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Systems and software engineering — Life cycle profiles for very small entities (VSEs) —

Part 7-1: Space software engineering guidelines

Ingénierie des systèmes et du logiciel — Profils de cycle de vie pour très petits organismes (TPO) —

Partie 7-1: Lignes directrices relatives à l'ingénierie logicielle spatiale

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Foreword

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

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

A list of all parts in the ISO/IEC 29110 series can be found on the ISO and IEC websites.

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 and www.iec.ch/national-committees.

Introduction

0.1 Introduction to the ISO/IEC 29110 series

Very small entities (VSEs) around the world are creating valuable products and services. For the purpose of the ISO/IEC 29110 series, a VSE is an enterprise, organization (e.g. government agency, non-profit organization), department or project having up to 25 people. Many VSEs develop and/or maintain systems and software components used in those systems, either as independent products or incorporated in the larger systems. Due to this a recognition of VSEs as suppliers of high-quality products is required.

According to the Organisation for Economic Co-operation and Development (OECD) SME and Entrepreneurship Outlook report (2019) “Small and medium-sized enterprises (SMEs) and entrepreneurship are essential drivers of economic and social well-being. Representing 99 % of all businesses, generating about 60 % of employment and totalling between 50 % and 60 % of value added in the OECD area. Almost one person out of three is employed in a micro firm with less than 10 employees”. The challenge facing OECD governments is to provide a business environment that supports the competitiveness of this large heterogeneous business population and that promotes a vibrant entrepreneurial culture.

From studies and surveys conducted, it is clear that the majority of International Standards do not address the needs of VSEs. Implementation of and conformance with these standards is difficult, if not impossible.

Consequently, VSEs have no, or very limited, ways to be recognized as entities that produce quality systems/system elements including software in their domain. Therefore, VSEs are excluded from some economic activities.

It has been found that VSEs find it difficult to relate International Standards to their business needs and to justify the effort required to apply standards to their business practices. Most VSEs can neither afford the resources, in terms of number of employees, expertise, budget and time, nor do they see a net benefit in establishing over-complex systems or software life cycle processes. To address some of these difficulties, a set of guidelines has been developed based on a set of VSE characteristics. The guidelines are based on subsets of appropriate standards processes, activities, tasks, and outcomes, referred to as Profiles. The purpose of a profile is to define a subset of International Standards relevant to the VSEs' context; for example, processes, activities, tasks, and outcomes of ISO/IEC/IEEE 12207 for software; and processes, activities, tasks, and outcomes of ISO/IEC/IEEE 15288 for systems; and information products (documentation) of ISO/IEC/IEEE 15289 for software and systems.

VSEs can achieve recognition through implementing a profile and by being audited against ISO/IEC 29110 specifications.

The ISO/IEC 29110 series can be applied at any phase of system or software development within a life cycle. The ISO/IEC 29110 series is intended to be used by VSEs that do not have experience or expertise in adapting/tailoring ISO/IEC/IEEE 12207 or ISO/IEC/IEEE 15288 standards to the needs of a specific project. VSEs that have expertise in adapting/tailoring ISO/IEC/IEEE 12207 or ISO/IEC/IEEE 15288 are encouraged to use those standards instead of the ISO/IEC 29110 series.

The ISO/IEC 29110 series is intended to be used with any life cycle, such as waterfall, iterative, incremental, evolutionary or agile.

Systems, in the context of the ISO/IEC 29110 series, are typically composed of hardware and software components.

The ISO/IEC 29110 series, targeted by audience, has been developed to improve system or software and/or service quality, and process performance. Figure 1 describes the ISO/IEC 29110 series and positions the parts within the framework of reference.

