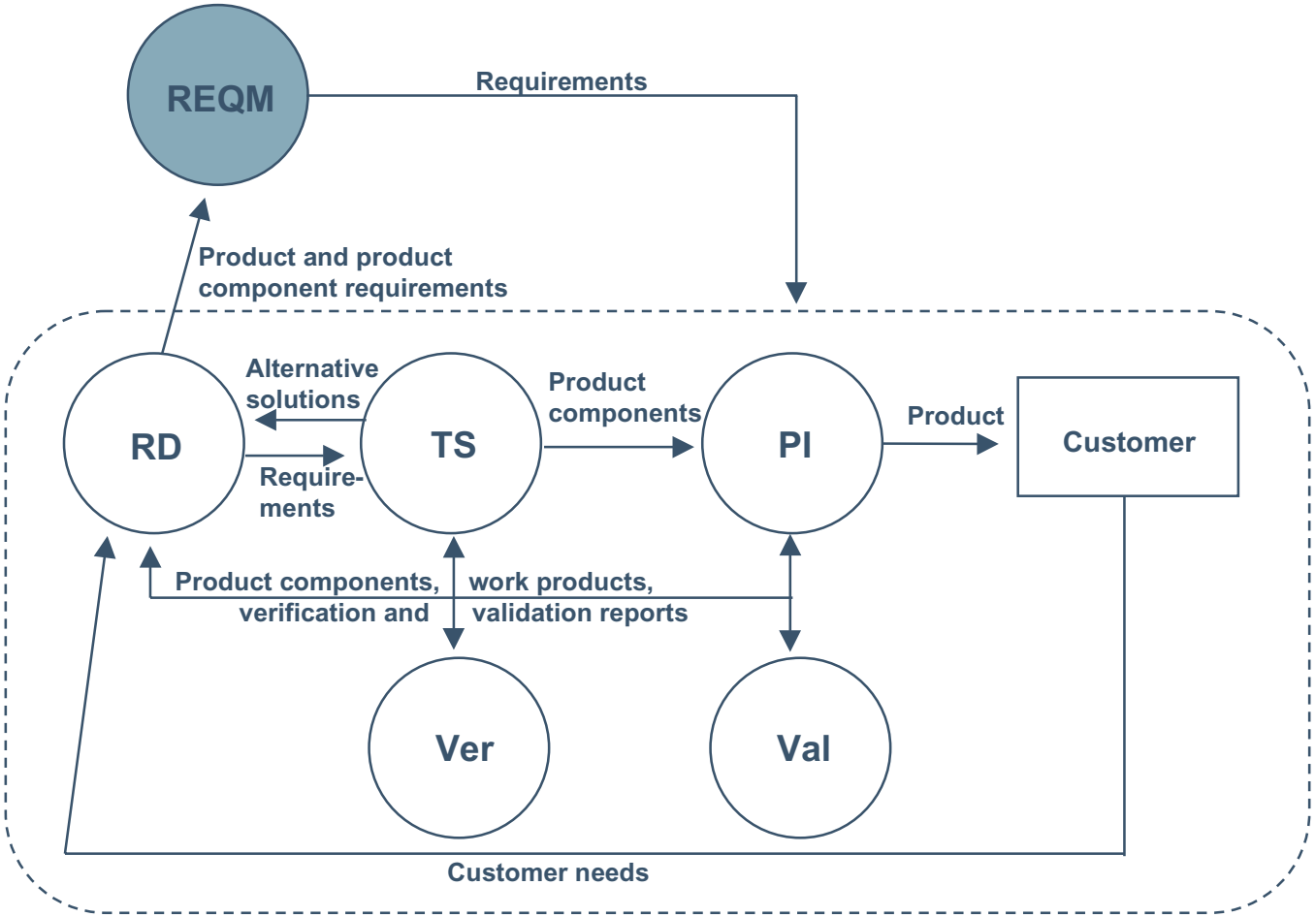
CMMI Engineering Process Areas



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Requirements Management: Overview

CMMI

Purpose

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

RUP

Workflow

Requirements

Synergy

- RUP provides adequate support mechanisms
- RUP integrates the tracking (or change management) of requirements with capturing and analyzing requirements

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Requirements Management: Mapping

CMMI

SG 1: Manage Requirements

Requirements are managed and inconsistencies with project plans and work products are identified.

RUP

Workflow: Requirements
WD: Understand Stakeholder Needs
WD: Manage the Scope of the System
WD: Manage Changing Requirements
Workflow: Analysis and Design
WD: Analyze Behavior
WD: Design Components
WD: Design Database
WD: Design Real-time

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Requirements Management: Synergy

Specific Goal	Specific Practice
Manage Requirements	• Obtain an Understanding of Requirements (H) • Obtain Commitment to Requirements (Level 2) (H) • Manage Requirement Changes (H) • Maintain Bi-Directional Traceability of Requirements (Level 2) (H) • Identify Inconsistencies between Project Work and Requirements (H)

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Requirements Management: Detail Example

SP1.2-2: Obtain commitment to the requirements from the project participants.

RUP Elements:
Workflow: Requirements
Workflow Detail: Manage the Scope of the System
Activity: Prioritize Use Cases

Comments: RUP employs use cases to plan and package the work to be done. The architect comes up with a first cut at a list of prioritized use cases. The project team is involved in revising the prioritized list based on project risks, availability of resources, and stakeholder needs.

Degree of Synergy: **High**

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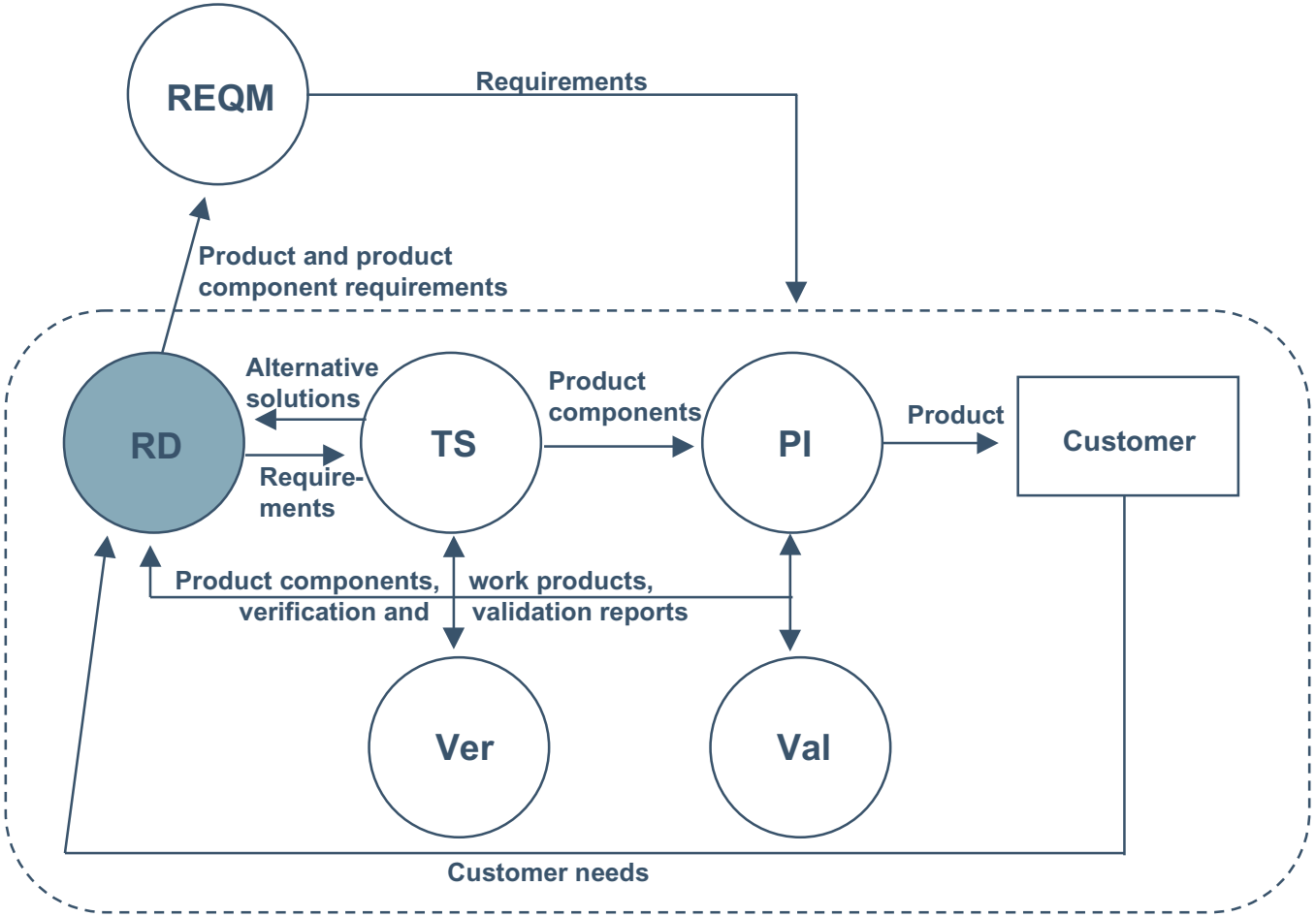
CMMI Engineering Process Areas



Requirements Development: Overview

CMMI

Purpose

Produce and analyze customer, product, and product component requirements.

RUP

Workflows

Requirements, Configuration and Change Management, Analysis and Design, Implementation, Test

Synergy

- RUP provides good support mechanisms
- RUP “features” equivalent to customer requirements
- Interfaces treated as one kind of requirement
- Prototyping key approach for requirements (incl. interfaces) validation

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Requirements Development: Mapping -1

CMMI	RUP
SG 1: Develop Customer Requirements Stakeholder needs, expectations, constraints, and interfaces are collected and translated into customer requirements.	Workflow: Requirements WD: Understand Stakeholder Needs WD: Analyze the Problem WD: Define the System Workflow: Configuration and Change Management WD: Manage Change Requests
SG 2: Develop Product Requirements Customer requirements are refined and elaborated to develop product and product component requirements for the product life cycle.	Workflow: Requirements WD: Refine the System Definition WD: Develop Software Development Plan Workflow: Analysis and Design WD: Analyze Behavior

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Requirements Development: Mapping -2

CMMI

SG 3: Analyze and Validate Requirements

The requirements are analyzed and validated, and a definition of required functionality is developed.

RUP

Workflow: Requirements
Guidelines: Use-case Storyboard
WD: Analyze the Problem, Understand Stakeholder Needs, Define the System, Manage the Scope of the System, Refine the System Definition, Manage Changing Requirements
Workflow: Analysis and Design
WD: Define a Candidate Architecture
Workflows: Implementation, Test (to create and assess prototypes)

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Requirements Development: Synergy -1

Specific Goal	Specific Practice
Develop Customer Requirements	• Collect Stakeholder Needs (H) • Elicit Needs (Level 2) (H) • Transform Stakeholder Needs, Expectations, Constraints, and Interfaces into Customer Requirements (H)
Develop Product Requirements	• Establish Product and Product Component Requirements (H) • Allocate Product Component Requirements (M) • Identify Interface Requirements (H)

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Requirements Development: Synergy -2

Specific Goal	Specific Practice
Analyze and Validate Requirements	• Establish Operational Concepts and Scenarios (H) • Establish a Definition of Required Functionality (H) • Analyze Requirements (H) • Evaluate Product Cost, Schedule and Risk (Level 3) (H) • Validate Requirements (H) • Validate Requirements with Comprehensive Methods (Level 2) (H)

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Requirements Development: Detail Example

SP2.2-1: Allocate the requirements for each product component.

