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Information technology — Software and systems engineering — Tools and methods for product line organizational management

Technologies de l'information — Ingénierie des systèmes et du logiciel — Outils et méthodes pour le management organisationnel d'une gamme de produits

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Contents

Page

Foreword	vi
Introduction	vii
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Reference model for product line organizational management	2
4.1 Overview	2
4.2 Organizational-level product line planning	3
4.3 Organizational product line enabling	3
4.4 Organizational product line management	4
5 Organizational-level product line planning	6
5.1 General	6
5.2 Business opportunity analysis	6
5.2.1 Principal constituents	6
5.2.2 Analyse market needs	7
5.2.3 Examine competitive environments	8
5.2.4 Forecast technology trends	8
5.2.5 Establish product line objectives	9
5.2.6 Define product roadmap	9
5.2.7 Estimate benefits, funding and potential risks	9
5.2.8 Quantify the measure of success	10
5.2.9 Document the business case proposal	10
5.3 Customer relationship management	11
5.3.1 Principal constituents	11
5.3.2 Identify one or more interest groups of the customer	12
5.3.3 Implement integrated communication mechanism at the product line level	12
5.3.4 Aggregate customer requests for product management and scoping	12
5.3.5 Maintain and evolve customer relationships from a product line perspective	13
5.3.6 Establish mutually beneficial long-term relationships	13
5.3.7 Document the customer relationship management plan	13
5.4 Developing a sourcing strategy	14
5.4.1 Principal constituents	14
5.4.2 Define primitive sourcing strategies	14
5.4.3 Account for evolving product line requirements	15
5.4.4 Mandate product line architecture compliance	15
5.4.5 Ensure continuity of support over the life of the product line	16
5.4.6 Examine ownership and data rights	16
5.4.7 Analyse alternative contracting approaches	16
5.4.8 Set up evaluation criteria for choosing among competing bidders	17
5.4.9 Document the sourcing strategies	17
5.5 Organizational deployment and innovation planning	17
5.5.1 Principal constituents	17
5.5.2 Analyse appropriate best practices of product line deployment and innovation	18
5.5.3 Identify organizational capability to nurture a product line	18
5.5.4 Define procedures for product line deployment and innovation	19
5.5.5 Assign roles and responsibilities for product line deployment and innovation	19
5.5.6 Specify schedules and resources for product line deployment and innovation	20
5.5.7 Document the organizational product line deployment and innovation plan	20
5.6 Organizational operations planning	20
5.6.1 Principal constituents	20
5.6.2 Establish organizational operations policy	21

5.6.3	Analyse organizational operations needs to produce domain asset and products.....	22
5.6.4	Define procedures for organizational operations.....	22
5.6.5	Assign roles and responsibilities for product line operations.....	22
5.6.6	Specify schedules and resources for product line operations.....	23
5.6.7	Specify how to monitor, measure and control product line operations.....	23
5.6.8	Specify how to coordinate with product line process improvement roles.....	24
5.6.9	Document the organizational operations plan.....	24
5.7	Value management planning.....	24
5.7.1	Principal constituents	24
5.7.2	Analyse measurable values achievable through the product line adoption	25
5.7.3	Define measures and metrics for value management	25
5.7.4	Define procedures for value management	26
5.7.5	Assign roles and responsibilities for value management	26
5.7.6	Specify schedules and resources for value management.....	27
5.7.7	Document the value management plan.....	27
5.8	Organizational product line evolution planning.....	27
5.8.1	Principal constituents Purpose	27
5.8.2	Analyse changing trends of market and technology	28
5.8.3	Identify organizational capabilities for product line evolution	29
5.8.4	Define procedures for product line evolution	29
5.8.5	Assign roles and responsibilities for product line evolution	29
5.8.6	Specify schedules and resources for product line evolution	30
5.8.7	Document the organizational product line evolution plan	30
6	Organizational product line enabling.....	30
6.1	General	30
6.2	Structuring the product line organization	31
6.2.1	Principal constituents	31
6.2.2	Define responsibilities for decision-making in a product line	32
6.2.3	Structure the product line organizational charter and boundaries.....	32
6.2.4	Assign roles, responsibilities and resources to the defined organizational structure.....	32
6.2.5	Manage product line organization structure.....	33
6.2.6	Monitor product line organizational effectiveness	33
6.2.7	Improve product line organizational structure.....	33
6.3	Organizational product line infrastructure	34
6.3.1	Principal constituents	34
6.3.2	Identify product line infrastructure needs	34
6.3.3	Specify schedules and resources required for establishing product line infrastructure	35
6.3.4	Document product line infrastructure establishment plan	35
6.3.5	Monitor and assess the effectiveness of product line infrastructure	35
6.3.6	Manage product line infrastructure for evolving needs	36
6.4	Organizational product line quality management	36
6.4.1	Principal constituents	36
6.4.2	Establish organizational product line quality management policy	37
6.4.3	Design product line quality management for reuse	37
6.4.4	Perform product line quality evaluation	38
6.4.5	Communicate and ensure resolution of noncompliance issues	38
6.4.6	Monitor and assess the effectiveness of quality management	38
6.4.7	Coordinate with product line process improvement roles	39
6.5	Organizational strategy and policy for product family management	39
6.5.1	Principal constituents	39
6.5.2	Define markets for a family of products	40
6.5.3	Structure technology trends	41
6.5.4	Perform technical probe	41
6.5.5	Define strategic product family	41
6.5.6	Monitor and assess value achievement of a product family	42

