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Software, systems and enterprise — Architecture processes

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National foreword

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Software, systems and enterprise — Architecture processes

Logiciel, systèmes et entreprise - Processus d'architecture

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Foreword

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

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of 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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To claim full conformance, a user of this document shall demonstrate conformance with respect to one or more of the following three criteria:

— Claiming "conformance to outcomes" asserts achievement of all required outcomes of the declared set of processes.

NOTE 1 In this situation, the provisions for activities and tasks of the declared set of processes are guidance rather than requirements, regardless of the verb form that is used in the provision.

NOTE 2 Some users could have innovative process variants or life cycle models that achieve the objectives of the declared set of processes without implementing all of the activities or delivering all the work products. These users can instead assert conformance to the outcomes of the declared set of processes.

— Claiming "conformance to activities" asserts achievement of all requirements for the activities of the declared set of processes.

NOTE 3 Conformance at the task level is considered to be too constraining in most situations. The tasks specified in this document are recommendations only.

— Claiming "conformance to work products" asserts achievement of all required work products (as specified in the fifth subclause in each process description) associated with the declared set of processes.

NOTE 4 In tailoring, work products required in this document can be modified (added to, combined or retitled). The titles of work products can be tailored to satisfy requirements of an organization, its projects, or agreements based on the tailored conformance to this document. The contents of the work products correspond to the selected or tailored processes.

NOTE 5 The three criteria—conformance to outcomes, conformance to activities, and conformance to work products—are not necessarily equivalent since specific performance of activities could need, in some cases, a higher level of capability than just the achievement of process outcomes and delivery of the work products.

4.4 Tailored conformance

When use of this document establishes a set of processes that do not qualify for full conformance, the selected or adapted clauses and subclauses shall be identified in accordance with the Tailoring process defined in Annex A. The claim of tailored conformance shall include the modified text to replace the relevant clause or subclause. Tailoring may be performed by process, outcomes, activities, work products and tasks. Tailored conformance shall demonstrate achievement of the outcomes, activities and work products as tailored. Tailored conformance can also entail selection or modification of tasks, although the tasks are not required for conformance purposes. All the levels of tailoring are acceptable as long as consequence of a partial conformance is understood and accepted. A rationale shall be provided to show relevance of this tailoring.

5 Process overview and application

5.1 General

This document describes each of the architecture processes in terms of a purpose, desired outcomes, and a list of activities for achieving those outcomes. Tasks are recommended for implementing those activities. Table 1 provides the purpose of each process.

Table 1 — Architecture processes and their purposes

Clause	Process	Purpose
6	Architecture Governance	Establish and maintain alignment of architectures in the architecture collection with enterprise goals, policies and strategies and with related architectures

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Table 1 *(continued)*

Clause	Process	Purpose
7	Architecture Management	Implement architecture governance directives to achieve architecture collection objectives in a timely, efficient and effective manner
8	Architecture Conceptualization	Characterize the problem space and determine suitable solutions that address stakeholder concerns, achieve architecture objectives and meet relevant requirements
9	Architecture Evaluation	Determine the extent to which one or more architectures meet their objectives, address stakeholder concerns and meet relevant requirements
10	Architecture Elaboration	Describe or document an architecture in a sufficiently complete and correct manner for the intended uses of the architecture
11	Architecture Enablement	Develop, maintain and improve the enabling capabilities, services and resources needed to perform the other architecture processes

These architecture processes and their key interactions in terms of typical information flows for a particular team, project, organization or enterprise are depicted in Figure 1. The interactions between the core processes are not labeled here but are depicted in more detail in Figure 2. Not all the possible interactions are shown in Figure 1 and Figure 2 for implementing these processes. Typical interactions with external processes are described in Annex C.

The architecture processes may execute concurrently with interactions between them and iterating over time. At the same time, governance directives and management instructions flow from Architecture Governance process to the Architecture Management process and operational plans and status flows from the Architecture Management process to the Architecture Governance process. The interactions between the core processes are described in 5.4.

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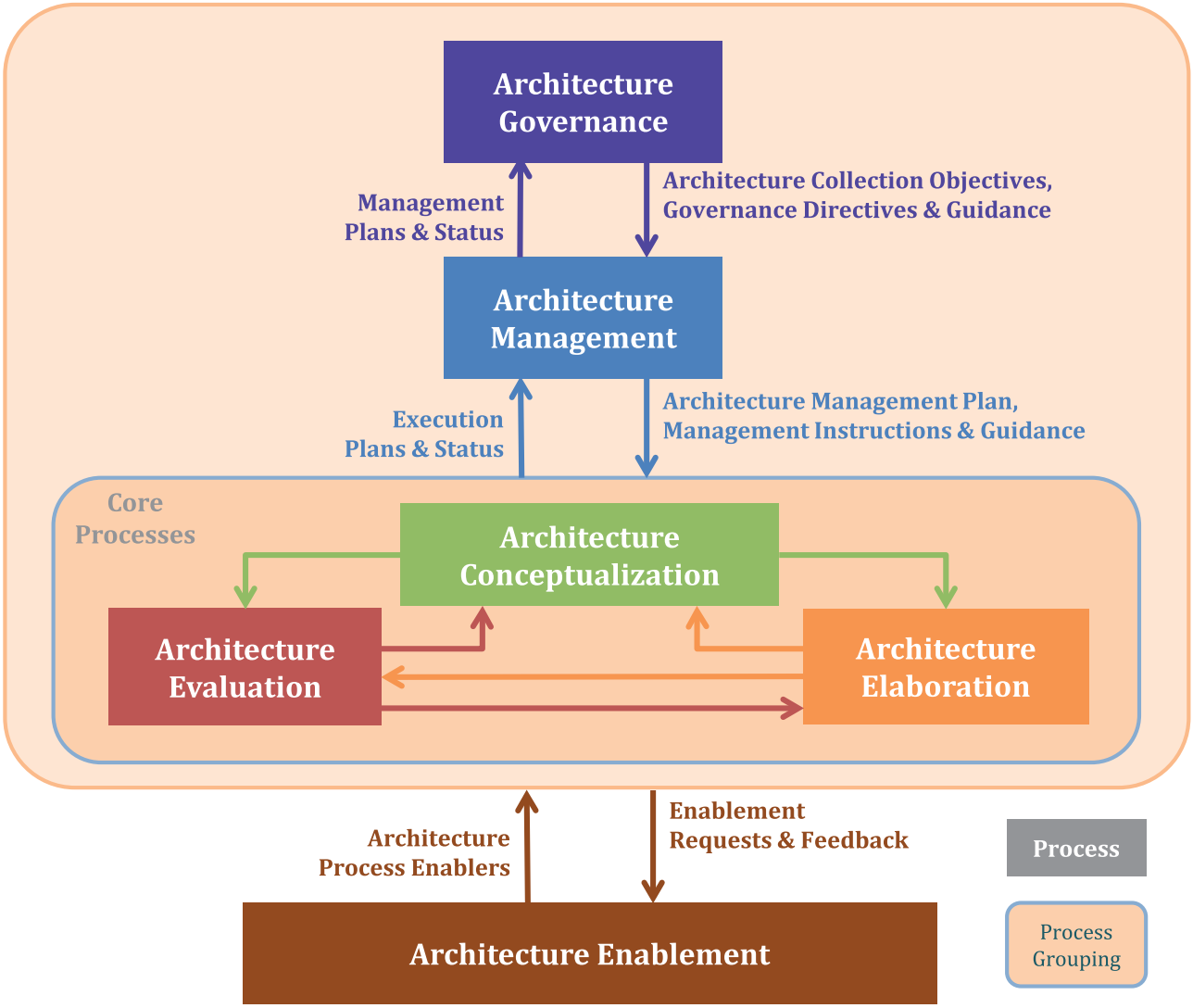

