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Software and systems engineering — Methods and tools for product line transition management

Ingénierie du logiciel et des systèmes — Méthodes et outils destinés à la gestion de la transition des gammes de produits

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

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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.

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).

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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 Joint 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

Software and Systems Product Line (SSPL) engineering and management creates, exploits and manages a common platform to develop a family of products (e.g. software products, systems architectures) at lower cost, with reduced time to market and better quality. As a result, it has gained increasing global attention since the 1990s.

Product line transition management supports a product line organization to launch and institutionalize the product engineering and management. The results of the product line technical probe are major inputs to determine the transition strategy and continuous improvement of product line institutionalization.

This document can be used in the following modes:

— by organizations that want to switch from single-system development to SSPL for producing their products – to provide guidance on how to launch and institutionalize the product line engineering;

— by a product line organization – to provide guidance on the evaluation and selection for methods and tools for product line transition management;

— by providers of methods and tools – to provide guidance on implementing or developing methods and/or tools by specifying a comprehensive set of methods and tools capabilities for supporting product line transition 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 variability modelling in product lines. Other standards in the ISO/IEC 26550 family of standards are as follows:

ISO/IEC 26550, ISO/IEC 26551, ISO/IEC 26552, ISO/IEC 26553, ISO/IEC 26554, ISO/IEC 26555, ISO/IEC 26556, ISO/IEC 26557, ISO/IEC 26558, ISO/IEC 26559 and ISO/IEC 26560 are published. ISO/IEC 26561 is to be published. ISO/IEC 26563 and ISO/IEC 26564 are planned International Standards.

— 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 organizational management are provided in ISO/IEC 26556;

— 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 product line technical probe are provided in ISO/IEC 26561 (International Standard under development);

— Processes and capabilities of methods and tools for configuration management of asset are provided in ISO/IEC 26563 (planned International Standard);

— Processes and capabilities of methods and tools for product line measurement are provided in ISO/IEC 26564 (planned International Standard);

— Others (ISO/IEC 26564 to ISO/IEC 26599): To be developed.

Software and systems engineering — Methods and tools for product line transition management

1 Scope

This document, within the context of methods and tools for supporting the transitioning the organization's current development approach to software and systems product line engineering**:**

— defines processes for product line transition management. Those processes are described in terms of purpose, inputs, tasks and outcomes;

— defines method capabilities to support the defined tasks of each process;

— defines tool capabilities that automate or semi-automate tasks and methods.

This document does not concern processes and capabilities of tools and methods for a single system but rather deals with those for a family of products.

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 http://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
aspect
special consideration within *product line* (3.8) engineering process groups and tasks to which one can associate specialized methods and tools

3.2
product line institutionalization
considering *product line* (3.8) engineering as part of working culture by involved managers and staff members

3.3
product line technical probe
technical probe
probe
diagnostic process for investigating the organization's readiness to adopt, or ability to succeed with, the *product line* (3.8) engineering and management

3.4
product line transition
transition
switching to *product line* (3.8) engineering from single system engineering

3.5
product line transition plan
transition plan
plan that describes *product line transition strategy* (3.7), resources required, responsibilities, detailed transition processes, major changes in product development and success measures for operationalizing the *product line transition* (3.4)

3.6
product line transition scenario
transition scenario
scenario including who, what, in what procedures and orders, and how to do their roles and responsibilities for deploying *product line transition strategy* (3.7)

3.7
product line transition strategy
transition strategy
set of plans intended to switch to *product line* (3.8) engineering

3.8
software and systems product line
SSPL
product line
paradigm for the creation, exploitation, and management of a common platform for a family of products

Note 1 to entry: Typical goals of product lines are to lower costs, reduce time to market, and improve quality.

4 Reference model for product line transition management

4.1 Overview

Markets, economic pressures, competitors, and technological trends lead an organization to transition to product line. However, transition to product line engineering is not easy because product line requires investments and changes on the development paradigm to achieve the established business objectives. Once an organization decides to switch to product line engineering due to external or internal reasons, an organization should establish business objectives that motivate an organization's transition to product line engineering and that would be measures for the success of transition.

For a successful transition to product line engineering an organization should establish a proper transition strategy based on the established business objectives. In addition, the transition strategy should be designed to fit the organizational structure and an organization's capability against the essential capabilities of the product line operation. In accordance with the designed transition strategy a pilot project can be conducted or product line engineering can be introduced from a single department or for part of the whole product and thereafter a product line can be incrementally expanded. The transition strategy also considers returns on investments, and later in the scoping the results should be used for the further estimation of benefits expected from product line adoption. During the transition an organization is adapted for the successful switching to the product line engineering. Example transition strategies are provided in Annex A.

The reference model specifies the structure of supporting processes and subprocesses for product line transition management. As shown in Figure 1, product line transition management can be structured into three processes: transition management, transition operationalization and transition support. In the rest of this document, tasks, methods and tools are described in terms of processes and subprocesses defined in the reference model.

Each process is divided into subprocesses and each subprocess is described in terms of the following attributes:

— the title of the subprocess;

— the purpose of the subprocess;

— the inputs to produce the outcomes;

— the tasks to achieve the outcomes;

— the outcomes of the subprocess.

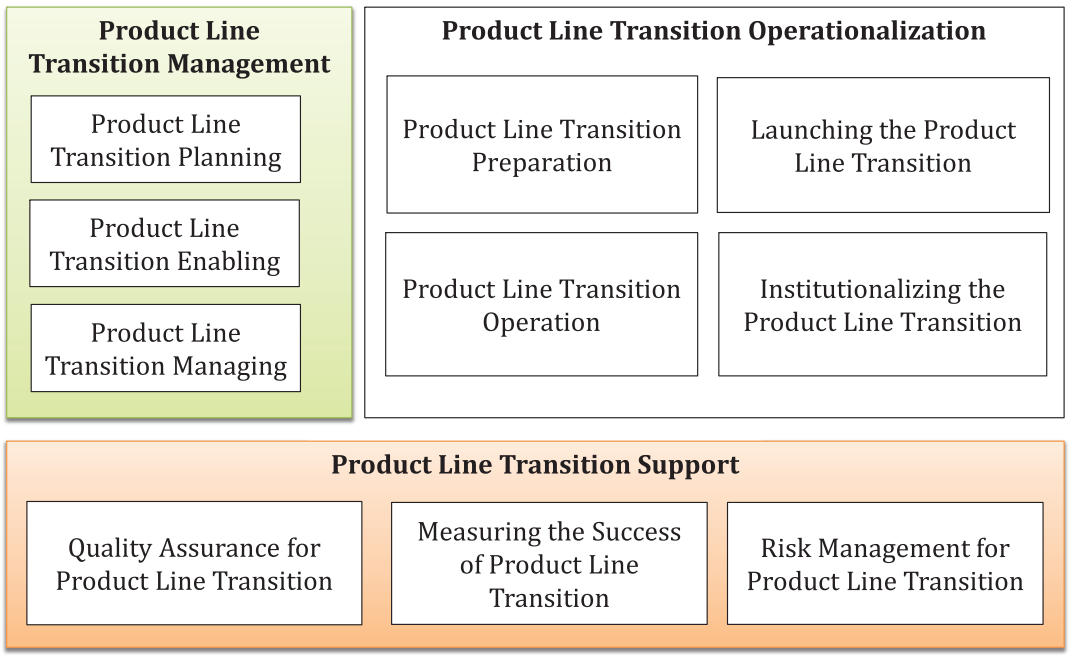

Figure 1 — Reference model for product line transition management

4.2 Product line transition management

The transition management process provides managerial supports for planning transition (e.g. resource estimation, responsibility allocation, success measures), supports for providing necessary resources, tools and infrastructures for implementing transition plans and supports for analysing the plan versus the actual status of the transition. The transition management shall do the following:

— *product line transition planning* establishes plans for transition operationalization;

— *product line transition enabling* defines, maintains and assures the availability of environments, guidance, and measurement necessary to switching to the product line engineering and management;

— *product line transition managing* provides integrated management for the product line transition operationalization; this subprocess reviews the transition operationalization's actual status against plans, controls issues, and takes corrective actions if necessary.

