ITEA2 Project
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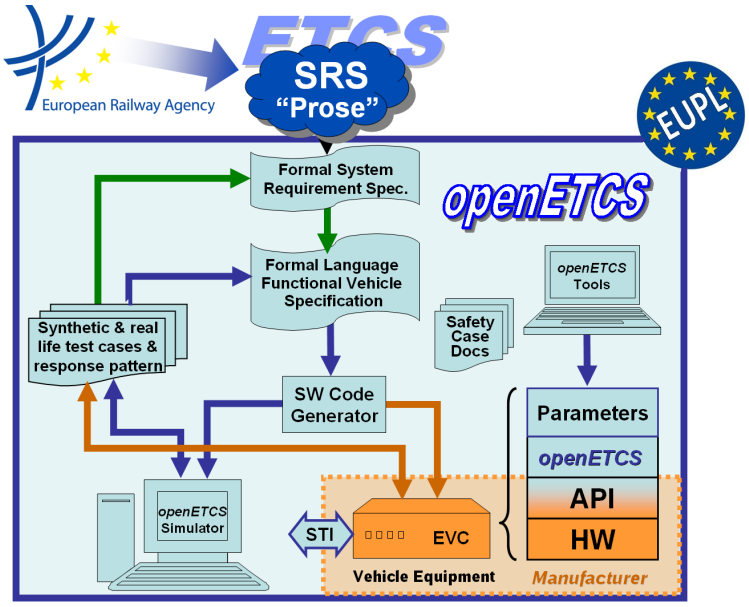
Work-Package 1: “Management”

Project Quality Assurance Plan

Izaskun de la Torre

September 25, 2013



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Work-Package 1: “Management”

OETCS/WP1/D1.3.1
September 25, 2013

Project Quality Assurance Plan

Izaskun de la Torre

SQS
Avenida Zugazarte 8
48930 Getxo, Spain

Description of work

Prepared for openETCS@ITEA2 Project

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Document History

Table 1. Documentation History

Version	Date	Chapters modified	Reason	Name
0.0.0	15.11.2012	All	First Steps on frame evaluation	Rico Kaseroni (DB) Peyman Farhangi (DB)
0.1.0	27.11.2012	All	First Steps on Content	Rico Kaseroni (DB) Jan Welte (TUBS) Peyman Farhangi (DB) Matthias Kuhn (DB)
0.1.1	29.11.2012	All	Optimaziation of document structure, Revision of Chapters according to EN 50128, Merging with project specific tasks	Stephan Jagusch (AEbt) Rico Kaseroni (DB) Cyril Cornu (All4tec)
0.2.0	30.11.2012	Baseline Requirements for certification	Extention of Chapter according to EN 50128	Jan Welte (TUBS) Rico Kaseroni (DB)
0.3.0	19.12.2012	All	Extention of Chapter 0, 1, 2, 3	All4Tech, DB, SQS
0.4.0	11.01.2013	All	Extention to existing and further Chapters	All4Tech, DB, SQS
0.6.0	28.01.2013	All	intellectual property (IP) Clean	Rico Kaseroni (DB) Cyril Cornu (All4tec)
0.6.1	29.01.2013	Scrum	Contribution	Bernd Hekele (DB)
0.7.0	01.02.2013	All	More Content	Rico Kaseroni (DB)
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0.9.1	07.02.2013	Scrum	Optimization	Bernd Hekele (DB)
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0.9.4	12.02.2013	All	Optimization	Rico Kaseroni (DB)
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0.9.4.6	15.02.2013	ALL	Optimization	Rico Kaseroni (DB)
0.9.5	22.02.2013	ALL	Restructuring & Optimization	Rico Kaseroni (DB)
0.9.5.1	01.03.2013	ALL	LaTeX conversion	Peter Mahlmann (DB)
0.9.5.2	04.03.2013	ALL	LaTeX Optimization	Rico Kaseroni (DB)
0.9.5.3	10.04.2013	ALL	New Structure	Izaskun de la Torre (SQS)

Table 1 – continued from previous page

Version	Date	Chapters modified	Reason	Name
0.9.5.4	20.04.2013	ALL	New Content	Bernd Hekele (DB) Jan Welte (TUBS) Marielle Petit-Doche (Systerel) Stefan Rieger (TWT) Izaskun de la Torre (SQS)
0.10.0	26.08.2013	chapter 1.2 and 8.2	New Content	Bernd Hekele (DB) Stefan Rieger (TWT)
0.10.0	17.09.2013	chapter CAT1 and CAT2	Updated Content	Bernd Hekele (DB)
0.10.1	25.09.2013	Chapter 1	Terminology	Jan Welte (TUBS)

1 Introduction

1.1 Purpose

The purpose of the QA Plan is to define the processes, methods and tools that will be used to develop the OpenETCS project meeting ITEA requirements, following Open Source principles and practices and applying the SCRUM Methodology. Besides, two of the project outcomes, the OpenETCS software, the OpenETCS Tool Chain, will have to comply with CENELEC requirements.

Due to the nature of the OpenETCS project (Research and Development (R & D) EU project with a complex list of project outcomes and deliverables), the QA Plan is specifically designed to provide a complete, consistent and integrated view of the development process at both project and product level (i.e. the development life-cycle is described partially in two different deliverables, the QA plan should manage to provide an integrated view).

The QA Plan also describes the activities to monitor and manage quality in all aspects of the project:

- Defining and ensuring that all processes and products are compliant with the corresponding standard and requirements, according to the required system/software safety integrity level
- Identifying nonconformances
- Providing timely quality status feedback to management and affected personnel
- Ensuring noncompliance issues are addressed

Therefore, it describes the QA functions, responsibilities and specific monitoring and control activities.

1.2 Goals of the openETCS project

The main goals and deliverables of the OpenETCS project are:

A semi-formal reference specification for the ETCS requirements and architecture, completed by strictly formal models of sub-parts

The first goal of the project is to propose a semi-formal specification of the ETCS on-board unit (OBU) functionalities according to UNISIG SUBSET-026 [8], baseline 3.

The purpose of this model is:

- to enhance the understanding of the subset;
- to be able to animate the model for testing and analysing purpose at system level;
- to provide information on the completeness and soundness of the SUBSET-026;
- to be used as a reference semi-formal specification for the implementation of an on-board unit (by the OpenETCS project team and by industrial actors);

The output is a model, at least semi-formal, which can be extended to many formal approaches (SCADE, Simulink, B tools, OpenETCS tool chain...) that can be given to all railway actors, and if possible associated to SRS documents in the ERA database.

Thus, strictly formal models can be designed from this semi-formal model which allows for formal proofs of sub-parts of SUBSET-026. This will allow improving the understanding of the system, and will provide elements for verification and validation using formal proof.

The final goal is that industrial actors work with this model instead of the natural language specification. The objective is to cover as much as possible of the functionality of the on-board unit described in SUBSET-026 and to show the capabilities of analyses of a complex system using formal approaches.

Definition the of safety case concept for the full model and apply it on a subset of the on-board unit

The safety strategy and the safety case concept required for the full validation of the product, compliant to the CENELEC standards shall be taken into account in all steps of the specification and design process. This will allow industrial actors to reuse the models and processes to develop certifiable products.

In particular the definition of the process shall take into account specification as well as verification and validation of the safety properties on the models. The outputs of WP4 (safety plan, safety case concept, verification plan and validation plan) will complete the description of the safety process.

Providing a tool chain and process/methodologies for developing an on-board software that can fulfil the CENELEC requirements for SIL4 software

The design process of the system and the associated tools of the tool chain shall be suitable to provide a certifiable product. For this purpose all steps of the process and the choice of the methods and tools shall be justified to ensure a safe approach to build an ETCS system.

The full safety process required to make OpenETCS *certifiable* according to CENELEC 50126, 50128 and 50129 shall be described in detail. The safety process will detail precisely which activities are required, why they are required, and the choices that are made to claim that a safe design process is guaranteed.

The use of formal methods, supported by tools, is highly recommended in this safety process for specification, design, verification and validation of the certifiable product.

