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**Systems and software engineering —  
Life cycle management —**

**Part 1:  
Guidelines for life cycle management**

*Ingénierie des systèmes et du logiciel — Gestion du cycle de vie —  
Partie 1: Lignes directrices pour la gestion du cycle de vie*

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## Foreword

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

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

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

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: [Foreword - Supplementary information](#)

The committee responsible for this document is ISO/IEC JTC 1, *Information technology, SC 7, Software and systems engineering*.

This first edition of ISO/IEC/TS 24748-1 cancels and replaces ISO/IEC/TR 24748-1, which has been technically revised.

ISO/IEC 24748 consists of the following parts, under the general title *Systems and software engineering — Life cycle management*:

- *Part 1: Guidelines for life cycle management* [Technical Specification]
- *Part 2: Guide to the application of ISO/IEC 15288 (System life cycle processes)*
- *Part 3: Guide to the application of ISO/IEC 12207 (Software life cycle processes)*
- *Part 4: Systems engineering planning* [ISO/IEC/IEEE]
- *Part 5: Software development planning* [ISO/IEC/IEEE]

The following parts are under preparation:

- *Part 6: Guide to system integration engineering*

## Introduction

The purpose of this Technical Specification is to facilitate the joint usage of the process content of the latest revisions of ISO/IEC/IEEE 15288 and ISO/IEC 12207, by providing unified and consolidated guidance on life cycle management of systems and software. This is to help ensure consistency in system concepts and life cycle concepts, models, stages, processes, process application, key points of view, adaptation and use in various domains as the two International Standards are used in combination. That will in turn help a project team design a life cycle model for managing the progress of their project.

This Technical Specification will also aid in identifying and planning use of life cycle processes described in ISO/IEC/IEEE 15288 and ISO/IEC 12207 that will enable the project to be completed successfully, meeting its objectives/requirements for each stage and for the overall project.

Besides the above, there is also increasing recognition of the importance of ensuring that all life cycle stages and all aspects within each stage are supported with thorough guidance to enable alignment with any process documents that might subsequently be created that focus on areas besides systems and software, including hardware, humans, data, processes (e.g. review process), procedures (e.g. operator instructions), facilities and naturally occurring entities (e.g. water, organisms, minerals).

By addressing these needs specifically in this Technical Specification, the users of the process-focused ISO/IEC 12207 and ISO/IEC/IEEE 15288 will not only benefit from having one document complementarily addressing the aspect of product or service life cycle: they will also benefit from a framework that links life cycle management aspects to more than just the systems or software aspects of products or services.

ISO/IEC/IEEE 15288 and ISO/IEC 12207 also have published guidelines (ISO/IEC/TR 24748-2 and ISO/IEC/TR 24748-3), respectively, to support use of the two revised International Standards individually.

# Systems and software engineering — Life cycle management —

## Part 1: Guidelines for life cycle management

### 1 Scope

This Technical Specification provides guidelines for the life cycle management of systems and software, complementing the processes described in ISO/IEC/IEEE 15288 and ISO/IEC 12207. This Technical Specification:

- addresses systems concepts and life cycle concepts, models, stages, processes, process application, key points of view, adaptation and use in various domains and by various disciplines;
- establishes a common framework for describing life cycles, including their individual stages, for the management of projects to provide, or acquire either products or services;
- defines the concept and terminology of a life cycle;
- supports the use of the life cycle processes within an organization or a project. Organizations and projects can use these life cycle concepts when acquiring and supplying either products or services;
- provides guidance on adapting a life cycle model and the content associated with a life cycle or a part of a life cycle;
- describes the relationship between life cycles and their use in applying the processes in ISO/IEC/IEEE 15288 (systems aspects) and ISO/IEC 12207 (software aspects);
- shows the relationships of life cycle concepts to the hardware, human, services, process, procedure, facility and naturally occurring entity aspects of projects; and
- describes how its concepts relate to detailed process standards, for example, in the areas of measurement, project management and risk management.

### 2 Terms and definitions

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

#### 2.1

##### **acquirer**

stakeholder that acquires or procures a product or service from a supplier

Note 1 to entry: Other terms commonly used for an acquirer are buyer, customer, owner, purchaser, or internal/organizational sponsor.

[SOURCE: ISO/IEC/IEEE 15288:2015]

#### 2.2

##### **acquisition**

process of obtaining a system, product or service

[SOURCE: ISO/IEC/IEEE 15288:2015]

### 2.3

#### **activity**

set of cohesive tasks of a process

[SOURCE: ISO/IEC/IEEE 15288:2015]

### 2.4

#### **agile development**

software development approach based on iterative development, frequent inspection and adaptation, and incremental deliveries, in which requirements and solutions evolve through collaboration in cross-functional teams and through continual stakeholder feedback

[SOURCE: ISO/IEC/IEEE 26515:2011]

### 2.5

#### **agreement**

mutual acknowledgement of terms and conditions under which a working relationship is conducted

EXAMPLE Contract, memorandum of agreement.

[SOURCE: ISO/IEC/IEEE 15288:2015]

### 2.6

#### **architecture**

<system> fundamental concepts or properties of a system in its environment embodied in its elements, relationships, and in the principles of its design and evolution

Note 1 to entry: ISO/IEC 12207 and ISO/IEC/IEEE 15288 use the word “elements” instead of “components” and this Technical Specification follows that usage.

[SOURCE: ISO/IEC/IEEE 42010:2011]

### 2.7

#### **architecture framework**

conventions, principles and practices for the description of architectures established within a specific domain of application and/or community of stakeholders

EXAMPLE 1 *Generalized Enterprise Reference Architecture and Methodologies (GERAM)* (ISO 15704) is an architecture framework.

EXAMPLE 2 *Reference Model of Open Distributed Processing (RM-ODP)* (ISO/IEC 10746) is an architecture framework.

[SOURCE: ISO/IEC/IEEE 42010:2011]

### 2.8

#### **architecture view**

work product expressing the architecture of a system from the perspective of specific system concerns

[SOURCE: ISO/IEC/IEEE 42010:2011]

### 2.9

#### **architecture viewpoint**

work product establishing the conventions for the construction, interpretation and use of architecture views to frame specific system concerns

[SOURCE: ISO/IEC/IEEE 42010:2011]

## 2.10 audit

independent examination of a work product or set of work products to assess compliance with specifications, standards, contractual agreements, or other criteria

[SOURCE: ISO/IEC/IEEE 24765:2010]

## 2.11 baseline

approved version of a configuration item, regardless of media, formally designated and fixed at a specific time during the configuration item's life cycle

[SOURCE: IEEE 828:2012]

## 2.12 concept of operations

verbal and/or graphic statement, in broad outline, of an organization's assumptions or intent in regard to an operation or series of operations

Note 1 to entry: The concept of operations frequently is embodied in long-range strategic plans and annual operational plans. In the latter case, the concept of operations in the plan covers a series of connected operations to be carried out simultaneously or in succession. The concept is designed to give an overall picture of the organization operations. See also *operational concept* (2.25).

Note 2 to entry: It provides the basis for bounding the operating space, system capabilities, interfaces and operating environment.

[SOURCE: ANSI/AIAA G-043A-2012e]

## 2.13 concern

<system> interest in a system relevant to one or more of its stakeholders

Note 1 to entry: A concern pertains to any influence on a system in its environment, including developmental, technological, business, operational, organizational, political, economic, legal, regulatory, ecological and social influences.

[SOURCE: ISO/IEC/IEEE 42010:2011]

## 2.14 configuration item

item or aggregation of hardware, software, or both, that is designated for configuration management and treated as a single entity in the configuration management process

[SOURCE: ISO/IEC/IEEE 24765:2010, modified — added “item or”.]

## 2.15 customer

organization or person that receives a product or service

EXAMPLE Consumer, client, user, acquirer, buyer, or purchaser.

Note 1 to entry: A customer can be internal or external to the organization.

[SOURCE: ISO 9000:2015, modified — added “service”.]

## 2.16 design

<process> to define the architecture, system elements, interfaces, and other characteristics of a system or system element

[SOURCE: ISO/IEC/IEEE 24765:2010, modified – changed “components” to “system elements”.]

**2.17**  
**design**

result of the process in [2.15](#)

Note 1 to entry: Information, including specification of system elements and their relationships, that is sufficiently complete to support a compliant implementation of the architecture.

Note 2 to entry: Design provides the detailed implementation-level physical structure, behavior, temporal relationships and other attributes of system elements.

[SOURCE: ISO/IEC/IEEE 24765:2010]

**2.18**  
**design characteristic**

design attributes or distinguishing features that pertain to a measurable description of a product or service

[SOURCE: ISO/IEC/IEEE 24765:2010]

**2.19**  
**enabling system**

system that supports a system-of-interest during its life cycle stages but does not necessarily contribute directly to its function during operation

EXAMPLE When a system-of-interest enters the Production Stage, a production-enabling system is required.

Note 1 to entry: Each enabling system has a life cycle of its own. This Technical Specification is applicable to each enabling system when, in its own right, it is treated as a system-of-interest.

[SOURCE: ISO/IEC/IEEE 15288:2015]

**2.20**  
**environment**

<system> context determining the setting and circumstances of all influences upon a system

[SOURCE: ISO/IEC/IEEE 42010:2011]

**2.21**  
**facility**

physical means or equipment for facilitating the performance of an action, e.g. buildings, instruments, tools

[SOURCE: ISO/IEC/IEEE 15288:2015]

**2.22**  
**incident**

anomalous or unexpected event, set of events, condition, or situation at any time during the life cycle of a project, product, service, or system

[SOURCE: ISO/IEC/IEEE 15288:2015]

**2.23**  
**information item**

separately identifiable body of information that is produced, stored, and delivered for human use

[SOURCE: ISO/IEC/IEEE 15289:2015]

**2.24**  
**life cycle**

evolution of a system, product, service, project or other human-made entity from conception through retirement

[SOURCE: ISO/IEC/IEEE 15288:2015]

**2.25****life cycle model**

framework of processes and activities concerned with the life cycle that may be organized into stages, which also acts as a common reference for communication and understanding

[SOURCE: ISO/IEC/IEEE 15288:2015]

**2.26****operational concept**

verbal and graphic statement of an organization's assumptions or intent in regard to an operation or series of operations of a system or a related set of systems

Note 1 to entry: The operational concept is designed to give an overall picture of the operations, using one or more specific systems, or set of related systems, in the organization's operational environment from the users' and operators' perspective. See also *concept of operations* (2.11).

[SOURCE: ANSI/AIAA G-043A-2012e]

**2.27****operator**

individual or organization that performs the operations of a system

Note 1 to entry: The role of operator and the role of user may be vested, simultaneously, or sequentially, in the same individual or organization.

Note 2 to entry: An individual operator combined with knowledge, skills and procedures may be considered as an element of the system.

Note 3 to entry: An operator may perform operations on a system that is operated, or of a system that is operated, depending on whether or not operating instructions are placed within the system boundary.

[SOURCE: ISO/IEC/IEEE 15288:2015]

**2.28****organization**

group of people and facilities with an arrangement of responsibilities, authorities and relationships

EXAMPLE Company, corporation, firm, enterprise, institution, charity, sole trader, association, or parts or combination thereof.

Note 1 to entry: An identified part of an organization (even as small as a single individual) or an identified group of organizations can be regarded as an organization if it has responsibilities, authorities and relationships. A body of persons organized for some specific purpose, such as a club, union, corporation, or society, is an organization.

[SOURCE: ISO 9000:2015, modified — Note 1 to entry has been added.]

**2.29****party**

organization entering into an agreement

Note 1 to entry: In this Technical Specification, the agreeing parties are called the acquirer and the supplier.

[SOURCE: ISO/IEC/IEEE 15288:2015]

**2.30****problem**

difficulty, uncertainty, or otherwise realized and undesirable event, set of events, condition, or situation that requires investigation and corrective action

[SOURCE: ISO/IEC/IEEE 15288:2015]

### 2.31

#### **process**

set of interrelated or interacting activities that transforms inputs into outputs

[SOURCE: ISO/IEC/IEEE 15288:2015]

### 2.32

#### **process outcome**

observable result of the successful achievement of the process purpose

[SOURCE: ISO/IEC 12207:2008]

### 2.33

#### **process purpose**

high level objective of performing the process and the likely outcomes of effective implementation of the process

Note 1 to entry: The purpose of implementing the process is to provide benefits to the stakeholders.

[SOURCE: ISO/IEC/IEEE 15288:2015]

### 2.34

#### **product**

result of a process

Note 1 to entry: There are four agreed generic product categories: hardware (e.g. engine mechanical part), software (e.g. computer program), services (e.g. transport), and processed materials (e.g. lubricant). Hardware and processed materials are generally tangible products, while software or services are generally intangible.

[SOURCE: ISO 9000:2015]

### 2.35

#### **project**

endeavour with defined start and finish criteria undertaken to create a product or service in accordance with specified resources and requirements

Note 1 to entry: A project is sometimes viewed as a unique process comprising co-coordinated and controlled activities and composed of activities from the Project Processes and Technical Processes defined in the referenced International Standards.

[SOURCE: ISO/IEC/IEEE 15288:2015]

### 2.36

#### **qualification**

process of demonstrating whether an entity is capable of fulfilling specified requirements

[SOURCE: ISO/IEC 12207:2008]

### 2.37

#### **quality assurance**

part of quality management focused on providing confidence that quality requirements will be fulfilled

[SOURCE: ISO 9000:2015]

### 2.38

#### **quality characteristic**

inherent characteristic of a product, process, or system related to a requirement

Note 1 to entry: Critical quality characteristics commonly include those related to health, safety, security, assurance, reliability, availability and supportability.

[SOURCE: ISO 9000:2015, modified — Note 1 to entry added.]

### 2.39

#### **quality management**

coordinated activities to direct and control an organization with regard to quality

[SOURCE: ISO 9000:2015]

### 2.41

#### **requirement**

statement that translates or expresses a need and its associated constraints and conditions

[SOURCE: ISO/IEC/IEEE 29148:2011]

### 2.42

#### **resource**

asset that is utilized or consumed during the execution of a process

Note 1 to entry: Includes diverse entities, such as funding, personnel, facilities, capital equipment, tools and utilities, such as power, water, fuel and communication infrastructures.

Note 2 to entry: Resources include those that are reusable, renewable, or consumable.

[SOURCE: ISO/IEC/IEEE 15288:2015]

### 2.43

#### **retirement**

withdrawal of active support by the operation and maintenance organization, partial or total replacement by a new system, or installation of an upgraded system

[SOURCE: ISO/IEC/IEEE 15288:2015]

### 2.44

#### **risk**

effect of uncertainty on objectives

Note 1 to entry: An effect is a deviation from the expected, positive or negative. A positive effect is also known as an opportunity.

Note 2 to entry: Objectives can have different aspects (such as financial, health and safety, and environmental goals) and can apply at different levels (such as strategic, organization-wide, project, product and process).

Note 3 to entry: Risk is often characterized by reference to potential events and consequences, or a combination of these.

Note 4 to entry: Risk is often expressed in terms of a combination of the consequences of an event (including changes in circumstances) and the associated likelihood of occurrence.

Note 5 to entry: Uncertainty is the state, even partial, of deficiency of information related to understanding or knowledge of an event, its consequence, or likelihood.

[SOURCE: ISO Guide 73:2009, 1.1]

### 2.45

#### **security**

protection against intentional subversion or forced failure, containing a composite of four attributes: confidentiality, integrity, availability and accountability, plus aspects of a fifth, usability, all of which have the related issue of their assurance

[SOURCE: NATO AEP-67]

**2.46**

**service**

performance of activities, work, or duties

Note 1 to entry: A service is self-contained, coherent, discrete and can be composed of other services.

Note 2 to entry: A service is generally an intangible product.

[SOURCE: ISO/IEC 12207:2008]

**2.47**

**software item**

source code, object code, control code, control data, or a collection of these items

Note 1 to entry: A software item can be viewed as a system element of the referenced International Standard and of ISO/IEC/IEEE 15288:2015.

[SOURCE: ISO/IEC 12207:2008]

**2.48**

**software product**

set of computer programs, procedures, and possibly associated documentation and data

[SOURCE: ISO/IEC 12207:2008]

**2.49**

**software unit**

atomic level software component of the software architecture that can be subjected to stand-alone testing

[SOURCE: ISO 26262-1:2011]

**2.50**

**stage**

period within the life cycle of an entity that relates to the state of its description or realization

Note 1 to entry: As used in this Technical Specification, stages relate to major progress and achievement milestones of the entity through its life cycle.

Note 2 to entry: Stages often overlap.

[SOURCE: ISO/IEC/IEEE 15288:2015]

**2.51**

**stakeholder**

individual or organization having a right, share, claim, or interest in a system or in its possession of characteristics that meet their needs and expectations

EXAMPLE End users, end user organizations, supporters, developers, producers, trainers, maintainers, disposers, acquirers, supplier organizations and regulatory bodies.

Note 1 to entry: Some stakeholders can have interests that oppose each other or oppose the system.

[SOURCE: ISO/IEC/IEEE 15288:2015]

**2.52**

**supplier**

organization or an individual that enters into an agreement with the acquirer for the supply of a product or service

Note 1 to entry: Other terms commonly used for supplier are contractor, producer, seller, or vendor.

Note 2 to entry: The acquirer and the supplier sometimes are part of the same organization.

[SOURCE: ISO/IEC/IEEE 15288:2015]

**2.53****system**

combination of interacting elements organized to achieve one or more stated purposes

Note 1 to entry: A system is sometimes considered as a product or as the services it provides.