Figure 1 — Architecture processes and their interactions

5.2 Relationship of architecture to other processes and information elements

There are other life cycle processes that are affected by these architecture processes. For example, system requirements may be derived from the architecture and the architecture may be driven by requirements. The specific nature of how architecture and requirements are related to each other is organization dependent so cannot be specified in this document.

Likewise, architecture has a relationship to risks, decisions, project planning, integration, verification, acquisition, supply, quality management, investment management and so on, but the specific nature of these relationships cannot be specified in this document. The architecture processes shall interact with other processes and information elements as described in Annex C.

Iteration of the architecture processes with the Business or Mission Analysis process, System Requirements Definition process, Design Definition process and Stakeholder Needs and Requirements Definition process is often employed so that there is a negotiated understanding of the problem to be solved and a satisfactory solution is identified. The results of the architecture processes are widely used across the other life cycle processes. Architecture processes may be applied at many levels of abstraction, highlighting the relevant detail that is necessary for the decisions at that level.

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5.3 Architecture Governance and Management processes

Architecture governance and management processes are applicable to a collection of architectures, typically in an enterprise or project context. During architecture governance and management, the stakeholders who make financial, governance and technical decisions are identified, documented and included in performance of the activities of these processes. The governance process ensures proper oversight and accountability, and identifies, manages, audits and disseminates all information related to architecture collection decisions. It is applicable for all architecture efforts in an organization.

The management process implements governance directives and guidance and captures this in an architecture management plan. The core processes are monitored and assessed against the plan and appropriate controls are implemented to direct course corrections. Instructions and guidance are issued to the core processes as a means to provide further direction beyond what the plan provides, especially with respect to directing how the architecture(s) should be developed and used.

Architecture governance specifies the governance directives and guidance that can be used to drive the appropriate evolution of architectures in the architecture collection. It also specifies the architecture collection objectives to be pursued and establishes the strategy to be adopted for achievement of these objectives. It uses the management plans and status regarding the architecture collection to monitor compliance with governance directives and guidance.

NOTE 1 The governance framework typically comprises a set of controls over the creation and monitoring of all architecture process components, work products and outcomes.

NOTE 2 Absolute control may not be possible in cases like: SOS situations, federated architectures, consortium-based architectures, public-private partnerships, etc.

Architecture management specifies the management plans and instructions that are used to drive the core architecture processes. It uses the execution plans and status of the core processes to monitor compliance with management plans and instructions. In addition to management instructions, management guidance is developed as a means to assist those following the plans and instructions in implementing governance directives and in carrying out work to be in better alignment with management intent.

NOTE 3 See Annex G for additional information regarding architecture governance and management.

5.4 Architecture Conceptualization, Evaluation and Elaboration processes

Key interactions between the core processes (Conceptualization, Evaluation and Elaboration) are illustrated in Figure 2. These processes can also be triggered by other processes external to these three processes. Conceptualization specifies the objectives of the architecture and the quality measures that can be used in the assessment of its value. Value is defined in terms of the extent to which stakeholder concerns are addressed. These architecture objectives are based on the problem/opportunity identification and definition that occurs in this process. Architecture concepts are generated with value in mind and are then assessed using these quality measures.