The tool chain should include model editors, code generators, verification tools (including formal provers), validation tools (including test generators, simulators,..), document generation, version management, maintenance facilities, ...

Provide an executable software package generated from the specification of on-board ETCS

An executable software of the specification shall be provided, as well as a non vital implementation of the on-board unit for laboratory test, simulation and as reference. It will be a non-vital implementation, able to be executed in real-time and in interaction with other components.

1.3 Intended Audience

The QA Plan addresses all the stakeholders who are in the position to interact with OpenETCS project

Audience	Use	Role
OpenETCS Consortium Members	It provides information and access to the QA procedures and guidelines to be followed/applied during the different phases of the project development life-cycle. It provides a consistent and integrated view of the development process followed.	Consultation Reviewer Contributor or Committer
OpenETCS Quality Manager	It contains the quality targets to be achieved and the corresponding QA activities to be implemented and monitored.	Author
CENELEC Assessors	It shows the SQA strategy conceived and the one effectively implemented	To assess whether the project results comply to CENELEC standards
Open Source Community (Users, Adopters, Contributors, Committers)	Provision of information and access to the QA related procedures and guidelines implemented. Provision of information on the on-going projects Provision of guidelines on how to participate to any of the projects	For consultation and/or engagement
ITEA Representative	The QA Plan constitutes a Project Deliverable	For evaluation

Table 2. Intended Audience

1.4 Evolution

The first version of the document, prepared at the beginning of the project, will be updated regularly with the evolution of the OpenETCS project. The methods and tools to be applied during the development of the OpenETCS software products will be decided based upon the results of the research activities carried out during the project.

The QA Plan document will incorporate such decisions as they are taken with a proper justification of their appropriateness to meet the quality targets. The QA manager will guarantee the document is up to date.

The QA Plan document has been conceived as a reference document. This means that detailed descriptions of procedures, guidelines, methods and/or tools will not necessarily be included in the document but adequately referenced *(chapter 1.5)*. The authors of such documents and/or Wiki pages will be responsible for keeping them updated. The QA manager will monitor such activities and will guarantee changes are appropriately reflected in the QA Plan, when appropriate.

The QA Manager will maintain the QA Plan backlog [4] [Wiki].

Major revisions of the QA Plan will be accomplished by the Committers to the Management Project. Minor review process will be done with the participation of the external community, following procedure [11]

1.5 References, Guidelines and Standards

Standards				
Internal Code	Name	Version/ Edition/ Date	Repository	Responsible
[1]	EN 50128		governance	CENELEC
[9]	ISO 9001		governance	International Organization for Standardization
[7]	SUBSET-023	3.0.0	SSRS	UNISIG
[8]	SUBSET-026	3.3.0	SSRS	UNISIG

Table 3. Standards

References				
Internal Code	Name	Version/ Edition/ Date	Repository	Responsible
[23]	Full Project Proposal (FPP)	3.0	management	Klaus-Rüdiger Hase
[24]	Software Configuration Management Plan		governance	Jürgen Weiss
[17]	Project Co-operation Agreement	02e	management	Bernd Hekele
[16]	OpenECTS IP Policy	0.1	ecosystem	Bernd Hekele
[15]	OpenETCS Internal Assessment Plan		internal-assessment	Cyril Cornu
[21]	OpenETCS Validation & Verification Plan	01	validation	Marc Behrens Hardi Hungar
[4]	QA Plan Backlog	0.1.0	governance	Izaskun de la Torre
[5]	Traceability Matrix	0.1.0	governance	Izaskun de la Torre

Table 4. References

Procedures				
Internal Code	Name	Version/ Edition/ Date	Repository	Responsible
[11]	Review Process	0.2.1	governance	Ainhoa Gracia
[12]	Revision Process	0.2.1	governance	Ainhoa Gracia
[3]	Change/Problem Management Process	0.1.0	governance	Izaskun de la Torre
[14]	Grieving Handling Process		governance	Bernd Hekele
[19]	Committer Approvement Process		ecosystem	Jonas Helming
[20]	openETCS Development Process		ecosystem	Jonas Helming
[6]	Training Process	0.1.0	governance	Izaskun de la Torre
[10]	Document Control Process	0.1.0	governance	Ainhoa Gracia

Table 5. Procedures

Guidelines				
Internal Code	Name	Version/ Edition/ Date	Repository	Responsible
[13]	Contribution guidelines	01	ecosystem	Bernd Hekele
[18]	Committer Election Guideline		ecosystem	Jonas Helming
[22]	openETCS Publishing Guideline (see also Sct. 10)		Dissemination	Stefan Rieger
[27]	Expert Election Guideline		governance	*To be defined*

Table 6. Guidelines

Templates				
Internal Code	Name	Version/ Edition/ Date	Repository	Responsible
[25]	Competence Matrix Template	0.1.0	governance	Jan Welte
[26]	Expert database Template		governance	*To be defined*

Table 7. Templates

1.6 openETCS Terminology

The openETCS project deals with topics from different domains like railway vehicles, signaling systems, formal methods and tool development. As every of these domains has their specific terminology, the identification of all relevant terms and abbreviations is an important part of the openETCS development process. Respectively a terminology process has been defined which

collects, defines, analyses and distributes the relevant terminology for all parts of the openETCS project.

1.6.1 Terminology Process

The openETCS terminology process is based on the main openETCS development environement mainly github and Latex. In addition the iglos (https://www.iglos.de/iglos/) environment is used to model and manage terminology relations. The overall process contains the following steps:

1. Term proposals with definition, source and relation proposals via https://github.com/openETCS/glossary/issues or through extraction from project documents
2. Inclusion of term, definition, source and relation proposals into iglos, to manage the terminology work and allow analysis of the terminology (e.g. for consistency)
3. Export of terms and abbreviations and their information as definitions, sources and relations from iglos using a csv-file
4. Transformation of the csv-file into a latex glossary (https://github.com/openETCS/glossary/blob/master/Latex_Glossary/openETCS-Latex-Glossary.tex)for all project documents
5. All glossary files and their documentation is provided in the github glossary repository and continuously updates

Depending on the needs further extractions from the iglos database can be created providing terminology for specific openETCS activities.

The glossary and the list of abbreviations respectively acronyms is then added to any latex document by using the glossaries package. The latex commands to do this can be found in the *User Manual for glossaries.sty v3.07* or in the short description in the glossary wiki at https://github.com/openETCS/glossary.

The following subsections list the important glossary terms and the abbreviations used in this document.

1.6.2 Glossary

assessor	person or agent appointed to carry out the assessment.
designer	.
formal methods	Formal methods are system design techniques that use rigorously specified mathematical models to build software and hardware systems..
integrator	.

intellectual property	.
on-board unit	on-board equipment for ETCS and the ETCS-related GSM-R..
validator	person or agent appointed to carry out validation.

1.6.3 Abbreviations

ASR	assessor.
DES	designer.
ETCS	European Train Control System.
HR	Highly Recommended.
IMP	implementer.
INT	integrator.
IP	intellectual property.
ISTQB	International Software Testing Qualifications Board.
OBU	on-board unit.
R & D	Research and Development.
SCMP	System Configuration Management Plan.
SIL	safety integrity level.
SW	software.
TSI	Technical Specification for Interoperability.
TST	tester.
V & V	Verification and Validation.
VAL	validator.
VER	verifier.
WP	Work Package.

2 Project Organization

OpenETCS is a cooperative European-ITEA project. The project plan (objectives, work plan schedule, role of the partners, project organization) is described in the [23] FPP document, which is updated regularly (at least yearly). The project is accomplished according to the Project Co-operation Agreement (PCA) [17] signed by the partners.

The organization of the project has to meet the following constraints and challenges to succeed:

1. As an ITEA project, the project has to meet requirements imposed by the ITEA Office that affect both the organization and the outcomes of the project.
2. As an ITEA project, the effective involvement of the partners is sometimes hampered by external constraints (i.e. local financing, local approvals) so mechanisms to guarantee the "required competence" is available when needed are to be implemented. Besides, OpenETCS operates in a regulated environment where demonstrating the competence of the personnel assigned to the different activities is required.
3. Some of the results (software & tool chain) have to be certifiable; CENELEC SIL4 requirement [8] have to be followed and the corresponding evidence provided.
4. As an open source project, Open Source principles will be respected; high degrees of engagement from the community are intended.
5. As it is the intention to apply SCRUM, the appropriate responsibilities and mechanisms have to be implemented

The following chapters shows the mechanisms implemented at organizational level to guarantee the above mentioned objectives are achieved.

