



BSI Standards Publication

Systems and software engineering — Life cycle management

Part 1: Guidelines for life cycle management

National foreword

This British Standard is the UK implementation of [ISO/IEC/IEEE 24748-1:2018](#). It supersedes [PD ISO/IEC TS 24748-1:2016](#), which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee IST/15, Software and systems engineering.

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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: Partie 1: Lignes directrices pour la gestion du cycle de vie



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Documents

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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 ISO documents should be noted. This document was drafted in accordance with the rules given in the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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

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

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

This document was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, SC 7, *Software and systems engineering* in cooperation with the Systems and Software Engineering Standards Committee of the IEEE Computer Society, under the Partner Standards Development Organization cooperation agreement between ISO and IEEE.

This first edition of [ISO/IEC/IEEE 24748-1](#) cancels and replaces [ISO/IEC TS 24748-1:2016](#), which has been technically revised to include movement of material from the new edition of ISO/IEC/IEEE 24748-2.

A list of all parts in the ISO/IEC/IEEE 24748 series can be found on the ISO website.

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

Introduction

The purpose of this document is to facilitate the joint usage of the process content of the latest revisions of both [ISO/IEC/IEEE 15288](#) and [ISO/IEC/IEEE 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. Hence, [ISO/IEC/IEEE 15288](#) and [ISO/IEC/IEEE 12207](#) are the documents that apply the concepts found in this document to specific processes.

NOTE ISO/IEC/IEEE 16326 also applies the concepts found in this document, in the process context for project management.

This document will also aid in identifying and planning use of life cycle processes described in [ISO/IEC/IEEE 15288](#) and [ISO/IEC/IEEE 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 helping to ensure 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 document, the users of the process-focused [ISO/IEC/IEEE 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/IEEE 12207](#) also have published guidelines (ISO/IEC/IEEE 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 document provides guidelines for the life cycle management of systems and software, complementing the processes described in [ISO/IEC/IEEE 15288](#) and [ISO/IEC/IEEE 12207](#). This document:

- 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/IEEE 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 Normative references

There are no normative references in this document.

3 Terms and definitions

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

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

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEEE Standards Dictionary Online: available at <http://ieeexplore.ieee.org/xpls/dictionary.jsp>

3.1 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]

3.2 acquisition

process of obtaining a system, product or service

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

3.3 activity

set of cohesive tasks of a process

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

3.4 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:—]

3.5 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]

3.6 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/IEEE 12207](#) and [ISO/IEC/IEEE 15288](#) use the word “elements” instead of “components” and this document follows that usage.

[SOURCE: ISO/IEC/IEEE 42010:2011, modified — Note 1 to entry has been added.]

3.7 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]

3.8

architecture view

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

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

3.9

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]

3.10

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 24765:2017]

3.11

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]

3.12

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* (3.26).

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]

3.13

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]

3.14

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 24765:2017]

3.15

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”.]

3.16

design, verb

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

[SOURCE: ISO/IEC/IEEE 24765:2017]

3.17

design, noun

result of the process in [3.16](#)

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, behaviour, temporal relationships and other attributes of system elements.

[SOURCE: ISO/IEC/IEEE 24765:2017]

3.18

design characteristic

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

[SOURCE: ISO/IEC/IEEE 24765:2017]

3.19

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 document 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]

3.20

environment

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

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

3.21

facility

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

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

3.22

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]

3.23

information item

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

[SOURCE: ISO/IEC/IEEE 15289:—]

3.24

life cycle

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

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

3.25

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]

3.26

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* ([3.12](#)).

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

3.27

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]

3.28

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.]