Note 2 to entry: In practice, the interpretation of its meaning is frequently clarified by the use of an associative noun, e.g. aircraft system. Alternatively the word “system” is substituted simply by a context-dependent synonym, e.g. aircraft, though this potentially obscures a system principles perspective.

Note 3 to entry: A complete system includes all of the associated equipment, facilities, material, computer programs, firmware, technical documentation, services and personnel required for operations and support to the degree necessary for self-sufficient use in its intended environment.

[SOURCE: ISO/IEC/IEEE 15288:2015]

**2.54****system element**

member of a set of elements that constitutes a system

EXAMPLE Hardware, software, data, humans, processes (e.g. processes for providing service to users), procedures (e.g. operator instructions), facilities, materials and naturally occurring entities, or any combination.

Note 1 to entry: A system element is a discrete part of a system that can be implemented to fulfill specified requirements.

[SOURCE: ISO/IEC/IEEE 15288:2015]

**2.55****system-of-interest**

system whose life cycle is under consideration in the context of this document

[SOURCE: ISO/IEC/IEEE 15288:2015]

**2.56****systems engineering**

interdisciplinary approach governing the total technical and managerial effort required to transform a set of stakeholder needs, expectations, and constraints into a solution and to support that solution throughout its life

[SOURCE: ISO/IEC/IEEE 24765:2010]

**2.57****task**

required, recommended, or permissible action, intended to contribute to the achievement of one or more outcomes of a process

[SOURCE: ISO/IEC/IEEE 15288:2015]

**2.58****technical management**

application of technical and administrative resources to plan, organize and control engineering functions

[SOURCE: ISO/IEC 12207:2008]

**2.59****trade-off**

decision-making actions that select from various requirements and alternative solutions on the basis of net benefit to the stakeholders

[SOURCE: ISO/IEC/IEEE 15288:2015]

## 2.60

### user

individual or group that interacts with a system or benefits from a system during its utilization

Note 1 to entry: The role of user and the role of operator are sometimes vested, simultaneously or sequentially, in the same individual or organization.

[SOURCE: ISO/IEC 25010:2011]

## 2.61

### validation

confirmation, through the provision of objective evidence, that the requirements for a specific intended use or application have been fulfilled

Note 1 to entry: A system is able to accomplish its intended use, goals and objectives (i.e. meet stakeholder requirements) in the intended operational environment. The right system was built.

Note 2 to entry: In a life cycle context, validation involves the set of activities for ensuring and gaining confidence that a system is able to accomplish its intended use, goals and objectives in an environment like the operational environment.

[SOURCE: ISO 9000:2015, modified — Note 1 to entry and Note 2 to entry have been added.]

## 2.62

### verification

confirmation, through the provision of objective evidence, that specified requirements have been fulfilled

Note 1 to entry: Verification is a set of activities that compares a system or system element against the required characteristics. This includes, but is not limited to, specified requirements, design description and the system itself. The system was built right.

[SOURCE: ISO 9000:2015 modified — Note 1 to entry has been added.]

## 3 Life cycle-related concepts

### 3.1 System concepts

#### 3.1.1 General

This subclause is included to highlight and explain essential concepts on which this Technical Specification is based. These concepts are directly applicable to software, as addressed in ISO/IEC 12207, systems, as addressed in ISO/IEC/IEEE 15288, and to hardware, facilities, services, humans, processes and procedures, data and naturally occurring entities.

#### 3.1.2 Systems

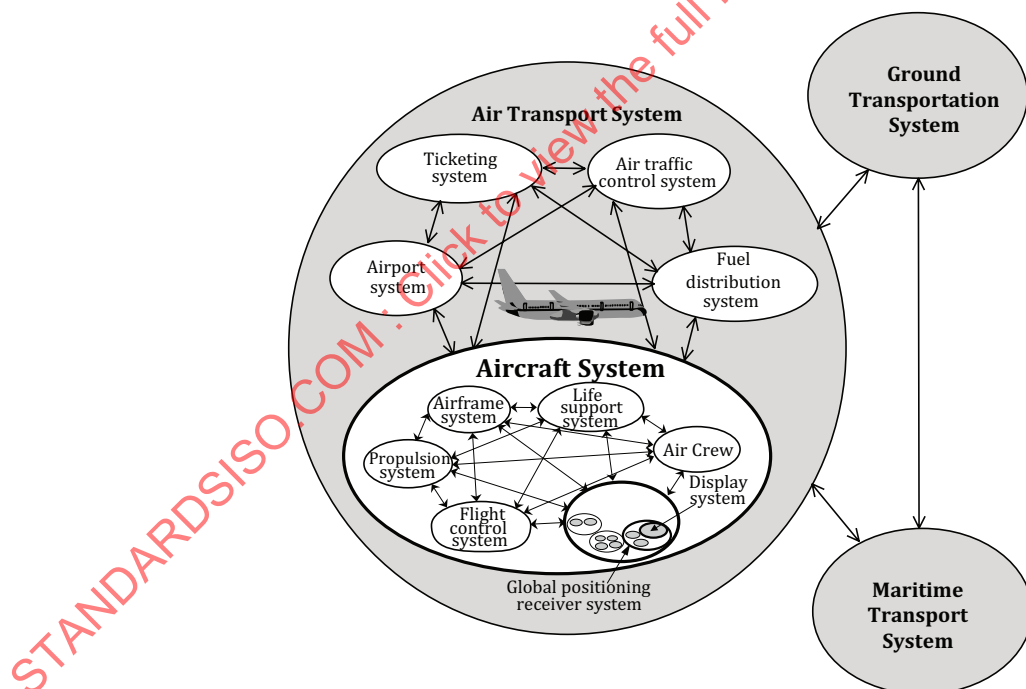
The systems considered in this Technical Specification are man-made and utilized to provide services in defined environments for the benefit of users and other stakeholders. These systems may be configured with one or more of the following: hardware, software, services, humans, data, processes (e.g. processes for providing services to users), procedures (e.g. operator instructions), facilities and naturally occurring entities (e.g. water, organisms, minerals).

The perception and definition of a particular system, its architecture and its system elements depend on an observer's interests and responsibilities. One person's system-of-interest can be viewed as a system element in another person's system-of-interest. Conversely, it can be viewed as being part of the environment of operation for yet another person's system-of-interest.

[Figure 1](#) exemplifies the multitude of perceivable systems-of-interest in an aircraft and its environment of operation. First, [Figure 1](#) in its entirety comprises a transportation system with air, ground and

water elements, which can be a system-of-interest. Next, any one element of the transportation system can be viewed as a system-of-interest, such as the Air Transport System. The example can be continued through the levels so that, for example, the display can be an element of the navigation system, which is in turn an element of the aircraft system within the air transport system. However, from an equally valid perspective, such as that of display manufacturers, the display will be their system-of-interest and they will then determine the elements within their display system. On a deeper level, [Figure 1](#) also illustrates the following:

- the importance of defined boundaries that encapsulate meaningful needs and practical solutions;
- the perception of system structure (in this case, the physical structure, hierarchical in this instance);
- that an entity at any level in a system structure can be viewed as a system;
- that a system is comprised of a fully integrated, defined set of subordinate systems;
- that characteristic properties at a system's boundary arise from the interactions between subordinate systems;
- that humans can be viewed as users external to a system (e.g. air crew and navigation system) and as system elements within a system (e.g. air crew and aircraft);
- that a system can be viewed as an isolated entity (that is, a product), or as an ordered collection of functions capable of interacting with its surrounding environment, (i.e. a set of services);
- that a system can be viewed as part of a larger system of systems and that a system of systems can be viewed as a system.



**Figure 1 — Typical system view of an aircraft in its environment of use**

Whatever the boundaries chosen to define the system, the concepts and models in this Technical Specification are generic and permit a practitioner to correlate or adapt individual instances of life cycles to its system concepts and principles.

In this Technical Specification, humans are considered both as users and as elements of a system. In the first case, the human user is a beneficiary of the operation of the system. In the second case, the human is an operator carrying out specified system functions, such as those involved in providing a service. An

individual can be, simultaneously or sequentially, a user and an element of a system, for example, the pilot of a private aircraft in the civil aviation system.

Humans contribute to the performance and characteristics of many systems for numerous reasons, e.g. their special skills, the need for flexibility and for legal reasons. Whether they are users or operators, humans are highly complex, with behaviour that is frequently difficult to predict, and they need protection from harm. This requires that the system life cycle processes address human element factors in the areas of: human factors engineering, system safety, health hazard assessment, manpower, personnel and training. These issues are addressed by particular activities and iterations in the life cycle, and are described in more detail in ISO 9241-210:2010 and ISO/TR 18529:2000.

### 3.1.3 System structure

The system life cycle processes in this Technical Specification are described in relation to a system that is composed of a set of interacting physical, logical and/or other system elements, depicted in [Figure 2](#), each of which can be implemented to fulfil its respective specified requirements. Responsibility for the implementation of any system element may therefore be delegated to another party through an agreement.

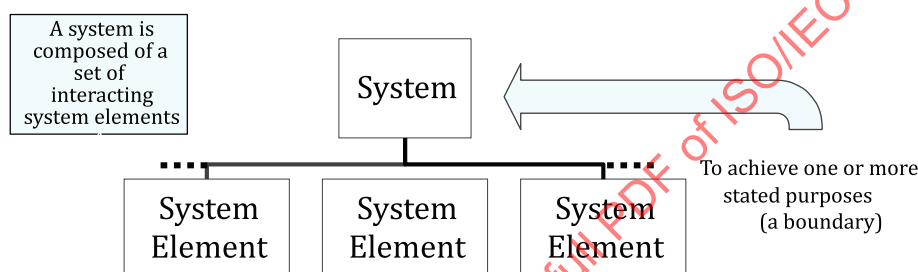


Figure 2 — System and system element relationship

The relationship between the system and its complete set of system elements can typically be resolved in a single step only for the simplest of systems-of-interest. For more complex systems-of-interest, a prospective system element may itself need to be considered as a system (that in turn is comprised of system elements) before a complete set of system elements can be defined with confidence, as indicated by [Figure 3](#). In this manner, the system life cycle processes are applied recursively to a system-of-interest to resolve its structure to the point where understandable and manageable system elements can be implemented or reused, or acquired from another party. While [Figures 2](#) and [3](#) imply a hierarchical relationship, in reality there are an increasing number of systems that, from one or more aspects are not hierarchical, such as networks and other distributed systems. So, recursion is not necessarily linearly downward in all cases.

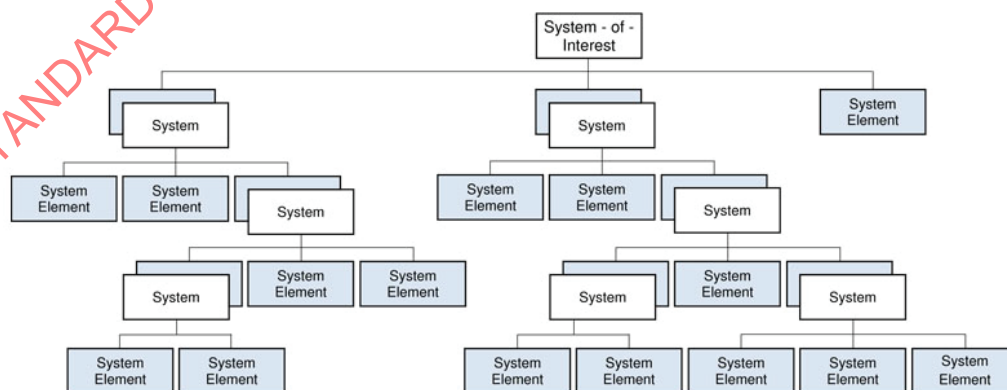


Figure 3 — System-of-interest structure

### 3.1.4 Structure in systems and projects

Each system in the structure illustrated in [Figure 2](#) (or [Figure 3](#)) could be the responsibility of a separate project. This can be true whether the system is hierarchical, as used for the illustration, or other system structure, such as a network, or a mix of structures. The point is that there can be (and typically is) a strong correlation between levels of detail in the system structure and levels of responsibility in a set of projects. Each project characteristically has responsibility for acquiring and using system elements subordinate to it and creating and supplying to the level superior to it, as would be the case for hierarchical, non-hierarchical, or mixed, system structures.

Any particular project normally views its system as the system-of-interest and whilst it can influence higher system levels, it does not have responsibility for them. However, even though it may not have responsibility for each system element considered by itself, it does have responsibility for all system elements that constitute its system-of-interest and consequently for the output of projects at all levels subordinate to it, as shown in [Figure 4](#).

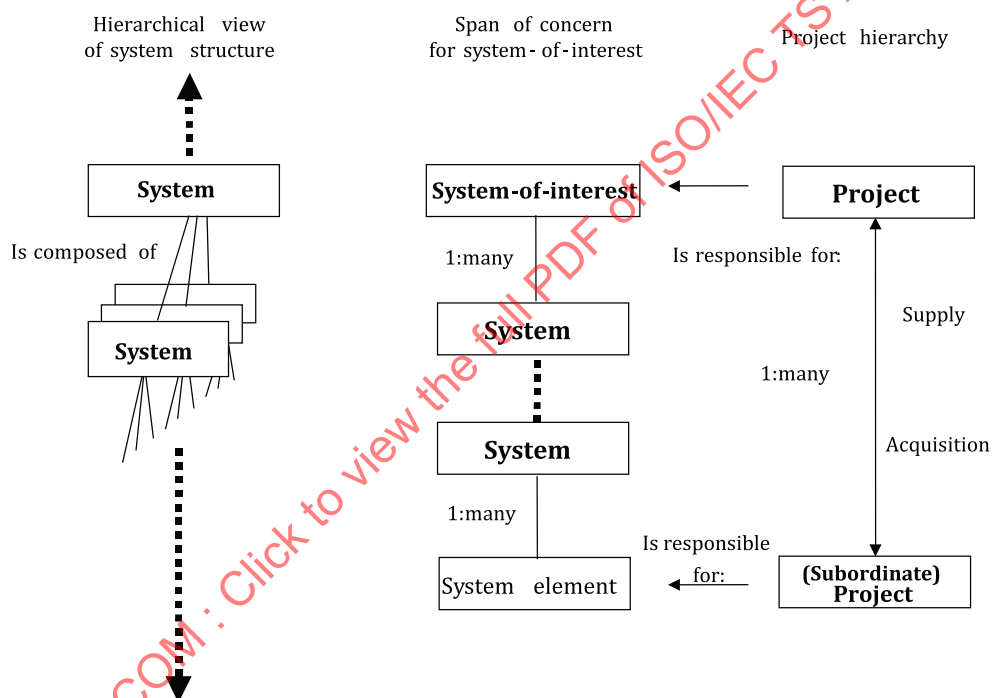


Figure 4 — System and project hierarchies

In practice, the risks associated with implementing systems that fulfil specified requirements typically diminish with descending level of detail in the system-of-interest's structure and eventually are no longer of direct attention or concern to the particular project. At this level (not necessarily the same level down different paths of system-of-interest decomposition), a system element can be acquired with acceptable risk and the detail of its composition can remain hidden below some level. For example, if the system-of-interest for the project were a radar, in normal practice, the formulation and cure of the slurry mix for the resistive part of a composition resistor on a printed circuit board in a subassembly in a system element of the system-of-interest would not be addressed directly. Rather, the requirements at the system-of-interest and possibly the system element level would drive choices that would force a particular selection of this material in order to meet all the requirements for the higher level elements. From the system-of-interest view, the system elements may appear to be where specialist disciplines or particular implementation technology practices are present.

### 3.1.5 Enabling systems

Throughout the life cycle of a system-of-interest, essential services are required from systems that are not directly a part of the operational environment of the system-of-interest, e.g. mass-production system, training system, maintenance system. Each of these systems enables a part, for example, a stage, or stages, of the life cycle of the system-of-interest to be conducted. Termed “enabling systems”, they facilitate progression of the system-of-interest through its life cycle. The relationship between the services delivered to the operational environment by the system-of-interest and the services delivered by the enabling systems to the system-of-interest are shown in Figure 5. Enabling systems can be seen to contribute indirectly to the services provided by the system-of-interest. The interrelationships between the system-of-interest and the enabling systems can be bi-directional or a one-way relationship at each stage in which the system-of-interest and specific enabling systems interrelate. In addition to interacting with enabling systems, the system-of-interest may also interact with other systems in the operating environment, shown as Systems A, B, and C. Requirements for interfaces with enabling systems and other systems in the operational environment will need to be included in the requirements for the system-of-interest.