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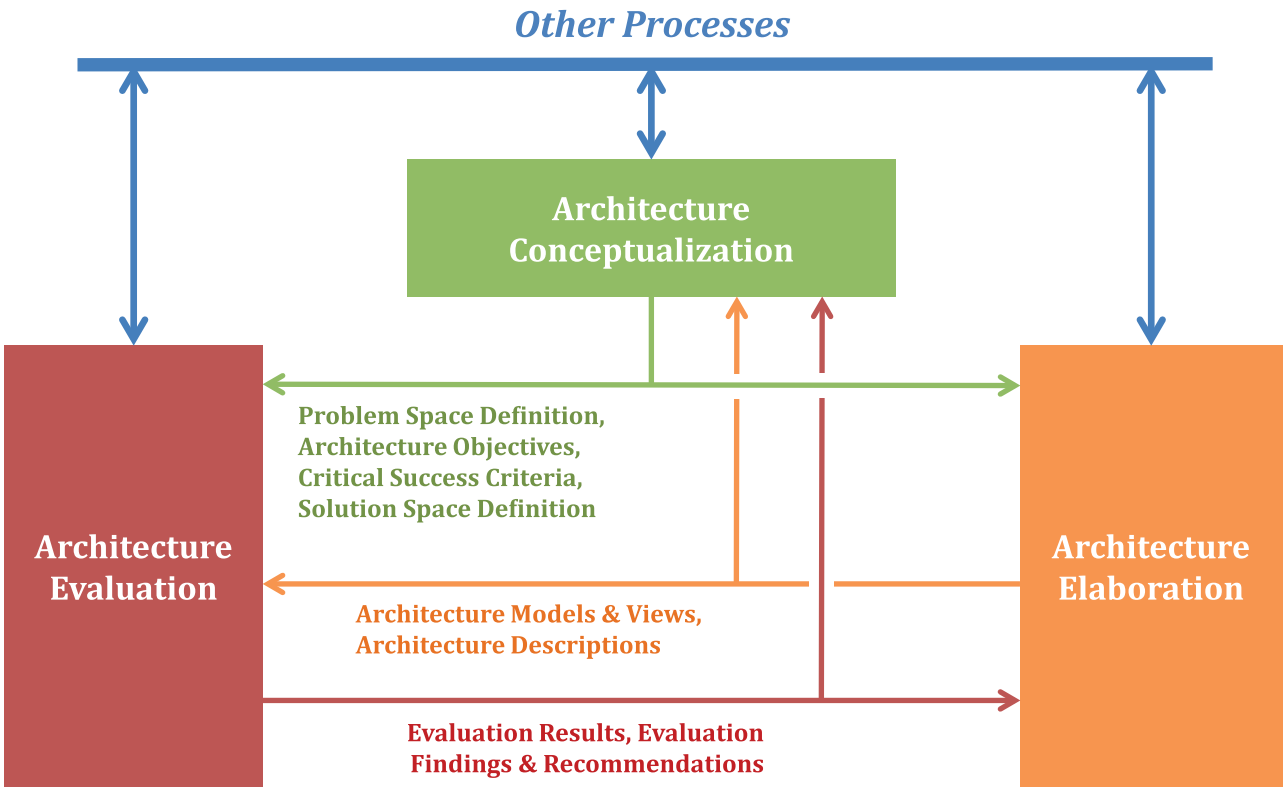

Figure 2 — Interactions between the core processes and with other processes

Conceptualization aids architects and others in characterizing the problem space, synthesizing potential solutions, formulating candidate architectures and expressing these architectures in a form that is suitable for the intended uses. The name of the process being "conceptualization" does not mean that the results are necessarily at the "conceptual" level, or consist of a set of conceptual models and views. The results could include a "logical" architecture or a "physical" architecture, depending on the nature of the situation.

During early stages, it can be important to be agile and quick in conceptualizing many alternative architectures. Some of these early architecture descriptions are little more than sketches. After doing several quick rounds of evaluation and conceptualization, there can then be a smaller number of viable architectures that are worth capturing in a more complete form and storing in the repository for later use. A more complete form of architecture description would be developed during architecture elaboration.

Conceptualization can use the results of architecture elaboration, when appropriate. Architecture conceptualization only needs to describe the architecture to the level of specificity and granularity that is suitable for its intended users, which in many cases does not require significant elaboration. The elaboration of architecture views, models and descriptions can often occur later in the life cycle of the architecture, after the architecture has become more mature and the extra effort of elaboration becomes worthwhile. Elaboration can often be deferred until after several architecture alternatives have been examined for their suitability, and they are selected down to one or a few alternatives for further examination and eventual use downstream in the engineering effort.

During evaluation, there could be a recognition that alternative architecture concepts are needed to more completely search the tradespace. However, in some cases there can be only a single architecture that is being evaluated for its suitability. Value assessments can be based on analysis of relevant architecture attributes and properties of the situation, or on an assessment of how much value is delivered to, for example, an operational setting or to individual users. The assessment and analysis results, along with estimates of assessment uncertainty, are returned along with key findings and recommendations, to determine if the proposed architecture sufficiently addresses stakeholder concerns. If not, then additional cycles between conceptualization and evaluation are pursued.

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When further elaboration of the architecture is needed then the architecture objectives, architecture concepts and properties are expressed in a sufficiently complete and correct manner that can be delivered and used as the basis for more complete modeling, delineation and decomposition of these concepts and properties. Elaborated models and views, along with supporting materials, can be used to provide more detailed understanding of the architecture and to check for consistency with the original concepts and alignment with the objectives.

During evaluation, there can sometimes be a need for more complete models and views. In these cases, elaboration could be requested to generate additional models and views. During evaluation these models and views can be annotated with the results of the evaluation and with comments on strengths and weaknesses of the architecture or its description.

NOTE These processes can be repeated for each level of decomposition, refinement, realization, abstraction, disaggregation, etc. of the architecture. In such a case, the processes need to ensure that the architecture at that level is aligned with relevant architectures above and below that level.

Any of the architecture processes can generate or contribute to an architecture description of varying scope, granularity and formality. However, the elaboration process captures the architecture description in a sufficiently complete and correct manner for the intended uses and intended users of the architecture downstream from the architecture effort.

5.5 Architecture Enablement process

Architecture enablement selects, modifies and develops capabilities, services and resources in support of the other processes. In this document, these things are called enablers. This process can be used to enable the development of an individual architecture or a collection of architectures, or provide enabling resources, capabilities and services to all architecture endeavors of an organization. Architecture enablement ensures that the information regarding the different enablers is uniformly organized and integrated.

The other architecture processes request enablers to assist in performing the activities, utilize the enablers and provide feedback in terms of the effectiveness of the enablers and the changes that are necessary to improve their effectiveness. These other processes also may contribute enablers to the Architecture Enablement process which can then be made available for use by other projects. Architecture enablement tracks the usage and usefulness of the enablers and the difficulties that are faced when utilizing these enablers. Architecture enablement establishes and maintains enablers for use throughout the organization.