3.29

party

organization entering into an agreement

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

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

3.30

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]

3.31

process

set of interrelated or interacting activities that transforms inputs into outputs

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

3.32

process outcome

observable result of the successful achievement of the process purpose

[SOURCE: ISO/IEC/IEEE 12207:2017]

3.33

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]

3.34

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]

3.35

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]

3.36

qualification

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

[SOURCE: ISO/IEC/IEEE 12207:2017]

3.37

quality assurance

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

[SOURCE: ISO 9000:2015]

3.38

quality characteristic

inherent characteristic of an object related to a requirement

[SOURCE: ISO 9000:2015]

3.39

quality management

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

[SOURCE: ISO 9000:2015]

3.41

requirement

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

[SOURCE: ISO/IEC/IEEE 29148:—]

3.42

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]

3.43

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]

3.44

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]

3.45 **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]

3.46 **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/IEEE 12207:2017]

3.47 **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/IEEE 12207:2017]

3.48 **software product**

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

[SOURCE: ISO/IEC/IEEE 12207:2017]

3.49 **software unit**

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

[SOURCE: ISO 26262-1:2018]

3.50 **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 document, 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]

3.51 **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]

3.52

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]

3.53

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]

3.54

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 fulfil specified requirements.

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

3.55

system-of-interest

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

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

3.56

system-of-systems (SoS)

set of systems that integrate or interoperate to provide a unique capability that none of the constituent systems can accomplish on its own

Note 1 to entry: Each constituent system is a useful system by itself, having its own management, goals, and resources, but coordinates within the SoS to provide the unique capability of the SoS.

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

3.57

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 24765:2017]

3.58

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]

3.59

technical management

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

[SOURCE: ISO/IEC/IEEE 12207:2017]

3.60

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]

3.61

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]

3.62

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 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.]

3.63

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.]

4 Life cycle-related concepts

4.1 General

This Clause addresses system and life cycle concepts. For completeness, process, organizational and project concepts are covered in [Annexes A, B and C](#), respectively.

4.2 System concepts

4.2.1 General

This sub clause is included to highlight and explain essential concepts on which this document is based. These concepts are directly applicable to software, as addressed in [ISO/IEC/IEEE 12207](#), systems, as addressed in [ISO/IEC/IEEE 15288](#), and to hardware, facilities, services, humans, processes and procedures, data and naturally occurring entities.

4.2.2 Systems

The systems considered in this document 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.

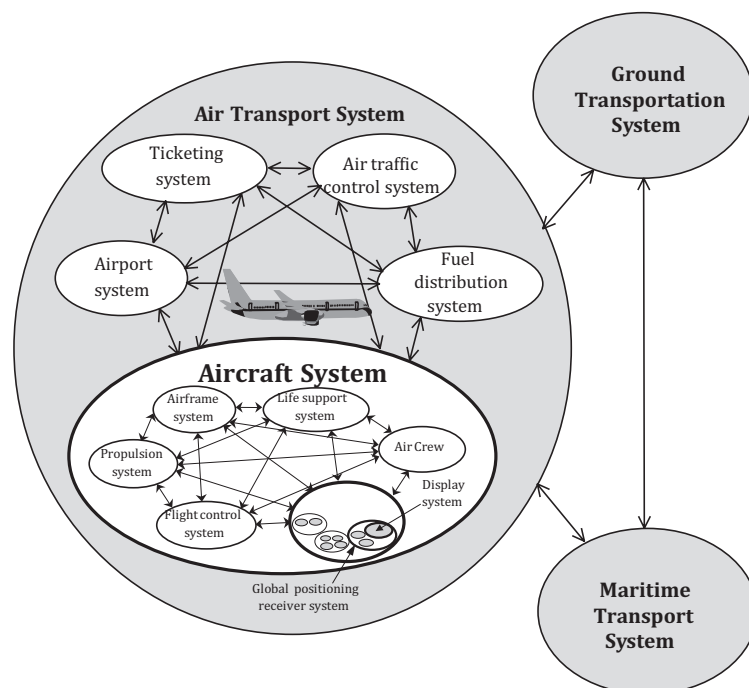


Figure 1 — Typical system view of an aircraft in its environment of use

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

In this document, 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.

NOTE ISO/TR 18529 is being superseded by ISO/IEC 9241-220 which is under development.

4.2.3 System structure

The system life cycle processes in this document 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.