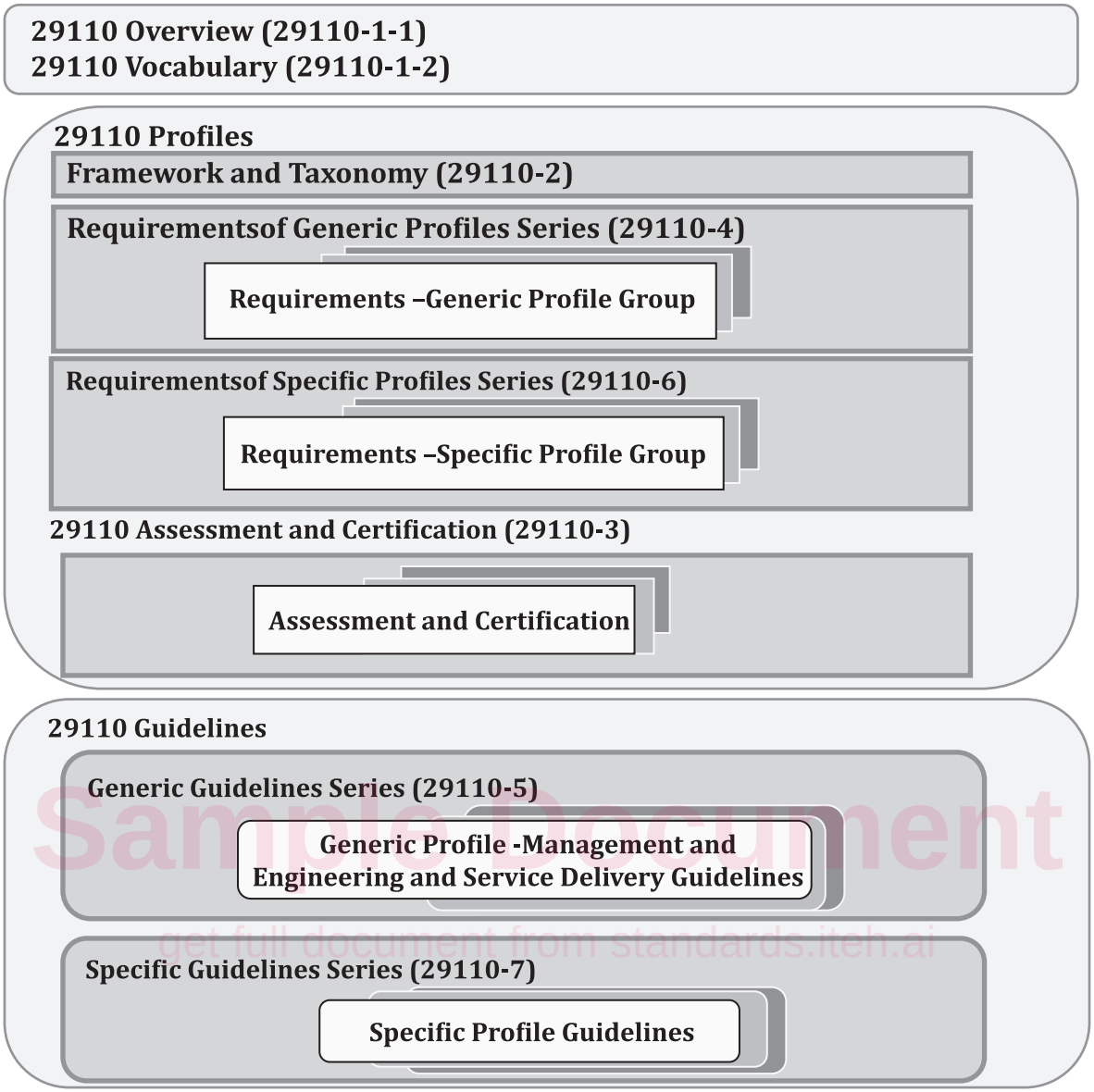

Figure 1 — ISO/IEC 29110 series

If a new profile is needed, ISO/IEC 29110-4 or ISO/IEC 29110-6 and or ISO/IEC 29110-7, ISO/IEC 29110-5 can be developed with minimal impact to existing documents.