EXAMPLE Enabling capabilities include, among other things, procedures, methods, tools, frameworks, architecture viewpoints, work product templates, decision support systems, storage, configuration management and reference models. Enabling services include, among other things, infrastructure, technologies, skilled personnel and automation agents. Enabling resources include, among other things, architecture repository, library, registry, communication channels and mechanisms, human and technical resources, and training and licenses for tools and methods.

The key enablers are the architecture repository, library and registry. The architecture repository provides mechanisms to store, manage and manipulate architecture work products. It also provides appropriate access to projects, organizations, and individuals. The architecture library provides services to the projects or organizations for finding and organizing information. It also catalogs and stores source materials for ready access by all those involved in an architecture effort. In support of the repository and library is an architecture registry, where the items can be referenced as to their intended uses, anticipated limitations, location in the repository or library, pointers to other relevant materials that enable proper utilization, and to their stage of development.

NOTE See Annex F for additional information regarding architecture enablement practices.

5.6 Relationship of architecture to design

Architecture processes provide one or more architecture alternatives that frame the concerns of stakeholders and addresses their key requirements. Architecture can be widely used across the life

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cycle processes of the architecture entity. Architecture processes can be applied at many levels of abstraction, highlighting the relevant features that are necessary for the decisions at that level.

As defined in 3.3, architectures provide the fundamental concepts or properties of the architecture entity and associated governing principles. Architectures should be described using a set of views and models that are complete, consistent and correct. The completeness of an architecture view or model is determined relative to its intended use.

Design, as defined in ISO/IEC/IEEE 15288, is a technical process providing sufficient details about the architecture entity and its elements to enable an implementation consistent with architecture. An effective architecture guides the design activities in such a way that it allows for maximum flexibility in the design tradespace.

Through use of the Design Definition process in ISO/IEC/IEEE 15288, insights are gained into the relation between the requirements specified for the architecture entity and the emergent properties and behaviors of the architecture entity that arise from the interactions and relations between the elements and between the properties of those elements.

Sometimes the elements of the architecture entity are initially notional until Design Definition process in ISO/IEC/IEEE 15288 has occurred since this depends on the actual design(s) to be done. Sometimes a “reference architecture” is created using these notional elements as a means to convey architectural intent and to check for design feasibility.

Interfaces and interactions between elements are defined at a level of detail necessary to convey the architectural intent and could be further refined in the Design Definition process. The Design Definition process considers any applicable technologies and their contribution to the system solution. Design Definition provides the level of the definition necessary for realization, such as drawings, detailed design descriptions, software code, task descriptions, etc.

The Design Definition process provides feedback to the architecture processes to consolidate or confirm the concepts and properties of the architecture entity, along with the allocation, partitioning and alignment of architectural entities to elements that compose the architecture entity.

5.7 Architecture adaptation

All the processes are involved with adaptation of the architecture to a given situation. Conceptualization and Elaboration act directly to make the architecture evolve and adapt. Evaluation provides evidence for decision making on architecture evolution and change. Architecture-related decisions could be made in conjunction with the architecture processes, but this is usually the responsibility of some other process where the decision is most relevant. Governance and Management provide directives and instructions for architecture evolution and change. Enablement provides enabling capabilities, services and resources that support the other processes in adapting the architecture.

5.8 Process application

5.8.1 Criteria for processes

The determination of architecture processes in this document is based upon three basic principles:

— Each architecture process has strong relationships among its outcomes, activities and work products.

— The dependencies between the processes are reduced to a minimum.

— A process is capable of execution by a single organization in the life cycle.

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5.8.2 Description of processes

Each process of this document is described in terms of the following attributes:

— The title conveys the scope of the process as a whole.

— The purpose describes the goals of performing the process.

— The outcomes express the observable results expected from the successful performance of the process.

— The activities are sets of cohesive tasks of the process.

— The tasks are recommended actions intended to contribute to the achievement of one or more outcomes (i.e. results) that come about due to execution of the process.

— The work products help achieve the desired outcomes and can be produced based on the activities of the process.

Additional detail regarding this form of process description can be found in ISO/IEC TR 24774.

5.8.3 General characteristics of processes

In addition to the basic process attributes described above, processes may be characterized by other attributes common to all processes. ISO/IEC 33002 identifies common process attributes that characterize six levels of achievement within a measurement framework for use in process assessment activities. ISO/IEC/IEEE 15288:2015, Annex C includes the list of process attributes that contribute to the achievement of higher levels of process capability as defined in ISO/IEC 33002.

ISO/IEC 33020 specifies a process measurement framework for assessment of process capability.

Annex C in this document specifies how system life cycle processes in ISO/IEC/IEEE 15288 should use architecture-related information. Annex C in this document also specifies how the architecture processes should use information items from ISO/IEC/IEEE 15288 processes.

5.8.4 Tailoring

Annex A is normative and defines the basic activities needed to perform tailoring of this document.

Tailoring may entail the changing or removal of architecture processes. It may be performed for many reasons including the scale of the architecting endeavor, the purpose of the desired architecture (such as the kind of architecture sought), and the approach to architecting which is employed. For example, if the purpose of the architecting endeavor is to devise an architecture from an extant system or system design (i.e. to employ reverse architecting) then certain processes, such as architecture conceptualization in this particular case, may not need to be performed.

In all cases where such tailoring of architecture processes is employed, the rationale behind the tailoring shall be recorded. Recording of the rationale assists stakeholders in determining the value arising from the architecting effort and the confidence they should attribute to its outcomes.

Note that tailoring may diminish the perceived value of a claim of conformance to this document. This is because it is difficult for other organizations to understand the extent to which tailoring may have removed desirable provisions. An organization asserting a single-party claim of conformance to this document may find it advantageous to claim full conformance to a smaller list of processes rather than tailored conformance to a larger list of processes.

The processes described in this document are not intended to preclude or discourage the use of additional processes that organizations find useful. In particular, governance and directives of the organization can be applied for tailoring of the architecture governance and management processes and therefore tailoring of the process outcomes and the other architecture processes.

