Capability Maturity Model Integration (CMMI)

Introduction and Overview

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Ralf Kneuper

- Dipl.-Mathematiker, Univ. of Bonn
- PhD Computing Science, Univ. of Manchester
- 1989-1995: Software AG
  - Quality assurance, quality management, ISO 9000
- 1995-2005: Deutsche Bahn/TLC/DB Systems
  - Senior consultant, project lead
  - Quality management, internal CMM(I) consultant, development processes, project management
- Since 2003: Independent consultant on CMMI
- Speaker of GI SIG on software processes
- SEI-Authorized CMM Lead Assessor, CMMI Lead Appraiser
- Coordinator of the German CMM(I) Lead Appraiser and Instructor Board (CLIB)

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# Where do I find out more about CMMI?

Original CMMI documentation

- **Capability Maturity Model Integration (CMMI), CMMI for Systems Engineering and Software Engineering (CMMI-SE/SW, V1.1) Continuous Representation CMU/SEI-2002-TR-001**

- **Capability Maturity Model Integration (CMMI), CMMI for Systems Engineering and Software Engineering (CMMI-SE/SW, V1.1) Staged Representation CMU/SEI-2002-TR-002**

  - both available at http://www.sei.cmu.edu/cmmi

- **Mary Beth Chrissis, Mike Konrad, Sandy Shrum: CMMI. Guidelines for Process Integration and Product Improvement. 663 S., SEI Series in Software Engineering, Addison-Wesley, Boston, 2003**

Further reading

- **Ahern, Clouse, Turner: CMMI Distilled. A Practical Introduction to Integrated Process Improvement. 2nd ed, Addison-Wesley, 2003**

- **Kneuper: CMMI. Verbesserung von Software-prozessen mit Capability Maturity Model Integration. 2nd edition, dpunkt.verlag, January 2006 (http://www.dpunkt.de/cmmi/)**

- **see also http://www.kneuper.de/cmmi/cmmi-lit.htm**
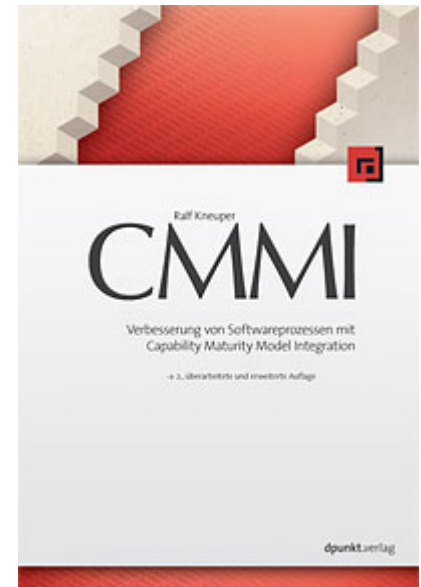
"The quality of a product is largely determined by the quality of the process that is used to develop and maintain it."

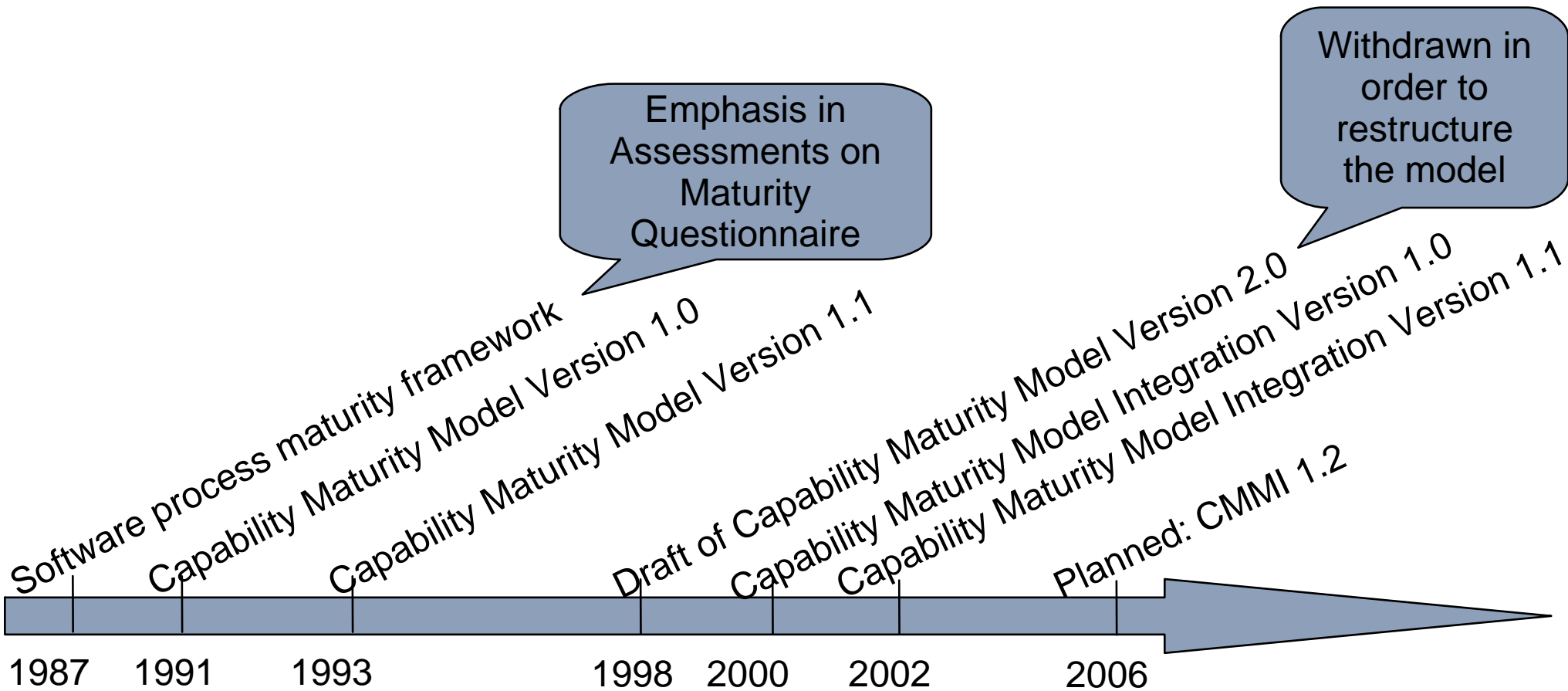Based on TQM principles as taught by Shewhart, Juran, Deming and Humphrey.

Why do we want software process improvement (CMM, CMMI, ...)?