RUP Elements:
Workflow: Analysis and Design
Workflow Detail: Analyze Behavior
Activity: Use-case Analysis, Identify Design Elements

Comments: RUP transforms the behavioral descriptions from the use cases into a set of design elements for the product using an object-oriented approach for analysis and design. RUP does not refer to this set of activities as “requirements flowdown”.

CMMI stipulates that higher-level functionality that becomes the responsibility of 2+ product components must be partitioned for unique component allocation. This can lead to a functional design, which RUP explicitly avoids.

Degree of Synergy: **Medium**

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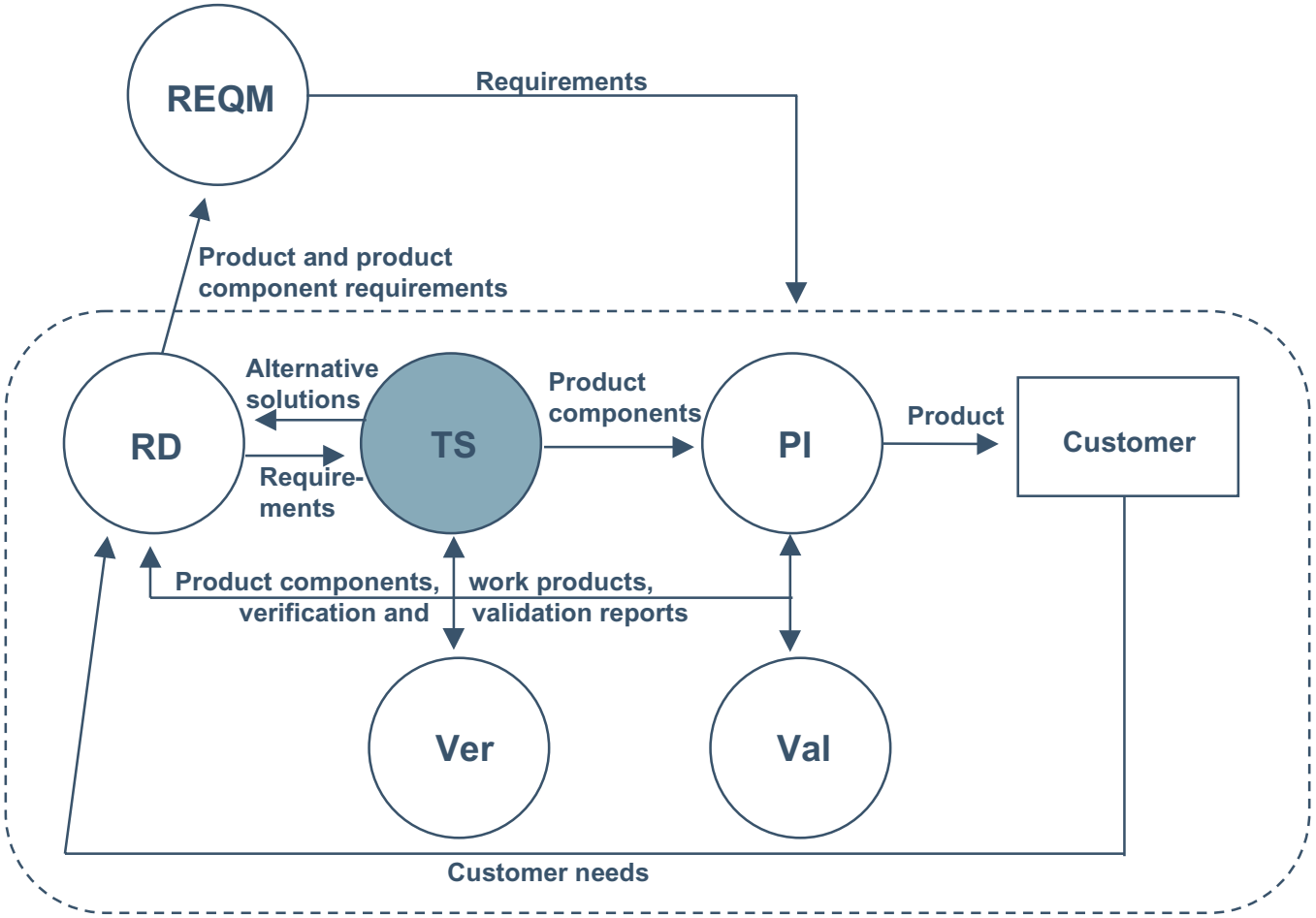
CMMI Engineering Process Areas



Technical Solution: Overview

CMMI

Purpose

Develop, design, and implement solutions to requirements. Solutions, designs and implementations encompass products, product components, and product related processes either singly or in combinations as appropriate.

RUP

Workflows

Analysis and Design, Implementation, Deployment, Project Management

Synergy

- RUP addresses the central goals of forming, designing, and implementing engineered solutions
- RUP provides greater guidance on architecture development and validation than CMMI
- RUP does not explicitly cover consideration of design alternatives except at the architectural level
- RUP does not explicitly cover the use of selection criteria for product solutions or components

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Technical Solution: Mapping -1

CMMI	RUP
SG 1: Select Product Component Solutions Product or product component solutions, including applicable product related processes, are selected from alternative solutions.	Workflow: Project Management WD: Conceive New Project Artifact: Business Case Workflow: Analysis and Design WD: Define a Candidate Architecture WD: Refine the Architecture
SG 2: Develop the Design Product or product component designs are developed.	Workflow: Analysis & Design (all workflow details, activities, guidelines, artifacts)

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Technical Solution: Mapping -2

CMMI

SG 3: Implement the Product Design

Product components, and associated support documentation, are implemented from their designs.

RUP

Workflow: Implementation
WD: Implement Component
Artifact: Programming Guidelines
Workflow: Deployment
WD: Develop Support Materials

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Technical Solution: Synergy -1

Specific Goal	Specific Practice
Select Product Component Solutions	• Develop Alternative Solutions and Selection Criteria (M) • Develop Detailed Alternative Solutions and Selection Criteria (Level 2) (L) • Evolve Operational Concepts and Scenarios (Level 2) (H) • Select Product Component Solutions (M)

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Technical Solution: Synergy -2

Specific Goal	Specific Practice
Develop the Design	• Use Effective Design Methods (H) • Develop a Technical Data Package (H) • Establish a Complete Technical Data Package (Level 3) (H) • Establish Interface Descriptions (H) • Design Comprehensive Interface (Level 3) (H) • Perform Make, Buy, or Reuse Analyses (Level 3) (L)
Implement the Product Design	• Implement the Design (H) • Establish Product Support Documentation (H)

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Technical Solution: Detail Example

SP1.1-1: Develop alternative solutions and establish selection criteria.

RUP Elements:

Workflow: Project Management
Artifact: Business Case
Workflow: Analysis and Design
Workflow Details: Define a Candidate Architecture, Refine the Architecture

Comments: The Business Case describes at least two approaches to realizing the system Vision, and analyze these in terms of capability, risk impact, schedule, and economic outcomes. Project options might include differing contractual bases, differing project lifecycles, differing mixes of 'make' and 'buy', and so on During the Project Approval Review, one of the offered choices is selected. RUP provides references to sources for risk and decision analysis techniques but does not explicitly establish criteria.
While RUP is very architecture focussed, it does not provide guidance on product component selection.

Degree of Synergy: **Medium**

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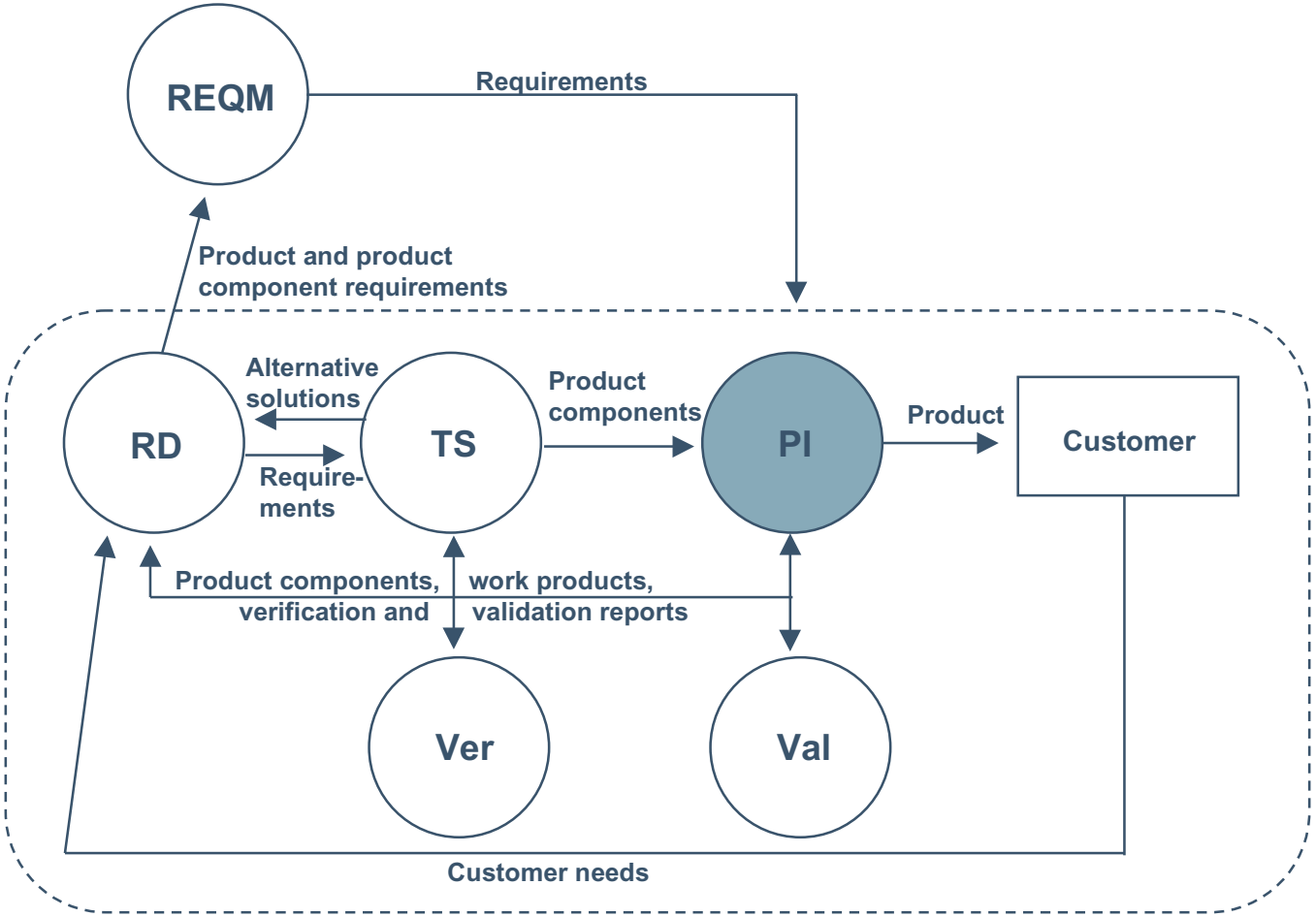
CMMI Engineering Process Areas



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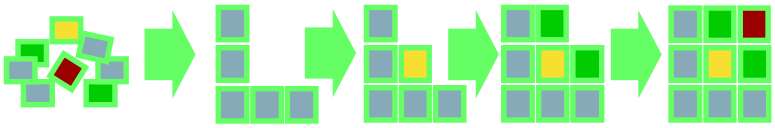
Product Integration: Overview

CMMI

Purpose

Assemble the product from the product components, ensure that the product, as integrated, functions properly and deliver the product.