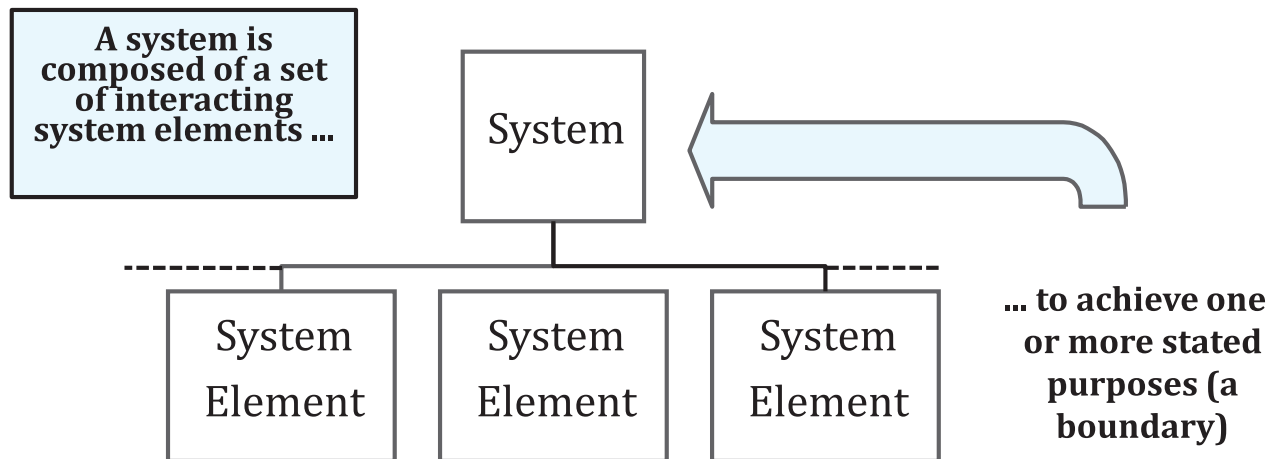


Figure 2 — System and system element relationship

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 can be 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.

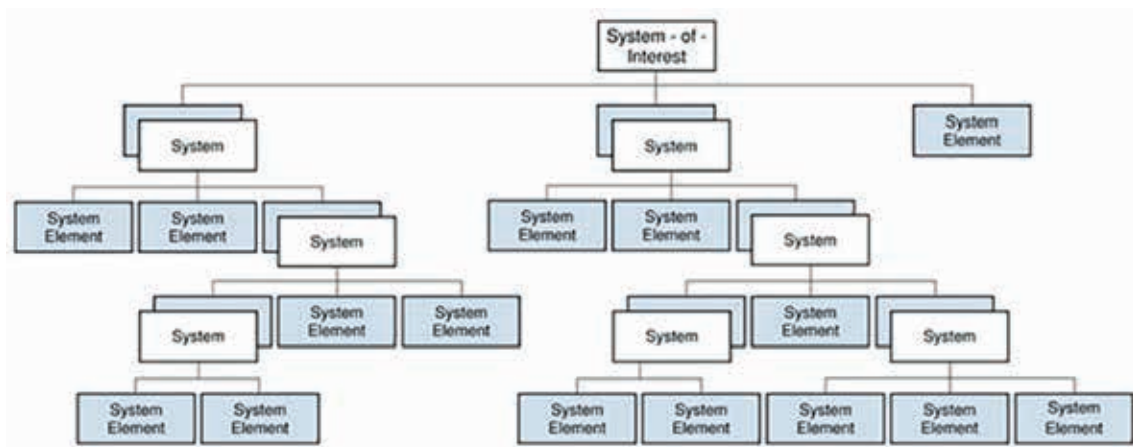


Figure 3 — System-of-interest structure

4.2.4 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 4. 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.

