Software Engineering

Standardization of Software Processes

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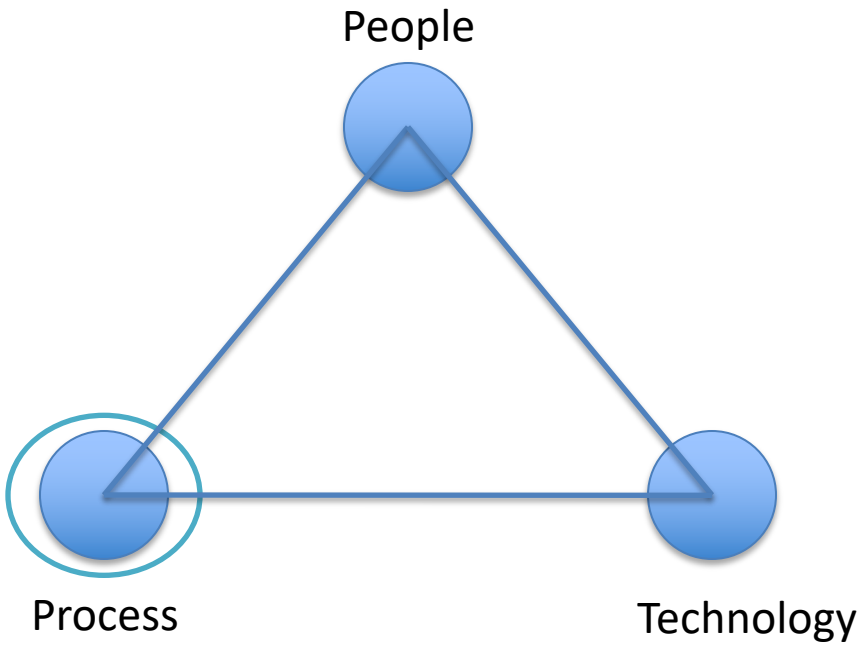
Summary

- Introduction to **Process Models**
- The **C**apability **M**aturity **M**odel **I**ntegration
- The **ISO 12207** standard for software lifecycle processes
- The **ISO 9000** family of standards for quality management systems

Three main factors in Software Development

- Process struggles to be accepted



Process Improvement

- As the process factor gains more acceptance, various process models are being developed
- Organizations seek to **improve software** quality by **improving their development process**

What is a process model?

- A process model is a **structured collection of practices** that describe the characteristics of effective processes
- **Included practices** are those proven by **experience** to be **effective**

How is a process model used?

- A process model is used
  1. to **set** process **measurable objectives** and **priorities**
  2. to ensure **stable**, **capable**, and **mature processes**
  3. as a **guide** for **improvement** of projects and organizational processes
  4. to **diagnose/certify** the **state** of an organization's current practices

Capability Maturity Model Integration (CMMI)

Some slides are taken from slideshare :