RUP

Workflows

Implementation, Test, Deployment, Change & Configuration Management, Analysis & Design

Synergy

- RUP supports the general intent of product integration
- RUP does not single interfaces out for special treatment but does treat them as first class elements of any design and integration

Product Integration: Mapping -1

CMMI	RUP
SG 1: Prepare for Product Integration The strategy for conducting product integration is established and maintained.	Workflow: Implementation WD: Plan the Integration Artifact: Integration Build Plan Workflow: Change and Configuration Management WD: Create Project CM Environment Activity: Create Integration Workspace
SG 2: Ensure Interface Compatibility The product component interfaces, both internal and external, are compatible.	Workflow: Analysis and Design Artifact: Design Model Workflow: Implementation WD: Structure the Implementation Model, Integrate each Subsystem, Integrate the System Workflow: Test WD: Execute Integration Tests, Execute System Test

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Product Integration: Mapping -2

CMMI

SG 3: Assemble Product Components and Deliver the Product

Verified product components are assembled and the integrated, verified, and validated product is delivered.

RUP

Workflow: Implementation
WD: Implement Component
Activity: Perform Unit Tests
WD: Integrate Each Subsystem
WD: Integrate the System
Workflow: Test
WD: Execute Test in Integration Test Stage
Workflow: Deployment
WD: Product Deployment Unit
WD: Package Product
WD: Provide Access to Download Site

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Product Integration: Synergy -1

Specific Goal	Specific Practice
Prepare for Product Integration	• Establish a Product Integration Strategy (H) • Establish the Product Integration Environment (Level 2) (H) • Define Detailed Product Integration Procedures (Level 3) (H)
Ensure Interface Compatibility	• Review Interface Descriptions for Completeness (H) • Manage Interfaces (H)

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Product Integration: Synergy -2

Specific Goal	Specific Practice
Assemble Product Components and Deliver the Product	• Confirm Readiness of Product (H) • Components for Integration (H) • Assemble Product Components (H) • Checkout Assembled Product Components (H) • Package and Deliver the Product or Product Components (H)

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Product Integration: Detail Example

SP2.1-1: Review interface descriptions for coverage and completeness.

RUP Elements:

Workflow: Analysis and Design
- Artifact: Design Model

Workflow: Implementation
- Workflow Details: Structure the Implementation Model, Integrate each Subsystem, Integrate the System

Workflow: Test
- Workflow Details: Execute Integration Tests, Execute System Test

Comments: Interfaces are a critical part of the architecture and design in RUP. The primary review mechanism is building architectural prototypes and integrating and testing the executables in each iteration such that the interfaces are exercised in a more realistic setting.

Degree of Synergy: **High**

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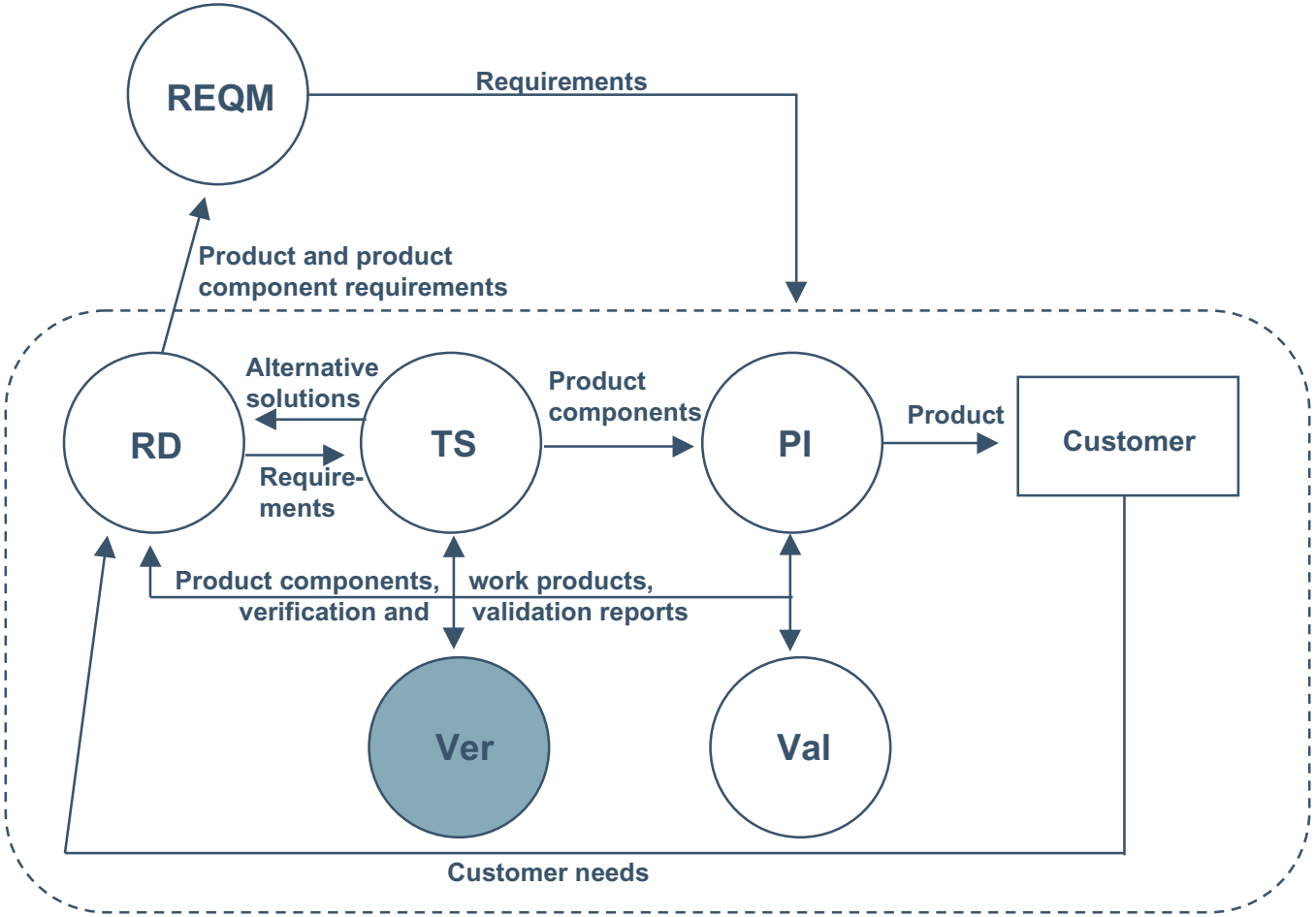
CMMI Engineering Process Areas



Verification: Overview

CMMI

Purpose

Assure that selected work products meet their specified requirements.

RUP

Workflows

Test, Environment, Implementation

Synergy

- RUP provides good support for verification practices
- Verification occurs with each iteration

Verification: Mapping

CMMI	RUP
SG 1: Prepare for Verification Preparation for verification is conducted.	Workflow: Test WD: Plan Test WD: Design Test Workflow: Environment WD: Support Environment
SG 2: Perform Peer Reviews Peer reviews are performed on selected work products.	Work Guideline: Reviews (applies to all work products in all workflows)
SG 3: Verify Selected Work Products Selected work products are verified against their specified requirements.	Workflow: Test WD: Execute Integration Test WD: Execute System Test WD: Evaluate Test Workflow: Implementation WD: Implement Component

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Verification: Synergy

Specific Goal	Specific Practice
Prepare for Verification	• Establish a Verification Strategy (H) • Establish the Verification Environment (Level 2) (H) • Establish Detailed Verification Plans (Level 3) (H)
Perform Peer Reviews	• Prepare for Peer Reviews (H) • Conduct Peer Reviews (H) • Analyze Peer Review Data (Level 2) (H)
Verify Selected Work Products	• Perform Verification (H) • Analyze Verification Results and Identify Corrective Actions (Level 2) (H) • Perform Re-Verification (H)

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Verification: Detail Example

SP3.3-1: Perform re-verification of corrected work products and ensure that work products have not been negatively impacted.

RUP Elements:
Workflow: Test
Workflow Detail: Execute Tests
Activity: Execute Tests in Integration Test Stage
Activity: Execute Tests in System Test Stage
Activity: Fix a Defect

Comments: In iterative development, regression testing occurs with each iteration. If bugs fix are needed, another iteration is performed with its own test activities. For each iteration a new version of the test model is developed that contains old tests (as regression tests), and new tests that take new functionality into account.

Degree of Synergy: **High**

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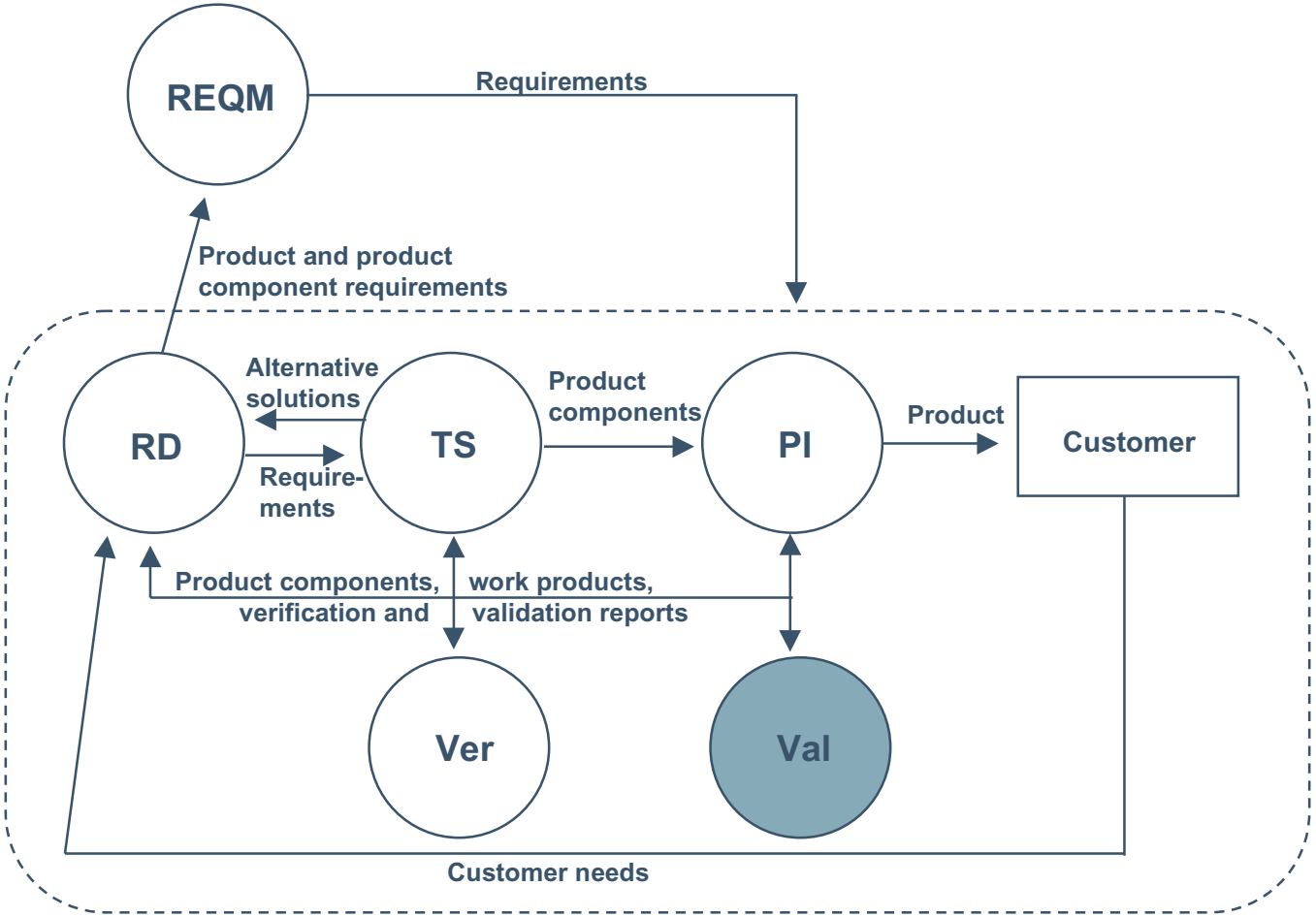
CMMI Engineering Process Areas