6.5.7	Coordinate with deployment and innovation management roles	42
6.5.8	Coordinate with evolution management roles	42
6.5.9	Manage organization-wide product line engineering	42
7	Organizational product line management	43
7.1	General	43
7.2	Product line deployment and innovation management	43
7.2.1	Principal constituents	43
7.2.2	Tailor the organizational deployment and innovation plan	44
7.2.3	Build an awareness and advocacy	45
7.2.4	Conduct a pilot project	45
7.2.5	Monitor direction and performance	45
7.2.6	Perform tuning and improvement	46
7.2.7	Promote product line institutionalization	46
7.2.8	Evaluate product line deployment and innovation	46
7.3	Operations management	47
7.3.1	Principal constituents	47
7.3.2	Tailor the operations management portion of the organizational operations plan	48
7.3.3	Specify guidance for shared responsibilities in product line engineering and management	48
7.3.4	Manage operations against operations plan	49
7.3.5	Manage sourcing operations against sourcing strategy	49
7.3.6	Identify inconsistencies between plans and actual status	50
7.3.7	Provide appropriate feedback to product line operations planning roles	50
7.4	Organization-level product line monitoring and control	50
7.4.1	Principal constituents	50
7.4.2	Tailor the monitoring and control portion of organizational operations plan	51
7.4.3	Monitor operations for producing domain asset against planning	52
7.4.4	Monitor operations for producing member products against planning	52
7.4.5	Monitor sourcing against sourcing strategy	53
7.4.6	Take corrective actions	53
7.4.7	Measure monitoring and control plan versus actual status	53
7.4.8	Provide appropriate feedback to product line operations planning roles	54
7.5	Organizational product line risk management	54
7.5.1	Principal constituents	54
7.5.2	Identify risks for organizational implementation of product line engineering and management	55
7.5.3	Assess the identified risks	55
7.5.4	Develop organizational risk mitigation plans	56
7.5.5	Execute the mitigation plan	56
7.5.6	Measure mitigation plan versus actual status	56
7.5.7	Provide appropriate feedback to organizational risk mitigation planning roles	57
7.6	Product line evolution management	57
7.6.1	Principal constituents	57
7.6.2	Tailor the organizational product line evolution plan	58
7.6.3	Produce the defined evolution outcomes	58
7.6.4	Achieve the defined evolution goals	58
7.6.5	Measure evolution plan versus actual status	59
7.6.6	Manage the evolution procedures	59
7.6.7	Provide appropriate feedback to product line evolution planning roles	60
Annex A (informative) Exemplar product line organizational structure	61	
Annex B (informative) Mapping from ISO/IEC 26556 to ISO/IEC/IEEE 15288 and ISO/IEC/IEEE 12207	62	
Bibliography	64	

Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 7, *Software and systems engineering*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The main purpose of this document is to deal with the capabilities of methods and tools of software and systems product line (SSPL) organizational management. This document defines how the tools and methods can support the software and systems product line-specific organizational management processes. Since product lines deal with multiple products that have similarities, product lines have an unprecedented level of organizational management complexities. This arises from several sources:

- there are inherent differences in organizational considerations because there are parallel development processes (domain and application engineering) in a product line, and the two processes are tightly related with each other around assets;
- the close relationships among domain engineering, application engineering and assets require the highly matured managerial capabilities for addressing the relationships; and
- there is a lack of tools and methods to support the product line-specific organizational management.

