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Information technology — Process assessment — Process assessment model for system life cycle processes

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Contents

Page

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).

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

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

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

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

This document cancels and replaces ISO/IEC 15504-6:2013, which has been technically revised.

The main changes compared to the previous edition are as follows:

— all processes and their base practices are changed to reflect the ISO/IEC/IEEE 15288 processes;

— all process related information products and their descriptions are revised;

— this process assessment model includes a process quality attribute of process performance and can be used with other models of process quality, for instance capability as described in ISO/IEC 33020.

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

Introduction

The set of International Standards ISO/IEC 33001 to ISO/IEC 33099, termed the ISO/IEC 330xx family, defines the requirements and resources needed for process assessment. The overall architecture and content of the series is described in ISO/IEC 33001. Several standards in the ISO/IEC 330xx family for process assessment are intended to replace and extend parts of the ISO/IEC 15504 series.

This document defines a process assessment model for system life cycle processes, conformant with the requirements of ISO/IEC 33004, for use in performing a conformant assessment in accordance with the requirements of ISO/IEC 33002.

A process assessment model is related to one or more process reference models. The process reference model defined in ISO/IEC/IEEE 15288 is used as the basis for the process assessment model in this document.

A process assessment model incorporates a process measurement framework conformant with the requirements of ISO/IEC 33003 and is expressed as a process quality characteristic with a defined set of process attributes.

A process assessment model includes a set of assessment indicators. Process performance indicators address the process purpose and outcomes of each process in the process assessment model. Process quality indicators demonstrate the achievement of the process attributes in the process measurement framework. These indicators may also provide a reference source of practices when implementing a process improvement program.

The assessment indicators are used as a basis for collecting objective evidence to support an assessor's judgement in assigning ratings of the performance and quality of an implemented process. The set of indicators defined in this document is not intended to be an all-inclusive set and applicable in its entirety. Subsets appropriate to the context and scope of the assessment should be selected, and potentially augmented with additional indicators.

A process assessment is conducted according to a documented assessment process. A documented assessment process will identify the rating method to be used in rating process attributes and identify or define the aggregation method to be used in determining ratings.

ISO/IEC 33020 provides a process measurement framework for the assessment of process capability which may be incorporated as a process measurement framework in this document. ISO/IEC 33020:2019, Annex B includes a set of process quality indicators for each process attribute in the process measurement framework.

Information technology — Process assessment — Process assessment model for system life cycle processes

1 Scope

This document defines a process assessment model for system life cycle processes, conformant with the requirements of ISO/IEC 33004, for use in performing a conformant assessment in accordance with the requirements of ISO/IEC 33002.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC/IEEE 15288:2015, *Systems and software engineering — System life cycle processes*

ISO/IEC 33001, *Information technology — Process assessment — Concepts and terminology*

ISO/IEC 33003, *Information technology — Process assessment — Requirements for process measurement frameworks*

ISO/IEC 33004:2015, *Information technology — Process assessment — Requirements for process reference, process assessment and maturity models*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 33001 apply.

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

— ISO Online browsing platform: available at https://www.iso.org/obp

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

4 The process assessment model

4.1 General

This document provides a basis for a process assessment model that is two-dimensional. In one dimension, the process dimension, the processes are defined and classified into process categories together with the set of assessment indicators of process performance. In the other dimension, the quality dimension, for each process attribute in the process measurement framework a set of process quality indicators is defined for the selected process quality characteristic.

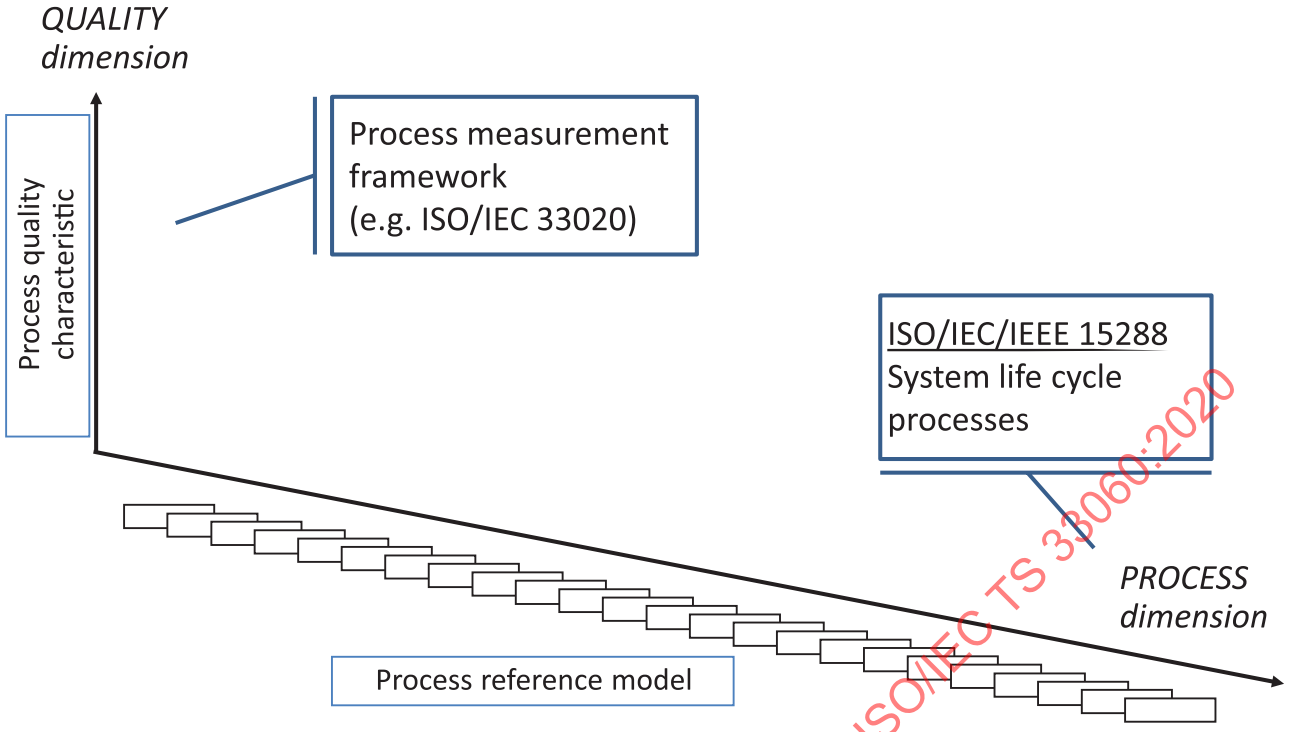

Figure 1 — Two-dimensional model

Figure 1 shows the process assessment model as a two-dimensional model, the process dimension with its relationship to ISO/IEC/IEEE 15288 system life cycle processes, and the quality dimension in relationship to a process measurement framework.

Users of this document may freely reproduce the detailed descriptions contained in the assessment model as part of any tool or other material to support the performance of process assessments, so that it can be used for its intended purpose.

4.2 Structure of the process assessment model

4.2.1 General

This clause describes the detailed structure of the process assessment model and its key components.

The process dimension comprises the set of processes defined with the process purpose and process outcomes together with a set of assessment indicators of process performance.

Processes included in a process reference model shall be in accordance with ISO/IEC 33004:2015, 5.4.

The processes in this document are derived directly from ISO/IEC/IEEE 15288 and meet the ISO/IEC 33004 requirements for process descriptions, process purposes and outcomes.

The quality dimension comprising a set of process attributes for a selected process quality characteristic is incorporated as a process measurement framework together with a set of process quality indicators.

NOTE ISO/IEC 33020 provides a process measurement framework for the assessment of process capability which can be incorporated into this document. ISO/IEC 33020 also includes a set of process quality indicators for each process attribute in the process measurement framework.

4.2.2 Processes

The process assessment model is based upon the system life cycle processes defined in ISO/IEC/IEEE 15288. The process reference model drawn from ISO/IEC/IEEE 15288 consists of the

process purpose and outcomes defined in that standard. If this document is used to claim full or tailored conformance to ISO/IEC/IEEE 15288, the requirements of ISO/IEC/IEEE 15288:2015, Clause 4 shall be satisfied.

Figure 2 lists the processes from ISO/IEC/IEEE 15288 that are included in the process dimension of the process assessment model and shows their classification into process groups.

The process groups and their associated processes are described in Clause 5.

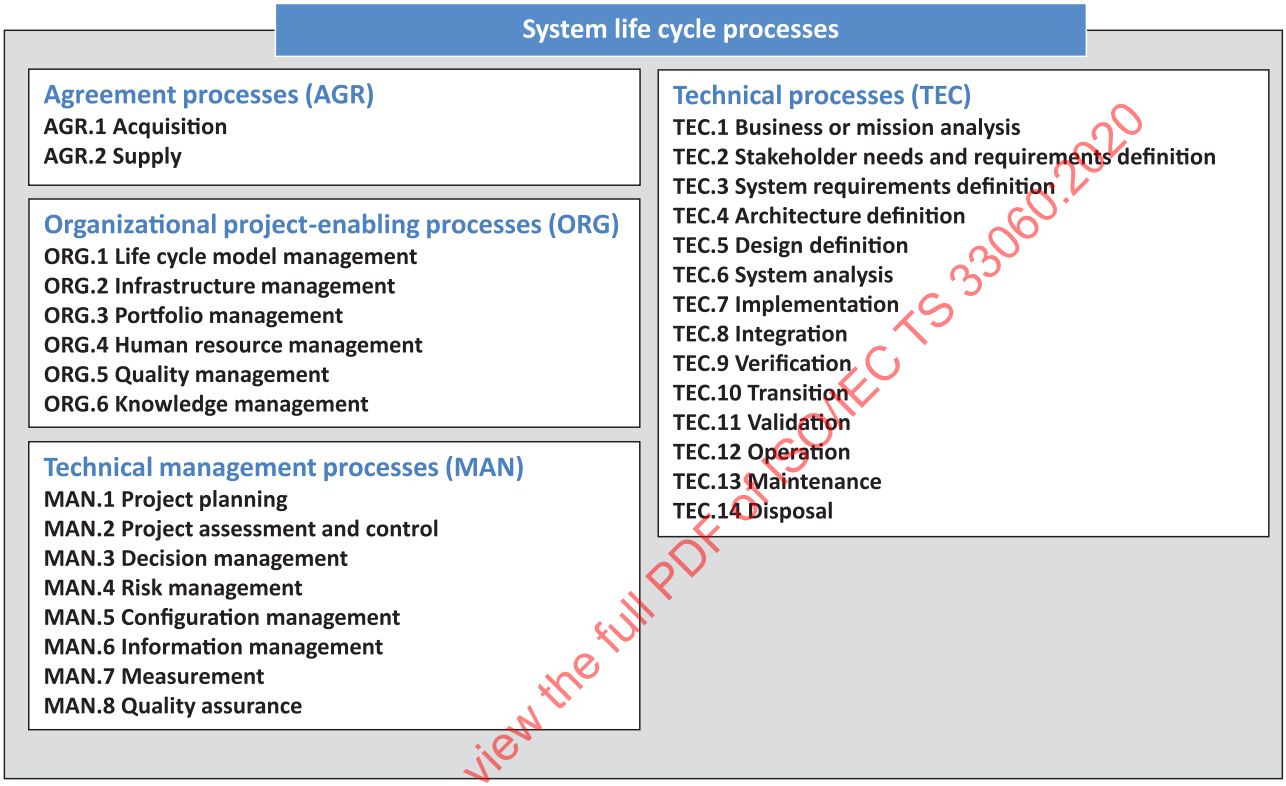

Figure 2 — Process groups

4.2.3 Process dimension

Each process has a process identifier (ID) consisting of the process group abbreviated name and the sequential number of the process in that group. Each process is described by its name, purpose, outcomes, base practices, and information products.

Each process is described in terms of a purpose statement. These statements contain the unique functional objectives of the process when performed in a particular environment. A list of specific process outcomes is associated with each of the process purpose statements, as a list of expected positive results of the process performance.

4.2.4 Quality dimension

For the quality dimension, the minimum requirement is that the process is performed, i.e. the implemented process achieves its process purpose and the expected outcomes are observable.

Process attributes are features of a process that can be evaluated on a scale of achievement, providing a measure of the quality of the process and are applicable to all processes.

4.3 Assessment indicators

A process assessment model is based on the principle that the quality of a process can be assessed by demonstrating the achievement of process attributes on the basis of evidences related to assessment indicators.