- **What does the customer want?**

  – High-quality results that satisfy the requirements and are completed in time and in budget

- **What does the management want?**

  – High customer satisfaction

  – High productivity

  – Control over projects

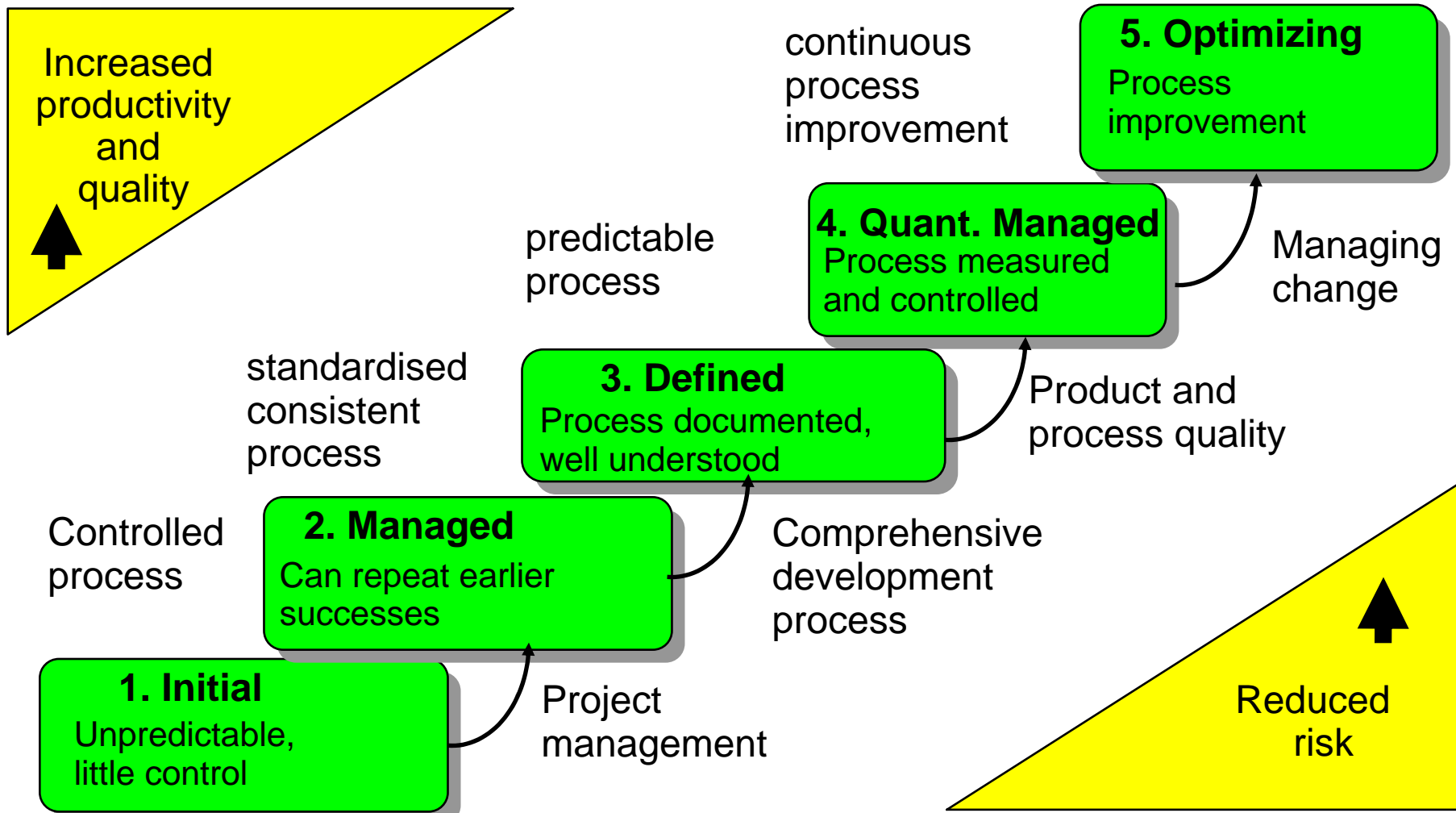- **What do the developers want?**

  – Do their job in peace

Software Process Improvement (SPI) supports achieving these goals!

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Versions of CMM(I)

Emphasis in Assessments on Maturity Questionnaire

Withdrawn in order to restructure the model

Software process maturity framework

Capability Maturity Model Version 1.0

Capability Maturity Model Version 1.1

Draft of Capability Maturity Model Version 2.0

Capability Maturity Model Integration Version 1.0

Capability Maturity Model Integration Version 1.1

Planned: CMMI 1.2

1987   1991   1993   1998   2000   2002   2006

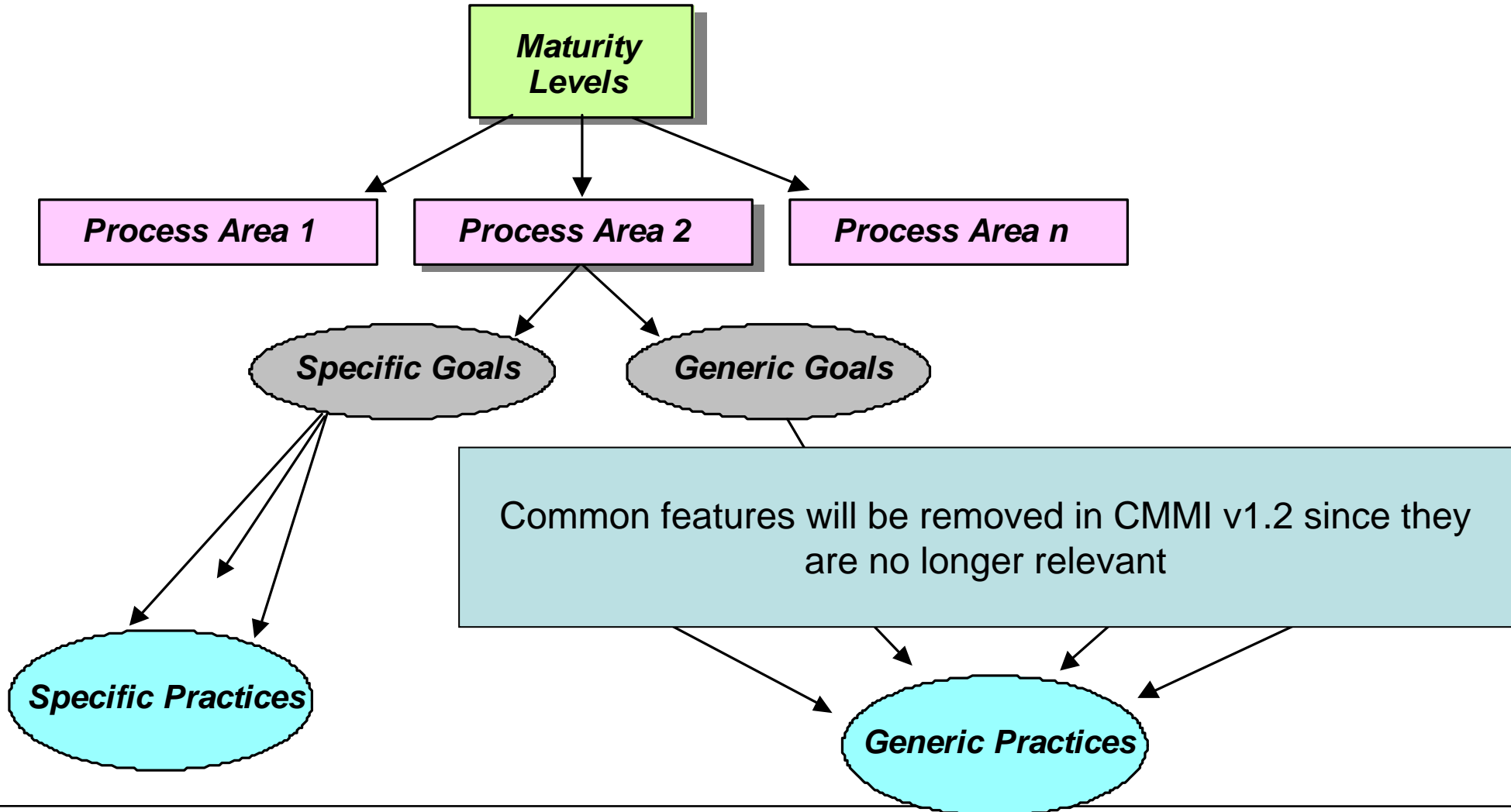# Capability Maturity Model Integration (CMMI) Project