Organizational management addresses the orchestration of the product line organization. Introduction and institutionalization of the product line strategy in an organization requires ongoing preparation, planning, execution and improvement efforts. Organizational management provides planning, monitoring and control, and management for product line adoption, transition, operations, evolution and organizational value achievement such as reusability, reducing cost and improving quality.

There are needs for defining product line-specific organizational management processes that integrate the involved product line disciplines with those for a single product. Furthermore, support of tools and methods are required so that a product line organization can perform organizational management under the systematic control of complexities. This document addresses the product line-specific processes in organizational management by dividing those into *organizational-level product line planning, organizational product line enabling, and organizational product line management* areas with the guidance of a set of tools and methods capabilities for supporting tasks for product line organizational management.

This document is intended to benefit people who acquire, supply, develop, operate and maintain tools and methods for product line organizational management. This document can be used in one or more of the following modes:

- by an organization intended to implement product lines — to understand, adopt and enact the processes, tools and methods for product line organizational management. This also helps the organization to evaluate and select relevant tools and methods based on business and user-related criteria; and
- by a tool vendor who facilitates or leverages product line engineering practices — to provide a set of tool capabilities that should be embodied in a tool for supporting product line organizational management.

The ISO/IEC 26550 family of standards addresses both engineering and management processes and capabilities of methods and tools in terms of the key characteristics of product line development. This document provides processes and capabilities of methods and tools for product line realization. Other ISO/IEC 26550 family of standards are as follows: ISO/IEC 26550, ISO/IEC 26551, ISO/IEC 26555, ISO/IEC 26557, ISO/IEC 26558 and ISO/IEC 26559 are published. ISO/IEC 26552, ISO/IEC 26553, ISO/IEC 26554, ISO/IEC 26560, ISO/IEC 26561, ISO/IEC 26562 and ISO/IEC 26563 are planned International Standards. The following list provides an overview of the family:

- processes and capabilities of methods and tools for domain requirements engineering and application requirements engineering are provided in ISO/IEC 26551;
- processes and capabilities of methods and tools for domain design and application design are provided in ISO/IEC 26552;

- processes and capabilities of methods and tools for domain realization and application realization are provided in ISO/IEC 26553;
- processes and capabilities of methods and tools for domain testing and application testing are provided in ISO/IEC 26554;
- processes and capabilities of methods and tools for technical management are provided in ISO/IEC 26555;
- processes and capabilities of methods and tools for variability mechanisms are provided in ISO/IEC 26557;
- processes and capabilities of methods and tools for variability modelling are provided in ISO/IEC 26558;
- processes and capabilities of methods and tools for variability traceability are provided in ISO/IEC 26559;
- processes and capabilities of methods and tools for product management are provided in ISO/IEC 26560;
- processes and capabilities of methods and tools for technical probe are provided in ISO/IEC 26561;
- processes and capabilities of methods and tools for transition management are provided in ISO/IEC 26562;
- processes and capabilities of methods and tools for configuration management of asset are provided in ISO/IEC 26563; and
- others (ISO/IEC 26564 to ISO/IEC 26599) are to be developed.

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Information technology — Software and systems engineering — Tools and methods for product line organizational management

1 Scope

This document, within the methods and tools of organizational management for software and systems product lines:

- enables the users of this document to holistically understand, adopt and enact the processes, tools and methods for product line organizational management;
- helps the users evaluate and select relevant tools and methods based on business and user-related criteria;
- helps make product line engineers, developers and tool vendors informed about capabilities of tools and methods that are required for supporting product line implementation from organizational aspects; and
- provides product line-specific processes and capabilities of tools and methods in organizational management.

This document concerns processes and capabilities of methods and tools for organizational management for a family of products, not for a single system.