4.3 Product line transition operationalization

The product line transition operationalization process performs operations for establishing suitable product line transition. This process deals with the organization's readiness for transitioning to producing product family via a product line from the single system development. The transition operationalization shall do the following:

— *product line transition preparation* evaluates the readiness of the transition to product line engineering and initiates to launch the transition;

— *launching the product line transition* prepares and initiates for switching to the product line engineering;

— *product line transition operation* switches to the product line engineering and management in accordance with the defined product line transition strategy; many changes in business, architecture, process, and organization structure occur; and

— *institutionalizing the product line transition* settles the product line engineering and management through the continuous improvement; an organization adapts its business, architecture, process, and organization structure to the product line engineering and management paradigm.

4.4 Product line transition support

The product line transition support process provides supports required for switching an organization's ways of offering products to markets to the product line engineering and management. To achieve these, the product line transition support shall do the following:

— *quality assurance for transition* objectively evaluates the activities and artefacts of the implemented product line transition;

— *measuring the success of transition* verifies the product line transition strategy and validates the relevant decisions; and

— *risk management for transition* identifies and mitigates risks related to product line transition.

The identification and analysis of the key differentiators between single-system engineering and management and product line engineering and management can help the 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.

Table 1 — Key aspects for identifying product line transition 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 are the descriptions for each aspect concerning product line transition management. The product line transition and its management processes and tasks shall be identified on the basis of these aspects. The concerns for product line transition and its management will enable the organization to understand the transition and its management processes, subprocesses, tasks, methods and tools' capabilities.

— Application engineering: Strategies and tactics to use in order to switch to the product line engineering include how application engineering derives member products based on the platforms. The application engineering process varies with the defined transition strategies.

— Binding: Cost of binding variants is one of the major costs that should be considered when an organization estimates costs of reusing domain assets, which are one of the major components consisting product line cost model. Estimated product line costs are used for determining the transition strategy.

— Collaboration: In accordance with a transition strategy, the product line organization structure and required collaborations among organization units differ.

— Configuration: Ways to derive configurations based on domain assets differ from the product line transition strategy.

— Domain asset: Domain assets shall be managed for achieving successful managed reuse, so the product line transition considers to achieve managed reuse for domain assets in domain engineering and application engineering.

— Domain engineering: An important part of product line transition among others is domain engineering because domain engineering produces platforms, which judge the success of a product line.

— Enabling technology support: Guidance, measurement and operationalization environments for product line transition should be provided.

— Measurement and tracking: The execution status of a product line transition should be measured and tracked for status control and achieving the success of transition.

— Platform: Platforms are produced during domain engineering and used to create member products during application engineering. Operations of the product line transition shall select and perform the right strategy and tactics with suitable transition management services.

— Product management: Product line transition is controlled by product management.

— Reference architecture: Many changes in architecture design shall be made during the transition process and building a reference architecture is one of the major aspects to be considered in a product line transition.

— Reusability: To obtain a positive return on investment in product development, enhancing reusability of existing artefacts and new ones is an important part of the product line transition.

— Texture: Many changes in architectural texture shall be made during the transition process for producing product family;

— Traceability: Better traceability should be achieved for a successful product line transition.

— Cross functional validation and verification: The transition process and their intermediate artefacts produced during transition should be validated and verified.

— Variability: In accordance with a transition strategy, ways to developing and modelling variability differ.

5 Product line transition management

5.1 General

The transition management supports the following:

— *product line transition planning*;

— *product line transition enabling*; and

— *product line transition managing*.

5.2 Product line transition planning

5.2.1 Principal constituents

5.2.1.1 Purpose

The purpose of this subprocess is to create the product line transition plan applied to launching and institutionalizing the product line transition.

5.2.1.2 Inputs

The following inputs should be available to perform the transition planning process:

— description of organizational process, details of participants including their expertise, description of organizational structure, and list of engineering methodologies used;

— business objectives of a product line;

— results and lessons obtained from the previous product line (not organization-wide, e.g., findings, strengths and weaknesses of the product line transition operation) or pilot product line (e.g., findings from launching the pilot transition);

— product line technical probe results (from ISO/IEC 26561); and

— product line adoption scenario (from ISO/IEC 26561).

5.2.1.3 Outcomes

The following outcomes shall be available as a result of the successful implementation of the transition planning process:

— *Product line transition strategy including key procedures and cost/benefit/ROI analysis* is specified.

— *Product line transition plan* is produced, documented, and committed.

5.2.1.4 Tasks

The organization shall implement the following tasks with respect to the transition planning process:

— *Establish organization's transition goal*: Define the transition goals that should be achieved by going from a non-product line organization toward a product line organization.

— *Determine organization's transition strategy*: Determine a strategy on how to change the organization's process, attitude, and technology toward product line basis by taking into account the business objectives.

— *Define key procedures for transition*: Define or refine procedures that will be used for moving from a non-product line organization to a product line organization.

— *Formulate schedules and required resources for transition*: Specify new roles necessary for product line transition, skills and efforts required, budget, environments, and infrastructures, and arrange schedules based on these.

— *Specify how to monitor, measure, and control the effectiveness of transition*: Determine key actions and measures for quantifying and qualifying the effectiveness of the product line transition activities and its results. Success factors are identified and their possibilities are validated in order to design quantifiable and predictable success measures for the product line transition operation.

— *Document product line transition plan*: Specify the best-suited product line transition strategy, resources required, responsibilities, detailed transition processes, major changes in product development and success measures for operationalizing the product line transition.

5.2.2 Establish organization's transition goal

The goal of this task is to establish why and for what an organization goes to a product line organization.

The goal of the transition can be to produce the next products more efficiently or to get them to the market faster to stay competitive.

The method should support establishing organization's transition goal with the following capabilities:

— examining the product line transition context and requirements;

— formulating product line transition goals;

— checking transition goals against product line business goals, product line scope and the current situation; and

— aligning established transition goals with product line business goals, product line scope and current situation.

A tool should support establishing organization's transition goal by allowing the user to do the following:

— access product line transition goals; and

— communicate product line transition goals with key stakeholders.

5.2.3 Determine organization's transition strategy

The goal of this task is to establish how an organization goes from a non-product line organization toward a product line organization with reasonable evidences such as cost/benefit analysis for the strategy.

The method should support determining the organization's transition strategy with the following capabilities:

— examining the established product line goals (objectives), product line scope, current situation, and transition goals in accordance with the organizational constraints;

— providing exemplar product line strategies with their brief pros and cons;

— defining candidate transition strategies;

— identifying and analysing risks of transition strategies;

— providing cost models for evaluating costs/benefits of a product line at transition strategy level; and

— reckoning advantages and disadvantages of each transition strategy (a method can provide characterization aspects or topics to compare candidate strategies).