2.1 openETCS project organisation

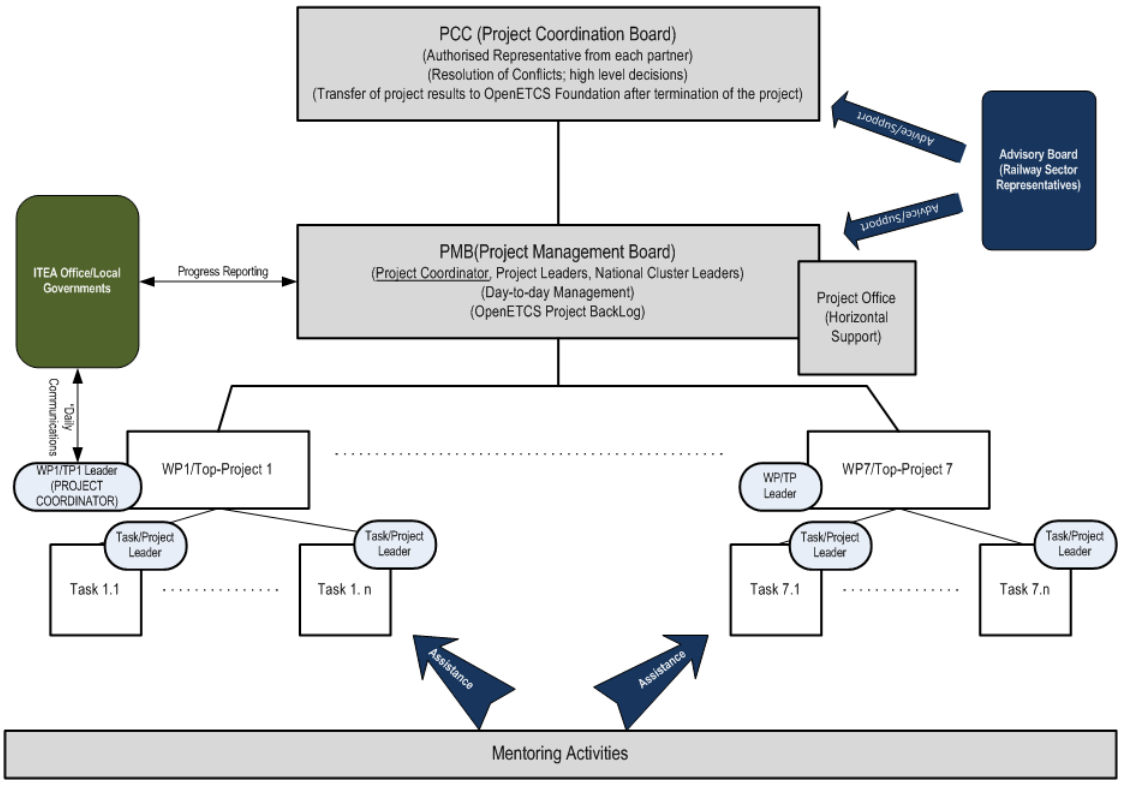

Figure 1. OpenETCS Project Structure

2.1.1 Compliance with ITEA Requirements

ITEA rules are documented in the ITEA2 Frame Agreement [XX].

Compliance to ITEA Requirements is achieved by means of:

- The appointment of a Project Coordinator (DB, WP1, supported by the Project Office) who leads the project and is responsible for the communications with the ITEA representatives.
- The appointment of a Local Coordinator per country, National Cluster Leader, who reports to the corresponding National Authorities of the progress of the local partners
- A signed PCA where cooperation rules and principles and working structures are agreed by all the partners.
- An OpenETCS Foundation NV which guarantees sustainability of the project results once the project is finished.

2.1.2 Compliance with Open Source Principles

Compliance to the Open Source Principles and related objectives is achieved by means of:

- An OpenETCS IP Policy and Procedures [16]
- An OpenETCS Development Process [20] [Wiki] based in the Eclipse Development Process [2], designed to promote dynamism in the development and openness. All the guidelines are maintained and available at the OpenETCS Ecosystem project [XX]:

  - The OpenETCS project is conceived as a project of projects organized in a hierarchical manner, where the WorkPackages, as defined within the WorkProgramme [23], are considered Top-Level Projects with their own charter. The so-called Tasks are projects, sub-projects of the corresponding Top-Level Project.
  - Anyhow, new projects can be launched, if needed and approved; existing projects can be archived, if they become inactive. Therefore the final structure of the OpenETCS project will very much depend on its evolution.
  - The list of OpenETCS projects with information on their status is available in [XX]
  - Any project (independently to its position in the hierarchy, and type) has its project leader, scope and maintains its own resources. The project leader is not only responsible to guarantee progress towards the scope of the project but to promote that the most appropriate community is engaged in the project life-cycle with openness and transparency. This community includes committers, contributors, users and adopters.
  - Every Top-project/Work Package (WP) has its own repository under the responsibility of the Top-Project/WP Leader. Agreements and principles on the repository structure and content can be found in [XX]
  - The PMB (Project Management Board) is responsible for maintaining and assuring the implementation of the OpenETCS Development Process and for ensuring the required “coordination" among the projects.
  - The Mentoring board (composed of XXX) is responsible for mentoring projects and advising.
  - The Project Office is responsible for the administrative tasks around the OpenETCS Development Process and maintains the OpenETCS Ecosystem project [XX]

- The tools to support the OpenETCS Development Process are open source tools. A relation of the tools approved by the consortium is [XX]
- The engagement of the OpenETCS Advisory Group will not only provide valuable technical insights but visibility of the project within the railway community.

2.1.3 Compliance with SCRUM Requirements

Agile Project Management ha been introduced to software projects in the 90-ties and is now a de-fact industry standard well documented in publications as e.g., in [XX].

Compliance to SCRUM Requirements is achieved by means of

- Each Work Package/Top-Project Leader is the SCRUM Product Owner of the corresponding WP/Top-Project results and maintains the corresponding backlog
- Each Project/Task Leader is the SCRUM Product Owner of the corresponding Tasks results and maintains the corresponding backlog
- The Project Coordinator is the SCRUM Product Owner of the project results and maintains the project results backlog.
- Weekly meetings are maintained to find and report on impediments, assess progress, promote cross-collaboration, plan next steps and therefore, maintain the corresponding backlog.
  - Weekly Scrum meetings are per definition open meetings, e.g., everybody from the teams can participate and contribute to the meeting.

  - The weekly meetings are strictly time-boxed.
  - At WP/Project level, the registered committers, contributors, users and adopters are invited to participate
  - At Open ETCS project level, the components of the PMB(Project Management Board) are invited.

- The work-packages resp. tasks need to organize there scrum teams according to practical needs.
- Teams are typically distributed in geography and in organisation (i.e., participating companies).
- Scrum teams typically have to provide several development roles (according to CENELEC and according to Eclipse). Guidance on the possible mixtrues of CENELEC roles into a Scrum team is documented in the appendices section of this guideline.
- To be able to be successful in Agile Development we need to set special focus to the role of the "User" of a product.
  - In general, the user of a product in openETCS should representratives of the project openETCS consuming the result of a scrum team.
  - The workpackage leader of the WP using an outcome of the team is the first candidate.
  - Representatives of partners making use of the openETCS result in long term are also natural users of a team result.
  - Partners in the openETCS project need to agree on the Users before the task when planning the interfaces.
- Each team has to select a scrum master. Scrum training is mandatory.
- A SCRUM master (WP1) is responsible for supporting the teams.

