
Software and systems engineering — Methods and tools for product line technical probe

*Ingénierie du logiciel et des systèmes — Méthodes et outils destinés à
la vérification technique des gammes de produits*





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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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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 technical probe diagnoses an organization's ability necessary to successfully adopt product line engineering and management. Product line engineering and management require abilities to deal with markets, competitors, costs, benefits, two different and closely related domain and application engineering processes, and the distribution of different domain and application engineering over organizations. Before transitioning to product line engineering, an organization should assess its ability from these aspects and decide whether or not to switch to product line engineering. Based on the results of product line technical probe, an organization can establish plans to continuously improve its abilities.

This document can be used in the following modes:

- by organizations that want to adopt SSPL for producing their products – to provide guidance on how to probe the organization's capabilities necessary to adopt or improve product line engineering;
- by a product line organization – to provide guidance on the evaluation and selection for methods and tools for product line technical probe; and
- by providers of methods and/or 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 technical probe.

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 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 26562 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 transition management are provided in ISO/IEC 26562 (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 technical probe

1 Scope

This document, within the context of methods and tools for supporting the diagnosis of the organization's capability to adopt or improve software and systems product line engineering:

- defines processes for product line technical probe; those processes are described in terms of purpose, inputs, tasks and outcomes;
- defines method capabilities to support the defined tasks of each process; and
- 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* (3.9) engineering process groups and tasks to which one can associate specialized methods and tools

3.2

main probe

phase to perform repetitive cycle for gathering and analysing data for finding strengths and challenges of an organization

3.3

post-probe

optional phase to prepare action plans for addressing challenges

3.4

pre-probe

phase to understand an organization's basic context such as current structure, terminology, product maturity level, implementation and documentation

3.5

product line adoption plan

plan that describes the changes in process, organization structure, and product building methods to get from the current to *product line* (3.9) engineering

3.6

product line adoption scenario

scenario that gives concrete sequence of actions related to *product line* (3.9) adoption

3.7

product line technical probe

technical probe

probe

diagnostic process for investigating the organization's readiness to adopt, or ability to succeed with, *product line* (3.9) engineering and management

3.8

product line transition

transition

switching to *product line* (3.9) engineering through the right procedures, so as to achieve business objectives that lead an organization to product line engineering

3.9

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 Abbreviated terms

CONOPS concept of operations

MCDM multiple condition decision method

5 Reference model for product line technical probe

5.1 Overview

A product line technical probe diagnoses an organization's readiness to adopt product line engineering. The technical probe includes whether an organization has abilities to succeed with product line engineering. When an organization considers the adoption of product line engineering, a product line technical probe informs an organization whether the organization has essential capabilities necessary to adopt product line engineering and at which maturity level the organization is based on the essential organizational, technical and software engineering framework. A product line technical probe provides overall pictures about an organization's current capability level compared with essential capabilities necessary to successfully provide products that conform to market and customer needs.

In accordance with the results of a product line technical probe, an organization can make a go/no-go decision about product line adoption; or in the case that an organization determines product line adoption, it establishes and implements action plans for resolving weaknesses found, so an organization can shift to product line engineering after it has the essential capabilities. During product line engineering and management, a product line technical probe supports continuous improvements of an organization's product line capability.

Software and systems product line requires mature capability level in both system and software engineering. In adopting a product line engineering approach, an organization extends the portfolio management process of ISO/IEC/IEEE 15288 and applies specializations of its product development, technical management, and infrastructure processes. Thus, a product line technical probe should diagnose an organization's ability from architecture and organizational management viewpoints as well as process capability. For successful product line adoption, an organization should continuously diagnose and improve its process, architecture, business, and organizational management capabilities.

5.2 Reference model for product line technical probe

The reference model specifies the structure of supporting processes and subprocesses for a product line technical probe. As shown in [Figure 1](#), a product line technical probe can be structured into three processes: technical probe management, technical probe operationalization and technical probe 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; and
- the outcomes of the subprocess.

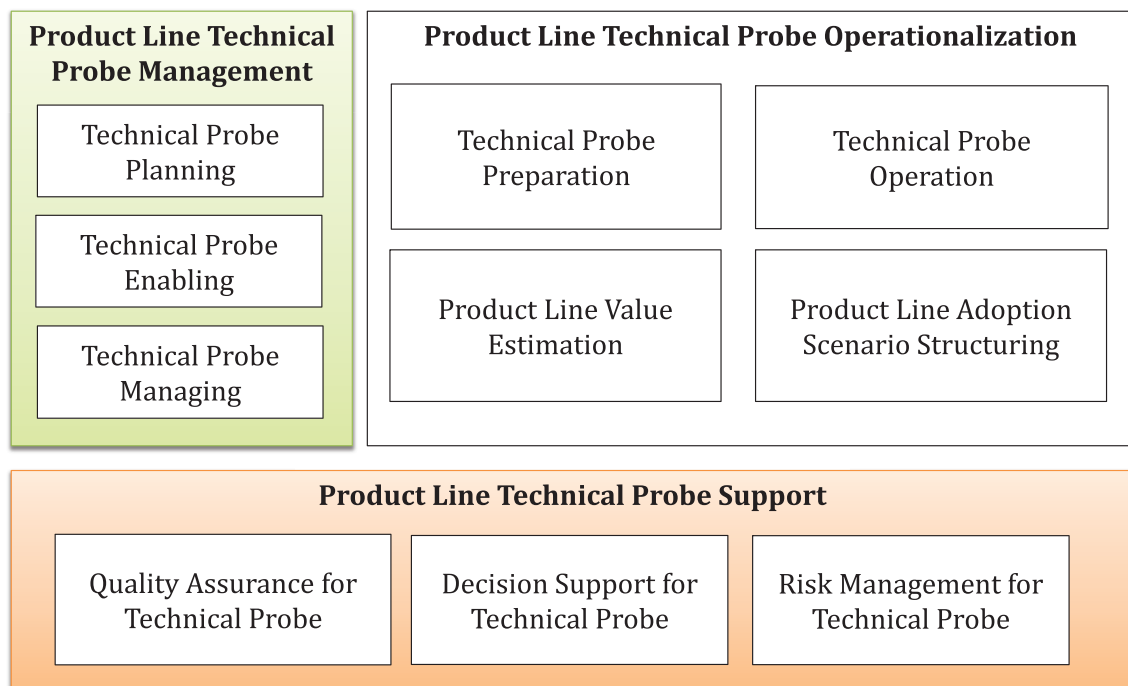


Figure 1 — Reference model for the product line technical probe

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

- *technical probe planning* establishes plans for initiating, operationalizing and supporting product line technical probe;
- *technical probe enabling* defines, maintains and assures the availability of environments, guidance, and measurement necessary to performing product line technical probe; and

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

The product line technical probe operationalization process performs operations for analysing an organization's readiness for adopting product line engineering and finding improvements required for successful and suitable product line adoption. This process deals from the organization's readiness for technical probe to producing product line adoption scenarios. The product line technical probe operationalization shall do the following:

- *technical probe preparation* initiates the product line technical probe by mobilizing participants and resources; this subprocess performs preliminary technical probe for coordinating participants and resources;
- *technical probe operation* performs the product line technical probe in accordance with the technical probe plans;
- *product line value estimating* determines returns on investments in order to decide whether an organization initiates product line transition or quits product line adoption; and
- *product line adoption scenario structuring* establishes the product line adoption strategy based on the findings delivered in technical probe operation.

