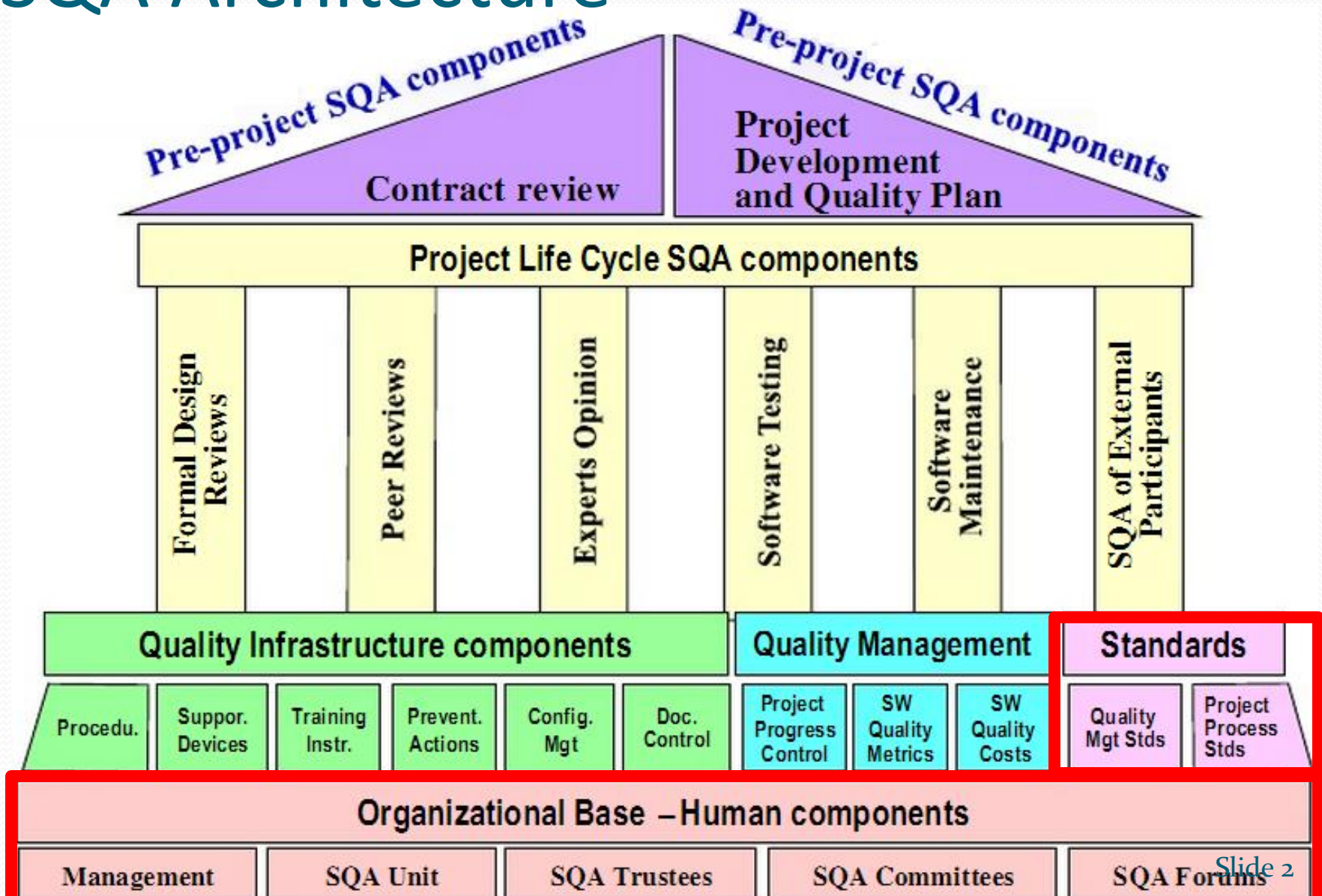# Standards and Organizing for SQA

1 Overview	2 Life cycle components	3 Infrastructure components	4 Management components	5 Standards and Organizing
6 Static tesing	7 Dynamic testing	8 Test management	9 Tools	

SQA Architecture

Learning objectives

- Explain the benefits of using SQA standards
- List SQA and software engineering standards
- Describe the general principles underlying quality management according to ISO 9000-3
- Describe the ISO 9000-3 certification process
- Explain the IEEE/EIA Std 12207 software life cycle architecture
- List the actors of a typical quality assurance organizational framework
- Describe the SQA unit's tasks

References

- Galin (2004). *Software Quality Assurance from theory to implementation.* Pearson Education Limited
- Ian Sommerville (2011). *Software engineering*. Ninth Edition. Addison-Wesley

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- Quality management standards
- Project process standards
- Management and its role in software quality assurance
- The SQA unit and other actors in the SQA system

The benefits of use of standards

- The ability to apply methodologies and procedures of the **highest professional level**

- **Better understanding** and **cooperation** between users of the same standards:

  - between team members and between project teams

  - between software developers and external participants in the project

  - between suppliers and customers

Organizations involved in SQA standards development

- Most prominent developers of SQA and software engineering standards:
  - ISO (International Standards Organization)
  - IEEE (Institute of Electric and Electronic Engineers) Computer Society
  - DOD (US Department of Defense)
  - ANSI (American National Standards Institute)
  - IEC (International Electrotechnical Commission)
  - EIA (Electronic Industries Association)

The contribution of organizations to SQA

- Provision of **updated international standards** for use by professionals and managers of SQA activities
- Provision of **SQA certification services** based on independent professional quality audits
- Provision of **tools for "self-assessment"** of an organization's SQA system and its operation