A tool should support determining the organization's transition strategy by allowing the user to do the following:

— access product line goals (objectives), product line scope, current situation, and transition goals;

— (semi-)automatically calculate costs/benefits in accordance with defined cost model (formula); and

— allow comparing transition strategies using visualized comparison matrix by characterization aspects or topics.

5.2.4 Define key procedures for transition

The goal of this task is to define and/or tailor key procedures of the product line launching and institutionalization.

The method should support defining key procedures for transition with the following capabilities:

— tailoring procedures used for transition based on the overall product line process;

— embedding the defined transition goals into the defined key procedures so that measuring of goal achievement is possible; and

— specifying the defined key procedures of transition using the documentation standard.

A tool should support defining key procedures for transition by allowing the user to do the following:

— access the overall product line transition process;

— share key procedures with relevant stakeholders;

— make decisions under the supports of decision-making procedures;

— integrate and calibrate procedures; and

— edit/fill out key phases and tasks of product line transition in accordance with the documentation standard.

5.2.5 Formulate schedules and required resources for transition

The goal of this task is to identify required resources to transfer from the current (legacy) state to the desired state of the product line organization.

The method should support formulating schedules and required resources for transition with the following capabilities:

— understanding difficulties in transition and capabilities of people, materials, and mechanisms that can be mobilized;

— estimating efforts and resources required; and

— defining the documentation standard for product line transition scheduling.

A tool should support formulating schedules and required resources for transition by allowing the user to do the following:

— access the information to formulate schedules for product line transition;

— access the information to assign the organization's available resources for product line transition; and

— specify a schedule for product line transition according to the defined documentation standard (graphically describe the schedules).

5.2.6 Specify how to monitor, measure, and control the effectiveness of transition

The goal of this task is to prepare measures used for quantitatively measuring the success of product line transition operation.

The method should support specifying how to monitor, measure, and control the effectiveness of product line transition with the following capabilities:

— defining observation points to monitor the effectiveness of transition;

— defining pre-conditions for monitoring the effectiveness of transition;

— defining measures and integration functions for evaluating the effectiveness of transition; and

— defining rules adhered to when the product line transition is controlled.

A tool should support specifying how to monitor, measure, and control the effectiveness of transition by allowing the user to do the following:

— access historical data related to monitoring and controlling other processes;

— specify escalation lines for controlling the issues and obtaining feedbacks;

— specify the monitor, measure and control plan using the documentation standard.

5.2.7 Document product line transition plan

The goal of this task is to finalize the product line transition plan document so as to start the product line launching process. The transition plan includes plans for product line launching and institutionalization, funding, and staffing.

The method should support documenting product line transition plan with the following capabilities:

— providing documentation standard for the product line transition plan (the contents of plan include stakeholder, transition strategy, transition procedures and estimates, staffing including required training);

— providing examples for each transition documentation item.

A tool should support documenting product line transition plan by allowing the user to do the following:

— edit/fill out transition plan using editable and changeable template;

— maintain the version control of the product line transition plan documents; and

— share the product line transition plan with the stakeholders.

5.3 Product line transition enabling

5.3.1 Principal constituents

5.3.1.1 Purpose

The purpose of this subprocess is to acquire the required resources and establish environments for launching product line transition.

5.3.1.2 Inputs

The following inputs should be available to perform the transition enabling process:

— product line transition plan;

— existing organizational project-enabling process description;

— developed and identified infrastructure elements;

— defined project management responsibilities, accountability, and authorities; and

— allocated resources and budgets for each project.

NOTE Refer to outcomes of the organizational project-enabling process of ISO/IEC/IEEE 15288 for detailed additional inputs.

5.3.1.3 Outcomes

The following outcomes shall be available as a result of the successful implementation of the transition enabling process:

— *Governance policy document for transition* is clarified.

— *Roles and responsibilities for transition* are structured.

— *Transition enablers including resources* are mobilized.

— *Action plan for transition process improvement* is established.

— *Transition processes* are continuously improved.

5.3.1.4 Tasks

The organization shall implement the following tasks with respect to the transition enabling process:

— *Establish governance policy for transition*: Define a transition policy including objectives, process, organization, evaluation, standards, and process improvement approaches for the product line transition.

— *Mobilize qualified human resources for transition*: Get ready all relevant participants to start to change or improve their process, development methods and technology, and organization to a product line basis.

— *Identify infrastructure and resource needs for transition operationalization and support*: Identify and develop the appropriate supporting tools, set of standards to be followed during the transition operationalization and support, logistics, skills, and staffs for transition operationalization and support.

— *Enable quality assurance measurement for transition*: Deploy measurement environments, including characterization models, measures, and data collection methods from the product line transition roles and responsibilities in order to measure the quality of the product line transition operation.

— *Improve transition process continuously*: Examine gaps between the aimed and achieved goals of the transition processes, so as to improve the processes continuously.

5.3.2 Establish governance policy for transition

The goal of this task is to ensure that the product line transition can be successfully performed.

The method should support establishing a governance policy for transition with the following capabilities:

— defining the documentation standard (e.g. the documentation standard consists of objective, process, organization of transition governance, evaluation of transition governance's quality) for the governance policy for transition; and

— specifying major contents of the governance policy for transition (example approaches that the governance policy can choose include the prototype approach, evolutionary approach, revolutionary approach, etc.)

A tool should support establishing a governance policy for transition by allowing the user to do the following:

— edit/fill out the contents of the documentation standard of the governance policy for transition;

— share the governance policy with downstream users of the organization defined in the governance policy; and

— use feedback channels for improving the governance policy.

5.3.3 Mobilize qualified human resources for transition

The goal of this task is to ensure that motivated individuals with required expertise are ready to start the product line transition.

The method should support mobilizing qualified human resources for transition with the following capabilities:

— training qualified human resources for necessary responsibilities of transition;

— checking qualifications of human resources for transition;

— aligning gaps between required and mobilized qualifications of human resources; and

— defining/refining evaluation criteria for the efficiency of mobilized human resources.

A tool should support mobilizing qualified human resources for transition by allowing the user to do the following:

— access the qualification of human resources that will be mobilized;

— record gaps between required and mobilized qualifications of human resources so as to have a chance to improve their qualifications; and

— monitor the efficiency of mobilized human resources in accordance with evaluation criteria.

5.3.4 Identify infrastructure and resource needs for transition operationalization and support

The goal of this task is to prepare and deploy enablers for the successful transition operationalization and support.

The method should support identifying infrastructure and resource needs for transition operationalization and support with the following capabilities:

— understanding the technical plan and other requirements defined for transition operationalization and support;

— define a template for identifying infrastructure and resource needs for transition operationalization and support;

— estimating infrastructure and resource needs for transition operationalization and support; and

— aligning gaps between what is available and what is required.

A tool should support identifying infrastructure and resource needs for transition operationalization and support by allowing the user to do the following:

— access information of the organization's available infrastructure and resources;

— edit/fill out the infrastructure and resource needs template.

5.3.5 Enable quality assurance measurement for transition

The goal of this task is to prepare and deploy enablers for measuring the quality of product line transition for determining the progress and the benefit of the activities are not satisfactory.