The product line technical probe support process provides supports required for producing correct technical probe findings and product line adoption scenarios so as to achieve the organization's values through product line engineering. To achieve these, the product line technical probe support shall do the following:

- *quality assurance for technical probe* objectively evaluates the activities and artefacts of the implemented product line technical probe;
- *decision support for technical probe* supports decision making for producing findings and recommendations of the product line technical probe and structuring product line adoption plan and scenarios; and
- *risk management for technical probe* identifies and mitigates risks related to product line technical probe.

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 technical probe 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 is the description for each aspect concerning product line technical probe. The product line technical probe processes and tasks shall be identified on the basis of these aspects. The concerns

for the product line technical probe will enable the organization to understand technical probe processes, subprocesses, tasks, methods and tools' capabilities.

- Application engineering: A technical probe diagnoses the organization's capability from the essential application engineering practices,
- Binding: A product line organization should be able to deal with a complete range of variability binding times, so a product line technical probe diagnoses this ability.
- Collaboration: Participants of a technical probe should closely collaborate with the probe team because a technical probe uses a series of interviews and reviews for data analysis as in software capability assessment.
- Configuration: Because member products are configured during the application engineering based on domain assets, a product line organization should have the capabilities required for configuring member products.
- Domain asset: A product line technical probe investigates an organization's ability for developing and maintaining all domain assets that will be commonly used by member products of a product line.
- Domain engineering: A product line technical probe diagnoses an organization's capability from the essential domain engineering practices.
- Enabling technology support: Technical probe-enabling supports provide resources and infrastructure necessary to initiate, support and control technical probe tasks.
- Measurement and tracking: Measurement and tracking have two aspects in a technical probe. One is the organization's capability to measure and control its product line processes, and another is its capability to measure and trace the status of action plans defined to adopt or improve product line engineering.
- Platform: A product line technical probe diagnoses the organization's capability to design and realize platforms that will be used by member products of a product line.
- Product management: The results of a product line technical probe are used when the product management process takes the direction of a product line evolution.
- Reference architecture: Product line engineering relies on a reference architecture, and the reference architecture is a key success factor of a product line. Thus, a product line technical probe investigates an organization's architecture capability.
- Reusability: Reusability that will be expected through the product line is initially estimated.
- Texture: For developing a family of products by using common assets, it is important to define rules and constraints for implementing architecture and evolving it over time. A product line technical probe investigates an organization's ability to select and define texture.
- Traceability: Product line technical probe assures a product line organization's ability to relate the assets of the different development roles, such as domain engineering, application engineering, and each of their different development stages.
- Cross functional validation and verification: Artefacts, processes, and tasks related to product line technical probe should be validated and verified when the needs arise.
- Variability: Variations among member products of initial product line portfolio defined for conducting product line pilot are analysed to use as an input for go/no-go decision.

6 Product line technical probe management

6.1 General

The product line technical probe management supports the following:

- *technical probe planning*;
- *technical probe enabling*; and
- *technical probe managing*.

6.2 Technical probe planning

6.2.1 Principal constituents

6.2.1.1 Purpose

The purpose of this subprocess is to create plans for product line technical probe applied to diagnose an organization's strengths and challenges in each of the selected product line frameworks.

6.2.1.2 Inputs

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

- initial information that provides an overview of the organizational context;
- objectives of the product line;
- description of the organizational structure;
- organization's process maturity level; and
- outcomes of decision support for technical probe process.

6.2.1.3 Outcomes

The following outcome shall be available as a result of the successful implementation of the technical probe planning process:

- *Product line technical probe plan* (including goals, key procedures, schedules, required resources, monitoring and control plan) is established and documented.

6.2.1.4 Tasks

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

- *Establish technical probe goals*: Define the technical probe goals and strategies that should be achieved through the product line technical probe and applied to achieve the goals.
- *Define key procedures for technical probe*: Determine or tailor procedures used for examining an organization's readiness to adopt a product line approach or to assess the current capability of product line practices.
- *Formulate schedules and required resources for technical probe*: Schedule the product line technical probe including time, activities, and key participants with required resources.

- *Specify how to monitor, measure, and control the effectiveness of technical probe:* Determine key actions and measures for quantifying and qualifying the effectiveness of the product line technical probe activities and its results.
- *Document the product line technical probe plan:* Set plans for performing the product line technical probe or improve the product line technical plan in accordance with the preliminary technical probe results.

6.2.2 Establish technical probe goals

The goal of this task is to define the product line technical probe goals and strategies for diagnosing an organization's readiness for the successful adoption or improvement of a product line approach.

The method should support establishing technical probe goals with the following capabilities:

- examining product line technical probe context and requirements;
- formulating product line technical probe goals; and
- reviewing established technical probe goals.

A tool should support establishing technical probe goals by allowing the user to do the following:

- access product line technical probe goals; and
- communicate product line technical probe goals with key stakeholders.

6.2.3 Define key procedures for technical probe

The goal of this task is to define and/or tailor key procedures for the preliminary, the technical probe, and the follow-on phases.

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

- tailoring procedures for the technical probe based on the overall product line process;
- embedding defined technical probe goals into defined key procedures so that measuring of goal achievement is possible; and
- specifying defined key phases and tasks of the technical probe.

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

- access the overall product line technical probe 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 the product line technical probe in accordance with the documentation standard.

6.2.4 Formulate schedules and required resources for technical probe

The goal of this task is to define the day-by-day technical probe schedule and resources required for activities such as people, devices and space. The typical probe schedule includes activities over time and participants.

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

- understanding difficulties in the technical probe and capabilities of people, materials, and mechanisms that can be mobilized;
- estimating efforts and resources required; and
- defining the documentation standard for technical probe scheduling.

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

- access information to formulate schedules for the technical probe;
- access information to assign the organization's available resources for the technical probe; and
- specify a schedule for the product line technical probe according to the defined documentation standard (graphically describe the schedules).

6.2.5 Specify how to monitor, measure, and control the effectiveness of technical probe

The goal of this task is to define ways to collect data that indicate the state of the probe, track, measure, and analyse relevant attributes of the technical probe process, so as to perform the corrective actions to obstacles.

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

- defining observation points to monitor the effectiveness of the technical probe;
- defining pre-conditions for monitoring the effectiveness of the technical probe;
- defining measures and integration functions for evaluating the effectiveness of the technical probe; and
- defining rules adhered when the product line technical probe is controlled.

A tool should support specifying how to monitor, measure, and control the effectiveness of the technical probe 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; and
- specify monitor, measure, and control plan using the documentation standard.

6.2.6 Document the product line technical probe plan

The goal of this task is to put the specified items of product line technical probe plan together and obtain approvals for implementing the product line technical probe plan.

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

- providing the documentation standard for the product line technical probe plan (the contents of plan include stakeholder, strategy of technical probe, technical probe tasks and estimates, staffing including required training); and
- providing examples for each technical probe documentation item.

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

- edit/fill out technical probe plan using editable and changeable template;
- maintain the version control of the technical probe plan documents; and
- share the product line technical probe plan with the stakeholders.

6.3 Technical probe enabling

6.3.1 Principal constituents

6.3.1.1 Purpose

The purpose of this subprocess is to acquire the required resources and establish environments for probing an organization's technical strengths and weaknesses in each of the selected product line engineering frameworks.

