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ISO/IEC 29110: Systems Engineering Standards for Very Small Enterprises

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Abstract

In 2011, a new Software Engineering Standards for very small entities (ISO/IEC 29110) was approved by the International Organization for Standardization (ISO). In 2014, an ISO/IEC 29110 systems engineering, management and engineering guide has been developed using ISO/IEC/IEEE 15288 systems engineering standard. Systems Engineering is an interdisciplinary approach governing the total technical and managerial effort required to transform a set of stakeholder needs, expectations, and constraints into a solution and to support that solution throughout its life [1]. A system is mainly composed of hardware components and often of software components. As an example, a recent top-of-the-line Sport Utility Vehicle (SUV) is equipped with 170 processors having over 100 million lines of code. This article presents this new ISO/IEC 29110 Systems Engineering Standards developed specifically for VSEs.

Introduction

Industry recognizes the value of Very Small Entities (VSEs), i.e., enterprises, organizations, departments or projects with up to 25 people, in contributing valuable products and services. A large majority of enterprises worldwide are VSEs. In Europe, for instance, as illustrated in Table 1, over 92% of enterprises have fewer than nine employees.

Table 1: Size of enterprises in Europe [2].

Type of enterprise	Number of employees	Annual turnover (EURO)	Number of enterprises (% of overall)	Number of enterprises
Micro-enterprises	1 - 9	≤ 2 million	92.2 %	19 968 000
Small enterprises	10 - 49	≤ 10 million	6.5 %	1 358 000
Medium enterprises	50 – 249	≤ 50 million	1.1 %	228 000
SMEs, total	87 100 000		99.8 %	21 544 000*
Large enterprises	> 250	> 50 million		
Large enterprises, Total	42 900 000		0.2 %	43 000

* Independent companies only, excluding legally independent companies that are part of large enterprises.

VSEs have unique characteristics, which make their business styles different to small and medium-sized enterprises (SMEs) and therefore most of the management processes are performed through a more informal and less documented manner [3]. Furthermore there is an acknowledged lack of adoption of standards in small and very small

companies, as the perception is that they have been developed for large software and systems companies and not with the small organisation in mind [4]. Accordingly the new standard ISO/IEC 29110 "Lifecycle profiles for Very Small Entities" is aimed at meeting the specific needs of VSEs [5]. The overall objective of this new systems engineering standard is to assist and encourage very small organizations in implementing, assessing and improving their systems engineering process. The approach [6] used by the ISO working group to develop ISO/IEC 29110 started with the pre-existing international standards, such as the systems engineering life cycle standard ISO/IEC/IEEE 15288 and the documentation standard ISO/IEC/IEEE 15289.

International Standards for VSEs

A. Development

Since an international standard dedicated to the systems life cycle processes was already available, i.e. ISO/IEC/IEEE 12288 [7], WG24, the ISO/IEC JTC1 SC71 working group mandated to develop the new set of standards for VSEs, used the concept of ISO standardized profiles (SP) to develop the new standards for VSEs developing systems. From a practical point of view, a profile is a kind of matrix which identifies precisely the elements that are taken from existing standards from those that are not. The overall approach followed by WG24 to develop this new standard for VSE consisted of the following steps:

- Develop a set of profiles for VSEs not involved in critical system development;
- Select the ISO/IEC/IEEE 15288 process subsets applicable to VSEs having up to 25 people;
- Develop a set of systems engineering profiles matching the existing ISO/IEC 29110 software engineering profiles;
- Select the description of the products, to be produced by a project, using ISO/IEC/IEEE 15289 standard [8];
- Develop guidelines, checklists, templates, examples to support the subsets selected.

B. Generic Profile Group

The generic profile group is a collection of four profiles (Entry, Basic, Intermediate, Advanced) and is applicable to VSEs that do not develop critical systems. VSEs targeted by the Entry profile are those working on small projects (e.g., at most six person-months of effort) and for start-ups. The Basic profile describes the development practices of a single application (e.g. a software or a system/sub-system) by a single project team. The Intermediate profile is targeted at VSEs developing multiple projects with more than one team within the organization. The Advanced profile is targeted at VSEs wishing to sustain and grow as independent competitive businesses.

The ISO/IEC 29110 standards and technical reports targeted by audience are described in Table 2. The set of documents, listed in table 2, for the software engineering Basic profile ([9-13] were published in 2011. The systems engineering Basic profile was published in August 2014. The systems engineering Entry profile should be published in early 2015.