The method should support enabling quality assurance measurement for transition with the following capabilities:

— refining actionable tasks for enabling quality assurance measurement for transition tasks;

— establishing mechanisms for enabling quality assurance measurement; and

— defining ways for resolving conflicts between quality assurance roles and other roles of transition.

A tool should support enabling quality assurance measurement for transition by allowing the user to do the following:

— access best practices of quality assurance measurement of the organization;

— accumulate raw data collected during quality assurance measurement for transition;

— use communication channels for sharing quality assurance measurement issues and resolving conflicts.

5.3.6 Improve transition process continuously

The goal of this task is to deploy mature transition processes by continuously improving the processes.

The method should support improving the transition process continuously with the following capabilities:

— collecting data for evaluating the effectiveness of the transition process (e.g., Prototype approach, Evolutionary approach, Revolutionary approach, etc.);

— analysing deviations from required performance of the transition process;

— establishing action plans for improving the transition process based on analysed deviations; and

— controlling and tracing the status of improvement activities to closure.

A tool should support improving the transition process continuously by allowing the user to do the following:

— accumulate raw data related to the improvement of the transition process;

— visualize deviation between the actual and expected transition process performance;

— share action plans with relevant participants and communicate about it; and

— check the status of improvement activities.

5.4 Product line transition managing

5.4.1 Principal constituents

5.4.1.1 Purpose

The purpose of this subprocess is to monitor, control, and improve the product line transition operation together with the product management roles.

5.4.1.2 Inputs

The following inputs should be available to perform the transition managing process:

— product line transition plan;

— governance policy document for transition;

— action plan for transition process improvement; and

— collected data from SSPL transition sub functions.

5.4.1.3 Outcomes

The following outcomes shall be available as a result of the successful implementation of the transition managing process:

— *Deviations of actual transition operation and support from expected* are managed.

— *Identified risks in transition* are mitigated.

— *Feedbacks given to planning and enabling functions* are managed.

5.4.1.4 Tasks

The organization shall implement the following tasks with respect to the transition managing process:

— *Tailor and allocate governance policy, R & R (role and responsibility), and resources to relevant sub functions of transition*: Organize or integrate the governance policy, R & R, and resources with relevant sub functions of the product line transition for a harmonious operation.

— *Collect data from SSPL transition sub functions*: Establish and activate mechanisms to gather status data from SSPL transition sub functions.

— *Monitor, measure, and control transition operationalization and support*: Evaluate the measurement results of the product line transition progress and adjust the product line transition operation.

— *Manage actual operation and support of transition*: Adapt the product line transition operation and support, so as to achieve business objectives, which are reasons for starting the product line transition.

— *Provide feedback to planning and enabling functions of transition*: Give constructive feedbacks to planning and enabling functions of the product line transition.

5.4.2 Tailor and allocate governance policy, R & R, and resources to relevant sub functions of transition

The goal of this task is to assign roles, responsibilities, required resources suitable to relevant sub functions of transition together with relevant rules and guides.

The method should support tailoring and allocating the governance policy, R & R, and resources to relevant sub functions of transition with the following capabilities:

— identifying the detailed context of transition operation and support;

— understanding the overall transition organization structure and its sub functions;

— adjusting the policy, R & R, and resources based on the identified detailed context; and

— mapping R & Rs and resources to each sub function.

A tool should support tailoring and allocating the governance policy, R & R, and resources to relevant sub functions of transition by allowing the user to do the following:

— access the defined governance policy, R & R, and resources for transition;

— generate matrix for allocation; and

— share tailored and allocated governance policy, R & R, and resources with relevant stakeholders.

5.4.3 Collect data from SSPL transition sub functions

The goal of this task is to collect data that will be used to monitor, measure, and control the transition sub functions.

The method should support collecting data from SSPL transition sub functions with the following capabilities:

— determining variables or data collection points from sub functions (sub functions include those related to common platform and product development);

— providing mechanisms for interaction and data collection with and from transition sub functions; and

— categorizing and/or organizing the collected data for analysis.

A tool should support collecting data from SSPL transition sub functions by allowing the user to do the following:

— store collected data from SSPL transition sub functions to permanent or temporary storage for analysis; and

— visualize categorized and/or organized data for analysis.

5.4.4 Monitor, measure, and control transition operationalization and support

The goal of this task is to take change actions determined during the reviews on the measurement results of the product line transition operation.

The method should support monitoring, measuring, and controlling transition operationalization and support with the following capabilities:

— refining/determining measures, metrics, and measurement points on the procedures of transition operational and support;

— defining integration/characterization functions for integrating monitored and measured results for evaluating the effectiveness of transition operation and support;

— identifying thresholds and decision alternatives in controlling transition operation and support; and

— building up knowledge related to controlling transition operation and support.

A tool should support monitoring, measuring, and controlling transition operationalization and support by allowing the user to do the following:

— integrate monitored and measured results using supporting mechanisms;

— (semi-)automate the calculation for the defined integration functions or characterisation functions;

— derive knowledge from the values of integration functions or characterisation functions; and

— visualize/represent thresholds and decision alternatives in controlling transition operation and support.

5.4.5 Manage actual operation and support of transition

The goal of this task is to analyse gaps between actual and expected operation and support of the product line transition, and thereafter continuously improve services and processes of transition operation and support.

The method should support managing actual operation and support of the transition with the following capabilities:

— determining the performance of transition by comparing the plan versus the actual operation and support results;

— analysing root causes of the gaps; and

— deriving improvement needs and action item for operation and support of the transition.

A tool should support managing actual operation and support of the transition by allowing the user to do the following:

— analyse gaps using the displayed plan versus the actual operation and support results of the transition;

— access execution traces and results for analysing root causes of the gaps; and

— share improvement action items using communication channels and implemented mechanisms.

5.4.6 Provide feedback to planning and enabling functions of transition

The goal of this task is to improve change actions determined during the reviews on the measurement results of the product line transition operation.

The method should support with the following capabilities:

— integrating lessons learned;

— defining mechanisms for propagating feedbacks to distributed product line transition organization; and

— delivering feedbacks to the right planning and enabling functions of the transition.

A tool should support by allowing the user to do the following:

— determine lessons learned by accessing integrated lessons learned;

— deliver feedbacks to relevant transition sub functions; and

— store lessons learned for further reference.

6 Product line transition operationalization

6.1 General

The product line transition operationalization supports the following:

— *product line transition preparation;*

— *launching the product line transition*;

— *product line transition operation*; and

— *institutionalizing product line transition*.

6.2 Product line transition preparation

6.2.1 Principal constituents

6.2.1.1 Purpose

The purpose of this subprocess is to create contents and activities of transition scenarios used to successfully deploy the transition strategy and to initiate changes to all relevant aspects of the product line transition.

6.2.1.2 Inputs

The following inputs should be available to perform the product line transition initiation process:

— product line transition strategy including key procedures and cost/benefit/ROI analysis;

— product line transition plan; and

— product line adoption scenarios (from ISO/IEC 26561).

6.2.1.3 Outcomes

The following outcomes shall be available as a result of the successful implementation of the product line transition initiation process:

— Scenarios for transition launch are specified.

6.2.1.4 Tasks

The organization shall implement the following tasks with respect to the product line transition initiation process:

— *Create transition scenarios to deploy transition strategy*: Describe stories and activities to effectively deploy the product line transition strategy.