There are two types of assessment indicators: process performance indicators and process quality indicators. Process performance indicators address the process purpose and outcomes of each process in the process dimension. Process quality indicators demonstrate the achievement of the process attributes in the quality dimension.

The process performance indicators are:

— Base practice (BP);

— Information product (IP).

The performance of base practices (BPs) provides an indication of the extent of achievement of the process purpose and process outcomes. The base practices correspond to ISO/IEC/IEEE 15288 activities and tasks. Information products (IPs) are either used or produced (or both), when performing the process. Information products that are the key outputs of the process, are primarily used as performance indicators.

Annex A provides the list of information products (IPs) associated with the processes in Clause 5. The information products are assorted by categories. The information products are outputs of processes which are indicated by the process IDs.

Process quality indicators depend on the process quality characteristic of interest. The minimum requirement is that at least one of the process attributes shall comprise the achievement of the defined process purpose and process outcomes for the process; this is termed the process performance attribute (see ISO/IEC 33003:2015, 4.2.1). Other process quality attributes can be defined as needed.

The process performance and process quality indicators represent types of objective evidence that might be found in an instantiation of a process and therefore could be used to judge achievement of quality. Figure 3 shows how the assessment indicators are related to process performance and process quality.

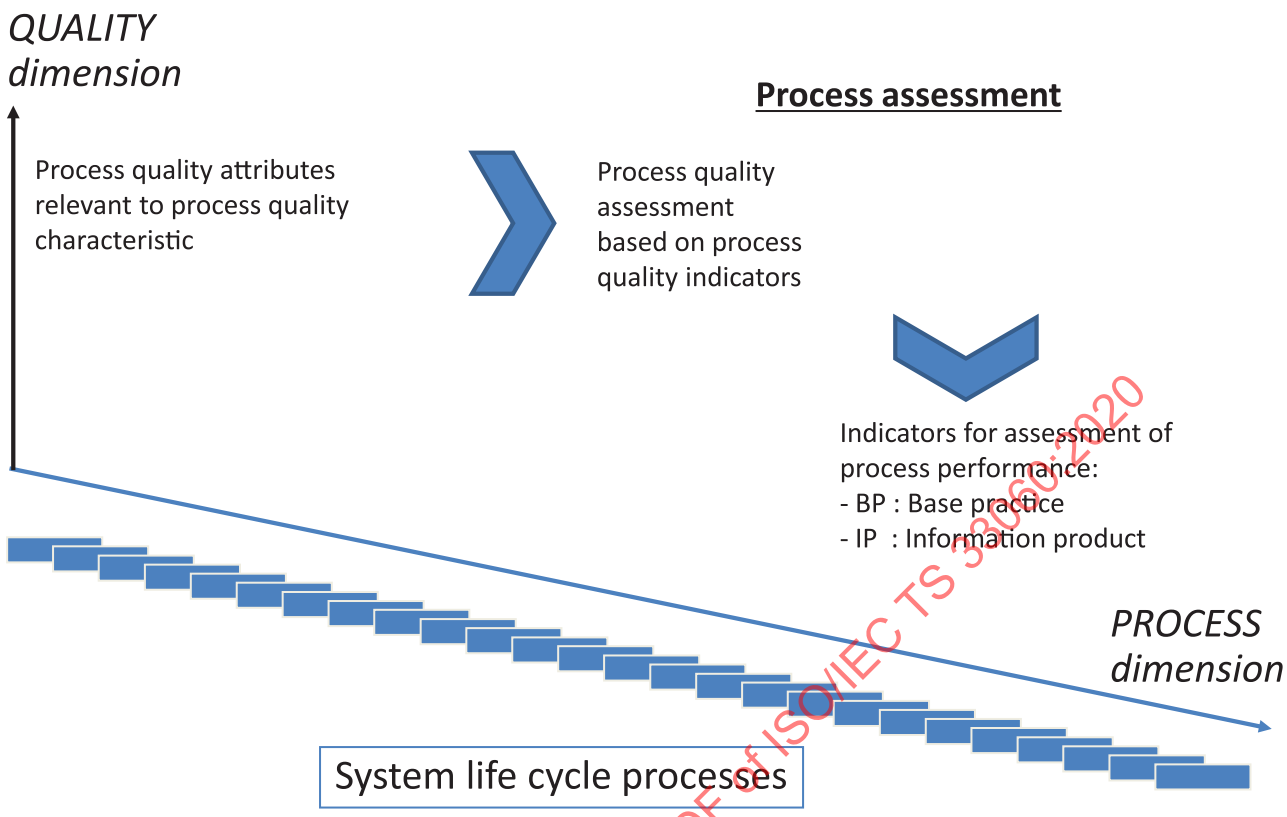

Figure 3 — Assessment indicators

5 The process dimension

5.1 General

The process dimension comprises the set of processes defined with process purpose and process outcomes together with a set of assessment indicators of process performance.

The individual processes each have a process identifier (ID) consisting of the process group abbreviated name and the sequential number of the process in that group and are described in terms of process name, process purpose, and process outcomes as defined in ISO/IEC/IEEE 15288.

In addition, the process dimension of the process assessment model provides information in the form of a set of:

a) base practices for the process providing a definition of the tasks and activities needed to accomplish the process purpose and fulfil the process outcomes; each base practice is associated to one or more process outcomes; and

b) information products that are the key outputs of the process, and are related to one or more process outcomes;

The process purposes, outcomes, base practices and information products associated with the processes are included in this clause. The base practices and information products constitute the set of indicators of process performance.

A documented assessment process and assessor judgment is needed to ensure that process context (application domain, business purpose, development methodology, size of the organization, etc.) is explicitly considered when using this information.

5.2 Agreement processes (AGR)

5.2.1 General

Organizations are producers and users of systems. One organization (acting as an acquirer) can task another (acting as a supplier) for products or services. This is achieved using agreements.

Generally, organizations act simultaneously or successively as both acquirers and suppliers of systems. The agreement processes can be used with less formality when the acquirer and the supplier are in the same organization. Similarly, they can be used within the organization to agree on the respective responsibilities of organization, project and technical functions (ISO/IEC/IEEE 15288).

5.2.2 Acquisition process

Process ID	**AGR.1**
Process name	**Acquisition process**
Process purpose	The purpose of the acquisition process is to obtain a product or service in accordance with the acquirer's requirements. NOTE As part of this process, the agreement is modified when a change request is agreed to by both the acquirer and supplier.
Process outcomes	As a result of the successful implementation of the acquisition process: a) A request for supply is prepared. b) One or more suppliers are selected. c) An agreement is established between the acquirer and supplier. d) A product or service complying with the agreement is accepted. e) Acquirer obligations defined in the agreement are satisfied.
Base practices	**AGR.1.BP1: Prepare for the acquisition.** [Outcome: a] 1) Define a strategy for how the acquisition will be conducted. 2) Prepare a request for the supply of a product or service that includes the requirements. **AGR.1.BP2: Advertise the acquisition and select the supplier.** [Outcome: b] 1) Communicate the request for the supply of a product or service to potential suppliers. 2) Select one or more suppliers. **AGR.1.BP3: Establish and maintain an agreement.** [Outcome: c, d] 1) Develop an agreement with the supplier that includes acceptance criteria. 2) Identify necessary changes to the agreement. 3) Evaluate impact of changes on the agreement. 4) Negotiate the agreement with the supplier. 5) Update the agreement with the supplier, as necessary. **AGR.1.BP4: Monitor the agreement.** [Outcome: d, e] 1) Assess the execution of the agreement. 2) Provide data needed by the supplier and resolve issues in a timely manner.

	AGR.1.BP5: Accept the product or service. [Outcome: d, e] 1) Confirm that the delivered product or service complies with the agreement. 2) Provide payment or other agreed consideration. 3) Accept the product or service from the supplier, or other party, as directed by the agreement. 4) Close the agreement.
Information products	Acquisition approach [Outcome: a] Request for supply [Outcome: a] Acquisition agreement [Outcome: c] Acquisition agreement change request [Outcome: c] Accepted system or system element [Outcome: d] Acquisition report [Outcome: e] Acquisition record [Outcome: e]

5.2.3 Supply process

Process ID	**AGR.2**
Process name	**Supply process**
Process purpose	The purpose of the supply process is to provide an acquirer with a product or service that meets agreed requirements. NOTE As part of this process, the agreement is modified when a change request is agreed to by both the acquirer and supplier.
Process outcomes	As a result of the successful implementation of the supply process: a) An acquirer for a product or service is identified. b) A response to the acquirer's request is produced. c) An agreement is established between the acquirer and supplier. d) A product or service is provided. e) Supplier obligations defined in the agreement are satisfied. f) Responsibility for the acquired product or service, as directed by the agreement, is transferred.
Base practices	**AGR.2.BP1: Prepare for the supply.** [Outcome: a] 1) Determine the existence and identity of an acquirer who has a need for a product or service. 2) Define a supply strategy. **AGR.2.BP2: Respond to a tender.** [Outcome: b] 1) Evaluate a request for the supply of a product or service to determine feasibility and how to respond. 2) Prepare a response that satisfies the solicitation.

	AGR.2.BP3: Establish and maintain an agreement. [Outcome: c] 1) Negotiate an agreement with the acquirer that includes acceptance criteria. 2) Identify necessary changes to the agreement. 3) Evaluate impact of changes on the agreement. 4) Negotiate the agreement with the acquirer, as necessary. 5) Update the agreement with the acquirer, as necessary. **AGR.2.BP4: Execute the agreement.** [Outcome: d, e] 1) Execute the agreement according to the established project plans. 2) Assess the execution of the agreement. **AGR.2.BP5: Deliver and support the product or service.** [Outcome: d, e, f] 1) Deliver the product or service in accordance with the agreement criteria. 2) Provide assistance to the acquirer in support of the delivered product or service, per the agreement. 3) Accept and acknowledge payment or other agreed consideration. 4) Transfer the product or service to the acquirer, or other party, as directed by the agreement. 5) Close the agreement.
Information products	Supply approach [Outcome: a] Request for supply response [Outcome: b] Supply agreement [Outcome: c] Supply agreement change request [Outcome: c] Supplied system [Outcome: d] Supply report [Outcome: e, f] Supply record [Outcome: e, f]

5.3 Organizational project-enabling processes (ORG)

5.3.1 General

The organizational project-enabling processes are concerned with providing the resources needed to enable the project to meet the needs and expectations of the organization's interested parties. The organizational project-enabling processes are typically concerned at a strategic level with the management and improvement of the organization's business or undertaking, with the provision and deployment of resources and assets, and with its management of risks in competitive or uncertain situations.

The organizational project-enabling processes establish the environment in which projects are conducted. The organization establishes the processes and life cycle models to be used by projects; establishes, redirects, or cancels projects; provides resources required, including human and financial; and sets and monitors the quality measures for systems and other deliverables that are developed by projects for internal and external customers.

The organizational project-enabling processes create a strong business image for many organizations and imply commercial and profit-making motives. Nevertheless, the organizational project-enabling processes are equally relevant to non-profit organizations, since they are also accountable to

stakeholders, are responsible for resources and encounter risk in their undertakings. This document can be applied to non-profit organizations as well as to profit-making organizations (ISO/IEC/IEEE 15288).

5.3.2 Life cycle model management process

Process ID	**ORG.1**
Process name	**Life cycle model management process**
Process purpose	The purpose of the life cycle model management process is to define, maintain, and assure availability of policies, life cycle processes, life cycle models, and procedures for use by the organization with respect to the scope of this document. This process provides life cycle policies, processes, models, and procedures that are consistent with the organization's objectives, that are defined, adapted, improved, and maintained to support individual project needs within the context of the organization, and that are capable of being applied using effective, proven methods and tools.
Process outcomes	As a result of the successful implementation of the life cycle model management process: a) Organizational policies and procedures for the management and deployment of life cycle models and processes are established. b) Responsibility, accountability, and authority within life cycle policies, processes, models, and procedures are defined. c) Life cycle models and processes for use by the organization are assessed. d) Prioritized process, model, and procedure improvements are implemented.
Base practices	**ORG.1.BP1: Establish the process.** [Outcome: a, b] 1) Establish policies and procedures for process management and deployment that are consistent with organizational strategies. 2) Establish the processes that implement the requirements of this document and that are consistent with organizational strategies. 3) Define the roles, responsibilities, accountabilities, and authorities to facilitate implementation of processes and the strategic management of life cycles. 4) Define business criteria that control progression through the life cycle. 5) Establish standard life cycle models for the organization that are comprised of stages, and define the purpose and outcomes for each stage. **ORG.1.BP2: Assess the process.** [Outcome: c] 1) Monitor process execution across the organization. 2) Conduct periodic reviews of the life cycle models used by the projects. 3) Identify improvement opportunities from assessment results. **ORG.1.BP3: Improve the process.** [Outcome: d] 1) Prioritize and plan improvement opportunities. 2) Implement improvement opportunities and inform relevant stakeholders.