2.1.4 Compliance with software management and organisation according to EN50128:2011

In principle, two of the OpenETCS project results (Software and Tool Chain) are to be CENELEC safety integrity level (SIL) 4 certifiable. These are two of the results from WP3 and WP7. The following mechanisms, at organizational level, will help the corresponding project leader to provide evidence of compliance with chapters 5.1 and 5.2. Anyhow, evidence that requirements imposed are met will have to be provided for each of the two software projects on a project by project basis.

- Every partner in the consortium is ISO9001 Certified or will be in the position to provide evidence of a quality management process is accordance to ISO9001
- Every partner maintains an updated CV of the staff/experts involved in OpenETCS
- A Required Competence Matrix (RCM) per role and project will be maintained *(Chapter 4)*.
- A database with the participants per role and task/project will be maintained by the task/project leader.
- Overall, the independence required to develop certifiable results is promoted by the Work Programme which is structured into the following “independent" WorkPackages/Top-Projects, each lead by a different organization.

  - WP2, focused on Requirements Specification is led by SNCF.
  - WP3, focused on the Software Implementation taking as input WP2 and WP7 results is led by Alstom France.
  - WP4 focused on the specification of the Verification and Validation (V & V) structure, is led by DLR
  - WP5 focused on demonstrating applicability/validity of WP3 and WP7 results is led by ERSA
  - WP7 focused on the development of the Tool Chain is led by DLR taking as input WP2 and WP4 inputs
  - For the purpose of validating/adapting technical approaches, tools and concepts before they are taken into consideration, three Use Cases will be engaged.
  - The Open Development Process facilitates the creation of the necessary projects required to achieve the OpenETCS project results.

- For each assessable result, CENELEC required software roles will be covered by experts from different WPs. Incompatibilities can be controlled and monitored as active participation to the different projects has to be granted, accepted and is appropriately registered *(Chapter 2.2)*. Evidence of competence can be provided by comparing the CV of each expert with the RCM for the role assigned.

- For each assessable result, if possible, the role of the assessor will be selected from the external community of the project. Meanwhile, an internal independent assessor will be appointed. The role and profile of this assessor is detailed in OpenETCS/internal-assessment [15] [wiki pages]

One of the mechanisms to guarantee the availability of competence staff when needed will be the design and implementation of a training programme. The training programme will be managed by the Project Office. The identification of needs will be performed by the project leaders, the PMB and the Quality Manager. The training process is detailed in [governance]

2.2 Committers assignment and responsibilities

Each Top-Project/WP leader is responsible for establishing and publishing the specific required competence matrix for the Top-Project/WP *(Chapter 4)*. This matrix will be updated in response to the demands imposed by the evolution of the project. The competence matrix template [25]is provided in [governance]

Each Top-Project/WP leader is responsible for developing the most appropriate communities of users, adopters, contributors and committers as required by the Top-Project/WP. A database will be maintained and assessed periodically by the Top-Project/WP Leader. This database will contain the coordinates of the expert, his/her role in the project and a basic explanation of adequacy. The expert database template is provided in [XX]

The required core competences as well as the expected contribution of each of the identified communities are described in Chapter 4.

Only committers have write-access to the project resources. Becoming a committer requires of the acceptance of the project leader and of the rest of the project committers. Guidelines on how to become a committer can be found in [ecosystem wiki pages].

- It is the responsibility of the Project Leader to make sure the required competence to develop a task is covered by the engaged committers.
- It is the responsibility of the Open ETCS Project Leader to guarantee the required competence for the project is covered by the effective committers.

Contributors have read-access to the project resources, and acceptance is not required. Guidelines on how to become a contributor can be found in [ecosystem wiki pages].

An expert can contribute to different projects with different roles. The data from different project will be integrated and analysed to detect potential incompatibilities, if applicable. This activity will be done by the QA Manager. The guideline on how to select expert is detailed in [XX].

2.3 Project QA Management

QA activities will be under the responsibility of the QA Manager, who reports to the Project Coordinator.

The QA Manager will be responsible for the identification, supervision and control of all the processes, methods and tools required to meet the quality targets of the project. It is also the responsibility of the QA manager to provide the necessary evidence that such activities have been developed.

The activities of the QA Manager will be:

- To maintain the QA Plan and associated procedures and guidelines.
- A QA Plan Backlog will be maintained, implemented and published
- To participate in the OpenETCS Ecosystem project in cooperation with the Project Office
- To perform periodical audits of the maturity of the different on-going projects; propose improvement actions, if necessary.
- To participate in the review processes of the different work products.
- To collaborate with the Project Office in the identification of gaps and in the development of the corresponding Training Programme.
- To perform quantitative and qualitative analysis at process and product levels. To maintain a set of metrics for all the processes.
- To produce and publish the corresponding quality reports.

3 Life Cycle

The openETCs project itself is a R & D project running over 3 years which has the goal to deliver products such as the on-board specification model and the corresponding tool chain to generate source code based on this model. While the project life cycle is limited through the project time span, the products shall be used and also developed further after the end of the openETCS project. Respectively, the project only presents the firth development part of the product life cycle.

3.1 Project Life Cycle

The project Life Cycle is implemented through a set of WPs broken down into Tasks. In response of the nature of the project, these WPs are grouped into three purpose driven categories. The first category (WP2, WP4) addresses the specification of the work to be developed and the validation of the results to be obtained; the second category (WP3, WP7, WP5) addresses the development itself and the demonstration of the software and the tools chain developed and the third category (WP1, WP6) addresses the project management, the quality assurance and the dissemination of the project. This structure permits both the development and the integration of conceptual (R & D) and implementation activities to achieve innovative, validated and fit-for-purpose results. The detailed description of the Work Package description and overview plan is covered by [FPP].

3.2 Product Life Cycle

As the OpenETCS project products shall be part of the train development the reference for their life cycles are the CENELEC standard phases defined in the EN50126. But as the products are in general R & D results, their life cycles do not include any certification or acceptance activities at the moment. The main OpenETCS products are the OpenETCS Software model and the OpenETCS tools chain development, which have their own life cycles. For both parts the main development, verification and validation activities are done during the OpenETCS project. For the software only the demonstrator implementation is part of the OpenETCS project, while any kind of implementation on a target hardware is out of the project. For the OpenETCS tools chain the basic implementation is part of the project, but all further steps from qualification on are out of the project. In general long time maintenance is a key concept of these products but it can not be established in the project time span.

3.2.1 Life Cycle of the OpenETCS Software

The software development life-cycle of the OpenETCS project should be complied with CEN50128. Requirements imposed by the standard are analyzed and shown in detail in D2.2, while the software development life cycle applied in this project is described in Deliverable 2.3 and D2.4. The Test and Validation activities are presented in D4.2. The integration, the assessment and any maintenance is only defined in relation to the demonstrator implementation as no further phase can are planed in depth at this point.

3.2.2 Life Cycle of the OpenETCS Tools chain

The development of the Tool Chain has to comply with EN50128. Requirements imposed by the standard are analyzed and shown in detail in D2.2. The tools chain development life cycle is described in D7.3. As the tools chain is a combination and improvement of already existing tools, which have a specific life-cycle, the tools chain life cycle mainly consists of integration and maintenance activities.

3.3 QA Management

Guidance: Refer to the procedures to implement the QA activities identified within the above mentioned development life-cycle.

CC: The parts §2.3 (Project QA management) and 3.3 (QA management) could be both in the same part (2 or 3). For us, the Quality Assurance has to refer to both project life-cycle and Software life-cycle.

IT: In chapter 2.2, the idea is to introduce the QA Organisation Roles (both project and software, as you say). In chapter 3.3 we will explain the QA activities

4 Roles

4.1 OpenETCS Roles

In view of the nature of the project, roles are grouped into three independent categories:

- CAT1: Open Source Development Process Roles
- CAT2: SCRUM Roles
- CAT3: CENELEC Roles

Therefore, any participant will always adopt a role within CAT1, a role within CAT2 and if he/she is involved in the development of a CENELEC assessable product, a third role in CAT3.

As already mentioned, OpenETCS is a project of projects. An expert can participate to different projects with different roles. Therefore an expert will have a CAT1, CAT2 and/or CAT3 role per project.