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6 Architecture Governance process

6.1 Purpose

The purpose of the Architecture Governance process is to establish and maintain alignment of architectures in the architecture collection with enterprise goals, policies and strategies and with related architectures.

NOTE See Annex G for additional information regarding architecture governance and management and the distinction between these related but separate processes.

6.2 Outcomes

As a result of the successful implementation of the Architecture Governance process:

a) Architecture collection objectives are addressing current and anticipated business needs of the enterprise and its customers and suppliers.

b) Architecting activities and decisions are aligned with enterprise and contextual concerns.

NOTE 1 Concerns can include organizational standards, policies, business priorities, relevant constraints and regulations.

c) Architecture decisions supported by rationale are made with appropriate authorities and communicated to stakeholders.

d) The various architectures within the architecture collection are consistent with, and in alignment to, the goals, objectives, strategy and vision of the organization responsible for the architecting effort.

e) The various architectures within the architecture collection are in alignment with each other as necessary.

f) Agreement of the purpose, objectives and goals for the architecture collection is maintained amongst the key stakeholders.

NOTE 2 Architecture governance outcomes are applicable across the organization while architecture management outcomes are applicable across the entire collection of architectures.

6.3 Implementation

The organization shall implement the activities in 6.4 (numbered as 6.4.N) in accordance with applicable organization policies and procedures with respect to the Architecture Governance process. The activities may be performed in any order that is deemed appropriate. The organization should implement the relevant tasks (identified as list items under each 6.4.N activity) as appropriate to the situation.

The organization should store organization policies and procedures to facilitate widespread access, enable auditing and encourage future reuse.

6.4 Activities and tasks

6.4.1 Prepare for and plan the architecture governance effort

a) Identify the set of architectures to be included in a single architecture collection that requires governance oversight.

b) Identify the set of existing architectures or reference architectures which may have direct applicability to the architecture collection and can be used as guiding oversight.

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c) Identify, define or establish architecture-related standards and policies driven by organizational policies, strategy and vision.

d) Establish roles, responsibilities, accountabilities, authorities and organizational structures to support the Architecture Governance process and reporting requirements and alignment with other relevant architectures.

e) Establish the architecture governance organizational structure that is consistent with the defined roles, authorities, responsibilities and accountabilities.

f) Establish guiding principles, policies and directives for performing architecture governance.

NOTE 1 These guiding principles, policies and directives delineate the procedures and work instructions to be performed by those who execute the governance activities. This is to ensure the governance directives are transparent and consistently followed. Sometimes a secretariat is used to administer these procedures and work instructions and to ensure they are properly followed.

g) Identify, define or establish architecture-related reusable elements from the set of existing architectures or reference architectures.

NOTE 2 These reusable elements can be governance directives, guiding principles, work instructions, governance organizational structure or procedures.

h) Identify knowledge assets (historical information, successful outcomes) that can aid in governance of the architecture collection.

i) Establish governance forums to carry out architecture governance work instructions in accordance with guiding principles.

j) Ensure responsibilities are appropriately assigned by utilizing a responsibility matrix.

k) Define procedures for identifying, managing, auditing and disseminating information related to architecture governance decisions.

1) Link these procedures to architecture collection strategies, policies and objectives.

2) Map these procedures to resources and constraints to support strategy, planning and decision making.

l) Plan the architecture governance effort using the Project Planning process in ISO/IEC/IEEE 15288 as a guide.

NOTE 3 ISO 21500 and ISO 21505 can be used as guidance for the planning effort.

1) Establish the scope of the architecture governance effort.

2) Establish metrics for the architecture governance effort.

NOTE 4 Annex B contains information about defining metrics for architecture processes. See B.2.1 for example metrics for architecture governance.

3) Identify the data and information needed for the architecture governance effort.

4) Obtain access to enablers needed for the architecture governance effort.

NOTE 5 The enablers can be obtained from the Architecture Enablement process. When enablers are obtained from other sources, these can become candidate enablers for use by other architecture efforts through the Architecture Enablement process.

EXAMPLE 1 Architecture governance enablers could be tools and methods that support accountability gap analysis, implementation gap analysis, objectives gap analysis and capacity gap analysis.

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5) Specify the work products and their outlines to be produced through performance of this process.

6) Identify and define architecture governance work elements and associated resources.

EXAMPLE 2 Architecture governance work elements could be policy documents, strategic objectives, vision, mission, values of the architecture governance board.

7) Develop architecture governance schedule and define associated milestones.

m) Produce an architecture governance plan that contains the planning information.

n) Obtain necessary approvals and funding for the plan.

o) Collect the data and information needed for the architecture governance effort.

6.4.2 Monitor, assess and control the architecture governance activities

a) Monitor and assess how changes to industry, governmental directives and guidance, and technological change could impact the architectures being governed.

NOTE 1 The evolution of disruptive technologies can impact the architectures being governed. E.g. Frequency Slice Processor as a new technology impacts the control system architectures.

b) Monitor and assess how changes to industry, government and technology could impact the governing directives and guidance.

c) Monitor and assess how changes to industry, government and technology regulations and policies could impact the governing directives and guidance.

d) Monitor and assess metrics for the architecture governance effort.

e) Identify and assess risks and opportunities associated with the architecture governance effort.

f) Ensure that other processes are properly using architecture governance directives and guidance.

NOTE 2 See C.1 for recommended interactions with system life cycle processes.

NOTE 3 See C.2 for recommended interactions with enterprise life cycle processes.

g) Report architecture governance activity plans and status in accordance with reporting requirements.

h) Assess and control the architecture governance effort using the Project Assessment and Control process in ISO/IEC/IEEE 15288 as a guide.

NOTE 4 ISO 21500 and ISO 21505 can be used as guidance for assessment and control.

i) Manage decisions about the architecture collection associated with architecture governance using the Decision Management process in ISO/IEC/IEEE 15288 as a guide.

NOTE 5 ISO 21505 can be used as guidance for strategic decision making.

j) Manage risks associated with architecture governance using the Risk Management process in ISO/IEC/IEEE 15288 as a guide.