http://www.slideshare.net/ivanlanin/capability-maturity-model-integrity-cmmi

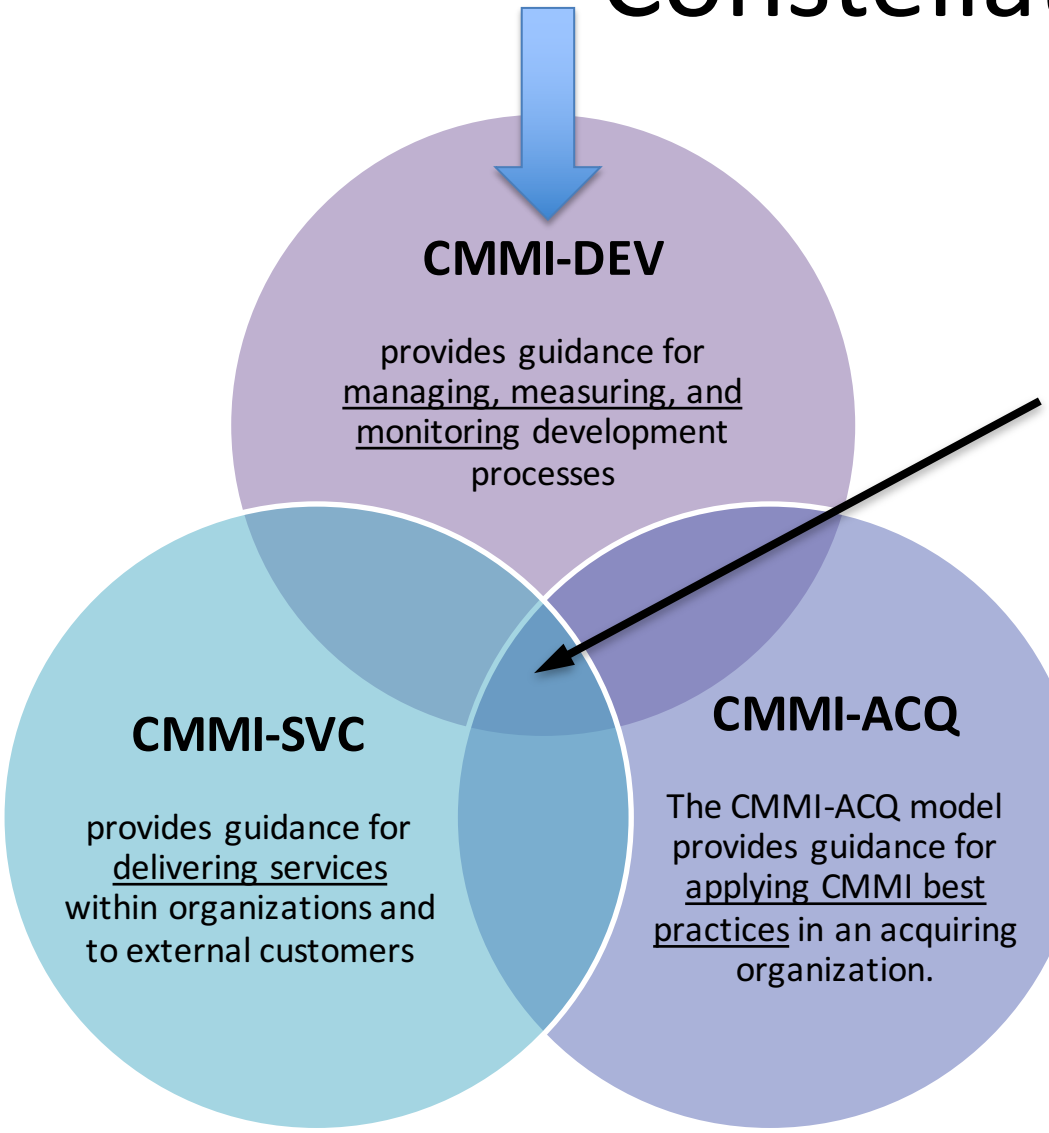
Short History

- The Software Engineering Institute (SEI) of Carnegie Mellon University developed CMM during the late 1980s
- The customer was the American Department of Defense (DoD)
- Success caused various CMMs to be developed
- CMMI integrates some of those

What is CMMI?

- CMMI is a **process improvement** approach that provides organizations with the essential elements of effective processes
- CMMI can be used in process improvements as a
  - **collection** of best practices
  - framework for **organizing** and **prioritizing** activities
- CMMI best practices are described in **models**, each addressing a different **area of interest**
- CMMI **framework** is the structure that organizes the components used in generating models
- Components in the CMMI Framework are organized into **constellations**, which facilitate construction of approved models