Information products	Life cycle model management strategy [Outcome: a, c, d] Organization policy [Outcome: a, b] Organization procedure [Outcome: a, b] Life cycle models [Outcome: a, b] Organizational measurement needs [Outcome: c, d] Organizational performance data [Outcome: c, d] Life cycle model management report [Outcome: c, d] Life cycle model management record [Outcome: c, d]

5.3.3 Infrastructure management process

Process ID	**ORG.2**
Process name	**Infrastructure management process**
Process purpose	The purpose of the infrastructure management process is to provide the infrastructure and services to projects to support organization and project objectives throughout the life cycle. This process defines, provides and maintains the facilities, tools, and communications and information technology assets needed for the organization's business with respect to the scope of this document.
Process outcomes	As a result of the successful implementation of the infrastructure management process: a) The requirements for infrastructure are defined. b) The infrastructure elements are identified and specified. c) Infrastructure elements are developed or acquired. d) The infrastructure is available.
Base practices	**ORG.2.BP1: Establish the infrastructure.** [Outcome: a, b, c, d] 1) Define project infrastructure requirements. 2) Identify, obtain and provide infrastructure resources and services that are needed to implement and support projects. **ORG.2.BP2: Maintain the infrastructure.** [Outcome: a, b, c, d] 1) Evaluate the degree to which delivered infrastructure resources satisfy project needs. 2) Identify and provide improvements or changes to the infrastructure resources as the project requirements change.
Information products	Infrastructure management strategy [Outcome: b, c] Infrastructure requirements [Outcome: a] Organization infrastructure [Outcome: b, c, d] Infrastructure change requests [Outcome: b, c] Infrastructure management report [Outcome: d] Infrastructure management record [Outcome: d]

5.3.4 Portfolio management process

Process ID	**ORG.3**
Process name	**Portfolio management process**
	The purpose of the portfolio management process is to initiate and sustain necessary, sufficient and suitable projects in order to meet the strategic objectives of the organization. This process commits the investment of adequate organization funding and resources, and sanctions the authorities needed to establish selected projects. It performs continued assessment of projects to confirm they justify, or can be redirected to justify, continued investment.
Process outcomes	As a result of the successful implementation of the portfolio management process: a) Business venture opportunities, investments or necessities are qualified and prioritized. b) Projects are identified. c) Resources and budgets for each project are allocated. d) Project management responsibilities, accountability, and authorities are defined. e) Projects meeting agreement and stakeholder requirements are sustained. f) Projects not meeting agreement or satisfying stakeholder requirements are redirected or terminated. g) Projects that have completed agreements and satisfied stakeholder requirements are closed.
Base practices	**ORG.3.BP1: Define and authorize projects.** [Outcome: a, b, c, d] 1) Identify potential new or modified capabilities or missions. 2) Prioritize, select and establish new business opportunities, ventures or undertakings. 3) Define projects, accountabilities and authorities. 4) Identify the expected goals, objectives, and outcomes of each project. 5) Identify and allocate resources for the achievement of project goals and objectives. 6) Identify any multi-project interfaces and dependencies to be managed or supported by each project. 7) Specify the project reporting requirements and review milestones that govern the execution of each project. 8) Authorize each project to commence execution of project plans. **ORG.3.BP2: Evaluate the portfolio of projects.** [Outcome: e, f] 1) Evaluate projects to confirm ongoing viability. 2) Act to continue or redirect projects that are satisfactorily progressing or can be expected to progress satisfactorily by appropriate redirection.

	ORG.3.BP3: Terminate projects. [Outcome: f, g] 1) Where agreements permit, act to cancel or suspend projects whose disadvantages or risks to the organization outweigh the benefits of continued investments. 2) After completion of the agreement for products and services, act to close the projects.
Information products	Portfolio management strategy [Outcome: a, b, c, d, e, f, g] Project portfolio [Outcome: a, b] Project authorization [Outcome: c, d] Project direction [Outcome: e, f, g] Organization lessons learned [Outcome: e, f, g] Portfolio management report [Outcome: e, f, g] Portfolio management record [Outcome: e, f, g]

5.3.5 Human resource management process

Process ID	**ORG.4**
Process name	**Human resource management process**
Process purpose	The purpose of the human resource management process is to provide the organization with necessary human resources and to maintain their competencies, consistent with business needs. This process provides a supply of skilled and experienced personnel qualified to perform life cycle processes to achieve organization, project, and stakeholder objectives.
Process outcomes	As a result of the successful implementation of the human resource management process: a) Skills required by projects are identified. b) Necessary human resources are provided to projects. c) Skills of personnel are developed, maintained or enhanced. d) Conflicts in multi-project resource demands are resolved.
Base practices	**ORG.4.BP1: Identify skills.** [Outcome: a, c] 1) Identify skill needs based on current and expected projects. 2) Identify and record skills of personnel. **ORG.4.BP2: Develop skills.** [Outcome: a, c] 1) Establish skills development strategy. 2) Obtain or develop training, education or mentoring resources. 3) Provide planned skill development. 4) Maintain records of skill development.

	ORG.4.BP3: Acquire and provide skills. [Outcome: b, c, d] 1) Obtain qualified personnel when skill deficits are identified. 2) Maintain and manage the pool of skilled personnel necessary to staff ongoing projects. 3) Make project assignments based on project and staff-development needs. 4) Motivate personnel, e.g., through career development and reward mechanisms. 5) Control multi-project management interfaces to resolve personnel conflicts.
Information products	Human resource management strategy [Outcome: a, b, c, d] Human resource requirements [Outcome: a] Qualified personnel [Outcome: b, c, d] Human resource management report [Outcome: c, d] Human resource management record [Outcome: c, d]

5.3.6 Quality management process

Process ID	**ORG.5**
Process name	**Quality management process**
Process purpose	The purpose of the quality management process is to assure that products, services and implementations of the quality management process meet organizational and project quality objectives and achieve customer satisfaction.
Process outcomes	As a result of the successful implementation of the quality management process: a) Organizational quality management policies, objectives, and procedures are defined and implemented. b) Quality evaluation criteria and methods are established. c) Resources and information are provided to projects to support the operation and monitoring of project quality assurance activities. d) Quality assurance evaluation results are gathered and analyzed. e) Quality management policies and procedures are improved based upon project and organizational results.
Base practices	**ORG.5.BP1: Plan quality management.** [Outcome: a, b, c] 1) Establish quality management policies, objectives, and procedures. 2) Define responsibilities and authority for implementation of quality management. 3) Define quality evaluation criteria and methods. 4) Provide resources and information for quality management.

	ORG.5.BP2: Assess quality management. [Outcome: b, d] 1) Gather and analyze quality assurance evaluation results, in accordance with the defined criteria. 2) Assess customer satisfaction. 3) Conduct periodic reviews of project Quality Assurance activities for compliance with the Quality Management policies, objectives, and procedures. 4) Monitor the status of quality improvements on processes, products, and services. **ORG.5.BP3: Perform quality management corrective and preventive action.** [Outcome: d, e] 1) Plan corrective actions when quality management objectives are not achieved. 2) Plan preventive actions when there is a sufficient risk that quality management objectives will not be achieved. 3) Monitor corrective and preventive actions to completion and inform relevant stakeholders.
Information products	Quality management strategy [Outcome: a, b] Quality management criteria and methods [Outcome: b] Quality management system [Outcome: a, b, c, d, e] Quality management corrective action [Outcome: c, e] Quality management report [Outcome: d, e] Quality management evaluation report [Outcome: d] Quality management record [Outcome: d, e]

5.3.7 Knowledge management process

Process ID	**ORG.6**
Process name	**Knowledge management process**
Process purpose	The purpose of the knowledge management process is to create the capability and assets that enable the organization to exploit opportunities to re-apply existing knowledge. This encompasses knowledge, skills, and knowledge assets, including system elements.
Process outcomes	As a result of the successful implementation of the knowledge management process: a) A taxonomy for the application of knowledge assets is identified. b) The organizational knowledge, skills, and knowledge assets are developed or acquired. c) The organizational knowledge, skills, and knowledge assets are available. d) Knowledge management usage data is gathered and analyzed.

Base practices	**ORG.6.BP1: Plan knowledge management.** [Outcome: a, b] 1) Define the knowledge management strategy. 2) Identify the knowledge, skills, and knowledge assets to be managed. 3) Identify projects that can benefit from the application of the knowledge, skills, and knowledge assets. **ORG.6.BP2: Share knowledge and skills throughout the organization.** [Outcome: b, c] 1) Establish and maintain a classification for capturing and sharing knowledge and skills across the organization. 2) Capture or acquire knowledge and skills. 3) Share knowledge and skills across the organization. **ORG.6.BP3: Share knowledge assets throughout the organization.** [Outcome: b, c] 1) Establish a taxonomy to organize knowledge assets. 2) Develop or acquire knowledge assets. 3) Share knowledge assets across the organization. **ORG.6.BP4: Manage knowledge, skills, and knowledge assets.** [Outcome: b, c, d] 1) Maintain knowledge, skills, and knowledge assets. 2) Monitor and record the use of knowledge, skills, and knowledge assets. 3) Periodically reassess the currency of technology and market needs of the knowledge assets.
Information products	Knowledge management strategy [Outcome: a] Knowledge management system [Outcome: b, c] Knowledge asset [Outcome: b] Knowledge management report [Outcome: d]

5.4 Technical management processes (MAN)

5.4.1 General

The technical management processes are concerned with managing the resources and assets allocated by organization management and with applying them to fulfill the agreements into which the organization or organizations enter. The technical management processes relate to the technical effort of projects, in particular to planning in terms of cost, timescales, and achievements, to the checking of actions to help ensure that they comply with plans and performance criteria, and to the identification and selection of corrective actions that recover shortfalls in progress and achievement. They are used to establish and perform technical plans for the project, manage information across the technical team, assess technical progress against the plans for the system products or services, control technical tasks through to completion, and aid in the decision-making process.

Typically, several projects will co-exist in any one organization. The technical management processes can be employed at a corporate level to meet internal needs (ISO/IEC/IEEE 15288).

5.4.2 Project planning process

Process ID	**MAN.1**
Process name	**Project planning process**
Process purpose	The purpose of the project planning process is to produce and coordinate effective and workable plans. This process determines the scope of the project management and technical activities, identifies process outputs, tasks and deliverables, establishes schedules for task conduct, including achievement criteria, and required resources to accomplish tasks. This is an on-going process that continues throughout a project, with regular revisions to plans. NOTE The strategies defined in each of the other processes provide inputs and are integrated in the project planning process. The project assessment and control process is used to assess whether the plans are integrated, aligned, and feasible.
Process outcomes	As a result of the successful implementation of the project planning process: a) Objectives and plans are defined. b) Roles, responsibilities, accountabilities, authorities are defined. c) Resources and services necessary to achieve the objectives are formally requested and committed. d) Plans for the execution of the project are activated.
Base practices	**MAN.1.BP1: Define the project.** [Outcome: a, b] 1) Identify the project objectives and constraints. 2) Define the project scope as established in the agreement. 3) Define and maintain a life cycle model that is comprised of stages using the defined life cycle models of the organization. 4) Establish a work breakdown structure based on the evolving system architecture. 5) Define and maintain the processes that will be applied on the project. **MAN.1.BP2: Plan project and technical management.** [Outcome: b, c] 1) Define and maintain a project schedule based on management and technical objectives and work estimates. 2) Define achievement criteria for the life cycle stage decision gates, delivery dates and major dependencies on external inputs or outputs. 3) Define the costs and plan a budget. 4) Define roles, responsibilities, accountabilities, and authorities. 5) Define the infrastructure and services required. 6) Plan the acquisition of materials and enabling system services supplied from outside the project. 7) Generate and communicate a plan for project and technical management and execution, including reviews.