NOTE System Architecture is a set of logical and physical principles used to achieve a mission within a given environment. Components that can be subsystems derived from System Architecture are: software products, human-based products such as crew or operators, or hardware products like mechanical structures, electronic boards and chemicals. The scope of this document spans from the system to subsystems and components. Both hardware-intensive and software-intensive systems are included, if they are part of a product family.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1

organizational risk

risks that inhibit the achievement of business values and product line objectives

Note 1 to entry: Risks related to domain asset development or member product development are dealt with in the technical risk management sub process of ISO/IEC 26555.

3.2

product roadmap

timeline with high-level milestones for a product life cycle, particularly the timeline for productive deployment of the product

4 Reference model for product line organizational management

4.1 Overview

Organizational management supports an entire product line effort. Introduction and institutionalization of the product line approach is not a one-step phase, but requires preparation and planning followed by execution and implementation.

The reference model specifies the structure of supporting processes and sub processes for product line organizational management. The reference model for product line organizational management in [Figure 1](#) is structured into three processes, organizational-level product line planning, organizational product line managing and organizational product line enabling. Each process is divided into sub processes and each sub process is described in terms of the following attributes:

- the title of the sub process;
- the purpose of the sub process;
- the inputs to produce the outcomes;
- the tasks to achieve the outcomes;
- the outcomes of the sub process; and
- the capabilities of methods and tools required for performing the tasks effectively and efficiently.

NOTE 1 The process mapping results with ISO/IEC/IEEE 15288 and ISO/IEC/IEEE 12207 of [Annex B](#) can be referred to differentiate this document from others.

NOTE 2 /st When the process, sub process, outcomes and tasks are listed or described in a sentence they are italicized in order to increase their visibility.

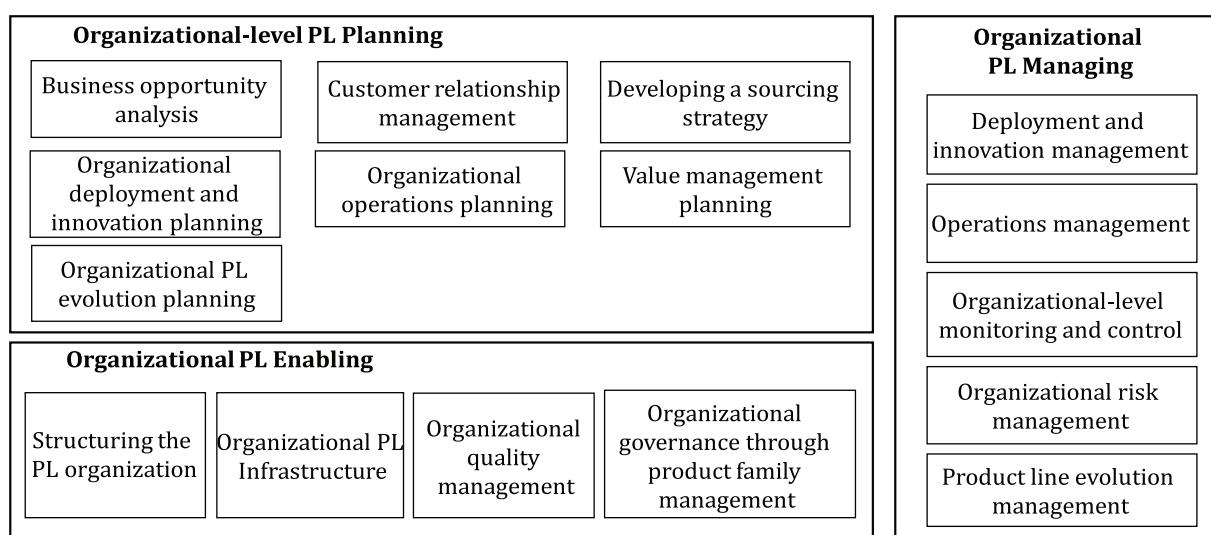


Figure 1 — Product line organizational management reference model

4.2 Organizational-level product line planning

The organizational-level product line planning justifies the effort to adopt the product line approach for developing domain assets and member products, and pertains to strategic or organizational-level planning. This process should analyse the reduced time-to-market, improved product quality, reduced costs and improved productivity achieved by adopting the product line approach. This process should establish schemes for managing the aforementioned aspects of a product line. The organizational-level product line planning shall serve to do the following:

