TECHNICAL REPORT

ISO/IEC
TR
29110-5-6-2

Systems and software engineering — Lifecycle profiles for Very Small Entities (VSEs) —

Part 5-6-2:
Systems engineering — Management and engineering guide: Generic profile group: Basic profile

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

Partie 5-6-2: Ingénierie des systèmes — Guide d'ingénierie et de gestion: Groupe de profil générique: Profil basique

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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 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).

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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 on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/IEC JTC 1, *Information technology*, Subcommittee SC 7, *Software and systems engineering*.

The full list of parts of ISO/IEC 29110 is available here.

Introduction

Very Small Entities (VSEs) around the world are contributing to valuable products and services. For the purpose of ISO/IEC 29110, a Very Small Entity (VSE) is an enterprise, an organization, a department or a project having up to 25 people. Since many VSEs develop and/or maintain system elements and software components used in systems, or sold to be used by others, a recognition of VSEs as suppliers of high quality products is required.

According to the Organization for Economic Co-operation and Development (OECD) SME and Entrepreneurship Outlook report (2005) 'Small and Medium Enterprises (SMEs) constitute the dominant form of business organization in all countries world-wide, accounting for over 95 % and up to 99 % of the business population depending on country'. 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. Subsequently 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 often cut off 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 application of 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 systems or software lifecycle processes. To rectify some of these difficulties, a set of guides has been developed according to a set of VSE characteristics. The guides 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 12207[2] for software; and processes, activities, tasks, and outcomes of ISO/IEC 15288[3] for systems; and information products (documentation) of ISO/IEC/IEEE 15289[4] 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 of standards and technical reports can be applied at any phase of system or software development within a lifecycle. This series of standards and technical reports is intended to be used by VSEs that do not have experience or expertise in adapting/tailoring ISO/IEC 12207 or ISO/IEC 15288 to the needs of a specific project. VSEs that have expertise in adapting/tailoring ISO/IEC 12207 or ISO/IEC 15288 are encouraged to use those standards instead of ISO/IEC 29110.

ISO/IEC 29110 is intended to be used with any lifecycles such as: waterfall, iterative, incremental, evolutionary or agile.

ISO/IEC 29110 series, targeted by audience, has been developed to improve system or software and/or service quality, and process performance. See Table 1.

Table 1 — ISO/IEC 29110 target audience

ISO/IEC 29110	Title	Target audience
Part 1	Overview	VSEs and their customers, assessors, standards producers, tool vendors and methodology vendors.
Part 2	Framework	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.
Part 5	Management and engineering guide	VSEs and their customers.

If a new profile is needed, ISO/IEC 29110-4 and ISO/IEC TR 29110-5 can be developed without impacting existing documents.

ISO/IEC TR 29110-1[5] defines the terms common to the Set of ISO/IEC 29110 Documents. It introduces processes, lifecycle and standardization concepts, the taxonomy (catalogue) of ISO/IEC 29110 profiles and the ISO/IEC 29110 series. It also introduces the characteristics and requirements of a VSE, and clarifies the rationale for specific profiles, documents, standards and guides.

ISO/IEC 29110-2[6] introduces the concepts for systems and software engineering standardized profiles for VSEs. It establishes the logic behind the definition and application of profiles. It specifies the elements common to all profiles (structure, conformance, assessment) of ISO/IEC 29110 profiles.

ISO/IEC TR 29110-3[7] defines the process certification scheme, assessment guidelines and compliance requirements needed to meet the purpose of the defined Profiles. ISO/IEC TR 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 TR 29110-3 is addressed to people who have direct relation with the assessment process, e.g. 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-m provides the specification for all profiles in one profile group that are based on subsets of appropriate standards elements.

This part of ISO/IEC 29110 provides a management and engineering guide for each Profile in one profile group.

Figure 1 describes the ISO/IEC 29110 International Standards (IS) and Technical Reports (TR) within the framework of reference. Overview, assessment guide, management and engineering guide are published as Technical Reports (TR). The Framework and taxonomy document, profile specifications and certification schemes are published as International Standards (IS).
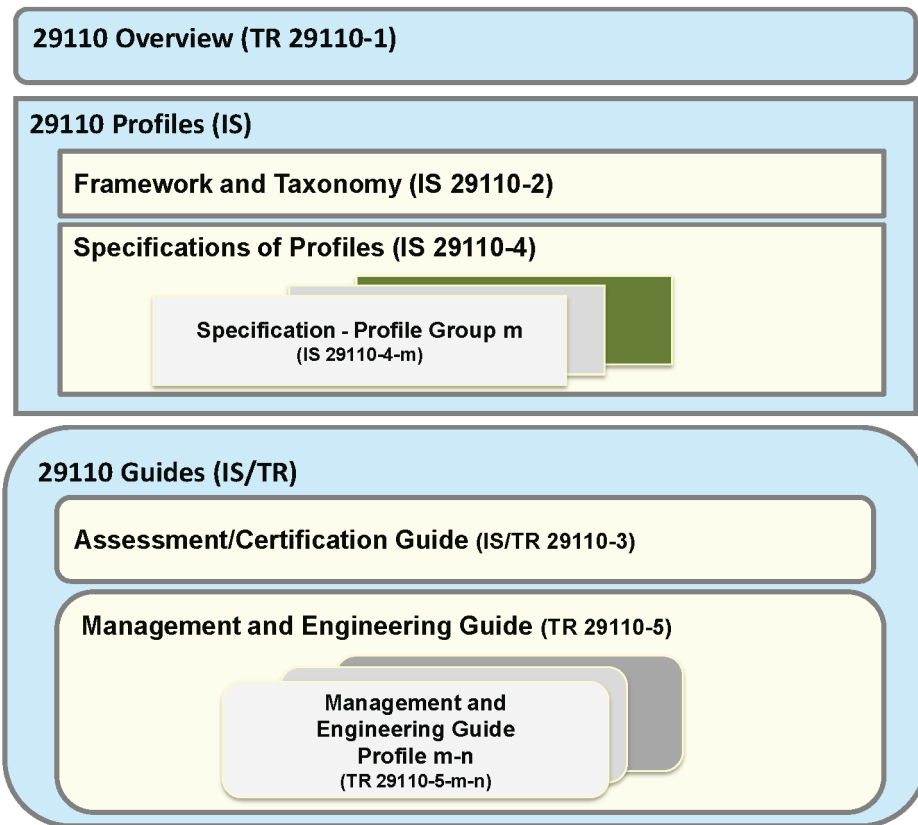
Figure 1 — ISO/IEC 29110 Series

Systems and software engineering — Lifecycle profiles for Very Small Entities (VSEs) —

Part 5-6-2:
Systems engineering — Management and engineering guide: Generic profile group: Basic profile

1 Scope

1.1 Fields of application

This part of ISO/IEC 29110 is applicable to Very Small Entities (VSEs). VSEs are enterprises, organizations, departments or projects having up to 25 people. The lifecycle processes described in the set of International Standards (IS) and Technical Reports (TR) are not intended to preclude or discourage their use by organizations bigger than VSEs.

This part of ISO/IEC 29110 provides the management and engineering guide to the Basic Profile described in ISO/IEC 29110-4-6 through Project Management and System Definition and realization processes. This part of ISO/IEC 29110 is a standalone guide; it is not intended for a VSE to use the standardized profile to implement this part of ISO/IEC 29110.

This part of ISO/IEC 29110 applies for non-critical systems development projects. The system development should fulfil the project requirements and the system description.

Using this part of ISO/IEC 29110, a VSE can obtain benefits in the following aspects:

— An agreed set of project requirements (technical part of contract) and expected products are agreed by the Acquirer.

— A disciplined management process, that provides project visibility and corrective actions of project problems and deviations, is performed.

— A systematic System Definition and Realization process, that satisfies Acquirer needs and ensures quality products, is followed.

VSEs developing software that is part of a larger system, and for stand-alone software products and services, are encouraged to use the management and engineering guide of the Basic Profile (ISO/IEC 29110-5-1-2[9]).

1.2 Target Audience

This part of ISO/IEC 29110 is targeted at VSEs who do not develop critical systems and do not have experience with SE process planning and implementation using ISO/IEC 15288.

It is intended to be used with any processes, techniques and methods that enhance the VSE's Stakeholder satisfaction and productivity.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC TR 29110-1, *Software engineering — Lifecycle profiles for Very Small Entities (VSEs) — Part 1: Overview*

3   Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC TR 29110-1:2011 and the following apply.

3.1
acquirer
stakeholder that acquires or procures a product or service from a supplier

Note 1 to entry: Other terms commonly used for an acquirer are buyer, customer, owner, or purchaser.

[SOURCE: ISO/IEC 15288:2008]

3.2
critical system
those items (e.g. functions, parts, software, characteristics, processes) having significant effect on the product realization and use of the product – including safety, performance, form, fit, function, producibility, service life, etc. – that require specific actions to ensure they are adequately managed

Note 1 to entry: Examples of critical items include safety critical items, fracture critical items, mission critical items, key characteristics, etc.

[SOURCE: (AS/EN/JIS Q) 9100:2009]

3.3
disposed system
system that has been transformed (i.e. state change) by applying the disposal process

Note 1 to entry: A systems approach considers the total system and the total lifecycle of the system. This includes all aspects of the system and the system throughout its life until the day users depose of the system and the external enterprises complete the handling of the disposed system products.

[SOURCE: ISO/IEC 15288:2008, modified]

3.4
operator
entity that performs the operations of a system

Note 1 to entry: The role of operator and the role of user may be vested, simultaneously or sequentially, in the same individual or organization.

Note 2 to entry: An individual operator combined with knowledge, skills and procedures may be considered as an element of the system.

Note 3 to entry: In the context of this specific definition, the term entity means an individual or an organization.

[SOURCE: ISO/IEC 15288:2008]

3.5
Systems Engineering Plan
SEP
top-level plan for managing the SE effort which, as such, defines how the project will be organized, structured, and conducted and how the total engineering process will be controlled to provide a product that satisfies stakeholder requirements

Note 1 to entry: Also called Systems Engineering Management Plan (SEMP).

[SOURCE: INCOSE:2010]

3.6
Small and Medium Enterprise
SME
enterprises which employ fewer than 250 persons and which have an annual turnover not exceeding 50 million euro, and/or an annual balance sheet total not exceeding 43 million euro)

[SOURCE: OECD 2005]

3.7
system
combination of interacting elements organized to achieve one or more stated purposes

Note 1 to entry: A system may be considered as a product or as the services it provides.

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" may be substituted simply by a context-dependent synonym, e.g. aircraft, though this may then obscure a system principles perspective.

[SOURCE: ISO/IEC 15288:2008]

3.8
trade-off
decision-making actions that select from various requirements and alternative solutions on the basis of net benefit to the stakeholders

[SOURCE: ISO/IEC 15288:2008]

3.9
user
individual or group that benefits from a system during its utilization

Note 1 to entry: The role of user and the role of operator may be vested, simultaneously or sequentially, in the same individual or organization.

[SOURCE: ISO/IEC 15288:2008]

3.10
system structure
decomposition of a system of interest into a set of interacting systems and system elements

Note 1 to entry: The system structure is described in a System Breakdown Structure (SBS).

[SOURCE: ISO/IEC 15288:2008]

3.11
statement of work
SOW
document used by the acquirer that includes the needs and expectations, the scope, objectives and deliverables

[SOURCE: ISO/IEC 12207:2008]

3.12
work breakdown structure
WBS
[Output/Input] deliverable-oriented hierarchical decomposition of the work to be executed by the project team to accomplish the project objectives and create the required deliverables

Note 1 to entry: It organizes and defines the total scope of the project.

[SOURCE: ISO/IEC/IEEE 24765:2010, modified]

4 Symbols and abbreviated terms

4.1 Naming, diagramming and definition conventions

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

Name – process identifier, followed by its abbreviation in brackets "( )".

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.

Objectives – specific goals to ensure the accomplishment of the process purpose. The objectives are identified by the abbreviation of the process name, followed by the letter "O" and a consecutive number, for example PM.O1, SR.O2, etc.

Input Products – products required to perform the process and its corresponding source, which can be another process or an external entity to the project, such as the Acquirer. Identified by the abbreviation of the process name and showed as two column table of product names and sources.

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

Internal Products – products generated and consumed by the process. Identified by the abbreviation of the process name and showed as one column table of the product names.

All products' names are printed in cursive and initiate with capital letters. Some products have one or more statuses attached to the product name surrounded by square brackets "[ ]"and separated by ",". The product status may change during the process execution. See Clause 10 for the alphabetical list of the products, its descriptions, possible statuses and the source of the product. The source can be another process or an external entity to the project, such as the Acquirer.