	MAN.1.BP3: Activate the project. [Outcome: c, d] 1) Obtain authorization for the project. 2) Submit requests and obtain commitments for necessary resources to perform the project. 3) Implement project plans.
Information products	Project objectives [Outcome: a] Project constraints [Outcome: a] Project plan (e.g., Systems Engineering Management Plan) [Outcome: a] Project budget [Outcome: b, c] Work Breakdown Structure [Outcome: b, c] Project schedule [Outcome: b, c] Project infrastructure needs [Outcome: c] Project human resources needs [Outcome: c] Acquisition need [Outcome: c] Project planning record [Outcome: d]

5.4.3 Project assessment and control process

Process ID	**MAN.2**
Process name	**Project assessment and control process**
Process purpose	The purpose of the project assessment and control process is to assess if the plans are aligned and feasible; determine the status of the project, technical and process performance; and direct execution to help ensure that the performance is according to plans and schedules, within projected budgets, to satisfy technical objectives. This process evaluates, periodically and at major events, the progress and achievements against requirements, plans and overall business objectives. Information is provided for management action when significant variances are detected. This process also includes redirecting the project activities and tasks, as appropriate, to correct identified deviations and variations from other technical management or technical processes. Redirection may include re-planning as appropriate.
Process outcomes	As a result of the successful implementation of the project assessment and control process: a) Performance measures or assessment results are available. b) Adequacy of roles, responsibilities, accountabilities, and authorities is assessed. c) Adequacy of resources is assessed. d) Technical progress reviews are performed.

	e) Deviations in project performance from plans are investigated and analyzed. f) Affected stakeholders are informed of project status. g) Corrective action is defined and directed, when project achievement is not meeting targets. h) Project replanning is initiated, as necessary. i) Project action to progress (or not) from one scheduled milestone or event to the next is authorized. j) Project objectives are achieved.
Base practices	**MAN.2.BP1: Plan for project assessment and control.** [Outcome: a] 1) Define the project assessment and control strategy. **MAN.2.BP2: Assess the project.** [Outcome: b, c, d, e, f] 1) Assess alignment of project objectives and plans with the project context. 2) Assess management and technical plans against objectives to determine adequacy and feasibility. 3) Assess project and technical status against appropriate plans to determine actual and projected cost, schedule, and performance variances. 4) Assess the adequacy of roles, responsibilities, accountabilities, and authorities. 5) Assess the adequacy and availability of resources. 6) Assess progress using measured achievement and milestone completion. 7) Conduct required management and technical reviews, audits and inspections. 8) Monitor critical processes and new technologies. 9) Analyze measurement results and make recommendations. 10) Record and provide status and findings from assessment tasks. 11) Monitor process execution within the project. **MAN.2.BP3: Control the project.** [Outcome: g, h, i, j] 1) Initiate necessary actions needed to address identified issues. 2) Initiate necessary project replanning. 3) Initiate change actions when there is a contractual change to cost, time or quality due to the impact of an acquirer or supplier request. 4) Authorize the project to proceed toward the next milestone or event, if justified.

Information products	Project assessment and control approach [Outcome: a] Project measurement needs [Outcome: a] Project performance data [Outcome: a] Project status report [Outcome: a, b, c, d, e, f] Project review result [Outcome d] Project control request [Outcome: g, h] Project change request [Outcome: g, h] Project authorization to proceed request [Outcome: i] Project lessons learned [Outcome: j] Project assessment and control record [Outcome: j]

5.4.4 Decision management process

Process ID	**MAN.3**
Process name	**Decision management process**
Process purpose	The purpose of the decision management process is to provide a structured, analytical framework for objectively identifying, characterizing and evaluating a set of alternatives for a decision at any point in the life cycle and select the most beneficial course of action. NOTE 1 This process is used to resolve technical or project issues and respond to requests for decisions encountered during the system life cycle, in order to identify the alternative(s) that provides the preferred outcomes for the situation. The methods most frequently used for decision management are the trade study and engineering analysis. Each of the alternatives is assessed against the decision criteria (e.g., cost impact, schedule impact, programmatic constraints, regulatory implications, technical performance characteristics, critical quality characteristics, and risk). Results of these comparisons are ranked, via a suitable selection model, and are then used to decide on an optimal solution. Key study data, (e.g., assumptions and decision rationale) are typically maintained to inform decision-makers, and support future decision-making. NOTE 2 When it is necessary to perform a detailed assessment of a parameter for one of the criteria, the system analysis process is employed to perform the assessment.
Process outcomes	As a result of the successful implementation of the decision management process: a) Decisions requiring alternative analysis are identified. b) Alternative courses of action are identified and evaluated. c) A preferred course of action is selected. d) The resolution, decision rationale and assumptions are identified.
Base practices	**MAN.3.BP1: Prepare for decisions.** [Outcome: a] 1) Define a decision management strategy. 2) Identify the circumstances and need for a decision. 3) Involve relevant stakeholders in the decision-making in order to draw on experience and knowledge.

	MAN.3.BP2: Analyze the decision information. [Outcome: b, d] 1) Select and declare the decision management strategy for each decision. 2) Determine desired outcomes and measurable selection criteria. 3) Identify the trade space and alternatives. 4) Evaluate each alternative, against the criteria. **MAN.3.BP3: Make and manage decisions.** [Outcome: c, d] 1) Determine preferred alternative for each decision. 2) Record the resolution, decision rationale, and assumptions. 3) Record, track, evaluate and report decisions.
Information products	Decision management approach [Outcome: a] Decision register [Outcome: a, c, d] Decision management report [Outcome: b, c, d] Decision management record [Outcome: d]

5.4.5 Risk management process

Process ID	**MAN.4**
Process name	**Risk management process**
Process purpose	The purpose of the risk management process is to identify, analyze, treat and monitor the risks continually. The risk management process is a continual process for systematically addressing risk throughout the life cycle of a system product or service. It can be applied to risks related to the acquisition, development, maintenance or operation of a system. NOTE Risk is defined in ISO Guide 73:2009 as "effect of uncertainty on objectives". This definition has a supplementary NOTE 1: "An effect is a deviation from the expected — positive and/or negative." A positive risk is sometimes commonly known as an opportunity, and addressed within the risk management process.
Process outcomes	As a result of the successful implementation of the risk management process: a) Risks are identified. b) Risks are analyzed. c) Risk treatment options are identified, prioritized, and selected. d) Appropriate treatment is implemented. e) Risks are evaluated to assess changes in status and progress in treatment.
Base practices	**MAN.4.BP1: Plan risk management.** [Outcome: a, b, c] 1) Define the risk management strategy. 2) Define and record the context of the Risk Management process. **MAN.4.BP2: Manage the risk profile.** [Outcome: a, b] 1) Define and record the risk thresholds and conditions under which a level of risk may be accepted. 2) Establish and maintain a risk profile. 3) Periodically provide the relevant risk profile to stakeholders based upon their needs.

	MAN.4.BP3: Analyze risks. [Outcome: a, b, c, e] 1) Identify risks in the categories described in the risk management context. 2) Estimate the likelihood of occurrence and consequences of each identified risk. 3) Evaluate each risk against its risk thresholds. 4) For each risk that does not meet its risk threshold, define and record recommended treatment strategies and measures. **MAN.4.BP4: Treat risks.** [Outcome: c, d, e] 1) Identify recommended alternatives for risk treatment. 2) Implement risk treatment alternatives for which the stakeholders determine that actions should be taken to make a risk acceptable. 3) When the stakeholders accept a risk that does not meet its threshold, consider it a high priority and monitor it continually to determine if any future risk treatment actions are necessary. 4) Once a risk treatment is selected, coordinate management action. **MAN.4.BP5: Monitor risks.** [Outcome: a, d, e] 1) Continually monitor all risks and the risk management context for changes and evaluate the risks when their state has changed. 2) Implement and monitor measures to evaluate the effectiveness of risk treatments. 3) Continually monitor for the emergence of new risks and sources throughout the life cycle.
Information products	Risk management approach [Outcome: a, b, c, d, e] Risk register [Outcome: a, b, c, d, e] Risk management report [Outcome: e] Risk management record [Outcome: e]

5.4.6 Configuration management process

Process ID	**MAN.5**
Process name	**Configuration management process**
Process purpose	The purpose of configuration management (CM) is to manage and control system elements and configurations over the life cycle. CM also manages consistency between a product and its associated configuration definition.
Process outcomes	As a result of the successful implementation of the configuration management process: a) Items requiring configuration management are identified and managed. b) Configuration baselines are established. c) Changes to items under configuration management are controlled. d) Configuration status information is available. e) Required configuration audits are completed. f) System releases and deliveries are controlled and approved.

Base practices	**MAN.5.BP1:** Plan configuration management. [Outcome: a, b] 1) Define a configuration management strategy. 2) Define the archive and retrieval approach for configuration items, configuration management artifacts and data. **MAN.5.BP2: Perform configuration identification.** [Outcome: a, b] 1) Identify the system elements and information items that are configuration items. 2) Identify the hierarchy and structure of system information. 3) Establish system, system element, and information item identifiers. 4) Define baselines through the life cycle. 5) Obtain acquirer and supplier agreement to establish a baseline. **MAN.5.BP3: Perform configuration change management.** [Outcome: c, d, f] 1) Identify and record Requests for Change and Requests for Variance. 2) Coordinate, evaluate, and disposition Requests for Change and Requests for Variance. 3) Submit requests for review and approval. 4) Track and manage approved changes to the baseline, Requests for Change, and Requests for Variance. **MAN.5.BP4: Perform configuration status accounting.** [Outcome: d, e] 1) Develop and maintain the configuration management status information, for system elements, baselines, and releases. 2) Capture, store and report configuration management data. **MAN.5.BP5: Perform configuration evaluation.** [Outcome: c, d, e,] 1) Identify the need for CM audits and schedule the events. 2) Verify the product configuration meets the configuration requirements. 3) Monitor the incorporation of approved configuration changes. 4) Assess whether the system meets baseline functional and performance capabilities. 5) Assess whether the system conforms to the operational and configuration information items. 6) Record the CM audit results and disposition action items. **MAN.5.BP6: Perform release control.** [Outcome: f] 1) Approve system releases and deliveries. 2) Track and manage system releases and deliveries.

Information products	Configuration management approach [Outcome: a] Configuration management system [Outcome: a, b, c, d, e, f] Configuration baseline [Outcome: b] Configuration management change request [Outcome c] Configuration management variance request [Outcome c, f] Configuration audit result [Outcome e] Configuration management report [Outcome: a, b, c, d, e, f] Configuration evaluation report [Outcome: d] Configuration management record [Outcome: a, b, c, d, e, f]

5.4.7 Information management process

Process ID	**MAN.6**
Process name	**Information management process**
Process purpose	The purpose of the information management process is to generate, obtain, confirm, transform, retain, retrieve, disseminate, and dispose of information, to designated stakeholders. Information management plans, executes, and controls the provision of information to designated stakeholders that is unambiguous, complete, verifiable, consistent, modifiable, traceable, and presentable. Information includes technical, project, organizational, agreement, and user information. Information is often derived from data records of the organization, system, process, or project.
Process outcomes	As a result of the successful implementation of the information management process: a) Information to be managed is identified. b) Information representations are defined. c) Information is obtained, developed, transformed, stored, validated, presented, and disposed of. d) The status of information is identified. e) Information is available to designated stakeholders.
Base practices	**MAN.6.BP1: Prepare for information management.** [Outcome: a, b] 1) Define the strategy for information management. 2) Define the items of information that will be managed. 3) Designate authorities and responsibilities for information management. 4) Define the content, formats and structure of information items. 5) Define information maintenance actions.

	MAN.6.BP2: Perform information management. [Outcome: c, d, e] 1) Obtain, develop, or transform the identified items of information. 2) Maintain information items and their storage records, and record the status of information. 3) Publish, distribute, or provide access to information and information items to designated stakeholders. 4) Archive designated information. 5) Dispose of unwanted, invalid, or unvalidated information.
Information products	Information management approach [Outcome: a, b] Information register [Outcome: a, b, c, d, e] Information management report [Outcome: e] Information management record [Outcome: c]

5.4.8 Measurement process

Process ID	**MAN.7**
Process name	**Measurement process**
Process purpose	The purpose of the measurement process is to collect, analyze, and report objective data and information to support effective management and demonstrate the quality of the products, services, and processes.
Process outcomes	As a result of the successful implementation of the measurement process: a) Information needs are identified. b) An appropriate set of measures, based on the information needs that are identified or developed. c) Required data is collected, verified, and stored. d) The data is analyzed and the results interpreted. e) Information items provide objective information that support decisions.
Base practices	**MAN.7.BP1: Prepare for measurement.** [Outcome: a, b] 1) Define the measurement strategy. 2) Describe the characteristics of the organization that are relevant to measurement. 3) Identify and prioritize the information needs. 4) Select and specify measures that satisfy the information needs. 5) Define data collection, analysis, access, and reporting procedures. 6) Define criteria for evaluating the information items and the Measurement process. 7) Identify and plan for the necessary enabling systems or services to be used.