- **Project started in 1997**

- **CMMI-SE/SW Version 1.0 released in August 2000**

- **CMMI-SE/SW Version 1.1 released in January 2002**

  - „staged" and „continuous" representation

  - one common document covering Systems and Software Engineering

  - some additional requirements compared to SW-CMM 1.1

  - in some cases requirements are stated more explicitly

    - mainly requirements that were obviously meant but not stated explicitly

  - SPICE (ISO 15504) - conformant

  - More structure, higher abstraction level

- **"Sunset period" until end of 2003**

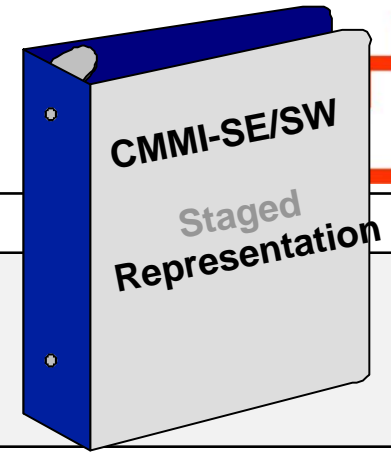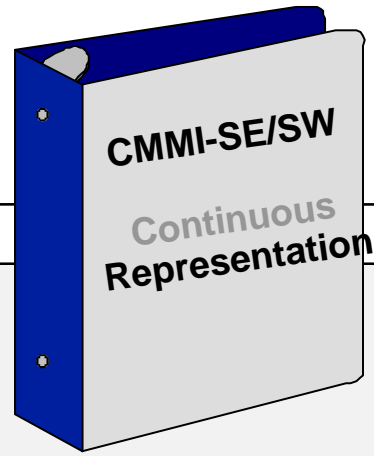- **Revised assessment method („SCAMPI" instead of „CBA-IPI")**

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The five maturity levels of CMMI

Increased productivity and quality

continuous process improvement

5. Optimizing
Process improvement

4. Quant. Managed
Process measured and controlled

Managing change

predictable process

3. Defined
Process documented, well understood

Product and process quality

standardised consistent process

2. Managed
Can repeat earlier successes

Comprehensive development process

Controlled process

1. Initial
Unpredictable, little control

Project management

Reduced risk

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Variants of CMMI

Representation / Application area	CMMI-SE/SW Continuous Representation	CMMI-SE/SW Staged Representation
System engineering (SE)	X	X
Software engineering (SW)	X	X
Integrated product and process development (IPPD)	X	X
Supplier Sourcing (SS)	X	X

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Levels

- **Capability Level (Continuous representation)**

    – Capability levels apply to one process area

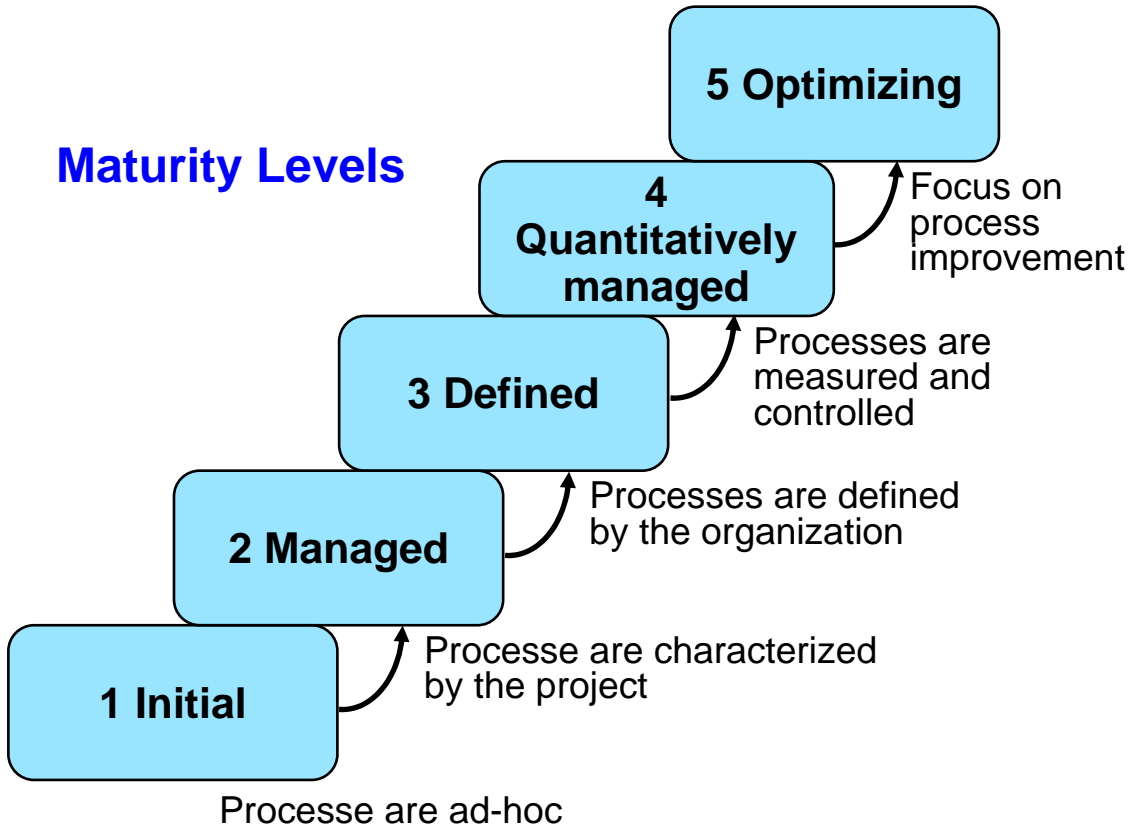   – Capability levels range from 0 (no requirements) to 5
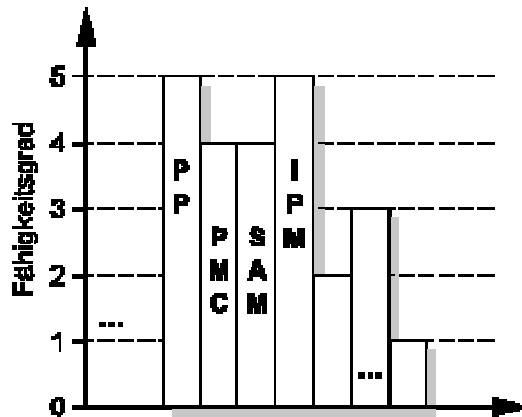
- **Maturity Level (Staged representation)**