Validation: Overview

CMMI

Purpose

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

RUP

Workflows

Project Management, Deployment

Synergy

- RUP begins validation early with use case reviews with the users and continues with each iteration's executable evaluated in a pre-release setting with selected users
- Product acceptance is defined as part of the project plan

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Validation: Mapping

CMMI	RUP
SG 1: Prepare for Validation Preparation for validation is conducted.	Workflow: Project Management WD: Develop Product Acceptance Plan Workflow: Deployment WD: Beta Test Product
SG 2: Validate Product or Product Components The product or product components are validated to ensure that they are suitable for use in their intended operating environment.	Workflow: Project Management WD: Close-out Project Artifact: Product Acceptance Plan Workflow: Deployment WD: Beta Test Product

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Validation: Synergy

Specific Goal	Specific Practice
Prepare for Validation	• Establish a Validation Strategy (H) • Establish the Validation Environment (Level 2) (H) • Define Detailed Validation Procedures (Level 3) (H)
Validate Product or Product Components	• Perform Validation (H) • Capture and Analyze Validation Results (H)

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Validation: Detail Example

SP1.1-1: Establish and maintain a validation strategy.

RUP Elements:
Workflow: Deployment
    Workflow Detail: Beta Test Product
        Activity: Manage Beta Test
Workflow: Project Management
    Workflow Detail: Develop Product Acceptance Plan

Comments: Inherent to RUP is the continual validation of each iteration's executable by actual users in order to identify defects or disconnects as early as possible. The product acceptance plan is co-developed with the users.

Degree of Synergy: **High**

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Topics

Goals and Purpose

CMMI Overview

RUP Overview

RUP to CMMI Mapping

- Project Management
- Engineering
- Support
- Process Management
- Generic Practices

Lessons Learned

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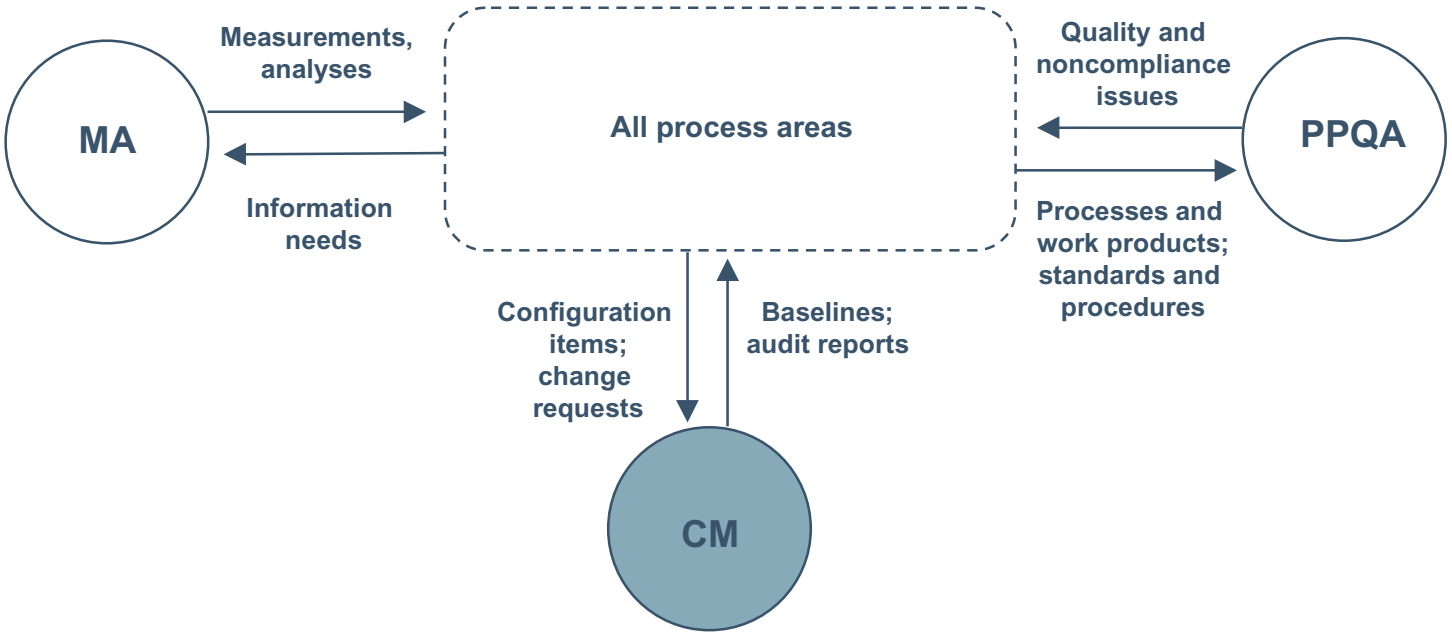
CMMI Basic Support Process Areas



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Configuration Management: Overview

CMMI

Purpose

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

RUP

Workflow

Configuration and Change Management

Synergy

- RUP provides good support mechanisms

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Configuration Management: Mapping -1

CMMI	RUP
SG 1: Establish Baselines Baselines of identified work products are established and maintained.	Workflow: Configuration and Change Management WD: Plan Project Configuration & Change Control WD: Change & Deliver Configuration Items WD: Manage Baselines & Releases
SG 2: Track and Control Changes Changes to the work products under configuration management are tracked and controlled.	Workflow: Configuration and Change Management WD: Manage Change Requests

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Configuration Management: Mapping -2

CMMI

SG 3: Establish Integrity

Integrity of baselines is established and maintained.

RUP

Workflow: Configuration and Change Management

WD: Monitor and Report Configuration Status

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Configuration Management: Synergy

Specific Goal	Specific Practice
Establish Baselines	• Identify Configuration Items (H) • Establish a Configuration Management System (H) • Create or Release Baselines (H)
Track and Control Changes	• Track Changes (H) • Control Changes (H)
Establish Integrity	• Establish Configuration Management Records (H) • Perform Configuration Audits (H)

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Configuration Management: Detail Example

SP1.3-1: Create or release baselines for internal use and for delivery to the customer.

RUP Elements:
Workflow: Configuration and Change Management
- Workflow Detail: Change and Deliver Configuration Items
- Workflow Detail: Manage Baselines and Releases

Comments: RUP provides for the creation of internal as well as external baselines (i.e., deployment unit = an executable collection of components, documents (end-user support material and release notes) and installation artifacts).

Degree of Synergy: **High**

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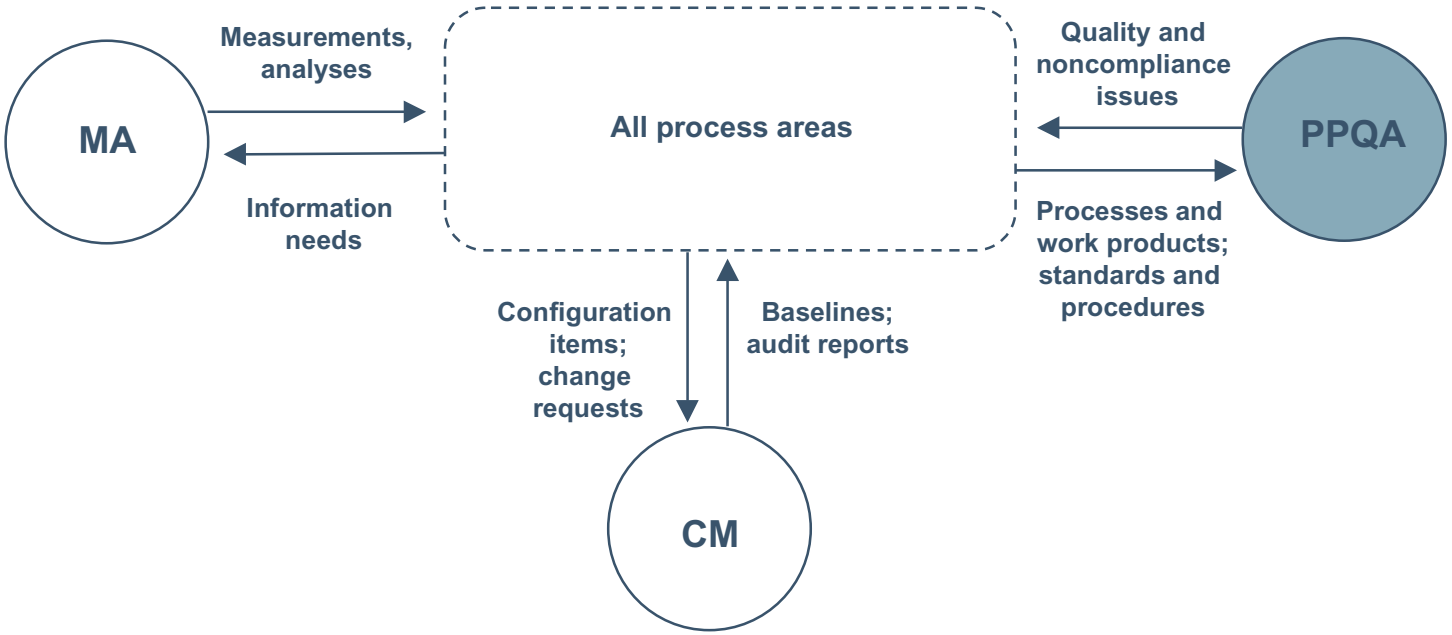
CMMI Basic Support Process Areas



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Process and Product Quality Assurance: Overview

CMMI

Purpose

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

RUP

Workflow

Project Management

Synergy

- RUP implements process and product quality throughout all workflows, phases, and iterations
- RUP Activity, Artifacts, Guidelines, Checkpoints, and Templates “encode” what should be evaluated

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Process and Product Quality Assurance: Mapping

CMMI	RUP
SG 1: Objectively Evaluate Processes and Work Products Adherence of the performed process and associated work products and services to applicable process descriptions, standards and procedures is objectively evaluated.	Workflow: Project Management Artifact: Quality Assurance Plan WD: Monitor and Control Project Activity: Assess Iteration Artifact: Review Record (reviews and checkpoints in each workflow)
SG 2: Provide Objective Insight Noncompliance issues are objectively tracked and communicated, and resolution is ensured.	Workflow: Project Management Artifact: Problem Resolution Plan WD: Monitor and Control Project: Activity: Handle Exceptions and Problems Artifact: Review Record (reviews and checkpoints in each workflow)

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Process and Product Quality Assurance: Synergy

Specific Goal	Specific Practice
Objectively Evaluate Processes and Work Products	• Objectively Evaluate Processes (H) • Objectively Evaluate Work Products and Services (H)
Provide Objective Insight	• Communicate and Ensure Resolution of Noncompliance Issues (H) • Establish Records (H)

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Process and Product Quality Assurance: Detail Example

SP2.1-1: Communicate quality issues and ensure resolution of noncompliance issues with the staff and managers.