— *Analyse the effectiveness of the transition scenarios*: Review a number of different scenarios with respect to benefits, drawbacks, the costs, and the ROI.

— *Select an optimal transition scenario*: Integrate the analysis results of transition scenarios, and select/adjust one that will be used for product line transition.

— *Specify the scenario for transition launch*: Define detailed activities for launching product line engineering from business, architecture, process, and organization aspects.

— *Train human resources responsible for transition*: Provide necessary training for the staff and management of the product line transition.

6.2.2 Create transition scenarios to deploy transition strategy

The goal of this task is to define candidate transition scenarios for a successful product line transition.

Transition scenarios should consider the products, skills, environments, and product line engineering process selected for the organization.

The method should support creating transition scenarios to deploy the transition strategy with the following capabilities:

— defining the documentation standard for the transition scenario including who, what, in what procedures and orders, and how to do their roles and responsibilities for deploying transition strategy;

— providing an exemplar transition scenario; and

— specifying candidate transition scenarios in accordance with the documentation standard.

A tool should support creating transition scenarios to deploy the transition strategy by allowing the user to do the following:

— access exemplar transition scenarios; and

— allow electrically specifying candidate transition scenarios.

6.2.3 Analyse the effectiveness of the transition scenarios

The goal of this task is to analyse benefits, drawbacks, and trade-offs of transition scenarios for selecting a suitable product line transition scenario. Cost model can be used to determine the cost and the ROI at the abstract level rather detailed cost estimation.

The method should support analysing the effectiveness of the transition scenarios with the following capabilities:

— defining comparison aspects or topics or evaluation criteria to analyse the effectiveness of candidate transition scenarios;

— identifying and analysing possible risks of the transition scenarios; and

— providing formula (or cost model) for evaluating advantages/disadvantages (or costs/benefits) at the transition scenario level.

A tool should support analysing the effectiveness of the transition scenarios by allowing the user to do the following:

— (semi-)automatically calculate advantages/disadvantages (or costs/benefits) of transition scenarios at the transition scenario level in accordance with the defined formula (or cost model); and

— allow reference to the organizational risk management.

6.2.4 Select an optimal transition scenario

The goal of this task is to determine activities to get from the current to the product line engineering as a development basis.

The method should support selecting an optimal transition scenario with the following capability:

— evaluating decisions made for selecting an optimal transition scenario.

A tool should support selecting an optimal transition scenario by allowing the user to do the following:

— allow reference for the organizational decision process.

6.2.5 Specify the scenario for transition launch

The goal of this task is to produce detailed document for the scenario used for the transition launch.

The method should support specifying the scenario for the transition launch with the following capabilities:

— managing possible risks that are involved during the transition process in accordance with the risk mitigation strategy; and

— putting all together outcomes produced during creating, analysing, and selecting transition scenario.

A tool should support specifying the scenario for the transition launch by allowing the user to do the following:

— allow reference to the organizational risk management process; and

— electronically specify the scenario for the transition launch.

6.2.6 Train human resources responsible for transition

The goal of this task is to prepare qualified human resources by training required capabilities.

The method should support training human resources responsible for the transition with the following capabilities:

— analysing train needs for the successful product line transition;

— providing entry/exit criteria for starting and finishing training; and

— defining pre-/post- tests for evaluating training results.

A tool should support training human resources responsible for transition by allowing the user to do the following:

— trace training status; and

— produce training reports.

6.3 Launching the product line transition

6.3.1 Principal constituents

6.3.1.1 Purpose

The purpose of this subprocess is to conduct a pilot transition first in accordance with the defined transition plan before moving toward the organization-wide product line adoption. This subprocess is to give the organization a chance to check and improve transition process so as to reduce risks occurred during the product line transition.

6.3.1.2 Inputs

The following inputs should be available to perform the launching the product line transition process:

— human resources for the product line transition;

— product line transition plan; and

— scenarios for the transition launch.

6.3.1.3 Outcomes

The following outcomes shall be available as a result of the successful implementation of the launching of the product line transition process:

— *Findings from launching the pilot transition* is delivered.

— *(Revised) product line transition plan* is produced.

— *Improved product line transition process* is shared.

— *Qualified human resources for the product line transition* are prepared.

6.3.1.4 Tasks

The organization shall implement the following tasks with respect to launching the product line transition process:

— *Launch a pilot transition*: Start the actual transition as the selected related products of a product line so as to improve the transition process before the organization moves toward the new product line engineering approach.

— *Deliver findings from launching the pilot transition*: Review, consolidate, and document findings such as unexpected risks, costs, roles and responsibilities, and any changes or revisions required in transition plan, process, and organization.

— *Improve the transition process from the actual pilot(s)*: Improve the defined transition process before the organization moves to product line engineering.

— *Retrain human resources responsible for transition*: Do supplementary training for the staff and management of the product line transition in accordance with the findings and recommendations obtained from the pilot transition.

6.3.2 Launch a pilot transition

The goal of this task is to do an actual transition pilot (pilots).

The method should support launching a pilot transition with the following capabilities:

— examining needs for a pilot transition;

— selecting suitable pilot objects (e.g. a series of subsystems of a product line, member products of a product line); and

— transferring human resources for launching a pilot transition.

A tool should support launching a pilot transition by allowing the user to do the following:

— access the transition plan and transition process that should apply to the transition; and

— communicate with each other using the communication mechanism.

6.3.3 Deliver findings from launching the pilot transition

The goal of this task is to derive findings from a pilot transition and report findings and recommendations.

The method should support delivering findings from launching the pilot transition with the following capabilities:

— defining action plans for improving the transition process based the actual transition pilot(s) results;

— preparing a planned organization wide transition by expanding the pilot transition;

— consolidating findings from the pilot transition; and

— providing the documentation standard for findings report.

A tool should support delivering findings from launching the pilot transition by allowing the user to do the following:

— share action plans with relevant participants;

— accumulate meaningful outputs produced with a unique identification number;

— edit/fill out the findings report based on the documentation standard.

6.3.4 Improve the transition process from the actual pilot(s)

The goal of this task is to implement action plans delivered from the actual pilot(s).

The method should support improving the transition process from the actual pilot(s) with the following capability:

— monitoring and controlling the improvement status of the transition process.

A tool should support improving the transition process from the actual pilot(s) by allowing the user to do the following:

— record the improvement status of the transition process; and

— update the defined transition process.

6.3.5 Retrain human resources responsible for transition

The goal of this task is to provide qualified human resources by retraining required capabilities.

The method should support retraining human resources responsible for the transition with the following capabilities:

— analysing retraining needs for the successful product line transition;

— providing entry/exit criteria for starting and finishing the retraining; and

— defining pre-/post- tests for evaluating retraining results.

A tool should support retraining human resources responsible for the transition by allowing the user to do the following:

— trace retraining status; and

— produce retraining reports.

6.4 Product line transition operation

6.4.1 Principal constituents

6.4.1.1 Purpose

The purpose of this subprocess is to evaluate the progress and results of launching the product line transition and improve the existing transition scenario for improving the transition operation.

6.4.1.2 Inputs

The following inputs should be available to perform the product line transition operation process:

— (revised) product line transition plan (during the pilot transition);

— improved product line transition process (during the pilot transition);

— findings from launching the pilot transition; and

— qualified human resources for the product line transition.

6.4.1.3 Outcomes

The following outcomes shall be available as a result of the successful implementation of the product line transition operation process:

— *Data from the transition operation* are accumulated.