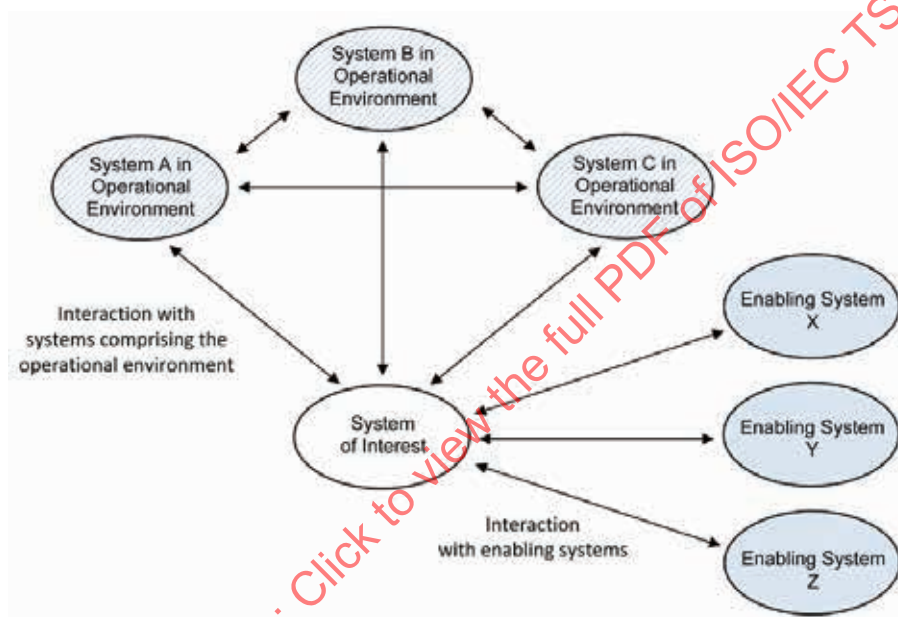


Figure 5 — System-of-interest, its operational environment and enabling systems

During each stage in the system life cycle, the relevant enabling systems and the system-of-interest are considered together. Since they are interdependent, they can also be viewed as a system. When a suitable enabling system does not already exist, the project that is responsible for the system-of-interest can also be directly responsible for creating and using the enabling system. Creating the enabling systems can be viewed as a separate project and subsequently another system-of-interest. Note that a given enabling system could be used more than once (i.e. several times during a given stage, or in multiple stages, or both) during a system's life cycle, and that such use can have discontinuities. The enabling system may also be used concurrently in multiple life cycle stages. Thus, it is necessary to consider the full life cycle and concurrency requirements for the enabling systems. For example, a specific fixture might be used for development retirement, for which there could be a significant time delay. Or the fixture could be needed for development, operations and maintenance, and have activities requiring the fixture concurrently. As another example, a training aid could be developed as part of the Concept Stage, then refined and reused in development, operation and maintenance stages.

## 3.2 Life cycle concepts

### 3.2.1 System life cycle model

Every system, whatever the kind or size, inherently evolves, from its initial conceptualization through its eventual retirement, as defined in 2.23. It is generally useful to build a model of this progression, showing each stage in the evolution, to help manage the evolution of the system. Models built for this purpose are termed life cycle models. Movement from one stage to another represents a decision point with specific criteria to be satisfied before movement to the next stage is allowed. These criteria usually are directly based either on the completion of specific tasks and demonstration of successful outcomes, or readiness to start specific tasks in order to achieve required outcomes, from sets of processes, such as are in ISO/IEC 12207 and ISO/IEC/IEEE 15288. A life cycle model, then, is a decision-linked conceptual segmentation of the definition of the need for the system, its realization as a product or service, or some mix of both, and its utilization, evolution and disposal. Note that the actual progression of a system through the parts of the model, however done, is the system's life cycle.

NOTE Life cycle, life cycle model and stage are 2.23, 2.24 and 2.50, respectively.

A system life cycle model is segmented by stages because it facilitates planning, provisioning, operating and supporting the system-of-interest. This segmentation by stages provides an orderly progression of a system through established decision-making gates to reduce risk and to ensure satisfactory progress. As stated before, it is the need to make a decision to specific criteria, usually process outcome-based, before a system can progress to subsequent stages that is the most important reason for using a life cycle model. Note that it may be useful to develop one or more specific process views from the viewpoint of stage transition decision making, following the information given in ISO/IEC/IEEE 15288:2015, Annex E and ISO/IEC 12207:2008, Annex E.

A secondary aspect of using a life cycle model is that it can help an organization ensure that it thinks of its work and its processes within a larger framework, which may have useful business overtones. See, for example, the discussion of a services life cycle model in 5.7.

Several factors make system life cycle planning, provisioning and operation difficult to manage. Economics and market forces, as well as novelty, complexity and operational stability affect the length of a system's life cycle. Some systems have life cycles that are decades long (for example, aircraft, satellites, ships) and some are very short (for example, instruments and consumer electronics).

A typical system, however, progresses through a common series of stages where it is conceptualized, developed, produced as a product or service (or a mix of both), utilized, supported and retired. The life cycle model is the framework that helps ensure that the system is able to meet its required functionality throughout its life. Thus, to define system requirements and develop system solutions during the Concept and Development Stages, experts from other stages (for example, production, utilization, support, retirement) are needed to perform trade-off analyses and to help make design decisions and arrive at a balanced solution. This helps ensure that a system has the necessary attributes designed in as early as possible. Also, it is essential to have the necessary enabling systems available to perform required stage functions.

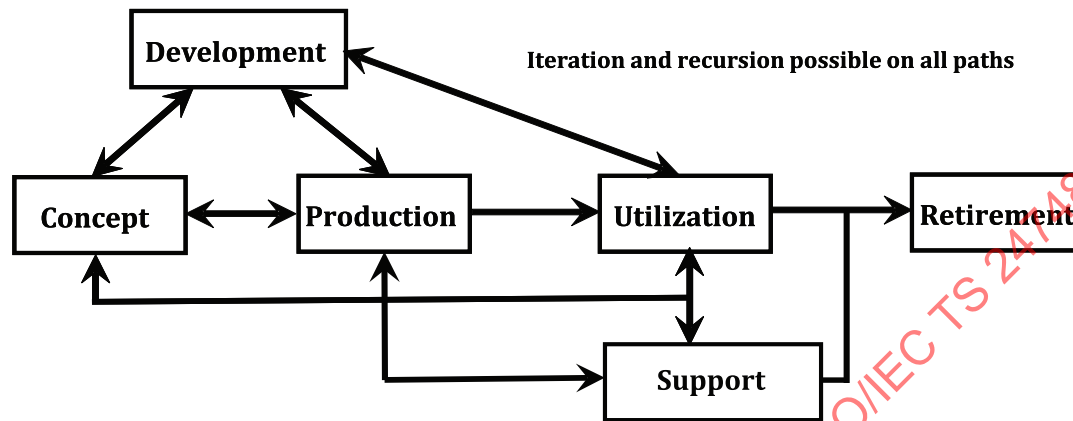
A representative system life cycle model, shown in Figure 6, illustrates this progression. The interfaces between stages are the decision points for determining that the system is ready to progress to subsequent stages in its evolution.

|         |             |            |             |         |            |
|---------|-------------|------------|-------------|---------|------------|
| Concept | Development | Production | Utilization | Support | Retirement |
|---------|-------------|------------|-------------|---------|------------|

Figure 6 — Representative life cycle model

The stages in Figure 6, although drawn as discrete, are in practice interdependent and overlapping. Further, the figure implicitly conveys a uniformity and single linearity of time progression that is not inherently part of a life cycle model: stages do not necessarily occur one after another in time sequence.

So, one actuality of the “progression” of a system through its life cycle could be as represented in [Figure 7](#). When, in this Technical Specification, reference is made to the next, subsequent, or later stage, this type of model must be kept in mind to avoid confusion by inferring linear time sequencing. Further, although each stage is represented in [Figure 7](#), as if it were approximately the same time duration as the other stages, in actuality, the durations of different stages can be and usually are quite different. For example, for a given system, the Concept Stage might last only weeks, the development might take months, the utilization could continue for years and retirement might be accomplished in days.



**Figure 7 — Life cycle model with some of the possible progressions**

A system progresses through its life cycle as the result of actions, performed and managed by people in organizations, using processes for their performance. The detail in the life cycle model is expressed in terms of these processes, their outcomes, relationships and occurrence. A key aspect of life cycle management is that each stage requires entry criteria that shall be met before effort from that stage is allowed. Further, each stage requires exit criteria before effort on that stage meets are criteria for satisfactory completion. Since stages can have complex relationships as illustrated in [Figure 7](#), definition of both entry and exit criteria for a specific stage are needed. For example, if one stage should be started before a “preceding” stage is completed, the stage being started should have its own entrance criteria separate from the exit criteria of the “preceding” stage. Thus, the use of stages corresponds to satisfying decision criteria before allowing further progress, providing a strong project control feature, whatever the sequence of stages within a given system’s life cycle model.

Five common principles associated with a life cycle model are the following:

- a system progresses through specific stages during its life;
- enabling systems should be available for each stage in order to achieve the outcomes of the stage;
- at specific life cycle stages, attributes, such as producibility, usability, supportability and disposability should be specified and designed into a system;
- progression to another stage requires satisfaction of exit criteria of the current stage and possibly entrance criteria for the following stage or stages;
- exit criteria are usually based on satisfactory outcomes of the stage being completed and may include demonstrable readiness to execute the processes in the subsequent stage or stages.

### 3.2.2 System life cycle stages

Life cycles vary according to the nature, purpose, use and prevailing circumstances of the system. Nevertheless, despite an apparently limitless variety in system life cycles, there is an underlying, essential set of characteristic life cycle stages that exists in the complete life cycle of any system. Each stage has a distinct purpose and contribution to the whole life cycle and should be considered when planning and executing the system life cycle.

The stages represent the major life cycle periods associated with a system and they relate to the state of the system description or realization of the system's set of products or services. The stages describe the major progress and achievement milestones of the system through its life cycle. They give rise to the primary decision gates of the life cycle. These decision gates are used by organizations to contain the inherent uncertainties and risks associated with costs, schedule and functionality when creating or utilizing a system. The stages thus provide organizations with a framework within which management has high-level visibility and control of project and technical processes.

Table 1 shows a commonly encountered example of life cycle stages. Also shown are the principal purposes of each of these stages and the possible decision options used to manage the achievement and risk associated with progression through the life cycle.

**Table 1 — Example of stages, their purposes and major decision gates**

| Life cycle stages | Purpose                                                                                                 | Decision options                                                                                                                                      |
|-------------------|---------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| Concept           | Identify stakeholders' needs<br>Explore concepts<br>Propose viable solutions                            | — Begin subsequent stage or stages<br>— Continue this stage<br>— Go to or restart a preceding stage<br>— Hold project activity<br>— Terminate project |
| Development       | Refine system requirements<br>Create solution description<br>Build system<br>Verify and validate system |                                                                                                                                                       |
| Production        | Produce systems<br>Inspect and test                                                                     |                                                                                                                                                       |
| Utilization       | Operate system to satisfy users' needs                                                                  |                                                                                                                                                       |
| Support           | Provide sustained system capability                                                                     |                                                                                                                                                       |
| Retirement        | Store, archive or dispose of system                                                                     |                                                                                                                                                       |

Organizations employ stages differently to satisfy contrasting business and risk mitigation strategies. Using stages concurrently and, in a few cases, even in different orders, can lead to life cycle forms with distinctly different characteristics. Sequential, incremental or evolutionary life cycle forms are frequently used. Alternatively, a suitable hybrid of these can be developed. The selection and development of such life cycle forms by an organization depend on several factors, including the business context, the nature and complexity of the system, the stability of requirements, the technology opportunities, the need for different system capabilities at different times and the availability of budget and resources. In addition, major decision gates, often called milestones and reviews to focus on making the decisions may be incorporated by an organization on an incremental basis within a stage, as well as at the end of a stage, to further manage risks.

Just as all the system elements of a system contribute to the system as a whole, so each stage of the life cycle needs to be considered during any other stage of the life cycle. As a consequence, the contributing parties need to coordinate and cooperate with each other throughout the life cycle. This synergism of the life cycle stages and the functional contributors is necessary for successful project actions. Close communication with project team members from the different functions and organizations responsible for other life cycle stages leads to consistency in the life cycle.

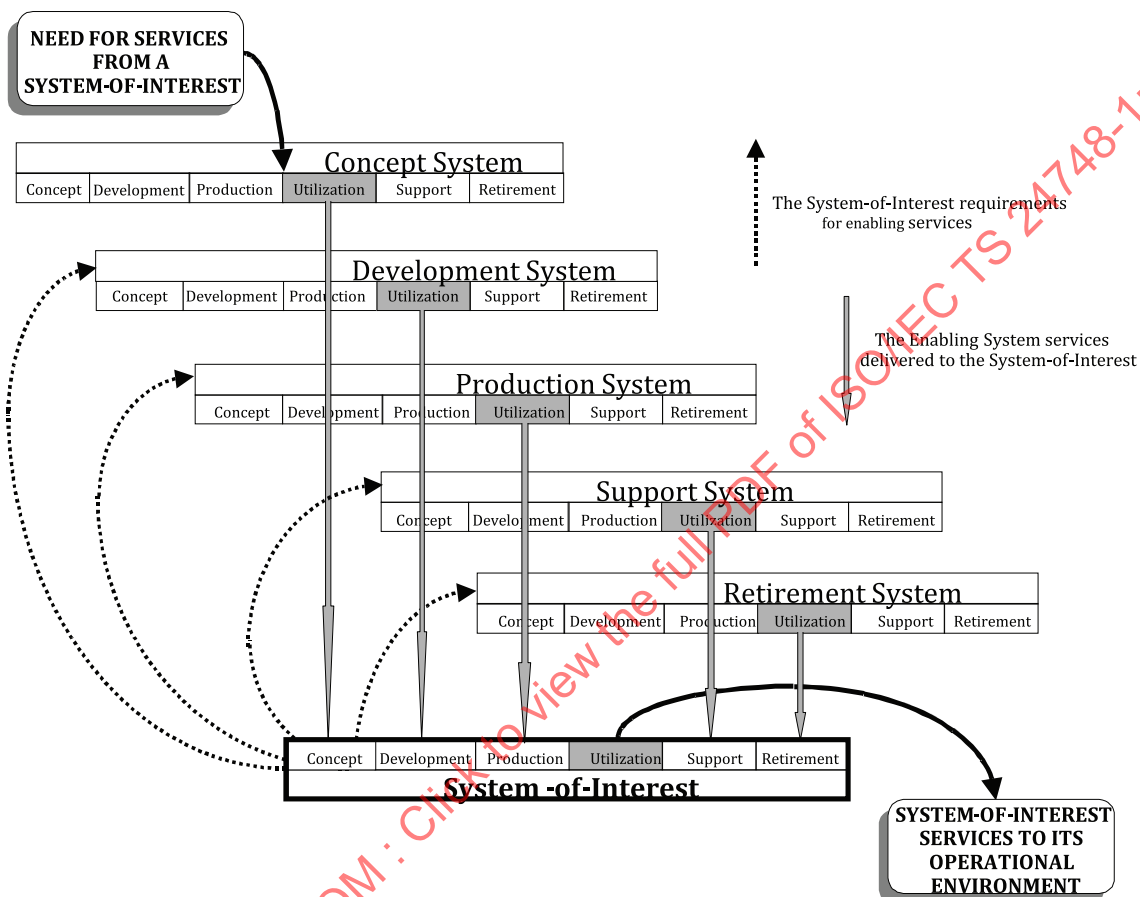
### 3.2.3 Stages in a system-of-interest and its enabling systems

As with any system, each enabling system also has its own life cycle. Each life cycle is linked and synchronized to that of the system-of-interest. For example, if an enabling system does not already exist, its requirement is defined during the Concept Stage of the system-of-interest (or later if lead times

permit), before the enabling system is utilized as shown in [Figure 8](#) to provide its particular service to the system-of-interest.

An enabling system may pre-exist the system-of-interest, i.e. be an existing part of the infrastructure of the organization responsible for the system-of-interest or be in a service supplier's organization. Pre-existing enabling systems can introduce additional constraints on the system-of-interest.

Each enabling system can itself be considered as a system-of-interest, having in turn its own enabling systems. Therefore, the concepts in this Technical Specification can also be applied to enabling systems.



### Figure 8 – System interaction with typical enabling systems

### 3.3 Process concepts

### 3.3.1 Life cycle processes

The life cycle processes defined in this Technical Specification can be used by any organization when acquiring and using, as well as when creating and supplying, a system. They can be applied at any level in a system's structure and at any stage in the life cycle.

The life cycle processes are based on principles of ownership (a process is associated with a responsibility, discussed further in [3.3.2](#)) and modularity. That is, the processes are the following:

- strongly cohesive, meaning that all the parts of a process are strongly related;
- loosely coupled, meaning that the number of interfaces among the processes is kept to a minimum.

The processes described in this Technical Specification are not intended to preclude or discourage the use of additional processes that organizations find useful.

### 3.3.1.1 General

Organizations, when considering a new project, should select a life cycle model, such as shown in [Figure 7](#) and the necessary life cycle processes to satisfy applicable life cycle stage entry or exit criteria. Decisions as to which processes to select should be based on cost-benefit or risk reduction. Within a life cycle stage, processes are performed as required to achieve stated objectives. The progression of a system through its life is the result of actions managed and performed by people in one or more organizations using the processes selected for a life cycle stage.

ISO/IEC/IEEE 15288 and ISO/IEC 12207 provide a specific example of four groups of system life cycle processes: Agreement, Organizational project-enabling, Technical management and Technical. Each process has a specific purpose, a set of expected outcomes and a set of activities and tasks. Each group of processes is described in [Clause 6](#) of each referenced International Standard and summarized below.

NOTE The process groups in ISO/IEC 12207 and ISO/IEC/IEEE 15288 are identical. There are differences between the two standards at lower levels within a given group (i.e. purpose, outcomes, activities and tasks). Those differences do not affect the discussion of project groups in this subclause.

### 3.3.1.2 Agreement processes

The agreement processes are applicable for establishing the relationship and requirements between an acquirer and supplier. The agreement processes provide the basis for initiation of other project processes to enable arriving at an agreement to conceive, develop, produce, utilize, support, or retire a system and to acquire or supply related services.

The agreement processes can be used for several purposes, such as listed below, to

- form and ensure completion of an agreement between an acquirer and a supplier for work on a system at any level of the system structure,
- establish and carry out agreements to acquire a system or related enabling system services,
- obtain work efforts by consultants, subcontractors, organizations, projects or individuals or teams within a project, and
- provide the basis for closing an agreement after the system has been delivered or work has been completed and payment made.