    – Maturity levels apply to the totality of all process areas

    – Maturity levels range from 1 (no requirements) to 5
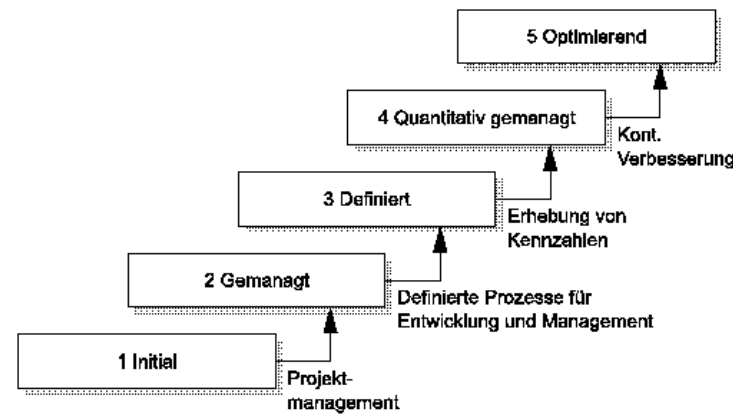
**Maturity Levels**

5 Optimizing

4 Quantitatively managed

Focus on process improvement

3 Defined

Processes are measured and controlled

2 Managed

Processes are defined by the organization

1 Initial

Processe are characterized by the project

Processe are ad-hoc

5 Optimizing

4 Quantitatively managed

3 Defined

2 Managed

1 Performed)

0 Incomplete

Capability Levels

- **Achieve Specific Goals (GG 1)**

  – Perform Base Practices (GP 1.1)

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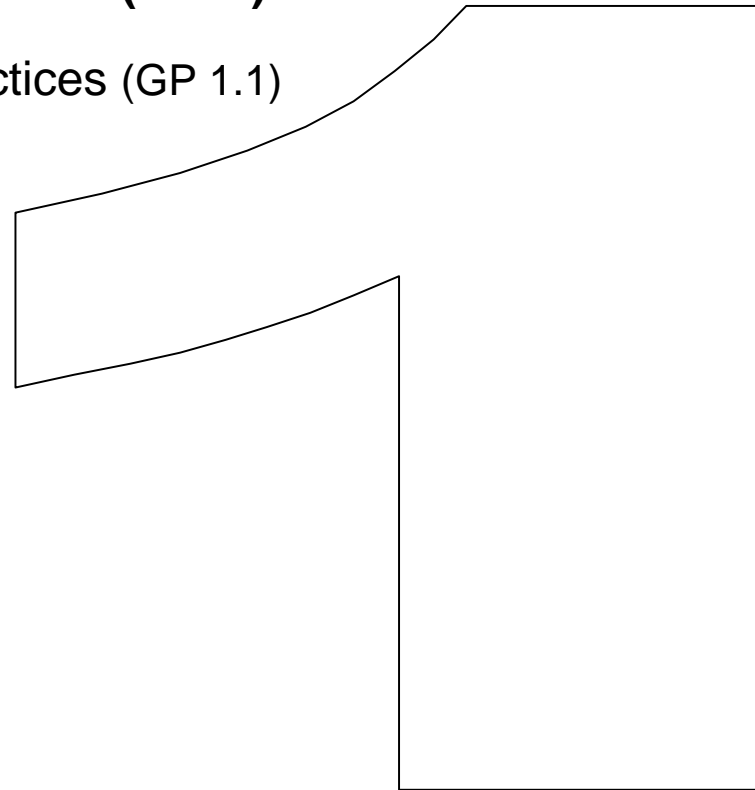
Careful: in CMM, „managed" referred to level 4

- **Institutionalize a Managed Process (GG 2)**

  – Establish an Organizational Policy (GP 2.1)

  – Plan the Process (GP 2.2)

  – Provide Resources (GP 2.3)

  – Assign Responsibility (GP 2.4)

  – Train People (GP 2.5)

  – Manage Configurations (GP 2.6)

  – Identify and Involve Relevant Stakeholders (GP 2.7)

  – Monitor and Control the Process (GP 2.8)

  – Objectively Evaluate Adherence (GP 2.9)

  – Review Status with Higher Level Management (GP 2.10)

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- **Institutionalize a Defined Process (GG 3)**

  – Establish a Defined Process (GP 3.1)
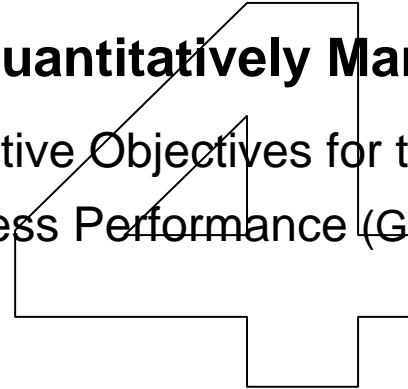
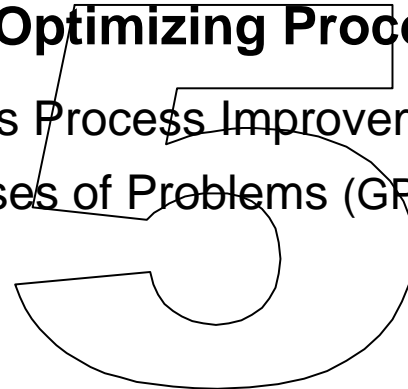 – Collect Improvement Information (GP 3.2)
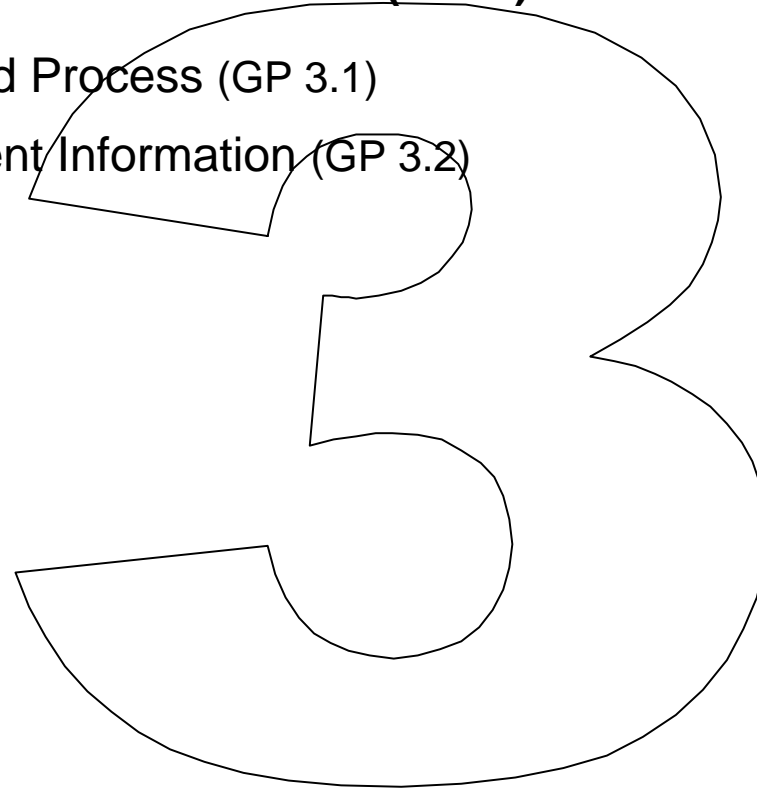
- **Institutionalize a Quantitatively Managed Process (GG 4)**

  – Establish Quantitative Objectives for the Process (GP 4.1)

 – Stabilize Subprocess Performance (GP 4.2)

- **Institutionalize an Optimizing Process (GG 5)**

  – Ensure Continuous Process Improvement (GP 5.1)

