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

Institute of Electrical and Electronics Engineers, Inc
3 Park Avenue, New York
NY 10016-5997, USA

Email: stds.ipr@ieee.org
Website: www.ieee.org

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Foreword

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

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

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

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.

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0 Introduction

0.1 Rationale for architecture processes

The complexity of human-made systems has grown to an unprecedented level, which leads to new opportunities and greater challenges for organizations that create, trade and utilize systems. To address these opportunities and challenges, it is increasingly necessary to apply concepts, principles, procedures and tools to make better architecture-related decisions, more effective architectures, better architecture strategy and increased architecture maturity. Architecture-related activities are now strategic aspects of projects and enterprises, and the use of architecture frameworks has become common practice in commercial, government, civil and military domains.

Architecture is increasingly applied to systems—and to other entities that are not traditionally considered to be systems, such as enterprises, services, data, business functions, mission areas, product lines, families of systems, software items, etc. The concept of architecture used in this document goes beyond the traditional use where the architecture entity is a system. This allows for a more generalized usage of architecture when the processes in this document are applied. These entities are becoming more complex and architecture practices are increasingly adopted to manage the complexity.

Within enterprises and the engineering disciplines, acknowledgement is increasing for the value added by architecture, both as a practice and in the realization of artifacts that guide engineering and management activities.

This document complements the architecture-related processes identified in ISO/IEC/IEEE 15288, ISO/IEC/IEEE 12207 and ISO 15704 with activities and tasks that enable architects and others to more effectively and efficiently implement architecture practices. Implementing these practices can help ensure that the architecture has greater influence on business and mission success.

0.2 Use of the term architecture in this document

This document uses the term architecture in a broad sense. When the word architecture is used without any qualifier the word refers to the general case where the architecture entails the fundamental concepts and properties of an architecture entity. When a qualifier is prepended to the word architecture, this indicates that the architecture applies to that entity, such as in the following cases:

— System Architecture: When the entity is a system.

— Enterprise Architecture: When the entity is an enterprise.

The following are kinds of architecture entities that can be dealt with by the architecture processes of this document: enterprise, organization, solution, system (including software systems), subsystem, business, data (as a data element or data structure), application, information technology (as a collection), mission, product, service, software item, hardware item, etc. The kind of entity can also be a product line, family of systems, system of systems, collection of systems, collection of applications, etc.

There can be cases where the word architecture is prepended by the subject of interest, not by the entity being architected, such as in the following examples: security architecture, functional architecture, physical architecture and so on. See E.4.1 for more examples.

Finally, there are cases when the word architecture is prepended by the purpose of the architecture, for example integration architecture, coherence architecture, design-control architecture, etc. See E.4.1 for more examples.

0.3 Purpose

The purpose of this document is to set the standard of performance for the governance, management, conceptualization, evaluation and elaboration of architectures, and activities that enable these processes. This document can be used as a process reference model in establishing architecture practice and be used across a range of contexts and situations. It provides guidance in conforming to

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the architecture processes specified in this document, and, in a larger context, to facilitate trading in systems, products and services.

0.4 Field of application

The processes specified in this document apply in the context of:

— understanding, developing and evolving entities through their life cycle stages such as conception, development, implementation, operation, sustainment, decommissioning and disposal;

— the type of architecture to be developed;

— organization(s) acting as users, customers and providers of the solution specified by the architecture description; and

— architecting of entities.

The intent is to provide processes applicable across a wide spectrum of architecting domains (such as the enterprise, systems, services and software domains) for use by a broad range of architects and users of these practices.

When the entity is a system then it is necessary to consider that:

— Systems can vary widely in terms of purpose, domain of application, complexity, size, novelty, adaptability, qualities, locations, life spans and evolution. This document specifies processes for the development and use of architecture that involves human-made systems including one-of-a-kind systems, mass-produced systems and customized, adaptable systems either as a complete stand-alone system or systems embedded and integrated into larger, more complex and complete systems.

— Systems addressed by this document can be configured with one or more of the following kinds of system elements: hardware, software, data, humans, processes (e.g. processes for providing services to users), procedures (e.g. operator instructions), facilities, materials and naturally occurring entities.

— The processes in this document can be used to define the architecture of a system as well as to independently define the architecture of a system of systems involving that system or the architecture of an element of that system, such as a software, data or hardware item.