RUP Elements:
Workflow: Project Management
Workflow Detail: Monitor and Control Project
Activity: Handle Exceptions and Problems

Comments: Following the Problem Resolution Plan, problem management procedures are triggered in Activity: Handle Exceptions & Problems based on problems identified in a Status Assessment, raising of Change Requests to track defects, anomalies discovered during reviews, or through non-conformances raised during process audits and reviews.

Degree of Synergy: **High**

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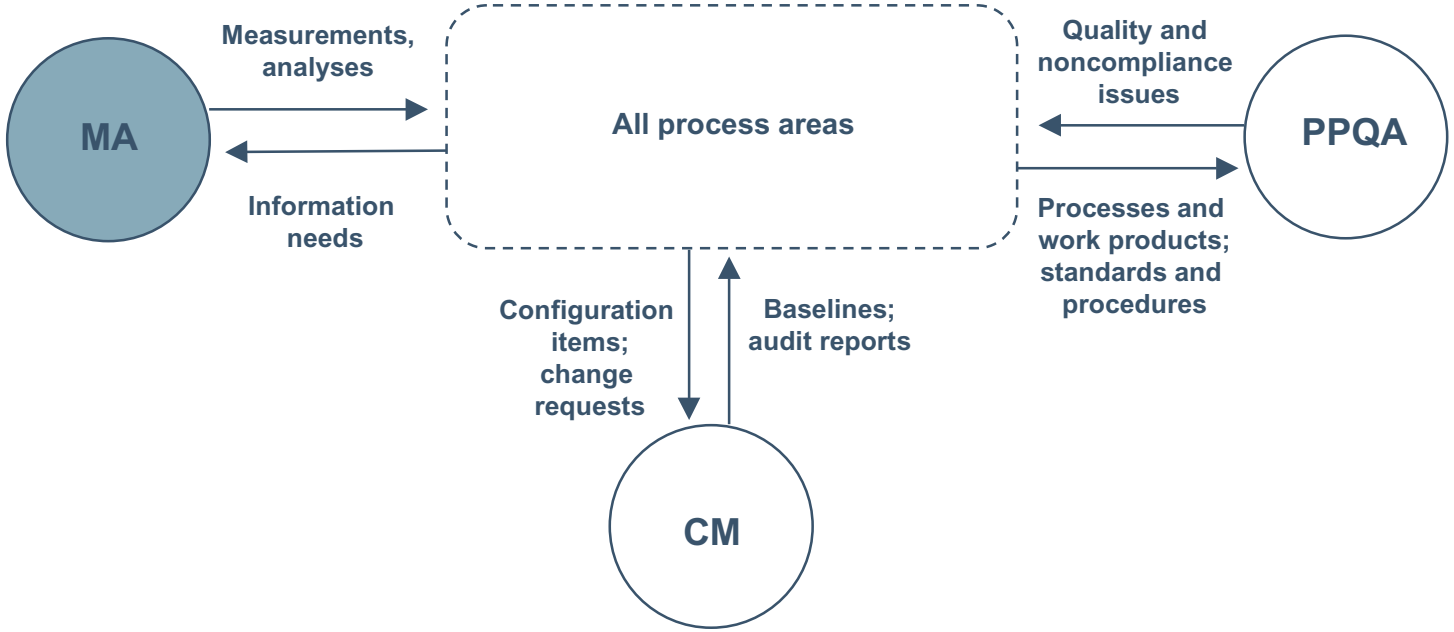
CMMI Basic Support Process Areas



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Measurement and Analysis: Overview

CMMI

Purpose

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

RUP

Workflow

Project Management

Synergy

- RUP provides good support mechanisms including extensive guidelines on candidate measures of project, process, and product
- RUP does not explicitly address the communication of measurement results to data providers

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Measurement and Analysis: Mapping

CMMI	RUP
SG 1: Align Measurement and Analysis Activities Measurement objectives and practices are aligned with identified information needs and objectives.	Workflow: Project Management WD: Develop Software Development Plan Activity: Develop Measurement Plan Guidelines: Metrics
SG 2: Provide Measurement Results Measurement results that address identified information needs and objectives are provided.	Workflow: Project Management WD: Monitor and Control the Project Activity: Monitor Project Status Activity: Report Status

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Measurement and Analysis: Synergy

Specific Goal	Specific Practice
Align Measurement and Analysis Activities	• Establish Measurement Objectives (H) • Specify Measures (H) • Specify Data Collection and Storage Procedures (H) • Specify Analysis Procedures (H)
Provide Measurement Results	• Collect Measurement Data (H) • Analyze Measurement Data (H) • Store Data and Results (H) • Communicate Results (H)

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Measurement and Analysis: Detail Example

SP2.4-1: Report results of measurement and analysis activities to all affected stakeholders.

RUP Elements:
Workflow: Project Management
Workflow Detail: Monitor and Control the Project
Activity: Report Status
Artifact: Status Assessment

Comments: Artifact: Status Assessment is drawn from the Project Measurements in Activity: Monitor Project Status. Status Assessment is used to ensure that expectations (i.e., Project Review Authority, project manager, and team leads in the functional areas) are synchronized and consistent. Data providers are not explicitly identified as receivers of measurement data.

Degree of Synergy: **High**

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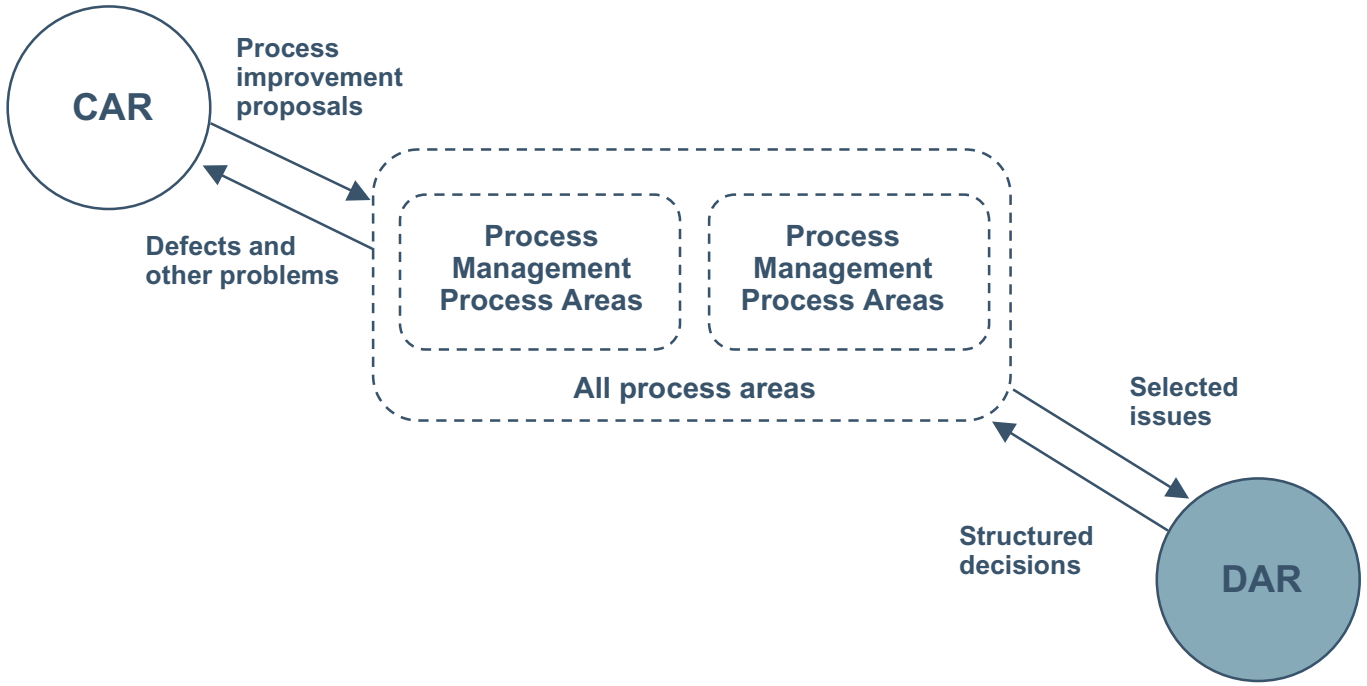
CMMI Advanced Support Process Areas



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Decision Analysis and Resolution: Overview

CMMI

Purpose

Make decisions using a structured approach that evaluates identified alternatives against established criteria.

RUP

Workflow

none

Synergy

- Decision analysis and resolution processes are outside the scope of RUP

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Decision Analysis and Resolution: Mapping

CMMI	RUP
SG 1: Evaluate Alternatives Decisions are based on an evaluation of alternatives using established criteria.	Workflow: none Outside the scope of RUP
SG 2: Provide Measurement Results Measurement results that address identified information needs and objectives are provided.	Workflow: none Outside the scope of RUP

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Decision Analysis and Resolution: Synergy

Specific Goal	Specific Practice
Evaluate Alternatives	• Establish and Use Guidelines for Decision Analysis (L) • Select Evaluation Technique (L) • Establish Evaluation Criteria (L) • Identify Proposed Alternatives (L) • Evaluate Alternative Solutions (L) • Select Solutions (L)

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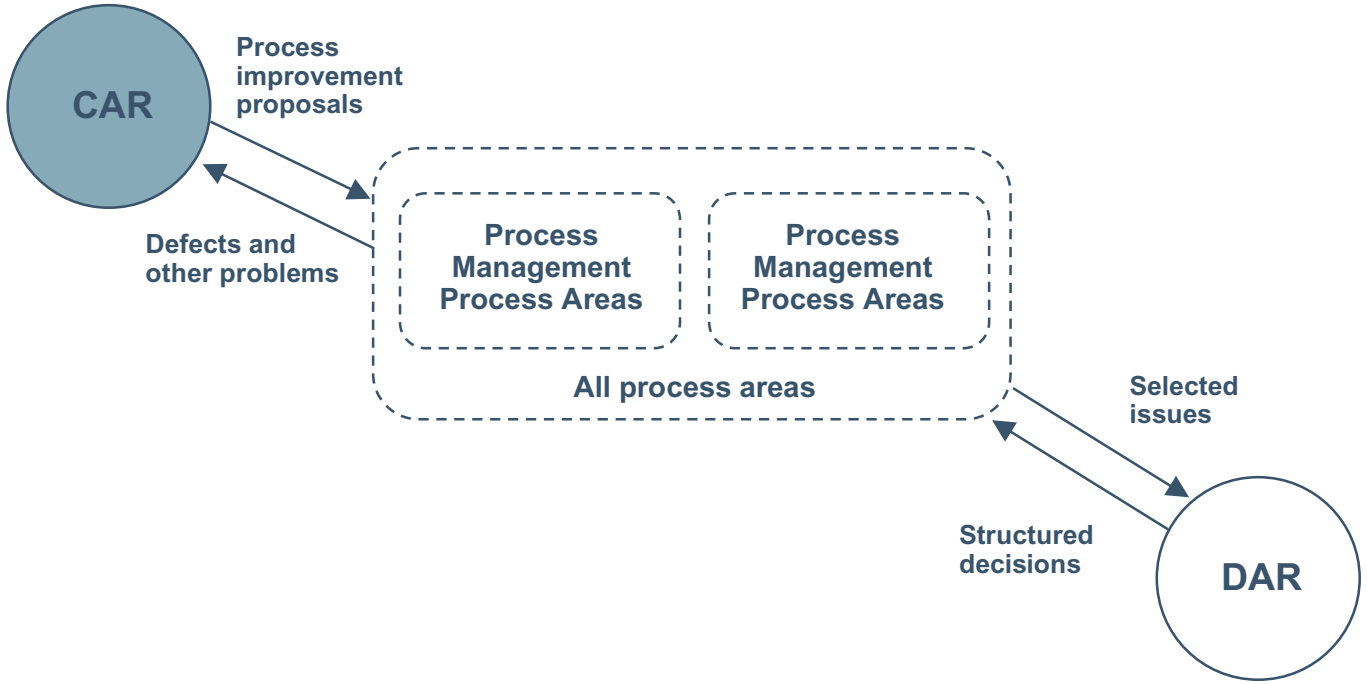
CMMI Advanced Support Process Areas



Causal Analysis and Resolution: Overview

CMMI

Purpose

Identify causes of defects and other problems and take action to prevent them from occurring in the future.