NOTE 6 ISO 31000, ISO 21500 and ISO 21505 can be used as guidance for risk management.

k) Establish configuration control management mechanism to govern the changes in the architecture collection.

6.4.3 Establish architecture collection objectives

a) Examine current and future business needs.

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NOTE 1 This task is an examination of information that comes from the Business or Mission Analysis process in ISO/IEC/IEEE 15288.

1) Examine current and future enterprise objectives that shall be achieved, such as maintaining competitive advantage.

2) Examine and evaluate the current and future enterprise vision, including strategies, proposals and supply arrangements (whether internal, external, or both) in support of the enterprise objectives.

NOTE 2 The examination can consider the external or internal pressures acting upon the enterprise, such as business change, technological change, economic and social trends and political influences.

3) Examine specific objectives of the strategies and proposals that are being evaluated.

b) Examine current and future mission needs for those missions supported by the enterprise.

NOTE 3 This task is examination of information that comes from the Business or Mission Analysis process in ISO/IEC/IEEE 15288.

1) Examine current and future mission objectives that shall be achieved.

2) Examine and evaluate possible future use of entities being architected, including strategies, proposals and supply arrangements (whether internal, external or both) in support of the mission objectives.

NOTE 4 The examination can consider the external or internal pressures acting upon the enterprise, such as technological change, economic and social trends, and political influences.

3) Examine specific objectives of the strategies and proposals that are being evaluated.

c) Establish architecture strategy by making the relevant decisions about the architectures in the architecture collection.

1) Discover, develop, define and evaluate the overall goals of the architecture collection as a whole.

i) Identify work to be performed to achieve these goals.

ii) Create a configuration of resources which are necessary ingredients in meeting these goals.

iii) Establish means of measuring governance effectiveness.

2) Define architecture governance policies related to the architecture collection.

3) Define a set of governance principles that apply to the architecture collection.

4) Determine adherence to objectives based on governance compliance criteria and strategies.

5) Establish management criteria for control of architecture governance practices, dispensations and compliance.

d) Identify the architecture collection objectives to be pursued and desired levels of achievement for each.

e) Establish procedures to investigate and capture how the architecture collection objectives can be changed when necessary.

6.4.4 Make architecture governance decisions

a) Establish and issue governance direction in the form of directives and guidance for architectures in the architecture collection.

1) Develop and issue governance directive(s) that drive the appropriate evolution of architectures in the architecture collection.

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NOTE 1 Governance directives could be about specific architecture patterns, reference architectures, standards, frameworks, principles, tools, methods, etc. that would need to be applied to the architectures or used when architecting.

2) Implement a governance framework that supports this governance directive so as to define conceptual and organizational structures and provide a structured decision-making approach.

NOTE 2 The governance framework typically comprises a set of controls over the creation and monitoring of all architecture process components, work products and outcomes.

NOTE 3 Absolute control may not be possible in cases like: SOS situations, federated architectures, consortium-based architectures, public-private partnerships, etc.

3) Establish a decision-making mechanism that minimizes or avoids potential conflicts of interests with escalation in the organization if the problems cannot be properly addressed by architecture governance.

4) Develop and issue directives on mandated standards to be used during execution of architecture processes.

b) Assign responsibility for, and direct preparation and implementation of, directives, standards and policies that set the direction for architecting efforts.

c) Analyze architectural dependencies to exploit the associations amongst the architectures in the architecture collection.

NOTE 4 Dependencies could be capabilities, resources, services, reference architectures, assumptions, principles, vocabulary, ontologies and so on.

d) Make strategic decisions within the scope of architecture governance responsibilities and authorities using the Decision Management process in ISO/IEC/IEEE 15288 as a guide.

NOTE 5 ISO 21505 can be used as guidance for strategic decision making.

e) Elevate other decisions to the appropriate enterprise decision forum.

f) Review and communicate the decisions.

6.4.5 Monitor and assess compliance with governance directives and guidance

a) Monitor the governance of the architecture collection by utilizing appropriate means.

NOTE 1 In order to see how well the architectures are helping to achieve the enterprise goals and objectives, architecture governance can monitor metrics from the development and use of actual entities based on the architecture.

NOTE 2 A dashboard is a common way of doing this.

b) Ensure that the architectures comply with external obligations and internal work practices.

NOTE 3 External obligations can vary between countries where the instances of architecture entity and its life cycle activities can occur.

c) Monitor management plans and status and assess compliance with governance directives and guidance for the architecture collection.

d) Allow the appropriate authority to access directly an entity constructed according to a design based upon an architecture description for an architecture to verify that it conforms to obligations established by governance directives.

NOTE 4 This access is to enable verification that a system, an enterprise, a software item, a service or other kind of architecture entity conforms to obligations established by governance directives. Merely checking the architecture for conformance could be insufficient since the architectural features could lack proper translation into design or operation of the entity.

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e) Check compliance with external obligations to be applied and standards that affect architecture governance.

6.4.6 Review implementation of governance directives and guidance

This activity includes the tasks necessary for closing out one iteration of the architecture governance endeavor by the organization driving the endeavor.

a) Review all information to assert that the architecture governance work is complete and that the architecture collection objectives have been met.

b) Establish procedures to capture, investigate and resolve the various reasons for non-implementation of governance directives and guidance.

NOTE Document and retain the investigation and the rationale to support later reviews. Resolutions may require modification of the directives and guidance.

c) Collect lessons learned regarding architecture governance as reported from the other architecture processes and make these lessons available to future projects.

d) Record lessons learned and communicate to all relevant stakeholders.

1) Contribute to best practices for architecture governance.

2) Scrutinize effectiveness of governance directives and guidance.

e) Examine the effectiveness of the governance policies and initiate steps to revise the policies as necessary.

f) Identify and select the changes to be made to the architecture governance directives and guidance.

g) Incorporate the changes into the architecture governance directives and guidance.

6.5 Work products

The following work products shall be produced:

— architecture governance plan,

— architecture governance directives and guidance,

— architecture governance compliance status report, and

— architecture collection objectives.