0.5 Reference model for processes

This document provides a process reference model defined according to the ISO/IEC TR 24774 guidelines. This process reference model is characterized by process purpose and process outcomes that result from the successful execution of the relevant tasks in each of the process activities, and the creation of relevant work products, following the process constructs of ISO/IEC/IEEE 15288 and ISO/IEC/IEEE 12207. Therefore, this document is useful to support process assessment as specified in ISO/IEC 33002. ISO/IEC/IEEE 15288:2015, Annex C provides information regarding the use of processes as a process reference model.

The processes specified in this document are applicable:

— concurrently, iteratively, incrementally and recursively to an architecture entity or its elements; and

— for the management and control of portfolios, programs and projects pertaining to the entities being architected.

0.6 Intended audience

The architecture processes specified in this document apply in the context of an enterprise or an extended enterprise, as well as on individual organizations or projects within the enterprise.

This document is applicable to organizations in their roles as both acquirers and suppliers of architected entities or their elements, and is useful for a single organization in a self-imposed mode or in a multi-

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party situation involving agreements between parties. Parties can be from the same organization or from different organizations and the situation can range from informal agreements to formal contracts.

The principal intended users of this document are architects and others who create, express, evaluate, communicate and document architectures. Other users include:

— clients, acquirers, designers, service providers, sub-contractors, users and operators of systems and others who need to understand architectures;

— developers and other stakeholders who need to understand, interpret and analyze architecture descriptions to establish, maintain and transform enterprises, systems or other entities;

— chief information officers, chief engineers, program/enterprise managers, auditors, independent assessors and those who oversee and evaluate architecture entities and their development;

— managers of architecting endeavors who establish, plan, monitor and control such undertakings;

— people involved in enterprise-wide activities that span development of multiple systems products, services and software, including those that seek to establish and codify architecture frameworks, architecture viewpoints and architecting methods;

— business analysts who need to understand the norms for the architecture process and process outcome sufficiently in order to verify whether a given architecture description (a) is consistent with their stakeholder needs, and (b) does not risk leaving any of their needs unsatisfied or contradicted; and

— developers of tools and methods used in support of architecting practices, architecture governance and management, and enablement of architecture process implementation.

Additional users include researchers who can use this document to provide a common framework for expressing their research discoveries related to novel methods or techniques that enable or improve the practices of architecting, architecture governance and architecture management, as well as improving the enablement of these practices.

0.7 Benefits from use of this document

This document provides a process framework that:

— contributes to the identification of job roles and responsibilities in the organization, along with requisite skills and competencies;

— facilitates proper oversight, accountability, consistent governance and management, and alignment within and between architectures;

— enables proper implementation of architecture governance directives and change management of architectures; and

— facilitates the effective planning and tracking of the architecture effort.

A set of well-specified architecture activities results in:

— an architecting capability that is applicable to all architecture efforts, irrespective of size and complexity;

— a framework that provides a consistent approach for developing an architecture based on addressing stakeholder concerns and for identifying the aspects of the architecture that would be required to address those concerns;

— standardized architecture approaches that can be adopted by enterprise, system, information technology, software, product and service architects;

— an effective mechanism that facilitates the understanding and communication of the problem and corresponding solution to various stakeholders; and

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— a common vocabulary that facilitates communication between stakeholders.

Various groups and individuals benefit from the use of standardized architecture processes, including:

— solution acquirers in helping them characterize the business context, evaluate providers' proposals, identify alternatives, make informed decisions, and in facilitating collaboration between providers who will work together on architecture development and governance;

— solution providers in helping them understand the problem/request, elaborate a proposal in their solution space, and define and justify their deliveries;

— solution users in helping them express the operational context, characterize their needs and evaluate providers' proposals in the context of their problem space;

— decision makers and program/project managers in helping them consider a range of options during creation and usage of architectures which are considered as a source of information and as a basis for the rationale when decisions are made; and

— other bodies such as legal, safety and security authorities, in helping them assess compliance with standards, policies, directives, treaties, regulations and laws.

0.8 Limitations

No formal traceability is made between ISO/IEC/IEEE 15288, ISO/IEC/IEEE 12207, ISO 15704 and this document. Consequently, meeting all requirements in this document does not necessarily mean that all requirements related to architecture processes specified in those other documents are met.

This document does not specify a particular life cycle model to be used when applying these processes.

The ISO/IEC/IEEE 24748 series provides guidance for life cycle definition and application of life cycle processes. Although this document does not establish a management system, the intent of this specification is to be compatible with the quality management system provided by ISO 9001, the service management system provided by ISO/IEC 20000-1 (also published as IEEE Std 20000-1), and the information security management system provided by ISO/IEC 27000.

This document does not specify detailed information items in terms of format, explicit content and recording media. ISO/IEC/IEEE 15289 addresses the content for life cycle process information items (documentation).