	MAN.7.BP2: Perform measurement. [Outcome: c, d, e] 1) Integrate procedures for data generation, collection, analysis, and reporting into the relevant processes. 2) Collect, store, and verify data. 3) Analyze data and develop information items. 4) Record results and inform the measurement users.
Information products	Measurement approach [Outcome: a, b] Measurement register [Outcome: a, b, c, d, e] Measurement report [Outcome: d, e] Measurement record [Outcome: c]

5.4.9 Quality assurance process

Process ID	**MAN.8**
Process name	**Quality assurance process**
Process purpose	The purpose of the quality assurance process is to help ensure the effective application of the organization's quality management process to the project. Quality assurance focuses on providing confidence that quality requirements will be fulfilled. Proactive analysis of the project life cycle processes and outputs is performed to assure that the product being produced will be of the desired quality and that organization and project policies and procedures are followed.
Process outcomes	As a result of the successful implementation of the quality assurance process: a) Project quality assurance procedures are defined and implemented. b) Criteria and methods for quality assurance evaluations are defined. c) Evaluations of the project's products, services, and processes are performed, consistent with quality management policies, procedures, and requirements. d) Results of evaluations are provided to relevant stakeholders. e) Incidents are resolved. f) Prioritized problems are treated. NOTE IEEE 730-2014 software quality assurance processes provides additional detail.
Base practices	**MAN.8.BP1: Prepare for quality assurance.** [Outcome: a, b] 1) Define a quality assurance strategy 2) Establish independence of quality assurance from other life cycle processes. **MAN.8.BP2: Perform product or service evaluations.** [Outcome: b, c] 1) Evaluate products and services for conformance to established criteria, contracts, standards, and regulations. 2) Monitor that verification and validation of the outputs of the life cycle processes are performed to determine conformance to specified requirements.

	MAN.8.BP3: Perform process evaluations. [Outcome: c] 1) Evaluate project life cycle processes for conformance. 2) Evaluate tools and environments that support or automate the process for conformance. 3) Evaluate supplier processes for conformance to process requirements. **MAN.8.BP4: Manage QA records and reports.** [Outcome: d] 1) Create records and reports related to quality assurance activities. 2) Maintain, store, and distribute records and reports. 3) Identify incidents and problems associated with product, service and process evaluations. **MAN.8.BP5: Treat incidents and problems.** [Outcome: d, e, f] 1) Incidents are recorded, analyzed, and classified. 2) Incidents are resolved or elevated to problems. 3) Problems are recorded, analyzed, and classified. 4) Treatments for problems are prioritized and implementation is tracked. 5) Trends in incidents and problems are noted and analyzed. 6) Designated stakeholders are informed of the status of incidents and problems. 7) Incidents and problems are tracked to closure.
Information products	Quality assurance approach [Outcome: a, b] Quality assurance criteria and methods [Outcome: b] Quality assurance system [Outcome: a, b, c, d, e] Quality assurance corrective action [Outcome: e, f] Quality assurance report [Outcome: d, e] Quality assurance evaluation report [Outcome: c, d] Quality assurance record [Outcome: c, d, e, f]

5.5 Technical processes (TEC)

5.5.1 General

The technical processes are concerned with technical actions throughout the life cycle. Technical processes transform the needs of stakeholders into a product and service. By applying that product or operating that service, technical processes provide sustainable performance, when and where needed, in order to meet the stakeholder requirements and achieve customer satisfaction. The technical processes are applied in order to create and use a system, whether it is in the form of a model or is a finished product. The technical processes apply at any level in a hierarchy of system structure and at any stage in the life cycle (ISO/IEC/IEEE 15288).

5.5.2 Business or mission analysis process

Process ID	**TEC.1**
Process name	**Business or mission analysis process**
Process purpose	The purpose of the business or mission analysis process is to define the business or mission problem or opportunity, characterize the solution space, and determine potential solution class(es) that could address a problem or take advantage of an opportunity.
Process outcomes	As a result of the successful implementation of the business or mission analysis process: a) The problem or opportunity space is defined. b) The solution space is characterized. c) Preliminary operational concepts and other concepts in the life cycle stages are defined. d) Candidate alternative solution classes are identified and analyzed. e) The preferred candidate alternative solution class(es) are selected. f) Any enabling systems or services needed for business or mission analysis are available. g) Traceability of business or mission problems and opportunities and the preferred alternative solution classes is established.
Base practices	**TEC.1.BP1: Prepare for business or mission analysis.** [Outcome: a, f] 1) Review identified problems and opportunities in the organization strategy with respect to desired organization goals or objectives. 2) Define the business or mission analysis strategy. 3) Identify and plan for the necessary enabling systems or services needed to support business or mission analysis. 4) Obtain or acquire access to the enabling systems or services to be used. **TEC.1.BP2: Define the problem or opportunity space.** [Outcome: b, c] 1) Analyze the problems and opportunities in the context of relevant trade-space factors. 2) Define the mission, business, or operational problem or opportunity. **TEC.1.BP3: Characterize the solution space.** [Outcome: b, c, d] 1) Define preliminary operational concepts and other concepts in life cycle stages. 2) Identify candidate alternative solution classes that span the potential solution space. **TEC.1.BP4: Evaluate alternative solution classes.** [Outcome: d, e] 1) Assess each alternative solution class. 2) Select the preferred alternative solution class(es).

	TEC.1.BP5: Manage the business or mission analysis. [Outcome: g] 1) Maintain traceability of business or mission analysis. 2) Provide key information items that have been selected for baselines.
Information products	Business or mission analysis approach [Outcome: a, b, c] Problem or opportunity statement [Outcome: a] Life cycle concepts [Outcome: c] Validation criteria [Outcome: b] Alternative solution classes [Outcome: b, d, e] Requirements imposed on enabling systems [Outcome f] Traceability mapping [Outcome: g] Business or mission analysis record [Outcome: a, b, c, d, e, f, g]

5.5.3 Stakeholder needs and requirements definition process

Process ID	**TEC.2**
Process name	**Stakeholder needs and requirements definition process**
Process purpose	The purpose of the stakeholder needs and requirements definition process is to define the stakeholder requirements for a system that can provide the capabilities needed by users and other stakeholders in a defined environment. It identifies stakeholders, or stakeholder classes, involved with the system throughout its life cycle, and their needs. It analyzes and transforms these needs into a common set of stakeholder requirements that express the intended interaction the system will have with its operational environment and that are the reference against which each resulting operational capability is validated. The stakeholder requirements are defined considering the context of the system of interest with the interoperating systems and enabling systems.
Process outcomes	As a result of the successful implementation of the stakeholder needs and requirements definition process: a) Stakeholders of the system are identified. b) Required characteristics and context of use of capabilities and concepts in the life cycle stages, including operational concepts, are defined. c) Constraints on a system are identified. d) Stakeholder needs are defined. e) Stakeholder needs are prioritized and transformed into clearly defined stakeholder requirements. f) Critical performance measures are defined. g) Stakeholder agreement that their needs and expectations are reflected adequately in the requirements is achieved. h) Any enabling systems or services needed for stakeholder needs and requirements are available. i) Traceability of stakeholder requirements to stakeholders and their needs is established.

Base practices	**TEC.2.BP1: Prepare for stakeholder needs and requirements definition.** [Outcome: a, d, h] 1) Identify the stakeholders who have an interest in the system throughout its life cycle. 2) Define the stakeholder needs and requirements definition strategy. 3) Identify and plan for the necessary enabling systems or services needed to support stakeholder needs and requirements definition. 4) Obtain or acquire access to the enabling systems or services to be used. **TEC.2.BP2: Define stakeholder needs.** [Outcome: b, d, e] 1) Define context of use within the concept of operations and the preliminary life cycle concepts. 2) Identify stakeholder needs. 3) Prioritize and down-select needs. 4) Define the stakeholder needs and rationale. **TEC.2.BP3: Develop the operational concept and other life cycle concepts.** [Outcome: b, d] 1) Define a representative set of scenarios to identify all required capabilities that correspond to anticipated operational and other life cycle concepts. 2) Identify the interaction between users and the system. **TEC.2.BP4: Transform stakeholder needs into stakeholder requirements.** [Outcome: c, d, e] 1) Identify the constraints on a system solution. 2) Identify the stakeholder requirements and functions that relate to critical quality characteristics, such as assurance, safety, security, environment, or health. 3) Define stakeholder requirements, consistent with life cycle concepts, scenarios, interactions, constraints, and critical quality characteristics. **TEC.2.BP5: Analyze stakeholder requirements.** [Outcome: e, f, g] 1) Analyze the complete set of stakeholder requirements. 2) Define critical performance measures that enable the assessment of technical achievement. 3) Feed back the analyzed requirements to applicable stakeholders to validate that their needs and expectations have been adequately captured and expressed. 4) Resolve stakeholder requirements issues. **TEC.2.BP6: Manage the stakeholder needs and requirements definition.** [Outcome: g, i] 1) Obtain explicit agreement on the stakeholder requirements. 2) Maintain traceability of stakeholder needs and requirements. 3) Provide key information items that have been selected for baselines.

Information products	Stakeholder needs and requirements definition approach [Outcome: a, b, c, d] Stakeholder identification [Outcome: a] Life cycle concepts [Outcome: b] Stakeholder requirements [Outcome: e, g] Validation criteria [Outcome: e, g] Critical performance measurement needs [Outcome: f] Critical performance data [Outcome: f] Requirements imposed on enabling systems [Outcome h] Traceability mapping [Outcome: i] Stakeholder needs and requirements definition record [Outcome: a, b, c, d, e, f, g, h, i]

5.5.4 System requirements definition process

Process ID	**TEC.3**
Process name	**System requirements definition process**
Process purpose	The purpose of the system requirements definition process is to transform the stakeholder, user-oriented view of desired capabilities into a technical view of a solution that meets the operational needs of the user. This process creates a set of measurable system requirements that specify, from the supplier's perspective, what characteristics, attributes, and functional and performance requirements the system is to possess, in order to satisfy stakeholder requirements. As far as constraints permit, the requirements should not imply any specific implementation.
Process outcomes	As a result of the successful implementation of the system requirements definition process: a) The system description, including system interfaces, functions and boundaries, for a system solution is defined. b) System requirements (functional, performance, process, non-functional, and interface) and design constraints are defined. c) Critical performance measures are defined. d) The system requirements are analyzed. e) Any enabling systems or services needed for system requirements definition are available. f) Traceability of system requirements to stakeholder requirements is developed.
Base practices	**TEC.3.BP1: Prepare for system requirements definition.** [Outcome: a, b, e] 1) Define the functional boundary of the system in terms of the behavior and properties to be provided. 2) Define the system requirements definition strategy. 3) Identify and plan for the necessary enabling systems or services needed to support system requirements definition. 4) Obtain or acquire access to the enabling systems or services to be used.

	TEC.3.BP2: Define system requirements. [Outcome: b, d] 1) Define each function that the system is required to perform. 2) Define necessary implementation constraints. 3) Identify system requirements that relate to risks, criticality of the system, or critical quality characteristics. 4) Define system requirements and rationale. **TEC.3.BP3: Analyze system requirements.** [Outcome: c, d] 1) Analyze the complete set of system requirements. 2) Define critical performance measures that enable the assessment of technical achievement. 3) Feed back the analyzed requirements to applicable stakeholders for review. 4) Resolve system requirements issues. **TEC.3.BP4: Manage system requirements.** [Outcome: d, f] 1) Obtain explicit agreement on the system requirements. 2) Provide key information items that have been selected for baselines. 3) Maintain traceability of the system requirements.
Information products	System requirements definition approach [Outcome: a, b, c] System function model [Outcome: a] System requirements [Outcome: a, b, d] Verification criteria [Outcome: a, b, d] Critical performance measurement needs [Outcome: c] Critical performance data [Outcome: c] Requirements imposed on enabling systems [Outcome e] Traceability mapping [Outcome: f] System requirements definition record [Outcome: a, b, c, d, e, f]

5.5.5 Architecture definition process

Process ID	**TEC.4**
Process name	**Architecture definition process**
Process purpose	The purpose of the architecture definition process is to generate system architecture alternatives, to select one or more alternative(s) that frame stakeholder concerns and meet system requirements, and to express this in a set of consistent views. Iteration of the architecture definition process with the business or mission analysis process, system requirements definition process, design definition process, and stakeholder needs and requirements definition process is often employed so that there is a negotiated understanding of the problem to be solved and a satisfactory solution is identified. The results of the architecture definition process are widely used across the life cycle processes. Architecture definition may be applied at many levels of abstraction, highlighting the relevant detail that is necessary for the decisions at that level.

