МУК 2020/2021:
Модели за управление на качеството на софтуера и ИТ услуги
(Увод в подобряване на процесите - PI, CMMI)

Quality Management Models:
Intro to Process Improvement (PI)

PART 3: Maturity Level 2+

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Remember: CMMI Representations

Staged

- **Maturity Level 5**: OID, CAR
- **Maturity Level 4**: OPP, QPM
- **Maturity Level 3**: RM, TS, PI, VER, VAL, OPF, OPD, OT, IPM, RSKM, DAR
- **Maturity Level 2**: REQM, PP, PMC, MA, PPQA, CM, SAM

Process Areas

- **Organizational Innovation & Deployment (OID)**
- **Causal Analysis and Resolution (CAR)**
- **Organizational Process Performance (OPP)**
- **Quantitative Project Management (QPM)**
- **Requirements Development (RD)**
- **Technical Solution (TS)**
- **Product Integration (PI)**
- **Verification (VER)**
- **Validation (VAL)**
- **Organizational Process Focus (OPF)**
- **Organizational Process Definition (OPD) + IPPD**
- **Organizational Training (OT)**
- **Integrated Project Management (IPM) + IPPD**
- **Risk Management (RSKM)**
- **Decision Analysis and Resolution (DAR)**

Continuous

- **Support**: CM, PPQA, MA, CAR, DAR
- **Engineering**: RD, TS, PI, VER, VAL
- **Process Management**: OPF, OPD, OT, OPP, OID

Requirements Management (REQM)
- Project Planning (PP)
- Project Monitoring and Control (PMC)
- Supplier Agreement Management (SAM)
- Measurement and Analysis (MA)
- Process and Product Quality Assurance (PPQA)
- Configuration Management (CM)
Remember:
ML2: Processes are “Managed”

Processes characterized for **PROJECTS** and often reactive

Requirements flow in.

Plans are developed in accordance with policies.

Activities are performed in accordance with plans.

Measurements and reviews occur at defined points.

The product flows out and *(usually)* works.
ML2: Managing the Project Involves

Understand and commit to the requirements
Estimating the scope and work that needs to be performed
Developing mechanisms to acquire identified products
Developing a project plan
Getting commitments to the plan
Working with suppliers to acquire identified products
Monitoring progress against the plan
Identifying and analyzing risks
Taking action to address significant deviations from the plan
Taking action to appropriately mitigate risks
Project Management PAs (overview)

ML2: Requirements management (REQM)
  o SG1: Manage requirements

+ ML3: Requirements Development (RD)
  o SG 1 Develop Customer Requirements
  o SG 2 Develop Product Requirements
  o SG 3 Analyze and Validate Requirements

Project Planning (PP)
  o SG1: Establish Estimates
  o SG2: Develop a project plan
  o SG3: Obtain Commitment to the plan

Project Monitoring and Control (PMC)
  o SG1: Monitor Project Against Plan
  o SG2: Manage Corrective action to closure

Supplier Agreement Management (SAM)
  o SG 1: Establish Supplier Agreements
  o SG 2: Satisfy Supplier Agreements
Think about:
What Product/SW Development Needs?

Establishing and maintaining sets of requirements
- customer requirements
- product requirements
- product component requirements
- managing the requirements as the product evolves
Requirements Management and Requirements Development

Compliments of Kasse Initiatives, LLC
ML3: Requirements Development

The purpose of Requirements Development (RD) is to produce and analyze customer, product, and product component requirements.

GOALS

- SG 1 Develop Customer Requirements
- SG 2 Develop Product Requirements
- SG 3 Analyze and Validate Requirements
SG 1 Develop **Customer Requirements**
Stakeholder needs, expectations, constraints, and interfaces are collected and translated into customer requirements.

SG 2 Develop **Product Requirements**
Customer requirements are refined and elaborated to develop product and product component requirements.

SG 3 **Analyze and Validate Requirements**
The requirements are analyzed and validated, and a definition of required functionality is developed.
Importance of Requirements Development

Present complete **clear validated** requirements **understood by all parties**

Establish solid **foundation** for downstream activities
Benefits of Proper Requirements Development

Development team and customer share the same vision of what is to be developed, tested and supported.

Requirements are easily traceable to/from downstream work products.

Acceptance by customer of downstream products is easy & swift.