This document does not specify any particular architecture framework or architecture documentation standard.

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Software, systems and enterprise — Architecture processes

1 Scope

This document establishes a set of process descriptions for the governance and management of a collection of architectures and the architecting of entities. This document also establishes an enablement process description that provides support to these other architecture processes.

The processes defined in this document are applicable for a single project, as well as for an organization performing multiple projects. These processes are applicable throughout the life of an architecture or a collection of architectures. These processes are applicable for managing and performing the activities within any stage in the life cycle of the architecture entities.

Annex D describes the relationships between this document and other standards.

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:

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

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

— IEEE Standards Dictionary Online: available at http://ieeexplore.ieee.org/xpls/dictionary.jsp

NOTE Definitions for other terms typically can be found in ISO/IEC/IEEE 24765, which provides the vocabulary for system and software engineering, available at www.computer.org/sevocab.

3.1
activity
set of cohesive *tasks* (3.23) of a *process* (3.16)

[SOURCE: ISO/IEC/IEEE 15288:2015, 4.1.3]

3.2
architecting
conceiving, defining, expressing, documenting, communicating, certifying proper implementation of, maintaining and improving an *architecture* (3.3) throughout the *life cycle* (3.11) for an *architecture entity* (3.6)

Note 1 to entry: The entity to be architected can be of several kinds, as illustrated in the following examples: system, *enterprise* (3.9), solution, business, data, application, information technology, mission, product, service, software, etc. See E.4 for more information on this topic.

Note 2 to entry: Certifying the proper implementation of an architecture is sometimes captured as a formal statement by the architect to the client or user that the system, as built, meets the criteria as ready for use.

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[SOURCE: ISO/IEC/IEEE 42010:2011, 3.1 modified — The word "system" has been replaced with "architecture entity"; the original NOTE has been removed; Notes 1 and 2 to entry have been added.]

3.3
architecture
fundamental concepts or properties of an entity in its environment and governing principles for the realization and evolution of this entity and its related *life cycle* (3.11) *processes* (3.16)

Note 1 to entry: *Architecture entity* (3.6) is the term used in this document when referring to the entity being architected or the entity subject to architecture processes. The fundamental concepts or properties of the architecture entity are usually intended to be embodied in the entity's components, the relationships between components, and the relationships between the entity and its environment.

Note 2 to entry: The concept of architecture used in this document applies broadly to the entity being architected or evaluated. This allows for a more generalized usage when the elements in this document are applied.

Note 3 to entry: The entity to be architected can be of several kinds, as illustrated in the following examples: *enterprise* (3.9), *organization* (3.14), solution, system, subsystem, business, data (as a data element or data structure), application, information technology (as a collection), mission, product, service, software item, hardware item, product line, family of systems, system of systems, etc. It also spans the variety of applications that utilize digital technology such as mobile, cloud, big data, robotics, Internet of things (IoT), web, desktop, embedded systems and so on.

Note 4 to entry: Representation of the concepts or properties of an entity and governing principles is captured in architecture *models* (3.13).

Note 5 to entry: Architectures can address a wide range of *concerns* (3.8) expressed, for example, through architecture *views* (3.24) and models, as illustrated in the following examples associated with particular kinds of architectures such as: security architecture, functional architecture, physical architecture, resilience architecture, etc.

3.4
architecture collection
group of *architectures* (3.3) held by an *organization* (3.14) that is subject to governance and management by the organization as a whole

Note 1 to entry: The architectures in the collection can have relationships with each other (as in the case of product lines). The architectures in the collection can be based on the same reference architecture.

3.5
architecture description
work product (3.26) used to express an *architecture* (3.3)

[SOURCE: ISO/IEC/IEEE 42010:2011, 3.3, modified — The abbreviated term has been removed.]

3.6
architecture entity
thing being considered, described, discussed, studied or otherwise addressed during the *architecting* (3.2) effort

EXAMPLE The following are kinds of architecture entities that can be dealt with by the *architecture* (3.3) *processes* (3.16): *enterprise* (3.9), *organization* (3.14), solution, *system* (3.22) (including software systems), subsystem, business, data (as a data element or data structure), application, information technology (as a collection), mission, product, service, software item, hardware item, product line, family of systems, system of systems, collection of systems, collection of applications, etc.

Note 1 to entry: When referring to the architecture itself of these architecture entities, it is common practice to place the name of the kind of entity in front of the word architecture. For example, the phrase system architecture is used when the thing being dealt with during the architecting effort is a system. Likewise, for the other kinds of entities that are being dealt with during the architecting effort.