- *Business opportunity analysis in a product line* establishes business opportunity by analysing market trends, customer's preference and technical trends for a family of products.
- *Customer relationship management for a family of products* identifies and helps ensure that customer requests conferring with product management.
- *Developing a sourcing strategy* establishes a general plan for achieving domain assets through outsourcing. Because domain assets should be reused for producing member products, development of outsourced domain assets should also be governed under the strictly defined product line plans. Even their development processes can be managed.
- *Organizational deployment and innovation planning* makes plans for deploying and innovating product line approach. The role of deployment and innovation plan is to establish a capability to populate and nurture a product line. Deployment and innovation plan includes resources (i.e. organization, people and budget) and quantified objectives by stages. This process supports the application of product line approaches. The current situation of an organization and the operating status of a product line are identified and assessed, so that the product line practices meet the individual organization's needs.
- *Organizational operations planning* establishes product line operations plans including resources, schedules, assigned responsibilities and procedure for producing domain assets and reusing them for fielding member products of a product line. Operation plan includes which and how organizational units are involved in production and evolution of a product line and how the organization develops products by using domain assets to develop their products.
- *Value management planning* integrates and manages the progress of deployment and innovation plans and the organizational-level objectives that should be achieved through product lines.
- *Organizational product line evolution planning* establishes plans for evolving a product line in accordance with the market changes such as technologies, competitors and customer preferences. A market analysis is conducted continuously to guide the evolution of a product line by introducing new products into the product line.

NOTE 1 Product family is a group of products.

NOTE 2 Member products are an identification of each product in a product family.

NOTE 3 Product line means systems view of a product family and member products.

4.3 Organizational product line enabling

The organizational product line enabling supports infrastructures required for managing and operating product lines, such as, structuring and training for the product line organization and collaboration management among relevant organization members or organizational units. Organizational product line enabling establishes a structure of authority and responsibilities for the product line and defines the infrastructure and processes required by product line engineering. The organization structures of a product line should be established and maintained before transitioning a product line. Once a product line has been launched, a product line undergoes continuous technological and organizational changes for a product line evolution. Therefore, training is a key process for both the initial time and the long-term evolution of the product line. Product lines demand a great deal of coordination across the boundaries of organizational units because a product line is installed across several organization

units of which roles for producing products within a product line are quite different. The organizational product line enabling shall serve to do the following:

- *Structuring the product line organization* establishes and maintains organizations required for product line deployment, innovation, operation and management. This process establishes and maintains the structure of product line organization such as functional groups of organization units, boundaries among them and inter-organizational unit relationships. This sub process allocates resources and assigns responsibilities to each functional group. Organizational deployments and innovations are also managed to improve organizational operations in accordance with the effectiveness of organization structure.
- *Organizational product line infrastructure* helps ensure that the organizational units responsible for creating, operating and evolving domain assets and member products have proper infrastructure for each work role. Training activities should be coordinated with other activities involved in product line adoption and evolution. The focus of training is on establishing a core competence for creating, populating and evolving domain assets in order to help ensure that the relevant organizational units have proper skills.
- *Organizational quality management* assures that product line organization adheres to the defined product line processes and helps ensure whether the qualities of member products and domain/application assets are maintained against the defined quality criteria from the organizational perspective.
- *Organizational governance through product family management* provides the framework for attaining an organization's goals and objectives of product line engineering and management by employing product family (or line) management since it performs governance responsibilities. Governance responsibilities of product family management include (but are not limited to): market definition of product family, technology scanning, technical probe, product family definition, value management of a product family, organizational deployment and innovation management from legacy system to SSPL, and product family evolution.

4.4 Organizational product line management

The organizational product line management provides managerial support for product line evolution, innovation and risk management for taking actions for internal or external environmental changes. A product line produces multiple products within the same line so the damages due to failure are greater than those of single product development. Thus, the management of the internal and external possible or occurred risks should be carefully performed. Moreover, the product line should continuously evolve in line with the changes on business opportunities, and operations should reflect these changes. Organizational product line management monitors and controls the product lines, defines and maintains a production schedule based on a product line strategy, costs and a budget plan. Organizational product line management also concerns a systematic evolution of an organization from a given state of product line sophistication. The organizational product line managing shall serve to do the following:

- *Deployment and innovation management* establishes plans for operation improvements that should be improved for achieving product line objectives and deploys the plans after pilots if necessary.
- *Operations management* provides managerial support for deploying the operations plan such as: operations plan versus actual implementation, sourcing and inconsistencies in real operations against plan.
- *Organization-level monitoring and control* measures the status of the achievement of product line objectives and takes a corrective action to make a product line organization achieve the established objectives.
- *Organizational risk management* deals with the risks that a software and systems product line organization can face because a product line requires a great deal of effort to coordinate organizational boundaries. Organizational risk management differs from technical risk management in that it manages risks that are possible across multiple organizational units involved in a product line.