  – Correct Root Causes of Problems (GP 5.2)

- **GG 4 and GG 5 are only contained in the continuous representation**

Agenda

- **Introduction**
- **History and Motivation**
- **Structure of CMMI**
- **Generic Goals – Overview**
- ◇ **Maturity Level 2 and 3 Process Areas**
- **Generic Goals – Revisited**
- **CMMI Appraisals**
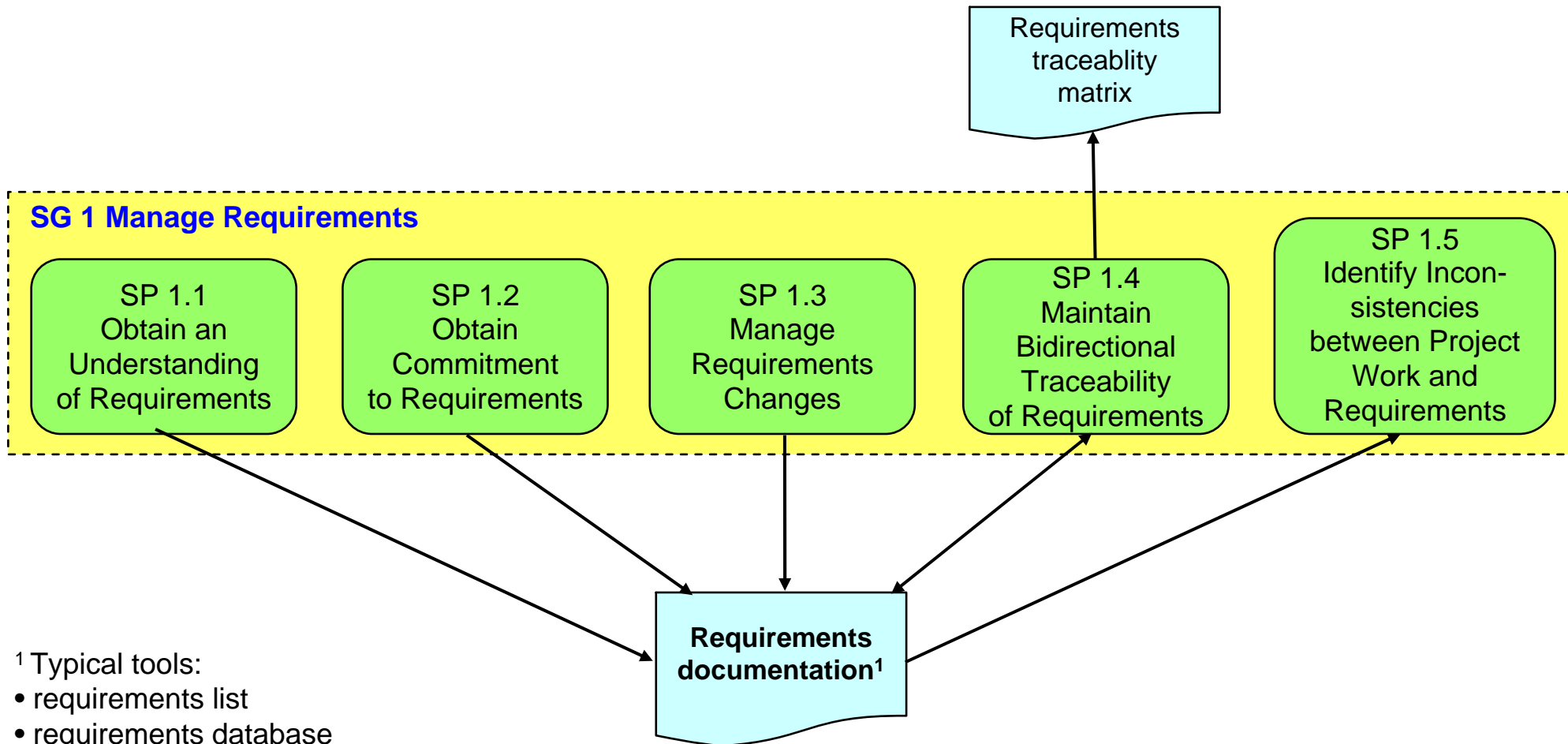- **Introducing CMMI into an Organization**
- **CMMI and ISO 15504 (SPICE)**
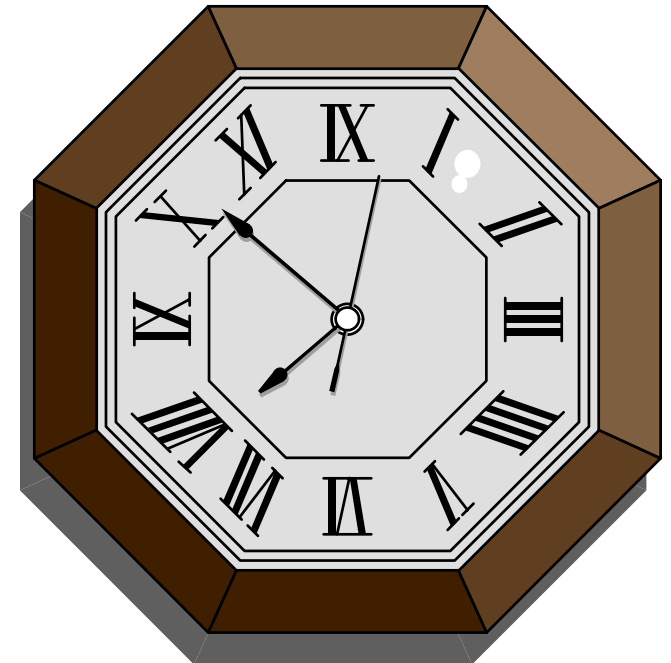
CMMI (CMMI-SE/SW V. 1.1)
Process Areas by Category and Maturity Level