### 3.3.1.3 Organizational project-enabling processes

Organizational project-enabling processes are for that part of the general management that is responsible for establishing and implementing projects related to the products and services of an organization. Thus, the organization through these distinct processes provides the services that both constrain and enable the projects, directly or indirectly, to meet their requirements.

The Organizational Project-enabling Processes included in International Standards, such as ISO/IEC 12207 and ISO/IEC/IEEE 15288 are not necessarily the only processes used by an organization for governance of its business. For example, organizations also have processes for managing accounts receivable, accounts payable, payroll processing and marketing. These business-related processes are not directly within the scope of the mentioned standards and thus are not discussed further in this Technical Specification. The Organizational Project-enabling Processes of ISO/IEC/IEEE 15288 and ISO/IEC 12207 are constrained in their scope to the aspects of those processes that are required to bound and guide the project, even though there are implicit relationships that the organization should address elsewhere, for example, in the Human Resource Management Process.

For multiple projects involved in or interfacing with an organization or for a teaming arrangement among external organizations, other organizational project-enabling processes can be appropriately tailored.

To perform these processes, it is not intended that a new organizational unit or discipline within an organization be created. Identified and defined roles, responsibilities and authorities may be assigned

to individuals or established organizational units. When necessary, however, a new organizational unit can be formed.

The organizational project-enabling processes have specific objectives to fulfil, such as listed below are the following:

- provide the proper environment so that projects within the organization can accomplish their purpose and objectives;
- ensure that there is an orderly approach to starting, stopping and redirecting projects;
- ensure that organizational policies and procedures are defined that set forth the relevant life-cycle processes of the International Standards cited above and that are applicable to projects within the organization and its constituent parts;
- ensure that appropriate models, methods and tools are selected and provided to projects so that they can complete process activities efficiently and effectively;
- ensure that projects have adequate resources for the project to meet budget, schedule and performance requirements within acceptable risks and that human resources are appropriately trained for completing their responsibilities;
- ensure that project work products for delivery to customers are of a suitable quality;
- ensure that knowledge acquired during the execution of a project is retained in a form that is accessible for future needs.

#### 3.3.1.4 Technical management processes

The technical management processes are used to manage technical process activities and to assure satisfaction of an agreement. Technical management processes are performed to establish and update plans, to assess progress against plans and system requirements, to measure and control work efforts, to make required decisions, to manage risks and configurations and to capture, store, and disseminate information. Outcomes from performing the technical management processes help in the accomplishment of the technical processes.

The technical management processes apply to technology exploration projects that are most often part of larger projects. When that is the case, the appropriate technical management processes are performed at each level of the system structure. These processes also apply when performing organizational project-enabling processes or carrying out the activities related to a life cycle stage, including utilization, support and retirement.

When several projects co-exist within one organization, technical management processes should be defined to allow for the management of the resources and performance of the multiple projects.

#### 3.3.1.5 Technical processes

The technical processes are applicable across all life cycle stages. For example, the following Technical Processes from ISO/IEC/IEEE 15288 should be performed to engineer a system.

- a) Business or Mission Analysis Process
- b) Stakeholder Needs and Requirements Definition Process
- c) System Requirements Definition Process
- d) Architecture Definition Process
- e) Design Definition Process
- f) System Analysis Process

- g) Implementation Process
- h) Integration Process
- i) Verification Process
- j) Transition Process
- k) Validation Process
- l) Operation Process
- m) Maintenance Process
- n) Disposal Process

NOTE The titles of these processes are identical to those in ISO/IEC 12207 except for c), which is System/Software Requirements Definition Process in that International Standard.

These processes should be performed to satisfy the entry or exit criteria of a system life cycle stage or set of stages. For example, they may be used during early system life cycle stages to create a feasible system concept, determine technology needs and establish future developmental costs, schedules and risks. During ensuing life cycle stages the technical processes may be used to define, realize and make use of a new system. During later system life cycle stages they may be used on legacy systems to make technology refreshments or technology insertions, as well as to correct variations from expected performance during production, utilization, support or retirement. These processes apply to both a system-of-interest and its enabling systems.

The last three Technical Processes listed (Operations Process, Maintenance Process and Disposal Process) can be used during any system life cycle to accomplish the objectives of a life cycle stage and support the technical processes used for engineering a system. The Operations Process and the Maintenance Process can be performed, as applicable, to support a particular version of a system. The Disposal Process can be performed to deactivate legacy systems, to dispose of legacy systems and to safely dispose of by-products from system use.

There may be additional technical processes used for a specific technical domain within a system, such as software, hardware, humans, or facilities, which would be discussed in the appropriate International Standard for that technical domain.

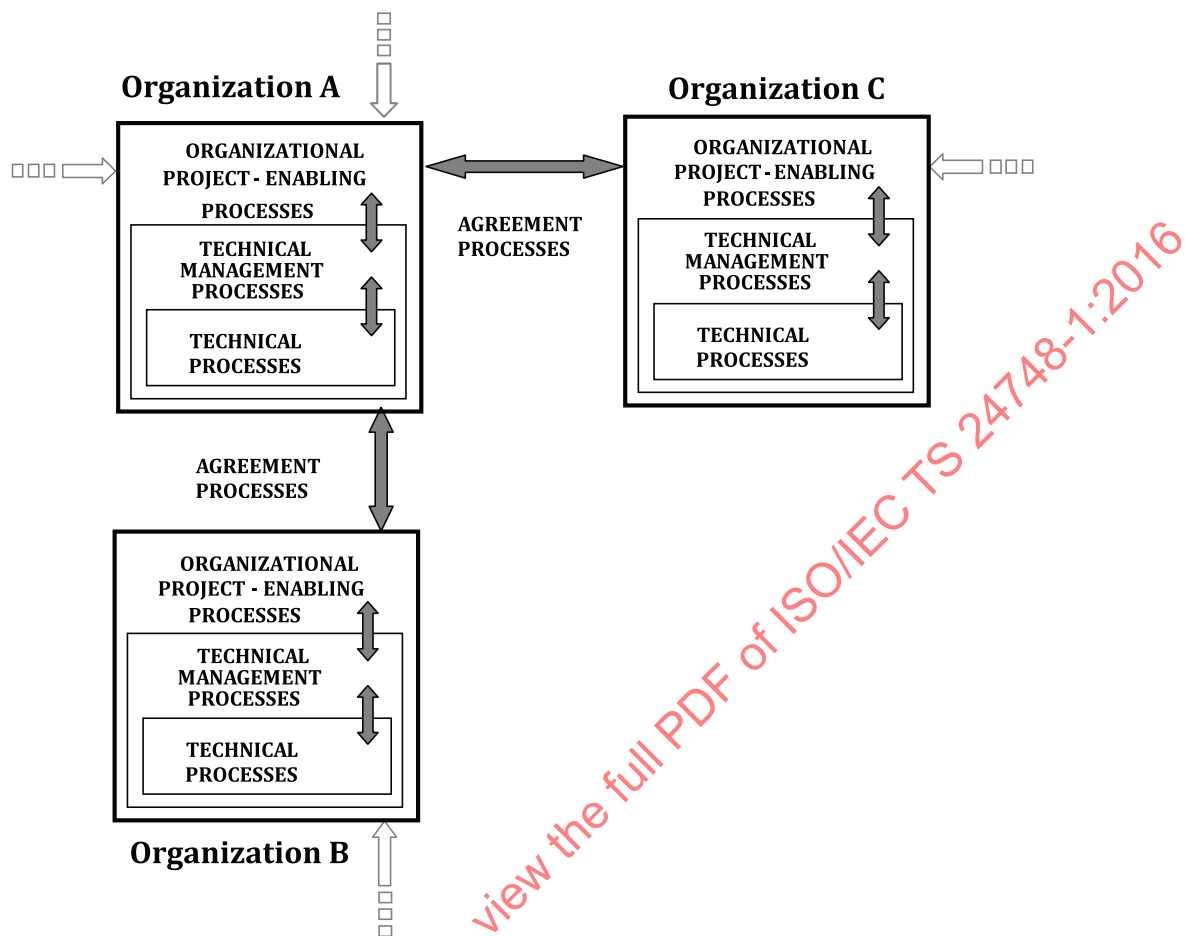
### 3.3.2 Process responsibility

An organization is a body of entities organized for some specific purpose and may be as diverse as a corporation, agency, society, union, or club. An organization may be part of a parent organization (e.g. a society being parent to clubs that are a part of it). When an organization enters into an agreement, it is a party. Parties may have the same parent organization, although it is equally possible that they have different parent organizations (e.g. two clubs from the same society making an agreement or two clubs from two different societies making an agreement).

Typically, organizations distinguish different areas of managerial responsibility and action through agreements, as indicated in [Figure 9](#). Together, these areas contribute to the organization's overall capability to trade. This Technical Specification employs a process model based on three primary organizational areas (or levels) of responsibility: organization, project and technical. Within each organization, a coordinated set of organizational project-enabling, technical management and technical processes contribute to the effective creation and use of systems, and therefore to achieving the organization's goals.

Each process is considered to be the responsibility of a party. An organization may perform one or more processes. A process may be performed by one organization or more than one organization, with one of the organizations being identified as the responsible party. A party executing a process has the responsibility for that entire process even though the execution of individual tasks may be by different parties. The responsibility aspect of the life cycle architecture facilitates adaptation and application

of International Standards, such as ISO/IEC/IEEE 15288 or ISO/IEC 12207 on a project, in which many parties may be legitimately involved.



**Figure 9 — Agreements on responsibilities for organizational project-enabling, technical management and technical processes among cooperating organizations**

Different organizations (or parts thereof) as parties, and different areas of responsibility within an organization, mutually establish their working relationships and acknowledge their respective responsibilities by making agreements. These agreements unify and coordinate the contributions made by different parties in order that they can meet a common business purpose.

### 3.4 Process application

Each system life cycle process in [Figure 10](#) can be invoked, as required, at any point, and at multiple points, throughout the life cycle and there is no definitive order or time sequence in their use. The detailed purpose and timing of use of these processes throughout the life cycle are influenced by multiple factors, including social, trading, organizational and technical considerations, each of which can vary during the life of a system. An individual system life cycle is thus a complex system of processes that will normally possess concurrent, iterative, recursive and time dependent characteristics. These statements are true for both a system-of-interest and any enabling systems.

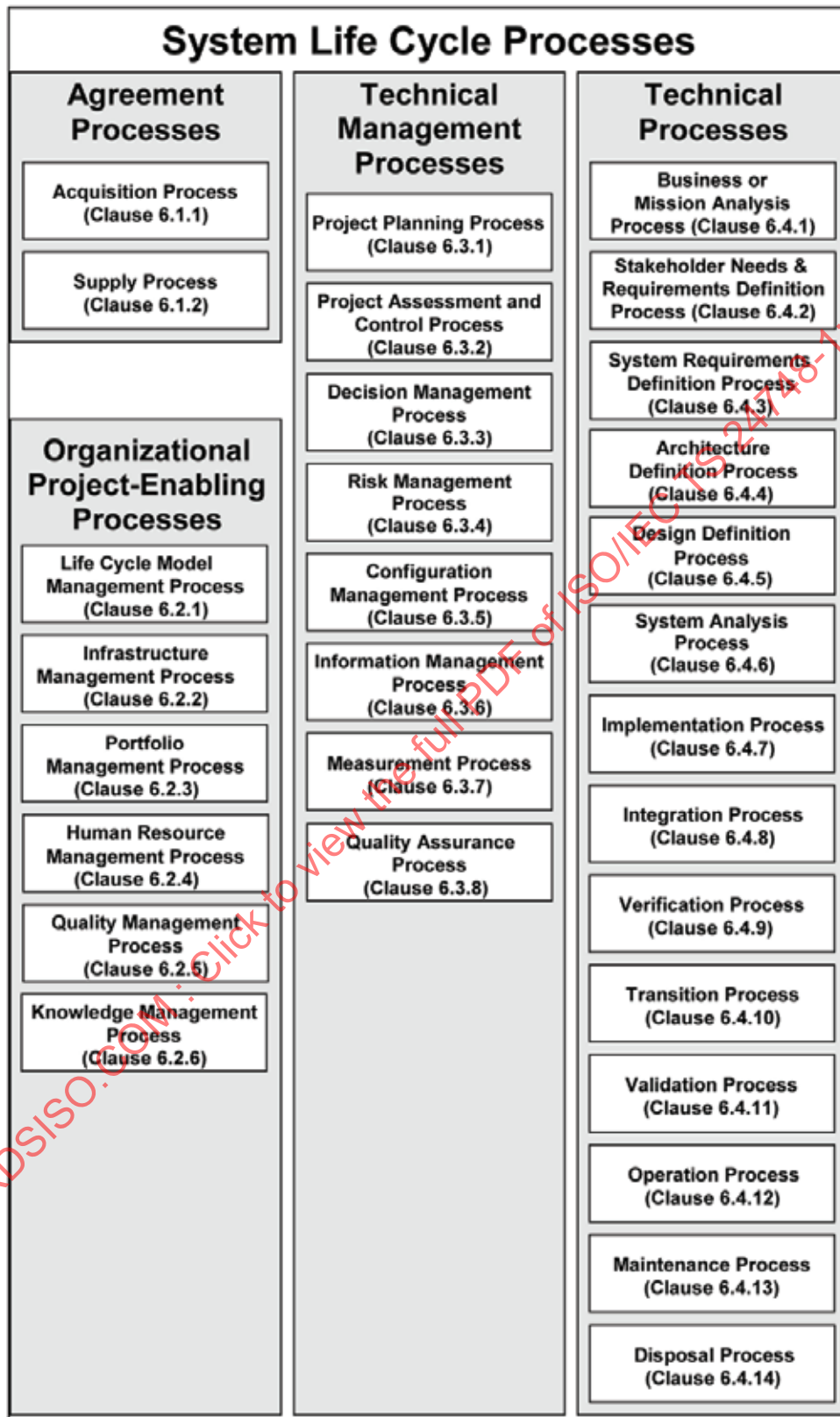


Figure 10 — System life cycle processes

NOTE 1 In Figure 10, the subclause numbers refer to the subclauses in ISO/IEC/IEEE 15288 and ISO/IEC 12207 where the processes are described, not to the clauses in this Technical Specification.

NOTE 2 In ISO/IEC 12207, the heading for the figure in that standard is System/Software Life Cycle Processes and the process in ISO/IEC 12207:2008, 6.4.3 is titled System/Software Requirements Definition Process.

Concurrent use of processes can exist within a project, e.g. when design actions and preparatory actions for building a system are performed at the same time, as well as between projects, e.g. when different system elements are designed at the same time under different project responsibility.

The iterative use of processes, i.e. the repeated application of a process or set of processes at the same hierarchical level of structural detail, is important for the progressive refinement of process outputs, e.g. the interaction between successive verification actions and integration actions can incrementally build confidence in the conformance of the product. The recursive use of processes, i.e. the repeated application of the same process or set of processes applied to successive levels of detail in a system's hierarchical structure is a key aspect of the application of this Technical Specification. The outputs of processes at any level, whether information, artefacts or services are inputs to the same processes used at the level above or level below. This results in a response, information, artefacts, or service, which can then modify the original output. In this way, the outputs across all levels of the system can be resolved and consistency achieved, e.g. system element descriptions that conform to an architecture.

The changing nature and complexity of the influences on the system (e.g. operational environment changes, new opportunities for system element implementation, modified structure and responsibilities in organizations) requires continual review of the selection and timing of process use. Process use in the life cycle is thus dynamic, responding to the many external influences on the system.

The life cycle stages assist the planning, execution and management of life cycle processes in the face of this complexity in life cycles by providing comprehensible and recognizable high-level purpose and structure. Precedence, particularly in similar market and product sectors can assist the selection of stages and the application of life cycle processes to build an appropriate and effective life cycle model for any system.

### 3.5 Processes under key views

This Technical Specification contains processes that are applicable throughout a life cycle. However, these processes may be used in different ways by different organizations and parties with different views and objectives. This subclause presents processes and their relationships under key views. See [3.3.1](#) for synopses of the processes.

[Figure 11](#) depicts illustrative examples of the life cycle processes and their relationships under different views of the usage of the Technical Specification. The basic views shown are: contract, management, technical management, engineering, operating, support and project. Further discussion of views, their creation and use, is given in [Annex A](#).