- *Product line evolution management* performs evolution in line with organizational product line evolution planning.

The identification and analysis of the key differentiators between single-system engineering and management and product line engineering and management can help organizations to understand the product line and to formulate a strategy for successful implementation of product line engineering and management. The key aspects have been defined in ISO/IEC 26550 and [Table 1](#) shows the category of the key aspects.

NOTE The following aspects have been derived on the basis of the key characteristics of product lines: reuse management, variability management, complexity management and quality management.

Table 1 — Key aspects for identifying product line-specific organizational management tasks

Category	Aspects
Reuse management	application engineering, domain assets, domain engineering, product management, platform, reusability
Variability management	binding, variability
Complexity management	collaboration, configuration, enabling technology support, reference architecture, texture, traceability
Quality management	measurement and tracking, cross functional verification and validation

The following text provides descriptions for each aspect concerning product line organizational management. The product line organizational management-relevant processes and tasks shall be identified on the basis of these aspects. The concerns specific to product line organizational management will enable an organization to understand the product line organizational management relevant processes, sub processes, tasks, methods and tools' capabilities.

- **Application engineering.** Organizational management provides organizational level supports to application engineering such as organization units for application engineering, training for platform reuse, general risk mitigation plans and so on. Most of all member products and their initial features are planned by organization management process.

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- **Binding.** Operations guide binding activities for producing each member product.
- **Collaboration.** Collaborations between domain and application organizations are planned and coordinated by organization management process.
- **Configuration.** To cope with the complexity of configuration management in product line enabling environment should be considered at organizational level.
- **Domain asset.** Qualities of domain assets and the overall quality of domain artefacts are managed in organization management.
- **Domain engineering.** Organizational level product line planning and organizational product line managing processes provide main inputs to product line scoping, which is the first step of domain engineering.
- **Enabling technology support.** Technologies for supporting efficient product line evolution, organizational risk management and organizational-level monitoring and control should be supported.
- **Measurement and tracking.** Measures for monitoring and controlling the status of the overall product line progress should be defined.
- **Platform.** Organizational-level plans such as: deployment and innovation plans, product line evolution plans and value management plans can be parts of platforms. Platforms can include organizational level measures and risk mitigation plans.

- **Product management.** Organizational product line evolution planning and product line evolution support product management.
- **Reference architecture.** Along with reference architecture, sourcing strategy is implemented.
- **Reusability.** Reusability should be planned at organizational level, and its achievement should be monitored and controlled from the whole product line organization's perspective.
- **Texture.** Organizational level monitoring and control support monitoring and controlling whether domain architecture, domain realization, domain testing and application realization adhere to rules and constraints defined in architectural texture at the organizational level.
- **Traceability.** Capabilities required for managing traceability are supported by training and human resource management.
- **Cross-functional validation and verification.** Organizational quality management supports validation and verification at the organizational level.
- **Variability.** At the organizational level, product line evolution reflects variability being added or removed.

5 Organizational-level product line planning

5.1 General

Organizational-level product line planning supports the following:

- *Business opportunity analysis;*
- *Customer relationship management;*
- *Developing a sourcing strategy;*
- *Organizational deployment and innovation planning;*
- *Organizational operations planning;*
- *Value management planning;* and
- *Organizational product line evolution planning.*

5.2 Business opportunity analysis

5.2.1 Principal constituents

5.2.1.1 Purpose

The purpose of this sub process is to define business case proposals that consist of analysed market (including segmented customer groups) needs, competitors' environments, technology trends, product line objectives and products roadmap to justify a decision about whether an organization will proceed to product line execution.

NOTE Products in this document include services, systems and solutions.

5.2.1.2 Inputs

The following inputs should be available to perform the business opportunity analysis process:

- organization's business objectives (values);