Process outcomes	As a result of the successful implementation of the architecture definition process: a) Identified stakeholder concerns are addressed by the architecture. b) Architecture viewpoints are developed. c) Context, boundaries, and external interfaces of the system are defined. d) Architecture views and models of the system are developed. e) Concepts, properties, characteristics, behaviors, functions, or constraints that are significant to architecture decisions of the system are allocated to architectural entities. f) System elements and their interfaces are identified. g) Architecture candidates are assessed. h) An architectural basis for processes throughout the life cycle is achieved. i) Alignment of the architecture with requirements and design characteristics is achieved. j) Any enabling systems or services needed for architecture definition are available. k) Traceability of architecture elements to stakeholder and system requirements is developed.
Base practices	**TEC.4.BP1: Prepare for architecture definition.** [Outcome: a, b, c, h, j] 1) Review pertinent information and identify key drivers of the architecture. 2) Identify stakeholder concerns. 3) Define the architecture definition roadmap, approach, and strategy. 4) Define evaluation criteria based on stakeholder concerns and key requirements. 5) Identify and plan for the necessary enabling systems or services needed to support the architecture definition process. 6) Obtain or acquire access to the enabling systems or services to be used. **TEC.4.BP2: Develop architecture viewpoints.** [Outcome: b, c, d, e] 1) Select, adapt, or develop viewpoints and model kinds based on stakeholder concerns. 2) Establish or identify potential architecture framework(s) to be used in developing models and views. 3) Capture rationale for selection of framework(s), viewpoints, and model types. 4) Select or develop supporting modeling techniques and tools.

	TEC.4.BP3: Develop models and views of candidate architectures. [Outcome: b, c, d, e, f, h] 1) Define the system context and boundaries in terms of interfaces and interactions with external entities. 2) Identify architectural entities and relationships between entities that address key stakeholder concerns and critical system requirements. 3) Allocate concepts, properties, characteristics, behaviors, functions, or constraints that are significant to architecture decisions of the system to architectural entities. 4) Select, adapt, or develop models of the candidate architectures of the system. 5) Compose views from the models in accordance with identified viewpoints to express how the architecture addresses stakeholder concerns and meets stakeholder and system requirements. 6) Harmonize the architecture models and views with each other. **TEC.4.BP4: Relate the architecture to design.** [Outcome: c, f, i, h] 1) Identify system elements that relate to architectural entities and the nature of these relationships. 2) Define the interfaces and interactions between the system elements and with external entities. 3) Partition, align, and allocate requirements to architectural entities and system elements. 4) Map system elements and architectural entities to design characteristics. 5) Define principles for the system design and evolution. **TEC.4.BP5: Assess architecture candidates.** [Outcome: g, h, i] 1) Assess each candidate architecture against constraints and requirements. 2) Assess each candidate architecture against stakeholder concerns using evaluation criteria. 3) Select the preferred architecture(s) and capture key decisions and rationale. 4) Establish the architecture baseline of the selected architecture. **TEC.4.BP6: Manage the selected architecture.** [Outcome: h, i, k] 1) Formalize the architecture governance approach and specify governance related roles and responsibilities, accountabilities, and authorities (related to design, quality, security, safety, etc.). 2) Obtain explicit acceptance of the architecture by stakeholders. 3) Maintain concordance and completeness of the architectural entities and their architectural characteristics. 4) Organize, assess, and control evolution of the architecture models and views. 5) Maintain the architecture definition and evaluation strategy.

	6) Maintain traceability of the architecture. 7) Provide key information items that have been selected for baselines.
Information products	Architecture definition approach [Outcome: a, h] System architecture model [Outcome: b, c, d, e, f, g, h, i] System architecture rationale [Outcome: b, c, d, e, f, g, h, i] System interface definition [Outcome: c, f] Critical performance measurement needs [Outcome: g] Critical performance data [Outcome: g] System architecture assessment report [Outcome: g] Requirements imposed on enabling systems [Outcome j] Traceability mapping [Outcome: k] Architecture definition record [Outcome: h]

5.5.6 Design definition process

Process ID	**TEC.5**
Process name	**Design definition process**
Process purpose	The purpose of the design definition process is to provide sufficient detailed data and information about the system and its elements to enable the implementation consistent with architectural entities as defined in models and views of the system architecture.
Process outcomes	As a result of the successful implementation of the design definition process: a) Design characteristics of each system element are defined. b) System requirements are allocated to system elements. c) Design enablers necessary for design definition are selected or defined. d) Interfaces between system elements composing the system are defined or refined. e) Design alternatives for system elements are assessed. f) Design artifacts are developed. g) Any enabling systems or services needed for design definition are available. h) Traceability of the design characteristics to the architectural entities of the system architecture is established.
Base practices	**TEC.5.BP1: Prepare for design definition.** [Outcome: a, c, g] 1) Determine technologies required for each system element composing the system. 2) Determine the necessary design characteristics types. 3) Define principles for evolution of the design. 4) Define the design definition strategy. 5) Identify and plan for the necessary enabling systems or services needed to support design definition.

	TEC.5.BP2: Establish design characteristics and design enablers related to each system element. [Outcome: b, c, d, e, f] 1) Allocate system requirements to system elements. 2) Transform architectural characteristics into design characteristics. 3) Define the necessary design enablers. 4) Examine design alternatives. 5) Establish the design artifacts. 6) Refine or define the interfaces between the system elements and with external entities. **TEC.5.BP3 Assess alternatives for obtaining system elements.** [Outcome: b, c, e, f] 1) Identify any candidate Non-Developmental-Items (NDI) that may be considered for use. 2) Assess each candidate NDI and new design alternative against criteria developed from expected design characteristics or system element requirements to determine suitability for the intended application. 3) Determine the preferred alternative among any candidate NDI solutions and new design alternatives for a system element. **TEC.5.BP4 Manage the design.** [Outcome: a, b, h] 1) Map design characteristics up to the system elements. 2) Capture design and rationale 3) Maintain traceability of design. 4) Provide key information items that have been selected for baselines.
Information products	Design definition approach [Outcome: a, b, c] System design model [Outcome: a, c, d, f] System design rationale [Outcome: a, c, d, f] System interface definition [Outcome: d] System element description [Outcome: a, b, d, e, f] Critical performance measurement needs [Outcome: e] Critical performance data [Outcome: e] System design assessment report [Outcome: e] Requirements imposed on enabling systems [Outcome g] Traceability mapping [Outcome: h] Design definition record [Outcome: f]

5.5.7 System analysis process

Process ID	**TEC.6**
Process name	**System analysis process**
Process purpose	The purpose of the system analysis process is to provide a rigorous basis of data and information for technical understanding to aid decision-making across the life cycle. The system analysis process applies to the development of inputs needed for any technical assessment. It can provide confidence in the utility and integrity of system requirements, architecture, and design. System analysis covers a wide range of differing analytic functions, levels of complexity, and levels of rigor. It includes mathematical analysis, modeling, simulation, experimentation, and other techniques to analyze technical performance, system behavior, feasibility, affordability, critical quality characteristics, technical risks, life cycle costs, and to perform sensitivity analysis of the potential range of values for parameters across all life cycle stages. It is used for a wide range of analytical needs concerning operational concepts, determination of requirement values, resolution of requirements conflicts, assessment of alternative architectures or system elements, and evaluation of engineering strategies (integration, verification, validation, and maintenance). Formality and rigor of the analysis will depend on the criticality of the information need or work product supported, the amount of information/data available, the size of the project, and the schedule for the results.
Process outcomes	As a result of the successful implementation of the system analysis process: a) System analyses needed are identified. b) System analysis assumptions and results are validated. c) System analysis results are provided for decisions. d) Any enabling systems or services needed for system analysis are available. e) Traceability of the system analysis results is established.
Base practices	**TEC.6.BP1: Prepare for system analysis.** [Outcome: a, c, d] 1) Identify the problem or question that requires system analysis. 2) Identify the stakeholders of the system analysis. 3) Define the scope, objectives, and level of fidelity of the system analysis. 4) Select the system analysis methods. 5) Define the system analysis strategy. 6) Identify and plan for the necessary enabling systems or services needed to support System analysis. 7) Obtain or acquire access to the enabling systems or services to be used. 8) Collect the data and inputs needed for the analysis.

	TEC.6.BP2: Perform system analysis. [Outcome: b, c] 1) Identify and validate assumptions. 2) Apply the selected analysis methods to perform the required system analysis. 3) Review the analysis results for quality and validity. 4) Establish conclusions and recommendations. 5) Record the results of the system analysis. **TEC.6.BP3: Manage system analysis.** [Outcome: e] 1) Maintain traceability of system analysis results. 2) Provide key information items that have been selected for baselines.
Information products	System analysis approach [Outcome a, b] Requirements imposed on enabling systems [Outcome d] Traceability mapping [Outcome: e] System analysis report [Outcome c] System analysis record [Outcome c, e]

5.5.8 Implementation process

Process ID	**TEC.7**
Process name	**Implementation process**
Process purpose	The purpose of the implementation process is to realize a specified system element. This process transforms requirements, architecture, design, including interface, into actions that create a system element according to the practices of the selected implementation technology, using appropriate technical specialties or disciplines. This process results in a system element that satisfies specified system requirements (including allocated and derived requirements), architecture, and design.
Process outcomes	As a result of the successful implementation of the implementation process: a) Implementation constraints that influence the requirements, architecture, or design are identified. b) A system element is realized. c) A system element is packaged or stored. d) Any enabling systems or services needed for implementation are available. e) Traceability is established.

Base practices	**TEC.7.BP1: Prepare for implementation.** [Outcome: a, d] 1) Define an implementation strategy. 2) Identify constraints from the implementation strategy and implementation technology on the system requirements, architecture characteristics, design characteristics, or implementation techniques. 3) Identify and plan for the necessary enabling systems or services needed to support implementation. 4) Obtain or acquire access to the enabling systems or services, and materials to be used. **TEC.7.BP2: Perform implementation.** [Outcome: b, c] 1) Realize or adapt system elements, according to the strategy, constraints, and defined implementation procedures. 2) Package and store the system element. 3) Record objective evidence that the system element meets system requirements. **TEC.7.BP3: Manage results of implementation.** [Outcome: e] 1) Record implementation results and any anomalies encountered. 2) Maintain traceability of the implemented system elements. 3) Provide key information items that have been selected for baselines.
Information products	Implementation approach [Outcome a, b, c, d, e] Constraints on solution [Outcome a] System element [Outcome b, c] System element description [Outcome b, c] Requirements imposed on enabling systems [Outcome d] Traceability mapping [Outcome: e] Implementation report [Outcome a, b, c, d, e] Implementation record [Outcome a, b, c, d, e]

5.5.9 Integration process

Process ID	**TEC.8**
Process name	**Integration process**
Process purpose	The purpose of the integration process is to synthesize a set of system elements into a realized system (product or service) that satisfies system requirements, architecture, and design. This process assembles the implemented system elements. Interfaces are identified and activated to enable interoperation of the system elements as intended. This process integrates the enabling systems with the system-of-interest to facilitate interoperation.

Process outcomes	As a result of the successful implementation of the integration process: a) Integration constraints that influence system requirements, architecture, or design, including interfaces, are identified. b) Approach and checkpoints for the correct operation of the assembled interfaces and system functions are defined. c) Any enabling systems or services needed for integration are available. d) A system composed of implemented system elements is integrated. e) The interfaces between the implemented system elements that compose the system are checked. f) The interfaces between the system and the external environment are checked. g) Integration results and anomalies are identified. h) Traceability of the integrated system elements is established.
Base practices	**TEC.8.BP1: Prepare for integration.** [Outcome: a, b, c] 1) Identify and define check points for the correct operation and integrity of the assembled interfaces and the selected system functions. 2) Define the integration strategy. 3) Identify and plan for the necessary enabling systems or services needed to support integration. 4) Obtain or acquire access to the enabling systems or services, and materials to be used. 5) Identify system constraints from integration to be incorporated in the system requirements, architecture or design. **TEC.8.BP2: Perform integration — Successively integrate system element configurations until the complete system is synthesized.** [Outcome: d, e, f] 1) Obtain implemented system elements in accordance with agreed schedules. 2) Assemble the implemented system elements. 3) Perform check of the interfaces, selected functions, and critical quality characteristics. **TEC.8.BP3: Manage results of integration.** [Outcome: g, h] 1) Record integration results and any anomalies encountered. 2) Maintain traceability of the integrated system elements. 3) Provide key information items that have been selected for baselines.