6.3.1.2 Inputs

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

- product line technical probe plan;
- document for organizational enabling processes; and
- resources and capabilities of organizational enabling.

6.3.1.3 Outcomes

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

- *Governance policy document for technical probe* is clarified.
- *Roles and responsibilities for technical probe* are structured.
- *Technical probe enablers including resources* are mobilized.
- *Action plan for technical probe process improvement* is documented.
- *Technical probe processes* are continuously improved.

6.3.1.4 Tasks

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

- *Establish governance policy for technical probe*: Define product line technical probe policy including objectives, process, organization, evaluation, standards, and process improvement approaches for the product line technical probe.
- *Mobilize qualified human resources for technical probe*: Organize the probe team and representatives from the organization's product line stakeholder groups.
- *Identify infrastructure and resource needs for technical probe operationalization and support*: Identify and develop the appropriate supporting tools, set of standards to be followed during the technical probe operationalization and support, logistics, skills, and staffs for technical probe operationalization and support.

- *Enable quality assurance measurement for technical probe*: Activate quality assurance in the product line technical probe for ensuring the quality of its work products, procedures, rules and constraints.
- *Improve technical probe process continuously*: Examine gaps between the aimed and achieved goals of the technical probe processes, so as to improve the processes continuously.

6.3.2 Establish governance policy for technical probe

The goal of this task is to ensure that the technical probe team members can perform their function.

The method should support establishing the governance policy for the technical probe with the following capabilities:

- defining the documentation standard (e.g. documentation standard consists of objective, process, organization of technical probe governance, evaluation of technical probe governance's quality) for the governance policy for the technical probe; and
- specifying major contents of the governance policy for the technical probe (e.g., pre-probe, main probe, post-probe, etc.).

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

- edit/fill out the contents of the documentation standard of the governance policy for the technical probe;
- share the governance policy with downstream users of the organization defined in the governance policy; and
- use feedback channels for improving the governance policy.

6.3.3 Mobilize qualified human resources for technical probe

The goal of this task is to ensure that individuals for the probe team composition have the required expertise and representatives selected for the probe interviews can provide accurate answers.

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

- selecting qualified human resources for the technical probe from inside and/or outside of the organization;
- 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 the technical probe 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.

6.3.4 Identify infrastructure and resource needs for technical probe operationalization and support

The goal of this task is to provide appropriate infrastructure and resources for the successful technical probe.

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

- understanding the technical plan and other requirements defined for technical probe operationalization and support;
- define a template for identifying infrastructure and resource needs for technical probe operationalization and support (e.g., pre-probe, main probe, post-probe, re-probe, etc.);
- estimating infrastructure and resource needs for technical probe operationalization and support; and
- aligning gaps between available and required.

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

- access information of the organization's available infrastructure and resources; and
- edit/fill out the infrastructure and resource needs template.

6.3.5 Enable quality assurance measurement for technical probe

The goal of this task is to assure that an organization can measure the quality of the technical probe planning, enabling, operationalizing, and managing.

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

- refining actionable tasks for enabling quality assurance measurement for technical probe tasks;
- establishing mechanisms for enabling quality assurance measurement; and
- defining ways for resolving conflicts between quality assurance roles and other roles of the technical probe.

A tool should support 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 the technical probe; and
- use communication channels for sharing quality assurance measurement issues and resolving conflicts.

6.3.6 Improve technical probe process continuously

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

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

- collecting data for evaluating the effectiveness of the technical probe process;
- analysing deviations from required performance of the technical probe process;
- establishing action plans for improving the technical probe process based on analysed deviations; and
- controlling and tracing the status of improvement activities to closure.

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

- accumulate raw data related to the improvement of the technical probe process;
- visualize the deviation between the actual and expected technical probe process performance;
- share action plans with relevant participants and communicate about it; and
- check the status of improvement activities.

6.4 Technical probe managing

6.4.1 Principal constituents

6.4.1.1 Purpose

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

6.4.1.2 Inputs

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

- product line technical probe plan;
- governance policy document for technical probe; and
- action plan for technical probe process improvement.

6.4.1.3 Outcomes

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

- *Status data from SSPL technical probe sub functions* are collected.
- *Feedbacks given to planning and enabling functions* are documented.

6.4.1.4 Tasks

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

- *Tailor and allocate governance policy, R & R (role and responsibility), and resources to relevant sub functions of technical probe:* Organize or integrate the governance policy, R & R, and resources with relevant sub functions of the product line technical probe for a harmonious operation.
- *Collect data from SSPL technical probe sub functions:* Establish and activate mechanisms to gather evidences from technical probe sub functions for monitoring and measuring the status of the product line technical probe.
- *Monitor, measure, and control technical probe operation and support:* Define and activate procedures and measures for monitoring, measuring and controlling the deviations from acceptance criteria.
- *Manage actual operation and support of technical probe:* Resolve deviations from the planned product line technical probe operation and support.
- *Provide feedback to planning and enabling functions of technical probe:* Document and give constructive feedbacks to planning and enabling functions of the product line technical probe.

6.4.2 Tailor and allocate governance policy, R & R, and resources to relevant sub functions of technical probe

The goal of this task is to assign roles, responsibilities, required resources suitable to relevant functions of the technical probe 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 the technical probe with the following capabilities:

- identifying detailed context of technical probe operation and support;
- understanding the overall technical probe 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 the technical probe by allowing the user to do the following:

- access the defined governance policy, R & R, and resources for technical probe;
- generate matrix for allocation; and
- share the tailored and allocated governance policy, R & R, and resources with relevant stakeholders.

6.4.3 Collect data from SSPL technical probe sub functions

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

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

- determining variables or data collection points from technical probe sub functions;
- providing mechanisms for interaction and data collection with and from technical probe sub functions; and
- categorizing and/or organizing the collected data for analysis.

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

- store collected data to permanent or temporary storage for analysis; and
- visualize categorized and/or organized data for analysis.

6.4.4 Monitor, measure, and control technical probe operation and support

The goal of this task is to monitor the current status of technical probe operation and support so as to take corrective actions.

The method should support monitoring, measuring, and controlling technical probe operation and support with the following capabilities:

- refining/determining measures, metrics, and measurement points on the procedures of technical probe operational and support;
- defining integration/characterization functions for integrating monitored and measured results for evaluating the effectiveness of technical probe operation and support;

- identifying thresholds and decision alternatives in controlling technical probe operation and support; and
- building up knowledge related to controlling technical probe operation and support.

A tool should support monitoring, measuring, and controlling technical probe operation and support by allowing the user to do the following:

- integrate monitored and measured results using supporting mechanisms;
- (semi-)automate 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 technical probe operation and support.

6.4.5 Manage actual operation and support of technical probe

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

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

- determining performance of the technical probe by comparing the plan versus actual operation and support results;
- analysing root causes of the gaps; and
- deriving improvement needs and action item for operation and support of the technical probe.

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

- analyse gaps using the displayed plan versus actual operation and support results of the technical probe;
- access execution traces and results for analysing root causes of the gaps; and
- share improvement action items using communication channels and implemented mechanisms.

6.4.6 Provide feedback to planning and enabling functions of technical probe

The goal of this task is to give constructive feedbacks to planning and enabling sub functions of the product line technical probe, so that corresponding participants develop improved plans and effective enabling capabilities.