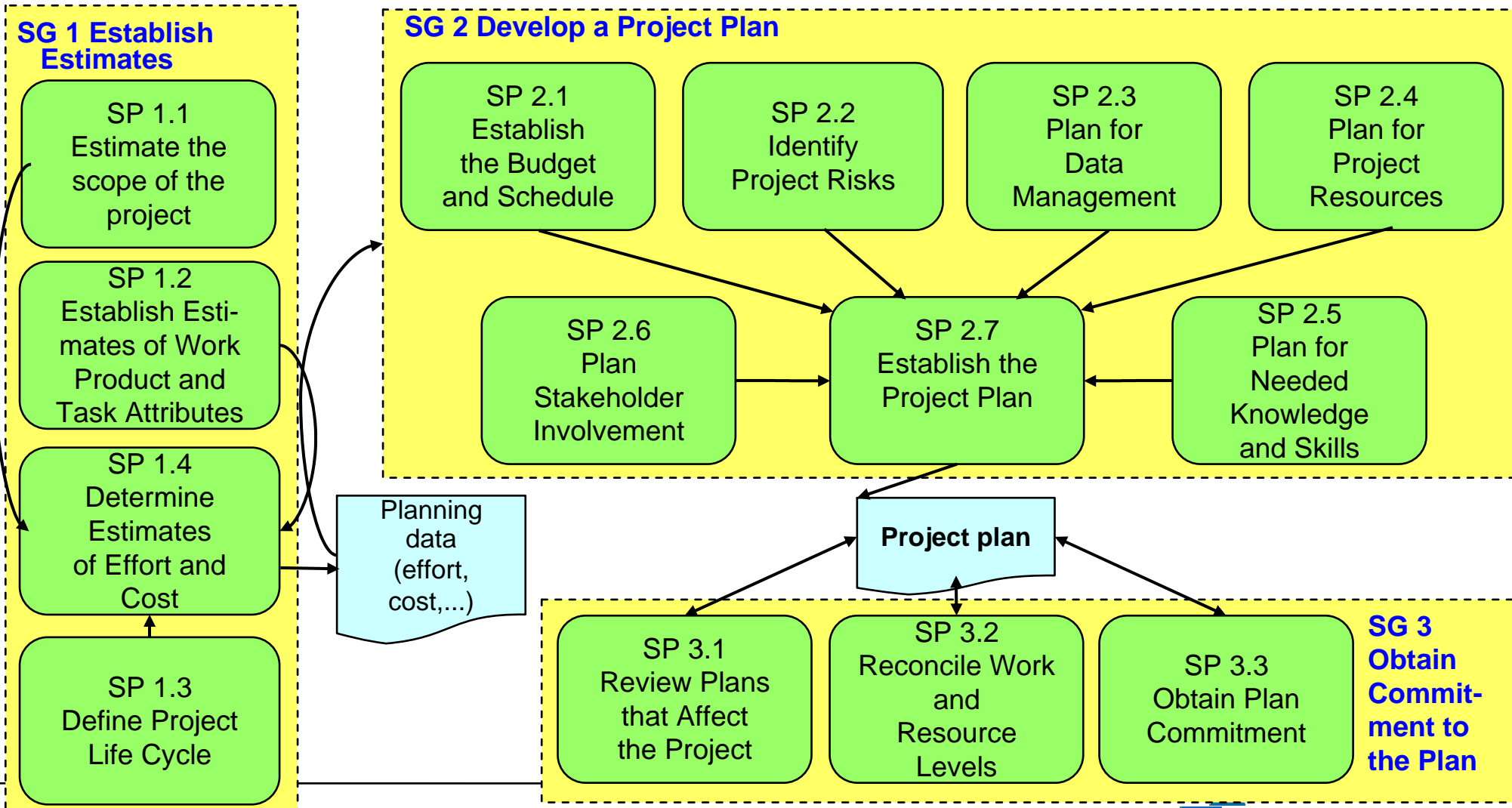|	Process Mgmt.	Project Management	Engineering	Support
2		Project Planning (PP)	Requirements Management (REQM)	Configuration Management (CM)
		Project Monitoring and Control (PMC)		Process & Product Quality Assurance (PPQA)
		Supplier Agreement Management (SAM)		Measurement and Analysis (MA)
3	Organizational Process Focus (OPF)	Integrated Project Management (IPM)	Requirements Development (RD)	Decision Analysis and Resolution (DAR)
	Organizational Process Definition (OPD)	Risk Management (RSKM)	Technical Solution (TS)	
	Organizational Training (OT)		Product Integration (PI)	
			Verification (VER)	
			Validation (VAL)	
4	Organizational Process Performance (OPP)	Quantitative Project Management (QPM)		
5	Organizational Innovation and Deployment (OID)			Causal Analysis and Resolution (CAR)

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**The purpose of Requirements Management
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.**
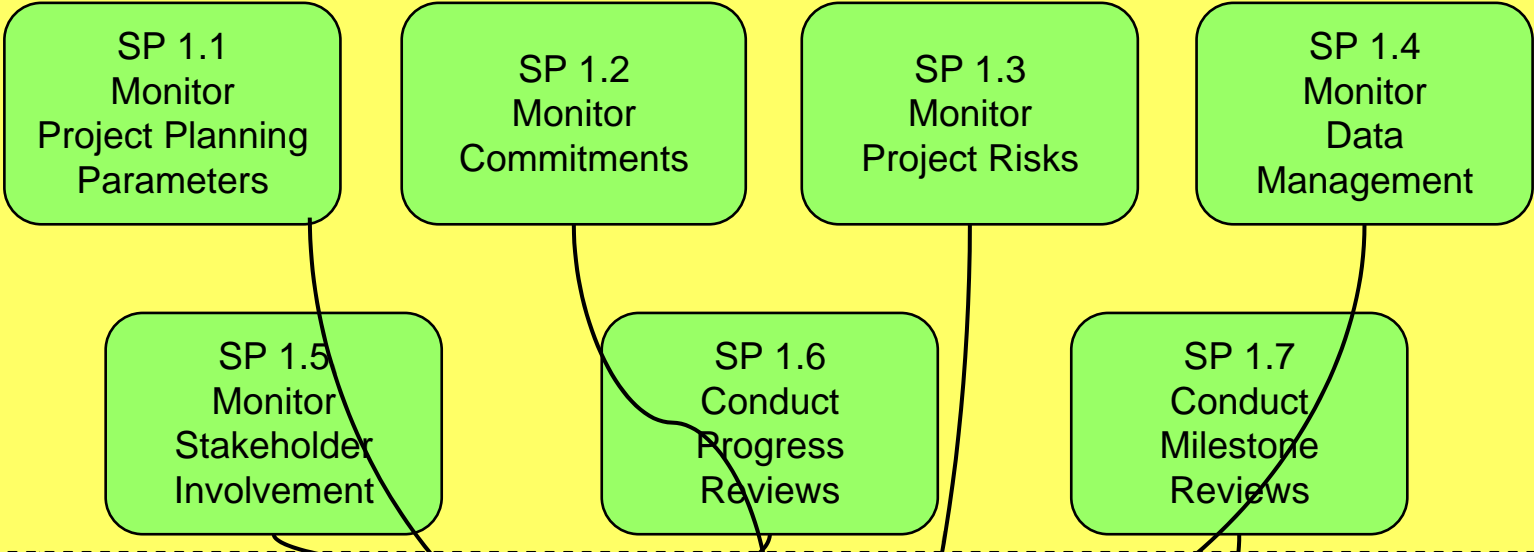
Requirements Management

Requirements traceablity matrix

SG 1 Manage Requirements

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

Requirements documentation[1]

[1] Typical tools:
• requirements list
• requirements database
• ...

Project Planning

SG 1 Establish Estimates

SP 1.1 Estimate the scope of the project

SP 1.2 Establish Estimates of Work Product and Task Attributes

SP 1.4 Determine Estimates of Effort and Cost

SP 1.3 Define Project Life Cycle

SG 2 Develop a Project Plan

SP 2.1 Establish the Budget and Schedule

SP 2.2 Identify Project Risks

SP 2.3 Plan for Data Management

SP 2.4 Plan for Project Resources

SP 2.6 Plan Stakeholder Involvement

SP 2.7 Establish the Project Plan

SP 2.5 Plan for Needed Knowledge and Skills

Planning data (effort, cost,...)