Classes of standards

Characteristics	Quality Management Standards	Project Process Standards
The target unit	Management of software development and/or maintenance and the specific **SQA units**	A software development and/or maintenance **project team**
The main focus	Organization's SQA systems, infrastructure and requirements	Methodologies for carrying out software development and maintenance projects
Standard's goal	Assuring *supplier's software quality* and *assessing its software process* capability	Assuring the quality of a *specific software project's products*
Examples	ISO 9000-3 SEI's CMM	ISO/IEC 12207 IEEE Std 1012-1998

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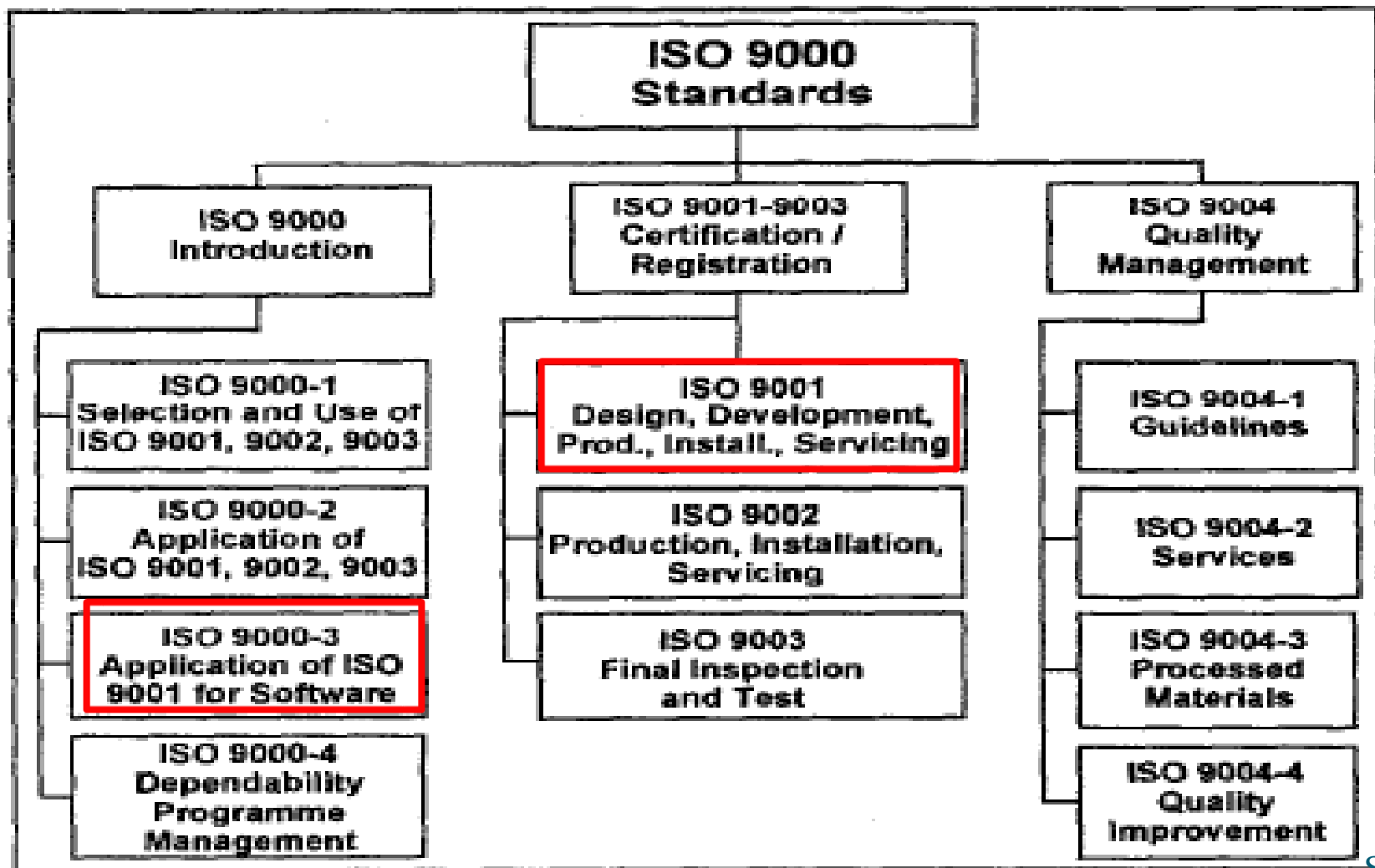- The SQA unit and other actors in the SQA system

Quality management standards

➢ ISO 9001 and ISO 9000-3

➢ Certification according to ISO 9000-3

➢ Capability Maturity Models (CMM)