RUP

Workflow

Project Management

Synergy

- In RUP, the iteration assessment supplies a natural point in each iteration to integrate causal analysis and resolution
- Projects would need to develop their own quantitatively-based causal analysis techniques

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Causal Analysis and Resolution: Mapping

CMMI	RUP
SG 1: Determine Causes of Defects Root causes of defects and other problems are systematically determined.	Workflow: Project Management WD: Manage Iteration Activity: Assess Iteration Artifact: Iteration Assessment
SG 2: Address Causes of Defects Root causes of defects and other problems are systematically addressed to prevent their future occurrence.	Workflow: Project Management WD: Plan for Next Iteration Activity: Develop Iteration Plan Artifact: Development Case Workflow: Test Activity: Execute System Tests

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Causal Analysis and Resolution: Synergy

Specific Goal	Specific Practice
Determine Causes of Defects	• Select Data for Analysis (M) • Analyze Causes (L)
Address Causes of Defects	• Implement the Action Proposals (M) • Evaluate the Effect of Changes (M) • Record Data (L)

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Causal Analysis and Resolution: Detail Example

SP1.2-1: Perform causal analysis of selected defects and other problems and propose actions to address them.

RUP Elements:

Workflow: Project Management

Workflow Detail: Manage Iteration

Activity: Assess Iteration, Artifact: Iteration Assessment

Comments: In RUP, each iteration ends with an assessment of the iteration's objectives, risks, and defects that is used to modify the project or improve the process. Artifact: Iteration Assessment captures the result of an iteration, the degree to which the evaluation criteria was met, lessons learned, and changes to be done. While RUP provides an appropriate context for causal analysis, this CMMI practice assumes a statistical basis for the selection of defects and problems to address and the use of causal analysis techniques to analyze the defects. These aspects would need to be added to the iteration assessment, planning the next iteration, updating the development case, and specifying specific product and process measures in the measurement plan.

Degree of Synergy: **Low**

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Topics

Goals and Purpose

CMMI Overview

RUP Overview

RUP to CMMI Mapping

- Project Management
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- Support
- Process Management
- Generic Practices

Lessons Learned

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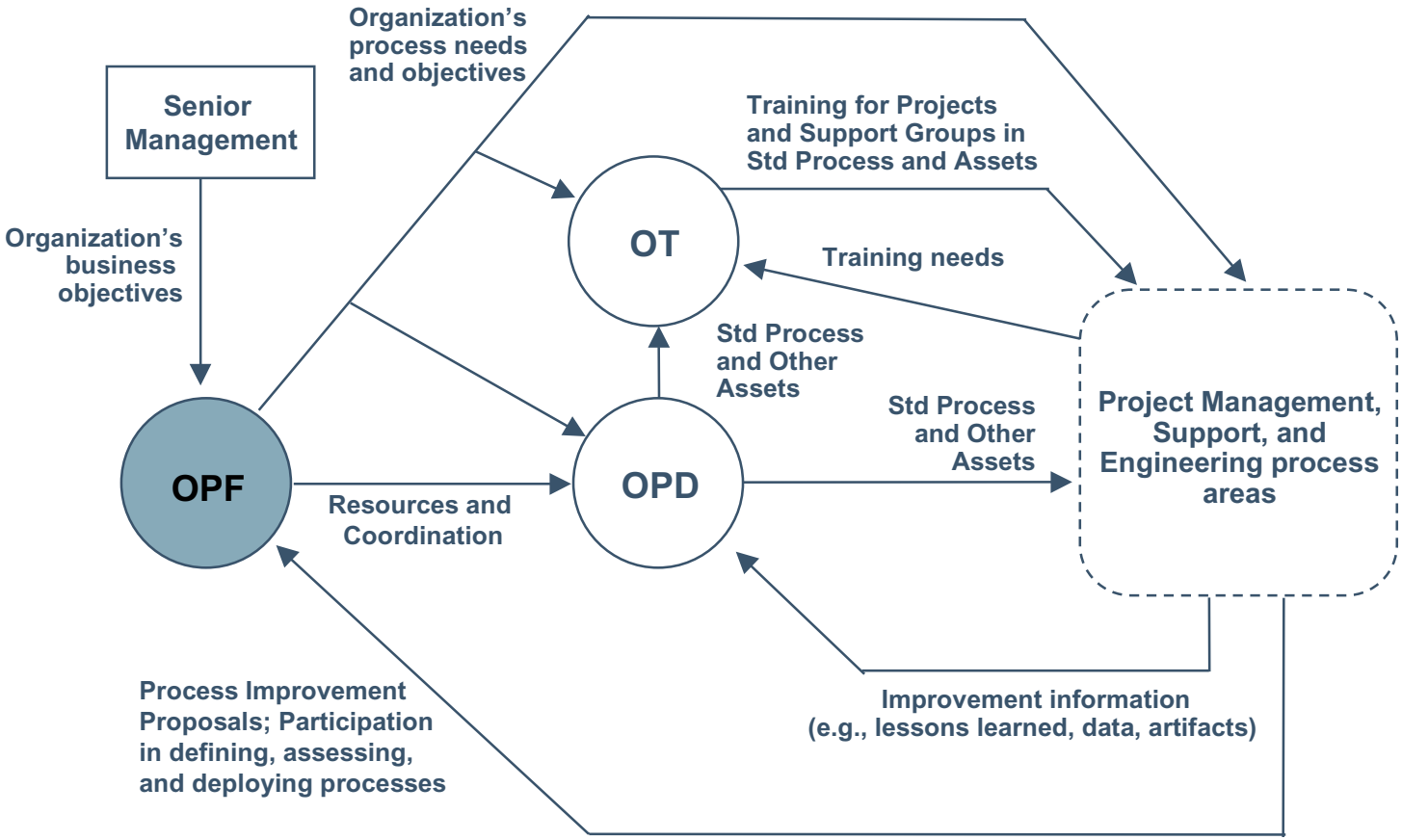
CMMI Basic Process Management Process Areas



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Organizational Process Focus: Overview

CMMI

Purpose

Establish and maintain an understanding of the organization's processes and process assets, and to identify, plan, and implement the organization's process improvement activities.

RUP

Workflow

Environment

Synergy

- RUP is primarily a project level tool
- Organizations wanting to use RUP for process management process areas may need to add workflows to address organizational process focus and definition issues

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Organizational Process Focus: Mapping

CMMI	RUP
SG 1: Determine Process Improvement Opportunities Strengths, weaknesses, and improvement opportunities for the organization's processes are identified periodically and as needed.	Workflow: Environment WD: Prepare Environment for Project Activity: Development-Organization Assessment
SG 2: Plan and implement Process Improvement Activities Improvements are planned and implemented, process assets are deployed, and process-related experiences are incorporated into the organization's process assets.	Workflow: Environment WD: Prepare Environment for Project Activity: Development-Organization Assessment

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Organizational Process Focus: Synergy

Specific Goal	Specific Practice
Determine Process Improvement Opportunities	• Establish Organizational Process Needs (L) • Assess the Organization's Processes (H) • Identify the Organization's Process Improvements (H)
Plan and Implement Process Improvement Activities	• Establish Process Action Plans (M) • Implement Process Action Plans (L) • Deploy Process and Related Assets (L) • Incorporate Process-Related Experiences into the Organization's Process Assets (L)

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Organizational Process Focus: Detail Example

SP1.2-1: Assess the processes of the organization periodically and as needed to maintain an understanding of their strengths and weaknesses.

RUP Components:
Workflow: Environment
Workflow Detail: Prepare Environment for Project
Activity: Development Organization Assessment

Comments: When preparing for a new project, RUP provides an activity to assess the organization's processes

Degree of Synergy: **High**

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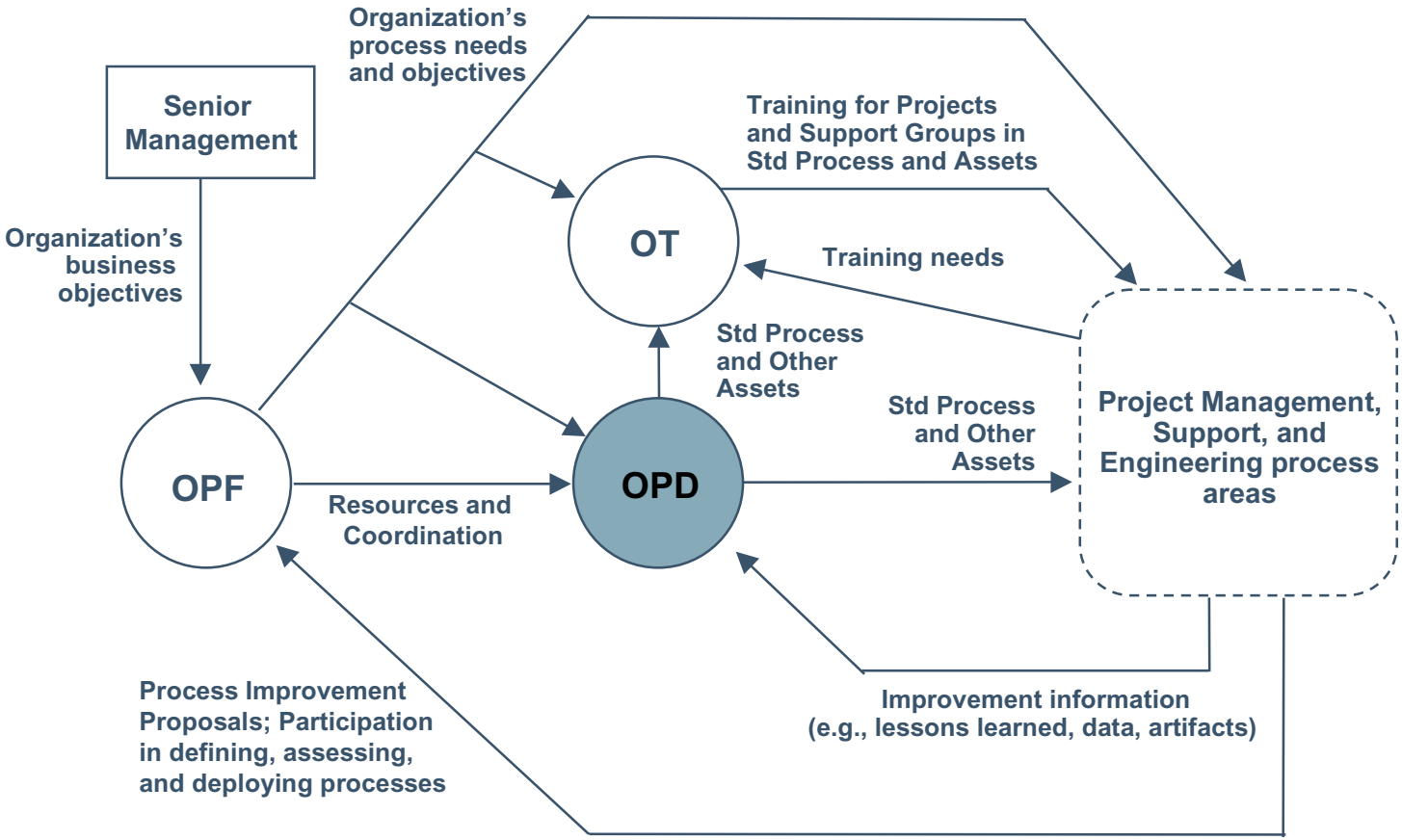
CMMI Basic Process Management Process Areas



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Organizational Process Definition: Overview

CMMI

Purpose

Establish and maintain a usable set of organizational process assets.