ISO/IEC 29110-1-1 introduces processes, life cycle and standardization concepts, the taxonomy (catalogue) of ISO/IEC 29110 profiles and the ISO/IEC 29110 series. ISO/IEC 29110-1-1 also introduces the characteristics and needs of a VSE, and clarifies the rationale for specific profiles, documents, standards and guidelines. ISO/IEC 29110-1-2 defines the terms common to the ISO/IEC 29110 series.

ISO/IEC 29110-2 introduces the concepts for systems and software engineering profiles for VSEs. It establishes the logic behind the definition and application of profiles. For standardized profiles, it specifies the elements common to all profiles (structure, requirements, conformance, assessment). For domain-specific profiles (profiles that are not standardized and developed outside of the ISO process), it provides general guidance adapted from the definition of standardized profiles.

ISO/IEC 29110-3 defines certification schemes, assessment guidelines and compliance requirements for process capability assessment, conformity assessments, and self-assessments for process improvements. ISO/IEC 29110-3 also contains information that can be useful to developers of certification and assessment methods and developers of certification and assessment tools. ISO/IEC 29110-3 is addressed to people who have direct involvement with the assessment process, for example, the auditor, certification and

accreditation bodies and the sponsor of the audit, who need guidance on ensuring that the requirements for performing an audit have been met.

ISO/IEC 29110-4 provides the specifications for all generic profiles of the generic profile group that are based on subsets of appropriate standards elements.

ISO/IEC 29110-5 provides a management, engineering and service delivery guidelines for profiles of the generic profile group.

ISO/IEC 29110-6 provides the specifications for specific profiles that are based on subsets of appropriate standards elements.

ISO/IEC 29110-7 provides a guideline for each profile of the specific profile group.

0.2 Introduction to this document

Industry and large organisations recognize the value of VSEs, i.e. enterprises, organisations (e.g. government agency, non-profit organisation), projects or departments with up to 25 people, in contributing with emerging new technology that bigger organisations cannot use them as easily nor incorporate them in their solutions as fast.

But often these VSEs are not ready to comply with the stringent requirements for space projects. The purpose of this document is to ultimately achieve the process capacity to participate in the development of critical software in the space domain. But not all software in the space domain can be addressed. For example, for software embedded in products that can be fatal to human life, additional safeguards will be required.

VSE in space domain can demonstrate the quality in their processes in a stepwise approach to eventually participate in space projects in a faster and feasible way.

The mainstream of space projects so far has been large rockets and artificial satellites developed by government agencies and large organizations. Inevitably, the development process applied in space projects was rigorous and extensive. In recent years, these traditional space development trends have changed. Development of small artificial satellites and system development, in which multiple small artificial satellites called “satellite constellation” are linked and collaborate, is being actively considered by small companies from around the world.

Many start-ups have entered the development of these small space systems and are enlivening the industry. In short, many VSEs are entering the space industry. However, in many cases, these VSEs are not ready to comply with the development requirements of space projects. These challenges involve discipline and more rigorous processes than for non-critical systems. Although the processes involved in software engineering are extremely important in the space sector, there are not many space-related standards focused on VSE.

In many cases, VSEs refer to space agency standards and implement processes that are not appropriate for their scale and risk.

VSEs in the space domain, i.e. space-VSEs, can demonstrate the quality of software processes expected by the space domain in the risk-based approach to participate in space projects.

This document provides management and engineering guidelines for the specific space profiles.

This document presents an Intermediate space profile (Clause 6) and an Advanced space profile (Clause 7). To use this document, it is presupposed that the VSE has already implemented the software Basic profile guidelines (i.e. ISO/IEC 29110-5-1-2). The correspondence between the four-stage roadmap of the generic profile guidelines and the space profile guidelines is shown in Table 1.