At the request of WG24, all ISO/IEC 29110 Technical Reports are available at no cost from ISO.

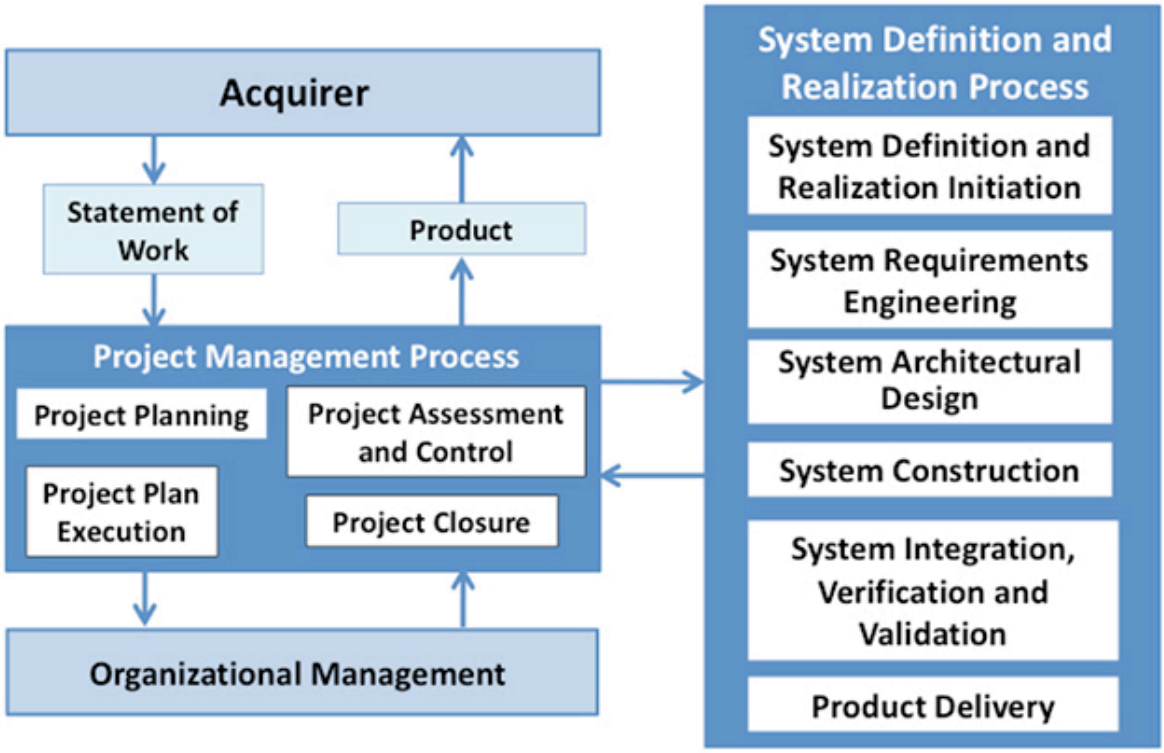
Table 2. ISO/IEC 29110 target audience (adapted from ISO 2014a)

ISO/IEC 29110	Title	Target audience
Part 1	Overview	VSEs and their customers, assessors, standards producers, tool vendors and methodology vendors.
Part 2	Framework and taxonomy	Standards producers, tool vendors and methodology vendors. Not intended for VSEs.
Part 3	Certification and Assessment guide	VSEs and their customers, assessors, accreditation bodies.
Part 4	Profile specifications	Standards producers, tool vendors and methodology vendors. Not intended for VSEs.
Part 5	Management and engineering guide	VSEs and their customers.

C. The Systems engineering Basic Profile

The systems engineering Basic profile, as illustrated in Figure 2, is composed of two processes: A Project Management (PM) process and a System definition and Realization (SR) process. As defined in ISO/IEC 29110, the purpose of the Project Management (PM) process is to establish and carry out in a systematic way the tasks of the system development, which allows complying with the project's objectives in the expected quality, time and cost.

Fig. 2. Basic profile processes and activities



The purpose of the System Definition and Realization (SR) process is the systematic performance of the analysis, design, construction, integration, verification, and validation activities for new or modified system according to the specified requirements. As illustrated in figure 2, an acquirer provides a statement of work (SOW), or an agreement, as an input to the PM process and receives a product as a result of SR process execution.