The method should support providing feedback to planning and enabling functions of the technical probe with the following capabilities:

- integrating lessons learned;
- defining mechanisms for propagating feedbacks to distributed product line technical probe organization; and
- delivering feedbacks to the right planning and enabling functions of the technical probe.

A tool should support providing feedback to planning and enabling functions of technical probe by allowing the user to do the following:

- determine lessons learned by accessing integrated lessons learned;

- deliver feedbacks to relevant technical probe sub functions; and
- store lessons learned for further reference.

7 Product line technical probe operationalization

7.1 General

The product line technical probe operationalization supports the following:

- *technical probe preparation*;
- *technical probe operation*;
- *product line value estimation*; and
- *product line adoption scenarios structuring*.

7.2 Technical probe preparation

7.2.1 Principal constituents

7.2.1.1 Purpose

The purpose of this subprocess is to prepare detailed contents and concrete activities for implementing product line technical probe operation. Scenarios for implementing the product line technical probe may be defined.

Refer [Annex B](#) for the exemplar adoption scenario and [Annex C](#) for the exemplar frameworks of maturity and questionnaires.

The results of this subprocess are used for giving shape to the product line technical probe plan.

7.2.1.2 Inputs

The following inputs should be available to perform the technical probe preparation process:

- description of the organizational structure;
- list of available evidences such as documentations and activities relate to stating a product line;
- product line technical probe plan; and
- outcomes of decision support for the technical probe process.

7.2.1.3 Outcomes

The following outcomes shall be available as a result of the successful implementation of the technical probe preparation process:

- *Context of technical probe* is documented.
- *Technical probe phases with their tasks* are specified.
- *SSPL stakeholders* are identified.
- *Data storage for data to be probed* is established.
- *Preliminary phase findings* are documented.

7.2.1.4 Tasks

The organization shall implement the following tasks with respect to the technical probe preparation process:

- *Review and refine the context of technical probe:* Gather initial information of an organization and refine the sketch of the organizational context used to plan the probe before the technical probe is conducted.
- *Specify the phases of technical probe:* Determine the technical probe processes to be performed.
- *Identify the organization's SSPL stakeholders:* Find individuals participating in the product line efforts and also having interests in the success of the product line, and select representatives who will participate in the technical probe.
- *Analyse the organization's level of process maturity:* Determine the organization's level of software process discipline.
- *Distribute and gather preliminary phase questionnaire:* Ask representatives of the product line to submit evidences to diagnose before starting official technical probe processes.
- *Analyse and document preliminary phase findings:* Find the first round of data of the organization and document the results.

7.2.2 Review and refine the context of technical probe

The goal of this task is to provide an overview of the organizational context to be probed.

The method should support reviewing and refining the context of the technical probe with the following capabilities:

- decomposing the organization's contexts into several aspects (e.g. probe, process maturity, legacy, management and structural, implementation, and documentation context);
- developing preliminary questions for each decomposed organization's context (context-setting questionnaires) by providing a set of exemplar questions; and
- mapping and aligning organization specific terminologies (terminology particular to the organization) for reducing confusion and understanding.

A tool should support reviewing and refining the context of technical probe by allowing the user to do the following:

- access and collect data (e.g. goals, relevant documentation, organization structure) necessary for reviewing the organization's context;
- allow online contact with stakeholders for reviewing the organization's context;
- edit and document preliminary questions; and
- establish data storage for collected data for online access at the technical probe operation.

7.2.3 Specify the phases of technical probe

The goal of this task is to determine the probe process suitable to the refined product line culture of the organization. A framework for software product line practice developed in Software Engineering Institute of Carnegie Mellon University defines three phases, the preliminary phase, the technical probe phase, and the follow-on phase.

The method should support specifying the phases of technical probe with the following capabilities:

- determining technical probe phases suitable for the organization's context;

- providing an exemplar technical probe schedule used for defining an organization-specific technical probe schedule; and
- defining entry and exit criteria for each phase or for each major step.

A tool should support specifying the phases of the technical probe by allowing the user to do the following:

- allow online technical probe scheduling and management with outcomes of each milestone.

7.2.4 Identify the organization's SSPL stakeholders

The goal of this task is to determine representatives from the product line stakeholder groups to participate in the technical probe.

CMU/SEI's software product line framework^[20] describes the following as the possible stakeholder groups. But the stakeholder groups can vary with the organization:

- senior managers/executives;
- middle managers;
- product managers;
- technical team leaders;
- architects, senior designers;
- system analysts, requirements analysts; and
- internal/external customers.

The method should support identifying the organization's SSPL stakeholders with the following capabilities:

- identify the stakeholder groups of the organization who are involved or have interests in the product line approach; and
- select representatives from the stakeholder groups who can answer questions of each decomposed organization's context.

A tool should support identifying the organization's SSPL stakeholders by allowing the user to do the following:

- establish an online contact environment with stakeholders.

7.2.5 Analyse the organization's level of process maturity

The goal of this task is to know the organization's process maturity level as information for framing the organization.

The method should support analysing the organization's level of process maturity with the following capabilities:

- providing process framework used for analysing the organization's level of process maturity;
- providing evaluation methods for analysing the organization's level of process maturity (existing well-known process model and evaluation method can be used); and
- revising preliminary phase questionnaires in accordance with the organization's level of process maturity.

A tool should support analysing the organization's level of process maturity by allowing the user to do the following:

- access the current product (or product line) building processes; and
- establish data storage for process evidences.

7.2.6 Distribute and gather preliminary phase questionnaire

The goal of this task is to check up the organization's overall experience of the product line effort before proceeding to the technical probe phase. The results of the preliminary phase questionnaires are used to improve the questionnaires used for the technical probe phase and refine the details of the technical probe phase.

The method should support distributing and gathering preliminary phase questionnaire with the following capability:

- determining stakeholders who will answer the questionnaire.

A tool should support distributing and gathering preliminary phase questionnaire by allowing the user to do the following:

- allow online questionnaire distribution and gathering; and
- (semi-)automate the compilation for the answers (the answers possible to compile statistics automatically).

7.2.7 Analyse and document preliminary phase findings

The goal of this task is to produce a document for the preliminary phase findings. The document of the preliminary phase findings is used as a basis for documenting the final findings and recommendations.

CMU/SEI's software product line framework^[20] provides the following first round of data:

- goals for the product line effort;
- status of the product line effort;
- organization's hopes to learn from the probe;
- current organizations structure;
- terminology particular to the organization;
- organization's level of process maturity;
- a list of available, relevant documentation; and
- organization's product line stakeholder groups.

The method should support analysing and documenting preliminary phase findings with the following capabilities:

- deriving product building culture of the organization (if product line effort has begun, analysing the product line culture); and
- providing the documentation standard (including an exemplar document) for documenting preliminary findings.

A tool should support analysing and documenting preliminary phase findings by allowing the user to do the following:

- access data listed to be analysed at the preliminary phase; and

- edit document for preliminary phase findings.

7.3 Technical probe operation

7.3.1 Principal constituents

7.3.1.1 Purpose

The purpose of this subprocess is to perform the product line technical probe to identify problem areas of an organization before adopting or transiting a product line.