Constellations



16 shared Core Process Areas

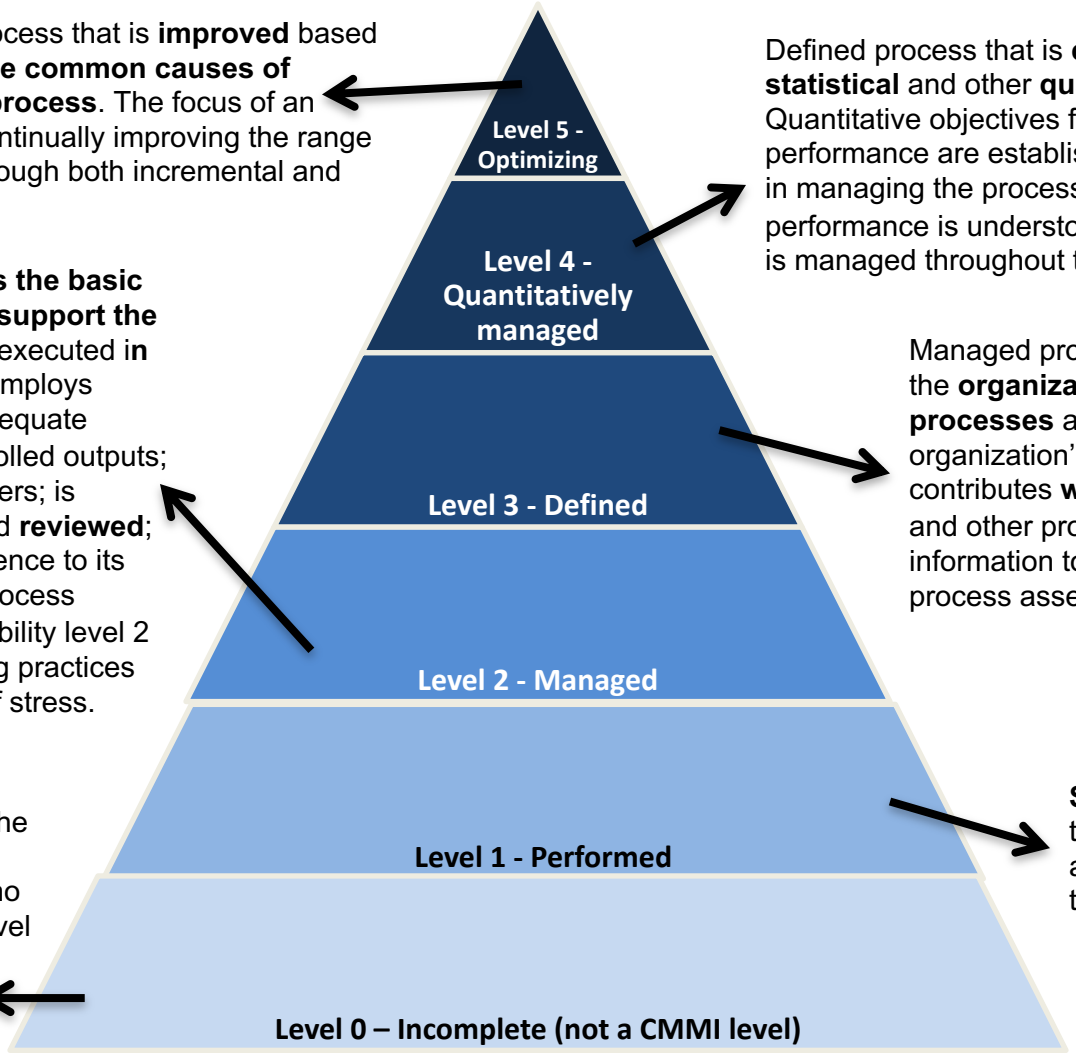
1.Causal Analysis and Resolution (CAR)
2.Configuration Management (CM)
3.Decision Analysis and Resolution (DAR)
4.Integrated Project Management (IPM)
5.Measurement and Analysis (MA)
6.Organizational Innovation and Deployment (OID)
7.Organizational Process Definition (OPD)
8.Organizational Process Focus (OPF)
9.Organizational Process Performance (OPP)
10.Organizational Training (OT)
11.Project Monitoring and Control (PMC)
12.Project Planning (PP)
13.Process and Product Quality Assurance (PPQA)
14.Risk Management (RSKM)
15.Quantitative Project Management (QPM)
16.Supplier Agreement Management (SAM)

Capability levels (continuous rep.)

Quantitatively managed process that is **improved** based on an u**nderstanding of the common causes of variation inherent in the process**. The focus of an optimizing process is on continually improving the range of process performance through both incremental and innovative improvements

Performed process that **has the basic infrastructure in place to support the process**. It is planned and executed i**n accordance with policy**; employs skilled people who have adequate resources to produce controlled outputs; involves relevant stakeholders; is **monitored**, **controlled**, and **reviewed**; and is **evaluated** for adherence to its process description. The process discipline reflected by capability level 2 helps to ensure that existing practices are retained during times of stress.

Not performed or partially performed. **One or more** of the specific **goals** of the process area **are not satisfied**, and no generic goals exist for this level since there is no reason to institutionalize a partially performed process.



Defined process that is **controlled** using **statistical** and other **quantitative** techniques. Quantitative objectives for quality and process performance are established and used as criteria in managing the process. Quality and process performance is understood in statistical terms and is managed throughout the life of the process.