ISO 9001 and ISO 9000-3

- ISO: International Organization for Standardization
- ISO 9000: an international set of **standards for quality management**, applicable to a range of organisations from manufacturing to service industries
- ISO 9001: applied to organizations that design, develop, and maintain products, **including software**
- ISO 9000-3: represents implementation of the general methodology of quality management ISO 9000 Standards to the **software development and maintenance**
- Both ISO 9001 and ISO 9000-3 are reviewed and updated once every 5–8 years
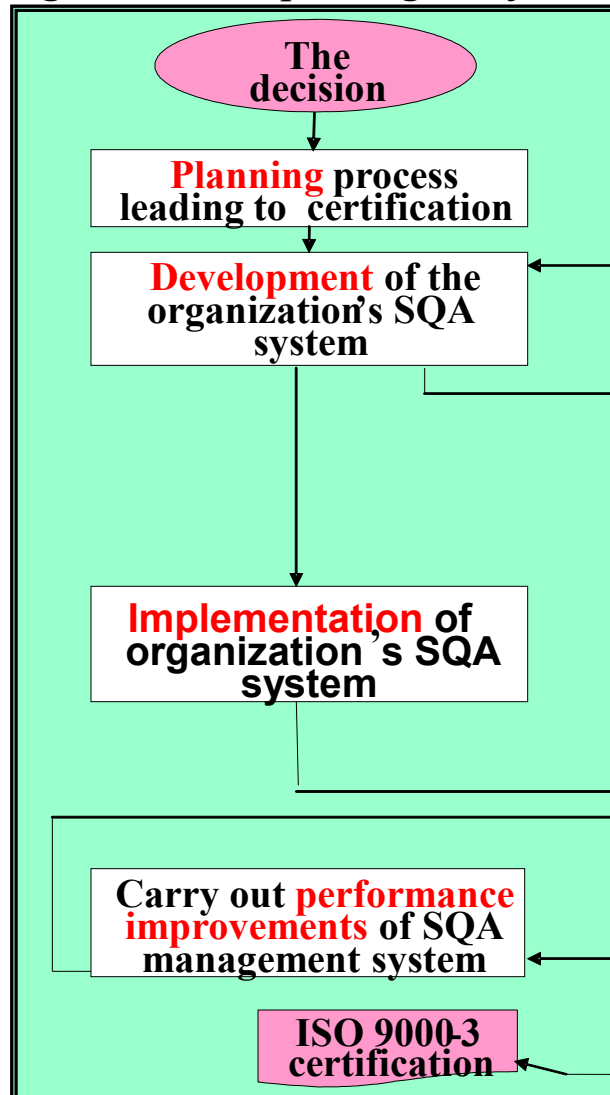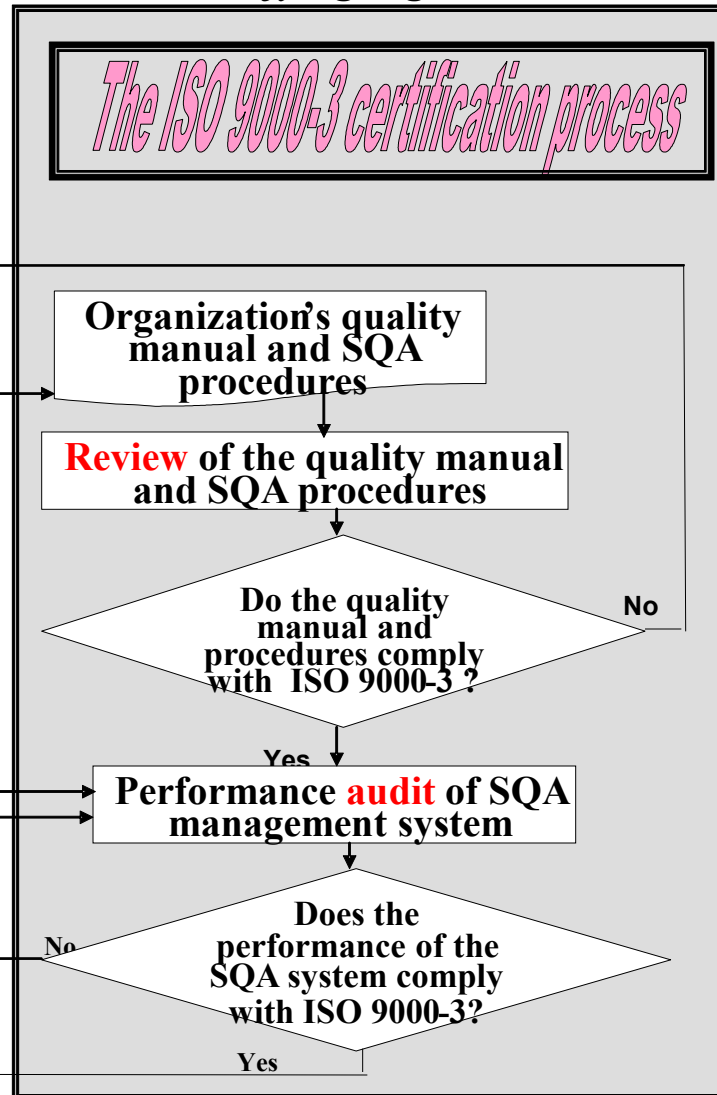
Overview of ISO 9000

ISO 9000-3 Principles

1) Customer focus
2) Leadership
3) Involvement of people
4) Process approach
5) System approach to management
6) Continual improvement
7) Factual approach to decision making
8) Mutually supportive supplier relationships

ISO 9000-3: Certification process

Software Capability Maturity Model (CMM)

- Developed by the Software Engineering Institute (SEI), sponsored by the U.S. Department of Defense (DoD) in the late 1980s

- A methodology used to **develop** and **refine** an organization's software development process, from *ad hoc* practices, to formally defined steps

- It has been widely adopted in industry, primarily by large software development organizations

The principles of CMM

- **Quantitative management methods** increases the organization's capability to control the quality and improve the productivity

- Application of the **five-level** capability maturity model that enables to evaluate the achievements and determine the efforts needed to reach the next capability

- Generic process areas that **define the "what"** — not "how" enables the model's applicability to a wide range of implementation organizations:
  - it allows use of any life cycle model
  - it allows use of any design methodology, development tool and programming language
  - it does not specify any particular documentation standard