In the Appendices A, B, C and D, the responsibilities and the core competences required by each role are detailed. It is the responsibility of the QA Manager to keep them updated

In the case of CAT 1 roles, specific technical competence will be required depending on the scope of the project. For this reason a new column has been added. In this column, specific technical competences for each project and role are to be included. It is the responsibility of each project leader to provide this information.

According to the open development process followed by Open ETCS, the QA process is also a project. For this reason the QA Manager will have to meet the competences of a Project Leader and the specific competences imposed by CENELEC and the OpenETCS project to the Quality Manager activities. When needed, specific responsibilities imposed by a project to a role will be detailed too.

As project results affected by CENELEC are already identified, both core and specific required competence per CAT 3 role are included in Appendices C and D.

4.2 Roles within the Development process of the openETCS Software

The responsibilities and competences for every role specific to the openETCS Software development are listed in Appendix C. The independence of different roles is the core concept of the

quality assurance strategy required be CENELEC standards. As openETCS is a collective project by various independent partners, the project organization already ensures full independence between the roles administrated by experts from different partners.

4.3 Roles within the Development process of the openETCS Tools Chain

See Appendix D

4.4 QA Activities

The QA Manager will be in charge of:

- Maintaining the Requirements Competence Matrices updated in response to the evolution of the OpenETCS project
- Performing periodical audits of the participants' database per project; trace database with the RCM (Required Competence Matrix) for such project
- Identify training needs and provide the required support to the Project Office in the definition and organization of the corresponding training activities.
- In the case of CENELEC related project, provide the necessary evidence of competence and independency between roles. If this is not possible, propose the necessary solutions and support the projects in its implementation

5 Methods, measures and tools for quality assurance (product + open ETCS software + Tools chain)

Selection of methods and tools used in each phase of the OpenETCS process is a part of the WP7 activities. This selection is based on the state of art established by WP2 (D2.1 and D2.2), the set of requirements defined by WP2 (D2.6-9) and the process definition (D2.3, D2.4, D4.1, D4.2.3).

Results of the selection of methods and tools are given in the D7.1 and D7.2 deliverables. Conformance of the methods and tools are going to be discussed in D7.3.

The following table give details of all this deliverables.

Deliverable	Content of Relevance for this Chapter
D2.1: Report on existing methodologies	State of the art on methods and tools
D2.2: Report on CENELEC Standards	CENELEC requirements to be fulfilled and the approach followed by the project to provide evidence
D2.3: Process definition	OpenETCS process definition
D2.4: Report on Methods definition	Description of methods and tools to use to follow the OpenETCS process
D2.6-9: Set of requirements for the OpenETCS project	Definition of the requirements that the selected methods and tools shall follow
D4.1: Report on V & V Plan & Methodology	Detailed description of the V & V process and how are used the methods and tools to cover V & V artifacts
D4.2.3: Safety Plan	Detailed requirements on methods and tools to be used during the process to obtain a SIL4 developement of on-board unit
D7.1: Report on the final choice(s) for the primary tool chain (means of description, tool and platform)	Selected methods and tools to be used during the specification and design part of the OpenETCS process
D7.2: Report on all aspects of secondary tooling (results of T7.2)	Selected methods and tools to complete the OpenETCS process (V & V, safety analyses,..)
D7.3: Tool chain qualification process description	This report describe how the selected methods and tools fit the qualification requirements according CENELEC standard

Table 10. Referenced deliverables

5.1 Methods, measures and tools for quality assurance OpenETCS Application Software

It is assumed that the OpenETCS application software will be SIL4 compliant. Therefore, the methods, techniques and tools shall be suitable to SIL 4.

MPD(Systerel): It is not totally exact: one of the aim of the project is to provide a tool chain which allows to develop SIL4 software, the OpenETCS applcation software produced during the project has not as objective to be SIL4 compliant.

MPD(Systerel): The current OpenETCS process, and the selection of methods and tools, do not cover only software development but also system phases as described in EN50129 or EN50126.

5.2 Methods, measures and tools for quality assurance openETCS Tools chain

The Tool Chain will be composed of a set of tools with different levels of interaction. The document D7.3 provides a description of the Tool Chain architecture, jointly with a description

of the constituent tools. Following CENELEC criteria, each tool belongs to one of the following classes: T1, T2 and T3. Class 3 and Class 2 Tools are obliged to follow specific development methods, techniques and tools.

5.3 Quality Control and Monitoring Activities

Guidance: Describe the measures to monitor the appropriate implementation of the selected methods and tools.

JW: This is a broad topic, the main issues will be covered by the verification, validation and safety plan. This aspect should introduce the general principals and tools and then reference those documents.

IT: OK. I think there is an error in the template. Instead of QA Activities, it is Quality Control and Monitoring Activities.

6 Documentation

The documentation structure of the OpenETCS project is composed of:

- Deliverables, which constitute the official outcomes of the different Top-Projects/WPs
  - The relation and scope of the deliverables to be produced along OpenETCS can be found in the FPP [23].
  - The updated status of development of each Deliverable can be found in [State-of-Deliverables Wiki].
  - The approved and therefore valid version of each Deliverables can be found in the repository of the Top-Project/WP it belongs to.
- Contractual documents, with the Commission and among the project partners
  - The status of development of each contractual document can be found under the repository of Management (WP1).
  - The last approved and therefore valid version of each contractual document can be found under the repository of Management (WP1).
- Periodic Progress Reports, to show progress to ITEA and EC representatives.
  - The state of each Periodic Report can be found under repository of Management (WP1).
  - The last approved and therefore valid version of each Periodic Progress Report can be found under the repository of Management (WP1).
- Supporting Documents, in the form of Templates and Procedures
  - The procedures and templates applicable to a specific Top-Project/WP can be found in the repository of the corresponding TP/WP.
  - The procedures and templates applicable to the whole project can be found in the repository of Governance.
- Internal Reports, in the form of Meeting Minutes
  - The minutes of the weekly scrum meetings are found in the repository of Governance.

The nomenclature used for the naming of the different documents is provided in [governance Wiki].

For each TP/WP the relation of existing documents is provided in the form of a list [Wiki]. This list includes a direct access to the valid version of each document.

6.1 Documentation Structure within the development process of the openETCS Software

As a SIL4 software, the documentation structure has to comply with CENELEC requirements. The following table shows the document structure required by CENELEC for a SIL 4 development and the corresponding documents produced in the OpenETCS project.

Table 11. Documentation Structure

Documentation Structure within the development process of the openETCS Software				
Phase	**SIL4**	**Document**	**WP/Task**	**Link**
Planning	Highly Recommended (HR)	Software Quality Assurance Plan Software Quality Assurance Verification Report Software Configuration Management Plan Software Verification and Validation Plan	(to be defined)	(to be defined)
Software Requirements	HR	Software Requirements Specification Software Requirements Test Specification Software Requirements Verification Report	(to be defined)	(to be defined)
Architecture and design	HR	Software Architecture Specification Software Design Specification Software Interface Specification Software Integration Test Specification Software/Hardware Integration Test Specification Software Architecture and design verification report	(to be defined)	(to be defined)
Component Design	HR	Software Component design specification Software Component Test Specification Software Component design verification report	(to be defined)	(to be defined)
Component Implementation and Testing	HR	Software source code and supporting documentation Software source code verification report Software Component Test Report	(to be defined)	(to be defined)

Continued on next page

Table 11 – continued from previous page

Documentation Structure within the development process of the openETCS Software				
Phase	**SIL4**	**Document**	**WP/Task**	**Link**
Integration	HR	Software Integration Test Report Software/Hardware Integration Test Report Software Integration Verification Report	(to be defined)	(to be defined)
Overall Software Testing/Final validation	HR	Overall Software Test Report Software Validation Report Tools Validation Report Release Note	(to be defined)	(to be defined)
Systems configured by Application Data/ algorithms	HR	Application Requirements Specification Application Preparation Plan Application Test Specification Application Architecture and Design Application Preparation Verification Report Application Test Report Source Code of Application Data/Algorithms Application Data/Algorithms Verification Report	(to be defined)	(to be defined)
Software Deployment	HR	Software Release and Deployment Plan Software Deployment Manual Release Notes Deployment Records Deployment Verification Report	(to be defined)	(to be defined)
Software Maintenance	HR	Software Maintenance Plan Software Change Records Software Maintenance Records Software Maintenance Verification Report	(to be defined)	(to be defined)
Software Assessment	HR	Software Assessment Plan Software Assessment Report	(to be defined)	(to be defined)

6.2 Documentation Structure within the development process of the openETCS Tools chain

Guidance: See Chapter 6.1

6.3 Quality Control and Monitoring Activities

Guidance: Describe the methods to review the documentation structure

JW: For me this should not be the review of the documentation structure, but the documentation quality control activities. These are looked at in detail over the next to chapters, therefore this should be a general overview.