— *Findings, strengths and weaknesses of the product line transition operation* are documented.

— *Gaps between to-be and as-is* are assessed and resolved.

6.4.1.4 Tasks

The organization shall implement the following tasks with respect to the product line transition operation process:

— *Perform organization wide transition operation*: Do the transition from the old production system to the new product line engineering approach in accordance with the transition path defined in the transition plan and process.

— *Capture relevant data from the operation*: Collect transition operation data that will be used to evaluate findings, strengths and weaknesses.

— *Document the findings, strengths and weaknesses*: Analyse the captured relevant data from the transition operation and integrate them into findings, strengths and weaknesses of the transition operation.

— *Assess gaps between to-be and as-is*: Identify gaps between the current transition operation status of the organization and the target images of the organization.

— *Improve the transition process from the gap assessment results*: Bridge gaps assessed.

6.4.2 Perform organization wide transition operation

The goal of this task is to move to the new product line engineering process and approach.

The method should support performing an organization wide transition operation with the following capability:

— defining the detailed transition operation path so that participants follow the path.

A tool should support performing an organization wide transition operation by allowing the user to do the following:

— check transition operation path.

6.4.3 Capture relevant data from the operation

The goal of this task is to accumulate meaningful data used for assessing the current status of transition.

The method should support capturing relevant data from the operation with the following capability:

— defining data that should be captured from the transition operation.

A tool should support capturing relevant data from the operation by allowing the user to do the following:

— store captured data for analysing at the subsequent tasks.

6.4.4 Document the findings, strengths, and weaknesses

The goal of this task is to specify and report findings, strengths, and weaknesses for sharing the current transition status.

The method should support documenting the findings, strengths, and weaknesses with the following capabilities:

— defining the documentation standard for specifying the findings, strengths, and weaknesses; and

— providing exemplar documentation for the findings, strengths, and weaknesses.

A tool should support documenting the findings, strengths, and weaknesses by allowing the user to do the following:

— edit/fill out the documentation standard; and

— refer to exemplar documentation for the findings, strengths, and weaknesses.

6.4.5 Assess gaps between to-be and as-is

The goal of this task is to identify gaps to be bridged for achieving the transition goals.

The method should support assessing gaps between to-be and as-is with the following capability:

— providing assessment criteria for as-is transition operation.

A tool should support assessing gaps between to-be and as-is by allowing the user to do the following:

— refer to the transition goals, which are the to-be image of the organization after the completion of transition operation;

— access the current transition operation data; and

— access the documents for the findings, strengths and weaknesses.

6.4.6 Improve the transition process from the gap assessment results

The goal of this task is to resolve gaps between to-be and as-is so that the transition process fulfils the transition goals.

The method should support improving the transition process from the gap assessment results with the following capability:

— deriving improvement action items from the gap assessment results.

A tool should support improving the transition process from the gap assessment results by allowing the user to do the following:

— share improvement action items with the participants of the relevant transition process.

6.5 Institutionalizing the product line transition

6.5.1 Principal constituents

6.5.1.1 Purpose

The purpose of this subprocess is to institutionalize product line engineering by senior management and process managers so that the involved managers and staff consider product line engineering as part of their working culture.

6.5.1.2 Inputs

The following inputs should be available to perform the institutionalizing the product line transition process:

— data accumulated from the transition operation;

— document for findings, strengths, and weaknesses of the product line transition operation; and

— roles and responsibilities for the transition.

6.5.1.3 Outcomes

The following outcomes shall be available as a result of the successful implementation of the institutionalizing the product line transition process:

— *Long-term vision of the product line that provides solutions for future products* are established.

— *Responsibilities of roles for institutionalization* are assigned.

— *Gaps and improvement actions* are derived.

— *Values of defined measures for monitoring the status/effects of the actions* are calculated.

— *Continuous improvement action items for institutionalization* are documented.

6.5.1.4 Tasks

The organization shall implement the following tasks with respect to the institutionalizing the product line transition process:

— *Assign responsibilities of roles for institutionalization*: Assign responsibilities to senior management and process manager roles so that product line engineering is institutionalized.

— *Identify gaps to drive improvements for institutionalization*: Examine gaps to be bridged so that product line engineering is integrated in the process infrastructure and internalized.

— *Exercise necessary actions to fill the gaps*: Simulate actions conducted to bridge gaps before performing actions so that the organization reduces errors or loss due to wrong decision making about gaps and bridging actions.

— *Monitor the status/effects of the actions*: Trace the status of improvement and institutionalization progress.

— *Perform continuous improvement for institutionalization*: Improve the capabilities of business, architecture, process, and organization for embodying product line engineering organization wide.

6.5.2 Assign responsibilities of roles for institutionalization

The goal of this task is to identify suitable roles from the organization hierarchy and assign them institutionalization responsibilities.

The method should support assigning responsibilities of roles for institutionalization with the following capabilities:

— identifying roles (e.g. senior management who will be able to provide strong management support) that should be institutionalized for making other staff members convinced about product line engineering; and

— defining and mapping necessary responsibilities of roles for institutionalization.

A tool should support assigning responsibilities of roles for institutionalization by allowing the user to do the following:

— share assigned responsibilities with relevant roles.

6.5.3 Identify gaps to drive improvements for institutionalization

The goal of this task is to examine gaps that should be bridged for product line institutionalization.

The method should support identifying gaps to drive improvements for institutionalization with the following capabilities:

— defining gap assessment aspects (e.g. business, architecture, process, organization) and criteria (e.g. quality of architecture and process capability level) for institutionalization;

— providing standard framework for product line engineering; and

— deriving improvements for bridging gaps for institutionalization.

A tool should support identifying gaps to drive improvements for institutionalization by allowing the user to do the following:

— access product line transition results; and

— share the defined gaps and improvement actions with relevant participants.

6.5.4 Exercise necessary actions to fill the gaps

The goal of this task is to rehearse actions before implementing.

The method should support exercising necessary actions to fill the gaps with the following capabilities:

— defining detailed steps of actions to fill the gap; and

— deriving the revised improvement actions.

A tool should support exercising necessary actions to fill the gaps by allowing the user to do the following:

— record the exercise results of necessary actions; and

— share the revised improvement actions.

6.5.5 Monitor the status/effects of the actions

The goal of this task is to check the status and effects of the improvement actions.

The method should support monitoring the status/effects of the actions with the following capabilities:

— defining measures for monitoring the status/effects of the actions; and

— providing ways to tracing the status/effects of the actions.

A tool should support monitoring the status/effects of the actions by allowing the user to do the following:

— collect data for making decisions related to the status/effects of the actions; and

— visualize the status/effect of the actions.

6.5.6 Perform continuous improvement for institutionalization

The goal of this task is to improve the organization's capability of product line engineering continuously.

The method should support performing continuous improvement for institutionalization with the following capabilities:

— establishing long-time vision of the product line that provides solutions for future products; and

— deriving continuous improvement action items for institutionalization.

A tool should support performing continuous improvement for institutionalization by allowing the user to do the following:

— share long-time vision of the product line; and

— document continuous improvement action items for institutionalization.

7 Product line transition support

7.1 General

The product line transition support supports the following:

— *quality assurance for product line transition*;

— *measuring the success of product line transition*; and

— *risk management for product line transition*.