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3.7
architecture framework
conventions, principles and practices for use by *architecture*-related (3.3) activities that have been established within a specific domain of application or community of *stakeholders* (3.21)

EXAMPLE 1 Generalised Enterprise Reference Architecture and Methodology (GERAM) (see ISO 15704) includes an architecture description framework (called the GERA Modelling Framework).

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

EXAMPLE 3 Department of Defense Architecture Framework (DoDAF), Ministry of Defence Architecture Framework (MODAF), Department of National Defense/Canadian Armed Forces Architecture Framework (DNDAF), NATO Architecture Framework (NAF), The Open Group Architecture Framework (TOGAF®) are some architecture frameworks.

Note 1 to entry: The concept of architecture framework has been expanded in this document beyond the way this term is used in ISO/IEC/IEEE 42010 where it is used strictly with regard to the "description of architectures".

3.8
concern
matter of interest or importance to a *stakeholder* (3.21)

EXAMPLE Affordability, agility, availability, dependability, flexibility, maintainability, reliability, resilience, usability and viability are examples of concerns. Survivability, depletion, degradation, loss, obsolescence are examples of concerns. The PESTEL mnemonic is a reminder of possible areas of concern: political, economic, social, technological, environmental, and legal.

3.9
enterprise
bold or complex endeavor

Note 1 to entry: One or more *organizations* (3.14) can participate in an enterprise. In case of multi-organization enterprises, each of the organizations brings various resources forward for use in the enterprise and they participate to the extent that they benefit from their involvement. The purpose of the enterprise is to address some challenges that these participating organizations cannot readily address on their own. Within a single organization, an enterprise may refer to a subset of the organization which is typically addressing particularly challenging or complex issues, often over a defined duration, and may undertake this with certain relaxations, tightening or otherwise authorized modifications of standard corporate *processes* (3.16) and practices (see definition of organization).

3.10
library
place containing collections of *work products* (3.26) and useful information items for people to read, borrow or refer to, and for machines to access and retrieve data from

Note 1 to entry: In a *repository* (3.19), work products and other items are preserved for future retrieval when needed, whereas in a library, working data is temporarily stored and retrieved as necessary.

3.11
life cycle
<entity> set of distinguishable *phases* (3.15) or *stages* (3.20) that an entity goes through from its conceptualization until it ceases to exist

3.12
life cycle
<architecture> set of distinguishable *phases* (3.15) or *stages* (3.20) that an *architecture* (3.3) goes through

Note 1 to entry: The architecture life cycle starts with the identification of a need for the architecture and ends when it is no longer needed.

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3.13
model
abstract representation of an entity or collection of entities that provides the ability to portray, understand or predict the properties or characteristics of the entity or collection under conditions or situations of interest

Note 1 to entry: A model can use a formalism that could be based on mathematical or scientific principles and concepts. A model can be generated using an established metamodel. Metamodels are often used to facilitate development of accurate, complete, consistent and understandable models.

Note 2 to entry: A model can be used to construct or express *architecture* (3.3) *views* (3.24) of the entity. Descriptive models and analytic models are two kinds of models. A model should be governed by a model kind in accordance with ISO/IEC/IEEE 42010.

Note 3 to entry: A reference model can be used to capture a general case that is used as the basis for creating special case models for particular conditions or situations. A reference model can be used to encourage and enforce uniformity of architectures and architecture elements.

Note 4 to entry: The model can be an architecture model, *architecture entity* (3.6) model, concept model or reference model, as the case may be.

3.14
organization
group of people and facilities with an arrangement of responsibilities, authorities and relationships

EXAMPLE Company, corporation, firm, *enterprise* (3.9), 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 explicitly stated responsibilities, authorities and relationships. A body of persons organized for some specific purpose, such as a club, union, corporation or society, can be an organization.

Note 2 to entry: One or more organizations will participate in an enterprise. In case of multi-organization enterprises, each of the organizations brings various resources forward for use in the enterprise and they participate to the extent that they benefit from their involvement. The purpose of the enterprise is to address some challenges that these participating organizations cannot readily address on their own. Within a single organization, an enterprise may refer to a subset of the organization which is typically addressing particularly challenging or complex issues, often over a defined duration, and may undertake this with certain relaxations, tightening or otherwise authorized modifications of standard corporate *processes* (3.16) and practices. See definition of enterprise.

3.15
phase
period of time in the *life cycle* (3.11) during which activities are performed that enable achievement of objectives for that phase

3.16
process
set of interrelated or interacting activities that transforms inputs into outputs

[SOURCE: ISO 9000:2015, 3.4.1, modified — The words “use inputs to deliver an intended result” have been replaced with “transforms inputs into outputs”; Notes 1 to 6 to entry have been removed.]