7 Architecture Management process

7.1 Purpose

The purpose of the Architecture Management process is to implement architecture governance directives to achieve architecture collection objectives in a timely, efficient and effective manner.

NOTE See Annex G for additional information regarding architecture governance and management, and the distinction between these related but separate processes.

7.2 Outcomes

As a result of the successful implementation of the Architecture Management process:

a) Architecting activities are in alignment with architecture governance directives and guidance.

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b) Architecting activities are identified and prioritized, maximizing value to relevant stakeholders given available resources.

c) Inputs, including stakeholder inputs, and resources for architecting are identified, made available and utilized effectively.

d) Architecture collection objectives are monitored and assessed for achievement.

NOTE Architecture governance outcomes are applicable across the organization while architecture management outcomes are applicable across the entire collection of architectures.

7.3 Implementation

The organization shall implement the activities in 7.4 (numbered as 7.4.N) in accordance with applicable organization policies and procedures with respect to the Architecture Management process. The activities may be performed in any order that is deemed appropriate. The organization should implement the relevant tasks (identified as list items under each 7.4.N activity) as appropriate to the situation.

Architecture management work products should be stored in the architecture repository for future reference and audit. The repository should be used to facilitate widespread access, enable auditing and encourage future reuse.

7.4 Activities and tasks

7.4.1 Prepare for and plan the architecture management effort

a) Identify and categorize architectures into an architecture collection based on their relevance, respective purpose and scope, time validity and alignment with each other.

b) Identify architectures, used and to be worked, in the architecture collection that require architecture management oversight.

c) Develop a charter for management of the architecture collection.

NOTE 1 ISO 21500 and ISO 21505 can be used as guidance for developing the charter.

1) Identify organizational assets (people, resources, processes) that influence management of the architecture collection.

2) Identify knowledge assets (historical information, issues and defect resolutions, successful outcomes) that can aid in management of the architecture collection.

3) Identify internal and external factors and criteria that influence management of the architecture collection.

4) Identify in-scope and out-of-scope items that influence management of the architecture collection.

5) Identify skill gap of people involved in architecture management and establish training and improvement plans to address the gap.

6) Develop a statement of work in alignment with the charter for management of the architecture collection.

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7) Define measurable architecture management objectives and related success criteria for the architecture collection.

d) Develop the architecture management organizational structure.

1) Identify the necessary managerial roles, responsibilities and authorities that are concerned with or involved in architecture management.

2) Define an architecture management control hierarchy corresponding to the identified roles and responsibilities.

3) Ensure proper delegation of management responsibilities in the architecture management control hierarchy.

4) Ensure proper allocation of roles to identified role players in the architecture management hierarchy.

e) Plan the effort for managing the architecture collection using the Project Planning process in ISO/IEC/IEEE 15288 as a guide.

NOTE 2 ISO 21500 and ISO 21505 can be used as guidance for planning of the management effort.

1) Establish the scope of the architecture management effort.

2) Identify metrics and metrics data collection strategy for the architecture management effort.

NOTE 3 Annex B contains information about defining metrics for architecture processes. See B.2.2 for information on architecture metrics.

3) Collect the data and information needed for the architecture management effort.

4) Obtain access to enablers needed for the architecture management effort.

NOTE 4 The enablers will usually be obtained from the Architecture Enablement process. When enablers are obtained from other sources, these can become candidate enablers for use by other projects through the Architecture Enablement process.

EXAMPLE 1 Architecture management enablers could be tools, methods and procedures for scheduling, budgeting, and cost analysis.

5) Specify the work products and their outlines to be produced through performance of this process.

6) Identify and define architecture management work elements and associated resources.

EXAMPLE 2 Architecture management work elements could be work breakdown structure, risk breakdown structure.

7) Develop architecture management schedule and define associated milestones.

8) Produce an architecture management plan that contains the planning information.

9) Obtain necessary approvals and funding for the architecture management plan.

7.4.2 Monitor, assess and control the architecture management activities

a) Report architecture management activity plans and status.

b) Monitor and assess whether architecture governance directives and guidance are being followed.

c) Monitor and assess metrics for the architecture management effort.

d) Identify and assess risks and opportunities associated with the architecture management effort.

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e) Ensure that other processes are properly using architecture management work instructions.

NOTE 1 See C.1 for recommended interactions with system life cycle processes.

NOTE 2 See C.2 for recommended interactions with enterprise life cycle processes.

f) Report architecture management activity plans and status in accordance with reporting requirements.

g) Assess and control the architecture management effort using the Project Assessment and Control process in ISO/IEC/IEEE 15288 as a guide.

NOTE 3 ISO 21500 and ISO 21505 can be used as guidance for assessment and control.

h) Manage decisions about the architecture collection associated with architecture management using the Decision Management process in ISO/IEC/IEEE 15288 as a guide.

NOTE 4 ISO 21505 can be used as guidance for strategic decision making.

i) Manage risks associated with architecture management using the Risk Management process in ISO/IEC/IEEE 15288 as a guide.

NOTE 5 ISO 31000, ISO 21500 and ISO 21505 can be used as guidance for risk management.

7.4.3 Develop architecture management approach

a) Identify architecture management approaches, constraints, methods, tools and techniques according to architecture governance policies, directives and guidance.

NOTE 1 Management by objectives, management by measurement and management by policies are examples of management approaches.

NOTE 2 Annex H provides information on mapping of processes to architecture frameworks. TOGAF, DoDAF and NAF are examples of architecture frameworks that contain architecture management methods.

b) Develop architecture management plans in accordance with governance directions for the architecture collection.

1) Identify architecture collection requirements and other concerns.

2) Define architecture management scope statement (scope description, acceptance criteria, architecture deliverables, exclusions, constraints, assumptions).

3) Establish specific architecture management goals that address the architecture collection objectives and specify the reasons for their sufficiency.

4) Prioritize the goals in terms of their importance in achieving architecture collection objectives.

5) Create a work definition that provides a common framework for the overall planning and control of the architecture collection.

6) Establish the resources necessary for performing the architecture management work elements and assign responsibility and authority to the management hierarchy.