Project plan

SP 3.1 Review Plans that Affect the Project

SP 3.2 Reconcile Work and Resource Levels

SP 3.3 Obtain Plan Commitment

SG 3 Obtain Commitment to the Plan

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Project Monitoring and Control

Supplier Agreement Management
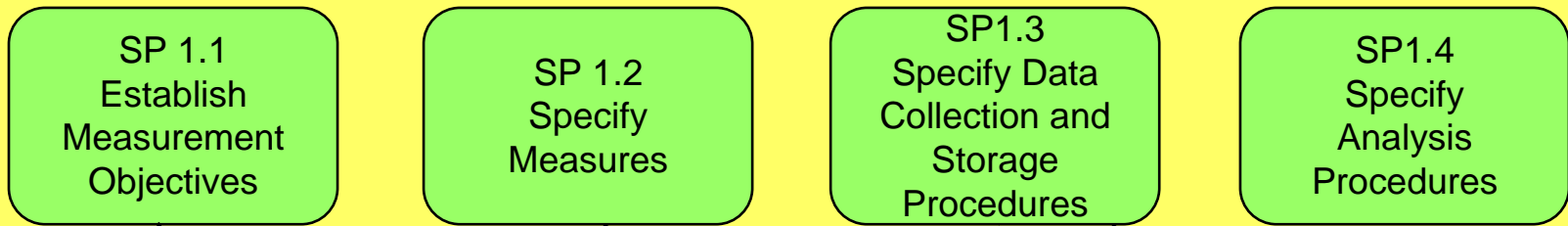
Measurement and Analysis

Process and product quality assurance

SG 1 Objectively Evaluate Processes and Work Products

Processes & work products

SP 1.1 Objectively Evaluate Processes

SP 1.2 Objectively Evaluate Work Products and Services

Review minutes (deviations)

QA review data base

SP 2.1 Communicate and Ensure Resolution of Noncompliance Issues

SP 2.2 Establish Records

QA reporting (trends, etc.)

SG 2 Provide Objective Insight
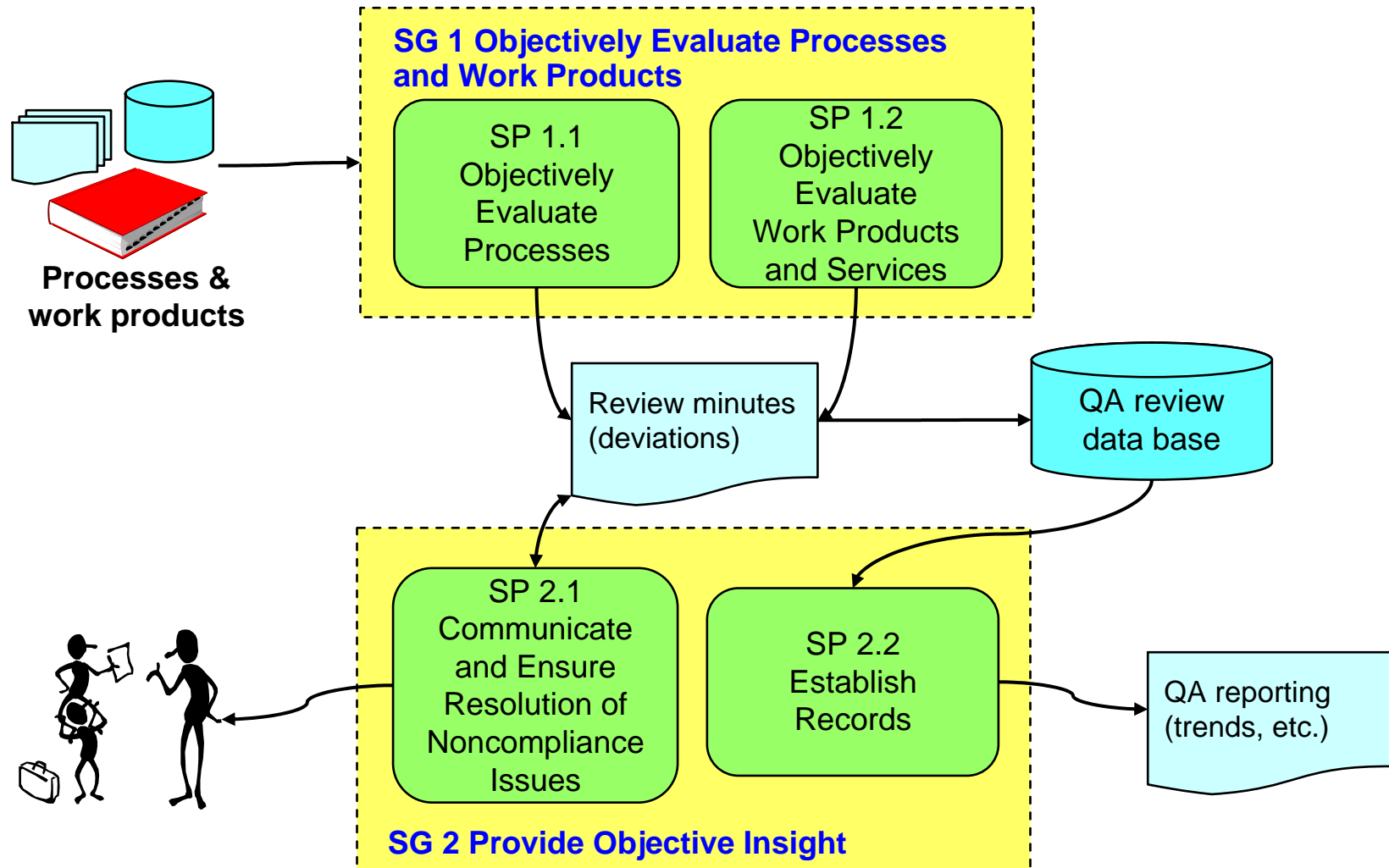
**The purpose of Requirements Development
is to produce and analyze customer, product,
and product-component requirements.**

The purpose of Technical Solution is to design, develop, and implement solutions to requirements.
Solutions, designs, and implementations encompass products, product components, and product-related lifecycle processes either singly or in combinations as appropriate.

The purpose of Product Integration is to assemble the product from the product components, ensure that the product, as integrated, functions properly, and deliver the product.

The purpose of Verification is
to ensure that selected work products
meet their specified requirements.

The purpose of Validation is
to demonstrate that a product or product
component fulfills its intended use
when placed in its intended environment.

Verification vs. Validation

- **Verification**

  - „Do things right"
  - do what was specified previously

- **Validation**

  - „Do the right thing"
  - do what the customer really needs

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

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

The purpose of Organizational Training is to develop the skills and knowledge of people so they can perform their roles effectively and efficiently.