Rectangle boxes – the rectangle boxes following the description of processes objectives make the correspondence with ISO/IEC 15288:2008 standard.

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 9 for the alphabetical list of the roles, its abbreviations 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 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 products. The notation used in the diagrams does not imply the use of any specific process lifecycle.

Activity – a set of cohesive tasks. Task is a requirement, recommendation, or permissible action, intended to contribute to the achievement of one or more objectives of a process. 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 brackets "( )". For example PM.1 Project Planning (PM.O1, PM.O5, PM.O6, PM.O7) means that the activity PM.1 Project Planning contributes to the achievement of the listed objectives: PM.O1, PM.O5, PM.O6 and PM.O7. The activity description begins with the task summary and is followed by the task descriptions table. 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.

Tasks description table 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 PM1.1, PM1.2, and so on.

— Input Products – products needed to execute the task.

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

Incorporation to *Project Repository* – list of products to be saved in *Project Repository*; the *Configuration Management Strategy* has to be applied to some of them (see Clause 7.7.2 and 8.7.2). It is useful as a checklist for project manager and technical leader.

NOTE   Tables used in process description are for presentation purpose only.

4.2   Abbreviated Terms

The following abbreviations are used in this document:

ACQ   Acquirer

HW   Hardware

IVV   Integration, Verification, Validation

PO   Purchase Order

PM   Project Management

PJM   Project Manager

SBS   System Breakdown Structure

SDD   System Design Document

SEMP   System Engineering Management Plan

SEP   Systems Engineering Plan

SMART   Specific, Measurable, Achievable, Relevant and Traceable

SME   Small and Medium Enterprise

SBS   System Breakdown Structure

SOW   Statement of Work

SR   System Definition and Realization

STK   Stakeholder

SW   Software

TPM   Technical Performance Management

VSE   Very Small Entity

WBS   Work Breakdown Structure

5   Systems Thinking

The traditional approach to solve a problem is called Cartesian. This approach focuses on dividing a problem into smaller parts and, once resolved each part, the whole problem is solved. This approach, however, has limitations because you can lose insight of the whole system. To overcome this limitation,

there is the System Thinking, which analyses and observes the system as a whole and identifies the interrelationships among the parts that compose it and also with the system environment (e.g. enabling systems).

System Thinking allows for a better understanding of the systems as a whole: System Thinking is used to broaden the perspective to larger environments by considering the entire lifecycle of the system and the different possible applications of the system. Systems can be immersed in different environments and multiple relationships will emerge. Every project has a context in which the system is embedded. Thus a system is not only composed of software and hardware, but is always part of a larger operation, often involving people and other systems. The designer must clearly understand these relationships before defining a solution.

The "system" perspective enables to design of an optimized system taking into account all needs and constraints. This perspective also helps to invent new solutions to meet existing needs or in some cases create new needs.

For the purpose of this standard, System Thinking should be considered particularly when understanding the system to be designed so that, when identifying the requirements, all the stakeholders must be considered as well as the context in which the system should operate. Following this approach, when deploying the requirements in smaller modules, it will help ensure effective integration the parts.

6   Overview

The Basic Profile Management and Engineering Guide applies to a Very Small Entity (VSE), i.e. enterprise, organization, department or project having up to 25 people, dedicated to system development of non-critical systems. The project may fulfil an external or internal contract. The internal contract between the project team and its Acquirer need not be explicit.

The Guide provides Project Management (PM) and System Definition and Realization (SR) processes which integrate practices based on the selection of ISO/IEC 15288, *Systems and software engineering —System life cycle processes* and ISO/IEC/IEEE 15289, *Systems and software engineering – Content of life-cycle information products (documentation)* standards elements. Annex A provides information about Deployment Packages which will facilitate the implementation of these processes.

This part of ISO/IEC 29110 is intended to be used by the VSE to establish processes to implement any development approach or methodology including, e.g. agile, evolutionary, incremental, test driven development, etc. based on the VSE organization or project needs.

Using the Guide, VSE can obtain benefits in the following aspects:

— A set of project requirements (technical part of the contract) and expected products are agreed with the Acquirer.

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

— A systematic System Definition and Realization process, that satisfies Acquirer needs and ensures quality products, is followed.

To use the Guide the VSE needs to fulfil the following entry conditions:

— Project *Needs and Expectations* are documented;

— Feasibility of the project was performed before its start;

— Project team, including project manager and system engineer, is assigned and trained; and

— Goods, services and infrastructure to start the project are available.

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.

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.

Both processes are interrelated (see Figure 2).
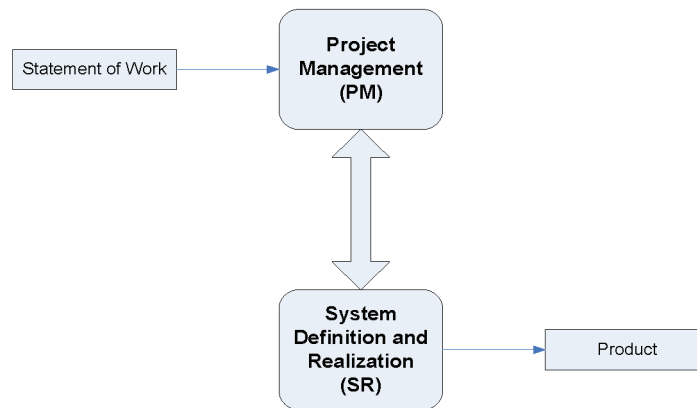
Figure 2 — Basic profile guide processes (diagram notation is explained in section 4.1)

PM process uses the Acquirer's *Statement of Work* to elaborate the *Project Plan*. If there is no statement of work available from the customer, the Project Manager (PJM), in collaboration with the Work Team, has to clarify the basis to develop the statement of work. The PM project assessment and control tasks compare the project progress against the *Project Plan* and actions are taken to eliminate deviations or incorporate changes to the *Project Plan*. The PM project closure activity ensures delivery of *the product (new or modified product)*, produced by SR (System Definition and Realization) process, and gets the Acquirer's acceptance to formalize the end of the project. A *Project Repository* is established to save the work products and to control its versions during the project.

The execution of the SR process is driven by the *Systems Engineering Management Plan (SEMP)*. An early SR activity is to generate a *SEMP*. The *SEMP* will guide the execution of the requirements elicitation, analysis, system design, system construction, integration and verification, validation, product delivery, maintenance and disposal activities.

The Acquirer provides a *Statement of Work (SOW)* as an input to Project Management process and receives *Products* as a result of System Definition and Realization process execution (see Figure 2).

7   Project Management (PM) process

7.1   PM purpose

The purpose of the Project Management process is to establish and carry out in a systematic way the *Tasks* of the system development project, which allows complying with the project's *Objectives* in the expected quality, time and costs.

This part of ISO/IEC 29110 is intended to be used by the VSE to establish processes to implement any development approach or methodology including, e.g. agile, evolutionary, incremental, test driven development, etc. based on the VSE organization or project needs.

7.2   PM objectives

PM.O1. The *Project Plan*, the *Statement of Work* (SOW) and commitments are reviewed and accepted by both the Acquirer and the Project Manager. The *Tasks* and *Resources* necessary to complete the work are sized and estimated.

PM.O2. Progress of the project is monitored against the *Project Plan* and recorded in the *Progress Status Record.* Corrections to remediate problems and deviations from the plan are taken when project targets are not achieved. Closure of the project is performed to get the Acquirer acceptance documented in the *Product Acceptance Record.*

PM.O3. *Change Requests* are addressed through their reception and analysis. Changes to system requirements are evaluated by the project team for cost, schedule, risks and technical impact.

PM.O4. Review meetings with the Work Team and the Acquirer, suppliers are held. Agreements are registered and tracked.

PM.O5. A *Risk Management Approach* is developed. Risks are identified, analysed, prioritized, and monitored as they develop and during the conduct of the project. Resources to manage the risks are determined.

PM.O6. A *Product Management Strategy* is developed. Items of *Product* are identified, defined and baselined. Modifications and releases of the items are controlled and made available to the Acquirer and Work Team. The storage, handling and delivery of the items are controlled.

PM.O7. Quality Assurance is performed to provide assurance that work products and processes comply with the *Project Plan* and *System Requirements Specifications*.

NOTE   The implementation of the Quality Assurance is through the performance of the verifications, validations and review *Tasks* performed in Project Management and System Definition and Realization processes.

PM.O8. A *Disposal Management Approach* is developed to end the existence of a system entity.

7.3   PM input products

Table 2 — PM input products

Name	Source
Statement of Work	Acquirer
All deliverables from SR	Work Team
Change Request	Acquirer, Stakeholders
	Work Team
	Suppliers

7.4   PM output products

Table 3 — PM output products

Name	Destination
Project Plan	System Definition and Realization
Product Acceptance Record	Organizational Management
Project Repository	System Definition and Realization
Meeting Record	Acquirer, Stakeholders

Table 3 *(continued)*

Name	Destination
Product	Acquirer, Stakeholders
	System Definition and Realization
	Suppliers
Purchase order	Suppliers
Disposed System	Acquirer, Stakeholders
	Suppliers

7.5 PM internal products

Table 4 — PM internal products

Name
Change Request
Correction Register
Justification Document
Meeting Record
Progress Status Record
Project Repository
Product Acceptance Record
Verification Report

7.6 PM roles involved

Table 5 — PM roles involved

Role	Abbreviation
Acquirer	ACQ
Stakeholders	STK
Project Manager	PJM
Work Team	WT
Designer	DES
Systems Engineer	SYS

7.7 PM diagram

The following diagram shows the flow of information between the Project Management Process activities including the most relevant work products and their relationship.
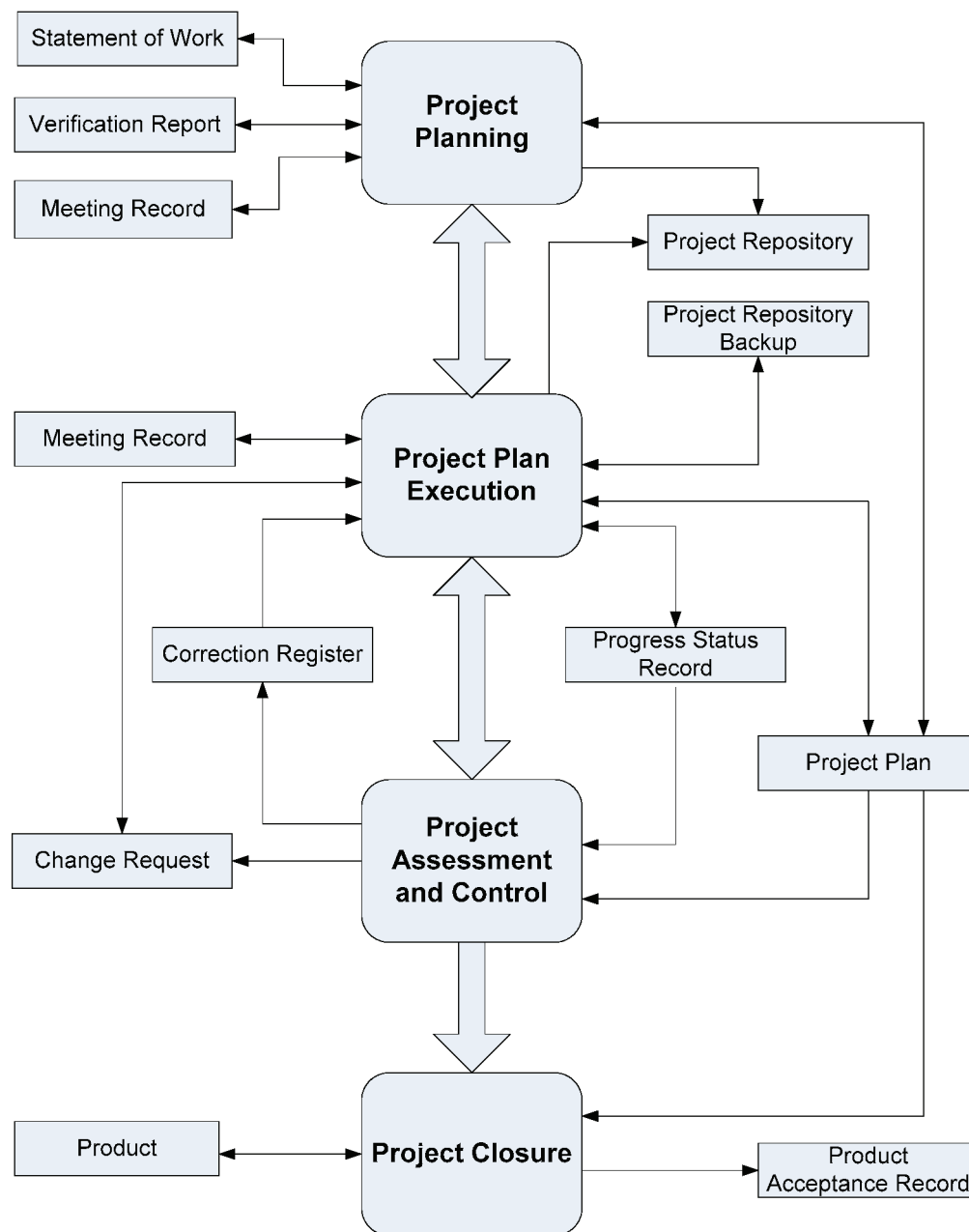
Figure 3 — Project Management process diagram

Note: All the feedback lines are not all displayed to facilitate readability.