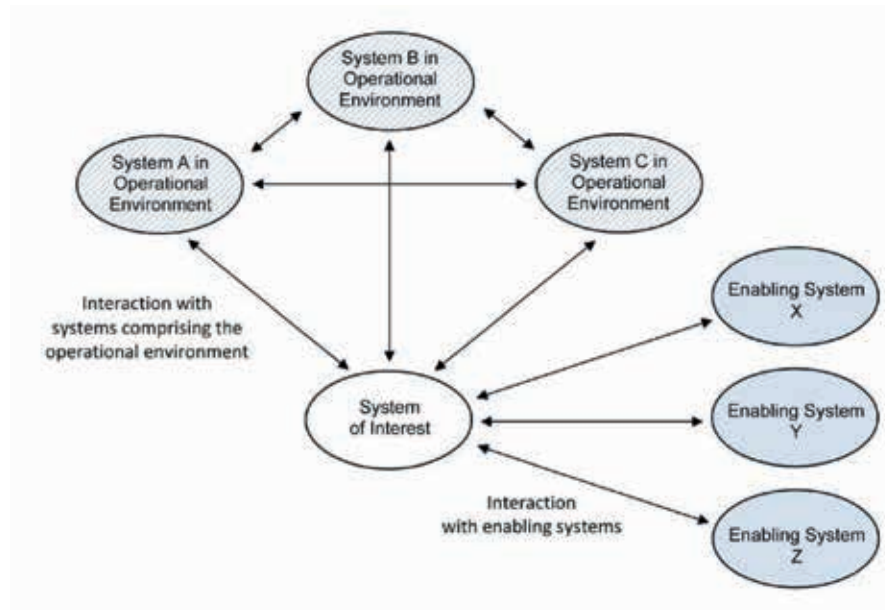


Figure 4 — System-of-interest, its operational environment and enabling systems

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.

4.3 Life cycle concepts

4.3.1 System life cycle model

Every system, whatever the kind or size, inherently evolves, from its initial conceptualization through its eventual retirement, as defined in 3.43. 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/IEEE 15288](#) and [ISO/IEC/IEEE 12207](#). 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 [3.24](#), [3.25](#) and [3.50](#), 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 enable 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/IEEE 12207:2017](#), Annex E.

A secondary aspect of using a life cycle model is that it can help an organization think 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 [6.3.4.1](#).

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 in the activities of 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 5](#), 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
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Figure 5 — Representative life cycle model

The stages in [Figure 5](#), 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 6](#). When, in this document, reference is made to the next, subsequent, or later stage, this type of model should be kept in mind to avoid confusion by inferring linear time sequencing. Further, although each stage is represented in [Figure 6](#), 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.

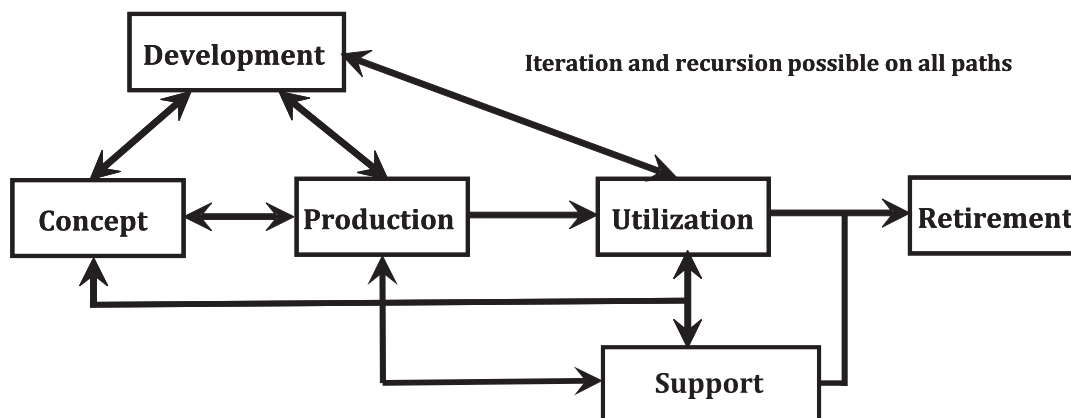


Figure 6 — Life cycle model with some of the possible progressions

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 to 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 6](#), 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:

- 1) a system progresses through specific stages during its life;
- 2) enabling systems should be available for each stage in order to achieve the outcomes of the stage;
- 3) at specific life cycle stages, attributes, such as producibility, usability, supportability and disposability should be specified and designed into a system;
- 4) progression to another stage requires satisfaction of exit criteria of the current stage and possibly entrance criteria for the following stage or stages;
- 5) 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.