SW-CMM Levels

Level	Focus	Description
5: Optimizing	Continuous Process Improvement	**Continuous process improvement** is enabled by quantitative feedback from the process and from piloting innovative ideas and technologies
4: Managed	Product and Process Quality	**Detailed measures** of the software process and product quality are collected. Both the software process and products are quantitatively understood and controlled
3: Defined	Engineering Process	The software process for both management and engineering activities is **documented, standardized, and integrated** into a standard software process for the organization. All projects use an approved, tailored version of the organization's standard software process for developing and maintaining software
2: Repeatable	Project Management	Basic project management processes are established to **track cost, schedule, and functionality**. The necessary process discipline is in place to repeat earlier successes on projects with similar applications
1: Initial	No focus	Project success primary depends on individuals and their heroics

CMMI

- CMMI is the successor of the CMM
- In 2002, CMMI Version 1.1 was released, Version 1.2 followed in August 2006, and CMMI Version 1.3 in November 2010
- The CMMI structure
  - Capability maturity level 1: Initial
  - Capability maturity level 2: Managed
  - Capability maturity level 3: Defined
  - **Capability maturity level 4: Quantitatively managed**
  - Capability maturity level 5: Optimizing

Comparisons, contrasts and applicability

- Similar
  - the CMM and ISO 9000 address similar issues and have the common concern of quality and process management
- Difference

ISO	CMM
Focus on the **customer-supplier** relationship	The attention on the software **supplier** to improve its internal processes
Wide range of industries	Specific to the software industry

Comparisons, contrasts and applicability

ISO	CMM
Follow a set of standards to make **success repeatable**	Emphasizes a process of **continuous improvement**
The next step is only to **maintain** that level of certification	An **on-going process of evaluation and improvement**, moving from one level of achievement to the next. Even at the highest level of maturity in CMM, the focus is on continuous improvement

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SQA project process standards

➢ Structure and content of IEEE software engineering standards

➢ IEEE/EIA Std 12207 – software life cycle processes

➢ IEEE Std 1012 – verification and validation

➢ IEEE Std 1028 – reviews

Slide 24

Structure and content of IEEE software engineering standards

A. Conceptual standards
- Guiding principles and overall approach, example:
  - IEEE 610.12 – Glossary of Software Engineering Terminology
  - **IEEE/EIA 12207.0 — Information Technology Software Life Cycle Processes**
B. Prescriptive standards of conformance, example:
- Requirements to which a software developer must conform
  - **IEEE 829 — Software Test Documentation**
  - **IEEE 1012 – Software Verification And Validation**
  - **IEEE 1028 – Software Reviews**
C. Guidance standards
- Implementation of class B standards, example:
  - IEEE 1233 – Guide for Developing System Requirement Specifications
  - IEEE/EIA 12207.1 – Guide, Information technology – Software Life Cycle Processes – Life Cycle Data
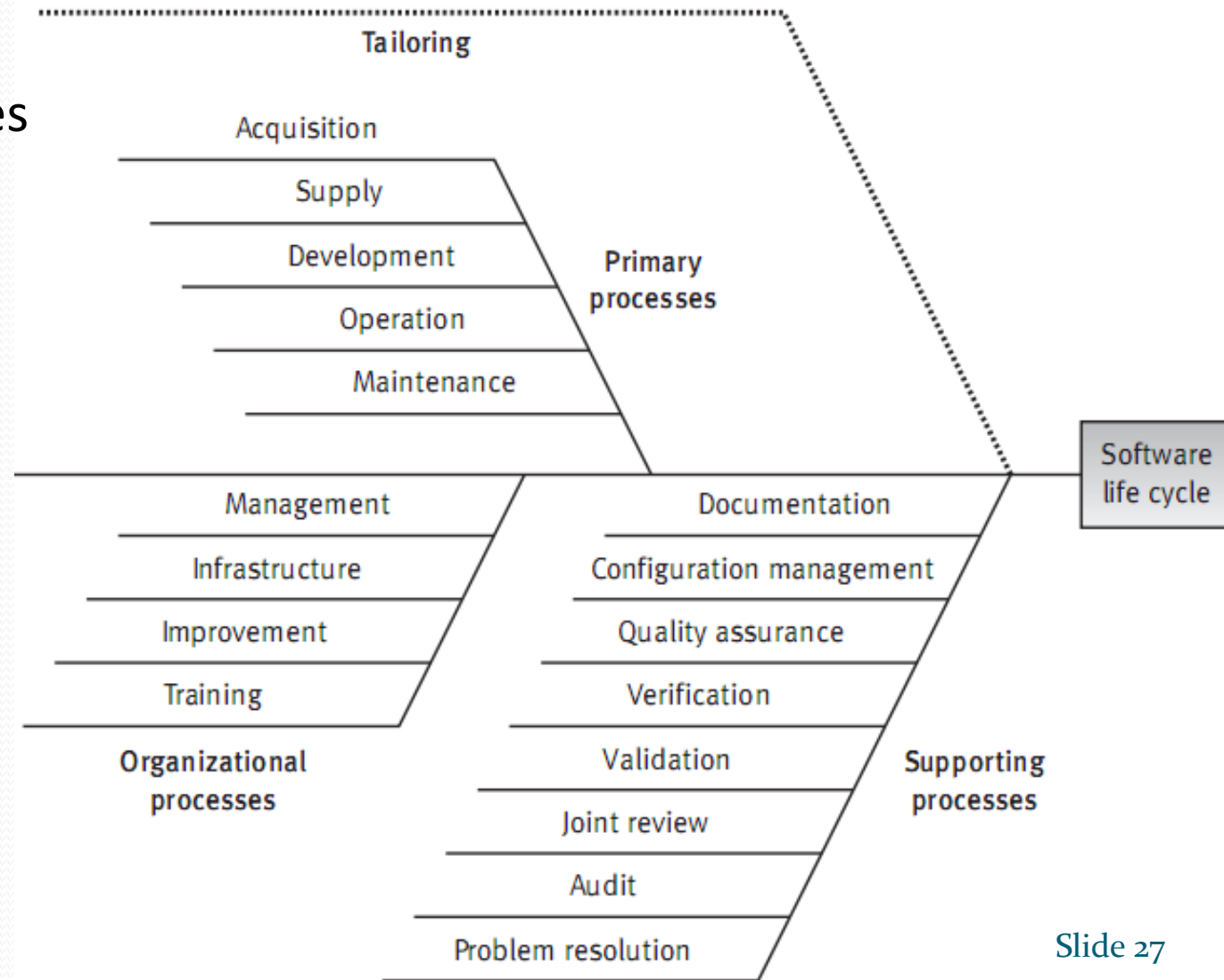
IEEE/EIA Std 12207
IT Software Life Cycle Processes