Low risk of increased costs to meet customer needs and expectations.
### Remember:

#### Defects - Insertion Pattern & Cost of Removal

<table>
<thead>
<tr>
<th>Where Defects are Introduced</th>
<th>Requirements</th>
<th>Design</th>
<th>Code</th>
<th>Software Test</th>
<th>System Test</th>
<th>Field Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relative Cost to Fix</td>
<td>$1</td>
<td>$1</td>
<td>$1</td>
<td>$6</td>
<td>$12</td>
<td>$100</td>
</tr>
</tbody>
</table>

Source: SEPG Asia Pacific 2009 presented by Ravindra Nath, KUGLER MAAG CIE GmbH
AS MARKETING REQUESTED IT

AS SALES ORDERED IT

AS ENGINEERING DESIGNED IT

AS WE MANUFACTURED IT

AS FIELD SERVICE INSTALLED IT

WHAT THE CUSTOMER WANTED!!

“COMMUNICATION” MEANS: SAYING AND HEARING HAVE THE SAME MESSAGE

Tree Swing picture from 1970s - Businessballs.com (Ack T & W Fleet)
Terminology

**Allocated Requirement** - Requirement that levies all or part of the performance and functionality of a higher level requirement on a lower level architectural element or design component.

**Derived Requirement** - Requirements that are not explicitly stated in the customer requirements, but are inferred (1) from contextual requirements (e.g., applicable standards, laws, policies, common practices, and management decisions), or (2) from requirements needed to specify a product component. Derived requirements can also arise during analysis and design of components of the product or system. (See also “product requirements.”)
Terminology II

**Customer Requirement** - The result of eliciting, consolidating, and resolving conflicts among the needs, expectations, constraints, and interfaces of the product's relevant stakeholders in a way that is acceptable to the customer. (See also “customer.”)

**Product Requirement** - A refinement of the customer requirements into the developers’ language, making implicit requirements into explicit derived requirements. (See also “derived requirements” and “product component requirements.”) The developer uses the product requirements to guide the design and building of the product.

**Product Component Requirements** - A complete specification of a product component, including fit, form, function, performance, and any other requirement.
SG 1 Develop Customer Requirements

SP 1.1 Elicit Needs
Elicit stakeholder needs, expectations, constraints, and interfaces for all phases of the product lifecycle.

SP 1.2 Transform Stakeholder Needs into Customer Requirements
Transform stakeholder needs, expectations, constraints, and interfaces into customer requirements.
SG 2 Develop Product Requirements

SP 2.1 Establish Product and Product Component Requirements
Establish and maintain product and product component requirements, which are based on the customer requirements.

SP 2.2 Allocate Product Component Requirements
Allocate the requirements for each product component.

SP 2.3 Identify Interface Requirements
Identify interface requirements.
SG 3 Analyze and Validate Requirements

**SP 3.1 Establish Operational Concepts and Scenarios**
Establish and maintain operational concepts and associated scenarios.

**SP 3.2 Establish a Definition of Required Functionality**
Establish and maintain a definition of required functionality.

**SP 3.3 Analyze Requirements**
Analyze requirements to ensure that they are necessary and sufficient.

**SP 3.4 Analyze Requirements to Achieve Balance**
Analyze requirements to balance stakeholder needs and constraints.

**SP 3.5 Validate Requirements**
Validate requirements to ensure the resulting product will perform as intended in the user's environment.
Requirements Development Sampling of Work Products

- **SP 1.1**: Elicit Needs
- **SP 1.2**: Transform Stakeholder Needs into Customer Requirements
- **SP 2.1**: Establish Product and Product Component Requirements
- **SP 2.2**: Allocate Product Component Requirements
- **SP 2.3**: Identify Interface Requirements
- **SP 3.1**: Establish Operational Concepts and Scenarios
- **SP 3.2**: Establish a Definition of Required Functionality and Quality Attributes
- **SP 3.3**: Analyze Requirements
- **SP 3.4**: Analyze Requirements to Achieve Balance
- **SP 3.5**: Validate Requirements

Customer Requirements

Product, Product Component, and Interface Requirements
How Requirements Development interacts with other Process Areas

Who does RD depend upon?
- Requirements Management (ML2:REQM) for managing requirements
- Technical Solution (ML3:TS) for development of alternative solutions and identification of product components
- Risk Management (ML3:RSKM) for identification and management of requirements risks

Who depends on RD?
- Requirements Management (ML2:REQM) takes requirements from RD
- Product Integration (ML3:PI) takes interface requirements
- Verification & Validation (ML3: VER & VAL)
Where Requirements Development stands in the model?