7.7.1 PM activities

The Project Management Process has the following activities:

— PM.1 Project Planning

— PM.2 Project Plan Execution

— PM.3 Project Assessment and Control

— PM.4 Project Closure

7.7.1.1 PM.1 Project Planning, (PM.O1, PM.O5, PM.O6, PM.O7)

The Project Planning activity documents the planning details needed to manage the project. The activity provides:

— Reviewed *Statement of Work* (SOW) and the *Tasks* needed to provide the contract *Deliverables*.

— System Breakdown Structure (SBS), to provide the list of system and system elements of the project.

— Project life cycle, including task dependencies and duration.

— Project quality assurance strategy through verification and validation of work products/*Deliverables*, Acquirer, Stakeholders and Work Team reviews.

— Work Team, Acquirer and other Stakeholders roles and responsibilities.

— Project *Resources* and training needs.

— Estimates of effort cost and schedule.

— *Risk Management Approach*.

— *Disposal Management Approach.*

— *Change Control Process* and *Configuration Management* strategy.

— *Project Repository* to store, handle and deliver controlled product and document versions and baselines.

Table 6 — PM.1 task list

Role	Task List – PM.1	Input Products	Output Products
PJM SYS	PM.1.1 Review the *Statement of Work*	Statement of Work	Statement of Work *[reviewed]*
PJM ACQ	PM.1.2 Define with the *Acquirer* the *Delivery Instructions* of each one of the *Deliverables* specified in the *Statement of Work.*	Statement of Work *[reviewed]*	Project Plan • Delivery Instructions
PJM DES	PM.1.3 Define the System Breakdown Structure (SBS) that represents the relationship between the system and its system elements. Note: the system boundaries must be defined Note: this task is iterative as the SBS is based on the System Design Document (SDD). The SDD is at the beginning preliminary and all system elements hierarchy is not necessary defined completely. The SBS is updated while the SDD is progressively completed.	System Design Document	Project Plan • System Breakdown Structure
PJM WT	PM.1.4 Select a product lifecycle and define milestones according to the Statement of Work	Project Plan • System Breakdown Structure Statement of Work	Project Plan • Milestones

Table 6 *(continued)*

Role	Task List – PM.1	Input Products	Output Products
PJM SYS	PM.1.5 Identify the specific *Tasks* to be performed in order to produce the *Deliverables* and their *System Elements* identified in the *Statement of Work*. Include *Tasks* in the SR process along with verification, validation and reviews with Acquirer/other stakeholders and Work Team *Tasks* to ensure the quality of work products. Identify the *Tasks* to perform the *Delivery Instructions*. Document the *Tasks*. This task is performed in parallel with the definition of the SEMP.	Statement of Work *[reviewed]* Project Plan • System Breakdown Structure	Project Plan • Tasks
PJM	PM.1.6 Establish the *Estimated Duration* to perform each task.	Project Plan • Tasks	Project Plan • Estimated Duration
PJM	PM.1.7 Identify and document the *Resources*: human, material, equipment and tools, standards, including the required training of the Work Team to perform the project. Include in the schedule the dates when *Resources* and training will be needed.	Statement of Work *[reviewed]*	Project Plan • Resources
PJM	PM.1.8 Establish the *Composition of Work Team* assigning roles and responsibilities according to the *Resources*.	Project Plan • Resources	Project Plan • Composition of Work Team
PJM	PM.1.9 Assign estimated start and completion dates to each one of the *Tasks* in order to create the *Schedule of the Project Tasks* taking into account the assigned *Resources*, sequence and dependency of the *Tasks*. Define milestones of the project (e.g. end of phases, payments, deliveries)	Project Plan • Tasks • Estimated Duration • Composition of Work Team	Project Plan • Schedule of the Project Tasks • Milestones
PJM	PM.1.10 Calculate and document the project *Estimated Effort and Cost*.	Project Plan • Schedule of the Project Tasks • Resources	Project Plan • Estimated Effort and Cost
PJM	PM.1.11 Identify and document a *Risk Management Approach* and the risks which may affect the project.	All elements previously defined	Project Plan • Risk Management Approach
PJM	PM.1.12 Identify and document a *Disposal Management Approach*.	Statement of Work *[reviewed]*	Project Plan • Disposal Management Approach
PJM	PM.1.13 Document the *Configuration Management Strategy* in the *Project Plan*. *Identify the Configuration items* *Define the applicable configuration status* *Define the tasks and actors to manage the changes and the configuration.*	Project Plan • System Breakdown Structure	Project Plan • Configuration Management Strategy

Table 6 *(continued)*

Role	Task List – PM.1	Input Products	Output Products
PJM	PM.1.14 Include *System Description*, *Scope*, *Objectives*, *Deliverables*, and reference *to the SOW* in the *Project Plan*.	Statement of Work *[reviewed]*	Project Plan • System Description • Scope • Objectives • Deliverables • Reference to the SOW
PJM	PM.1.15 Generate the *Project Plan* integrating the elements previously identified and documented.	All elements previously defined	Project Plan • Reference to the SOW • Objectives • System Description • Scope • System Breakdown Structure • Tasks • Deliverables • Estimated Duration • Resources • Composition of Work Team • Milestones • Schedule of the Project Task • Estimated Effort and Cost • Risk Management Approach • Configuration Management Strategy • Delivery Instructions • Disposal Management Approach
PJM WT	PM.1.16 Verify and obtain approval of the *Project Plan*. Verify that all *Project Plan* elements are viable and consistent. The results found are documented in a *Verification Report* and corrections are made until the document is approved by PJM.	Project Plan	Verification Report • Project Plan Verification Report Project Plan *[verified]*
PJM ACQ STK	PM.1.17 Review and accept the *Project Plan*. Acquirer and other Stakeholders review and accept the *Project Plan*, making sure that the *Project Plan* elements match with the *Statement of Work*.	Project Plan *[verified]* Statement of Work	Meeting Record Project Plan *[accepted]*

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Table 6 *(continued)*

Role	Task List – PM.1	Input Products	Output Products
PJM	PM.1.18 Establish the *Project Repository* using the *Configuration Management Strategy*.	Project Plan • Configuration Management Strategy	Project Repository
PJM WT	PM1.19 Assign *Tasks* to the work team members related to their role, according to the current *Project Plan*.	Project Plan *[accepted]* • Tasks	Project Plan *[accepted]* • Tasks *[assigned]*

7.7.1.2 PM.2 Project Plan Execution (PM.O2, PM.O3, PM.O4, PM.O5, PM.O7)

The Project Plan Execution activity implements the documented plan on the project. The activity provides:

— *Progress Status Record* of the project updated.

— Analysed and evaluated change requests to the plan impacting cost, schedule and technical requirements.

— Approved changes to the plan.

— Reviews and agreements with the Work Team (WT), Acquirer (ACQ) and Stakeholders (STK).

— Back up of the *Project Repository*, and its recovery if necessary.

Table 7 — PM.2 task list

Role	Task List – PM.2	Input Products	Output Products
PJM WT	PM.2.1 Monitor the *Project Plan* execution and record actual data in *Progress Status Record.*	Project Plan *[accepted]*	Progress Status Record
ACQ PJM STK	PM.2.2 Analyse and evaluate the *Change Request* for cost, schedule and technical impact. The *Change Request* can be initiated externally by the Acquirer and other Stakeholders, or internally by the Work Team. Update the *Project Plan*, if the accepted change affects agreements with Acquirer and Stakeholders. *Change Request*, which affects those agreements, needs to be negotiated by both parties (see PM.2.4).	Change Request *[submitted]* Project Plan *[accepted]*	Change Request *[evaluated]*
PJM WT	PM.2.3 Conduct revision meetings with the Work Team, identify problems, review risk status, record agreements and track them to closure. * If an artefact has to be purchased, review and issue the Purchase Order (PO) developed in activity SR.3 to acquire the artefact.	Project Plan *[accepted]* Progress Status Record Correction Register Meeting Record *Purchase order *[initiated]*	Meeting Record *[updated]* * Purchase Order *[approved]*

Table 7 *(continued)*

Role	Task List – PM.2	Input Products	Output Products
PJM ACQ STK WT	PM.2.4 Conduct revision meetings with the Acquirer, Stakeholders, record agreements and track them to closure. *Change Request* initiated by Acquirer, and other Stakeholders, or initiated by Work Team, which affects the Acquirer, Stakeholders needs to be negotiated to reach acceptance of both parties. If necessary, update the *Project Plan* according to new agreement with Acquirer and other stakeholders.	Project Plan *[accepted]* Progress Status Record Change Request *[evaluated]* Meeting Record	Meeting Record *[updated]* Change Request *[agreed]* Project Plan *[updated]*
PJM WT	PM.2.5 Perform configuration management According to the configuration management strategy, manage in configuration the different artefacts of the project. Generate Product as planned. Identify changes (e.g. architecture, requirements) and/or *Project Plan* to address major deviations, potential risks or problems concerning the accomplishment of the project. Initiate Change Requests on baselined artefacts and analyse impacts (technical cost, quality) before change approval by PJM. Track the changes to closure.	• Project Plan • Stakeholders Requirements Specifications • * Concept of Operations • System Requirements Specifications • System Elements Requirements Specifications • System Design Document • System • Bought, built or re-used System Elements (HW, HW+SW) • Bought, built or re-used Software Elements • IVV Plan • IVV Integration Procedure • Integration Report • Verification Report • Validation Report • System Operation Guide • System User Manual • System Maintenance Document • System Training Specifications • Change Request *[agreed]* • Progress Status Record *[evaluated]*	Product Change Request *[submitted]*

Table 7 *(continued)*

Role	Task List – PM.2	Input Products	Output Products
PJM	PM.2.6 *Manage Project Repository* Update Project Repository at each new System Configuration. Perform backup and recovery testing according to the *Configuration Management Strategy.*	Project Plan [*updated*] • Configuration Management Strategy Product Project Repository	Project Repository [*updated*] Project Repository Backup
PJM	PM.2.7 Perform *Project Repository* recovery using the *Project Repository Backup*, if necessary.	Project Repository Backup	Project Repository [*recovered*]

7.7.1.3   PM.3 Project Assessment and Control (PM.O2)

The Project Assessment and Control activity evaluates the performance of the plan against documented commitments. The activity provides:

— Evaluation of actual plan performance and progress against targets.

— Identified and evaluated significant cost, schedule and technical performance deviations and problems.

— Review of project risks and identification of new risks.

— Documented change requests, appropriate corrective action defined, and changes tracked to closure.