- Purpose
  - To establish an **internationally recognized model** of common software life cycle processes that can be referenced by the software industry worldwide
  - To promote understanding among business parties by application of commonly recognized processes, activities and tasks

IEEE/EIA Std 12207
Software life cycle architecture

(1) Process classes
(2) Processes
(3) Activities
(4) Tasks

IEEE Std 1012
Software Verification & Validation

- Purpose
  - **Establish** a common framework for V&V activities and tasks for all software life cycle processes
  - **Define** V&V requirements, including their inputs and outputs
  - **Define** software integrity levels and the appropriate V&V tasks
  - **Define** the content of a SVVP (software V&V plan) document
- Concept: page 514
- Content: page 516

IEEE Std 1028
Review

- Purpose: to define systematic review procedures that are:
  - applicable for reviews performed throughout the software life cycle
  - conform with the review requirements defined by other standards
- Types of Reviews
  - Management reviews
  - Technical reviews
  - Inspections
  - Walkthroughs
  - Audits
- Review document structure: page 547

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The software development organizational structure

- **Top management**, including the organization's general manager and its executives (CEOs)
- **Department managers**, including managers of software development, maintenance and software testing departments
- **Project managers** and **team leaders** of development projects and maintenance services

The quality assurance organizational framework

- Managers:
    - Top management executives, especially the executive directly in charge of software quality assurance
    - Software development and maintenance **department managers**
    - Software testing department managers
    - **Project managers** and team leaders of development and maintenance projects
    - Leaders of software testing teams
- Testers:
    - Members of software testing teams
- SQA professionals and interested practitioners:
    - SQA trustees
    - SQA committee members
    - SQA forum members
    - SQA unit team members

Top management's quality assurance Responsibilities

- **Assuring the quality** of company's software products and software maintenance services
- **Communicating to employees** at all levels the importance of product and service quality additionally to customer satisfaction
- **Assuring satisfactory** functioning and full conformity to customer requirements
- Ensuring that the **SQA 's system objectives** are established and realized
- **Planning and overseeing implementation of changes** for the SQA system adaptation to internal or external transformations (e.g. changes in clientele, competition or technology)
- **Intervening directly** to aid resolving crisis situations and minimize damages
- **Ensuring availability** of resources demanded by the SQA systems

Top management's quality assurance Main tools

- Establishment and updating of the organization's **software quality policy**

- Assignation of one of the **executives in charge** of software quality issues

- Regular **management reviews** of performance with respect to software quality issues

Top management's quality assurance Main tools: Software quality policy

- Example:

Frame 25.2	Lion Quality Software (LQS) Ltd – software quality policy

The Company's Quality Goal

The principal goal of Lion Quality Software is to provide software products and software maintenance services that fully comply with customer requirements and expectations, at the scheduled time and according to the agreed budget.

The Company's Quality Policy

The quality policy adopted by LQS supports this goal by:

- Assigning maximum priority to customer satisfaction by promptly fulfilling requirements and expectations and requests and complaints.

- Involving employees in determination of quality objectives and commitment to their achievement.

- Performing development and maintenance tasks correctly the first time around and minimizing the need for rework and correction.

Top management's quality assurance
Main tools: The executive in charge of software quality

- Responsibility for preparation of an annual SQA activities program and budget

- Responsibility for preparation of SQA system development plans

- Overall control of implementation of the annual SQA regular activities program and planned SQA development projects

- Presentation and advocacy of SQA issues to executive management

Top management's quality assurance Main tools: Management review

- **Assess achievement** of the quality objectives set for the organization's software quality management system
- **Initiate updates** and improvements of the software quality management system and its objectives
- **Outline directions** for remedying major SQA deficiencies and software quality management problems
- **Allocate additional resources** to the software quality management system

Department management

- Quality system related responsibilities
  - preparation of the department's annual SQA **activities** and program **budget**
  - preparation of departments SQA system development **plans**
  - **control** of performance of the departments annual SQA program and development projects

Department management (cont'd)

- Project related responsibilities
  - control of **compliance to quality assurance procedures** in departments units
  - detailed follow up of **contract review results** and proposal approval
  - follow up of software **tests and results**
  - follow up of quality of **maintenance services** provision
  - follow up of the **project risks** and their solutions
  - …

Project management

- Professional hands on tasks:
  - **preparation** of project and quality plans and their updates
  - **involvement** in joint customer-supplier committee
  - close **follow up** of project team staffing