7.2 Quality assurance for product line transition

7.2.1 Principal constituents

7.2.1.1 Purpose

The purpose of this subprocess is to measure the product line transition process, work products, and products to assure that product line transition achieve the planned objectives and qualities by adhering to the defined transition process.

7.2.1.2 Inputs

The following inputs should be available to perform the quality assurance for the product line transition process:

— improved product line transition process;

— work products produced during the product line transition; and

— quantitative and qualitative quality assurance measures.

NOTE Work products produced during the product line transition include revised product line transition plan, document for findings, strengths and weaknesses of the product line transition operation, and continuous improvement action items for institutionalization.

7.2.1.3 Outcomes

The following outcomes shall be available as a result of the successful implementation of the quality assurance for product line transition process:

— *Quality risks* are identified and mitigated.

— *Evidences of the product line transition quality* are produced.

— *Non-conformance issues and their status of the product line transition* are produced and managed.

— *Status reports of corrective actions for the product line transition* are produced and managed.

— *Status reports of quality trends for the product line transition* are produced and managed.

7.2.1.4 Tasks

The organization shall implement the following tasks with respect to the quality assurance for the product line transition process:

— *Objectively evaluate transition process*: Assure that performed product line transition processes adhere to the organization's process descriptions, standards, and procedures.

— *Objectively evaluate transition work products*: Assure that the product line transition process associated work products satisfy the stated criteria.

— *Communicate and resolve noncompliance issues*: Objectively track, communicate, and resolve noncompliance issues found during evaluation.

— *Establish records of transition quality assurance activities*: Record product line transition quality assurance activities so that status and results are maintained and traced.

7.2.2 Objectively evaluate transition activities

The goal of this task is to assure whether the product line transition process performed adheres to the organizational process standard.

The method should support objectively evaluating transition activities with the following capabilities:

— selecting or sampling product line transition activities (e.g. selection criteria or sampling method);

— providing evaluation criteria for product line transition activities;

— identifying noncompliance issues;

— identifying quality risks possible in the product line transition; and

— identifying lessons learned that could improve product line transition activities.

A tool should support objectively evaluating transition activities by allowing the user to do the following:

— access evidences related to product line transition process performed;

— refer to quality assurance measures related to product line transition activities;

— assign values for quality assurance measures; and

— determine the quality level of product line transition activities.

7.2.3 Objectively evaluate transition work products

The goal of this task is to assure the quality of planned work products produced during the product line transition.

The method should support objectively evaluating transition work products with the following capabilities:

— selecting or sampling product line transition work products (e.g. selection criteria or sampling method);

— providing evaluation criteria for product line transition work products;

— identifying noncompliance issues; and

— identifying lessons learned that could improve product line transition work products.

A tool should support objectively evaluating transition work products by allowing the user to do the following:

— access evidences related to product line transition work products;

— refer to quality assurance measures related to product line transition work products;

— assign values for quality assurance measures; and

— determine the quality level of product line transition work products.

7.2.4 Communicate and resolve noncompliance issues

The goal of this task is to document the results of quality assurance activities for the product line transition.

The method should support communicating and resolving noncompliance issues with the following capabilities:

— supporting a template for noncompliance issues;

— establishing escalation lines for resolving noncompliance issues when they cannot be resolved with the appropriate product line transition staffs (the escalation line might include technical probe staffs, appropriate product line stakeholders);

— tracking noncompliance issues throughout the established escalation lines; and

— analysing noncompliance issues if there are any product line transition relevant quality trends.

A tool should support communicating and resolving noncompliance issues by allowing the user to do the following:

— document noncompliance issues in accordance with the documentation template;

— allow communication links among staffs and managers within the established escalation lines;

— share the status of noncompliance issues among staffs and managers within the established escalation lines; and

— analyse statistically quality trends of product line transition process and work products.

7.2.5 Establish records of transition quality assurance activities

The goal of this task is to document the results of quality assurance activities for the product line transition.

The method should support establishing records of transition quality assurance activities with the following capability:

— supporting a template for reporting the results of quality assurance activities for the product line transition (the template includes quality assurance activities, status of corrective actions and quality trends).

A tool should support establishing records of transition quality assurance activities by allowing the user to do the following:

— document a report for the results of quality assurance activities for the product line transition in accordance with the documentation template.

7.3 Measuring the success of product line transition

7.3.1 Principal constituents

7.3.1.1 Purpose

The purpose of this subprocess is to measure the progress and the benefit of the transition activities for determining whether they are satisfactory.

Important success measures can include the amount of change that assets must undergo for use in individual member products, defects, assets that are or are not being used, and time to market.

7.3.1.2 Inputs

The following inputs should be available to perform the measuring the success of product line transition process:

— (revised) product line transition plan; and

— data from the transition operation.

7.3.1.3 Outcomes

The following outcomes shall be available as a result of the successful implementation of the measuring the success of product line transition process:

— *Success levels of product line transition are documented* and shared.

— *Improvement action items* are executed for continuous improvement of product line transition process.

7.3.1.4 Tasks

The organization shall implement the following tasks with respect to the measuring the success of product line transition process:

— *Integrate measurement results of product line transition*: Collect and store data from the product line transition process and then characterize the product line transition results using the defined characterization functions.

— *Evaluate the success of product line transition*: Determine the achieved success level of product line transition efforts using the defined success measures against planned product line transition goals.

— *Record results and inform the relevant stakeholders*: Document the achieved success level of product line transition and analyse root causes of unachieved transition goals in order to share them with the relevant product line stakeholders.

— *Improve the product line transition process continuously*: Analyse root causes for finding parts of product line transition process where improvements are essential to achieve the defined product line transition goals.

7.3.2 Integrate measurement results of product line transition

The goal of this task is to characterize the success of product line transition.

Characterization functions are defined in accordance with the goals of product line transition. The goals of product line transition can be defined from different product line stakeholders' perspective such as managers, architects, engineers and quality assurance. For example, the goals of managers are reducing cost and increasing efficiency while architects' and engineers' goals are developing the products according to the requirements and with reasonable efforts.

The method should support integrating measurement results of product line transition with the following capabilities:

— translating product line transition goals to quantitative and measurable ones;

— defining characterization functions to integrate measurement results of product line transition;

— collating characterization functions with success measures;

— identifying measurement points that provide inputs for the defined characterization functions; and

— determining mechanisms to collect data and calculate values of the defined characterization functions.

A tool should support integrating measurement results of the product line transition by allowing the user to do the following:

— access the product line transition plan in order to refer to the defined product line transition goals;

— establish a data repository for accumulating data from the product line transition process;

— collect and accumulate data into the data repository from identified measurement points; and

— (semi-)automate the calculation of the defined characterization functions.

7.3.3 Evaluate the success of product line transition

The goal of this task is to find obstacles to the successful product line transition.

The method should support evaluating the success of the product line transition with the following capabilities:

— evaluating the values of characterization functions for determining the success levels of the product line transition;

— collate the values of characterization functions with the translated quantitative product line transition goals; and

— determining the success levels of the product line transition.

A tool should support evaluating the success of the product line transition by allowing the user to do the following:

— visualize the values of characterization functions and translated quantitative product line transition goals for easy comparison; and

— determine the success levels of the product line transition based on the visualization results.

7.3.4 Record results and inform to the relevant stakeholders

The goal of this task is to share the evaluation results with the relevant stakeholders in order to have a chance to improve the product line transition process.