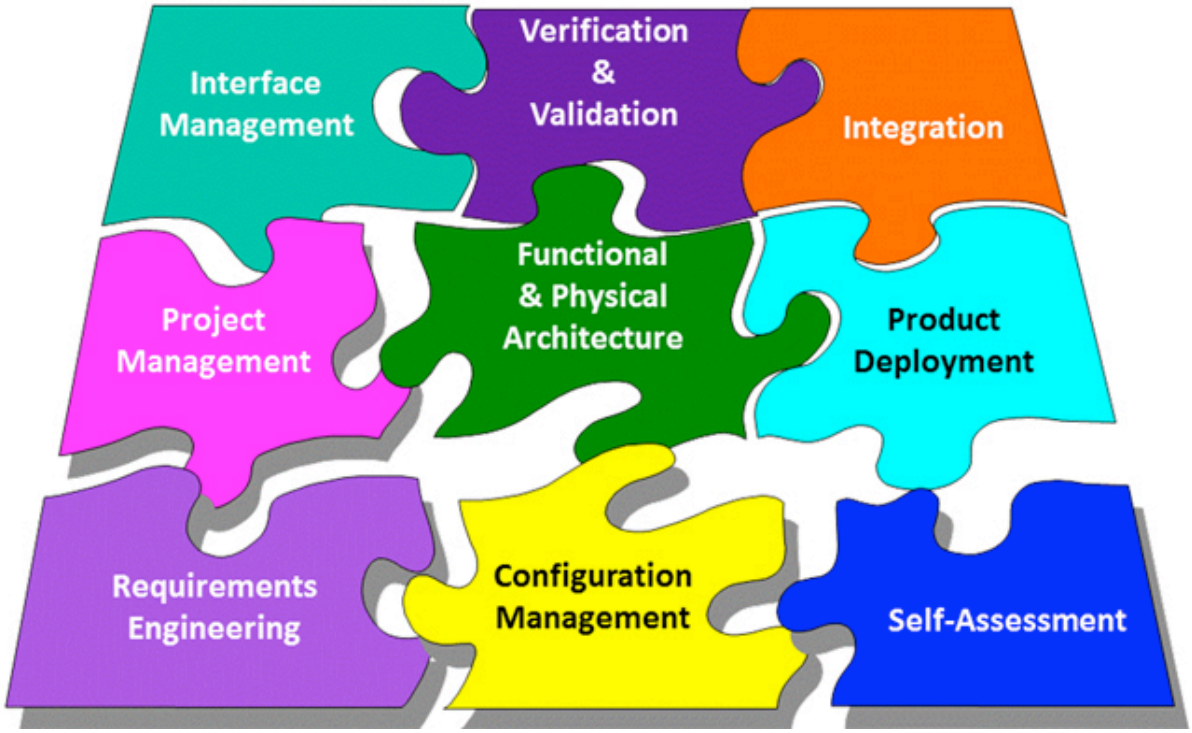
D. Development of Deployment Packages

A novel approach was taken to assist VSEs with the deployment of ISO/IEC 29110 and to provide guidance on the actual implementation this standard. A set of Deployment Packages (DPs) have been developed to define guidelines and explain in more detail the processes defined in the ISO/IEC 29110 profiles [14]. The elements of a typical DP are: Description of processes, activities, tasks, steps, roles, products, templates, checklists, examples, references and mapping to standards and models, and a list of tools. The mappings show that a deployment package has explicit links to standards, such as ISO/IEC/IEEE 12207, or models, such as the Capability Maturity Model® Integration (CMMI) for Development. Hence by implementing a DP, a VSE can see its concrete step to achieve or demonstrate coverage [15].

DPs were designed such that a VSE can implement its content, without having to implement the complete ISO/IEC 29110 framework, i.e. all the management and engineering activities, at the same time. A set of nine DPs have been developed to date

and are freely available from [16]. Figure 3 illustrates the set of DPs developed to support the Basic Profile. The set of DPs has been translated in Spanish and was used by students when implementing ISO/IEC 29110 in Latin America.

Fig. 3. Deployment Packages support for systems engineering Basic Profile [29]



A first commercial software solution using the DPs has been developed to facilitate the implementation of the Basic profile. The tool which is based on the well-known Atlassian tool suite, facilitates the role of the project manager and enhances team collaboration. It has the following characteristics:

- Project artefacts are shared in one place;
- Project documentation is managed;
- A project progress dashboard can be generated;
- Integrated with model-based solutions.