7.3.1.2 Inputs

The following inputs should be available to perform the technical probe operation process:

- data storage for data to be probed;
- preliminary phase findings;
- SSPL stakeholders; and
- outcomes of decision support for the technical probe process.

7.3.1.3 Outcomes

The following outcome shall be available as a result of the successful implementation of the technical probe operation process:

- *Technical probe report* is documented and reported.

7.3.1.4 Tasks

The organization shall implement the following tasks with respect to the technical probe operation process:

- *Perform technical probe interview with organization's SSPL stakeholders*: Conduct the probe interviews with the selected representatives.
- *Capture relevant data from the interview*: Gather interview data and evidences used to assess process capability and possible technical risks by practice areas of the product line evaluation framework.
- *Document the findings, strengths and weaknesses*: Consolidate and document a set of findings, strengths and weaknesses of the current practices that characterize the organization's ability relative to product line adoption or success.
- *Assess gaps between to-be and as-is*: Identify gaps to resolve for the successful product line adoption or improvement. To-be of an organization can be the practices of the evaluation framework.
- *Provide recommendations*: Devise recommendations with an action plan that contains plans to overcome weaknesses and exploit strengths that are critical to product line success.

7.3.2 Perform technical probe interview with organization's SSPL stakeholders

The goal of this task is to do interview sessions with the organization's selected product line representatives so that the probe team gathers data.

The method should support performing the technical probe interview with the organization's SSPL stakeholders with the following capabilities:

- preparing the interview questions based on the practice areas of the evaluation framework; and

- providing exemplar interview questionnaires.

A tool should support performing technical probe interview with organization's SSPL stakeholders by allowing the user to do the following:

- allow online contact with stakeholders.

7.3.3 Capture relevant data from the interview

The goal of this task is to extract meaningful data from the interview sessions performed.

The method should support capturing relevant data from the interview with the following capabilities:

- classifying responses gathered from interviewees as strengths or weaknesses (e.g. attaching labels); and
- identifying areas requiring further information or clarification.

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

- store captured data for analysing at the subsequent tasks.

7.3.4 Document the findings, strengths and weaknesses

The goal of this task is to document the technical probe results to report to the product line organization.

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.

7.3.5 Assess gaps between to-be and as-is

The goal of this task is to find gaps to be resolved so that the organization succeeds the product line adoption.

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

- providing assessment criteria for as-is product (or product line) building operation.

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

- refer to the product line goals, which are the to-be image of the organization's product line effort;
- access technical probe results; and
- access the documents for the findings, strengths and weaknesses.

7.3.6 Provide recommendations

The goal of this task is to address the probe findings with one or more action plans.

The method should support providing recommendations with the following capability:

- prioritizing recommendations by the probe team.

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

- share recommendation report.

7.4 Product line value estimation

7.4.1 Principal constituents

7.4.1.1 Purpose

The purpose of this subprocess is to evaluate the potentials of adopting the product line in terms of the organization's strengths and challenges relative to its product line effort.

7.4.1.2 Inputs

The following inputs should be available to perform the product line value estimation process:

- technical probe findings and recommendations; and
- outcomes of decision support for the technical probe process.

7.4.1.3 Outcomes

The following outcome shall be available as a result of the successful implementation of the product line value estimation process:

- *Product line value estimation results* are produced and delivered.

7.4.1.4 Tasks

The organization shall implement the following tasks with respect to the product line value estimation process:

- *Determine potential member products*: review the technical probe findings and devise an initial product line members based on the probed results.
- *Measure potential reusability and opportunity*: measure potential benefits such as reusability and opportunity and required product line efforts based on the probed results.
- *Analyse costs and benefits of a product line*: Evaluate a product line quantitatively in order to inform the results to the high level decision makers for the subsequent decisions.
- *Perform go/no-go decision to a product line basis*: Make a decision on whether the organization adopt a product line approach or continue applying a product line approach in accordance with the technical probe results.
- *Hand over product line value estimation results to scoping*: Deliver the product line value estimation results including the initial product line members and costs/benefits analysis results to the scoping phase.

7.4.2 Determine potential member products

The goal of this task is to define a product line based on the technical probe results.

The method should support determining potential member products with the following capabilities:

- re-examining and consolidating general observations, findings, weaknesses, strengths, recommendations and stakeholder group's context for deriving member products of a product line; and
- identifying potential member products that are expected to produce the best results.

A tool should support determining potential member products by allowing the user to do the following:

- access the probe results; and
- access information to candidate member products.

7.4.3 Measure potential reusability and opportunity

The goal of this task is to evaluate potential reusability and opportunities such as improvements in quality, productivity and cost effectiveness of potential member products.

The method should support measuring potential reusability and opportunity with the following capabilities:

- identifying factors that should be measured to decide potential reusability and opportunity;
- selecting objects (e.g. critical subsystems, modules, components, organization units, customers) used for deciding potential reusability and opportunity; and
- providing metrics used for deciding potential reusability and opportunity.

A tool should support measuring potential reusability and opportunity by allowing the user to do the following:

- access objects used for deciding potential reusability and opportunity;
- collect required data; and
- decide the value of measures using defined metrics.

7.4.4 Analyse the costs and benefits of a product line

The goal of this task is to perform quantitative examination for a product line so that the organization makes a go/no-go decision.

The method should support analysing the costs and benefits of a product line with the following capabilities:

- defining cost constituents (e.g. cost for adapting the organization, building core assets, building product-specific parts, and reusing common parts);
- providing a cost model that is able to be used at an abstract level;
- making the cost model flexible so that the organization can consider other factors such as market pressure and available investment; and
- providing exemplar applications of the cost model (e.g. applications in accordance with business domain, organization size, or adoption scenarios).

A tool should support analysing the costs and benefits of a product line by allowing the user to do the following:

- align cost model algorithms in accordance with the selected cost constituents and factors;
- allow data required for calculating costs and benefits; and

- calculate formulae of the defined cost model.

7.4.5 Perform go/no-go decision to a product line basis

The goal of this task is to decide whether an organization adopts a product line approach or not.

The method should support performing a go/no-go decision to a product line basis with the following capabilities:

- defining decision guidelines that will be made based on the probe results, costs and benefits; and
- coordinating the go/no-go decision on switching to product line approach with other decision-making roles.

A tool should support performing the go/no-go decision to a product line basis by allowing the user to do the following:

- access the measured results of potential reusability and opportunity; and
- access the results of costs and benefits of a product line.

7.4.6 Hand over product line value estimation results to scoping

The goal of this task is to initiate the product line scoping process for adopting a product line approach.

The method should support handing over product line value estimation results to scoping with the following capability:

- consolidating product line value estimation results to be handed over to the scoping process.

A tool should support handing over product line value estimation results to scoping by allowing the user to do the following:

- document product line value estimation results; and
- share product line value estimation results with scoping roles.

7.5 Product line adoption scenarios structuring

7.5.1 Principal constituents

7.5.1.1 Purpose

The purpose of this subprocess is to define stories, use cases, and tasks for product line adoption using technical probe results.

7.5.1.2 Inputs

The following inputs should be available to perform the product line adoption scenarios structuring process:

- technical probe reports including the findings, strengths, weaknesses and recommendations;
- product line adoption strategy; and
- product line adoption process.

7.5.1.3 Outcomes

The following outcome shall be available as a result of the successful implementation of the product line adoption scenarios structuring process:

- *A draft CONOPS for the product line adoption* is produced.