The method should support recording results and informing the relevant stakeholders with the following capabilities:

— identifying obstacles to the success of the product line transition in the product line transition strategy;

— analysing parts of the product line transition process that tackles the transition goal achievement (e.g., an organization can use incremental transition, pilot transition, or tactical transition strategies); and

— providing the documentation standard for documenting the success levels of the product line transition and analysed obstacles.

A tool should support recording results and informing the relevant stakeholders by allowing the user to do the following:

— document the success levels of the product line transition and analysed obstacles; and

— share the document with the relevant stakeholders.

7.3.5 Improve the product line transition process continuously

The goal of this task is to improve the product line transition process so that an organization switches to a successful product line organization.

The method should support improving the product line transition process continuously with the following capabilities:

— defining improvement action items in accordance with the selected product line transition strategy; and

— modifying product line transition strategy.

A tool should support improving the product line transition process continuously by allowing the user to do the following:

— share improvement action items with relevant product line stakeholders; and

— hand the improved product line transition process over to the next iteration of the product line transition.

7.4 Risk management for product line transition

7.4.1 Principal constituents

7.4.1.1 Purpose

The purpose of this subprocess is to manage risks that are involved in the product line transition strategy and plan, together with risk mitigation strategies.

7.4.1.2 Inputs

The following inputs should be available to perform the risk management for product line transition process:

— probable risk sources (e.g., organizational culture, organization's process and architecture capability);

— lessons learned from the other risk management activities;

— outcomes of the product line transition;

— technical risk management subprocess in ISO/IEC 26555; and

— organizational risk management subprocess in ISO/IEC 26556.

7.4.1.3 Outcomes

The following outcomes shall be available as a result of the successful implementation of the risk management for product line transition process:

— *Risk assessment results of product line transition strategy* including risks, likelihood of risks, potential impacts on the successful product line transition, and ways to address the identified risks are documented.

— *Mitigation plans and risk monitoring plans* for the risks included in the selected strategy are developed and documented.

— *Risk mitigation results* are assessed and reported.

— *Lessons learned* are evaluated and documented.

7.4.1.4 Tasks

The organization shall implement the following tasks with respect to the risk management for product line transition process:

— *Identify risks related to the success of transition*: Identify risks related to the selected product line transition strategy.

— *Develop mitigation plans for the identified risks*: Prepare risk mitigation or contingency plans for the risks included in the selected product line transition strategy.

— *Monitor the execution of the mitigation plan*: Monitor and measure the risk status during and after the execution of the mitigation plans for the risks included in the product line transition strategy.

— *Learn from actual results of risk management for transition*: Summarize lessons learned from the actual versus expected results of risk management execution for the product line transition strategy.

7.4.2 Identify risks related to the success of transition

The goal of this task is to identify probable risks during product line transition and risks based on the selected product line transition strategy.

The method should support identifying risks related to the success of the transition with the following capabilities:

— identifying risks involved in product line transition strategies for selection; and

— analysing and prioritizing potential risks involved in the selected product line transition strategy when the risks occur then the organization may not achieve established product line transition goals (the severity and efforts of each candidate product line transition strategy can be analysed for supporting the right strategy selection).

A tool should support identifying risks related to the success of the transition by allowing the user to do the following:

— refer to established goals that the organization is trying to accomplish through the product line transition;

— access the necessary data and information in regard to product line transition strategies in order to analyse and make decisions about risks;

— make risks accessible and communicable to relevant product line transition participants; and

— integrate other managerial supports and tools of the product line engineering.

7.4.3 Develop mitigation plans for the identified risks

The goal of this task is to prepare risk mitigation or contingency plans for the risks in regard to the product line transition strategy.

The method should support developing mitigation plans for the identified risks with the following capabilities:

— determining the risk mitigation strategy and efforts for the risks related to the selected product line transition strategy;

— defining steps for the product-line-transition-specific risk management process in accordance with the product line transition strategy;

— developing risk mitigation plans for the risks related to the selected product line transition strategy;

— identifying triggering criteria of mitigation plans; and

— aligning collaboration among all product line transition participants.

A tool should support developing mitigation plans for the identified risks by allowing the user to do the following:

— estimate risk mitigation efforts; and

— document and maintain risk mitigation plans for the selected product line transition strategy.

7.4.4 Monitor the execution of the mitigation plan

The goal of this task is to monitor and measure the risk status during and after the implementation of the mitigation plans for the scored and prioritized risks of the product line transition.

The method should support monitoring the execution of the mitigation plan with the following capabilities:

— initiating the mitigation plans for the risks in regard to the product line transition strategy;

— monitoring the triggering conditions of mitigation plans in accordance with the implementation of the selected product line transition strategy;

— tracking the readiness of risk mitigation action items;

— tracking the risk status to check the effectiveness of mitigation actions; and

— collecting measurement data on the risk handling activities.

A tool should support monitoring the execution of the mitigation plan by allowing the user to do the following:

— represent the mitigation/management status of the product line transition;

— trace risk mitigation action items;

— collect measurement values from the implementation of the product line transition strategy;

— visualize risk status (e.g. threshold graph); and

— collaborate with participants or stakeholders for parallel management of risks.

7.4.5 Learn from actual results of risk management for product line transition

The goal of this task is to summarize lessons learned from the actual versus expected results of risk management for the risks in regard to the product line transition.

The method should support learning from actual results of risk management for product line transition with the following capabilities:

— analysing actions taken to reduce or control the product line transition risks;

— reviewing consequences of the execution of the mitigation plan;

— evaluating the success or failure in actions taken to reduce or control risks; and

— preserving the lessons learned from the execution of the product line transition strategy.

A tool should support learning from the actual results of risk management for the product line transition by allowing the user to do the following:

— access consequences of the actual results of the execution of the mitigation plans for the risks in regard to the product line transition; and

— access lessons learned for the next risk analysis and execution of the mitigation plans for the same transition strategy.

Annex A
(informative)

Exemplar product line transition strategies

The transition strategy is an important part of product line transition process. The following four strategies are major transition strategies[18]:

The incremental introduction strategy starts a single group product line with a small investment and, if it is determined that the product line is successful, expands ranges to other groups with a careful incremental investment. In this strategy, an organization can change or stop the product line transition in the early stages of small investment, but it takes a long time to establish the complete platform and transfer to full product line engineering. Continuous changes for the platform can be required because variability can be added or changed in accordance with new groups are added.

The tactical transition strategy starts a product line with problems related to conventional engineering such as change management and configuration management for multiple similar and related products. This strategy changes only specific sub-processes and methods of conventional engineering using product line engineering for resolving problems. For example, an organization develops a product line architecture that specifies common and variable parts for easy configuration management of similar products. However, if an organization misunderstands the cause of the problem, this strategy may lead to unnecessary efforts of an organization.

The pilot transition strategy starts a product line with a potentially successful product or parts of a product or a new product. In accordance with the results, the related products are incorporated into the product line. This strategy let the organization check efforts and changes on process and technology through a prototype or toy product with a small investment of time and money. However, it takes a long time to introduce the full product line.

The big-bang transition strategy starts a product line across the organization. This strategy follows two product line engineering life cycles, i.e., domain and application engineering. The organization prepares a complete platform during domain engineering, and thereafter each member product is derived during application engineering. This strategy can be used when the organization is confident about the success of product line engineering in the market. This strategy requires a large amount of investment.

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