Table 1 — Correspondence between ISO/IEC 29110 guidelines

ISO/IEC 29110-5-1		ISO/IEC 29110-7-1
VSE generic profiles guidelines	Title of profile	Title of profile
ISO/IEC 29110-5-1-1	Entry profile	Not applicable
ISO/IEC 29110-5-1-2	Basic profile	Basic profile
ISO/IEC 29110-5-1-3	Intermediate profile	Intermediate space profile
ISO/IEC 29110-5-1-4	Advanced profile	Advanced space profile

The processes in this document are contained in Clauses 6, 7, 8 and 9. It is recognised that specific projects or organizations may not need to use all the processes provided by this document. Therefore, implementation of this document typically involves selecting a set of processes suitable to the organization or project and will so be reflected in the project plan of each project.

Using this document, a VSE can obtain the following benefits:

Basic profile:

— the Basic profile is the starting point for space-VSE. This profile is identical to that in ISO/IEC 29110-5-1-2; it is not included in this document;

— refer to ISO/IEC 29110-5-1-2 for the benefits of the Basic profile.

Intermediate space profile:

— an agreed set of project requirements and expected work products is delivered to the customers;

— a disciplined management process that provides project visibility and corrective actions of project problems and deviations is performed;

— managing and controlling project work products;

— ensuring that project problems are identified and resolved;

— ensuring that work products and processes are aligned with the project discipline.

Advanced space profile:

— ensuring that safety and/or dependability concepts and related requirements are obtained;

— a safety and dependability related process that achieve safety and dependability requirements of product is performed;

— strengthening non-testing verification activities.

The users of this document select the processes to be deployed and map them onto the specific project life cycle model. The parties are also responsible for selecting and applying the software development methods and for performing the activities and tasks suitable for the software project.

Systems and software engineering — Life cycle profiles for very small entities (VSEs) —

Part 7-1: Space software engineering guidelines

1 Scope

This document provides guidelines for the implementation of the specific space profiles for VSEs through a set of development processes.

This document is applicable to small suppliers, developers, managers and quality assurance managers of software products in the space domain.

The document can also be applied by a single party through a self-imposed set of processes.

This document does not prescribe a specific system or software life cycle model, development methodology, model or technique.

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 and IEC maintain terminology databases for use in standardization at the following addresses:

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

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

3.1
Advanced profile
profile (3.12) targeted at VSEs which want to sustain and grow as an independent competitive system and/or *software* (3.19) development business

[SOURCE: ISO/IEC 29110-2-1:2015, 4.3]

3.2
Advanced space profile
profile (3.12) that provides safety and *dependability* (3.8) related processes to achieve safety-related requirements of *software* (3.19)

3.3
agreement
mutual acknowledgement of terms and conditions under which a working relationship is conducted

EXAMPLE Contract, memorandum of agreement.

[SOURCE: ISO/IEC/IEEE 12207:2017, 3.1.5]

3.4
baseline
formally approved version of a configuration item, regardless of media, formally designated and fixed at a specific time during the configuration item's life cycle

[SOURCE: ISO/IEC/IEEE 12207:2017, 3.1.11]

3.5
Basic profile
profile (3.12) targeted at VSEs developing a single product by a single work team

[SOURCE: ISO/IEC 29110-1-2:2015, 4.11]

3.6
conditional task
task that can be mandatory under some specified condition(s), can be optional under other specified conditions, and can be out of scope or not applicable under other specified conditions

Note 1 to entry: These shall be observed if the specified condition(s) apply.

[SOURCE: ISO/IEC 29110-1-2:2024, 3.28]

3.7
defect
imperfection or deficiency in a work product where that work product does not meet its requirements or specifications and needs to be either repaired or replaced

[SOURCE: ISO/IEC 23531:2020, 3.1]

3.8
dependability
ability of a system to perform as and when required

Note 1 to entry: Dependability includes availability, *reliability* (3.16), resilience, maintainability, and in some cases, other characteristics such as durability, safety and security. Dependability is used as a collective term for the time-related quality characteristics of an item.