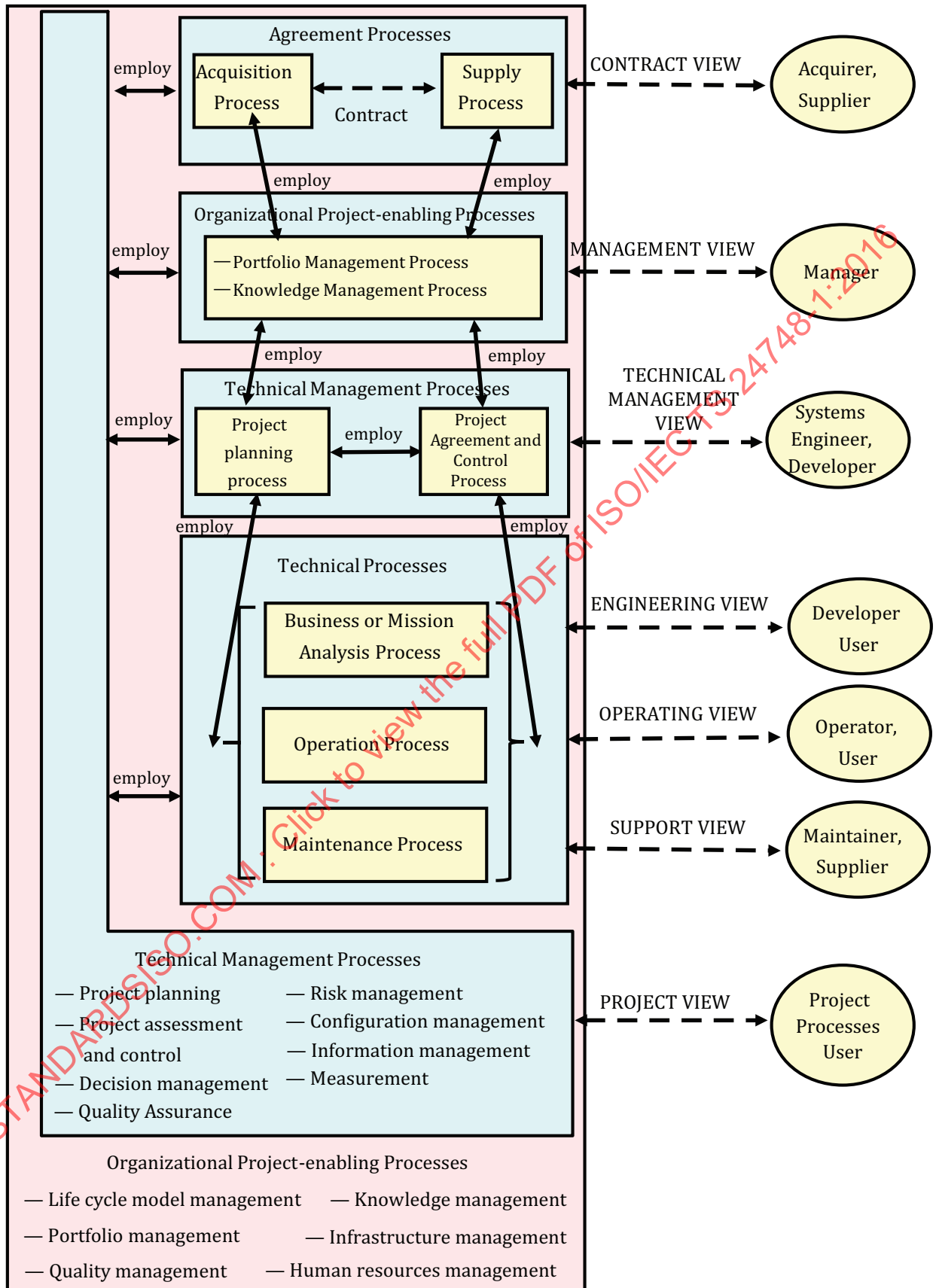


Figure 11 — Life cycle processes roles and relationships

Under the contract view, acquirer and supplier parties negotiate and enter into a contract or other agreement and employ the Acquisition Process and Supply Process respectively. Under the management view, the organization establishes, uses and maintains a process framework that services multiple projects and complements their technical effort. Under the technical management view, the organization initiates, supports and controls projects. Under the engineering view, the developer or maintainer conducts its respective engineering tasks to produce or modify products or services. Under the operating view, the operator provides operation service for the users. Under the support view, the maintainers and suppliers apply parts and services to sustain and improve the operation of the system. Under the project view, parties (such as configuration management or information management) provide supporting services to others in fulfilling specific, unique tasks. Also shown (see the bottom box) are some of the organizational project-enabling processes provided by the organization to support multiple projects; these are employed by an organization at a higher, e.g. corporate, level to establish and implement an underlying structure made up of associated life cycle processes and personnel and their continuous improvement.

The processes and parties (or stakeholders) are only related functionally. They do not dictate a structure for a party.

An organization or a party gets its name from the process it performs, for example, it is called an acquirer when it performs the Acquisition Process.

An organization may perform one process or more than one process, a process may be performed by one organization or more than one organization. Under one contract or application of this Technical Specification, a given party should not perform both the Acquisition Process and the Supply Process, but it can perform other processes.

In the Technical Specification itself, the relationships between the processes are only static. The more important dynamic, real-life relationships between the processes, between the parties, and between the processes and the parties are established when the appropriate International Standard (e.g. ISO/IEC/IEEE 15288 for systems or ISO/IEC 12207 for software) is applied on projects in a manner specific to that project. Each process (and the party performing it) contributes to the project in its own unique way. The Acquisition Process (and the acquirer) contributes by defining the product or service (or both) to be obtained. The Supply Process (and the supplier) contributes by providing the product or service. The Integration Process (and the integrator) contributes by “looking” to the system for correct derivation and definition of software, hardware and other products, as well as services, by supporting proper integration of products and services back into an overall system. The Operation Process (and the operator) contributes by operating the products or providing the services in the system’s environment for the benefit of the users, the business, and the mission. The Maintenance Process (and the maintainer) contributes by maintaining and sustaining the products and services for operational fitness and by providing support and advice to the user community. Each process contributes by providing unique, specialized functions to other processes as needed.

Where processes are applied to system elements of a specific nature (e.g. software), the relevant processes from the standard that applies to that kind of element will be invoked (in this case, ISO/IEC 12207), as well as appropriate system processes. This holds true for elements of all types. Thus, there is a complementary duality of process interplay as the particulars of a system are instantiated. As a specific example, the validation process for software will be invoked as part of the overall process of validating the system, to ensure that the software is validated as part of the system.

All of the above statements apply to enabling systems, as well as the system-of-interest.

## 4 Life cycle stages

### 4.1 General

Life cycle stages are the specific framework within which system life cycle processes are applied to life cycle models. The value of stages is that entry into and exit from each stage represents a decision point. Therefore, progress is explicitly gated and the criteria for each step of progress, moving to the

next stage is also explicit. These criteria determine when a stage can be exited and when the next appropriate stage can be commenced. For stages that follow each other in linear fashion, the exit and entrance criteria are the same. However, more complex stage relationships may necessitate separate exit and entrance criteria.

Each life cycle process of ISO/IEC 12207 and ISO/IEC/IEEE 15288 can be invoked at any point throughout the life cycle, as was noted in 3.3 and 3.4. The order and sequence in which processes are invoked, and when they are invoked, is driven by the project requirements and context: there is no unique definitive order or time sequence for their use within a stage or across several stages. Note that, for a given process, the outcome or outcomes for one stage may not be the same as for other stages. It is necessary to consider the outcome or outcomes for each process invoked during a given stage to ensure that the appropriate outcome or outcomes are obtained to support the exit criteria for that stage and the entrance criteria for any ensuing stages.

So, system, software, service (or other) life cycle processes can be invoked concurrently, iteratively, recursively and time dependently in whatever stages of an individual system, software, service, or other, life cycle model are applicable to a given project. The scale and rigour of process application in the listed stages and the duration of these stages will be determined by the varying business and technical needs of the projects defining and using the life cycle model.

The processes invoked are generally performed by systems other than the system-of-interest, e.g. by enabling systems.

This Technical Specification describes the following six stages as examples:

- a) Concept Stage;
- b) Development Stage;
- c) Production Stage;
- d) Utilization Stage;
- e) Support Stage;
- f) Retirement Stage.

In the following subclauses, for each example stage, an overview description is given, followed by descriptions of the example stages purpose and outcomes.

## 4.2 Concept Stage

### 4.2.1 Overview

The Concept Stage begins with initial recognition of a need or a requirement for a new system-of-interest or for the modification to an existing system-of-interest. This is an initial exploration, fact finding and planning period when economic technical, strategic and market bases are assessed through acquirer/market survey, business or mission analysis, solution space identification and feasibility analysis and trade-off studies. Acquirer/user feedback to the concept is obtained.

One or more alternative concepts to meet the identified need or requirement are developed through analysis, feasibility evaluations, estimations (such as cost, schedule, market intelligence and logistics), trade-off studies, and experimental or prototype development and demonstration. The need for one or more enabling systems for development, production, utilization, support and retirement of the system-of-interest is identified and candidate solutions are included in the evaluation of alternatives in order to arrive at a balanced, life cycle solution. Typical outputs are stakeholder requirements, concepts of operation, assessment of feasibility, preliminary system requirements, outline architecture and design solutions in the form of drawings, models, prototypes, etc., and concept plans for enabling systems, including whole life cost and human resource requirements estimates and preliminary

project schedules. Decisions are made whether to continue with the implementation of a solution in the Development Stage or to cancel further work.

It is presumed that the organization has available enabling systems for the Concept Stage that consist of the methods, techniques, tools and competent human resources to undertake market/economic analysis and forecasting or mission analysis, feasibility analysis, trade-off analysis, technical analysis, whole life cost estimation, modelling, simulation, and prototyping.

#### 4.2.2 Purpose

The Concept Stage is executed to assess new business opportunities or mission assignments and to develop preliminary system requirements and a feasible architecture and design solution.

#### 4.2.3 Outcomes

The outcomes of the Concept Stage are listed below.

- a) The identification of new concepts that offer such things as new capabilities, enhanced overall performance, or reduced stakeholders' total ownership costs over the system life cycle.
- b) An assessment of feasible system-of-interest concepts, with initial architectural and other solutions, including enabling systems throughout the life cycle, for closure against both technical and business or mission stakeholder objectives.
- c) The preparation and baselining of stakeholder requirements and preliminary system requirements (technical specifications for the selected system-of-interest and usability specifications for the envisaged human-machine interaction).
- d) Refinement of the outcomes and cost estimates for stages of the system life cycle model.
- e) Risk identification, assessment and mitigation plans for this and subsequent stages of system life cycle model.
- f) Identification and initial specification of the services needed from enabling systems throughout the life of the system.
- g) Concepts for execution of all succeeding stages.
- h) Plans and exit criteria for the Development Stage.
- i) Development and satisfaction of stage exit criteria.
- j) Approval to proceed to the appropriate stage or stages, based on the specific life cycle model in use by the project.

### 4.3 Development Stage

#### 4.3.1 Overview

The Development Stage begins with sufficiently detailed technical refinement of the system requirements, system architecture, and the design solution and transforms these into one or more feasible products that enable a service during the Utilization Stage. The system-of-interest may be a prototype in this stage. The hardware, software, operator, process and facility interfaces are specified, analysed, designed, fabricated, integrated, tested and evaluated, as applicable and the requirements for production, training and support facilities, and transitions, are defined. This stage also ensures that the aspects of other stages (production, utilization, support, and retirement) and their enabling systems' requirements and capabilities are considered and incorporated into the design through the involvement of all interested parties. Feedback is obtained from stakeholders and those who will produce, operate, use, support and retire the system-of-interest through such means as a series of technical or other reviews. Outputs are a system-of-interest or a prototype of the final system-of-interest, refined

requirements for enabling systems or the enabling systems themselves and all documentation and cost estimates of future stages.

Planning for this stage begins in the preceding stage to ensure the organization has available or can establish, an infrastructure of development enabling systems, consisting of facilities, processes, procedures, methods, techniques, tools and competent human resources to undertake analysis, modelling and simulation, prototyping, design, integration, test, transition and documentation. These items are developed or acquired to be available when needed to support development.

#### 4.3.2 Purpose

The Development Stage is executed to develop a system-of-interest that meets stakeholder requirements and can be produced, tested, evaluated, operated, supported and retired.

#### 4.3.3 Outcomes

The outcomes of the Development Stage are listed below.

- a) Baselined technical information, including evaluated and refined system requirements are as follows:
  - hardware diagrams, drawings and models;
  - software design documentation;
  - process and procedure documentation;
  - facility design documentation;
  - interface specifications;
  - production plans;
  - operating instructions;
  - training manuals for operators;
  - maintenance procedures;
  - retirement considerations.
- b) Project budget and schedule baselines and life cycle ownership cost estimates.
- c) A system-of-interest structure comprised of, for example, hardware elements, software elements, human elements, process elements, facility elements and the interfaces (internal and external) of all such elements.
- d) Verification and validation documentation.
- e) Transition planning documentation.
- f) Evidence supporting a decision, with all risks and benefits considered, that the system-of-interest meets all specified requirements and is producible, operable, supportable and capable of retirement and is cost effective for stakeholders.
- g) Refined and baselined requirements for the enabling systems.
- h) A prototype or final system-of-interest.
- i) Refined outcomes and cost estimates for the Production, Utilization, Support and Retirement Stages.
- j) Definition of the enabling system services required in subsequent life cycle stages.

- k) Plans and exit criteria for the Production and Support Stages.
- l) Identification of current risks and determination of their treatment.
- m) Satisfaction of stage exit criteria.
- n) Approval to proceed to the appropriate stage or stages, based on the specific life cycle model in use by the project.

## 4.4 Production Stage

### 4.4.1 Overview

The Production Stage begins with the approval to produce the system-of-interest. The system-of-interest may be individually produced, assembled, integrated and tested, as appropriate, or may be mass-produced. Planning for this stage begins in the preceding stage. Production may continue throughout the remainder of the system life cycle. During this stage, the system may undergo enhancements or redesigns, the enabling systems may need to be reconfigured and production staff re-trained in order to continue evolving a cost effective service from the stakeholder view.

It is presumed that the organization has available the budget and enabling systems that consist of production equipment, facilities, tools, processes, procedures and competent human resources. These items are developed or acquired in order to be available when needed to enable production.

### 4.4.2 Purpose

The Production Stage is executed to produce or manufacture the system-of-interest, test it and produce related enabling systems as needed.

### 4.4.3 Outcomes

The outcomes of the Production Stage are listed below.

- a) Qualification of the production capability.
- b) Acquisition of resources, material, services and system elements to support the target production quantity goals.
- c) The system produced according to approved and qualified production information.
- d) Packaged product transfer to distribution channels or acquirer.
- e) Plans and exit criteria for the Utilization Stage and the Support Stage.
- f) Updated concepts for execution of all succeeding stages.
- g) Current risks and mitigating actions identified.
- h) Quality assured systems-of-interest accepted by the acquirer.
- i) Satisfaction of stage exit criteria.
- j) Approval to proceed to the appropriate stage or stages, based on the specific life cycle model in use by the project.

## 4.5 Utilization Stage

### 4.5.1 Overview

The Utilization Stage begins after installation and transition to use of the system. The Utilization Stage is executed to operate the product at the intended operational sites to deliver the required services with continuing operational and cost effectiveness. This stage ends when the system-of-interest is taken out of service.

Planning for this stage begins in the preceding stages. This stage includes those processes related to use of the system to provide services, as well as monitoring performance and identifying, classifying and reporting of anomalies, deficiencies, and failures. The response to identified problems includes taking no action; maintenance and minor (low cost/temporary) modification (4.6); major (permanent) modification and system-of-interest life extensions (4.3 and 4.4), and end-of-life retirement (4.7).

During this stage, the product or services can evolve giving rise to different configurations. Enabling systems may likewise evolve. The operator operates the different configurations and the responsible product supplier manages the status and descriptions of the various versions and configurations of the product or services in use.

It is presumed that the organization has available the Utilization Stage enabling system which consists of facilities, hardware and software, processes, procedures, trained personnel and instruction manuals. These items are developed or acquired in order to be available when needed to support utilization.

### 4.5.2 Purpose

The Utilization Stage is executed to operate the product, to deliver services within intended environments and to ensure continuing operational effectiveness.

### 4.5.3 Outcomes

The outcomes of the Utilization Stage are listed below.

- a) Experienced personnel with the competence to be operators in the system-of-interest and provide operational services.
- b) An installed system-of-interest that is capable of being operated and of providing sustainable operational services.
- c) Performance and cost monitoring and assessment to confirm conformance to service objectives.
- d) Identification of problems or deficiencies, informing appropriate parties (user, development, production or support) of the need for corrective action.
- e) New opportunities for system-of-interest enhancement through stakeholder feedback.
- f) Plans and exit criteria for the Retirement Stage.
- g) Satisfaction of stage exit criteria.
- h) Approval to proceed to the appropriate stage or stages, based on the specific life cycle model in use by the project.

## 4.6 Support Stage

### 4.6.1 Overview

The Support Stage begins with the provision of maintenance, logistics and other support for the system-of-interest's operation and use. Planning for this stage begins in the preceding stages. The

Support Stage is completed with the retirement of the system-of-interest and termination of support services.

This stage includes those processes related to providing services that support utilization of the system-of-interest. This stage also includes processes to use and monitor the support system itself and its services, including the identification, classification, and reporting of anomalies, deficiencies and failures of the support system and services. Actions to be taken as a result of identified problems with the support system include maintenance and minor modification of the support system and services, major modification of the support system or services (4.3 and 4.4), and end-of-life retirement of the support system and services (4.7).

During this stage, the support system and services can evolve under different versions or configurations. The support organization operates the different versions or configurations and the responsible product organization manages the status and descriptions of the various versions and configurations of the support system and services in use.

It is presumed that the supporting organization has available the enabling systems, which consist of facilities, equipment, tools, processes, procedures, trained support personnel and maintenance manuals. The items making up the support enabling system are developed and acquired in order to be ready when needed to support the system-of-interest.

#### 4.6.2 Purpose

The support stage is executed to provide logistics, maintenance, and support services that enable continuing system-of-interest operation and a sustainable service.

#### 4.6.3 Outcomes

The outcomes of the Support Stage are listed below.

- a) Trained personnel who will maintain the system and provide the support services.
- b) Organizational interfaces with the operating and production organizations that ensure problem resolution and corrective actions.
- c) Maintained product and services and the provision of all related support services, including logistics, to the operational sites.
- d) Product and service maintenance and corrected design deficiencies.
- e) All required logistics support, including a spare parts inventory sufficient to satisfy operational availability goals.
- f) Current risks and mitigating actions identified.
- g) Agreement to terminate support services.
- h) Satisfaction of stage exit criteria.
- i) Approval to proceed to the appropriate stage or stages, based on the specific life cycle model in use by the project. Ordinarily, this would be the Retirement Stage.