7.5.1.4 Tasks

The organization shall implement the following tasks with respect to the product line adoption scenarios structuring process:

- *Coordinate the adoption strategy with the technical probe results*: Orchestrate and coordinate the overall adoption strategies to address the recommendations of the product line technical probe.
- *Structure product line adoption scenarios*: Develop a sketch of product line adoption to achieve the goals specified in the product line adoption plan.
- *Document a draft CONOPS*: Define how to adopt a product line approach (i.e. recommended set of actions), who participate for the product line adoption, what they do, and when and in which order they do the operational processes.

7.5.2 Coordinate the adoption strategy with the technical probe results

The goal of this task is to obtain an optimal product line adoption strategy by adjusting it in accordance with the technical probe results.

The method should support coordinating the adoption strategy with the technical probe results with the following capabilities:

- identifying parts of the product line adoption strategy to be adjusted based on the technical probe results;
- examining ways to addressing the probe findings and surmounting the challenges; and
- exploiting the organization's identified strengths.

A tool should support coordinating the adoption strategy with the technical probe results by allowing the user to do the following:

- access the technical probe results (findings, recommendations); and
- edit the product line adoption strategy.

7.5.3 Structure product line adoption scenarios

The goal of this task is to develop scenarios of the processes for the product line adoption. Scenarios include various steps for each process.

The method should support structuring product line adoption scenarios with the following capabilities:

- providing documentation standard including main contents (e.g. action plan for addressing findings, surmounting the challenges, and exploiting identified strengths) that should be covered by the product line adoption scenario;
- describing detailed steps for product line adoption scenarios; and
- allowing variances (e.g. alternative or optional) when the steps for each process are described.

A tool should support structuring product line adoption scenarios by allowing the user to do the following:

- generate the outline of a scenario; and
- structure product line adoption scenarios.

7.5.4 Document a draft CONOPS

The goal of this task is to produce a draft CONOPS that describes how, when, and in which procedures the stakeholders of a product line do their roles and responsibilities for the product line adoption.

The method should support documenting a draft CONOPS with the following capabilities:

- specifying how the product line adoption processes will be used;
- specifying participants who perform the product line adoption together with their specific activities; and
- specifying when and in which order the specific product line adoption operations are performed.

A tool should support documenting a draft CONOPS by allowing the user to do the following:

- generate the outline of the draft CONOPS;
- specify CONOPS in detail using the electric documentation template; and
- share the draft CONOPS with the relevant participants.

8 Product line technical probe support

8.1 General

The product line technical probe support supports the following:

- *quality assurance for technical probe;*
- *decision support for technical probe; and*
- *risk management for technical probe.*

8.2 Quality assurance for technical probe

8.2.1 Principal constituents

8.2.1.1 Purpose

The purpose of this subprocess is to measure the product line technical probe activities and work products to assure that the product line technical probe achieves the planned objectives and qualities by adhering the defined technical probe process.

8.2.1.2 Inputs

The following inputs should be available to perform the quality assurance for the technical probe process:

- phases and key procedures applied to the technical probe;
- technical probe work products; and

- quantitative and qualitative quality assurance measures.

NOTE Examples of technical probe work products include product line technical probe plan, preliminary phase findings, and technical probe report.

8.2.1.3 Outcomes

The following outcomes shall be available as a result of the successful implementation of the quality assurance for the technical probe process:

- *Evidences of the technical probe quality* are produced.
- *Non-conformance issues with their status and results of the technical probe* are produced and managed.
- *Status reports of corrective actions for the technical probe* are produced and managed.
- *Status reports of quality trends for the technical probe* are produced and managed.

8.2.1.4 Tasks

The organization shall implement the following tasks with respect to the quality assurance for the technical probe process:

- *Objectively evaluate technical probe process*: Assure that performed technical probe processes adhere to the organization's process descriptions, standards, and procedures.
- *Objectively evaluate technical probe work products*: Assure that work products associated with technical probe process satisfy the stated criteria.
- *Communicate and resolve noncompliance issues*: Objectively track, communicate, and resolve noncompliance issues found during evaluation.
- *Establish records of technical probe quality assurance activities*: Record technical probe quality assurance activities so that the status and results are maintained and traced.

8.2.2 Objectively evaluate technical probe process

The goal of this task is to assure whether the technical probe process performed adheres to the organizational process standard.

The method should support objectively evaluating technical probe process with the following capabilities:

- selecting or sampling the pre-/main-/post- technical probe process (e.g. selection criteria or sampling method);
- providing evaluation criteria for the pre-/main-/post- technical probe process;
- identifying noncompliance issues; and
- identifying lessons learned that could improve the pre-/main-/post- technical probe process.

A tool should support objectively evaluating the technical probe process by allowing the user to do the following:

- access evidences related to the pre-/main-/post- technical probe process performed;
- refer quality assurance measures related to the pre-/main-/post- technical probe process;
- assign values for quality assurance measures; and
- determine the quality level of the product line technical probe process.

8.2.3 Objectively evaluate technical probe work products

The goal of this task is to assure the quality of planned work products produced during the technical probe.

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

- selecting or sampling pre-/main-/post- technical probe work products (e.g. selection criteria or sampling method);
- providing evaluation criteria for pre-/main-/post- technical probe work products;
- identifying noncompliance issues; and
- identifying lessons learned that could improve pre-/main-/post- technical probe work products.

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

- access evidences related to pre-/main-/post- technical probe work products;
- refer quality assurance measures related to pre-/main-/post- technical probe work products;
- assign values for quality assurance measures; and
- determine the quality level of product line technical probe work products.

8.2.4 Communicate and resolve noncompliance issues

The goal of this task is to define action items to resolve noncompliance issues found during the technical probe quality assurance.

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 technical probe 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 technical-probe-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 the technical probe process and work products.

8.2.5 Establish records of technical probe quality assurance activities

The goal of this task is to document the results of technical probe quality assurance activities.

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

- supporting a template for reporting the results of the technical probe quality assurance activities (template includes quality assurance activities, status of corrective actions and quality trends).

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

- document a report for the results of the technical probe quality assurance activities in accordance with the documentation template.

8.3 Decision support for technical probe

8.3.1 Principal constituents

8.3.1.1 Purpose

The purpose of this subprocess is to measure the progress and the benefit of the technical probe activities for determining whether they are satisfactory. Refer to [Annex A](#) as one kind of the decision support method.

8.3.1.2 Inputs

The following input should be available to perform the decision support for the technical probe process:

- organization's existing decision procedure.

8.3.1.3 Outcomes

The following outcomes shall be available as a result of the successful implementation of the decision support for technical probe process:

- *Decision support policy for the technical probe* is established.
- *Tailored decision procedure for the technical probe* is produced.
- *Guide for decision execution* is provided.
- *Rationale for decisions concerning the technical probe* is documented.

8.3.1.4 Tasks

The organization shall implement the following tasks with respect to the decision support for technical probe process:

- *Establish decision support policy for technical probe*: Define a policy that governs decisions made in the technical probe.
- *Tailor decision procedure for technical probe*: Modify and refine decision procedures in detail for the technical probe.
- *Guide the decision execution for technical probe*: Provide guidance that should be followed when decisions related to the technical probe are made.
- *Document the rationale for decisions concerning technical probe*: Specify rationales for decisions made during the technical probe activities.
- *Learn from decision results of technical probe*: Capture lessons from the results of decisions made in the technical probe.