Table 8 — PM.3 task list

Role	Task List – PM.3	Input Products	Output Products
PJM WT	PM.3.1 Evaluate project progress with respect to the *Project Plan*, comparing: • actual *Tasks* against planned *Tasks* • actual results against established project *Objectives* • actual resource allocation against planned *Resources* • actual cost against budget estimates • actual time against planned schedule • actual risk against previously identified	Project Plan [*updated*] Progress Status Record	Progress Status Record [*evaluated*]

Table 8 *(continued)*

Role	Task List – PM.3	Input Products	Output Products
PJM WT	PM.3.2 Establish and execute actions to treat deviations or problems and identified risks concerning the accomplishment of the plan, as needed, document them in *Correction Register* and track them to closure.	Project Plan • Risk Management Approach Progress Status Record [*evaluated*]	Correction Register • Rational of deviation correction actions [*initial*]
PJM WT	PM.3.3 Elaborate or update the Justification Document of the Project Record the reasons of needs. Record issues, hypothesis, architecture trade-off studies and decisions of the project. Keep track of meetings and decisions. Regroup or reference the Verification and Validation Reports in the Justification Document (if appropriate or needed) Establish traceability between the rationale and the related Systems Engineering artefacts	Correction Register • Rationale of deviation correction actions [*initial*] System Design Document • System Functional Architecture • System Physical Architecture Traceability Matrix Meeting Record Validation Reports: • Stakeholders Requirements Specifications • System Requirements Specification • Product Delivery • System User Manual • System Verification Reports: • Project Plan • Stakeholders Requirements Specifications • System Requirements Specifications • System Design Document • IVV Plan • IVV Procedure • System • System Operation Guide • System User Manual • Product Delivery • System Configuration	Justification Document • Justification of choices and decisions • Functional architecture trade-offs • Physical architecture trade-offs [*initial*]

7.7.1.4   PM.4 Project Closure (PM.O2, PM.O8)

The Project Closure activity provides the project's documentation and products in accordance with contract requirements. The activity provides:

— Delivery of the product as specified in the *Delivery Instructions*.

— Support of Acquirer and Stakeholders product acceptance in accordance to *Delivery Instructions*.

— Completion of the project and sign of the *Acceptance Record.*

— Execution of the *Disposal Management Approach.*

Table 9 — PM.4 task list

Role	Task List – PM.4	Input	Output
PJM ACQ	PM.4.1. Formalize the completion of the project according to the *Delivery Instructions* established in the *Project Plan,* providing acceptance support and getting the *Product Acceptance Record* signed.	Project Plan • Delivery Instructions Product [*delivered*]	Product Acceptance Record Product [*accepted*]
PJM WT	PM.4.2 Update *Project Repository.*	Product [*accepted*] Project Repository [*updated*]	Project Repository [*baselined*]
PJM WT	PM.4.3 Execute the *Disposal Management Approach*	Project Plan	Disposed System

7.7.2 PM incorporation to Project Repository

The list of products to be saved in *Project Repository*. After the incorporation, *Configuration Management Strategy* has to be applied to *Project Plan.*

Table 10 — PM repository products

Product
Project Plan
Change Request
Product Acceptance Record
Meeting Record
Correction Register
Progress Status Record
Purchase Order
Verification Report
Validation Report
Delivery Instructions
Justification Document

8 System Definition and Realization (SR) process

8.1 SR purpose

The purpose of the System Definition and Realization process is the systematic performance of the specification of system/system element, analysis, design, construction, integration and verification/validation activities for new or modified system according to the specified requirements.

This part of ISO/IEC 29110 is intended to be used by the VSE to establish processes to implement any development approach or methodology including, e.g. agile, evolutionary, incremental, test driven development, etc. based on the VSE organization or project needs.

8.2 SR objectives

SR.01. *Tasks* of the activities are performed through the accomplishment of the current *Project Plan.*

SR.O2. System requirements are defined, analysed for correctness and testability, approved by the Acquirer, baselined and communicated.

SR.O3. The System architectural design is developed and baselined. It describes the *System elements* and internal and external interfaces of them. Consistency and traceability to system requirements are established.

NOTE   System architecture and detailed design can be performed separately according to the project schedule.

SR.O4. System elements defined by the design are produced or acquired. Acceptance tests are defined and performed to verify the consistency with requirements and the design. Traceability to the requirements and design are established.

SR.O5. System elements are integrated. Defects encountered during integration are corrected and consistency and traceability to *System Architecture* are established.

SR.O6. A *System Configuration*, as agreed in the Project Plan, and that includes the engineering artefacts is integrated, baselined and stored at the *Project Repository*. Needs for changes to the *Product* are detected and related change requests are initiated.

SR.O7. Verification and Validation *Tasks* of all required work products are performed using a defined criteria to achieve consistency among output and input products in each activity. Defects are identified, and corrected; records are stored in the *Verification/Validation Reports*.

NOTE   It's not the intention that all verification activities and work products are made available to the acquirer and other stakeholders. Verifications should be performed by individuals that have organizational freedom, authority, to permit objective evaluation, and to initiate, effect, resolve and verify problem resolution.

8.3   SR input products

Table 11 — SR input products

Name	Source
Project Plan	Project Management
Project Repository	Project Management

8.4   SR output products

Table 12 — SR output products

Name	Destination
All deliverables from SR	Project Management

8.5   SR internal products

Table 13 — SR internal products

| Name |
|---|
| *Validation Report* |
| *Verification Report* |

8.6   SR roles involved

Table 14 — SR roles involved

Role	Abbreviation
Acquirer	ACQ
Systems Engineer	SYS
Designer	DES
Developer	DEV
IVV Engineer	IVV
Project Manager	PJM
Stakeholder	STK
Supplier	SUP
Work Team	WT

8.7   SR diagram

Overview SR diagram

The following diagram shows the flow of information between the System Definition and Realization Process activities including the most relevant work products and their relationship.
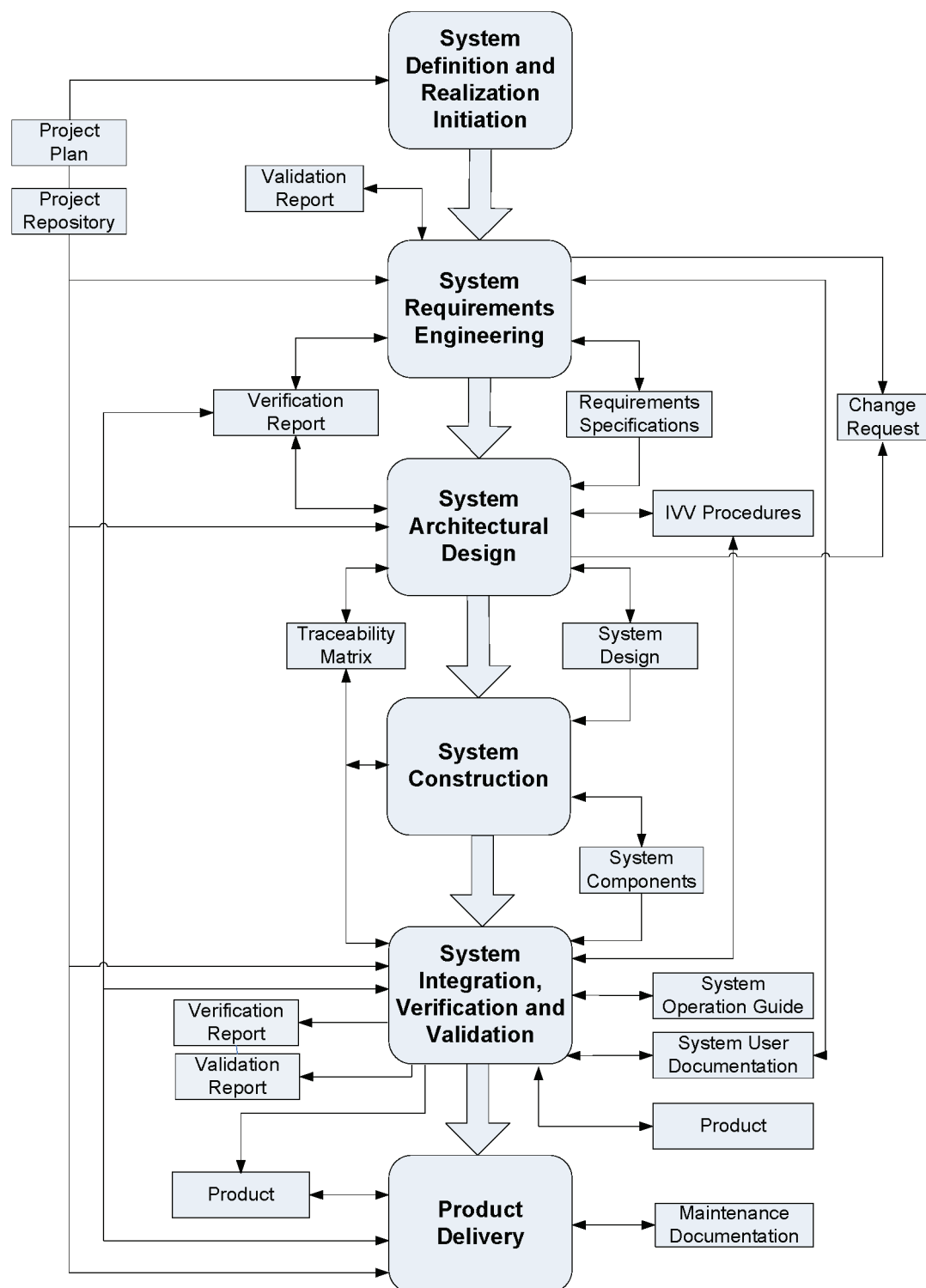
Figure 4 — System Definition and Realization process diagram

Note: All the feedback lines are not all displayed to facilitate readability.

8.7.1 SR activities

The System Definition and Realization Process has the following activities:

— SR.1 System Definition and Realization Initiation

— SR.2 System Requirements Engineering

— SR.3 System Architectural Design

— SR.4 System Construction

— SR.5 System Integration, Verification and Validation

— SR. 6 Product Delivery

8.7.1.1 SR.1 System Definition and Realization Initiation (SR.O1)

The System Definition and Realization Initiation activity ensures that the *Project Plan* established in Project Planning activity is committed to by the Work Team. The activity provides:

— Review of the *Project Plan* by the Work Team to determine task assignment.

— Commitment to *Project Plan* by the Work Team and Project Manager.

— An established implementation environment.

Table 15 — SR.1 task list

Role	Task List – SR.1	Input Products	Output Products
PJM WT	SR.1.1 Revise the current *Project Plan* with the Work Team members in order to achieve a common understanding and get their engagement with the project.	Project Plan	Project Plan [*reviewed*]
PJM SYS	SR.1.2 SYS shall define in cooperation with the PJM the technical activities and generate the SEMP.	Project Plan [*reviewed*]	Systems Engineering Management Plan
PJM WT	SR.1.3 Define the data model of the project Define the entities to manage in the project (e.g. requirement, *system element*, *IVV plan*, *IVV procedure*, *Integration Report*, *Verification Report*, *Validation Report*), their properties (e.g. maturity, version, target release) and their relation (e.g. satisfy, allocated to, verify, validate)	Project Plan [*reviewed*]	Data Model
PJM WT	SR.1.4 Set or update the implementation environment.	Project Plan [*reviewed*] Data Model	Implementation environment

8.7.1.2 SR.2 System Requirements Engineering (SR.O2, SR.O6, SR.O7)

The System Requirements Engineering activity elicits and analyses the Acquirer and other Stakeholders' requirements, including legal and/or regulatory requirements. It establishes the agreed system requirements. In parallel of the architectural design activities, it establishes System Element requirements. The activity provides:

— Work Team review of the *Project Plan* to determine task assignment.

— Elicitation, analysis and specification of Acquirer and other stakeholders' requirements.

— Specification and agreement on the System requirements.