[SOURCE: IEEE 7000:2021, modified — Note 1 to entry has been added.]

3.9
generic profile group
profile (3.12) group applicable to VSEs (very small entities) that do not develop critical systems or critical *software* (3.19) and have typical situational factors

[SOURCE: ISO/IEC 29110-1-2:2024, 3.45]

3.10
integration test
progressive linking and testing of programs or modules in order to ensure their proper functioning in the complete system

[SOURCE: ISO/IEC/IEEE 24765:2017, 3.2033]

3.11
Intermediate space profile
profile (3.12) that provides disciplined management processes for *project* (3.13) visibility and corrective actions to the project problems

Note 1 to entry: Technical support processes are being strengthened to meet the high-quality and *reliability* (3.16) demands of the space domain.

3.12
profile
subset of appropriate standards' processes and their outcomes, activities and tasks combined to accomplish a particular function

[SOURCE: ISO/IEC 29110-1-2:2024, 3.70]

3.13
project
endeavour with defined start and finish dates undertaken to create a product or service in accordance with specified resources and requirements

Note 1 to entry: A project is sometimes viewed as a unique process comprising coordinated and controlled activities and composed of activities from the technical management processes and technical processes defined in this document.

[SOURCE: ISO/IEC/IEEE 12207:2017, 3.1.37]

3.14
quality assurance
part of quality management focused on providing confidence that quality requirements will be fulfilled

[SOURCE: ISO 9000:2015, 3.3.6]

3.15
regression testing
testing performed following modifications to a test item or to its operational environment, to identify whether failures in unmodified parts of the test item occur

Note 1 to entry: Regression testing differs from retesting in that it does not test that the modification works correctly, but that other parts of the system have not been accidentally affected by the change.

Note 2 to entry: The adequacy of a set of regression test cases depends on the item under test and on the modifications to that item or its operational environment.

[SOURCE: ISO/IEC/IEEE 29119-1:2022, 3.64]

3.16
reliability
capability of a product to perform specified functions under specified conditions for a specified period of time without interruptions and failures

Note 1 to entry: Wear does not occur in *software* (3.19). Limitations in reliability are due to results from faults in requirements, design and implementation, or from contextual changes.

Note 2 to entry: *Dependability* (3.8) is often used as a synonym for reliability. However, dependability has a larger scope in that it includes security, performance efficiency, and continuing support and others in addition to the subcharacteristics of reliability.

[SOURCE: ISO/IEC/IEEE 24765:2017, 3.3387, definition 2, modified — "degree to which a system, product or component performs" has been changed to "capability of a product to perform"; "without interruptions and failures" has been added; the original note 1 to entry has been replaced by two new notes to entry.]

3.17
risk reduction measure
measure to reduce or mitigate risk

Note 1 to entry: A typical risk reduction measure is a safety-related system in the IEC 61508 series.

[SOURCE: ISO/IEC/IEEE 15026-1:2019, 3.3.9]

3.18
safety-critical software
software whose failure or malfunction can result in death or serious injury to people, loss of or severe damage to equipment or property, or damage to the natural environment

[SOURCE: ISO/IEC 29110-5-1-2:2025, 3.27]

3.19
software
computer programs, procedures, and possibly associated documentation and data pertaining to the operation of a computer system

[SOURCE: ISO/IEC/IEEE 24765:2017, 3.3783, definition 1]

3.20
space-VSE
enterprise, organization (e.g. government agency, non-profit organization), department or *project* (3.13) having up to 25 people that develops or maintains systems and/or *software* (3.19) in the space domain

3.21
stakeholder
individual or organization having a right, share, claim, or interest in a system or in its possession of characteristics that meet their needs and expectations

[SOURCE: ISO/IEC/IEEE 12207:2017, 3.1.59, modified — EXAMPLE and note 1 to entry have been removed.]