7) Define management measures that allow assessment of compliance with the architecture management goals.

c) Ensure the architecture collection is established and maintained in accordance with the relevant architecture management plans.

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d) Develop the architecture management schedule in accordance with the architecture management plan(s).

   1) Develop the schedule for the activities identified in the work definition and define precise and measurable milestones.

   2) Define the activities, their dependencies and resources necessary for creating and managing the architecture collection.

   3) Estimate the duration of each of the activities and include them as part of the schedule.

e) Develop a budget and associated justification to manage the architecture collection.

f) Secure adequate types and quantities of funding and resources to properly implement the planned architecture activities.

   NOTE 3 If it is not within the remit of the Architecture Management process to provide funding and resources for the planned architecture activities, then this process could champion these needs to the organizational entity that can.

g) Adapt the architecture management plan using an agile approach according to new information.

   1) Adjust management activities, schedule, directions and goals in response to new information.

   2) Prepare adaptive management actions that respond to new problems or opportunities.

   3) Apply new knowledge, insights and technologies that contribute to achieving architecture management objectives.

7.4.4 Perform management of the architecture collection

Architecture management is about management of the architecture collection.

NOTE 1 Often, it is necessary to manage individual architectures in the architecture collection and could require individual directions and additional tasks to specific architecture endeavors.

a) Establish and issue management direction in the form of documented instructions and guidance for the architecture collection.

b) Establish and issue management instructions and guidance on mandated standards and policies to be used during execution of architecture processes.

c) Assign resources to all the identified roles in accordance with the sequence of tasks that needs to be performed.

d) Activate the necessary tracking systems which can capture work performance information and use it to control architecture development.

e) Perform the tasks defined in the architecture collection management plan to achieve the architecture collection objectives.

f) Assess architecture management measures, work performance information, resource utilization, probable risks and new opportunities and manage changes to improve work performance.

g) Provide relevant information to all stakeholders as outlined in the architecture management plan.

h) Periodically confirm that work performance results conform to the architecture collection requirements including deviations and dispensations.

   NOTE 2 An appropriate periodicity of confirmation can be inversely proportional to the magnitude of effort involved in performing the tasks outlined in the architecture management plan.

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i) Set strategic directions for architectures in the architecture collection that addresses policy decisions.

j) Establish individual plans for the development or revision of architectures in the architecture collection.

k) Manage decisions about the architectures in the architecture collection using the Decision Management process in ISO/IEC/IEEE 15288 as a guide.

NOTE 3 ISO 21505 can be used as guidance for strategic decision making

l) Manage risks associated with architecture management using the Risk Management process in ISO/IEC/IEEE 15288 as a guide.

NOTE 4 ISO 31000, ISO 21500 and ISO 21505 can be used as guidance for risk management.

m) Manage changes to the architectures using the Configuration Management process in ISO/IEC/IEEE 15288 as a guide.

7.4.5 Monitor architecting effectiveness

a) Monitor and control work performance by tracking, reviewing and regulating the progress to meet the management objectives based on the architecture management plan.

1) Monitor work performance to identify variances from the architecture management plan.

2) Monitor management issues and recommend preventive action in anticipation of possible problems.

3) Monitor status reports and recommend corrective action when necessary.

4) Monitor management plan execution progress against the schedule estimates.

5) Monitor health of the architecture collection using the identified management measures and identify any areas that require additional attention.

6) Monitor the status of the architecture collection scope and manage changes to the scope baseline.

7) Monitor the status of the architecture collection schedule and manage changes to the schedule baseline.

b) Monitor effectiveness of the architecture management effort.

NOTE 1 Plan, schedule, budget, approach, outcome and performance are typical monitored elements.

c) Assess actual outcomes against planned targets and make corrective actions when necessary.

d) Collect and communicate performance information to all relevant stakeholders at periodic intervals.

1) Maintain accurate and timely information concerning the architecture collection.

2) Assess whether the architecture management objectives are being reached.

3) Provide forecasts to update current schedule information.

e) Define quality assurance actions and audits that confirm execution of the architecture management plans using the Quality Assurance process in ISO/IEC/IEEE 15288 as a guide.

f) Report architecture management activity plans and status in accordance with reporting requirements.

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g) Maintain a list of known needs and gaps and periodically perform analysis and prioritization to select architecture activities to be performed.

h) Assess and control the architecture management effort in accordance with the Project Assessment and Control process in ISO/IEC/IEEE 15288.

NOTE 2 ISO 21500 and ISO 21505 can be used as guidance for assessment and control.

7.4.6 Prepare for completion of the architecture management plan

This activity includes the tasks necessary for closing out one iteration of the architecture management endeavor.

NOTE This could be because the architecture life-cycle has come to a closure and a new architecture is planned to be taken up.

a) Close execution of the architecture management plan when appropriate.

b) Review all information to determine whether any mid-stream changes are necessary and incorporate the changes into the architecture management plan, schedule, budget and the management approach.

c) Review all information to determine whether the architecture management work is complete and the architecture collection objectives have been met, so that architecture management changes may be closed, or there are significant gaps that necessitate and drive changes to the architecture management plan, schedule, budget and approach.

d) Assess metrics for the architecture management effort.

e) Check compliance with standards that affect the architectures in the architecture collection.

f) Establish procedures to investigate and capture the various reasons for management actions taken as part of architecture management.

g) Record lessons learned and communicate to all relevant stakeholders.

1) Contribute to best practices for architecture management.

2) Scrutinize effectiveness of management approaches that were adopted in order to address the architecture management problem.

h) Identify changes to be made to the architecture management plan, schedule, budget and the management approach.

i) Select the changes to be made in the next iteration of the architecture management plan, schedule, budget and the management approach.

j) Analyze the impact of the selected changes on the architecture management plan, schedule, budget and the management approach and adapt accordingly.

k) Incorporate the changes into the architecture management plan, schedule, budget and the management approach.

7.5 Work products

The following work products shall be produced:

— architecture management plan,

— architecture management status report,

— architecture management work instructions and guidance,

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