— Specification of system elements' requirements

— Verification of implemented system against System and System elements requirements

— Validation of Stakeholder, System and System Elements requirements

— Validation of implemented system against Stakeholder requirements

— Establish and update the traceability between Stakeholders, System, System Elements requirements

— Establish and update the coverage of Requirements by IVV artefacts

— Configuration management of System Requirements Engineering products as agreed in the Configuration Management Plan

Table 16 — SR.2 task list

Role	Task List – SR.2	Input Products	Output Products
SYS ACQ STK	SR.2.1 Elicit acquirer and other stakeholders requirements and analyse system context Identify and consult information sources of requirements (e.g. Acquirer, users, stakeholders, previous systems, documents), Statement of Work, Concept documents, previous System description, etc. Analyse the context of use of the system with acquirer and other stakeholders: • Identify the stakeholders • Define the concepts of use of the system • Define scenarios, business processes Generate or update the * Concept of Operations that describes the way the system works from the operator's perspective. Identify and analyse requirements to • Determinate the scope and system boundary, • If applicable, identify the strengths and weaknesses of the previous system • Ensure that the Stakeholder requirements are complete and consistent • Elicit missing Stakeholder requirements Resolve conflicting, duplicate and out-of-scope Stakeholder requirements Generate or update the *Stakeholders' Requirements Specifications.*	Project Plan • Tasks [*assigned*] Statement of Work [*reviewed*] Systems Engineering Management Plan	Stakeholders Requirements Specifications [*initiated*]
PJM WT	SR.2.2 Verify the *Stakeholders Requirements Specifications* with PJM Obtain Work Team agreement on the *Stakeholder Requirements Specifications*	Stakeholders Requirements Specifications [*initiated*]	Stakeholders Requirements Specifications [*verified*] Verification Report • Stakeholders Requirements Specifications [*published*]

Table 16 *(continued)*

Role	Task List – SR.2	Input Products	Output Products
PJM SYS ACQ STK	SR.2.3 Validate the *Stakeholders Requirements Specifications* with the Acquirer and other stakeholders Obtain Acquirer and Stakeholder agreement on the *Stakeholder Requirements Specifications*	Stakeholders Requirements Specifications [*verified*]	Validation Report • Stakeholders Requirements Specifications [*published*] Stakeholders Requirements Specifications [*validated*]
SYS DES	SR.2.4 Elaborate System Requirements and Interfaces Define the system boundary. Define interface requirements between the System and its environment. Note: Interface requirements are included in *System Requirements Specifications.* Separate specification document can be established. Define System requirements, System design constraints and interface requirements with external entities/actors using the SMART criteria: Specific, Measurable, Accepted, Realistic and Traced. Define the external functions ensured by the system (black box). Define reuse constraints. Define the applicable requirements and constraints to the system Generate or update the *System Requirements Specifications*	Stakeholder Requirements Specifications [*validated*]	System Requirements Specifications [*initiated*]

Table 16 *(continued)*

Role	Task List – SR.2	Input Products	Output Products
DES SYS	SR.2.5 Elaborate *System Elements Requirements Specifications* and the *System Interfaces Specifications* Note: System Element requirements are generally elaborated in parallel with the System Functional and Physical Architectural Design Activity (see Activities SR.3.1 and SR.3.3) Allocate System requirements to System elements using the functional and physical architecture and decompose requirements so that System element requirements are distinctively and clearly defined. Elaborate System element requirements derived from the System architectural design but that cannot be traced to a specific parent System requirement Refine as necessary external interface requirements and identify internal interface requirements between System Elements. Generate or update a *System Element Requirements Specifications* for each System Element defined in the System Design Document. Note: Interface requirements are included in System Elements Requirements Specifications. Separate specification document can be established. Note: System elements requirements become needs and expectation in input of the system elements implementation.	System Requirements Specifications [*initiated*] System Design Document	System Elements Requirements Specifications - System Interfaces Specifications [*initiated*]
PJM WT	SR.2.6 Verify and obtain Work Team (WT) agreement on the *System and System Elements Requirements Specifications* Ensure with WT that requirements are SMART. In particular • are precise, concise, non-ambiguous • are consistent (in the same specification, with input specifications) • are properly traced • can be implemented (DES) • can be verified and validated (IVV) • fall within cost and schedule constraints of the project The results found are documented in a *Verification Report* and corrections are made until the document is approved by PJM. If documents are under configuration, identify and characterize the impact of the change and initiate if necessary (i.e. change approved) a *Change Request.*	System Requirements Specifications [*initiated*] System Elements Requirements Specifications [*initiated*]	Verification Report • System Requirements Specifications System Requirements Specifications [*verified*] Systems Elements Requirements Specifications [*validated*] Change Request (if needed)

Table 16 *(continued)*

Role	Task List – SR.2	Input Products	Output Products
ACQ STK SYS	SR.2.7 Validate that System *Requirements Specifications* satisfies *Stakeholders Requirements Specifications.* The results found are documented in a *Validation Report* and corrections are made until the document is approved by the SYS.	System Requirements Specifications [*verified*] Stakeholders Requirements Specifications [*validated*]	Validation Report • System Requirements Specifications [*published*] System Requirements Specifications [*validated*]
SYS DES	SR.2.8 Define or update traceability between Requirements According to the *data model* defined in SR.1.2, at each level of decomposition of the system, define or update traceability between • System requirements, interface requirements and their parent stakeholder's requirements • System elements requirements, interface requirements and their parent system requirements.	Stakeholder Requirements Specifications [*validated*] System Requirements Specifications [*validated*] System Elements Requirements Specifications [*validated*]	Traceability Matrix *[updated]*
SYS IVV	SR.2.9 Establish or update the *IVV plan* and *IVV Procedures* for the System verification and validation. Establish traceability between IVV Plan and the specified Requirements, between IVV Procedures and IVV Plan Note: Verification is the confirmation, through the provision of objective evidence, that specified requirements have been fulfilled. Methods of verification are: inspection, review, simulation, test. Note: Validation is the confirmation, through the provision of objective evidence, that the requirements for a specific intended use or application have been fulfilled Note: The IVV plan can be a single document or a separate document	System Requirements Specifications [*validated*] System Elements Requirements Specifications Stakeholders Requirements specifications [*validated*]	IVV plan [*published*] IVV Procedures [*published*]

8.7.1.3   SR.3 System Architectural Design (SR.O3, SR.O6, SR.O7)

The System Architectural activity transforms the system requirements to the system functional and physical architecture. The activity provides:

— Work Team review of the *Project Plan* to determine task assignment.

— Design the system functional architecture and associated interfaces.

— Design the system physical architecture and associated interfaces, allocation of the functional to the physical architecture.

— Work Team review of the System *Requirements Specifications.*

— *Functional and physical Design* verified and defects corrected.

— Verified *IVV Plan (Integration, Verification, validation, Qualification) and Verification Procedures.*

— Traceability between the functional architecture definition and the System Requirements and between the physical architecture definition, the System Elements and the functional architecture definition.

— Design products placed under configuration management.

Table 17 — SR.3 task list

Role	Task List – SR.3	Input Products	Output Products
DES	SR.3.1 Document or update the *Functional System Design.* Elaborate the functional architecture with the internal functions of the system and their relations (interfaces), by analysing: • The System Requirements • The external functions of the system (black box) Define the internal functions and interfaces. Identify the artefacts to reuse. Decide whether to make, buy or reuse. * Elaborate the Purchase Order (PO) for the artefact to be purchased. Define in parallel the System elements requirements and interface requirements	Project Plan • Tasks [*assigned*] System Requirements Specifications [*validated*] Traceability Matrix [*updated*]	System Design Document: • System Functional Architecture *Purchase order *[initiated]*
SYS DES	SR.3.2 Make trade-offs of the *System* Functional *Architecture* Make trade-offs among the different possible functional architectures relative to the requirements. Update the *Justification Document* and establish traceability with the requirements as defined in PM. Functional architecture can be done in a model based environment and generated as a document. Note: trade-offs is used here as a product name of a recording decision-making action within a *Justification Document*	System Design Document: • System Functional Architecture	Justification Document • System Functional architecture trade-offs

Table 17 *(continued)*

Role	Task List – SR.3	Input Products	Output Products
DES	SR.3.3 Document or update the Physical System Design. Elaborate the physical architecture by: • analysing the System Requirements (e.g. non functional requirements allocated directly the System Elements) • analysing the Functional Architecture and allocating internal functions to System Elements • Identifying System Elements to reuse. Identify the artefacts to reuse. Decide whether to make, buy or reuse. * Elaborate the Purchase Order for the artefact to be purchased. Analyse the design as needed to demonstrate it can satisfy System Requirements (e.g. maintainability, reliability, security, safety integrity, usability) Elaborate the physical and functional interfaces (external and internal) between System Elements. Define in parallel the interface requirements	System Requirements Specifications [*validated*] System Design Document: • System Functional Architecture	System Design Document: • System Physical Architecture *Purchase order *[initiated]*
SYS DES	SR.3.4 Make trade-offs of the System Physical Architecture Make trade-offs among the different possible physical architectures relative to the requirements and the functional architecture. Update the *Justification Document* and establish traceability with the requirements. Physical architecture can be done in a model based environment and generated as a document Generate or update the Traceability Matrix. Note: trade-offs is used here as a product name of a recording decision-making action within a *Justification Document*	System Design Document: • System Functional Architecture • System Physical Architecture	Justification Document • System physical architecture trade-offs Traceability Matrix [*updated*]
SYS DES DEV	SR.3.5 Verify and obtain approval of the *System Design.* Verify correctness of *System Design*, its feasibility and consistency with their System *Requirements Specifications*. Use the *Traceability Matrix* to verify the adequate satisfaction of System Requirements. The results found are documented in a *Verification Report* and corrections are made until the document is approved by DES. If System Design is under configuration management, identify and characterize the impact of the change and initiate if necessary (i.e. change approved) a *Change Request.*	System Design Document - System Functional Architecture - System Physical Architecture Traceability Matrix System Requirements Specifications [*validated*]	Verification report • System Design Document System Design Document [*validated*] Change Request (if needed) Traceability Matrix [*updated*] Change request (if needed)

Table 17 *(continued)*

Role	Task List – SR.3	Input Products	Output Products
DES SYS	SR.3.6 Establish or update *the Integration plan and Integration Procedures* for System integration. Define or update the *IVV Plan and IVV Procedures* based in the System Design and the *System Elements Requirements Specifications* Establish traceability between IVV Plan and the specified Requirements, between IVV Procedures and IVV Plan.	System Elements Requirements Specifications [*validated*] System Design Document [*validated*]	IVV Plan IVV Procedures Traceability Matrix [*updated*]
SYS	SR.3.7 Document the **System User Manual* or update the current one, if appropriate. Note: The *System User Manual* can be initiated in a preliminary version from the *System Requirements Specifications*, **Concept of Operation* are available. *(Optional)	* Concept of Operations System Requirements Specifications System Design Document System [*verified*]	• System User Manual [*preliminary*]
SYS ACQ STK	SR.3.8 Verify and obtain approval of the ** System User Manual,* if appropriate Verify consistency of the System *User Manual* with the System. Demonstrate the use of the System with its *User Manual.* The results found are documented in the *Verification Report* and corrections are made until the document is approved by ACQ and STK. *(Optional)	* System User Manual System [*preliminary*]	Verification Report • System User Manual Validation Report • System User Manual * System User Manual [*verified*]

8.7.1.4   SR.4 System Construction (SR.O4, SR.O6, SR.O7)

The System Construction involves Physical Construction and/or Software Construction.

The Software Construction develops the software elements of the system from the *System Design.*

The Hardware Construction develops the Hardware system elements from the *System Design*, that include (or not) software elements. The activity provides:

— Work Team review of the *Project Plan* to determine task assignment.

— Work Team review of the Physical *Design*.

— *Hardware System Elements* to be developed and tested.

— *Software System Elements* to be developed and tested.

— Traceability between Hardware *Construction, Software Construction* and *Physical Architecture,*

Table 18 — SR.4 task list

Role	Task List – SR.4	Input Products	Output Products
DEV	SR.4.1 Construct or update Software System Elements. Software Construction could be performed according to the ISO/IEC TR 29110-5-1–2	Project Plan - Tasks [*assigned*] System Elements Requirements Specifications [*validated*]	Bought, built or re-used Software System Elements Software System Elements data
DEV	SR.4.2 Construct or update Hardware System Elements. Buy, build or re-use the Hardware System Elements identified in the *System Design Document* and in accordance with the *Project Plan* with regards to fabrication stages (i.e. prototyping, first article, pre-series, series production) In case of Hardware System Elements with software, integrate the Software System Elements into the Hardware System Elements	Project Plan - Tasks [*assigned*] System Design Document [*validated*] System Elements Requirements Specifications [*validated*] Software System Elements Software System Elements data	Bought, built or re-used System Elements (HW, HW+SW) System Elements data (HW, HW+SW)
DEV DES SYS	SR.4.3 Verify that the *System Elements* satisfy their *System Elements Specifications* Perform in-coming acceptance verification of System Elements in accordance with: • the *Project Plan* • the *System Design Document* • the *System Elements Requirements Specifications* • the applicable *Verification Procedures*. Note: for Hardware System Elements that include software, this task includes the verification of the integration of the software into the hardware System Elements.	Bought, built or re-used System Elements (HW, HW+SW) Project plan [*accepted*] System Design Document [*validated*] System Elements Requirements Specifications [*validated*] IVV Procedures [*verified*]	Bought, built or re-used System Elements (HW, HW+SW) [*verified*] Bought, built or re-used System Elements (HW, HW+SW) [*rejected*]
DEV	SR.4.4 Correct the defects found until successful verification (reaching exit criteria) is achieved.	Bought, built or re-used System Elements (HW, HW+SW) [*rejected*]	Bought, built or re-used System Elements (HW, HW+SW) [*accepted*]

8.7.1.5 SR.5 System Integration, Verification and Validation (SR.O5, SR.O6, SR.O7)

The System Integration and verification, validation activity ensures that the integrated System Elements (e.g. Hardware, Hardware + Software) satisfy the system requirements. The activity provides:

— Work Team review of the *Project Plan* to determine task assignment.