The solution provides project artefacts and documentation templates. It enforces the management and engineering processes, and it facilitates progress tracking (e.g. traceability). When using a model-based approach, project artefacts such as requirements, tests, changes and models can be integrated and traced. The solution will be available in several languages, including English, French and Spanish.

Pilot projects adoption strategy

The working group behind the development of this standard is advocating the use of pilot projects as a mean to accelerate the adoption and utilization of ISO/IEC 29110 by VSEs [17]. Pilot projects are an important mean of reducing risks and learning more about the organizational and technical issues associated with the deployment of new

software engineering practices [18]. To date a series of pilot projects have been completed in several countries with the results published in a variety of literature [19, 20, 21].

The first ISO/IEC 29110 systems engineering implementation project took place in a start-up VSE, of the Montréal area, specialized in the integration of interactive communication systems-public address, visual information and media, vehicle wayside communications, networking and radio and safety systems such as CCTV, fire management, access control and intrusion detection, perimeter protection, emergency intercom in the mass transit industry (trains and buses). In this industry, customers often require a CMMI® maturity level, such as a CMMI level 2 for sub-system suppliers. In 2012, the VSE was composed of just four professionals. It was felt that implementing the process areas of CMMI® was too demanding at that time. The company decided to implement the draft version of the ISO/IEC 29110 systems engineering Basic profile as a foundation for its development work. It was felt that, once the processes were documented and implemented in a few projects, the VSE could, if required, perform a gap analysis between the CMMI level 2 practices and the Basic profile and implement the practices needed for a level 2 assessment.

A 400-employee Canadian division of a large American engineering company, of the Montréal area, has developed and implemented project management processes for their small-scale and medium-scale projects. The company was already using a robust project management process for their large-scale projects. The objectives of this project were to reduce cost overruns and project delays, standardize practices to facilitate the integration of new managers, increase the level of customer satisfaction and to reduce risk-related planning deviations. This project was managed like all other engineering project of the organization. For this project, the engineering organization used the new ISO/IEC 29110 standards developed specifically for very small entities, i.e. enterprises, organizations, departments or projects having up to 25 people. An analysis of the cost and the benefits of the implementation of small and medium scale project management processes was performed using the ISO economic benefits of standard methodology. The engineering enterprise estimated that, over a three-year timeframe, savings of about 780,000$ would be realized due to the implementation of project management processes using the new ISO/IEC 29110 standard.

Conclusion and future work

Industry recognizes the contribution of VSEs in terms of the valuable products and services they offer. A large majority of organizations worldwide have fewer than 25 people. Most system and software engineering standards are not easily applied in VSEs, where they are generally found difficult to understand and implement.

Working Group 24 (WG24) mandated by ISO has developed a set of standards and guides to address the needs of VSEs developing system or software. WG24 has finalized in 2014 the development of the ISO/IEC 29110 systems engineering Basic profile. The members of the International Council on System Engineering (INCOSE) VSE WG produced a set of deployment packages to help implement the Basic profile. WG24 has

finalized the Entry profile for systems engineering: It should be published by ISO in early 2015 Once the Entry profile is available, the INCOSE VSE working group will be able to start the development of deployment packages to support it.

Once the ISO/IEC 29110 Intermediate and Advanced profiles for software are ready, work will start on the two corresponding systems engineering profiles for VSEs.

Since many VSEs around the world are developing components which are integrated in critical systems, WG24 and the INCOSE VSE WG will conduct an analysis to determine if a set of systems/software engineering standards for such VSEs should be developed.

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Additional information

An information web site provides more information, as well as articles by WG24 members and deployment packages for software and systems engineering. We also invite you to read the following research papers to get more informations regarding the ISO/IEEC 29110:

Claude Y. Laporte, Ronald Houde and Joseph Marvin (2014). Systems Engineering International Standards and Support Tools for Very Small Enterprises. 24th Annual International Council on Systems Engineering (INCOSE) International Symposium, Las Vegas, July 1st, 2014.

Laporte, C.Y. and O'Connor, R.V., Systems and Software Engineering Standards for Very Small Entities: Implementation and Initial Results, Proceedings of the 9th International Conference on the Quality of Information and Communications Technology (QUATIC), September 2014.

Laporte, C. Y. and O'Connor, R. V., Designing Systems Engineering Profiles for VSEs, Proceedings 14th International Conference on Software Process Improvement and Capability dEtermination (SPICE 2014), CCIS Vol. 477, Springer-Verlag, November 2014

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