- **Maturity level 3**
- **Engineering process area**

**Diagram:**
- **REQM** (Requirements)
- **RD** (Requirements Development)
- **TS** (Technical Solution)
- **PI** (Product Integration)
- **VER** (Verification)
- **VAL** (Validation)
- **Customer**

**Flow:**
- Customer needs → Customer
- Customer needs → RD
- RD → Requirements
- Requirements → TS
- TS → Product components
- Product components → PI
- PI → Product
- Product → Customer
- PI → VER
- VER → Product components, work products, verification and validation reports
- RD → Alternative solutions
- Alternative solutions → RD
- RD → Requirements
- Requirements → TS
- TS → Product components
- Product components → PI
- PI → Customer

**Abbreviations:**
- PI = Product Integration
- RD = Requirements Development
- REQM = Requirements Management
- TS = Technical Solution
- VAL = Validation
- VER = Verification
The Requirements Management (REQM, ML2) and Requirements Development (RD, ML3) Partnership

Requirements Development

Requirements Management

Compliments of
Kasse Initiatives, LLC
The purpose of Requirements Management (REQM) is to manage the requirements of the project’s products and product components and to identify inconsistencies between those requirements and the project’s plans and work products.

**GOALS**

SG1: Manage Requirements
Requirements are managed and inconsistencies with project plans and work products are identified.

The process area also has generic goals to support institutionalization.
When Requirements Management Is Not Done Well...

Requirements are accepted by staff from any source they deem to be authoritative.

The project experiences a high level of requirements changes.

There are high levels of rework throughout the project.

There is an inability to prove that the product meets the approved requirements.

Lack of requirements traceability often results in incomplete or incorrect testing of the product.
Relevant Terminology

Requirements traceability
A discernable association between requirements and related requirements, implementations, and verifications.

Bidirectional traceability
An association among two or more logical entities that is discernable in either direction (i.e., to and from an entity).
Requirements Management (REQM) Specific Practices

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
Requirements Management Context

- **Manage Requirements**
  - Obtain an Understanding of Requirements
  - Obtain Commitment to Requirements
  - Manage Requirements Changes
  - Maintain Bidirectional Traceability of Requirements

- **Traceability Matrix**
  - Identify Inconsistencies Between Project Work and Requirements

- **Requirements**
REQM Practices implementation:

• Acceptance criteria in place?
• Requirements comply to criteria?
• Is understanding reached and is it documented? How?
• Who are the relevant stakeholders?
• Did they agree to requirements?
• Is the commitment documented? How?
• All requirements and their changes documented?
• Requirements change history and rationale documented?
• Are changes evaluated by affected stakeholders?
• Bi-directional traceability among the requirements and the project plans and work products maintained?
• Are the project plan/activities/work products reviewed to assess the consistency with the (changed) requirements?
• If inconsistencies have been are corrective actions initiated to solve them?
Remember - Generic practices ML2?

GP2.1: Establish an Organizational Policy
GP2.2: Plan the Process
GP2.3: Provide Resources
GP2.4: Assign Responsibility
GP2.5: Train People
GP2.6: Manage Work Products
GP2.7: Identify and Involve Relevant Stakeholders
GP2.8: Monitor and Control the Process
GP2.9: Objectively Evaluate Adherence
GP2.10: Review Status with Higher Level Management
Sampling the Generic Practices

GP 2.5: Train People

*Train the people performing or supporting the requirements management process as needed.*

**Elaboration for Requirements Management**

Examples of training topics include the following:

- Application domain
- Requirements definition, analysis, review, and management
- Requirements management tools
- Configuration management
- Negotiation and conflict resolution
Sampling the Generic Practices

GP 2.6: Manage Work Products (Configurations)

*Place designated work products of the requirements management process under appropriate levels of control.*

**Elaboration for Requirements Management**

Examples of work products placed under control include the following:

- Requirements
- **Requirements traceability matrix**
Remember: Why do we need bidirectional traceability???

Forward Traceability
- Sources of the Requirement
- Requirements
- Work Products that Implement the Requirements

Backward Traceability
- Sources of the Requirement
- Requirements
- Work Products that Implement the Requirements

Benefits:
- Analyze the impact of a change
  - All work products affected by a changed requirement
  - All requirements affected by a change or defect in a work product

Assess current status of the requirements and the project
- Identify missing requirements
- Identify gold plating (overdoing)
Sampling the Generic Practices

GP 2.7: Identify and Involve relevant Stakeholders
Identify and involve the relevant stakeholders of the requirements management process as planned.