— Understanding of *IVV plan and Procedures* and the integration environment.

— Integrated *System Elements*, corrected defects and documented results.

— Documented and verified operational and system user documentations.

— Verified System baseline.

Table 19 — SR.5 task list

Role	Task List – SR.5	Input Products	Output Products
DES SYS DEV IVV	SR.5.1 Verify *IVV plan and IVV Procedures.* Verify consistency between System *Requirements Specifications*, *System Design* and *IVV Plan and IVV Procedures.* The results found are documented in a *Verification Report.*	Project Plan • Tasks [*assigned*] IVV plan IVV Procedure System Requirements Specifications [*validated*] System Design Document [*validated*]	Verification Report • IVV plans • IVV Procedures IVV plan [*verified*] IVV Procedures [*verified*]
IVV DES SUP	SR.5.2 Integrate the System using *System Elements* (HW, HW+SW) Verify the interfaces according to *IVV Plan* and *IVV Procedures* for integration testing. The results found are documented in the *Integration Report.*	System Design Document [*validated*] System Elements Requirements Specifications [*validated*] Traceability Matrix [*updated*] Bought, built or re-used System Elements (HW, HW+SW) [*accepted*] Integration Procedures [*verified*]	Integration Report System [*integrated*]
IVV SYS	SR.5.3 Verify the System against its Requirements The results found are documented in a *Verification Report.* Prepare the acceptance of the system.	System Requirements Specifications [*validated*] Traceability Matrix [*updated*] IVV Procedures [*verified*]	System [*verified*] Verification Report

Table 19 *(continued)*

Role	Task List – SR.5	Input Products	Output Products
IVV SYS ACQ	SR.5.4 Validate the System against its Stakeholders Requirements Accept the System by ACQ	Stakeholders Requirements Specifications [*validated*] Traceability Matrix [*updated*] IVV Procedures [*verified*] System [*verified*]	System [*validated*] Validation Report Product Acceptance Record • System [*approved*]
WT	SR.5.5 Correct the defects found and retest to detect faults introduced by the modifications.	System [*validated*] Verification Report Validation Report IVV Procedures [*verified*]	System [*corrected*] Verification Report [*defects eliminated*] Validation Report [*defects eliminated*]
SYS DES	SR.5.6 Document the *System Operation Guide* or update the current guide, if appropriate. *(Optional)	System [*verified*]	*System Operation Guide [*preliminary*]
SYS ACQ STK	SR.5.7 Verify and obtain approval of the *System Operation Guide*, if appropriate Verify consistency of the *System Operation Guide* with the System. The results found are documented in a *Verification Report*. *(Optional)	*System Operation Guide	Verification Report • System Operation Guide *System Operation Guide [*verified*] and [*baselined*]

8.7.1.6   SR.6 Product Delivery (SR.06, SR.07)

The Product Delivery activity provides the integrated System (i.e. Product) to the Acquirer and other stakeholders. The activity provides:

— Work Team review of the *Project Plan* to determine task assignment.

— Verified System *Maintenance Document*.

— Delivery of the *Product* and applicable system documentation in accordance with the *Delivery Instructions*.

Table 20 — SR.6 task list

Role	Task List – SR.6	Input Products	Output Products
PJM WT	SR.6.1 Review Product	System elements Project Plan • Delivery Instructions	Product Acceptance Record - Product
SYS DES	SR.6.2 Document the *System Maintenance Document* or update the current one(s).	Project Plan • Tasks assigned System Configuration	System Maintenance Document [*initiated*]
SYS DES	SR.6.3 Identify training needs and develop System User and Maintenance Training Curriculum and Material in accordance with the *Project Plan*. Note: The *System Training Specifications* is an input to develop the System and Maintenance training enabling systems.	System Requirements Specifications [*validated*] System User Manual [*verified*]	System Training Specifications [*initiated*]
PJM SYS DES STK ACQ	SR.6.4 Verify and obtain approval of the System *Maintenance Document and System Training Specifications.* Verify consistency of System *Maintenance Document* with *System Requirements Specifications.* Verify consistency of System *Training Specification with System Requirements Specifications.* Validate the *System Training Specifications* and *System Maintenance Document* with the acquirer and the other stakeholders The results found are documented in a *Verification Report* and corrections are made until the document is approved by PJM and maintenance as a stakeholder (STK).	System Maintenance Document System Training Specifications	Product Acceptance Record - Product [*approved*] and [*published*] System Maintenance Document [*validated*] System training Specifications [*validated*]
PJM ACQ	SR.6.5 Perform delivery Support delivery of training to Acquirer and other Stakeholders including: • Training-the-trainer • Support to pilot training classes In case of Hardware/Software upgrades, support transition from previous to new system, according to Project Plan including; • Legacy data conversion/transfer • System transition provisions such as interim/bridge System or System Elements • Replaced/obsolete hardware/software/data "sun setting", archiving or disposal	Project Plan • Tasks on Product delivery assigned • Delivery Instructions Product System [*validated*]	Product [*delivered*]
PJM	SR.6.6 Transition to Manufacturing and In-service/After-sales Support	Product [*delivered*]	Product Acceptance Record [*published*]

8.7.2   SR incorporation to the Project Repository

The list of products to be saved in the *Project Repository*. After the incorporation, the *Configuration Management* has to be applied to: System *Requirements Specifications, System Design, Traceability Matrix, IVV Plan and IVV Procedure, System Elements (Hardware, Hardware + Software, Software), System, System Operation Guide, System User Documentation, Maintenance and Training Documentation.*

Table 21 — SR repository products

Product
Implementation Environment
Stakeholders Requirements Specifications
System Requirements Specifications
System Elements Requirements Specifications
System Operation Guide
System Design Document   • *System Functional Architecture*   • *System Physical Architecture*
Justification Document
System Functional Architecture Trade-offs
System Physical Architecture Trade-offs
IVV plan
IVV Procedures
Traceability Matrix
Bought, built or re-used System Elements (HW, HW+SW)
System
System User Manual
System Maintenance Document
System Training Specifications
Verification Reports
Validation Reports
System Configuration
Product Acceptance Record

9   Roles

This is an alphabetical list of the roles, its abbreviations and suggested competencies description. All role names are printed in roman and abbreviated with capital letters. This list is showed as a four-column table for presentation purpose only.

Table 22 — Roles

	Role	Abbreviation	Competency
1.	Acquirer	ACQ	The Acquirer is the Stakeholders representative. He is responsible for the acquisition of the System.
			The acquirer may be internal or external to the supplier organization. Acquisition of a product may involve, but does not necessarily require, a legal contract or a financial transaction between the acquirer and supplier. In some context the Acquirer is the end user of the system.
			Knowledge of the Stakeholders processes and ability to explain the Stakeholders requirements. The Acquirer is the role of the organization that receives the product or service. In some context the Acquirer is the end user of the system.
			The Acquirer must have the authority to approve the requirements and their changes.
			The Stakeholders includes user representatives in order to ensure that the operational environment is addressed.
			Knowledge and experience in the application domain.
2.	Designer	DES	Knowledge and experience in the architecture design.
			Knowledge of the revision techniques.
			Knowledge and experience in the planning and performance of integration tests.
			Knowledge of the editing techniques.
			Experience on the system development and maintenance.
3.	Developer	DEV	Knowledge in fabrication, development (HW, SW)
			Knowledge and experience in the application domain
4.	IVV Engineer	IVV	Knowledge of the Requirements, Design
			Knowledge in inspection, peer review, simulation, and review techniques
			Knowledge in testing techniques
5.	Project Manager	PJM	Leadership capability with experience making decisions, planning, personnel management, delegation and supervision, finances and system development.
6	Stakeholder	STK	Stakeholders are actors that have an interest in the system, all along its life cycle, such as, representatives of users, users, maintainers, security, trainers, regulatory bodies, suppliers.
			STK should have Knowledge of the Stakeholder (e.g. manufacturer, maintainer, tester, logistic) processes and ability to explain the Stakeholder requirements.
			The Stakeholder (representative) must have the authority to approve the requirements and their changes.
			Knowledge and experience in the application domain.
7.	Supplier	SUP	Supplier of a System Element of the system: hardware, software, or hardware with software.

Table 22 *(continued)*

	Role	Abbreviation	Competency
8.	Systems Engineer	SYS	Knowledge and experience eliciting, specifying and analysing the requirements.
			Knowledge in designing user interfaces and ergonomic criteria.
			Knowledge of the revision techniques.
			Knowledge of the requirements authoring.
			Knowledge of the business domain
			Experience on system development, integration, operation and maintenance
			Experience on the system development and maintenance.
9.	Work Team	WT	Knowledge and experience according to their roles on the project: SYS, DES, DEV, IVV.
			Knowledge on the standards used by the Acquirer and/or by the VSE.

10 Product description

This is an alphabetical list of the input, output and internal process products, its descriptions, possible states and the source of the product. The source can be another process or an external entity to the project, such as the Acquirer. This list is showed as a four-column table for presentation purpose only. ISO/IEC/IEEE 15289:2011 definitions of Information Products were used to develop the Product Descriptions of Table 23.

The product status gives the information to the project team about the type of work (tasks) already done on the product (for example: evaluated, verified, tested, baselined). This information can be used to start next tasks which can use the product as an input. Some products have no status assigned because they are only informative and they do not change the content (for example: Acceptance Record, Correction Register, Project Repository Backup, Verification/Validation Results).

Table 23 — Product Descriptions

	Name	Description	Source
1.	*Change Request*	Identifies a *System*, or documentation problem or desired improvement, and requests modifications. It may have the following characteristics: • Identifies purpose of change • Identifies request status • Identifies requester contact information • Impacted system(s), system element(s) • Impacted IVV facilities • Impact to operations of existing system(s) defined • Impact to associated documentation defined • Criticality of the request, date needed The applicable statuses are: submitted, evaluated, approved, rejected, postponed	System Definition and Realization Project Management

Table 23 *(continued)*

	Name	Description	Source
2.	*Correction Register*	Identifies activities established to correct a deviation or problem concerning the accomplishment of a plan. It may have the following characteristics: • Identifies the initial problem • Defines a solution • Identifies corrective actions taken • Identifies the ownership for completion of defined actions • Identifies the open date and target closure date • Contains a status indicator • Indicates follow up actions • Includes rational of deviation correction action The applicable statuses are: initial, published	Project Management
3.	*Data Model*	Defines the properties and relations between entities of a project. It may include: • Requirements • Functions • System elements • IVV plans • IVV results • Justification elements	Project Management
4.	*Disposed System*	A system that has been transformed (i.e. state change) by applying the disposal process	
5.	*Implementation Environment*	The environment and tools (software and hardware) required to specify, design, develop, integrate, verify, validate, manage the configuration and deploy the system.	System Definition and Realization
6.	*Integration Report*	Document the integration execution. It may include the record of: • Reference to the related IVV procedures • Date • Place • Duration • Verification check-list • Passed items of integration • Failed items of integration • Pending items of integration: not run, partial execution • Defects identified during integration The applicable status is: published	System Definition and Realization

Table 23 *(continued)*

	Name	Description	Source
7.	*IVV Plan*	Elements needed to integrate, verify and validate the system. It may be a single documents with dedicated paragraphs or separate documents (Integration plan, verification plan, validation plan, qualification plan) *IVV Plan* may include: • Identifies the IVV activities regarding the System Requirements: inspection, reviews, simulation, test items • Identifies the System integration strategy regarding the System Elements Requirements and interfaces. • Environmental constraints • Requirements for IVV means • Special procedural requirements The applicable statuses are: verified, published	System Definition and Realization
8.	*IVV Procedure*	Elements to execute the IVV tasks. It may be a single documents with dedicated paragraphs or separate documents (e.g. Integration procedure, verification procedure, validation procedure, qualification procedure) IVV Procedure may include: • Purpose of the IVV procedure • Reference to the IVV plan • Defines the prerequisites • Defines procedure steps including the step number, the required action and the expected results The applicable statuses are: verified, accepted, updated, and reviewed.	System Definition and Realization
9.	*Justification Document*	The justification document contains all the justifications of choices, decisions (e.g. trade-offs), results of integration verification validation. This document is elaborated progressively during the development of the system. It can be used to justify the compliance for certification or qualification. The applicable statuses are: initial, published	System Definition and Realization