Managed process that is **tailored** from the **organization's set of standard processes** according to the organization's tailoring guidelines, and contributes **work products**, **measures**, and other process improvement information to the organizational process assets.

Satisfies the **specific goals** of the process area. It supports and enables the work needed to produce work products.

Process Areas

- All CMMI models contain multiple Process Areas (PAs)
- **generic** goals and practices apply to all PAs
  - Performed process
  - Managed process
  - Defined process
- Each PA has 1 to 4 goals, and each goal is comprised of practices
  - **specific** goals and practices

CMMI-DEV: 22 Process areas

(http://www.software-quality-assurance.org/index.htm)

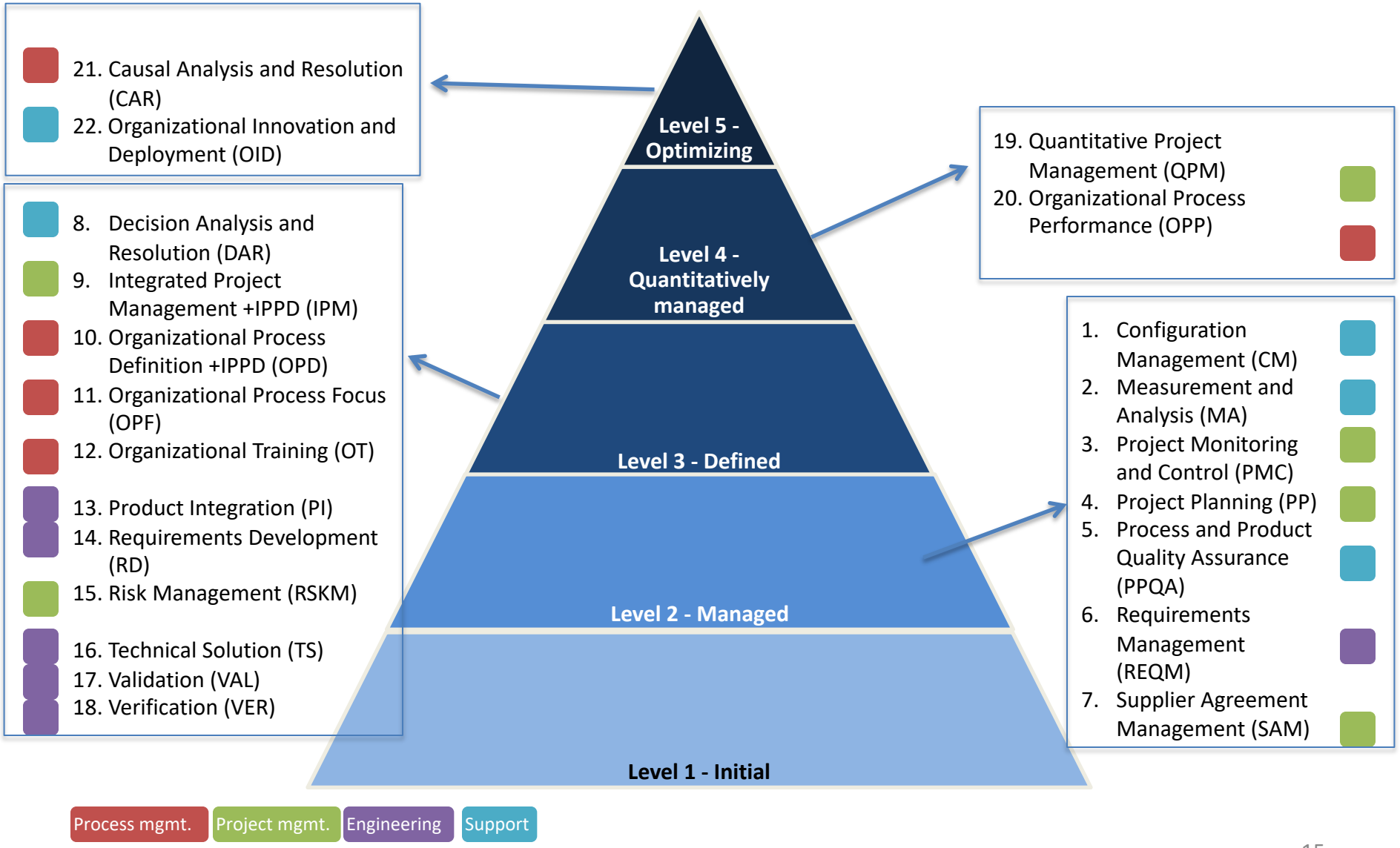
Process management (5)		Project management (6)		Engineering (6)		Support (5)	
• Organizational Innovation and Deployment (OID)	5	• Project Planning (PP)	2	• Requirements Management (REQM)	2	• Configuration Management (CM)	2
• Organizational Process Definition +IPPD (OPD)	3	• Project Monitoring and Control (PMC)	2	• Requirements Development (RD)	3	• Process and Product Quality Assurance (PPQA)	2
• Organizational Process Focus (OPF)	3	• Supplier Agreement Management (SAM)	2	• Technical Solution (TS)	3	• Measurement and Analysis (MA)	2
• Organizational Process Performance (OPP)	4	• Integrated Project Management +IPPD (IPM)	3	• Product Integration (PI)	3	• Decision Analysis and Resolution (DAR)	3
• Organizational Training (OT)	3	• Risk Management (RSKM)	3	• Verification (VER)	3	• Causal Analysis and Resolution (CAR)	5
		• Quantitative Project Management (QPM)	4	• Validation (VAL)	3		