8.3.2 Establish decision support policy for technical probe

The goal of this task is to define a policy, including guides and procedures that govern decision making in the technical probe. The decision policy governs when the technical probe team makes decisions for product line stakeholders, representatives, interview questionnaires, consolidating answers to produce findings, weaknesses, and strengths, and structuring product line adoption scenarios. This task utilizes guidance for the overall decision procedure provided in ISO/IEC 26555.

NOTE An exemplar generic decision procedure can be found in ISO/IEC 26555:

- formulate decision goals;
- define goal achievement measures;
- generate alternatives;
- converge on alternatives;
- evaluate alternatives;
- select the best alternatives;
- document the rationale;
- activate the decision;
- measure the performance of the decision results;
- review the gap between expected and actual goal achievement;
- analyse root cause of the gap; and
- learn by learning mechanism.

The method should support establishing a decision support policy for the technical probe with the following capabilities:

- defining a policy for generation, evaluation and selection of decision alternatives regarding the technical probe, which are critical for the consequences on the product line and business success;
- establishing a decision dissemination policy for relevant technical probe stakeholders (e.g. technical probe team and product line stakeholders).

A tool should support establishing a decision support policy for the technical probe by allowing the user to do the following:

- share the decision management policy with the technical probe stakeholders;
- communicate the established decision support policy for the technical stakeholders by implementing channels and mechanisms according to the decision-making structure.

8.3.3 Tailor decision procedure for technical probe

The goal of this task is to modify and refine decision procedures in detail for the technical probe based on procedures defined in the policy.

The method should support tailoring the decision procedure for the technical probe with the following capabilities:

- tailoring decision-making procedures to the specific characteristics of the technical probe, which are critical for the success of the technical probe and consequent business success;
- providing a documentation template including placeholders for tailoring specific possible parts of decision procedures for the technical probe; and

- defining a dissemination mechanism for the tailored decision procedures specific to the technical probe.

A tool should support the tailoring decision procedure for technical probe by allowing the user to do the following:

- choose the value for placeholders for tailoring decision procedures;
- implement the dissemination mechanism for the tailored decision procedures specific to the technical probe; and
- enrol relevant technical probe stakeholders of the technical probe for sharing decision procedures.

8.3.4 Guide the decision execution for technical probe

The goal of this task is to provide guidance when decisions are made during the technical probe activities.

The method should support guiding the decision execution for the technical probe with the following capabilities:

- unifying decision execution best practices for ensuring the successful decision-making in the technical probe;
- providing core entities for decisions made in the technical probe;
- making multi-criteria decisions;
- coordinating decision executions made by different decision makers (e.g. different but related decisions made in the technical probe team and product line stakeholders);
- enhancing collaborations among decision makers in the technical probe; and
- providing measures for analysing the effectiveness of decisions made in the technical probe.

A tool should support guiding the decision execution for technical probe by allowing the user to do the following:

- share decision execution best practices for the technical probe;
- display core entities referring them during decision making;
- establish multi-criteria decision support mechanisms for the technical probe; and
- collect data and visualize the effectiveness of decisions made in the technical probe.

8.3.5 Document the rationale for decisions concerning technical probe

The goal of this task is to describe rationales for decisions occurred during the technical probe activities, so that decisions made can be referenced in order that future decisions can be more effective and efficient.

The method should support documenting the rationale for decisions concerning technical probe with the following capabilities:

- identifying decision rationale concerning the technical probe activities in an objective way;
- providing a documentation template for the rationale for decisions concerning the technical probe; and
- sharing the decision rationale with relevant stakeholders.

A tool should support documenting the rationale for decisions concerning the technical probe by allowing the user to do the following:

- document the rationale for decisions concerning product management according to the documentation template; and
- communicate and take feedback on the decision rationale with relevant stakeholders.

8.3.6 Learn from decision results of technical probe

The goal of this task is to record lessons from decisions made and preserve the results for the later decisions that will be made during the technical probe activities.

The method should support learning from decision results of the technical probe with the following capabilities:

- quantifying and evaluating the consequences due to decisions made;
- reviewing gaps among assumptions, achieved values, and consequences;
- extracting lessons for decision-making practices from previous decisions; and
- consolidating the lessons learned and the existing decision practices for the next decisions.

A tool should support learning from decision results of the technical probe by allowing the user to do the following:

- visualize the consequences due to decisions made in the technical probe; and
- update decision best practices.

8.4 Risk management for technical probe

8.4.1 Principal constituents

8.4.1.1 Purpose

The purpose of this subprocess is to manage risks that are involved in the product line technical probe plan, pilots, and product line value estimation together with risk mitigation strategies.

8.4.1.2 Inputs

The following inputs should be available to perform the risk management for technical probe process:

- probable risk sources (e.g., interviewing capabilities of each probe team member, motivation/engagement of selected product line stakeholders, decisions for stakeholders, findings, recommendations, action plans and pilots, executive supports for adopting product line engineering, governance for the technical probe process);
- outcomes of the technical probe (e.g., technical probe plan, context of the technical probe, information to be probed, findings produced during the preliminary technical probe and main technical probe, recommendations and action plans produced during technical probe operationalization);
- lessons learned from the other risk management activities;
- technical risk management subprocess in ISO/IEC 26555;
- organizational risk management subprocess in ISO/IEC 26556; and
- outcomes of decision support for the technical probe process.

8.4.1.3 Outcomes

The following outcomes shall be available as a result of the successful implementation of the risk management for the technical probe process:

- *Risk assessment results* including risks, likelihood of risks, potential impacts on the technical probe, and ways to address the identified risks are documented.
- *Mitigation plans and risk monitoring plans* are developed and documented.
- *Risk mitigation results* are assessed and reported.
- Lessons learned are evaluated and documented.

8.4.1.4 Tasks

The organization shall implement the following tasks with respect to the risk management for the technical probe process:

- *Identify risks related to the success of technical probe results*: Identify risks related to the technical probe preparation, pre-/main-/post- product line technical probe methods, processes, biased technical probe results, capabilities of probe interviewers and interviewees, selected product line stakeholder groups, and the product line adoption scenarios.
- *Develop mitigation plans for the identified risks*: Prepare risk mitigation or contingency plans and executions for the identified risks during technical probe preparation and pre-/main-/post- product line technical probe.
- *Monitor the execution of the mitigation plan*: Monitor and measure the status of identified risks possible at the product line technical probe.
- *Learn from actual results of risk management for technical probe*: Summarize lessons learned from the risk management execution for the complex risks related to both technical and organizational aspects in doing the technical probe.

8.4.2 Identify risks related to the success of technical probe

The goal of this task is to identify severe risks in regard to the results of the technical probe operation, actions taken as the consequences of the technical probe, and probable risks in the product line adoption scenarios.

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

- identifying potential technical or organizational risks that need to be tackled to continue the product line technical probe;
- identifying potential risks involved in the product line technical probe outcomes when risks occur then the organization selects a wrong product line adoption or improvement approach;
- analysing and prioritizing identified potential risks involved in the product line technical probe; and
- identifying risks possible to occur while the product line adoption scenarios are applied.