IT: OK

7 Documentation Control

The Documentation Control procedure describes the steps to follow to ensure that the documentation developed whiting the openETCS project is current and suitable for use by the Eclipse community, the project members and the key customers. The main control activities covered by the procedure include the document creation and review, the approval, dissemination, archiving, modification and update due to a change request or the monitoring of the evolution among the time among others.

The implementation of this procedure, shall ensure that openETCS documents can be located easily, be periodically reviewed, have the nomenclature updated when needed, be available at any time, and be moved and archived when they are labelled ad obsolete.

The whole procedure is fully described in the [Document Control Procedure] .

7.1 Quality Control and Monitoring Activities

Guidance: Describe the methods to monitor both the control and process

8 Tracking and tracing of deviation

8.1 Traceability (openETCS software + Tools chain)

Guidance: Provide a description of traceability requirements, as well as how the traceability will be achieved, implement, maintained and verified. At this stage, exceptions if they exist should be justified.

8.2 Configuration Management

Configuration Management (CM) is used to handle changes systematically so that a system maintains its integrity over time. The Software Configuration Management Plan [SCMP] defines the procedures, techniques, and tools that are required to manage the software development, evaluate proposed changes, trace the status of changes, and to support an inventory of the system.

The main points to perform the configuration management process are:

- Configuration Management Tools
- Configuration Items
- Configuration Management Organization
- Configuration Control/Change Management
- Configuration Audits
- Baselines

The Quality Assurance Manager is accountable for the implementation of the System Configuration Management Plan (SCMP).

8.3 Fault Management

International Software Testing Qualifications Board (ISTQB) define a defect as "a flaw in a component or system that can cause the component or system to fail to perform its required function". A defect can be random or systematic. A defect, if encountered during execution, may cause a failure of the component or system". From the ISTQ glossary bug, fault and problem are defined to be the same as a defect.

A failure is a deviation of the component or system from its expected delivery, service or result. A failure is the consequence of a fault or error in a system but not all faults result in failures.

Faults, failures and errors encountered during the review activities (QA. Verification, Validation, Assessment) planned in the software development life-cycle, problems reported by users and customers as well as change requests initiated by any of the system stakeholders will be reported and managed following the Change/Problem Management Process [3] detailed in [governance] and through the Change/Problem Management Tool. This tool will be integrated with the Configuration management tool *GIT* and will be configured to implement and record all the information generated during the process.

The integration with the Configuration management tool *GIT* will permit:

- Traceability between Change/Problem Requests and the configuration items where the problem was located.
- Traceability between the configuration items modified and the corresponding Change/problem request.

The implementation of the workflow will permit:

- A complete history trail of the Change Request/Problem Report

The purpose of the Change/Problems Management implementation at OpenETCS project is to ensure that standardized methods and procedures are used for efficient and prompt handling of all changes/problems associated with the OpenETCS products, in order to minimize the number and impact of any related changes/problems. Changes/problems in the products may arise reactively in response to incidents, or proactively from seeking improved efficiency and effectiveness, as well as to enable or reflect OpenETCS initiatives, or products improvements.

The QA Manager will be in charge of:

- perform periodical audits and quality assessments of the bugs received
  - Audits to verify the process itself
  - Quality Assessments to verify the evolution of the product quality
- Assist in determining QA impacts
- Support Problem owner in analysis

8.4 Grievance Handling

Guidance: Refer to the specific procedure.

Describe the QA activities

BH: section is based on eclipse process and adopted to openETCS needs

It is a good culture to solve concerns as close as possible to the root cause of an problem or a misunderstanding. This means, the team where a problem is seen first is empowered to search for a solution of the problem first.

If the partners cannot agreed on a solution, the impediment is escalated to the next level in the project hierarchy.

When a member of the openETCS community has a concern about a Project, the member will raise that concern with the Project's Leadership (e.g., task leader in openETCS). If the member is not satisfied with the result, the member can raise the concern with the parent Project's Leadership, typically the workpackage leader.

The Member can continue appeals up the Project Leadership Chain and, if still not satisfied, thence to the project management board PMB, then the openETCS project lead, and finally to the project co-operation committee (PCC). All appeals and discussions will abide by the Guiding Principles of being open, transparent, and public.

Member concerns may include:

- Out of Scope. It is alleged that a Project is exceeding its approved scope.
- Dysfunctional. It is alleged that a Project is not functioning correctly or is in violation of one or more requirements of the Development Process.
- Contributor Appeal. It is alleged that a Contributor who desires to be a Committer is not being treated fairly.
- Invalid Veto. It is alleged that a -1 vote on a Review is not in the interests of the Project and/or of Eclipse.

A variety of grievance resolutions are available to the PMB up to, and including, rebooting or restarting a project with new Committers and leadership.

The issues seen during a sprint shall be taken to the sprint retrospective in order to help the team find an easy way in the future.

8.5 Modification and change control

A change is the addition, modification, or removal of a configuration item (CI), product, or product component, and/or its associated elements

The change requests initiated by any of the system stakeholders will be reported and managed following the Change/Problem Management Process [3] detailed in [governance] and through the Change/Problem Management Tool.

The Change/problem Management process aims to evaluate and plan the change/problem process to ensure that, if a change is made, it is done in the most efficient way possible, following the established procedures and ensuring the quality and continuity of the OpenETCS project and products at all times.

The QA Manager will be in charge of:

- perform periodical audits and quality assessments of the change request received
  - Audits to verify the process itself
  - Quality Assessments to verify the evolution of the product quality
- Assist in determining QA impacts
- Support Change owner in analysis

9 Supplier Control

This section describes what openETCS consortium expects its suppliers to do to ensure that all openETCS products' requirements and expectations are met.

This Supplier control applies to all Suppliers providing openETCS project with materials, products, processing, and related services.

At following, the expected Suppliers' general requirements are listed:

- Supplier shall ensure the confidentiality of openETCS project and products under development, and related product information, as well as intellectual property shared as a result of the working relationship.
- Suppliers are expected to have an effective quality system that ensures conforming product is delivered.
  - Suppliers shall maintain a Quality Management System suitable to the products and services provided to openETCS, that is certified by an accredited third-party certification body, i.e. ISO9001. This letter of accreditation should be provided to the respective QA personnel
  - In the absence of third-party certification, depending on the product, its application, value, and criticality, the OpenETCS community and Quality Assurance Manager may authorize the acceptance of other evidence of compliance
- Supplier should assure that all performance, endurance, maintenance, safety and warning requirements are met.
- The Supplier shall maintain documented procedures for identification of product from receipt and during processes of production and delivery. When traceability is a specified requirement, the Supplier shall establish and maintain a documented procedure for unique identification of individual product or batches
- The supplier shall provide and maintain suitable gauges, measuring instruments and test equipment to measure/test all material for conformance to OpenETCS requirements.

- Copies of quality conformance inspection data pertinent to material inspection must be provided by the supplier if required for each shipment or retained at Suppliers premises for future verification.
- The Supplier shall provide evidence that the following verifications required by the design record and control plan have been completed and that results indicate compliance with specified requirements
- Suppliers will be responsible for corrective action when changes to product specifications without prior notification to QA result in non- conformity to product or processes.
- OpenETCS requires all Suppliers to be approved prior to the issuance of contracts

Supplier Approval Process

- **Registration:** New suppliers must complete a registration form. This form initiates the approval
- **Evaluation:**
  - Ensure Supplier Risk Assessment considers both:
    - Quality risk
      - Finished Device Quality implications
    - Supply risk
      - Including implications of supplier going out of business
  - Evaluate Suppliers using Questionnaires, Self surveys and Audits techniques
  - Supplier's grading based upon evaluation results and assigned an evaluation status: Approved, conditional or not approved
- **Certification**: Classify Suppliers based on both QUALITY Risk and SUPPLY Risk.