3.22
validation
confirmation, through the provision of objective evidence, that the requirements for a specific intended use or application have been fulfilled

Note 1 to entry: A system is able to accomplish its intended use, goals and objectives (i.e., meet *stakeholder* (3.21) requirements) in the intended operational environment. The right system was built.

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

[SOURCE: ISO/IEC/IEEE 12207:2017, 3.1.71]

3.23
verification
confirmation, through the provision of objective evidence, that specified requirements have been fulfilled

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

[SOURCE: ISO 9000:2015, 3.8.12, modified — Notes 1 to 3 to entry have been replaced by a new note 1 to entry.]

4 Conventions and abbreviated terms

4.1 Naming, diagramming and definition conventions

The following process structure description and notation are used to describe the processes.

Process name – process identifier, followed by its abbreviation in parenthesis “( )”.

Process purpose – General goals and results expected of the effective implementation of the process. The implementation of the process should provide tangible benefits to the stakeholders. The purpose is identified by the abbreviation of the process name.

Process outcomes – Observable result of the successful achievement of the process purpose. Outcomes are identified by the abbreviation of the process name, followed by the letter "O" and a consecutive number, for example PM.O1, SI.O2.

Input work products – Work products which can be used to perform the process and its corresponding source, which can be another process or an external entity to the project, such as the customer. They are identified by the abbreviation of the process name and showed as two column table of work product names and sources.

Output work products – Work products generated by the process and its corresponding destination, which can be another process or an external entity to the project, such as customer. Identified by the abbreviation of the process name and showed as two column table of work product names and destinations.

Internal work products – Work products generated and consumed by the process. An internal work product is not reviewed or approved by the customer. Identified by the abbreviation of the process name and showed as one column table of the work product names.

All work products' names are initiate with capital letters. Some work products have one or more statuses attached to the work product name surrounded by square brackets "[ ]" and separated by ",". The work product state may change during the process execution. See Clause 9 for the alphabetical list of the work products, its descriptions, possible states and the source of the work product. The source can be another process or an external entity to the project, such as the customer.

Roles involved – Names and abbreviation of the functions to be performed by project team members. Several roles may be played by a single person and one role may be assumed by several persons. Roles are assigned to project participants based on the characteristics of the project. The role list is identified by the abbreviation of the process name and showed as two column table. See Clause 8 for the alphabetical list of the roles and required competencies description.

Diagram – Graphical representation of the processes. The large round-edged rectangles indicate process or activities, and the smaller square-edged rectangles indicate the work products. The directional or bidirectional thick arrows indicate the major flow of information between processes or activities. The thin directional or bidirectional arrows indicate the input or output work products. The thick dashed rectangle indicates the process group, for example, the engineering process group.

The notation used in the diagrams does not imply the use of any specific process life cycle.

Activity – A set of cohesive tasks. The task statements in this document are not imperative. A process activity is the first level of process workflow decomposition and the second one is a task. Activities are identified by process name abbreviation followed by consecutive number and the activity name.

Activity description – Each activity description is identified by the activity name and the list of related objectives surrounded by parenthesis "( )". For example, PM.01 project planning (PM.O1, PM.O5, PM.O6, PM.O7) means that the activity PM.01 project planning contributes to the achievement of the listed objectives: PM.O1, PM.O5, PM.O6 and PM.O7.

Task description – Each task description begins with an active verb (e.g. assign, test) and is followed by an object (e.g. review the project plan). To facilitate their implementation, a few tasks are broken down in elementary tasks. The task description doesn't impose any technique or method to perform it. The selection of the techniques or methods is left to the VSE or project team.

Task description tables contain four columns corresponding to:

— Role – the abbreviation of roles involved in the task execution.

— Task – description of the task to be performed. Each task is identified by activity ID and consecutive number, for example PM.01.01, PM.01.02.

— Input work products – work products needed to execute a task.

— Output work products – work products created or modified by the execution of a task.