- **The purpose of Integrated Project Management is to 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.**

  - SG 1 Use the Project's Defined Process

    - Establish the Project's Defined Process

    - Use Organizational Process Assets for Planning Project Activities

    - Integrate Plans

    - Manage the Project Using the Integrated Plans

    - Contribute to the Organizational Process Assets

SG 2 Coordinate and Collaborate with Relevant Stakeholders

- Manage Stakeholder Involvement

- Manage Dependencies

- Resolve Coordination Issues
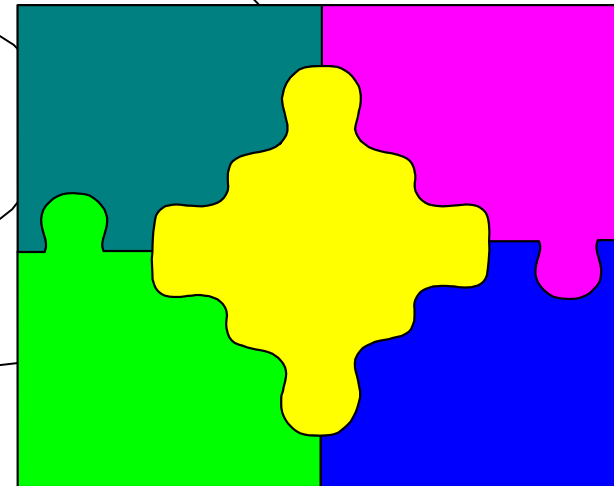
- **The purpose of Risk Manage-ment is to identify potential problems before they occur, so that risk-handling activities may be planned and invoked as needed across the life of the product or project to mitigate adverse impacts on achieving objectives.**

  – SG 1 Prepare for Risk Management

    • Determine Risk Sources and Categories

    • Define Risk Parameters

    • Establish a Risk Management Strategy

– SG 2 Identify and Analyze Risks

  • Identify Risks

  • Evaluate, Categorize, and Prioritize Risks

– SG 3 Mitigate Risks

  • Develop Risk Mitigation Plans

  • Implement Risk Mitigation Plans

- **The purpose of Decision Analysis and Resolution is to analyze possible decisions using a formal evaluation process that evaluates identified alternatives against established criteria.**

    - SG 1 Evaluate Alternatives
        - Establish Guidelines for Decision Analysis
        - Establish Evaluation Criteria
        - Identify Alternative Solutions
        - Select Evaluation Methods
        - Evaluate Alternatives
        - Select Solutions

Additional Process Areas for Other Disciplines
(all Maturity Level 3)

- **CMMI-SE/SW/IPPD**

    – Integrated Teaming (IT)

    – Organizational Environment for Integration (OEI)

    – Integrated Project Management for IPPD (IPM)

        • Two additional goals

- **CMMI-SE/SW/IPPD/SS**

    – Integrated Supplier Management (ISM)

Rough timeline for a SCAMPI Appraisals

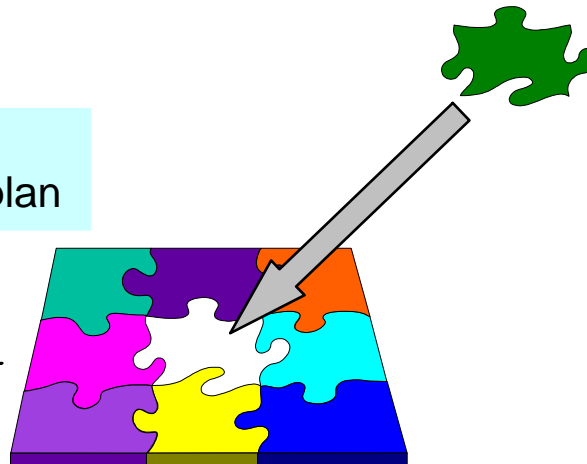decision to have assessment,
select lead assessor

1 - 2
months

create appraisal input

1 - 2
months

Readiness Review
prepare appraisal plan

1 - 2
months

Rough timeline for a SCAMPI Appraisals

decision to have assessment,
select lead assessor

1 - 2
months

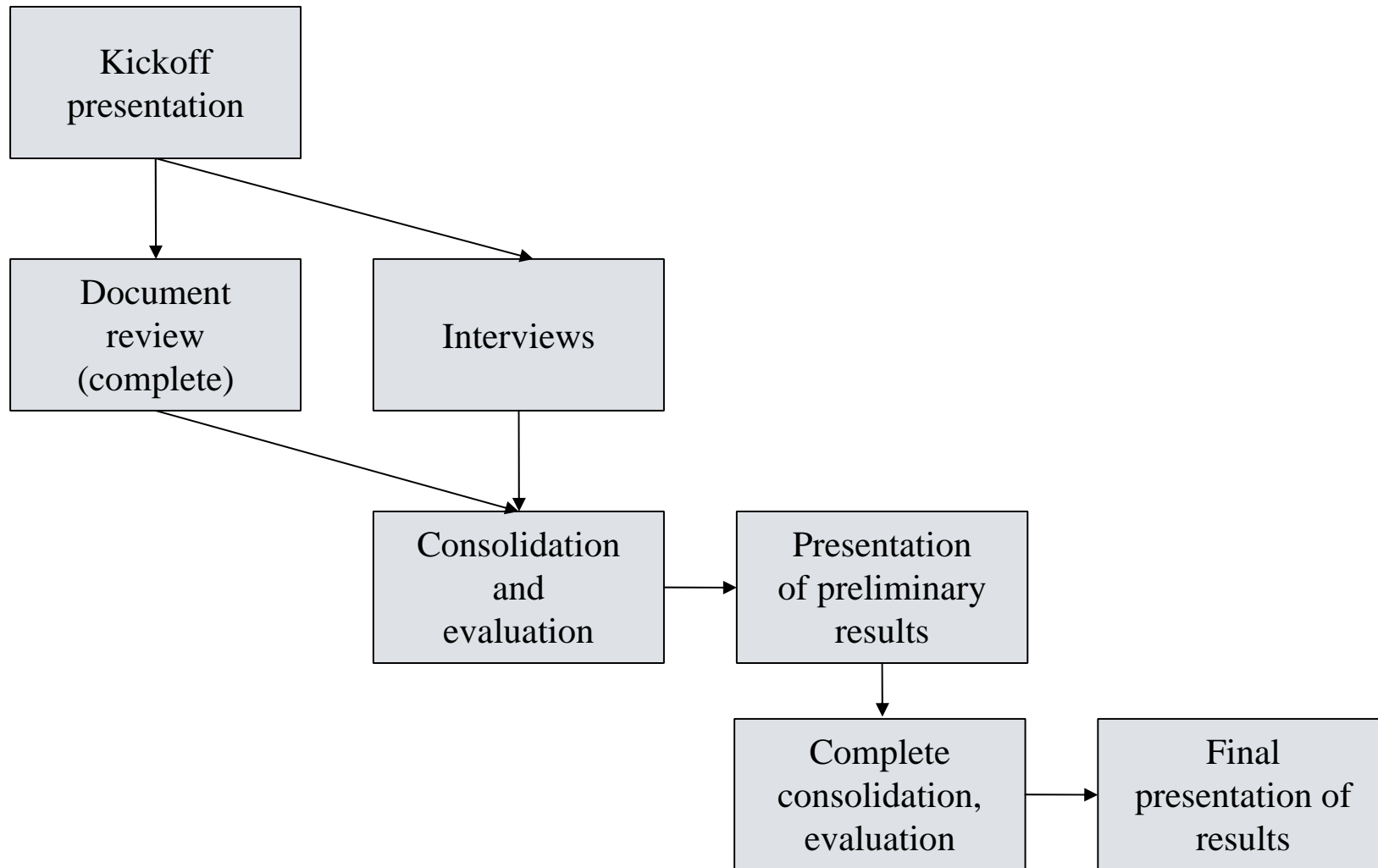create appraisal input

1 - 2
months

Readiness Review
prepare appraisal plan

1 - 2
months

Assessment on-site

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Appraisal Requirements for CMMI (ARC)

	Class A	Class B	Class C
Reliability and correctness of results	high	medium	low
Effort	high (>100 days)	medium	low
Frequency	low (< 1/year)	medium	high
Data Sources	3	2	1
Rating	yes	no	no
Standard Method	SCAMPI	none (SCAMPI B planned)	none (SCAMPI C planned)

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