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

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

stds.ipr@ieee.org
www.ieee.org

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Foreword

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

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

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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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Introduction

The complexity of human-made systems has grown to an unprecedented level. This complexity leads to new opportunities and greater challenges for organizations that conceive, develop, industrialize, produce, maintain, utilize, recycle and dismantle enterprises, systems and software, and for various stakeholders that are impacted by these things. To address these opportunities and challenges, organizations increasingly apply concepts, principles, procedures and tools to drive better architecture strategies, make better architecture-related decisions, create more useful and effective architectures and improve architecture maturity. Architecture-related activities are not only strategic in nature; they are tactical and operational as well. Furthermore, the use of architecture frameworks, architecture description languages and generalist modeling languages have become common practice in commercial, public service, government, civil and military domains.

The concept of architecture used in this document goes beyond the case where the architecture entity is a system. Architecture is increasingly being applied to things not normally thought of as systems, including entities with system-like structure and behavior such as enterprises, services, data, business functions, mission areas, product lines, families of systems, software items, etc. This allows for a more generalized usage of the concept of architecture when the evaluation elements specified in this document are applied.

Architecture evaluations are performed for many reasons, such as:

a) determining if an entity of interest has been or is being architected in such a way that it fulfils its intended purpose (or can be changed in a way that suits a new purpose);

b) evaluating the effectiveness and suitability of an architecture towards addressing stakeholder needs and expectations;

c) identifying risks for mitigation;

d) identifying opportunities for the improvement of an entity or its architecture;

e) clarifying the problem space and stakeholder needs; and

f) assessing progress towards meeting architecture objectives.

Architecture evaluations can be performed on any kind of architecture, including a reference architecture, an architecture for a family of systems or an architecture for a product line where there are multiple kinds of architecture entities for a single architecture.

This document provides a generic, conceptual guiding framework that can be used for the planning, execution and documentation of architecture evaluations. Execution is addressed by specification of evaluation elements that can be used during performance of an evaluation effort. Planning and documentation are addressed by specification of work products for the evaluation effort. An organization using this document can establish specific frameworks for the work products and the evaluation elements that can be used as the basis for multiple, recurring architecture evaluation efforts. An organization can also establish tools, methods, best practices, capabilities and resources based on the generic framework provided in this document. The generic framework makes it easier to compare evaluations and evaluation frameworks used in specific cases. Implementation of the proposed architecture framework will in time result in improvement of architecture maturity of the organization.

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Software, systems and enterprise — Architecture evaluation framework

1 Scope

This document specifies the means to organize and record architecture evaluations for enterprise, systems and software fields of application.

The aim of this document is to enable architecture evaluations that are used to:

a) validate that architectures address the concerns of stakeholders;

b) assess the quality of architectures with respect to their intended purpose;

c) assess the value of architectures to their stakeholders;

d) determine whether architecture entities address their intended purpose;

e) provide knowledge and information about architecture entities;

f) assess progress towards achieving architecture objectives;

g) clarify understanding of problem space and of stakeholder needs and expectations;

h) identify risks and opportunities associated with architectures; and

i) support decision making where architectures are involved.

NOTE This document addresses the evaluation of an architecture and not an evaluation of the architecture description's suitability. Matters concerning the evaluation of the architecture description fall within the scope of the architecture conceptualization and architecture elaboration processes as defined in ISO/IEC/IEEE 42020. However, it is sometimes the case that the architecture description is evaluated concurrently with the evaluation of the architecture itself.

The entity being evaluated can be of several kinds, as illustrated in the following examples: enterprise, organization, 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, etc. The kind of entity can also be a 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.

The generic Architecture Evaluation (AE) framework specified in this document can be used in support of the Architecture Evaluation process defined in ISO/IEC/IEEE 42020. Specific frameworks can be derived from this generic framework, which can provide a mapping to the system life cycle processes in ISO/IEC/IEEE 15288 or to the software life cycle processes in ISO/IEC/IEEE 12207.

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.

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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[1)].

3.1
architecture
fundamental concepts or properties of an entity in its *environment* (3.7) and governing principles for the realization and evolution of this entity and its related life cycle processes

Note 1 to entry: *Architecture entity* (3.3) 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, organization, 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.

Note 5 to entry: Architectures can address a wide range of *concerns* (3.6) expressed, for example, through architecture views 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.

[SOURCE: ISO/IEC/IEEE 42020:2019, 3.3]

3.2
architecture description
work product used to express an *architecture* (3.1)

Note 1 to entry: This document does not require the existence or use of an architecture description when performing an *architecture evaluation* (3.4). Some *value* (3.10) assessment methods do not demand existence of documented architecture models or views. Examples are customer focus group, expert panels and quality workshops where sufficient knowledge of the architecture is in the people participating in use of these methods. The same is true for architectural analysis in that not all methods applied here necessarily need an explicit description of the architecture.

[SOURCE: ISO/IEC/IEEE 42010:2011, 3.3, modified — The abbreviated term "AD" has been removed; Note 1 to entry has been added.]