2 3 4 5

Example

- **Project Monitoring and Control (PMC Level 2)**
- The purpose of Project Monitoring and Control PMC is to provide an understanding of the project's progress so that appropriate corrective actions can be taken when the project's performance deviates significantly from the plan.
- Specific Goals and practice
- SG 1 Monitor Project Against Plan
  - SP 1.1 Monitor Project Planning **Parameters**
  - SP 1.2 Monitor **Commitments**
  - SP 1.3 Monitor Project **Risks**
  - SP 1.4 Monitor **Data Management**
  - SP 1.5 Monitor **Stakeholder Involvement**
  - SP 1.6 Conduct **Progress Reviews**
  - SP 1.7 Conduct **Milestone Reviews**
- SG 2 Manage Corrective Action to Closure
  - SP 2.1 Analyze **Issues**
  - SP 2.2 Take **Corrective Action**
  - SP 2.3 Manage Corrective Action

5 Maturity levels (staged rep.)



ISO 12207 standard for software lifecycle processes

ISO 12207

- It *defines* and *structures* all **activities** involved in the **Software Development Process**
- Its main goal is to provide a **common language** to involved stakeholders
- It is based on a **functional** approach :
  - A set of coordinated activities transforming an input in an output
- **Five** primary lifecycle processes related to primary involved agents:
  - buyers, suppliers, developers, maintainers, operators, managers and technicians
- **Eight** supporting life cycle processes
- **Four** organizational processes

ISO 12207 cont.d

- The standard is based on two basic principles
  - **modularity** and **responsibility**
- Modularity means processes with minimum coupling and maximum cohesion
- Responsibility means to establish a responsibility for each process, facilitating the application of the standard in projects where many people can be legally involved

ISO 12207 processes

5. Primary life cycle processes

- 5.1 Acquisition
- 5.2 Supply
- 5.3 Development
- 5.4 Operation
- 5.5 Maintenance

6. Support processes

- 6.1 Documentation
- 6.2 Configuration management
- 6.3 Quality assurance process
- 6.4 Verification
- 6.5 Validation
- 6.6 Joint review
- 6.7 Audit
- 6.8 Problem solving

7.Organizational processes

- 7.1 Management
- 7.2 Infrastructure
- 7.3 Improvement
- 7.4 Training

Activities

- Each process has a set of outcomes associated with it and is detailed in terms of activities
- E.g., Activities of Software Development Process (5.3)
  - Process implementation
  - Information System Requirement Analysis
  - Information System Architecture Design
  - Software Requirement Analysis
  - Software Architecture Design
  - Software Design
  - Coding and Testing
  - Software Integration
  - Software Quality Testing
  - System Integration (hw+sw)
  - System Quality Testing
  - Software Deployment
  - Support for Software ‘put on trial’