Information products	Integration approach [Outcome b] Constraints on solution [Outcome a] Integrated system or system element [Outcome d] System interface definition [Outcome: e, f] Requirements imposed on enabling systems [Outcome c] Traceability mapping [Outcome: g] Integration report [Outcome g] Integration record [Outcome a, b, c, d, e, f, g, h]

5.5.10 Verification process

Process ID	**TEC.9**
Process name	**Verification process**
Process purpose	The purpose of the verification process is to provide objective evidence that a system or system element fulfils its specified requirements and characteristics. The verification process identifies the anomalies (errors, defects, or faults) in any information item (e.g., system requirements or architecture description), implemented system elements, or life cycle processes using appropriate methods, techniques, standards, or rules. This process provides the necessary information to determine resolution of identified anomalies.
Process outcomes	As a result of the successful implementation of the verification process: a) Constraints of verification that influence the requirements, architecture, or design are identified. b) Any enabling systems or services needed for verification are available. c) The system or system element is verified. d) Data providing information for corrective actions is reported. e) Objective evidence that the realized system fulfils the requirements, architecture and design is provided. f) Verification results and anomalies are identified. g) Traceability of the verified system elements is established.

Base practices	**TEC.9.BP1: Prepare for verification.** [Outcome: a, b] 1) Identify the verification scope and corresponding verification actions. 2) Identify the constraints that potentially limit the feasibility of verification actions. 3) Select appropriate verification methods or techniques and associated criteria for every verification action. 4) Define the verification strategy. 5) Identify system constraints from the verification strategy to be incorporated in the system requirements, architecture, or design. 6) Identify and plan for the necessary enabling systems or services needed to support verification. 7) Obtain or acquire access to the enabling systems or services to be used to support verification. **TEC.9.BP2: Perform verification.** [Outcome: c, e, f] 1) Define the verification procedures, each supporting one or a set of verification actions. 2) Perform the verification procedures. **TEC.9.BP3: Manage results of verification.** [Outcome: d, e, f, g] 1) Review verification results and any anomalies encountered. 2) Record operational incidents and problems and track their resolution. 3) Obtain stakeholder agreement that the system or system element meets the specified requirements. 4) Maintain traceability of the verified system elements. 5) Provide key information items that have been selected for baselines.
Information products	Verification approach [Outcome a, b, c, d, e, f, g] Constraints on solution [Outcome a] Verification criteria [Outcome: e] Verified system [Outcome c] Requirements imposed on enabling systems [Outcome b] Traceability mapping [Outcome: g] Verification report [Outcome d, e, f] Verification record [Outcome a, b, c, d, e, f, g]

5.5.11 Transition process

Process ID	**TEC.10**
Process name	**Transition process**
Process purpose	The purpose of the transition process is to establish a capability for a system to provide services specified by stakeholder requirements in the operational environment. This process moves the system in an orderly, planned manner into the operational status, such that the system is functional, operable, and compatible with other operational systems. It installs a verified system, together with relevant enabling systems, e.g., planning system, support system, operator training system, user training system, as defined in agreements. This process is used at each level in the system structure and in each stage to complete the criteria established for exiting the stage. It includes preparing applicable storage, handling, and shipping enabling systems.
Process outcomes	As a result of the successful implementation of the transition process: a) Transition constraints that influence system requirements, architecture, or design are identified. b) Any enabling systems or services needed for transition are available. c) The site is prepared. d) The system installed in its operational location is capable of delivering its specified functions. e) Operators, users and other stakeholders necessary to the system utilization and support are trained. f) Transition results and anomalies are identified. g) The installed system is activated and ready for operation. h) Traceability of the transitioned elements is established.
Base practices	**TEC.10.BP1: Prepare for transition.** [Outcome: a, b, c] 1) Define a transition strategy. 2) Identify and define any facility or site changes needed. 3) Identify and arrange training of operators, users, and other stakeholders necessary for system utilization and support. 4) Identify system constraints from transition to be incorporated in the system requirements, architecture or design. 5) Identify and plan for the necessary enabling systems or services needed to support transition. 6) Obtain or acquire access to the enabling systems or services to be used. 7) Identify and arrange shipping and receiving of system elements and enabling systems.

	TEC.10.BP2: Perform the transition. [Outcome: c, d, e, g] 1) Prepare the site of operation in accordance with installation requirements. 2) Deliver the system for installation at the correct location and time. 3) Install the system in its operational location and interface to its environment. 4) Demonstrate proper installation of the system. 5) Provide training of the operators, users, and other stakeholders necessary for system utilization and support. 6) Perform activation and check-out of the system. 7) Demonstrate the installed system is capable of delivering its required functions. **TEC.10.BP3: Manage results of transition.** [Outcome: f, h] 1) Record transition results and any anomalies encountered. 2) Record operational incidents and problems and track their resolution. 3) Maintain traceability of the transitioned system elements. 4) Provide key information items that have been selected for baselines.
Information products	Transition approach [Outcome a] Constraints on solution [Outcome a] Installed system [Outcome c, d, g] Requirements imposed on enabling systems [Outcome b] Traceability mapping [Outcome: h] Transition report [Outcome f] Transition record [Outcome a, b, c, d, e, f, g, h]

5.5.12 Validation process

Process ID	**TEC.11**
Process name	**Validation process**
Process purpose	The purpose of the validation process is to provide objective evidence that the system, when in use, fulfills its business or mission objectives and stakeholder requirements, achieving its intended use in its intended operational environment. The objective of validating a system or system element is to acquire confidence in its ability to achieve its intended mission, or use, under specific operational conditions. Validation is ratified by stakeholders. This process provides the necessary information so that identified anomalies can be resolved by the appropriate technical process where the anomaly was created.

Process outcomes	As a result of the successful implementation of the validation process: a) Validation criteria for stakeholder requirements are defined. b) The availability of services required by stakeholders is confirmed. c) Constraints of validation that influence the requirements, architecture, or design are identified. d) The system or system element is validated. e) Any enabling systems or services needed for validation are available. f) Validation results and anomalies are identified. g) Objective evidence that the realized system or system element satisfies stakeholder needs is provided. h) Traceability of the validated system elements is established.
Base practices	**TEC.11.BP1: Prepare for validation.** [Outcome: a, b, c, e] 1) Identify the validation scope and corresponding validation actions. 2) Identify the constraints that potentially limit the feasibility of validation actions. 3) Select appropriate validation methods or techniques and associated criteria for each validation action. 4) Define the validation strategy. 5) Identify system constraints from the validation strategy to be incorporated in the stakeholder requirements. 6) Identify and plan for the necessary enabling systems or services needed to support validation. 7) Obtain or acquire access to the enabling systems or services to be used to support validation. **TEC.11.BP2: Perform validation.** [Outcome: b, d, f] 1) Define the validation procedures, each supporting one or a set of validation actions. 2) Perform the validation procedures in the defined environment. 3) Review validation results to confirm that the services of the system that are required by stakeholders are available. **TEC.11.BP3: Manage results of validation.** [Outcome: f, g, h] 1) Record validation results and any anomalies encountered. 2) Record operational incidents and problems and track their resolution. 3) Obtain stakeholder agreement that the system or system element meets the stakeholder needs. 4) Maintain traceability of the validated system elements. 5) Provide key information items that have been selected for baselines.

Information products	Validation approach [Outcome a, c] Constraints on solution [Outcome c] Validation criteria [Outcome: a] Validated system [Outcome b, d] Requirements imposed on enabling systems [Outcome e] Traceability mapping [Outcome: h] Validation report [Outcome f, g] Validation record [Outcome a, b, e, f, g]

5.5.13 Operation process

Process ID	**TEC.12**
Process name	**Operation process**
Process purpose	The purpose of the operation process is to use the system to deliver its services. This process establishes requirements for and assigns personnel to operate the system, and monitors the services and operator-system performance. In order to sustain services, it identifies and analyzes operational anomalies in relation to agreements, stakeholder requirements and organizational constraints. NOTE ISO/IEC 20000-1 provides requirements for establishing a service management system, which supports the Operation process to achieve its purpose.
Process outcomes	As a result of the successful implementation of the operation process: a) Operation constraints that influence system requirements, architecture, or design are identified. b) Any enabling systems, services, and material needed for operation are available. c) Trained, qualified operators are available. d) System services that meet stakeholder requirements are delivered. e) System performance during operation is monitored. f) Support to the customer is provided.
Base practices	**TEC.12.BP1: Prepare for operation.** [Outcome: a, b, c] 1) Define an operation strategy. 2) Identify system constraints from operation to be incorporated in the system requirements, architecture, or design. 3) Identify and plan for the necessary enabling systems or services needed to support operation. 4) Obtain or acquire access to the enabling systems or services to be used. 5) Identify or define training and qualification requirements for personnel needed for system operation. 6) Assign trained, qualified personnel to be operators.

	TEC.12.BP2: Perform operation. [Outcome: d, e, f] 1) Use the system in its intended operational environment. 2) Apply materials and other resources, as required, to operate the system and sustain its services. 3) Monitor system operation. 4) Identify and record when system service performance is not within acceptable parameters. 5) Perform system contingency operations, if necessary. **TEC.12.BP3: Manage results of operation.** [Outcome: e] 1) Record results of operation and any anomalies encountered. 2) Record operational incidents and problems and track their resolution. 3) Maintain traceability of the operations elements. 4) Provide key information items that have been selected for baselines. **TEC.12.BP4: Support the customer.** [Outcome: d, e, f] 1) Provide assistance and consultation to the customers as requested. 2) Record and monitor requests and subsequent actions for support. 3) Determine the degree to which delivered system services satisfy the needs of the customers.
Information products	Operation approach [Outcome a] Constraints on solution [Outcome a] Trained operator [Outcome c] Operational system [Outcome d, f] Requirements imposed on enabling systems [Outcome b] Traceability mapping [Outcome: e] Operation report [Outcome e] Operation record [Outcome a, b, c, d, e, f]

5.5.14 Maintenance process

Process ID	**TEC.13**
Process name	**Maintenance process**
Process purpose	The purpose of the maintenance process is to sustain the capability of the system to provide a service. This process monitors the system's capability to deliver services, records incidents for analysis, takes corrective, adaptive, perfective, and preventive actions and confirms restored capability.

Process outcomes	As a result of the successful implementation of the maintenance process: a) Maintenance constraints that influence system requirements, architecture, or design are identified. b) Any enabling systems or services needed for maintenance are available. c) Replacement, repaired, or revised system elements are made available. d) The need for changes to address corrective, perfective, or adaptive maintenance is reported. e) Failure and lifetime data, including associated costs, is determined.
Base practices	**TEC.13.BP1: Prepare for maintenance.** [Outcome: a, b] 1) Define a maintenance strategy. 2) Identify system constraints from maintenance to be incorporated in the system requirements, architecture, or design. 3) Identify trades such that the system and associated maintenance and logistics actions results in a solution that is affordable, operable, supportable, and sustainable. 4) Identify and plan for the necessary enabling systems or services needed to support maintenance. 5) Obtain or acquire access to the enabling systems or services to be used. **TEC.13.BP2: Perform maintenance.** [Outcome: c, d, e] 1) Review incident and problem reports to identify future corrective, adaptive, perfective, and preventive maintenance needs. 2) Record maintenance incidents and problems and track their resolution. 3) Implement the procedures for correction of random faults or scheduled replacement of system elements. 4) Upon encountering random faults that cause a system failure, deploy actions to restore the system to operational status. 5) Perform preventive maintenance by replacing or servicing system elements prior to failure, according to planned schedules and maintenance procedures. 6) Perform failure identification actions when a non-compliance has occurred in the system. 7) Identify when adaptive or perfective maintenance is required. **TEC.13.BP3: Perform logistics support.** [Outcome: b, c] 1) Perform acquisition logistics. 2) Perform operational logistics. 3) Implement any packaging, handling, storage, and transportation needed during the life cycle. 4) Confirm that logistics actions satisfy the required replenishment levels so that stored system elements meet repair rates and planned schedules. 5) Confirm that logistics actions include supportability requirements that are planned, resourced, and implemented.