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

- access goals that motivated the product line technical probe (e.g. goals of the product line adoption or goals of the product line improvement);

- access information for selected technical probe methods, process, product line stakeholder groups, interview questions used for probe, executive commitment status and support, and technical probe team structure and members to analyse and make decisions about risks;
- make all technical probe team members and relevant product line stakeholders accessible and communicable;
- integrate with decision support, organizational and technical risk management including their support tools; and
- record and maintain prioritized potential risks.

8.4.3 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 technical probe.

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

- defining steps for managing knotty risks related to both organizational and technical aspects of the product line technical probe;
- determining the risk mitigation strategy and efforts for knotty risks related to both organizational and technical aspects of the product line technical probe;
- developing an overall risk mitigation plan and technical-probe-phase-specific risk mitigation plans;
- identifying triggering criteria of mitigation plans related to knotty risks; and
- aligning collaboration among all technical probe team members and relevant product line stakeholders.

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

- document and share steps for managing knotty risks related to both organizational and technical aspects of the product line technical probe;
- estimate risk mitigation efforts for knotty risks related to both organizational and technical aspects of the product line technical probe; and
- record and maintain risk mitigation plans.

8.4.4 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 mitigation plans for the scored and prioritized risks of the technical probe.

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 technical probe;
- monitoring the triggering conditions of mitigation plans;
- tracking the readiness of risk mitigation action items;
- tracking risk status to check for 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 risk mitigation and management status of the technical probe;
- trace risk mitigation action items by differentiating those for each technical probe phase, knotty risks and overall risks;
- collect measurement values;
- visualize risk status (e.g. threshold graph) for each technical probe phase as well as the overall status of the technical probe; and
- collaborate with participants or stakeholders for parallel management of risks.

8.4.5 Learn from actual results of risk management for technical probe

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

The method should support learning from actual results of risk management for the technical probe with the following capabilities:

- analysing actions taken to reduce or control the risks for technical probe preparation, pre-/main-/post-/re- product line technical probe;
- reviewing consequences of the execution of the mitigation plans, especially knotty risks related to several technical probe phases and both technical and organizational aspects;
- evaluating success in actions taken to reduce or control risks related to several technical probe phases and both technical and organizational aspects;
- evaluating failure in actions taken to reduce or control risks related to several technical probe phases and both technical and organizational aspects; and
- preserving the lessons learned from the execution for defining next mitigation plans at the technical probe.

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

- access consequences of the actual results of the execution of the mitigation plans for the risks related to several technical probe phases and both technical and organizational aspects; and
- record lessons learned for the next mitigation plan definition.

Annex A (informative)

Exemplar multi-criteria decision mechanism for technical probe

The MCDM (multi-criteria decision mechanism) is used by decision makers to find best fits alternatives for defined objectives and to analyse and evaluate them to obtain an optimal solution in a transparent manner. The MCDM has been used extensively in the health, safety, economics, and social sectors because it allows the decision maker to quantify their preference and trade-offs for alternatives according to given criteria. The product line technical probe should determine strengths and challenges in terms of enterprise process, architecture, business, and organizational culture for product line adoption. Based on these results, product line technical probe stakeholders can choose optimal product line adoption scenario to meet the established product line goals/objectives.

The MCDM should first set goals, objectives and criteria. Goal/objectives are product line goals/objectives established in accordance with external and internal pressures to consider product line adoption. The following is a set of goals/objectives:

- positive return on investment;
- managed reuse achievement;
- variety in products' features; and
- process and technology improvement.

Product line technical probe questionnaires should be written to include these goals/objectives. In product line technical probe, the criteria can be the desired state to achieve through product line adoption. The desired states are defined based on the strengths and challenges obtained through the product line technical probe. Desired states contribute to achieving the product line goal/objectives set earlier. Examples of the desired state are:

- target markets that the organization wants to lead through product line engineering and position;
- increase in productivity to improve through product line engineering;
- the degree of asset reuse of which an organization plans to achieve through product line engineering;
- process capability level; and
- customer satisfaction level.

The set of decision alternatives available in the product line technical probe can first be product line adoption scenarios. [Table A.1](#) is an example of the decision table. The trade-offs between these alternatives can be analysed in relation to product line adoption scenarios or transition strategies to the desired states.

Table A.1 — Example decision table

Criteria weight alternatives	DS1	DS2	...
	W1	W2	...
PL_AS1	a11	a12	
Key DS: Desired states PL_AS: Product line adoption scenarios			

Table A.1 (continued)

Criteria weight alternatives	DS1	DS2	...
	W1	W2	...
PL_AS2	a21	a22	
...	an1	an2	..
Key DS: Desired states PL_AS: Product line adoption scenarios			

In the product line technical probe, MCDM can also be used to determine organizational strengths or challenges. Criteria for decisions may be the desired states or the result of decomposing the product line objectives to a level that can be measurable or determinable.

Annex B

(informative)

Exemplar adoption scenario

For the adoption of product line technology, an extractive strategy is selected. This strategy suggests to develop the core assets in advance and to continue to incorporate improvements into the core assets with the parallel development of subsequent products within a product line. To transfer an organization's production system to the product line basis, the following scenario is defined^[21]:

- Establish and implement the core assets. For this, pilot project is launched in advance, and through the project the primary core assets are delivered. To initiate the product line, more core assets are added to make the assets more fine-tuned and robust.
- Choose one of the legacy systems under development as the starting point for the developed product line's core assets. Through this, the modularity, reliability, and stability of the core assets are demonstrated. Especially, an architectural structure can serve as the embryonic core asset base.
- Establish domain and application development teams and modify the system to meet the product line architecture. Twenty more experienced system and software engineers will be hired to keep the product line basis up.
- Establish the process and toolset to be used; an integrated tool environment will be established for configuration management, requirements and traceability management, product line architecture definition, system builds and configurations, testing, parameter tuning, and product release and distribution.
- Pilot the first product and use the experience to improve the process and toolset.
- Sequentially launch products within a product line and improve the process and toolset.

Annex C (informative)

Exemplar frameworks of maturity and questionnaire

The family evaluation framework (FEF) is an exemplar framework of maturity^[21]. The FEF measures an organization's maturity level of the product line in the following four dimensions.

- *Business* measures the business involvement in product line engineering. This dimension deals with the business relationships between domain and application engineering with respect to the current and future view of the business values, costs, and markets.
- *Architecture* measures the practices of product line engineering from the views of the core asset reuse, product line architecture, and variability management in those core assets and product line architecture.
- *Process* measures the processes used for product line engineering by dividing the processes into domain, application, and collaboration and coordination processes.
- *Organisation* measures the effectiveness of organization structures and the distributed responsibilities for domain engineering, application engineering, collaboration, and coordination.

The maturity level descriptions can be used to probe an organization's current status and ability to adopt the product line at the technical probe stage. The following is the exemplar questionnaires from the business dimension at the basic level:

- is the business arranged for project-based single system engineering?
- is there involvement in software product line engineering by the business?
- are there specific budgets for domain engineering?
- does the business planning consider software product line engineering?

The following is the exemplar questionnaires from the business dimension at the level 3:

- does the expected return on investment drive the marketing, sales, and development of product line products?
- is product line engineering influencing the investment decisions?
- is there an institutionalized mechanism to generate budget for domain engineering by the sales of systems produced by application engineering?
- is there is an awareness of the costs and profits of variability and how that generates a return on investment?

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