RUP

Workflow

Environment

Synergy

- Organizations could use RUP as the basis for their Organizational Standard Process
- Organizations would need to pay attention to Medium and Low synergy areas

Organizational Process Definition: Mapping

CMMI	RUP
SG 1: Create Organizational Process Assets A set of organizational process assets is available.	Workflow: Environment WD: Develop Guidelines Concept: Implementing a Process in an Organization Concept: Process Configuration
SG 2: Make Supporting Process Assets Available Process assets that support the use of the organization's set of standard processes are available.	Concept: Process Configuration

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Organizational Process Definition: Synergy

Specific Goal	Specific Practice
Create Organizational Process Assets	• Establish Standard Processes (M) • Establish Life-Cycle Model Descriptions (M) • Establish Tailoring Criteria and Guidelines (M)
Make Supporting Process Assets Available	• Establish An Organizational Measurement Repository (L) • Establish An Organizational-Process Asset Library (M)

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Organizational Process Definition: Detail Example

SP1.2-1: Establish and maintain descriptions of the life-cycle process models approved for use in the organization.

RUP Components:
Concepts: Process Configuration

Comments: Supplementary information suggests that RUP can be the organization's standard process. Following RUP should allow organizations to describe many life cycle types. RUP suggests that there may be more than one organization-wide process, one for each different type of development.

Degree of Synergy: **Medium**

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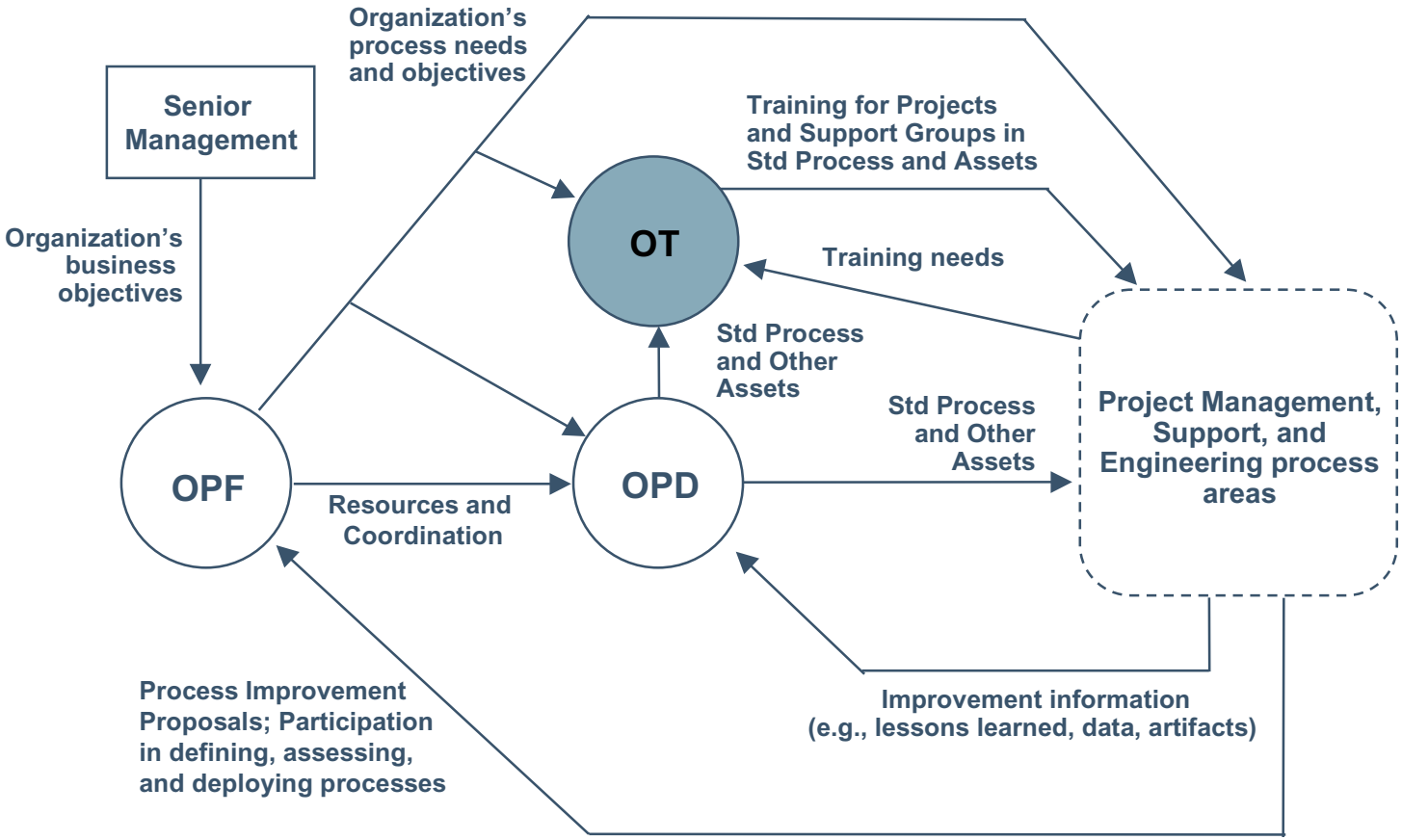
CMMI Basic Process Management Process Areas



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Organizational Training: Overview

CMMI

Purpose

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

RUP

Workflow

none

Synergy

- Organizational training issues are outside the scope of RUP

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Organizational Training: Mapping

CMMI	RUP
SG 1: Identify Training Needs and Make Training Available Training to support the organization's management and technical roles is identified and made available.	Workflow: none Outside of the scope of RUP
SG 2: Provide Necessary Training Training necessary for individuals to perform their roles effectively is provided.	Workflow: none Outside of the scope of RUP

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Organizational Training: Synergy

Specific Goal	Specific Practice
Identify Training Needs and Make Training Available	• Establish the Strategic Training Needs (L) • Determine which Training Needs are the Responsibility of the Organization (L) • Establish and Maintain Organizational Training Tactical Plan (L) • Establish and Maintain Training Capability (L)
Provide Necessary Training	• Deliver Training (L) • Establish Training Records (L) • Assess Training Effectiveness (L)

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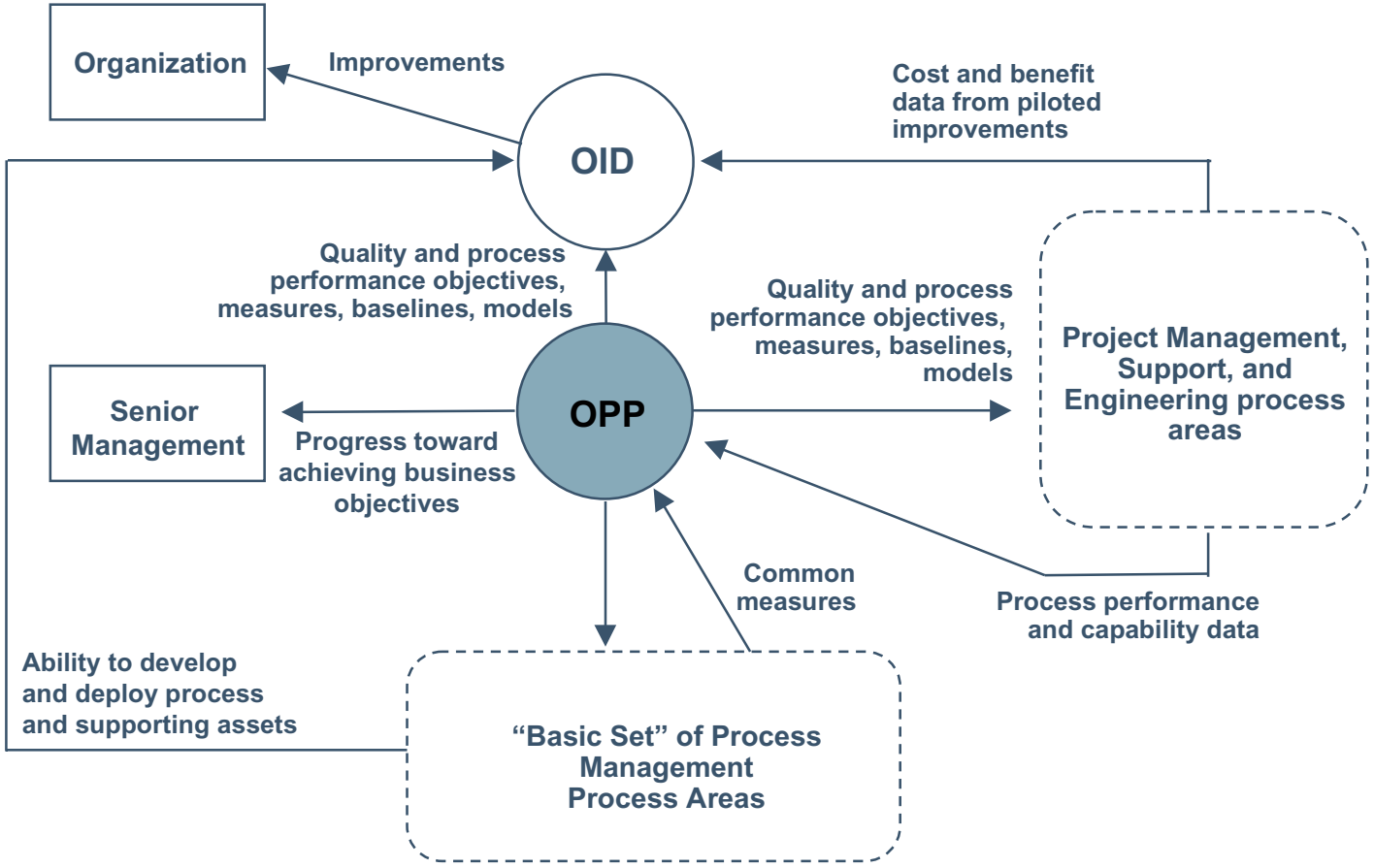
CMMI Advanced Process Management Process Areas



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Organizational Process Performance: Overview

CMMI

Purpose

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

RUP

Workflow

none

Synergy

- Establishing a quantitative understanding of an organization's set of processes is outside the scope of RUP

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Organizational Process Performance: Mapping

CMMI

SG 1: Establish Performance Baselines and Models

Baselines and models that characterize the expected process performance of the organization's set of standard processes are established and maintained.