Project management (cont'd)

- Management tasks:
  - deal with performance of review activities and consequent correction
  - address the performance of **acceptance tasks**
  - undertake software **installation** in customer sites and to show customer how to use software
  - deal with SQA **training** and instruction of project team members
  - address **customer requests** and satisfaction of customer
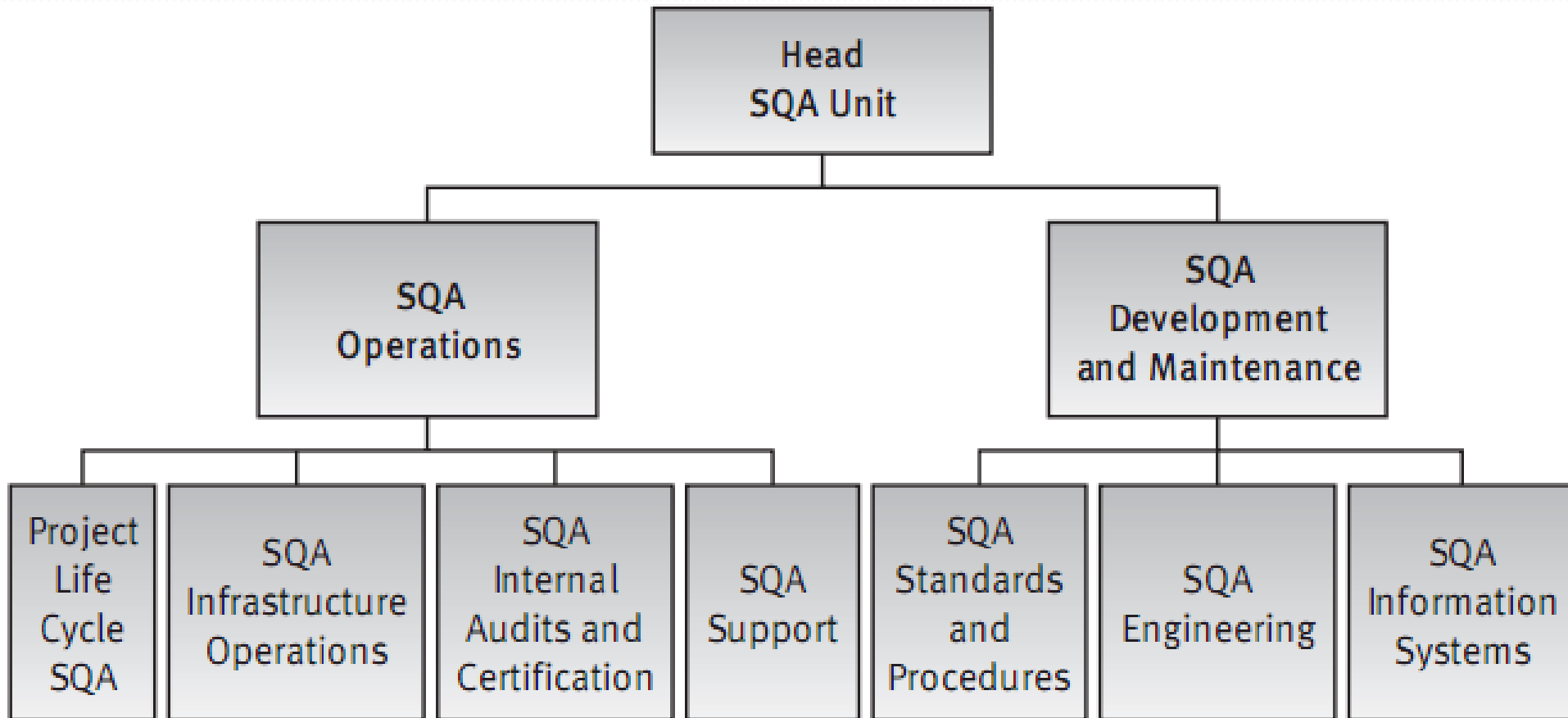 - …

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Actors in the SQA system

- SQA unit members
- SQA trustees
- SQA committee members
- SQA forum members

SQA Unit

SQA Unit - The Head [1]

- Tasks performed by the head of the SQA unit
  - **planning**
  - **management** of the unit
  - tasks related to **contacts** with customers and other external bodies as well as with the executive in charge of software quality
  - **SQA professional activities**

SQA Unit - The Head [2]

- Planning tasks
  - **preparation of proposed annual activity program and budget** for the unit
  - **planning** and **updating** the organization's software quality management system
  - **preparation of recommended annual SQA activities programs** for the software development and maintenance departments
  - **preparation of recommended SQA systems development plans** for the software development and maintenance departments

SQA Unit - The Head [3]