### 4.7 Retirement Stage

#### 4.7.1 Overview

The Retirement Stage provides for the removal of a system-of-interest and related operational and support services, including appropriate disposal of specified system elements. Planning for the Retirement Stage begins in the preceding stages. This stage begins when a system-of-interest is taken out of service.

This stage includes those processes related to operating the system that enables retirement of the system-of-interest (the retirement enabling system), including appropriate disposal of specified enabling system elements, and also includes monitoring performance of that enabling system and the identification, classification, and reporting of anomalies, deficiencies, and failures of the retirement enabling system. Actions to be taken as a result of identified problems include maintenance and minor modification of the retirement enabling system (4.6), major modification of the retirement enabling system (4.3 and 4.4), and end-of-life retirement of the retirement enabling system itself (4.7).

It is presumed that the organization has access to an enabling system, which consists of facilities, tools, processes, procedures, equipment, trained personnel and, as appropriate, access to recycling, disposal or containment facilities. The items making up the retirement enabling system are developed and acquired in order to be ready when needed to perform retirement functions.

This stage is applicable whenever a system-of-interest reaches its end-of-service life. Such end-of-service life can be the result of replacement by a new system, irreparable wear, catastrophic failure, no further use to the user, e.g. through change in mission or business direction, or when it is no longer cost effective to continue operating and supporting the system-of-interest.

#### 4.7.2 Purpose

The Retirement Stage is executed to provide for the removal of a system-of-interest and related operational and support services, and to operate and support the retirement system itself.

#### 4.7.3 Outcomes

The outcomes of the Retirement Stage are listed below.

- a) Experienced personnel who can provide retirement services.
- b) Required system-of-interest decommissioning, including disposal, refurbishing, or recycling, in accordance with applicable health, safety, security, privacy and environmental laws and regulations.
- c) Plans and procedures for transferring the provision of services to the new system-of-interest if applicable.
- d) Removal of waste.
- e) Environment returned to original or agreed state.
- f) Archived knowledge elements.
- g) Operational staff is redeployed.
- h) Satisfaction of stage exit criteria.

## 5 Life cycle adaptation

### 5.1 General

No two projects are the same. Each organization is driven by the nature of its mission or business, its social responsibilities and its forward strategy. These provide constraints on available opportunities that the organization and its projects can exploit. To help exploit opportunities, the organization establishes policies and procedures to guide the performance of projects. Variations in organizational policies and procedures, acquisition methods and strategies, project size and complexity, system requirements and development methods, among other things, influence how a system is acquired, developed, operated, or maintained.

To help establish these policies and procedures and to determine the resources needed by the organization International Standards, such as ISO/IEC/IEEE 15288 and ISO/IEC 12207 can be used to

provide specific standardized processes for use within one or more life cycle models. However, in the interest of cost reduction and quality improvement, the processes from the International Standards, as well as life cycle models, may be adapted for an individual project to reflect the variations appropriate to the organization, project and system. The term *tailoring* has grown into use in conjunction with this adaptation step, so it will be used henceforth in this Technical Specification. The two International Standards provide five primary mechanisms for adaptation:

**Process selection:** Claims of conformance to either standard are made for a declared set of processes. Neither an organization nor a particular project is required to use every process. They may select the processes relevant to their needs and declare that subset as the basis of conformance.

**Process substitution:** For example, some of the processes of ISO/IEC 12207 are described as “specializations” of processes in ISO/IEC/IEEE 15288. Explicit permission is granted to use the system-level process as a basis for conformance rather than the software-level process.

**Use of Outcomes, or Activities and Tasks:** The conformance clause of both standards allows claiming full conformance by demonstrating that all of the requirements of the declared set of processes have been satisfied, either by achieving the required outcomes or by achieving the requirements of the activities and tasks. The fact that outcomes are used as evidence of conformance provides that alternative selections of activities and tasks may be performed if the outcomes of the declared set of processes are achieved. Similarly, using activities and tasks to demonstrate conformance allows adaptation of the process to provide outcomes that are the most appropriate in the context of the life cycle model being used.

**Use of Notes:** Both standards use non-normative notes or other forms of guidance for provisions that are not required for conformance. In specific situations, implementation of selected notes will be appropriate.

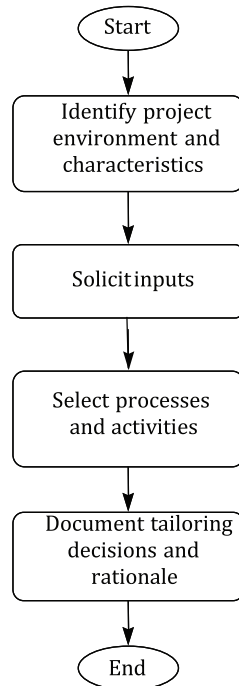
**Process tailoring:** In both standards, *tailoring* of processes is permitted. Tailoring is defined as the deletion of selected outcomes, activities, or tasks.

**NOTE** Tailoring is to be regarded as a last resort form of adaptation. If tailoring is performed, one may only claim tailored conformance rather than full conformance. Furthermore, the deletion of outcomes, activities or tasks may endanger downstream processes by depriving them of necessary prerequisites.

## 5.2 Adaptation sequence

### 5.2.1 General

[Figure 12](#) gives an illustrative sequence of steps that can be followed to adapt the standards to a particular need. First, the adaptations reflecting the project environment are addressed, and then inputs on possible changes are solicited from potentially affected parties. After that, the specific life cycle model and processes are selected. Finally, if necessary, the processes may be tailored, after which the tailoring decisions and rationale are documented. More specifics and examples for systems and software, respectively, can be found in ISO/IEC/TR 24748-2 and ISO/IEC/TR 24748-3.



**Figure 12 — Adaptation sequence**

### 5.2.2 Identify the project environment and characteristics

Organizational characteristics may be determined by considering such issues as organizational policies and procedures. Identify the relevant policies and procedures of the organizations involved, particularly of the acquirer and supplier with which the project needs to comply. Examples include policies and procedures related to: security, safety, privacy, risk management, use of an independent verification and validation agent, use of a specific computer programming language and, hardware resourcing. Identify any pertinent laws and regulations including those related to environment, public safety and privacy that may impact the project. It may be necessary to monitor such external sources on an ongoing basis to ensure that the system is compliant.

### 5.2.3 Solicit inputs

The requirements derived from the relevant business or mission and contractual needs are a major driver in adapting the life cycle model and processes from an International Standard. Affected parties should be involved in the adaptation decisions. These parties can help ensure that the resulting adapted processes are feasible and useful. Where possible, include feedback from previous projects. For example, ISO/IEC 12207 could be adapted according to the contract between a supplier and the purchaser of a software product. A customer may only require the design of software to be carried out and not full development of a software system. In another instance, if the customer requirements are for safety critical software instead of consumer software, it might be appropriate for the acquirer to require the execution of activities and tasks beyond those provided in ISO/IEC 12207.

### 5.2.4 Select the appropriate standards

ISO/IEC/IEEE 15288 and ISO/IEC 12207 provide an interoperable suite of processes suitable for the life cycles of both system and software products. Projects may vary in their relative emphasis upon system and software aspects. This variation may inform the choice of standards appropriate to the project.

- For system projects that have only minor software content, the use of the processes of ISO/IEC/IEEE 15288 may be sufficient. In this case, ISO/IEC 12207 need not be applied.

- For software projects that have only minor system-level content, the use of the processes of ISO/IEC 12207 may be sufficient. In this case, ISO/IEC/IEEE 15288 need not be applied.
- For projects that have both systems and software content, the use of both standards may be merited. It should be noted that ISO/IEC 12207 processes may contain process outcomes and tasks that are specializations of corresponding processes in ISO/IEC/IEEE 15288. In such cases, one may select the process from ISO/IEC/IEEE 15288 in preference to the process in ISO/IEC 12207. One criterion for selecting the source of the process may depend on the acquisition strategy. For example, if the system-level prime contractor is performing all configuration management, the prime might require all software subcontractors to conform to the configuration management process of ISO/IEC/IEEE 15288 rather than the software configuration management process of ISO/IEC 12207. When system-level processes are substituted for software processes, it is appropriate to clarify the role of the software implementers in supporting the execution of the system-level process.

### 5.2.5 Select life cycle model

Determine which life cycle model(s) are relevant and applicable for the project, such as Waterfall, evolutionary, builds, pre-planned product improvement, Spiral. All such models prescribe certain processes and activities that may be performed sequentially, repeated, and combined; in these models, the life cycle activities in the relevant International Standards should be mapped to the selected models. For evolutionary, build, and pre-planned product improvement models, the outputs of one project activity feed into the next. In these cases, the documentation should be complete at the end of an activity or a task. ([Annex B](#) provides guidance on development strategies and build planning.)

### 5.2.6 Select stages and processes

Identify the relevant life cycle model stages that need to be distinguished for the project, as well as their entry and exit criteria and their relationship (serial, parallel, wholly or partly combined). Define the outcomes that determine successful completion of each of the stages and the milestones or decision gates that distinguish them. Also, select and prioritize the processes of the appropriate International Standards that will be implemented to achieve the outcomes of the stages.

**NOTE** In implementing a suite of processes intended to be applied uniformly throughout an organization, it is usually preferable to start with those processes that will achieve the most significant returns, rather than attempting to implement all of the International Standard at once.

International Standards, such as ISO/IEC 12207 or ISO/IEC/IEEE 15288 do not define the sequencing of processes and activities and they do not prescribe any particular life cycle model. Mapping the organization's current processes, practices and/or methods to the processes, activities and tasks of the applicable International Standard is useful at this stage. The mapping may be used to verify the completeness of the approach; that is, to identify where gaps exist between the current situation and the target situation where processes from the International Standard are used.

### 5.2.7 Document the adaptation decisions and rationale

When applying International Standards, such as ISO/IEC 12207 or ISO/IEC/IEEE 15288, a mapping of the defined processes and activities onto the selected life cycle model should be documented, together with the determined relationships and the reasons for adopting this approach. The verification of this work is to demonstrate that the outcomes of each stage will be achieved by the processes selected to implement the stage. This documentation should be incorporated into the project management plan for implementing the applicable International Standard as it provides a reference framework for evaluating the success or otherwise of the approach taken.

Specific guidance and examples of adaptation can be found in Technical Specifications ISO/IEC/TR 24748-2 and ISO/IEC/TR 24748-3, the application guidelines for International Standards ISO/IEC 12207 and ISO/IEC/IEEE 15288, respectively.

### 5.3 Adaptation guidance

This subclause provides general guidance on adapting applications of International Standards, such as ISO/IEC 12207 and ISO/IEC/IEEE 15288 and is not exhaustive. This subclause may be used to perform first-level adaptation of the International Standards for a given business area or organization, for example, aviation, nuclear, medical, military, government agency. The second-level adaptation should be performed for each specific project or contract. In general, it is wise for organizations to select and implement processes without tailoring, tailoring should be reserved for the application of the processes to specific projects, and then only as a last resort when other means of adaptation are insufficient to achieve a cost-effective result. Refer to Technical Specifications ISO/IEC/TR 24748-2 and ISO/IEC/TR 24748-3 for more specific guidance.

When an International Standard, such as ISO/IEC/IEEE 15288 or ISO/IEC 12207 is used by an organization to form a set of policies and procedures governing project work, then adaptation may be used to appropriately reduce or extend the scope of the International Standard as necessary for the business strategy and kind of business for which the policies and procedures are framed.

When the International Standard is used by a project, then adaptation may be used to appropriately consider the particular characteristics of the project, life cycle stage or agreement. Since each project has to consider and demonstrate the benefits of what it does to satisfy stakeholder requirements, there is a need to concentrate on the relevant processes and activities and the expected outcomes, including specific output documentation.

The International Standard can be considered for a specific project with a set duration or for a continuous work effort conducted by an organization.

When adaptation is done, it may be important to ensure that applicable conformance requirements of the International Standard are met.

Either the organizational unit responsible for forming policies and procedures, or the project team or individual assigned to plan the project can be responsible for completing appropriate adaptation. In any event, all parties involved in the project should be involved in adaptation.

To aid adaptation, the following factors affecting the project effort should be considered.

- a) Determine which organizational policies are relevant and applicable, such as on computer languages, safety and security, hardware reserve requirements, and risk management.
- b) Determine which acquisition strategies are relevant and applicable for the project, such as types of contract, more than one contractor, involvement of subcontractors and verification and validation agents, level of acquirer's involvement with contractors, and evaluation of contractors' capabilities.
- c) Determine which support concepts are relevant and applicable, such as expected length of support, degree of change, and whether the acquirer or the supplier will support. If the product or service will have a long support life or is expected to change significantly, all documentation requirements should be considered.
- d) Project requirements, such as the required work, schedule, funding and technical requirements (for example, functional requirements, performance requirements and interface requirements) can drive stage timing and the definition of the system under consideration. These can also drive the criticality of the system and its enabling systems.
- e) Project size and criticality factors can drive the amount of controls appropriate for the processes used. A large project involving tens or hundreds of people represents a significant management problem compared with a project of, say, three people. Large projects or projects with subcontractors require careful management supervision and control of a diverse set of parties with varying characteristics. Some projects achieve this through joint reviews, audits, verification, validation and quality assurance. For small projects, all these controls may be excessive. Similarly, the more dependent the system is upon the product operating correctly and being finished on time, the more visibility and control are needed. Conversely, extreme overseeing and control of non-critical parts of the product is probably not cost-effective.

- f) The applicable processes of the International Standard that apply to the domain, business and type of organization (for example, supplier, user, acquirer, or other stakeholder) should be included in project plans. Other processes that are not in the International Standard can be required by an agreement or they can be required by the nature of the project, the applicable system or the type of organization. These processes may be added, complete with their purpose, outcomes and activities.
- g) The extent of adaptation and the use of the appropriate International Standard as a requirement or guideline depend upon the relative position of the project within the life cycle model. Identifying the current point in the life cycle model helps to determine, for example, whether the appropriate International Standard would be used to select methods for conducting computer modelling and simulation in an early stage, or how the International Standard might be adapted in a later stage to address operation, or maintenance of the product.
- h) Activities for each applicable process and the expected outcomes of each activity should be selected. Depending on the size and scope of the project, the type of organization and whether an unprecedented system is the object of the project, one or more of the International Standard activities for a process could possibly not apply. Likewise, outcomes and activities may be added to a process when needed to meet agreement requirements or to meet unique requirements for a system.
- i) Tasks, methods and tools required for activity completion should be determined. The applicable tasks, methods and available tools are not included in the International Standard. These may be added by the project or organization during planning for an adopted process. See ISO/IEC/TR 24748-2 and ISO/IEC/TR 24748-3 for sources of additional task detail.
- j) Reporting and technical review requirements applicable to the life cycle stage or stipulated in the governing agreement or in organizational policies and procedures should be considered.
- k) Project measurement requirement provisions should be included for the collection and reporting of key measures by which project progress will be evaluated.
- l) Requirements related to activities and tasks involving specialty engineering and functional disciplines may be integrated in appropriate processes. These processes include requirements (special requirements or critical project and system requirements) and life cycle stage entry or exit criteria (for example, safety, security, human factor engineering, design, software development, production, test and logistics). Specialty and functional plans that are needed to ensure completion of project work may be included in work definition.
- m) Applicable standards, policies and procedures, regulations and laws can be the source of additional process and activity requirements to add to the work definition, even though not included in the International Standard process requirements. Some reference standards for special factors that should be designed into architectural solutions are provided in ISO/IEC/TR 24748-2 and ISO/IEC/TR 24748-3.

Whatever life cycle model is used in dealing with problems arising during the execution of life cycle processes, it is useful to maintain a unified problem reporting capability. By its nature, a unified capability may deal with large numbers of problems. It is therefore useful to categorize the problems in various ways. [Annex D](#) describes two classifications: by category and by priority. Others may be applicable in particular situations.

Additional adaptation considerations can be found in the conformance requirements of the International Standard.

## 5.4 Scope adaptation

As an example, if an organization does development only and is not involved in the utilization, support, or retirement life cycle stages that organization could adapt the scope of the applicable International Standard accordingly by selecting only the appropriate processes. The policies and procedures called for in the non-applicable parts of the International Standard would not be included in the organization's

policies and procedures. Additionally, inputs such as those listed below can help shape the policies and procedures of an organization are the following:

- a) life cycle model and related entry or exit criteria used by the organization for decision making, as well as for establishing milestone reviews of a project. Select one or more appropriate life cycle models for the project, since hardware, software, humans and other aspects of the system may have their own life cycles. Determine whether the software life cycle model is a sub-part of the life cycle model of the system or is the complete life cycle model;
- b) resource availability and the resources the organization is willing to commit;
- c) expertise and skills available to the organization to provide the organization's products and services;
- d) technology available for the organization's products and services.

## 5.5 Stage adaptation

Depending on the specific system-of-interest and the environment in which a project is established to realize it, stages may be combined, eliminated, or added to the generic model. For example, an organization may buy a concept, establish a project to design and produce a system, then turn the result over to another organization for marketing to consumers, or operation and maintenance. In another case, there could be repeated iterations between concept and development stages or lengthy evolution after fielding of a system. Each stage in these cases would have different criteria for entry and exit, as well as possibly drawing on different processes. Accordingly, each stage in the life cycle, as well as the juxtaposition of each stage with those before and after it, requires specific consideration for the project and system to be realized.