1) *System and software engineering — Vocabulary*, available at www.computer.org/sevocab.

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3.3
architecture entity
thing being characterized by an *architecture* (3.1)

EXAMPLE The following are kinds of architecture entities that can be dealt with by the architecture processes: 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, 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.

[SOURCE: ISO/IEC/IEEE 42020:2019, 3.6, modified — The words "considered, described, discussed, studied, or otherwise addressed during the architecting effort" have been replaced with "characterized by an architecture".]

3.4
architecture evaluation
AE
judgment about one or more *architectures* (3.1) with respect to the specified evaluation objectives

EXAMPLE 1 Various kinds of judgments could be made during an architecture evaluation, such as validating that architectures address the *concerns* (3.6) of *stakeholders* (3.9), assessing the quality of architectures with respect to their intended purpose, assessing the *value* (3.10) of architectures or architecture entities to their stakeholders, determining whether architecture entities address their intended purpose, providing knowledge and information about architecture entities and identifying risks and opportunities associated with architectures.

EXAMPLE 2 Examples of architecture evaluations are provided in Annex C.

Note 1 to entry: A decision regarding disposition of the architecture is usually outside the scope of an AE effort, although it could be done in conjunction with the AE effort. The AE results are often reported to a decision maker who makes the actual determination of disposition based on those results and sometimes also on other *factors* (3.8) not considered by the AE effort. Sometimes this determination is called an "evaluation" but for the purpose of this document, the evaluation is limited to just the judgment with respect to relevant evaluation objectives.

3.5
architecture evaluation framework
conventions, principles and practices for evaluating *architectures* (3.1) in a consistent and repeatable manner

EXAMPLE Examples of AE frameworks are provided in Annex D for the following cases: Architecture Tradeoff Analysis Method (ATAM), the Method Framework and QUASAR method and Analysis of Alternatives (AoA).

Note 1 to entry: This framework can be generic in nature or specific to a domain of application, a collection of *concerns* (3.6) to be examined or a methodology. This document defines a generic AE framework and a specific AE framework can be derived from the generic framework.

Note 2 to entry: An AE framework can enable AE efforts to be performed in a more consistent and repeatable manner.

Note 3 to entry: The evaluation framework can consist of different sub-architecture frameworks for an entity with many layers or levels. These could be defined and consolidated as part of the comprehensive architecture framework package.

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3.6
concern
matter of interest or importance to a *stakeholder* (3.9)

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 other possible areas of concern: political, economic, social, technological, environmental, and legal. A longer list of examples is provided in 4.2.

Note 1 to entry: The concept of concern is similar to "quality attributes" as used in the ATAM. See Annex D for an overview of the ATAM approach. In ATAM, quality attributes are typically decomposed into concerns.

Note 2 to entry: The concept of concern is similar to the concept of quality. See A.4 for an overview of the quality concept.

[SOURCE: ISO/IEC/IEEE 42020:2019, 3.8, modified — In EXAMPLE, reference to 4.2 has been added; Notes 1 and 2 to entry have been added.]

3.7
environment
context determining the setting and circumstances of influences upon an *architecture entity* (3.3) or upon which the architecture entity can have an influence

Note 1 to entry: There can be things beyond the environment that have an indirect impact on the architecture entity. It could be important to account for these indirect effects by incorporating these causative agents in the environment even though they are not usually considered to be within the immediate context. *Value* (3.10) chain analysis is an example of where this is done.

3.8
factor
circumstance, fact or influence that contributes to a result or outcome

Note 1 to entry: A factor is something that contributes causally to a result. Factors identification can sometimes be driven by knowledge of desired effects.

3.9
stakeholder
role, position, individual or organization having a right, share, claim or other interest in an *architecture entity* (3.3) or its *architecture* (3.1) that reflects their needs and expectations

[SOURCE: ISO/IEC/IEEE 42020:2019, 3.20]

3.10
value
regard that something is held to deserve; the importance, worth, or usefulness of something to somebody

Note 1 to entry: *Architecture evaluation* (3.4) is focused primarily on the value of an *architecture* (3.1) with respect to *stakeholder* (3.9) *concerns* (3.6) or architecture objectives for that thing. However, sometimes the purpose of the evaluation effort is, by inference, to determine the impact of the architecture on the value of the *architecture entity* (3.3) when the entity is developed or evolved to align with the architecture concepts and properties.

Note 2 to entry: The determination of architecture value can take various aspects into account, such as worth, significance, importance, usefulness, benefit, and quality. These words have similar but not identical meaning. Worth is usually what one is willing to pay for something. Significance is about being worthy of attention. Importance is about the state or fact of being of great significance or value. Usefulness is about serving some purpose, or about being advantageous, helpful or of good effect. Benefit is about an advantage or profit gained from something. Quality is about the degree of excellence of something. Throughout this document, the term value is used to mean one or more of these other concepts, as appropriate.

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