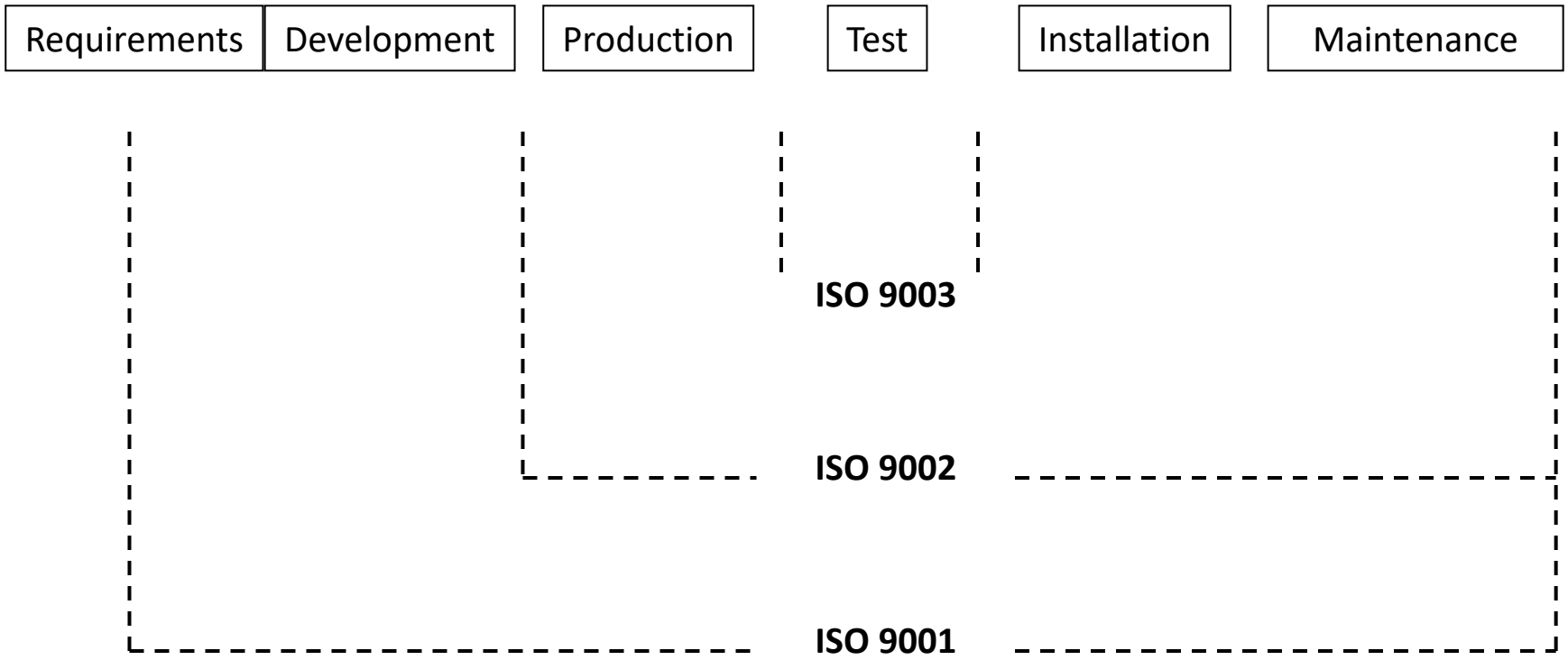
ISO 9000 family of standards for quality management systems

ISO 9000 (2015)

- ISO 9000 is maintained by ISO, the International Organization for Standardization
- It is administered by accreditation and certification bodies
- The ISO 9000 family addresses "Quality management”
- In 2013 alone, over **one million certificates** to the standard were issued across 187 countries, and many other companies and organizations have used the standard without seeking certification.
- It is also known as "Vision 2000", an update (2003) of the 1994 version (UNI EN ISO 9001: 2000)

Old standard

Before 2000 the standard was split in 3 pieces



The 20 Requirements of **OLD** ISO 9001: 1994

4.1 Management responsibility
4.2 Quality assurance
4.3 Contract review
4.4 Design review
4.5 Document management
4.6 Subcontracting
4.7 Customer product assessment
4.8 Tracciability
4.9 Process control
4.10 Test
4.11 Inspection and Testing Control of Inspection, Measuring, and Test Equipment
4.12 Inspection and Test Status
4.13 Control of Nonconforming Products
4.14 Corrective and Preventive Action
4.15 Handling, Storage, Packaging, and Delivery
4.16 Control of Quality Records
4.17 Inspections
4.18 Training
4.19 Servicing
4.20 Statistichal techniques