3.17
project
endeavor with defined start and finish criteria undertaken to create a product or service in accordance with specified resources and requirements

[SOURCE: ISO/IEC/IEEE 15288:2015, 4.1.33, modified — Note 1 to entry has been removed.]

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3.18
registry
book or *system* (3.22) for keeping an official list or record of *work products* (3.26) and the associated information items

Note 1 to entry: *Repository* (3.19) and *library* (3.10) items should be recorded in registries to enable better management and governance of these items.

3.19
repository
place where *work products* (3.26) and the associated information items are or can be stored for preservation and retrieval

Note 1 to entry: Repository items should be under configuration control.

Note 2 to entry: In a repository, work products and other items are preserved for future retrieval when needed, whereas in a *library* (3.10), working data is temporarily stored and retrieved as necessary.

3.20
stage
period within the *life cycle* (3.11) 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, 4.1.43]

3.21
stakeholder
role, position, individual or *organization* (3.14) having a right, share, claim or other interest in an *architecture entity* (3.6) or its *architecture* (3.3) that reflects their needs and expectations

3.22
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 a set of services.

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 system element is a discrete part of a system that can be implemented to fulfill specified requirements. A system element can be hardware, software, data, humans, *processes* (3.16) (e.g., processes for providing service to users), procedures (e.g., operator instructions), facilities, materials, and naturally occurring entities (e.g., water, organisms, minerals), or any combination.

Note 4 to entry: A system can be comprised of multiple subsystems. For example, an aircraft system can include an avionics subsystem and a radar subsystem. The distinction between a system and a subsystem is a matter of perspective, and as such the radar subsystem can be referred to as a radar system in some contexts.

[SOURCE: ISO/IEC/IEEE 15288:2015, 4.1.46, modified — in Note 1 to entry "the services it provides" is replaced by "a set of services"; Note 3 to entry is from ISO/IEC/IEEE 15288:2008; Note 4 to entry has been added.]

3.23
task
recommended action intended to contribute to the achievement of one or more outcomes of an *architecture* (3.3) *process* (3.16)

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3.24
view
<architecture> information item expressing the *architecture* (3.3) from the perspective of specific *stakeholders* (3.21) regarding specific aspects of the *architecture entity* (3.6) and its environment

Note 1 to entry: When the term view is used without any qualifier it refers to the general case. When a qualifier is prepended to the word view, this indicates that the architecture view is specific to a particular *viewpoint* (3.25), such as illustrated in these examples:

— operational view: when the associated viewpoint is dealing with operations;

— services view: when the associated viewpoint is dealing with services.

3.25
viewpoint
<architecture> conventions for the construction, interpretation and use of *architecture* (3.3) *views* (3.24) to address specific *concerns* (3.8) about the *architecture entity* (3.6)

Note 1 to entry: When the word "viewpoint" is used without any qualifier it refers to the general case. When a qualifier is prepended to the word viewpoint, this indicates that the viewpoint applies to a specific set of concerns, such as in the following examples: operational viewpoint, capability viewpoint, services viewpoint.

Note 2 to entry: ISO/IEC/IEEE 42010 specifies that an architecture view shall be governed by its viewpoint.

3.26
work product
artifact associated with the execution of a *process* (3.16)

4 Conformance

4.1 General

This document specifies requirements, recommendations and permissions for architecture processes in Clauses 6 through 11. Requirements are marked by the use of the verb "shall". Recommendations are marked by the use of the verb "should". Permissions are marked by the use of the verb "may". However, despite the verb that is used, the requirements for conformance are specified as described below.

4.2 Approach to conformance

The processes specified in this document are suitable for use during any stage in the life cycle of an entity, such as an enterprise, a project, a system or a product. Recognizing that particular projects or organizations may not need to use all of the processes provided by this document, implementation typically involves selecting and declaring a set of process activities suitable to the enterprise, organization or project. To accommodate that flexible implementation approach, this document provides two primary ways to claim conformance — full conformance and tailored conformance.

4.3 Full conformance cases

It is recognized that particular projects or organizations may not need to use all of the processes provided by this document. Therefore, implementation of this document typically involves selecting and declaring a set of processes suitable to the organization or project.

A claim of full conformance declares the set of processes for which conformance is claimed. The selected processes, for which conformance is claimed, are declared. Full conformance is achieved by demonstrating that requirements for the declared set of processes, as tailored, have been satisfied.

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