The QA Manager will be in charge of:

- inspect records/evidence of a supplier's quality management systems at their facility
- monitoring and feedback processes: Include periodic review of critical product/process data
- documents problem issues and requirements for the supplier
- analyses the supplier operating conditions,
- Establish Minimal performance for Quality and Delivery
- When a supplier provides a product/part, apply supplemental controls to further mitigate risk
  - Product Acceptance Activities
  - Supplier Performance and Monitoring: augmented frequency of reviews
- creates a corrective development profile together with the supplier,

10 Publishing Guideline

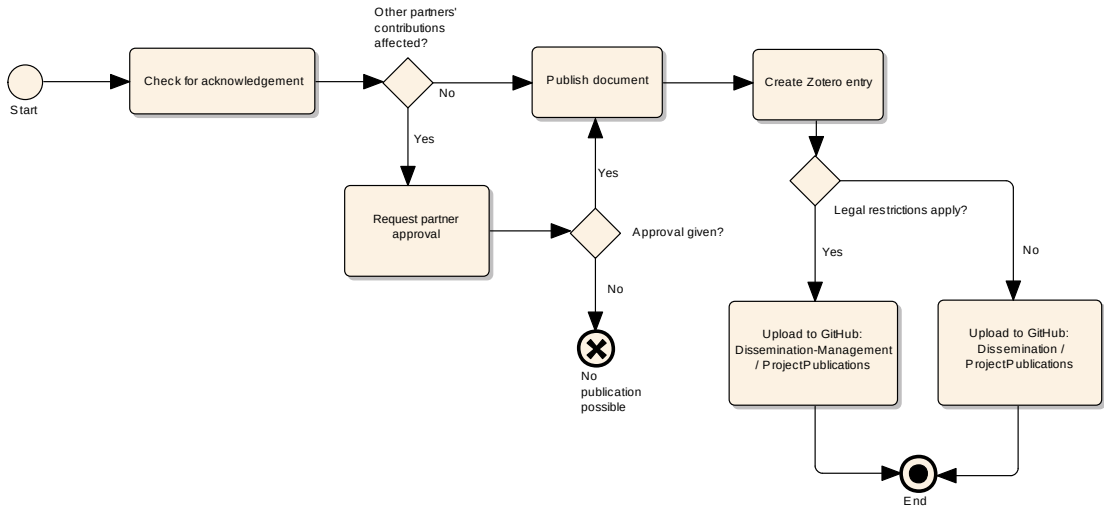

Figure 2. The publishing process as BPMN diagram

When publishing in the context of the openETCS project authors shall adhere to this guideline. Figure 2 depicts the steps as graphical BPMN process. The individual steps are described in detail in the following.

1. It must be ensured that the *project*, the *funding authority* and the *grant number* is mentioned in the paper/presentation. The following acknowledgements can be used:

   Germany This work was funded by the German Federal Ministry of Education and Research (Grant No. 01IS12021) in the context of the ITEA2 project openETCS.

   Belgium/Brussels region This work was funded by the Région de Bruxelles-Capitale / Brussels Hoofdstedelijk Gewest (Grant No. RBC/12 R 11) in the context of the ITEA2 project openETCS.

   Belgium/Walloon region This work was funded by the Walloon Region (DG06) (Grant No. 6921) in the context of the ITEA2 project openETCS.

   France This work was funded by the "Direction Générale de la compétitivité, de l'industrie et des services" (DGCIS) (Grant No. 112930309) in the context of the ITEA2 project openETCS.

   Spain This work was funded by the "Gobierno de España, Ministerio de Ciencia e Innovación" in the context of the ITEA2 project openETCS

2. Publications potentially affecting project contributions of other partners require explicit approval. A request for approval shall be accompanied with a reasonable deadline (e.g., two weeks). Please consider a joint publication with the involved partners.

3. An entry with the details of the publication should be added to the Zotero group *openETCS Publications* by using the Zotero tool or the website zotero.org. A how-to regarding the use of Zotero in openETCS is provided here. A link to an official and public webpage where the publication can be obtained/purchased should be included.

4. The final document should be uploaded to GitHub to one of the following directories:
   - To Dissemination-Management/ProjectPublications if legal restrictions apply for publication.
   - To Dissemination/ProjectPublications if it can be published freely under the openETCS Open License.

Appendices

A CAT1: Open Source Development Process Roles and Competence Matrix

Table 12. CAT1: Open Source Development Process Roles/Competences

CAT1: Open Source Development Process Roles/Competences				
Code	Role	Responsibilities (To be revised)	Core Competences	Specific Competences /Responsibilities per project
OPL	OpenETCS project Leader	Responsible to guarantee progress Promote that the most appropriate community is engaged in the project life-cycle Ensure that all personnel involved in all phases of the software, tool chain (products) and project life-cycle, including management activities, have the appropriate training, experience and qualifications	Good Project Management Skills Communication Skills Presentation Skills Moderation Skills Risk Management Skills	Not Applicable
WPL	WP Leader/Top-level project leader	Make sure the required competence to develop a task is covered by the engaged committers To ensure that all personnel who have responsibilities for the software are competent to discharge those responsibilities Ensure that the parties involved throughout the product life-cycle are independent, to the extent required by the software safety integrity level, in accordance with cenelec	Project Management Skills Good Technical Knowledge of the Workpackage Communication Skills Presentation Skills Moderation Skills Risk Management Skills	To be defined and followed up by each workpackage

Continued on next page

Table 12 – continued from previous page

CAT1: Open Source Development Process Roles/Competences				
Code	Role	Responsibilities (To be revised)	Core Competences	Specific Competences /Responsibilities per project
TL	Task Leader/ project leader	Maintains the corresponding backlog	Project Management Skills Technical Knowledge of the Workpackage Communication Skills Presentation Skills Moderation Skills Risk Management Skills	To be defined and followed up by each workpackage Project: QA activities responsible for the identification, supervision and control of all the processes, methods and tools required to meet the quality targets of the project
US	User	Not Applicable		
AD	Adopter	Reuse of the frameworks (within the companies that are contributing to the project and outside of the project), Reuse of the tools (within the companies that are contributing to the project and outside of the project,	Not in the scope of this document	Not in the scope of this document
CTB	Contributor	Contribute content, code, fixes, tests, documentation, or other work that is part of the Project Provide feedback Help new users Test, report or fix bugs Request new features Write or update documentation Write and update software	Not relevant	See "how to become a committer in openETCS" Good technical skills for the task of the workpackage Details may be defined and followed up by each workpackage

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Table 12 – continued from previous page

CAT1: Open Source Development Process Roles/Competences				
Code	Role	Responsibilities (To be revised)	Core Competences	Specific Competences /Responsibilities per project
CMT	Committer	Have the exclusive right to elect new Committers to their Project–no other group, including a parent Project, can force a Project to accept a new Committer. Monitor and contribute to the mailing lists Proactively report problems in the task tracking system, and annotating problem reports with status information, explanations, clarifications, or requests for more information from the submitter	**(To be fulfilled)**	**(To be fulfilled per project)**

B CAT2: SCRUM Roles and Competence Matrix

Table 13. CAT2: SCRUM Roles/Competences

CAT2: SCRUM Roles/Competences			
Code	Role	Responsibilities **(To be revised)**	Core Competences
POw	Product Owner	Managing and prioritizing the Product Backlog Planning the release Software and Tool chain acceptance Understand the value of the project Stakeholder Management We expect the WP-/Task Leader to act in this role	Agile Product Owner Training and Certificate is highly recommended Customer Orientation Deep Technical Knowledge of the Product he/she is responsible for Good knowledge of the use-case of the product Project Management Skills Risk Management Skills
ScM	Scrum Master	Team Coach Change Agent Owner of the Impediment Backlog Manage the development process Prepare Burndown charts Identify and eliminate obstacles that prevent the team from achieving their goals Ensures that the team is fully functional and productive Enables close cooperation across all roles and functions Ensure clear communication among everyone involved in the project	Agile Scrum Master Training and Certificate is highly recommended Moderation Skills Team Coaching Skills Experiences in the tasks the team is responsible for

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Table 13 – continued from previous page

CAT2: SCRUM Roles/Competences			
Code	Role	Responsibilities **(To be revised)**	Core Competences
ScT	Scrum Team	Self organizing (organizes itself and its work) Identify obstacles and informing the Scrum Master Development to achieve sprint goals. Implementing test cases Unit and initial Acceptance testing	Some Basic Scrum Training is needed Team needs to cover skills for all tasks needed to develop and release the product Looking at CENELEC, the roles to be covered in each team are Requirement Manager, Designer, Implementer, Tester, Verifier, and Integrator.