ISO 9000 standards

- ISO 9000:2015: Fundamentals and vocabulary
  - Describes fundamentals of the ISO 9000 family, and defines related terms
  - Contains the core language of the ISO 9000 series of standards, i.e., it contains detailed explanations of the seven quality management principles with tips on how to ensure these are reflected in the way you work. It contains many of the terms and definitions used in ISO 9001.
- **ISO 9001:2015: Requirements** (of a quality management system)
  - It is intended for being used in any organization which designs, develops, manufactures, installs and/or services any product or provides any form of service
  - It provides requirements which an organization needs to fulfill if it is to achieve **customer satisfaction** through consistent products and services which meet customer expectations
  - It includes requirement s for the **continual** (i.e., planned) **improvement** of the Quality Management System
  - It is the **target** of the certification process
- ISO 9004:2009: Guidance for Performance Improvement
  - It covers continual improvement
  - It gives advices on what an organization could do to enhance a mature system
- ISO 19011:2012 gives guidance for performing both internal and external **audits** to ISO 9001. This will help ensure your quality management system delivers on promise and will prepare you for an external audit, should you decide to seek third-party certification.

ISO 9001 certification: perceived advantages

- Improvement in "bottom line" profit through
  - Better **efficiency**
  - Continual **improvement**
  - Less waste
  - Consistent **control** of key processes
  - Possible reduction in insurance premiums
  - Provision of a vehicle for **training** new employees
  - The effective management of risk
  - <u>Increasing the potential for **world-wide recognition**</u>

ISO 9001 certification: perceived disadvantages

- Too abstract
- Costly to obtain and maintain
- Lengthy time-scale to obtain certification
- Time-consuming development
- Difficult to implement
- Organizational resistance to change
- Staff resistance to change
- Hard to maintain enthusiasm for the system
- More documentation

ISO 9000 Fundamental building blocks

- The Quality System as a series of processes
  1. Quality management system
  2. Management responsibility
  3. Resource management
  4. Product/service realization
  5. Measurement, analysis, and improvement

1.Quality Management System

- It deals with *general* and *documentation* requirements that are the foundation of the management system
- General requirements
  - How the **processes** of the management system **interact** to each other
  - What **resources** do you need to run the processes
  - How you will **measure** and **monitor** the processes
- Requirements for the documentation
  - What documentation is needed to operate the system effectively
  - How the documentation should be controlled

2.Management responsibility

- Top management must
  - **know** customers' requirements at a strategic level
  - make a **commitment to meet** these requirements as well as statutory and regulatory requirements
  - **set** policies and objectives
  - **plan** how the objectives will be met
  - ensure that there are clear internal **communications** and that the management system is regularly reviewed

3.Resource management

- It deals with the **people** and physical **resources** needed to carry out the process
- People should be competent to carry out their tasks
- Physical resources and work environment need to be capable of ensuring that the customers' requirements are satisfied

4.Product/Service realization

- It deals with the **processes** necessary to produce the product or to provide the service
  - the act of converting the input of the process to the output
- For a **manufacturing** organization
  - the process of converting iron ore to steel via a blast furnace for example
- For a **service** organization
  - the process of moving a product or person from one place to another e.g., a taxi journey
- For a **software** organization
  - The process of transforming requirements into a software specification

5.Measurement, analysis and improvement

- It deals with measurements to enable the systems to be **monitored**
- To measure if the management systems themselves are performing through **internal audits**
- To measure if the **processes** are **effective**
- To measure if the product is satisfying c**ustomer requirements**
- The aim is to **improve** systems and products

ISO Certification

- ISO does not itself certify organizations
- There are accreditation bodies that authorize certification bodies
- Organizations can apply for ISO 9001 compliance certification to a certification body
- Both the accreditation bodies and the certification bodies **charge fees** for their services
- The various accreditation bodies have mutual agreements with each other to ensure that certificates issued by one of the Accredited Certification Bodies (CB) **are accepted worldwide**
- An ISO certificate **is not a once-and-for-all** award, but must be renewed at regular intervals recommended by the certification body, usually around **three years**

Quality requirements

- A set of process requirements and resources that constitute the Quality Manual (QM) of the organization
- The QM specifies the organization's quality policy regardless specific commitments and customers
- The QM is adapted to specific projects, generating several Quality Policies

Documentation

- The ISO 9001 certification requires that processes are described in specific documents
  - Quality Manual (QM)
  - Quality Policy (QP)

Documentation