RUP

Workflow: none

Outside of the scope of RUP

Organizational Process Performance: Synergy

Specific Goal	Specific Practice
Establish Performance Baselines and Models	• Select Processes (L) • Establish Process Performance Measures (L) • Establish Quality and Process Performance Objectives (L) • Establish Process Performance Baselines (L) • Establish Process Performance Models (L)

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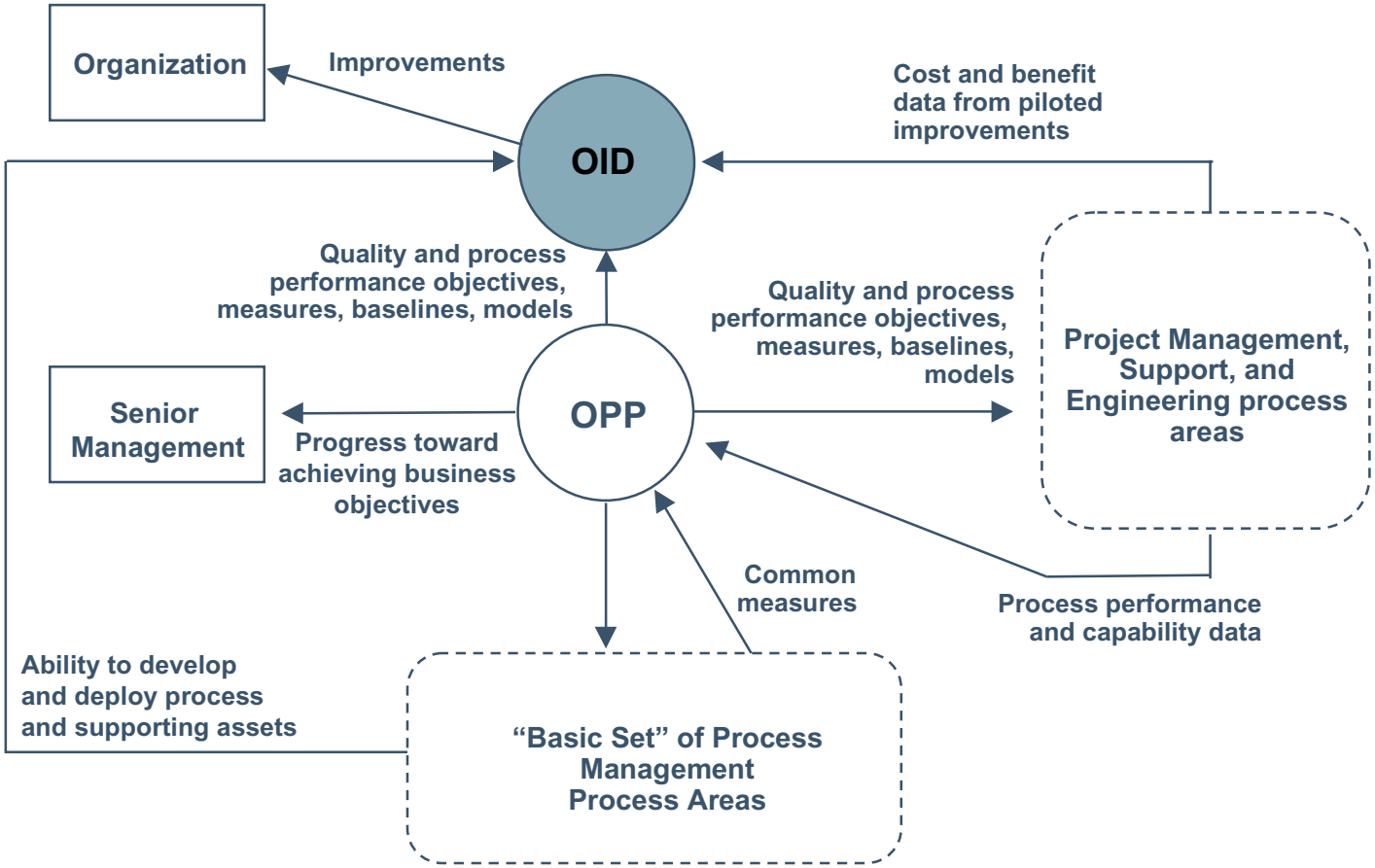
CMMI Advanced Process Management Process Areas



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Organizational Innovation and Deployment: Overview

CMMI

Purpose

Select and deploy incremental and innovative improvements that measurably improve the organization's processes and technologies. The improvements support the organization's quality and process performance objectives as derived from the organization's business objectives.

RUP

Workflow

none

Synergy

- Establishing measurable objectives for incremental and innovative process improvement is outside the scope of RUP

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Organizational Innovation and Deployment: Mapping

CMMI	RUP
SG 1: Select Improvements Process and technology improvements that contribute to meeting quality and process performance objectives are selected.	Workflow: none Outside of the scope of RUP
SG 2: Deploy Improvements Measurable improvements to the organization's processes and technologies are continually and systematically deployed.	Workflow: none Outside of the scope of RUP

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Organizational Innovation and Deployment: Synergy

Specific Goal	Specific Practice
Select Improvements	• Collect and Analyze Improvement Proposals (L) • Identify Innovations (L) • Pilot Improvements (L) • Select Improvements for Deployment (L)
Deploy Improvements	• Plan the Deployment (L) • Manage the Deployment (L) • Measure Improvement Effects (L)

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Topics

Goals and Purpose

CMMI Overview

RUP Overview

RUP to CMMI Mapping

- Project Management
- Engineering
- Support
- Process Management
- Generic Practices

Lessons Learned

Conclusions

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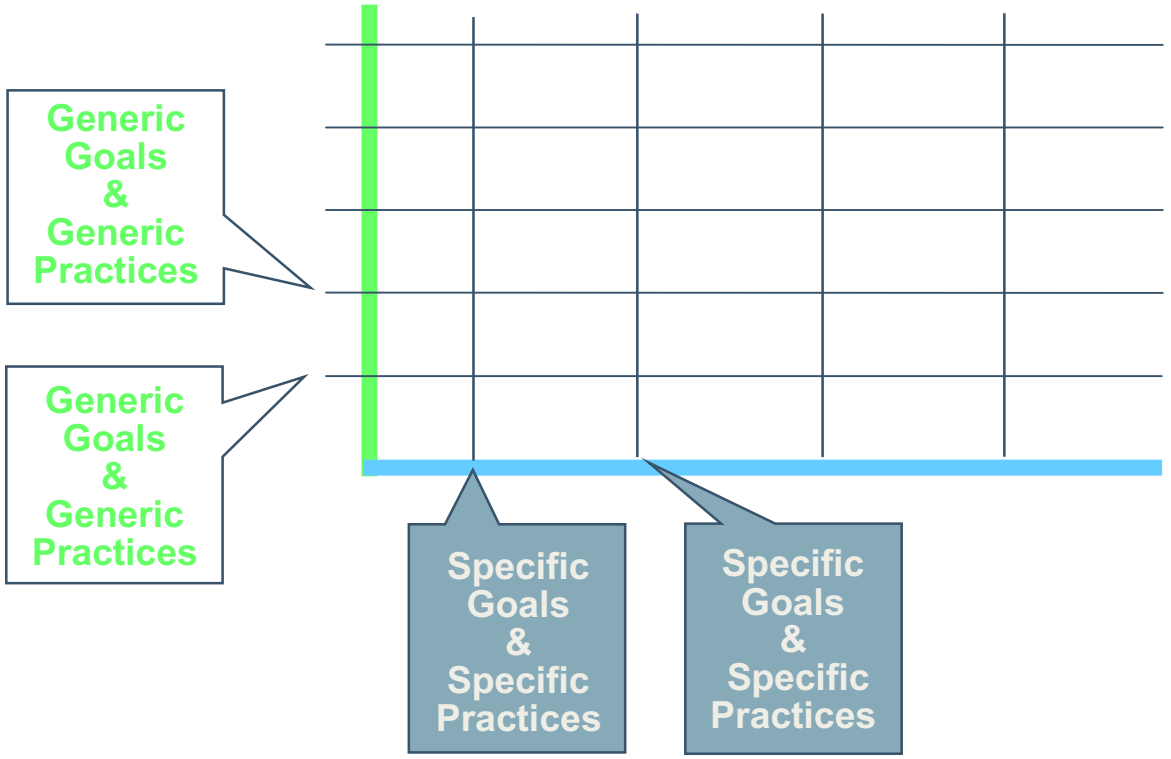
Continuous Representation Structure



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The Capability Levels

5 Optimizing

4 Quantitatively Managed

3 Defined

2 Managed

1 Performed

0 Incomplete

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Capability Level 0

Generic Goal	Generic Practices
There are none	• There are none

Capability Level 1

Generic Goal	Generic Practices
Achieve Specific Goals	• Identify Work Scope • Perform Base Practices

Capability Level 2

Generic Goal	Generic Practices
Institutionalize a Managed Process	• Establish and Maintain an Organizational Policy • Plan the Process • Provide Resources • Assign Responsibility • Train People • Manage Configurations • Identify and Involve Relevant Stakeholders • Monitor and Control the Process • Objectively Evaluate Adherence • Review Status with Higher-Level Management

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Capability Level 3

Generic Goal	Generic Practices
Institutionalize a Defined Process	• Establish a Defined Process • Collect Improvement Information

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Capability Level 4

Generic Goal	Generic Practices
Institutionalize a Quantitatively Managed Process	• Establish Quality Objectives • Stabilize Subprocess Performance

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Capability Level 5

Generic Goal	Generic Practices
Institutionalize an Optimizing Process	• Ensure Continuous Process Improvement • Correct Common Causes of Problems

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Topics

Goals and Purpose

CMMI Overview

RUP Overview

RUP to CMMI Mapping

Lessons Learned

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… On Planning the Comparison

- Determining the goals/objectives for the comparison before doing the comparison is key
- Comparison objectives, expected results, degree of rigor, and needed resources must be consistent to achieve reasonable results
- Determining the "level" on which to base the comparison must be part of setting the objectives and expected results
- Determining how comparison results will be captured before the review starts expedites the review
- Having all reviewers capture their findings in a similar manner is vital for later consolidation and reporting

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… On Executing the Comparison

- Prototyping the level of comparison to see if you get the desired results before the review saves rework
  - Avoid comparisons below the Specific Practice level
- Determining the basic principles that drive both the CMMI and the target process are essential to any valid comparison
- Determining the lexicon of the target process is essential for a valid review
  - Vital to understand the intent of a CMMI specific practice but don't expect an exact match of terminology

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… On Resources Used in the Comparison

- Reviewers need to be familiar (but not necessarily experts) with CMMI *and* the target process
- Reviewers must include resources that have in-depth understanding of CMMI and the target process (not necessarily the same person)
- Reviewers need to have a common understanding
  - Comparison objectives and expected results
  - Level of comparison, “rating” scheme, form of findings capture
  - Lexicon and basic principles of the target process
  - Intent of CMMI process areas

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CMMI Observations

CMMI provides good guidance on general systems development practices and institutionalization of process practices

CMMI could better address

- Architecture-related practices
- Recursive nature of the process elements in the engineering process areas
- “Waterfall” appearance of the engineering process areas

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RUP Observations

RUP provides strong engineering, basic support, and basic project management practices

- Clear definition of roles and responsibilities
- Integration of engineering and project management activities
- Use of iterations to mitigate risks as early as possible
- Validation of requirements and solutions
- Focus on early architecture definition and validation

Organizations using RUP may have need to address

- Statistical process control
- Organizational process elements
- Subcontractor or vendor management practices
- Institutionalization of processes

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Parting Thoughts

RUP is a software engineering process that is integrated with a suite of software development tools.

CMMI is a process framework that integrates systems and software engineering process elements and the organizational processes necessary to institutionalize them.

RUP and CMMI complement each other in achieving a mature software development organization.

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