Table 23 *(continued)*

	Name	Description	Source
10.	*Meeting Record*	Records the agreements established with Acquirer and/or Work Team. It may have the following characteristics: • Purpose of meeting • Attendees • Date, place held • Reference to previous minutes • What was accomplished • Identifies issues raised • Any open issues • Agreements • Next meeting, if any. The applicable status is: published.	Project Management
11.	*Product Accept-ance Record*	Documents the Acquirer acceptance of the *Deliverables* of the project. It may have the following characteristics: • Record of the receipt of the delivery • Identifies the date received • Identifies the delivered elements • Records the verification of any Acquirer acceptance criteria defined • Identifies any open issues (if applicable) • Signed by receiving Acquirer The applicable statuses are: approved, published	Project Management

Table 23 *(continued)*

	Name	Description	Source
12.	*Product*	A uniquely identified and consistent set of system elements including: • *Stakeholders Requirements Specification System Requirements Specification* • *System Elements Requirements Specification* • *System Design Document* • *Traceability Matrices (includes Requirements traceability matrix, Requirements coverage matrix)* • *System Elements* • *System* • *Bought, built or re-used System Elements* • *IVV Plan* • *IVV Procedure* • *Verification Report* • *Validation Report* • *System Operation Guide* • *System User Manual* • *System Maintenance Document* The main applicable statuses are: delivered and accepted.	System Definition and Realization

Table 23 (continued)

	Name	Description	Source
13.	*Project Plan*	Presents how the project processes and activities will be executed to ensure the project's successful completion, and the quality of the deliverable system. It Includes the following elements which may have the characteristics as follows: - Reference to the *SOW* - *System Description* - Purpose - General Acquirer requirements - *Scope* description of what is included and what is not - *Objectives* of the project - *Deliverables* – list of system items to be delivered to Acquirer - *System Breakdown Structure* - *Tasks with leaders and contributors*, including verification, validation and reviews with Acquirer and Work Team, to ensure the quality of work products. *Tasks* may be represented as a Work Breakdown Structure (WBS). - *Estimated Duration* of tasks - *Resources* (humans, materials, standards, equipment and tools) including the required training, and the schedule when the *Resources* are needed. - *Composition of Work Team and roles* - *Schedule of the Project Tasks,* the expected start and completion date for each task, and the relationship and dependencies of the *Tasks*. - *Milestones* - *Estimated Effort and Cost* - *Risk Management Approach* - Identification of Project Risks - Evaluation of each risk - Assignation of a priority to each risk - Treatment of risks - Periodically monitor risks for change - Periodically reviewing risk information on the risks identified	Project Management

Table 23 *(continued)*

	Name	Description	Source
13.	*Project Plan*	- *Configuration Management Strategy* - System configuration management tool and mechanisms identified - Version identification and control defined - Backup and recovery mechanisms defined - Storage, handling and delivery (including archival and retrieval) mechanisms specified - *Change control process* to manage the changes based on impact studies using traceability and change control boards. - *Delivery Instructions* - Elements required for system release identified (i.e. hardware, software, documentation) - Delivery requirements - Sequential ordering of *Tasks* to be performed - Applicable releases identified - Identifies all delivered *System Elements* with version information - Identifies any necessary backup and recovery procedures - *Disposal Management Approach* - Defines schedules, actions and resources - Defines how to transform the system into, or retain it in, a socially and physically acceptable state The applicable statuses are: verified, accepted, updated and reviewed.	
14.	*Project Repository*	Container to store project work products and deliveries. It may have the following characteristics: • Stores project work products • Stores released *Deliverables* products • Storage and retrieval capabilities • Ability to browse content • Listing of contents with description of attributes • Sharing and transfer of work products between affected groups • Effective controls over access • Maintain work products descriptions • Recovery of archive versions of work products • Ability to report work products status • Changes to work products are tracked to *Change Requests* The applicable statuses are: established, recovered and updated.	Project Management
15.	*Project Repository Backup*	Repository used to backup the *Project Repository* and, if necessary, to recover the information.	Project Management

Table 23 *(continued)*

	Name	Description	Source
16.	*Progress Status Record*	Records the status of the project against the *Project Plan*. It may have the following characteristics: • Status of actual *Tasks* against planned *Tasks* • Status of actual results against established *Objectives*/ goals • Status of actual resource allocation against planned *Resources* • Status of actual cost against budget estimates • Status of actual time against planned schedule • Status of actual risk against previously identified • Record of any deviations from planned *Tasks* and reason why. The applicable status is: evaluated.	Project Management
17.	*Purchase Order*	Defines the artefact to be purchased. It may have the following characteristics: • Name and address of supplier • Description of the item purchased • Agreed price • Quantity • Delivery date The applicable statuses are: initiated, approved.	

18.	*Stakeholders Requirements Specifications*	Defines the acquirer and other stakeholder's requirements.
		
		It may be in a single document with all stakeholders explicitly identified or in separate documents.
		
		It may have the following characteristics:
		
		• Introduction – general description of *the main goals; needs and expectations*
		
		• Requirements description:
		
		  - Regulation
		
		  - Capabilities
		
		  - Performances
		
		  - Scenarios, * Concepts of operations
		
		  - User interface
		
		  - Interfaces
		
		  - Reliability
		
		  - Maintenance
		
		  - Interoperability
		
		  - Constraints
		
		The applicable statuses are: initiated, approved, baselined
			System Definition and Realization

Table 23 *(continued)*

	Name	Description	Source

19.	*Statement of Work (SOW)*	Description of work to be done related to *System* development. It may Include:
		
		- *System Description (Needs and expectations)*
		
		  - Purpose
		
		  - Acquirer and stakeholders requirements
		
		  - Constraints (regulation, imposed solutions…)
		
		- *Scope* description of what is included and what is not
		
		- *Objectives* of the project
		
		- *Deliverables* list of products to be delivered to Acquirer
		
		A SOW could be part of a contract between the Acquirer and the Supplier
		
		The applicable status is: reviewed.
			Project Management

20.	*System*	Combination of interacting elements organized to achieve one or more stated purposes. The applicable statuses are: verified, validated.	System Definition and Realization
21.	*Systems Engineering Management Plan (SEMP)*	Identifies and describes the project organization, roles and responsibilities, overall tasks, and engineering management planning required to control the design, development, fabrication, and tests associated with the Project. It may have the following Characteristics: • Introduction, Purpose, Scope • Company and Government Documents • Technical Project Planning and Control • Project Organization, Responsibility and Authority, Standards, Procedures, and Training, Work Breakdown Structures, Technical Design Verification and Validation, Change Control Procedures, Systems Integration, Interface Control, Project Schedule and Milestones, Project Reviews, Technical Performance Management (TPM), Technical Communication, Mission Assurance, Project Risk Analysis • Systems Engineering Process • Project Requirements Analysis and Definition, Functional Analysis, Requirement Allocation, Trade-off Studies, Design Optimization/Effectiveness Compatibility, Lessons Learned, Synthesis, Logistics Support, Producibility Analysis, Documentation, Systems Engineering Tools, Information Technology Systems Security, • Integration of Speciality Engineering Effort • Speciality Engineering, Integration Design, Integrated Validation Plan, Safety, Security, and Mission Assurance • Acronyms list, project organization, project WBS, project schedule, document tree The applicable statuses are: verified, accepted, reviewed	System Definition and Realization

Table 23 *(continued)*

	Name	Description	Source
22.	*System Design Document*	Textual and/or graphical information, model on the *System* structure (solution). This structure may include the following parts: Functional Architecture: • Identifies the required *Internal Functions* • Identifies the relationship between *Internal Functions* • Consideration is given to any required: - *System* performance characteristics - Functional and human interfaces - Security characteristics Physical Architecture: • Provides hardware design • Identifies the required *Physical Elements* • Identifies the allocation of *Internal Functions to Physical Elements* • Provides format of input / output interfaces: physical interfaces, functional data through physical interfaces. • Defines the format of required data structures The applicable statuses are: verified and baselined.	System Definition and Realization
23.	*System Element*	A product, that is part of a system, and that can be implemented to fulfil specified requirements. Examples: hardware, hardware with software, software, data, humans, processes (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	System Definition and Realization
24.	*System Elements Requirements Specifications*	Defines the system elements requirements that satisfy the system requirements according to the system functional and physical architecture. Interfaces resulting from the system functional and physical architecture may be defined within the *System Elements Requirements Specifications* or in separate document. Each requirement is uniquely identified and is described with the SMART criteria. The applicable statuses are: initiated, verified, validated and baselined.	

Table 23 *(continued)*

	Name	Description	Source
25.	*System Mainte-nance Document*	Defines the requirements and operations to maintain the system. It may have the following characteristics: • Maintenance Strategy - Accounts for the system's technical availability, replacements for system elements and logistical support, maintenance personnel training and staff requirements • Maintenance Enabling System Requirements – Requirements for any system needed to enable maintenance of the system-of-interest need to be developed • Maintenance Constraints on Design – Any constraints on the design arising from the maintenance strategy • Maintenance Procedure • Maintenance Report – Including documentation of the maintenance activity results, reporting of failures and recommendations for action, and failure and lifetime performance data. This report also documents any required procedure or system changes that should be accomplished as part of on-going configuration management activities. The applicable statuses are: preliminary, verified, validated	System Definition and Realization
26.	*System Operation Guide*	Contains the necessary information to install and manage the *System*. It may have the following characteristics: • Criteria for operational use • A description of how to operate the product including: - operational environment required - supporting tools and material (e.g. system user manuals) required - possible safety warnings - start-up preparations and sequence - frequently asked questions (FAQ) - sources of further information and help to operate the product • Certification and safety approvals • Warranty and replacement instructions • It should be written in terms that the personnel responsible for the operation can understand. The applicable statuses are: preliminary, verified and baselined.	System Definition and Realization

Table 23 *(continued)*

	Name	Description	Source

27.	*System Requirements Specifications*	Defines the system requirements that satisfy the stakeholders' requirements. It may have the following characteristics:
		
		• Introduction – general description of the *System* and its use within the *Scope* of the Acquirer business;
		
		• Requirements description:
		
		  - Functionality – established needs to be satisfied by the System when it is used in specific conditions. Functionality must be adequate, accurate and safe
		
		  - User interface – definition of those user interface characteristics that allow to understand and learn the *system* easily so the user be able to perform his/her *Tasks* efficiently including the interface exemplar description
		
		  - External interfaces – definition of interfaces with other system, software or hardware
		
		  - Reliability – specification of the system execution level concerning the maturity, fault tolerance and recovery
		
		  - Efficiency – specification of the system execution level concerning the time and use of the *Resources*
		
		  - Maintenability – degree of effectiveness and efficiency with which a product or system can be modified by the intended maintainers.
		
		  - Portability – description of the *System* characteristics that allow its transfer from one place to other
		
		  - Design and construction limitations/constraints –Interoperability – capability for two or more systems or *System Elements* be able to change information each other and use it
		
		  - Reusability – feature of any product/sub-product, or a part of it, so that it can be used by several users as an end product, in the own system development, or in the execution of other system products
		
		  - Legal and regulative – needs imposed by laws, regulations, etc.
		
		Each requirement is uniquely identified and is described with the SMART criteria.
		
		The applicable statuses are: initiated, verified, validated and baselined.
			System Definition and Realization

28.	*System Training Specifications*	Describes the requirements and operation to train the users, maintainers, and support personnel of a system to accomplish required tasks at any point in the system life cycle (transition, use, maintenance, disposal). The applicable statuses are: initiated, verified, validated and baselined.	System Definition and Realization

Table 23 *(continued)*

	Name	Description	Source
29.	*System User Manual*	Describes the way of using the *System* based on the user interface. It may have the following characteristics: • User procedures for performing specified *Tasks* using the *System* • Installation and de-installation procedures • Brief description of the intended use of the *System*: a user-oriented document that describes a system's operational characteristics from the end user's viewpoint (the concept of operations) • The supplied and required *Resources* • Needed operational environment • Availability of problem reporting and assistance • Procedures to access and exit the *System* • Lists and explains *System* commands and system-provided messages to the user • As appropriate for the identified risk, it includes warnings, cautions, and notes, with corrections • It includes troubleshooting and error correction procedures. It is written in terms understandable by users. The applicable statuses are: preliminary, verified and baselined.	System Definition and Realization
30.	*Traceability Matrix*	Documents the relationship between engineering and IVV artefacts according to the data model. It include: • Requirements traceability matrix • Requirements coverage matrix The applicable statuses are: verified, baselined and updated.	System Definition and Realization

Table 23 *(continued)*

	Name	Description	Source
31.	*Validation Report*	Documents the validation execution. It may include the record of: • Reference to the related IVV procedures • Date • Place • Duration • Validation check-list • Passed items of validation • Failed items of validation • Pending items of validation: not run, partial execution • Defects identified during validation The applicable status is: published	System Definition and Realization
32.	*Verification Report*	Documents the verification execution. It may include the record of: • Reference to the related IVV procedures • Date • Place • Duration • Verification check-list • Passed items of verification • Failed items of verification • Pending items of verification: not run, partial execution • Defects identified during verification The applicable status is: published	System Definition and Realization

11 System tools requirements

11.1 System tools requirements overview

System tools that could be used to perform process activities.