- Management tasks
    - **management** of the SQA team's activities
    - **monitoring implementation** of the SQA activity program
    - **nomination** of team members, SQA committee members and SQA trustees
    - **preparation of special and periodic reports**, e.g., status of software quality issues within the organization and monthly performance reports
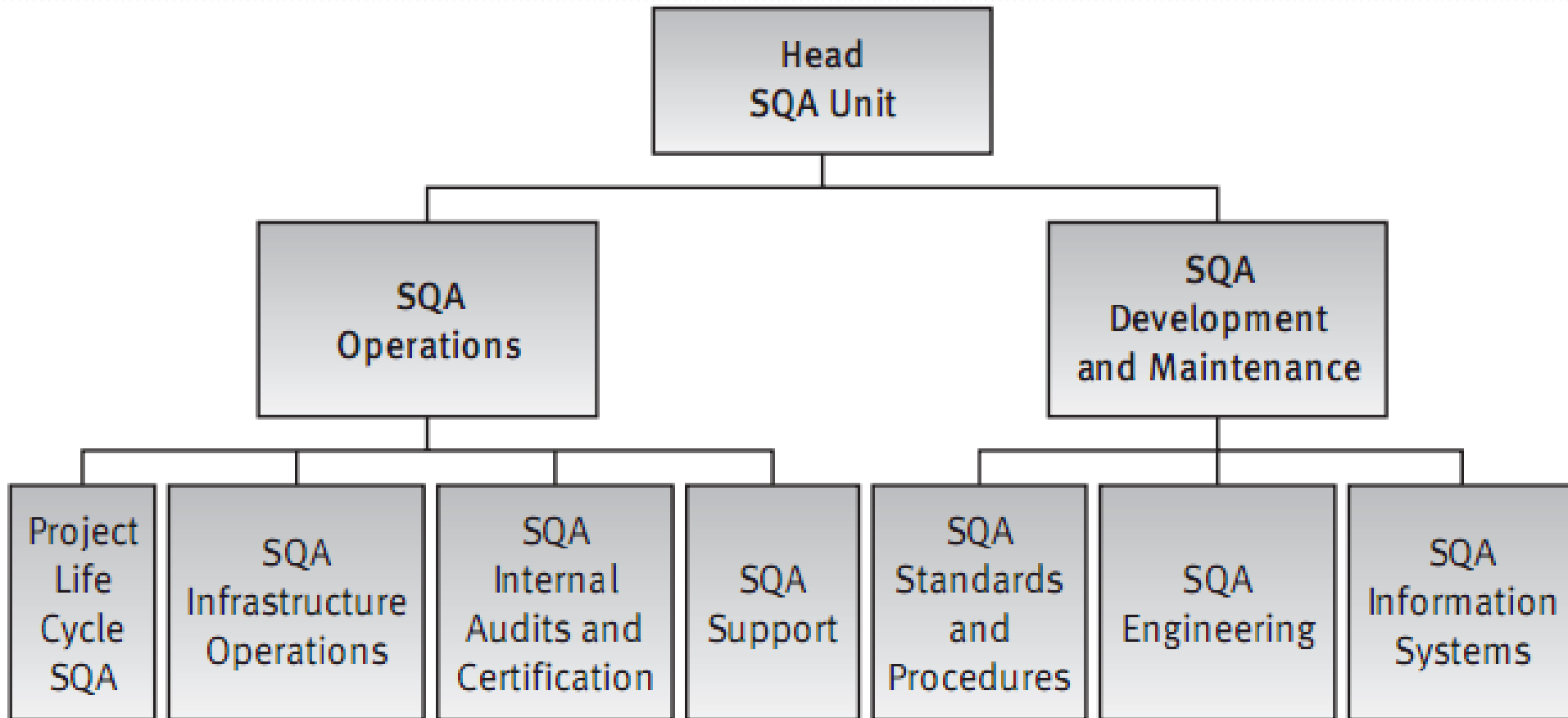
SQA Unit - The Head [4]

- Contacts with customers and other external bodies and the executive in charge of software quality
  - serving as the customer's address for software quality issues
  - outreach to customers with respect to quality of software products and services supplied
  - representation of the organization before external bodies regarding software quality issues
  - drafting the management review reports required for management review meetings
  - SQA organizational issues, preparing requested material, and so forth, for top management's consideration (done through the executive in charge of software quality)

SQA Unit - The Head [5]

- SQA professional activities
  - participation in project joint committees
  - participation in formal design reviews
  - review and approval of deviations from specifications (when required by procedures)
  - consultation with project managers and team leaders
  - participation in SQA committees and forums

SQA Unit

SQA Unit - SQA Operations Project life cycle SQA

- Responsible for making sure that the **project is following SQA procedures** throughout its life cycle
- Tasks
  - control tasks
    - follow up the development team to make sure they are complying with SQA procedures; approve and recommend various products; communicate with customers
  - participation tasks
    - take part in contract reviews, design reviews, software testing, and the installation of new products

SQA Unit - SQA Operations
SQA infrastructure operations

- Deals with all the quality infrastructure components in the SQA system (Procedures, Supporting devices, Staff Training, Preventive Actions, Configuration Management, and Document Control)