## 5.6 Process adaptation

When a project is established to satisfy a set of stakeholder requirements or acquirer specifications, processes included in the organizational policies and procedures, or in the applicable International Standard itself, can be adapted according to the scope, size and funding of the work to be done, as well as the team structure, requirements and schedules, the specific life cycle model used and project resources. In some cases, outcomes, activities or tasks, suggested by notes or other sources, may be added. In some cases, outcomes, activities or tasks may be deleted via tailoring.

The technical processes need special attention, because the process may be used by different parties with different objectives. For example, if a product is embedded in or integral to the system, all the activities in the processes should be considered and it should be specifically agreed who is required to *perform or support* each processes activities.

Also, development of a software product may have special technical risks. If the software technology used is not mature, or if the software product being developed is unprecedented or complex, or if the software product contains safety, security, or other critical requirements, then rigorous specification, design, testing, and evaluations may be needed. In those cases, verification and validation should be independent and address the complete product.

## 5.7 Life cycle model adaptation for domains, disciplines and specialties

### 5.7.1 Adaptation for domains

The life cycle model that is appropriate at the system level may need adaptation if the system-of-interest falls largely or entirely within one domain, such as software. Further, the life cycle model that best reflects events in one domain (such as software) may not be equally suitable for others (such as hardware, humans, processes, procedures, facilities and naturally occurring entities), as is illustrated by the examples shown in [Figure 13](#). Note that, for simplicity of illustration, these are drawn as if the stages are linearly sequential. However, as discussed in [3.2.1](#), the relations between stages are usually more complex.

The life cycle stages shown are illustrative only, this is not an exhaustive list of possible life cycle models. For example, using life cycle models is just as relevant to services as it is to hardware, software, or other products. A life cycle model for service management could include stages of: Service Strategy; Service Design; Service Transition Service Operation and; Continual Service Improvement, as shown in [Figure 13](#). The advantage to a service organization of using a life cycle model approach is that it gives them a unifying framework for examining what processes they need to have do their work. If a service management organization viewed itself as doing nothing but service operations, not thinking in terms of a life cycle model, it could, for example, fail to consider continual service improvement or not occasionally re-examine its service strategy. That could make the organization less desirable to a customer compared to a service management organization that uses a life cycle model framework to keep its competitive view, as wide as possible.

Note that, for all models, the length of any one stage or of the entire model, does not represent any uniform time scale or coincident start or stop timing.

The basic point is that each domain should be considered as an entity that can have a series of stages through which it goes, forming a life cycle model for that domain. As a result, when a system has elements that span multiple domains,

- a) every domain's life cycle model should be thought through, and
- b) the life cycle models and their stages must be considered as a whole and care taken that they work in concert.

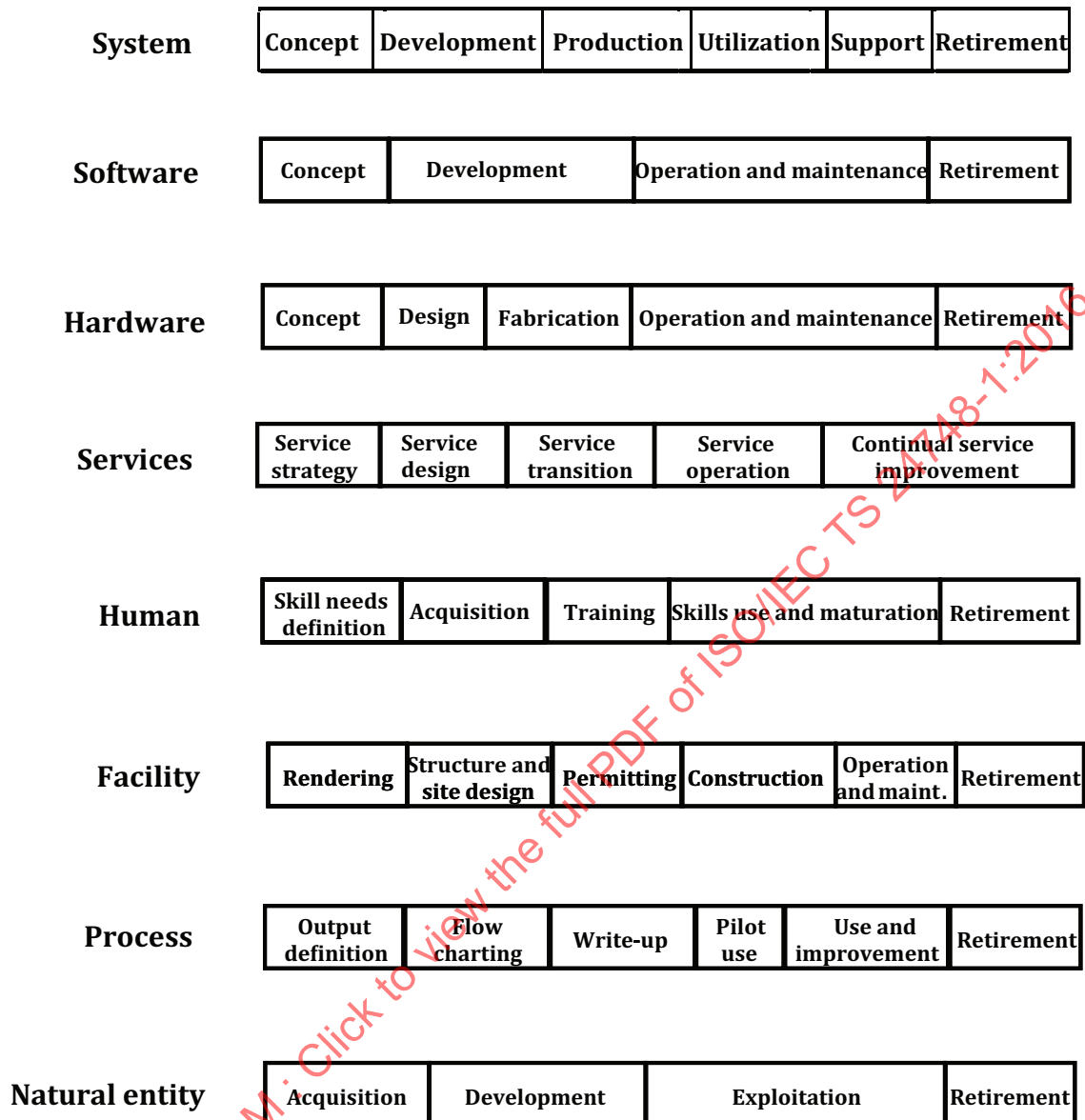


Figure 13 — Illustrative examples of domain life cycle models

### 5.7.2 Adaptation for disciplines

In general, life cycle models would not need to be developed or adapted for a specific discipline (such as mechanical engineering, electrical engineering, civil engineering, quality, system administration). Instead, the processes associated with the life cycle model(s) in which that discipline is used would be adapted to reflect the overall considerations discussed in [Clause 5](#) of this Technical Specification, possibly with additional adaptation for the discipline itself. For example, the agreement processes associated with a facility would be adapted to the specific facility project, as described in [Clause 5](#). In addition, some details might be adapted to reflect civil engineering concepts, practices, or terminology.

### 5.7.3 Adaptation for specialties

#### 5.7.3.1 General

The focus of International Standards is on the engineering, operation, maintenance and disposal of complex man-made products. Each product can have critical qualities that should be considered, with possible adaptation of specific processes, so that the product can be successful. The list of these critical

qualities is long and not well agreed on and could include, but not be limited, to such areas as: human factors, health and safety, reliability, maintainability, availability, supportability/usability, security, environmental impacts (including disposability), electromagnetic compatibility, mass properties, interoperability. These critical qualities, although requiring special knowledge and expertise in one area, generally cannot be evaluated in isolation from each other. For example, assessments of safety, human factors, and environmental compatibility may need to be done as one integrated effort and that assessment could link to yet others. Some, though obviously not all, of the critical qualities are discussed below to illustrate adaptation for specialities.

#### 5.7.3.2 Human

Human interaction with products and services associated with a system should be looked at from the perspective of impacts on operators, users and the general public. Impacts should be analysed to determine adverse impacts that should be avoided or mitigated through product related design requirements that could mitigate the adverse impacts identified.

#### 5.7.3.3 Health

Planned usage rates and environments, operational concepts and other requirements can present health risks with respect to potential damage to human life including operators and others (both people and animals) that come in contact with the product or exist within its operational environment. Use cases, human-machine interfaces, operating environments, electromagnetic radiation, heat and noise emissions and waste materials should be analysed to determine such risks. Outcomes from such analyses should include specific health concerns and recommendations as to health related design requirements that could prevent the health hazards identified.

NOTE Health issues may persist after the product is retired.

#### 5.7.3.4 Safety

Operational concepts and other product requirements can present safety risks with respect to potential damage to human life, property and the environment. Use cases, human-machine interfaces, operating environments, electromagnetic radiation, heat and noise emissions, waste materials and failure modes should be analysed to determine such risks. Outcomes from such analyses should include specific safety concerns and recommendations as to safety related design requirements that could prevent the safety hazards identified.

#### 5.7.3.5 Security

Operational concepts, usage environments and other product requirements can present security risks with respect to the product and its users. Risks include 1) access and damage to personnel, properties and information, 2) corruption, theft or compromise of sensitive information, 3) denial of approved access to property and information, 4) unauthorized system access and 5) loss of life or property. Applicable areas of security should be analysed to include physical security, communications security, computer security and electronic emissions security. Outcomes from such analyses should include specific security concerns and recommendations as to security related requirements that could mitigate the security risks identified.

#### 5.7.3.6 Interoperability

Data flows are essential within a product and possibly between products so that operational functions can be successfully performed over the product's life. The potential failure causes of data (or information) to properly flow should be analysed to include use of appropriate communication connectivity protocols with external systems or internal systems within a system structure. Outcomes from such analyses should include specific interoperability concerns and recommendations as to related design requirements that could improve interoperability.

### 5.7.3.7 Usability

The operational effectiveness and hence the acceptance of many products depends on a user's ability to realize the intended capability of the product. Systems that include human elements depend on operators of the product performing tasks within specified times and required accuracies and with efficient and effective resource utilization. Use cases, human-machine interfaces, operating environments and training and operating procedures should be defined based on targets for usability such as understandability, learnability, operability and attractiveness, and evaluated against quality of use criteria, such as effectiveness, productivity, safety and satisfaction.

### 5.7.3.8 Dependability

The failure potential of any part of the product will determine whether the product will be available when and as long as it is needed during any operational use and at any given (random) time. Factors that affect dependability include mean-time-between-failures, mean-time-to-repair and administrative down time. Such factors should be analysed to determine their impact over the product life. Outcomes from such analyses should include specific dependability concerns and recommendations as to related requirements that could help make the product more dependable.

### 5.7.3.9 Environmental impacts

The impacts on the environment from short and long-term use of a product, and disposing of hazardous materials related to its use or retirement, can present risks to all life forms. Risks include loss of life, illness and lowering of the standard of living. Environmental impacts as a result of use or disposal of waste products from product use or from disposal of the product or one of its elements that have reached end-of-life, should be analysed. Outcomes from such analyses should include specific environmental impact concerns and recommendations as to related requirements that could reduce risks related to product use and eventual disposal.

## 5.8 Adapting evaluation-related activities

Persons who are involved in any activity of the life cycle of a project or a process may conduct evaluations either on their own or other's products and activities. This Technical Specification groups these evaluations into five categories, which are listed below. The first four evaluation categories are at the project level; the last one is at the organizational level. These evaluations should be selected and adapted proportional to the scope, magnitude, complexity, and criticality of the project or of the organization. The problem, non-conformance, and improvement reports from these evaluations feed back into one or more of the life cycle processes shown in [Figure 10](#).

- a) Process-internal evaluations are conducted by personnel performing the assigned tasks within the process during their day-to-day activities.
- b) Verification and Validation are conducted by the acquirer, the supplier, or an independent party, to verify and validate the products in varying depth depending on the project. These evaluations do not duplicate or replace other evaluations, but supplement them.
- c) Joint reviews and audits are conducted in a joint forum by the reviewing and reviewed parties to evaluate status and compliance of products and activities on a pre-agreed to schedule. Additional guidance on joint reviews is given in [Annex C](#).
- d) Quality management is conducted by personnel independent of the personnel directly responsible for developing the product or executing the process. The goal is to *independently assure* conformance of the products and processes with the contract requirements and adherence to the established plans. This process may use the results from a, b, and c above as inputs. This process may coordinate its activities with those of a), b), and c).
- e) Improvement is conducted by an organization for efficient management and self-improvement of its process. This is conducted regardless of project or contract requirements.

## 6 Relationship with detailed process standards

This Technical Specification gives overall guidance on life cycles and adaptation that can be applied across the International Standards (the conformance documents) that could be applied to a particular situation. Further guidance on the application of the processes of each applicable International Standards would come from other Technical Specifications. These relationships are illustrated in [Figure 14](#).

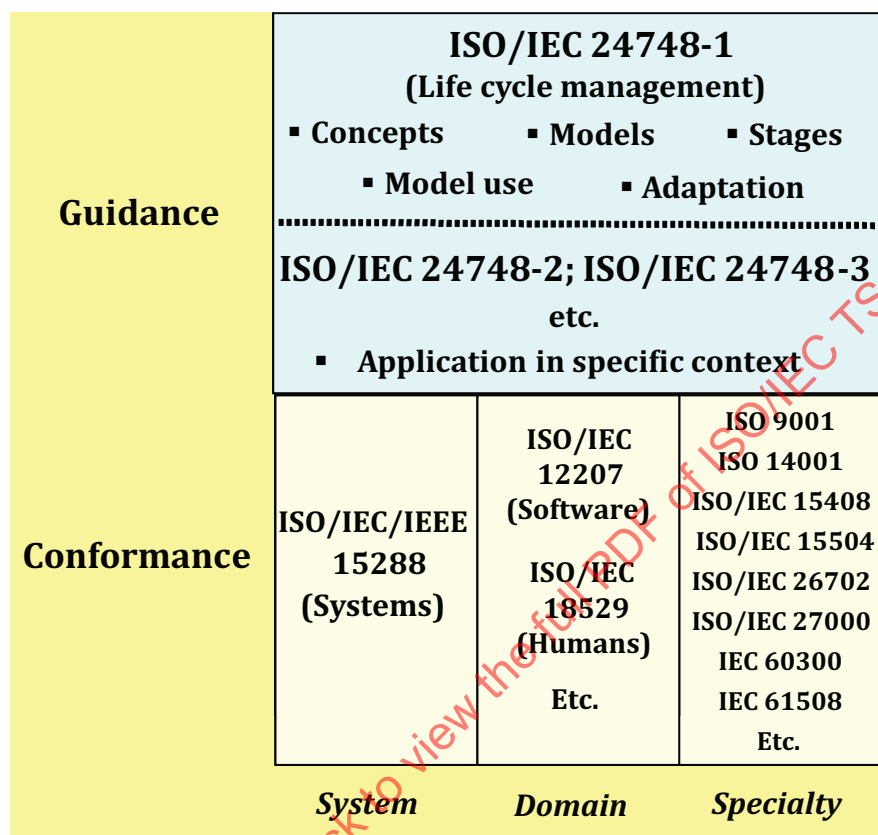


Figure 14 — ISO/IEC 24748 relationship to detailed process standards

ISO/IEC/IEEE 15288 defines a generic, top-level framework based upon a set of processes that can be combined into various suitable life cycle models. It does not, and is not intended to, define in detail systems engineering or the engineering of systems. However, the International Standard is expected to strengthen the relationships among systems engineering, software engineering and other affected engineering disciplines. It is intended to do this through promotion of consistent and uniform terminology among the various domains and engineering disciplines. It is also intended to establish interactions and improved communication between the various engineering disciplines needed to create systems.

The other International Standards address either domains (e.g. software, humans) in detail, or treat specific disciplines or specialties. The International Standards are used as the basis for building applicable sets of life cycle processes that provide activities to achieve a stated goal. The processes defined by the International Standards are likely to be invoked during the whole life cycle of the system. The International Standards are, in turn, supported by application guidelines, such as ISO/IEC 24748-1 for systems and ISO/IEC/TR 24748-2 for software. This Technical Specification thus provides spanning guidance in two key areas of interest across domains and disciplines, complemented by the specific conformance and guidance documents for each area. A more detailed view of the emphasis given each area (e.g. process definitions) by each of the International Standards and the related Technical Specifications is shown in [Table 2](#). For example, ISO/IEC/IEEE 15288 gives process definitions for systems engineering processes, including those also system-level processes also used in ISO/IEC 12207. ISO/IEC 12207 repeats those process definitions and adds processes specific to software. ISO/IEC 24748-

1 gives a general overview of the process definitions, as background for treatment of life cycle processes, while the other two Technical Specifications take the process sets as givens.