4.3.2 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 Explore concepts Propose viable solutions	<ul style="list-style-type: none"> — Begin subsequent stage or stages — Continue this stage — Go to or restart a preceding stage — Hold project activity — Terminate project
Development	Refine system requirements Create solution description Build system Verify and validate system	
Production	Produce systems 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.

4.3.3 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 7](#) 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 document can also be applied to enabling systems.

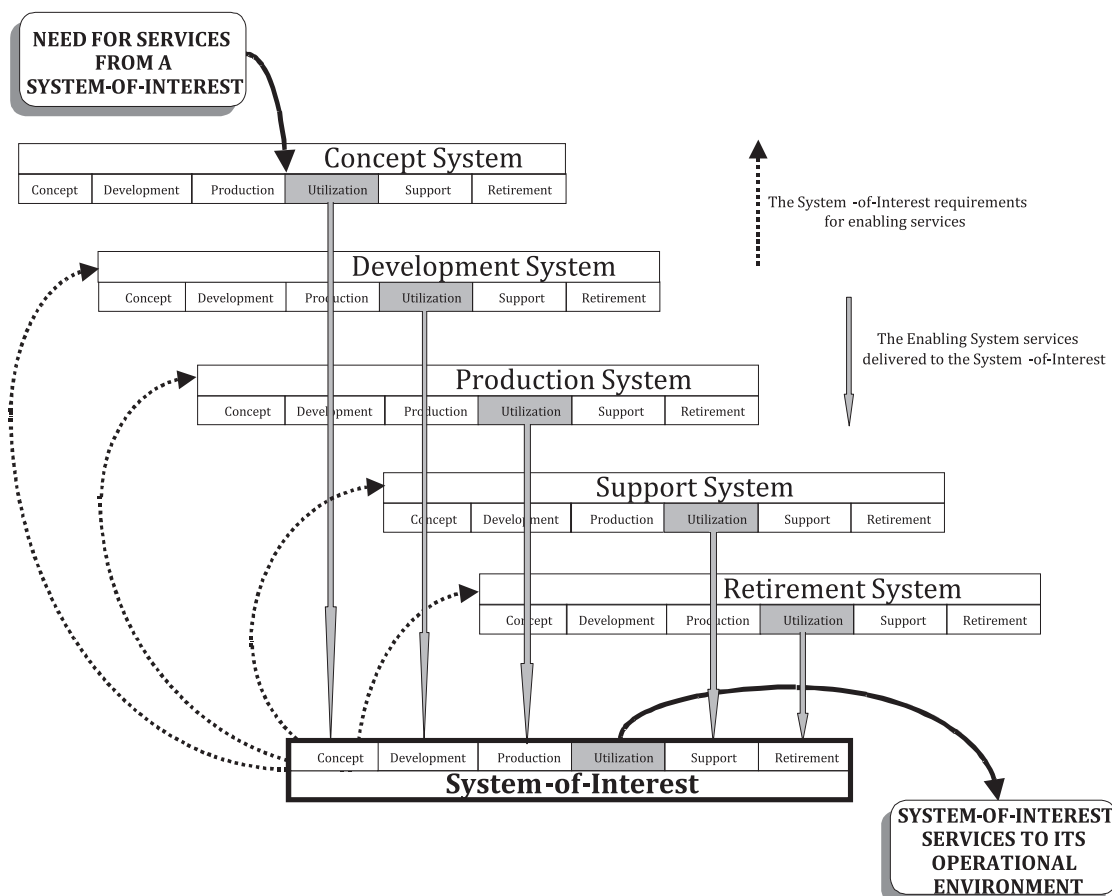


Figure 7 — System interaction with typical enabling systems

5 Life cycle stages

5.1 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/IEEE 15288](#) and [ISO/IEC/IEEE 12207](#) can be invoked at any point throughout the life cycle, as was noted in [4.2.1](#). 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 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 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.