	TEC.13.BP4: Manage results of maintenance and logistics. [Outcome: d, e] 1) Record maintenance and logistics results and any anomalies encountered. 2) Record operational incidents and problems and track their resolution. 3) Identify and record trends of incidents, problems, and maintenance and logistics actions. 4) Maintain traceability of the maintenance elements. 5) Provide key information items that have been selected for baselines. 6) Monitor customer satisfaction with system and maintenance support.
Information products	Maintenance approach [Outcome a] Constraints on solution [Outcome a] Trained maintainer [Outcome b] Maintained system [Outcome c] Requirements imposed on enabling systems [Outcome b] Traceability mapping [Outcome: d] Maintenance report [Outcome d, e] Maintenance record [Outcome a, b, c, d, e]

5.5.15 Disposal process

Process ID	**TEC.14**
Process name	**Disposal process**
Process purpose	The purpose of the disposal process is to end the existence of a system element or system for a specified intended use, appropriately handle replaced or retired elements, and to properly attend to identified critical disposal needs (e.g., per an agreement, per organizational policy, or for environmental, legal, safety, security aspects). This process deactivates, disassembles, and removes the system or any of its system elements from the specific use. It addresses any waste products, consigning them to a final condition and returning the environment to its original or an acceptable condition. The waste products can be in-process resulting during any life cycle stage, e.g., waste materials during fabrication. This process destroys, stores, or reclaims system elements and waste products in an environmentally sound manner, in accordance with legislation, agreements, organizational constraints, and stakeholder requirements. Disposal includes preventing expired, non-reusable, or inadequate elements from getting back into the supply chain. Where required, it maintains records in order that the health of operators and users, and the safety of the environment, can be monitored. When part of the system will continue to be in use in a modified form, the Disposal process helps ensure the proper handling of the portion being retired. NOTE The disposal process is intended to be applicable throughout the life cycle of the system, including disposing prototypes during the Concept and Development stages, dealing with waste during the Production stage, and decommissioning elements from modifications during the Utilization and Support stages.

Process outcomes	As a result of the successful implementation of the disposal process: a) Disposal constraints are provided as inputs to requirements, architecture, design, and implementation. b) Any enabling systems or services needed for disposal are available. c) The system elements or waste products are destroyed, stored, reclaimed, or recycled in accordance with safety and security requirements. d) The environment is returned to its original or an agreed state. e) Records of disposal actions and analysis are available.
Base practices	**TEC.14.BP1: Prepare for disposal.** [Outcome: a, b] 1) Define a disposal strategy for the system, to include each system element and any resulting waste products. 2) Identify system constraints from disposal on the system requirements, architecture and design characteristics, or implementation techniques. 3) Identify and plan for the necessary enabling systems or services needed to support disposal. 4) Obtain or acquire access to the enabling systems or services to be used. 5) Specify containment facilities, storage locations, inspection criteria, and storage periods, if the system is to be stored. 6) Define preventive methods to preclude disposed elements and materials that should not be repurposed, reclaimed, or reused from re-entering the supply chain. **TEC.14.BP2: Perform disposal.** [Outcome: c] 1) Deactivate the system or system element to prepare it for removal. 2) Remove the system, system element, or waste material from use or production for appropriate disposition and action. 3) Withdraw impacted operating staff from the system or system element and record relevant operating knowledge. 4) Disassemble the system or system element into manageable elements to facilitate its removal for reuse, recycling, reconditioning, overhaul, archiving, or destruction. 5) Handle system elements and their parts that are not intended for reuse in a manner that will assure they do not get back into the supply chain. 6) Conduct destruction of the system elements, as necessary, to reduce the amount of waste treatment or to make the waste easier to handle.

	TEC.14.BP3: Finalize the disposal. [Outcome: d, e] 1) Confirm that no detrimental health, safety, security, and environmental factors exist following disposal. 2) Return the environment to its original state or to a state that specified by agreement. 3) Archive information gathered through the lifetime of the system to permit audits and reviews in the event of long-term hazards to health, safety, security and the environment, and to permit future system creators and users to build a knowledge base from past experiences.
Information products	Disposal approach [Outcome a] Constraints on solution [Outcome a] Disposed system [Outcome c, d] Requirements imposed on enabling systems [Outcome b] Traceability mapping [Outcome: c] Disposal report [Outcome a, c] Disposal record [Outcome e]

6 The quality dimension

A process assessment model shall incorporate a process measurement framework conformant with the requirements of ISO/IEC 33003 and is expressed as a process quality characteristic with a defined set of process attributes. At a minimum, a process measurement framework includes a process quality attribute of process performance, which is needed to demonstrate that the process achieves its expected process outcomes. Other process quality attributes may be added over the process performance attribute.

NOTE 1 ISO/IEC 33020 provides a process measurement framework for the assessment of process capability which can be incorporated into this document. ISO/IEC 33020 also includes a set of process quality indicators for each process attribute in the process measurement framework.

The assessment indicators are used as a basis for collecting objective evidence to support an assessor's judgement in assigning ratings of the performance and quality of an implemented process. The set of indicators defined in this document are not intended to be an all-inclusive set and applicable in its entirety. Subsets appropriate to the context and scope of the assessment should be selected, and potentially augmented with additional indicators.

A process assessment is conducted according to a documented assessment process. A documented assessment process will identify the rating method to be used in rating process attributes and identify or define the aggregation method to be used in determining ratings.

NOTE 2 ISO/IEC 33020 includes a process attribute rating scale, process attribute rating method, and aggregation method which can provide a suitable basis for use for incorporating into any documented assessment process.

Annex A
(informative)

Information products

A.1 Information product descriptions

The information products (IPs) associated with the processes in Clause 5 are described in this annex. See Table A.1. The descriptions are exemplary. The IPs are assorted by categories which are defined in A.2. The IPs are outputs of processes which are indicated by the process IDs.

NOTE For further guidance, ISO/IEC/IEEE 15289 addresses the content for life cycle process information products (documentation).

Table A.1 — Information product descriptions

Information product	Information product description	Category	Output of
Accepted system or system element	System element or system is transferred from supplier to acquirer and the product or service is available to the project. [INCOSE SE Handbook 2015]	product	AGR.1
Acquisition agreement	The formal agreement between an acquirer and a supplier. Informally, commitments or agreements may be specified between an acquirer and a supplier of the same organization (sometimes called a memorandum of understanding). [Adapted from ISO/IEC/IEEE 15289]	agreement	AGR.1
Acquisition agreement change request	Requests from an acquirer to change an agreement with a supplier.	request	AGR.1
Acquisition approach	Specific approach to acquiring products and services that is based on considerations of supply sources, acquisition methods, requirements specification types, contract or agreement types, and related acquisition risks. [ISO/IEC/IEEE 24765]	plan	AGR.1
Acquisition need	The identification of a need that cannot be met within the organization encountering the need or a need that can be met in a more economical way by a supplier. [INCOSE SE Handbook 2015]	specification	MAN.1
Acquisition record	Permanent, readable form of data, information, or knowledge related to acquisition. [INCOSE SE Handbook 2015]	record	AGR.1
Acquisition report	An account prepared for interested parties in order to communicate the status, results, and outcomes of the acquisition activities. [INCOSE SE Handbook 2015]	report	AGR.1
Alternative solution classes	Identifies and describes the classes of solutions that may address the problem or opportunity. [INCOSE SE Handbook 2015]	description	TEC.1
Architecture definition approach	Approaches, schedules, resources, and specific considerations required to define the selected system architecture that satisfies the requirements. [INCOSE SE Handbook 2015]	plan	TEC.4

Table A.1 *(continued)*

Information product	Information product description	Category	Output of
Architecture definition record	Permanent, readable form of data, information, or knowledge related to architecture definition. [INCOSE SE Handbook 2015]	record	TEC.4
Business or mission analysis approach	Approaches, schedules, resources, and specific considerations required to conduct business or mission analysis and ensure business needs are elaborated and formalized into business requirements. [INCOSE SE Handbook 2015]	plan	TEC.1
Business or mission analysis record	Permanent, readable form of data, information, or knowledge related to business or mission analysis. [INCOSE SE Handbook 2015]	record	TEC.1
Configuration audit result	Artifacts that are expected through conduct of configuration audit and that can be considered elements of exit criteria [Adapted from IEEE 15288.2:2014]	record	MAN.5
Configuration baseline	Configuration information formally designated at a specific time during the life of a product, product component, service, or service component. [ISO/IEC/IEEE 24765]	record	MAN.5
Configuration evaluation report	Provides results of configuration management evaluations. It includes evaluation criteria. [Adapted from ISO/IEC/IEEE 15289]	report	MAN.5
Configuration management approach	Describes the responsible organization for authorizing and performing configuration management activities, and their relationship with other organizations. [Adapted from ISO/IEC/IEEE 15289]	plan	MAN.5
Configuration management change request	Identifies a problem, maintenance need, or desired improvement and requests modifications. The requested change may affect a contract, configuration item, system, service, hardware, software, interface, asset, or documentation. [Adapted from ISO/IEC/IEEE 15289]	request	MAN.5
Configuration management record	Permanent, readable form of data, information, or knowledge related to configuration management. [INCOSE SE Handbook 2015]	record	MAN.5
Configuration management report	Provides the status of controlled configuration items, including baselines, release identifiers, and location of the configuration item master version. For deactivated systems, it contains information about system disposal to trace potential future environmental, safety, or security impacts. [Adapted from ISO/IEC/IEEE 15289]	report	MAN.5
Configuration management system	System used to support and enable configuration management.	product	MAN.5
Configuration management variance request	Request to accept a configuration item or other designated item which, during production or after having been submitted for inspection, is found to depart from specified requirements, but is nevertheless considered suitable for use as is or after rework by an approved method. [Adapted from ISO/IEC/IEEE 24765]	request	MAN.5
Constraints on solution	Externally imposed limitation on system requirements, design, or implementation or on the process used to develop or modify a system. [ISO/IEC/IEEE 29148]	specification	TEC.7, TEC.8, TEC.9, TEC.10, TEC.11, TEC.12, TEC.13, TEC.14

Table A.1 *(continued)*

Information product	Information product description	Category	Output of
Critical performance data	Data provided for the identified system of interest measurement needs. [Adapted from INCOSE SE Handbook 2015]	data	TEC.2, TEC.3, TEC.4, TEC.5
Critical performance measurement needs	Identification of information needs of the decision makers with respect to system of interest expectations. [Adapted from INCOSE SE Handbook 2015]	specification	TEC.2, TEC.3, TEC.4, TEC.5
Decision management approach	Approaches, schedules, resources, and specific considerations required to perform decision management for a project. [INCOSE SE Handbook 2015]	plan	MAN.3
Decision management record	Permanent, readable form of data, information, or knowledge related to decision management. [INCOSE SE Handbook 2015]	record	MAN.3
Decision management report	An account prepared for interested parties in order to communicate the status, results, and outcomes of the decision management activities. [INCOSE SE Handbook 2015]	report	MAN.3
Decision register	A repository that supports the availability for use and communication of all relevant decision information in a timely, complete, valid, and, if required, confidential manner. [Adapted from INCOSE SE Handbook 2015]	registry	MAN.3
Design definition approach	Approaches, schedules, resources, and specific considerations required to define the system design that is consistent with the selected system architecture and satisfies the requirements. [INCOSE SE Handbook 2015]	plan	TEC.5
Design definition record	Permanent, readable form of data, information, or knowledge related to design definition. [INCOSE SE Handbook 2015]	record	TEC.5
Disposal approach	Presents how activities are conducted to retire systems or services and related documents. It identifies stakeholders and user organizations or users to be notified of the planned withdrawal from service, replacement systems and services, if any; a schedule for cessation of support. [Adapted from ISO/IEC/IEEE 15289]	plan	TEC.14
Disposal record	Permanent, readable form of data, information, or knowledge related to disposal. [INCOSE SE Handbook 2015]	record	TEC.14
Disposal report	An account prepared for interested parties in order to communicate the status, results, and outcomes of the disposal activities. [INCOSE SE Handbook 2015]	report	TEC.14
Disposed system	System that has been deactivated, disassembled, and removed from operations. [INCOSE SE Handbook 2015]	product	TEC.14
Human resource management record	Permanent, readable form of data, information, or knowledge related to human resource management. [INCOSE SE Handbook 2015]	record	ORG.4
Human resource management report	An account prepared for interested parties in order to communicate the status, results, and outcomes of the human resource management activities. [INCOSE SE Handbook 2015]	report	ORG.4