**Table 2 — Overview of coverage and emphasis among International Standards and Technical Reports**

| Area                                    | ISO/IEC/<br>IEEE 15288         | ISO/IEC 12207        | ISO/IEC 24748-1                                              | ISO/IEC/<br>TR 24748-2                  | ISO/IEC/<br>TR 24748-3                   |
|-----------------------------------------|--------------------------------|----------------------|--------------------------------------------------------------|-----------------------------------------|------------------------------------------|
| Process definitions                     | Systems engineering and common | Software engineering | General overview: what a process is and pointer to standards | n/a                                     | n/a                                      |
| Life cycle concepts                     | Summary                        |                      | Detail                                                       | n/a                                     | n/a                                      |
| Life cycle stages                       | Summary                        |                      | Detail                                                       | n/a                                     | n/a                                      |
| Life cycle tailoring                    | Process requirements           |                      | General guidance                                             | Specific detail for systems engineering | Specific detail for software engineering |
| Life cycle application/usage            | n/a                            |                      | General guidance                                             | Domain-specific guidance                | Do-main-specific guidance                |
| Life cycle model examples/illustrations | n/a                            |                      | General guidance                                             | Domain-specific examples                | Do-main-specific examples                |
| Terminology                             | Systems engineering            | Software engineering | Life cycle and pointer to standards                          | As needed                               | As needed                                |
| System process key concepts             | Summary                        | n/a                  | n/a                                                          | Detail in systems context               | n/a                                      |
| Software process key concepts           | n/a                            | Summary              | n/a                                                          | n/a                                     | Detail in software context               |
| Organization/project application        | Summary                        |                      | Summary in life cycle context                                | Detail in systems context               | Detail in software context               |
| Process application                     | Summary                        |                      | Summary in life cycle context                                | Detail in systems context               | Detail in software context               |
| Process tailoring                       | Normative requirements         |                      | Summary in life cycle context                                | Example for systems                     | Example for software                     |
| Process reference model                 | Detail                         |                      | General description and pointer to standards                 | n/a                                     | n/a                                      |
| Specialty applications                  | Summary                        |                      | Summary in life cycle context                                | Detail in systems context               | Detail in software context               |
| Conformance                             | Included                       |                      | n/a                                                          | n/a                                     | n/a                                      |

## **Annex A** **(informative)**

### **Process views**

#### **A.1 General**

There are instances where those representing a particular engineering interest would like to see gathered in a single place the set of process activities that directly and succinctly address their concern. For such interests, a process view can be developed to organize processes, activities, and tasks selected from ISO/IEC/IEEE 15288 and ISO/IEC 12207 to provide a focus to their particular concern in a manner that cuts across all or parts of the life cycle. This Annex provides a process viewpoint that may be used to define process views in these instances and gives examples from the viewpoints of the following:

- specialty engineering;
- interface management;
- security.

#### **A.2 The process view concept**

There may be cases where a unified focus is needed for activities and tasks that are selected from disparate processes to provide visibility to a significant concept or thread that cuts across the processes employed across the life cycle. It is useful to advise users of the standards on how to identify and define these activities for their use, even though they cannot locate a single process that addresses their specific concern.

For this purpose, the concept of a process view has been formulated. Like a process, the description of a process view includes a statement of purpose and outcomes. Unlike a process, the description of a process view does not include activities and tasks. Instead, the description includes guidance explaining how the outcomes can be achieved by employing the activities and tasks of the various processes in ISO/IEC/IEEE 15288 and ISO/IEC 12207. Process views can be constructed using the process viewpoint template found in [A.3](#).

#### **A.3 Process viewpoint**

A process view conforms to a process viewpoint. The process viewpoint provided here can be used to create process views.

- The Process viewpoint is defined by
  - its stakeholders: users of the standard, and
  - the concerns it frames: the processes needed to reflect a particular engineering interest.
- The contents of resulting process views should include the following:
  - process view name;
  - process view purpose;
  - process view outcomes;

- identification and description of the processes, activities and tasks that implement the process view, and references to the sources for these processes, activities and tasks in other standards.

NOTE The requirements for documenting viewpoints are found in ISO/IEC/IEEE 42010:2011, 5.4. This description is consistent with those requirements.

#### A.4 Process view for specialty engineering

This subclause provides an example of applying the process viewpoint to yield a process view for specialty engineering to illustrate how a project can assemble processes, activities and tasks of ISO/IEC/IEEE 15288 to provide focused attention to the achievement of product characteristics that have been selected as being of special interest.

This example treats the cluster of interests, generally called specialty engineering, which includes but is not limited to such areas as availability, maintainability, reliability, safety, human factors, and usability. Within ISO/IEC/IEEE 15288, these “ilities” requirements are referred to as “critical quality characteristics”. These characteristics determine how well the product meets its specified requirements in a specific area selected for focus.

NOTE 1 This is a generalized instance of a process view that covers a broad set of functional and non-functional characteristics related to specialty engineering. It provides a broad view across the processes. If a specific critical quality characteristic has a high priority relative to other characteristics, a specific process view could be created for that characteristic, including more detailed information and requirements.

*Name:* Specialty Engineering Process View

*Purpose:* The purpose of the Specialty Engineering Process View is to provide objective evidence that the system achieves satisfactory levels of certain critical quality characteristics selected for special attention.

*Outcomes:*

- Product critical quality characteristics are selected for special attention.
- Requirements for the achievement of the critical quality characteristics are defined.
- Measures for the requirements are selected and related to the desired critical quality characteristics.
- Approaches for achieving the desired critical quality characteristics are defined and implemented.
- The extent of achievement of the requirements is continually monitored.
- The extent of achievement of the critical quality characteristics are specified and developed.

NOTE 2 The outcomes permit the possibility that the desired critical quality characteristics cannot be directly measured but instead might be argued and inferred based on other product or process characteristics that can be measured.

*Processes, Activities and Tasks:*

This process view can be implemented using the following processes, activities, and tasks from ISO/IEC/IEEE 15288:

NOTE 3 ISO/IEC 25030 may be useful in specifying software product quality requirements.

NOTE 4 INCOSE Systems Engineering Handbook contains descriptions and elaboration about many of the specialty engineering areas and the associated critical quality characteristics.

- The Agreement Processes (6.1) provide for the establishment of expectations and responsibilities related to each specialty engineering area, including legal agreements and licensing requirements. Generally, this is done in the context of establishing and maintaining agreement processes for

all aspects of the system. In this case, or even when separate Agreement Process application is required for a specialty engineering area, all parts of both the Acquisition Process (6.1.1) and Supply Process (6.1.2) may be applicable.

- b) The Organizational Project-Enabling Processes (6.2) help ensure the organization's capability to acquire and supply products or services through the initiation, support and control of projects. These processes provide resources and infrastructure necessary to support projects and help ensure the satisfaction of organizational objectives and established agreements. Generally, this is done in the context of applicability of the processes from all viewpoints to one or more systems across multiple projects. However, specialty engineering stakeholders should review all parts of the six Organizational Project-Enabling Processes to assure that their interests are adequately addressed.
- c) The Project Assessment and Control Process (6.3.2) provides for monitoring the extent of achievement of the requirements and critical quality characteristics and communicating the results to stakeholders and managers. Relevant activities and tasks include (b) (6), (b) (7), (b) (9) and (b) (10).
- d) The Decision Management Process (6.3.3) provides assessment of alternative requirements, architecture characteristics and design characteristics against the decision criteria, including the critical quality characteristics. Results of these comparisons are ranked via a suitable selection model and are then used to decide on an optimal solution. Relevant activities and tasks include (b) all tasks; and (c) (1).
- e) The Risk Management Process (6.3.4), in its entirety, provides for identifying, evaluating, and handling risks of the system, including those related to meeting the critical quality characteristics.
- f) The Configuration Management Process (6.3.5) manages and controls system elements and configurations over the life cycle. Relevant activities and tasks include (a) (1), (d) (1), and (f) (2) for each discipline to be addressed under specialty engineering.
- g) The Information Management Process (6.3.6), in its entirety, provides for the specification, development and maintenance of information items for documenting and communicating the extent of achievement. It should be noted that information items used for the purpose of critical quality characteristics are sometimes specialized in nature. Sources for the description of these information items include industry associations, regulators, and specific standards.
- h) The Measurement Process (6.3.7), in its entirety, provides for defining an approach that relates measures to the required critical quality characteristics.
- i) The Quality Assurance Process (6.3.8) addresses identified anomalies (incident and problems) that relate to the achievement of critical quality characteristics.
- j) The Business or Mission Analysis Process (6.4.1) provides for the definition of the problem space and characterization of the solution space, including the relevant trade-space factors and preliminary life cycle concepts. This includes developing an understanding of the context and any key parameters, such as the critical quality characteristics (e.g., safety hazards, human interfaces, operational characteristics, and system assurance context). Relevant activities and tasks include (b) (1) and (b) (2); (c) (1); and (d) (1).
- k) The Stakeholder Needs and Requirements Definition Process (6.4.2) provides for the selection and definition of characteristics, including critical quality characteristics, and associated information items. The activities and the documentation are useful in identifying, prioritizing, defining, and recording requirements for the critical quality characteristics. Relevant activities and tasks include (a) (1) and (a) (2); (b) (2), (b) (3) and (b) (4); (c) (1) and (c) (2); (d) all tasks; and (e) (2).
- l) The System Requirements Definition Process (6.4.3) provides for the specification of parameters for the critical quality characteristics and the selection of measures for tracking the achievement of these requirements with respect to the specific system to be developed. Relevant activities and tasks include (a) (1); (b) all tasks; and (c) (2).

- m) The Architecture Definition Process (6.4.4) provides for the identification of stakeholder concerns from an architecture perspective. These concerns often translate into expectations or constraints across the life cycle stages that relate to the critical quality characteristics, such as utilization (e.g., availability, security, effectiveness, usability), support (e.g. reparability, obsolescence management), evolution of the system and of the environment (e.g, adaptability, scalability, survivability), production (e.g. manufacturability, testability), retirement (e.g. environmental impact, transportability), etc. This process further addresses those critical quality characteristic requirements that drive the architecture decisions, including the assessment of the architecture with respect to the concerns and associated characteristics. Relevant activities and tasks include (a) (2) and (a) (4); (b) (1); (c) (2), (c) (3), (c) (4), and (c) (5); (d) (1); and (e) (2).
- n) The Design Definition Process (6.4.5) provides for the determination of necessary design characteristics, which includes the critical quality characteristics, such as security of design criteria for the specialty characteristics and the evaluation of alternative designs with respect to those criteria. Relevant activities and tasks include (a) (2); (b) (1), (b) (2), (b) (3), (b) (4) and (b) (6); and (c) (2).
- o) The System Analysis Process (6.4.6) provides for the level of analysis needed to understand the trade space with respect to the critical quality characteristics through the conduct of mathematical analysis, modeling, simulation, experimentation, and other techniques. The analysis results are input to trades made through the Decision Management Process in support of other Technical Processes. Relevant activities and tasks include (a) all tasks; and (b) all tasks.
- p) The Implementation Process (6.4.7) provides for recording the evidence that critical quality requirements have been met. Relevant activities and tasks include (b) (3).
- q) The Integration Process (6.4.8) provides for planning the integration, including the considerations for critical quality characteristics, and the assurance that the achievement of the characteristics is determined and recorded. Relevant activities and tasks include (a) (1); (b) (3); and (c) (1).
- r) The Verification process (6.4.9), provides for the planning and execution of a strategy to perform verification, including the critical quality characteristics. The selected verification strategy may introduce design constraints that could affect the achievement of the characteristics. Relevant activities and tasks include (a) (1) and (3); (b) (1), (b) (2); and (c) (1) and (c) (2).
- s) The Transition Process (6.4.10) provides for installing the system in its operational environment. Because some specialty properties involve a trade-off between design constraints and operational constraints, attention to installation is often important. Relevant activities and tasks include (a) (4); and (b) (4), (b) (6), and (b) (7).
- t) The Validation Process (6.4.11) provides evidence that the services provided by the system meet the stakeholders' needs, including the critical quality characteristics. Relevant activities and tasks include (a) (1) and (a) (3); (b) (1) and (b) (2); (c) (1) and (c) (2).
- u) The Operation Process (6.4.12) provides for usage of the system. Assuring that critical quality characteristics are appropriately achieved involves monitoring the operation of the system. Relevant activities and task include (b) (3) and (b) (4); (c) (1) and (c) (2); and (d) (1) and (d) (2).
- v) The Maintenance process (6.4.13) sustains the capabilities of the system, helping to ensure its ongoing availability to provide its functions, including its critical quality characteristics. This includes failure analysis, maintenance tasks, and logistics tasks needed to assure continued operation of the system. Relevant activities and tasks include (b) all tasks; (c) all tasks; and (d) (1) and (d) (2).
- w) The Disposal Process (6.4.14) ends the existence of a system. The inherent need to anticipate disposal may place constraints on development. In fact, these constraints may themselves be critical quality characteristics. Relevant activities and tasks include (a) (2); (b) (1) and (b) (2); and (c) (3).

## A.5 Process view for interface management

This subclause provides an example of applying the process viewpoint to yield a process view for interface management, intended to illustrate how a project can assemble processes, activities and tasks of ISO/IEC/IEEE 15288 to provide focused attention to the achievement of product characteristics that have been selected as being of special interest.

This example treats a specific instance of a process view, called interface management, which includes but is not limited to interface definition, design, and change management. Within ISO/IEC/IEEE 15288, the tasks that comprise interface management are fully contained within the existing processes.

*Name:* Interface Management Process View

*Purpose:* The purpose of the Interface Management Process View is to facilitate of the identification, definition, design and management of interfaces of the system. .

*Outcomes:*

- a) Business or mission needs related to interfaces are identified.
- b) Stakeholder needs related to interfaces are identified
- c) Requirements for the interfaces are defined.
- d) Interfaces between system elements, as well as interfaces between the system and external systems are identified and defined.
- e) Approaches for achieving the desired interface characteristics are defined and implemented.
- f) The extent of realization of the interface requirements is continually monitored.
- g) The extent of achievement of the interface requirements are specified and developed.

*Processes, Activities and Tasks:*

This process view can be implemented using the following processes, activities, and tasks from ISO/IEC/IEEE 15288:

NOTE INCOSE Systems Engineering Handbook contains descriptions and elaboration about interface management.

- a) The Agreement Processes (6.1) provide for the establishment of expectations and responsibilities related to interface management, including legal agreements and licensing requirements. Generally, this is done in the context of establishing and maintaining agreement processes for all aspects of the system. In this case, or even when separate Agreement Process application is required, such as for a specific interface, all parts of both the Acquisition Process (6.1.1) and Supply Process (6.1.2) may be applicable.
- b) The Organizational Project-Enabling Processes (6.2) help ensure the organization's capability to acquire and supply products or services through the initiation, support and control of projects. These processes provide resources and infrastructure necessary to support projects and help ensure the satisfaction of organizational objectives and established agreements. Generally, this is done in the context of applicability of the processes from all viewpoints to one or more systems across multiple projects. However, interface management stakeholders should review all parts of the six Organizational Project-Enabling Processes to assure that their interests are adequately addressed.
- c) The Project Assessment and Control Process (6.3.2) provides for monitoring the extent of achievement of the requirements, including interfaces, and communicating the results to stakeholders and decision makers. Relevant activities and tasks include (b) (6), (b) (7), (b) (9) and (b) (10).

- d) The Decision Management Process (6.3.3) provides assessing alternative requirements, architecture characteristics and design characteristics against the decision criteria, including the interfaces. Results of these comparisons are ranked, via a suitable selection model and are then used to decide on an optimal solution. Relevant activities and tasks include (b) all tasks; and (c) (1).
- e) The Risk Management Process (6.3.4), in its entirety, provides for identifying, evaluating, and handling risks of the system, including those related to interfaces.
- f) The Configuration Management Process (6.3.5) manages and controls system elements and configurations over the life cycle. All activities and tasks in this process are particularly relevant to interface management.
- g) The Information Management Process (6.3.6), in its entirety, provides for the specification, development and maintenance of information items for documenting and communicating the extent of achievement.
- h) The Measurement Process (6.3.7), in its entirety, provides for defining an approach that relates measures to the required interface information needs, and then generating and using those measures to address the identified interface information needs.
- i) The Quality Assurance Process (6.3.8) addresses identified anomalies (incident and problems) that relate to the achievement of interface requirements. The Business or Mission Analysis Process (6.4.1) provides for the definition of the problem space and characterization of the solution space, including the description of the environment and context, as well as preliminary operational concepts. It often identifies external systems that must interface with the system-of-interest. Relevant activities and tasks include (b) (1) and (b) (2); and (c) (1).
- j) The Business or Mission Analysis Process (6.4.1) provides for the definition of the problem space and characterization of the solution space, including the relevant trade-space factors and preliminary life cycle concepts. This includes developing an understanding of the context and any key parameters, such as the critical interfaces within the system-of-interest, as well as those to external systems, and similarly for all enabling systems. Relevant activities and tasks include (b) (1) and (b) (2); (c) (1); and (d) (1).
- k) The Stakeholder Needs and Requirements Definition Process (6.4.2) provides for the definition of operational concepts and the interactions of the system with users and the intended environment (including other systems). It often identifies external systems that must interface with the system-of-interest. Relevant activities and tasks include (c) (1) and (c) (2); and (d) (1) and (d) (3).
- l) The System Requirements Definition Process (6.4.3) provides for the definition of the interface requirements. Relevant activities and tasks include (a) (1); (b) all tasks; (c) all tasks; and (d) all tasks.
- m) The Architecture Definition Process (6.4.4) provides for the identification of interfaces from an architecture perspective as the architecture models evolve. This process further describes and defines the interfaces to the extent needed for the architecture description. Relevant activities and tasks include (a) (2) and (a) (4); (c) (1) through (c) (4); (d) all tasks; and (f) (3) through (f) (6).
- n) The Design Definition Process (6.4.5) provides for the refinement and full definition of the interfaces and the creation of the necessary information items. Relevant activities and tasks include (b) (5) and (b) (6); and (d) (1) through (d) (3).
- o) The System Analysis Process (6.4.6) provides for the level of analysis needed to understand the trade space with respect to the interface requirements and definition through the conduct of mathematical analysis, modeling, simulation, experimentation, and other techniques. The analysis results are input to trades made through the Decision Management Process in support of other Technical Processes. Relevant activities and tasks include (a) all activities; and (b) all tasks.
- p) The Implementation Process (6.4.7) provides for development of the interfaces and recording the evidence that interface requirements for an implemented system element have been met. Relevant activities and tasks include (b) (3).