Elaboration for Requirements Management
Select relevant stakeholders from customers, end users, developers, producers, testers, suppliers, marketers, maintainers, disposal personnel, and others who may be affected by, or may affect, the product as well as the process.
Examples of activities for stakeholder involvement include the following:
• Resolving issues on the understanding of the requirements
• Assessing the impact of requirements changes
• Communicating the bidirectional traceability
• Identifying inconsistencies among project plans, work products, and requirements
Sampling the Generic Practices

**GP 2.8: Monitor and Control the process**

_Monitor and control the requirements management process against the plan for performing the process and take appropriate corrective action._

**Elaboration for Requirements Management**

Examples of measures and work products used in monitoring and controlling include the following:

- Requirements volatility (percentage of requirements changed)
- Schedule for coordination of requirements
- Schedule for analysis of a proposed requirements change
Sampling the Generic Practices

GP 2.10: Review Status with Higher Level Management
Review the activities, status, and results of the requirements management process with higher level management and resolve issues.

Elaboration for Requirements Management
Proposed changes to commitments to be made external to the organization are reviewed with higher level management to ensure that all commitments can be accomplished.
CMMI V2.0 [Next Generation CMMI]

REQUIREMENTS DEVELOPMENT AND MANAGEMENT (RDM)

• Combined REQM (ML2) and RD (ML3)
• New approach to ML and indicators
• Adapted to Agile organizations
• Process areas >>> Practice areas
CMMI V2.0 REQUIREMENTS DEVELOPMENT AND MANAGEMENT (RDM)

Level 1
- RDM 1.1 Record requirements

Level 2
- RDM 2.1 Elicit stakeholder needs, expectations, constraints, and interfaces or connections. (RD SP 1.1)
- RDM 2.2 Transform stakeholder needs, expectations, constraints, and interfaces or connections into prioritized customer requirements. (RD SP 1,1, 3.2)
- RDM 2.3 Develop an understanding with the requirements providers on the meaning of the requirements. (REQM SP 1.1.)
- RDM 2.4 Obtain commitment from project participants that they can implement the requirements. (REQM SP 1.2)
- RDM 2.5 Develop, record, and maintain bidirectional traceability among requirements and activities or work products. (REQM SP 1.4)
- RDM 2.6 Ensure that plans and activities or work products remain consistent with requirements. (REQM SP 1.4)

Level 3
- RDM 3.1 Develop and keep requirements updated for the solution and its components. (RD SP 2.1)
- RDM 3.2 Develop operational concepts and scenarios. (RD SP 3.1, 3.2)
- RDM 3.3 Allocate the requirements to be implemented. (RD SP2.2)
- RDM 3.4 Identify, develop, and keep updated interface or connection requirements. (RD SP 2.3)
- RDM 3.5 Ensure that requirements are necessary and sufficient. (RD SP 3.3)
- RDM 3.6 Balance stakeholder needs and constraints. (RD SP 3.4)
- RDM 3.7 Validate requirements to ensure the resulting solution will perform as intended in the target environment. (RD SP 3.5)
What to build
What to do
SAM
What to monitor
Replan
Plans
Status, issues, and results of reviews and monitoring
Corrective action

Product component requirements, technical issues, completed product components, and acceptance reviews and tests

Corrective action

Product and product component requirements

Product and product component requirements

Measurement needs

What to do
Commitments

Engineering and Support process areas

Supplier agreement

Supplier

PP = Project Planning
REQM = Requirements Management
SAM = Supplier Agreement Management

PMC = Project Monitoring and Control
PP = Project Planning
REQM = Requirements Management
SAM = Supplier Agreement Management
Just to mention SAM (Supplier Agreement Management)

The purpose of Supplier Agreement Management (SAM) is to manage the acquisition of products and services from suppliers.

SG 1: Establish Supplier Agreements
Agreements with the suppliers are established and maintained.

SG 2: Satisfy Supplier Agreements
Agreements with suppliers are satisfied by both the project and the supplier.
The essence of SAM

Applies to the acquisition of:
  products/components that are delivered to the project's customer
  significant products/components not delivered to the project's customer (for example, development tools and test environments).

Does not apply when supplier is part of the team

Suppliers:
  in-house vendors
  fabrication capabilities and laboratories
  commercial vendors

The acquired product is delivered to the project from the supplier and becomes part of the products delivered to the customer
SAM Practices:

Type of acquisition (COTS, contract, in-house, from the customer) determined?

Supplier selection based on evaluation?

Criteria for evaluation established/documentated?

Criteria for evaluation of proposals?

Agreement with supplier documented?

Agreement revised during project?

Criteria of evaluation of COTS?

Risk analysis performed on COTS?

Monitoring activities defined in the agreement?

Technical/management reviews with supplier performed?

Acceptance test/verification performed and results documented?