SQA Unit - SQA Operations
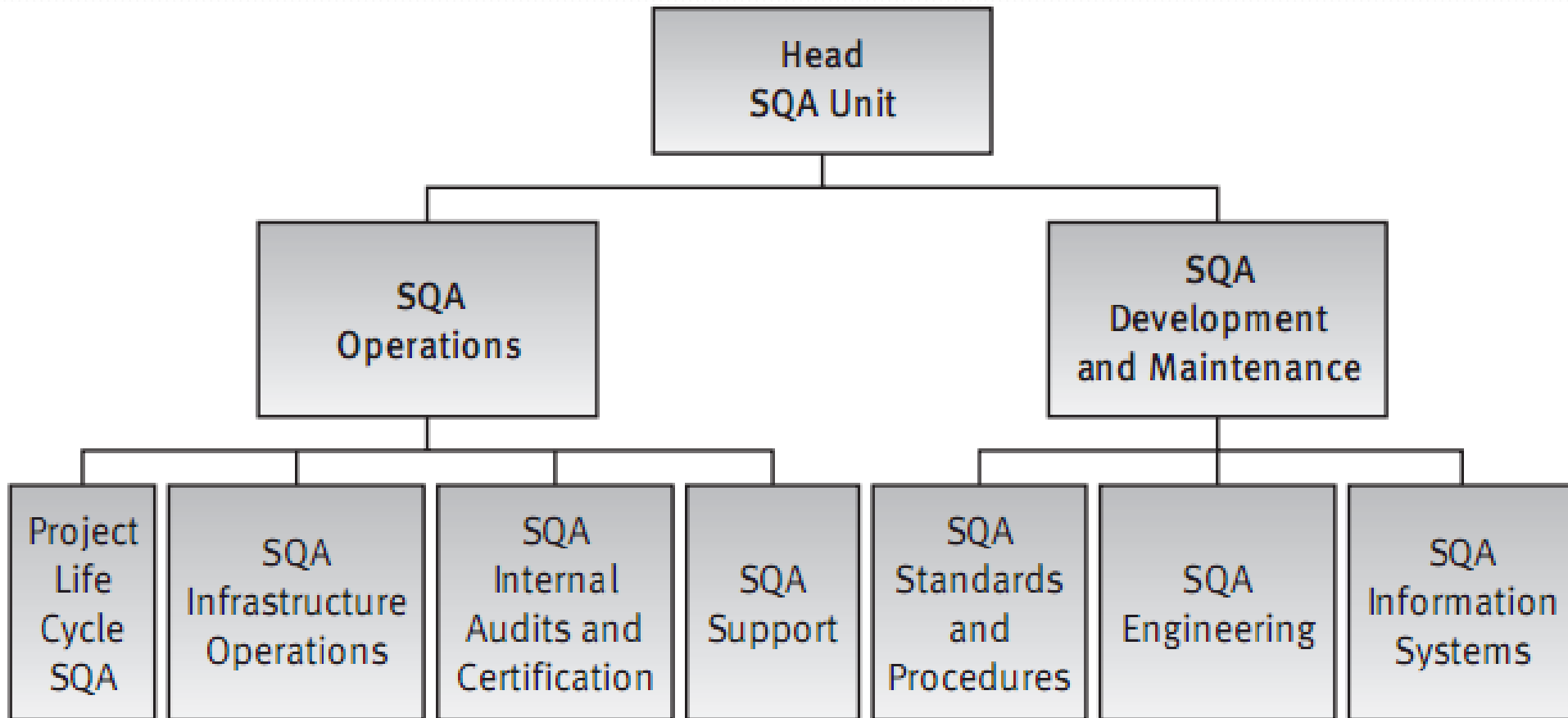# SQA audit and certification

- Organizations carry out four types of SQA audits, two of which are performed by the SQA unit:
  - internal SQA audits
  - SQA audits of the organization's subcontractors and suppliers to evaluate their SQA systems

SQA Unit - SQA Operations
SQA support

- Preparation of project plans and project quality plans
- Staffing review teams
- Choice of development methodologies and tools that reflect the failure experience data accumulated by the SQA unit
- Choice of measures to solve identified software development risks
- Choice of measures to solve schedule delays and budget overruns
- Choice of SQA metrics and software costs components

SQA Unit

SQA Unit - SQA Development and Maintenance Standards and procedures

- For standards
  - <u>follow-up</u> of developments and changes in SQA and software engineering standards and <u>recommending</u> adoption of additional standards

- For procedures
  - <u>coordination and participation</u> in development, maintenance and <u>updating</u> of procedures as well as <u>preparation</u> of an annual program for development of new procedures

SQA Unit - SQA Development and Maintenance Engineering

- Testing and evaluating new external developing methods and tools

- Developing solutions to difficulties in current developing method and tools internally

- Developing methods for measuring software quality and team productivity

SQA Unit - SQA Development and Maintenance Information System

- Create, develop and update an information system that is dedicated to SQA

Actors in the SQA system

- SQA unit members
- **SQA trustees**
- SQA committee members
- SQA forum members

SQA trustees and tasks

- SQA trustees are involved in unit-related tasks and organization-related tasks, which vary considerably among organizations
- Tasks
  - typical <u>unit-related</u> tasks: **support** other unit/team members in solving difficulties in implementation of software quality procedures, **help** their unit manager in performing his SQA tasks, and **report** to the SQA unit on substantial and systematic non-compliance situations and severe software quality failures
  - typical <u>organization-related</u> tasks: **initiation** of changes and **updates** of SQA procedures, initiation of organization-wide **improvements** of development and maintenance processes and applications to the CAB, **identification** of SQA training needs and preparation of proposals for appropriate training and/or instruction programs

Actors in the SQA system

- SQA unit members
- SQA trustees
- **SQA committee members**
- SQA forum members

SQA committees and tasks

- SQA committees is a body of various individuals and groups that have an interest in SQA

- Permanent committee

  - deal with issues that are continuous such as SQA procedures, quality metrics and corrective action,…

- Ad hoc committee

  - deal with a specific issues such as updates of a specific procedure, analysis and solution of a software failure,…

Actors in the SQA system

- SQA unit members
- SQA trustees
- SQA committee members
- **SQA forum members**

SQA forums – tasks and methods of operation

- SQA forums are informal components of the SQA organizational framework

- Established, operated and developed freely

- The purpose: discuss and communicate certain issues such as SQA procedure improvements, quality metrics, and corrective actions

- The forum can meet regularly or sporadically, and can define its preferred means of communication (Internet, intranet, electronic mail, etc.)

- Members of an open forum: SQA unit members, SQA trustees, software development and maintenance staff, SQA and software engineering consultants/experts, customer representatives