11.2 Project Management process

Table 24 — Project Management tools

Activity	Resource List
Project Planning Project Plan Execution Project Assessment and Control Project Closure	Tool allowing document, manage and control the *Project Plan.* Tool allowing Project scheduling, tasks definition, resources and cost management. Tool allowing the measurement of the project execution Tool to manage project configuration and changes.

11.3 System Definition and Realization process

Table 25 — System Definition and Realization tools

Activity	Resource List
System Definition and Realization Initiation System Requirements Engineering System Design System Integration System Verification Product Delivery	Requirements Engineering tool allowing elicitation, definition, management and traceability of requirements through the system life cycle (including exchanges with suppliers) Design tool allowing definition of the functional and physical architecture, definition of interfaces and traceability to the Requirements (including modelling tools). Tools allowing integration, verification, validation, qualification of the system. Tool to manage defects within a configuration management process Tools allowing training the stakeholders in the delivery phase to the use and maintenance of the system. Tools for documentation management.
System Construction	Construction Tools allowing developing the products of the system (hardware, software).

Annex A
(informative)

Systems Engineering Deployment Packages

In order to facilitate the implementation, by VSEs, of a Profile, a set of Deployment Packages are available. A deployment package is a set of artefacts developed to facilitate the implementation of a set of practices, of the selected framework, in a VSE. But, a deployment package is not a complete process reference model. Deployment packages are not intended to preclude or discourage the use of additional guidelines that VSEs find useful.

The elements of a typical deployment package are: technical description, relationships with ISO/IEC 29110, key definitions, detailed description of processes, activities, tasks, steps, roles, products, template, checklist, example, references and mapping to standards and models, and a list of tools. The mapping is only given as information to show that a Deployment Package has explicit links to Part 5, ISO standards, such as ISO/IEC 15288 and ISO/IEC/IEEE 15289, or models such as the CMMI-DEV® developed by the Software Engineering Institute. Hence by deploying and implementing a package, a VSE can see its concrete step to achieve or demonstrate coverage to Part 5. Deployment Packages are designed such that a VSE can implement its content, without having to implement the complete framework at the same time. The table of content of a system engineering deployment package is illustrated in Table A.1.

Table A.1 — Table of Content of a Systems Engineering Deployment Package

1. Technical Description

    Purpose of this document

    Why this Topic is important?

2. Definitions

3. Relationships with ISO/IEC 29110

4. Overview of Processes, Activities, Tasks, Roles and Products

5. Description of Processes, Activities, Tasks, Steps, Roles and Products

    Role Description

    System Description

    Artefact Description

6. Template(s)

7. Example(s)

8. Checklist(s)

9. Tool(s)

10. References to other Standards and Models (e.g. ISO 9001, ISO/IEC 15288, CMMI-DEV®)

11. References

12. Evaluation form

For the Basic Profile, a set of Systems Engineering Deployment Packages are available, at no cost, on the Internet:

a) System Requirements Engineering

b) System Architecture

c) Interface Management

d) System Integration, Verification and Validation

e) Configuration Management

f) Project Management

g) System Deployment

h) Self-Assessment

Annex B
(informative)

Mapping between the objectives of ISO/IEC TR 29110-5-6-2 and ISO/IEC 15288:2008

Sections B.1 and B.2 present the mapping between the objectives of ISO/IEC TR 29110-5-6-2 and ISO/IEC 15288:2008.

B.1 Correspondence with Project Management Process

PM.O1. The *Project Plan*, the *Statement of Work* (SOW) and commitments are reviewed and accepted by both the Acquirer and the Project Manager. The *Tasks* and *Resources* necessary to complete the work are sized and estimated.

6.3.1 Project Planning Process

a) Project plan is available;

e) Plan for the execution of the project is activated.

6.3.7 Measurement Process

a) The information needs of technical and management processes are identified.

[ISO/IEC 15288:2008, 6.3.1, 6.3.7]

PM.O2. Progress of the project is monitored against the *Project Plan* and recorded in the *Progress Status Record.* Corrections to remediate problems and deviations from the plan are taken when project targets are not achieved. Closure of the project is performed to get the Acquirer acceptance documented in the *Product Acceptance Record*.

6.3.2 Project Assessment and Control Process

a) Project performance measures or assessment results are available;

d) Affected parties are informed of project status;

e) Corrective action is defined and detected when project achievement is not meeting planned targets; and

h) Project objectives are achieved

6.3.7 Measurement Process

d) The required data are collected, stored, analysed, and the results interpreted; and

e) Information products are used to support decisions and provide an objective basis for communication.

6.1.1 Acquisition Process

d) An agreement to acquire a product or service according to defined acceptance criteria is established.

e) A product or service complying with the agreement is accepted.

6.4.6 Verification Process

d) Objective evidence that the realized product satisfies the system requirements and the architectural design is provided.

6.3.3 Decision Management Process

> d) *The resolution, decision rationale and assumptions are captured and reported.*
>
> *[ISO/IEC 15288:2008, 6.3.2, 6.3.7.2, 6.1.1.2, 6.4.6.2, 6.3.3]*

PM.03. *Change Requests* are addressed through their reception and analysis. Changes to system requirements are evaluated by the project team for cost, schedule, risks and technical impact.

> *6.3.5 Configuration Management Process*
>
> d) *Changes to items under configuration management are controlled.*
>
> *[ISO/IEC 15288:2008, 6.3.5]*

PM.04. Review meetings with the Work Team and the Acquirer, suppliers are held. Agreements are registered and tracked.

> *6.4.6 Verification Process*
>
> a) *Plan verification*
>
>   1) *Define the strategy for verifying the system entities throughout the life cycle.*
>
>   2) *Define a verification plan based on system requirements.*
>
> b) *Perform verification*
>
>   3) *Make available verification data on the system.*
>
>   4) *Analyse, record and report verification, discrepancy and corrective action information.*
>
> *[ISO/IEC 15288:2008, 4.4.6]*

PM.05. A *Risk Management Approach* is developed. Risks are identified, analysed, prioritized, and monitored as they develop and during the conduct of the project. Resources to manage the risks are determined.

> *6.3.4 Risk Management Process*
>
> b) *Appropriate risk management strategies are defined and implemented.*
>
> c) *Risks are identified as they develop and during the conduct of the project;*
>
> d) *Risks are analysed, and the priority in which to apply resources to treatment of these risks is determined.*
>
> *[ISO/IEC 15288:2008, 6.3.4]*

PM.06. A *Product Management Strategy* is developed. Items of *Product* are identified, defined and baselined. Modifications and releases of the items are controlled and made available to the Acquirer and Work Team. The storage, handling and delivery of the items are controlled.

> *6.3.5 Configuration Management Process*
>
> a) *a configuration management strategy is defined;*
>
> b) *Items requiring configuration management are defined:*
>
> d) *Changes to items under configuration management are controlled.*
>
> e) *The configuration of released items is controlled.*

f) *The status of items under configuration management is made available throughout the life cycle.*

[ISO/IEC 15288:2008, 6.3.5]

PM.07. Quality Assurance is performed to provide assurance that work products and processes comply with the *Project Plan* and *System Requirements Specifications*.

NOTE   The implementation of the Quality Assurance is through the performance of the verifications, validations and review *Tasks* performed in Project Management and System Definition and Realization processes.

6.2.5 Quality Management Process

a) *Organization quality management policies and procedures are defined.*

b) *Organization quality objectives are defined.*

c) *Accountability and authority for quality management are defined.*

e) *Appropriate action is taken when quality objectives are not achieved.*

[ISO/IEC 15288:2008, 6.2.5]

PM.08. A *Disposal Management Approach* is developed to end the existence of a system entity.

6.4.11 Disposal Process

a) *A system disposal strategy is defined.*

b) *Disposal constraints are provided as inputs to requirements.*

d) *The environment is returned to its original or an agreed state.*

[ISO/IEC 15288:2008, 6.4.11]

B.2   Correspondence with System Definition and Realization Process

SR.01. *Tasks* of the activities are performed through the accomplishment of the current *Project Plan*.

6.3.1 Project planning process

d) *Plans for the execution of the project are activated and maintained.*

[ISO/IEC 15288:2008, 6.3.1]

SR.02. System requirements are defined, analysed for correctness and testability, approved by the Acquirer, baselined and communicated.

6.4.1 Stakeholder Requirements Definition Process

a) *The required characteristics and context of use of services and operational concepts are specified.*

b) *The constraints on a system solution are defined.*

d) *The stakeholder requirements are defined.*

6.4.2 Requirements Analysis Process

a) *The required characteristics, attributes, and functional and performance requirements for a product solution are specified.*

d) *A basis for verifying that the system requirements are satisfied is defined.*

6.3.5 Configuration Management Process

c) *Configuration baselines are established.*

> *d)   Changes to items under configuration management are controlled.*
>
> *f)   The status of items under configuration management is made available throughout the life cycle.*
>
> *[ISO/IEC 15288:2008, 6.4.1, 6.4.2, 6.3.5]*

SR.O3. The System architectural design is developed and baselined. It describes the *System elements* and internal and external interfaces of them. Consistency and traceability to system requirements are established.

> *6.4.3 Architectural Design Process*
>
> *a)   An architectural design baseline is established.*
>
> *b)   The implementable set of system elements descriptions that satisfy the requirements for the system are specified.*
>
> *c)   The interface requirements are incorporated into the architectural design solution.*
>
> *d)   The traceability of architectural design to system requirements is established.*
>
> *e)   A basis for verifying the system elements is defined.*
>
> *f)   A basis for the integration of system elements is established.*
>
> *6.4.4 Implementation Process*
>
> *a)   An implementation strategy is defined;*
>
> *b)   Implementation technology constraints on the design are identified*
>
> *[ISO/IEC 15288:2008, 6.4.3, 6.4.4]*

NOTE   System architecture and detailed design can be performed separately according to the project schedule.

SR.O4. System elements defined by the design are produced or acquired. Acceptance tests are defined and performed to verify the consistency with requirements and the design. Traceability to the requirements and design are established.

> *6.4.4 Implementation Process*
>
> *c)   A system element is realized;*
>
> *d)   A system element is packaged and stored in accordance with an agreement for its supply.*
>
> *[ISO/IEC 15288:2008, 6.4.4]*

SR.O5. System elements are integrated. Defects encountered during integration are corrected and consistency and traceability to *System Architecture* are established.

> *6.4.5 Integration Process*
>
> *a)   A system integration strategy is defined.*
>
> *c)   A system capable of being verified against the specified requirements from architectural design is assembled and integrated.*
>
> *[ISO/IEC 15288:2008, 6.4.5]*

SR.O6. A *System Configuration*, as agreed in the Project Plan, and that includes the engineering artefacts is integrated, baselined and stored at the *Project Repository*. Needs for changes to the *Product* are detected and related change requests are initiated.

6.1.2 Supply Process

e) A product or service conforming to the agreement is supplied according to agreed delivery procedures and conditions.

f) Responsibility for the acquired product or service, as directed by the agreement, is transferred.

6.3.6 Information Management Process

a) Information to be managed is identified;

c) Information is transformed and disposed as required; and

f) Information is made available to designated parties.

[ISO/IEC 15288:2008, 6.1.2, 6.3.6]

SR.O7. Verification and Validation *Tasks* of all required work products are performed using a defined criteria to achieve consistency among output and input products in each activity. Defects are identified, and corrected; records are stored in the *Verification/Validation Reports*.

6.4.6 Verification Process

a) a verification strategy is defined;

c) Data providing information for corrective action is reported

d) Objective evidence that the realized product satisfies the system requirements and the architectural design is provided.

6.4.8 Validation Process

a) a validation strategy is defined;

b) The availability of services required by stakeholders is confirmed;

c) validation data is provided;

d) Data capable of providing information for corrective action is reported;

[ISO/IEC 15288:2008, 6.4.6, 6.4.8]

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