C CAT3: CENELEC Roles and Competence Matrix for OpenETCS software product

Table 14. CAT3: CENELEC Roles/Competences for OpenETCS application software project

CAT3: CENELEC Roles/Competences for OpenETCS application software project			
Code	Role	Responsibilities (**To be revised**)	Competences
PM	OpenETCS software Project Manager	Identify which roles are needed for the project Verify that at least one person fulfills an identified project role Guarantee the required competence for the project is covered by the effective committers Initialize the distribution of roles between partners to ensure independence of the roles Ensure compliance with the quality management system Responsible to guarantee progress according to scheduled plans Responsible for the delivery and implementation of the software Ensure the compliance and the delivery of safety requirements Approve full and partial products to be delivered by the development process Ensure that records and traceability are maintained throughout the decision making and project Ensure appropriate validation for the project through project partners	Understand requirements of software development process Understand quality, competencies, organizational and management requirements according to relevant standards Understand the requirements of the verification, validation and safety process Able to evaluated the impact of different options for the performance concerning implementation, validation and safety

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Table 14 – continued from previous page

CAT3: CENELEC Roles/Competences for OpenETCS application software project			
Code	Role	Responsibilities (**To be revised**)	Competences
RQM	Requirement manager	Responsible for the software model and source code requirement specification Establishes and maintain traceability to and from the system-level requirements Ensure that software and derived specifications requirements are under system configuration and changes management control. Ensure consistency and completeness of the software requirements specification Develop and maintain documents related to software requirements	experience in railways sector and safety attributes in the railway domain experience with requirements management process and tools knowledges of Technical Specification for Interoperability (TSI) and related CENELEC requirements

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Table 14 – continued from previous page

CAT3: CENELEC Roles/Competences for OpenETCS application software project			
Code	Role	Responsibilities (**To be revised**)	Competences
designer (DES)	Designer	Transform software requirements on acceptable solutions Derive the requirements for the system and software architecture Identify the key design issues that must be resolved to support successful development of the software Allocate the software and derived requirements to the chosen architecture components and interfaces Maintain requirement traceability for the software architecture's requirements, and to and from software requirements Identify suitable derived requirements that address the effectiveness and cost of life-cycle phases following development, such as production and operation Develop and maintain design documentation Ensure that the design documents are under system configuration and changes management control. Design or select design methods and support tools Apply principles and suitable design standards Develop component specifications if it is applicable	Competent in software development in the railway domain Competent in safety design principles Familiarity with methods and tools for design analysis and design testing Ability to work with design constraints for safety relevant software in On-Board systems Understanding of the system constraints created through the TSI Understanding of the relevant parts of EN 50128 like design methods

Continued on next page

Table 14 – continued from previous page

CAT3: CENELEC Roles/Competences for OpenETCS application software project			
Code	Role	Responsibilities (**To be revised**)	Competences
implementer (IMP)	Implementer	Transform design solutions in data, models, source code and finally executable code for the demonstrator Apply safety design principles Apply specific rules for data preparation/codification Perform analysis to verify intermediate results Develop and maintain implementing documents comprising the methods, types of data, models and listings applied Maintain traceability to and from the design Maintain the generated or modified data/codes/models under system configuration and changes management control.	Competent in safety relevant software implementation for embedded systems Competent in the implementation language and supporting tools Capable of applying the specified coding standards and programming styles Understanding of the system constraints created through the On-Board hardware respectively the demonstrator Understanding of the relevant parts of EN 50128 like design methods
tester (TST)	Tester	Ensure the test activities planning Develop tests specification (goals and cases) Ensure traceability of test objectives to specified software requirements Ensure traceability of test cases to the specified tests objectives Ensure that the planned tests are implemented and performed Identify deviations from the expected results and record in the test reports Communicate deviation to the authority in charge of the changes management for evaluation and decision making Record the results reports Select the equipment for testing the software	Competent in ETCS specification, used means of description (model/ source code), used train and track parameter and other application data source Competent in various test approaches/methods to identify to identify the most appropriate method or combination of methods for every aspect of an artifact Capable of deriving test cases from TSI (specifically Subset 26) and the specification model Understanding of the relevant parts of EN 50128 like test methods

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Table 14 – continued from previous page

CAT3: CENELEC Roles/Competences for OpenETCS application software project			
Code	Role	Responsibilities (**To be revised**)	Competences
verifier (VER)	Verifier	Develop a software (SW) Verification Plan Check the documented test suitability (completeness, coherency, relevance, traceability) with the verification objectives Identify anomalies, evaluate in terms of the risk, record them and communicate them to the authority in charge of the changes management for evaluation and decision making Manage the verification process (revision, integration and testing) and ensure the independence of the activities as needed Develop a verification report with the results of the verification activities	Competent in ETCS specification, used means of description (model/ source code), used train and track parameter and other application data source Competent in various verification approaches/methods to identify the most appropriate method or combination of methods for every aspect of an artifact Capable of deriving verification procedures from TSI (specifically Subset 26) and the specification model Understanding of the relevant parts of EN 50128 like verification methods
integrator (INT)	Integrator	Manage the integration process using software baselines Develop sw and sw /hw integration test specification for sw components based on the specifications and on the designer's components architecture Develop and maintain records of the integration activities Identify integration anomalies; record them and communicate them to the authority in charge of the changes management for evaluation and decision making Develop a report of components and the overall system integration covering the integration results	Competent in ETCS specification, used programming language, used API and demonstrator hardware Competent in various integration approaches/methods to identify the most appropriate method or combination of methods for the demonstrator implementation Understanding the design and functionality requirements for intermediated development levels Capable of deriving integrator tests from the set of integrated functions Understanding of the relevant parts of EN 50128 like integration tests

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Table 14 – continued from previous page

CAT3: CENELEC Roles/Competences for OpenETCS application software project			
Code	Role	Responsibilities (**To be revised**)	Competences
validator (VAL)	Validator	Develop a Validation Plan specifying the main tasks and activities for the sw validation Agree on the Validation Plan with the assessor Review Sw requirements in relation to their intended use/environment Ensure sw fulfill all sw requirements Evaluate the assessment of the software process and of the software according to CENELEC requirements and the assigned SIL Review the verification and tests correctness, consistency and suitability Check the correctness, consistency and suitability of the test cases and executed tests Ensure that all validation plan activities are carried out Review and classify deviations, evaluate in terms of the risk, record them and communicate them to the authority in charge of the changes management for evaluation and decision making Provide recommendation about sw suitability Record Validation Plan deviations Conduct audits, inspections or reviews of the overall project at various stages of development as may be appropriate Review and analyse validation reports of the previous sw Check whether the developed solutions are traceable to the sw requirements Ensure that records associated hazardous situations and nonconformances are reviewed Ensure that all dangerous situations are appropriately resolved Develop a Validation Report Express their agreement or disagreement about the sw version	Competent in ETCS On-Board units Experience in safety attributes for train control systems Competent in various validation approaches/methods to identify the most appropriate method or combination of methods for the demonstrator implementation Capable of deriving types of validation evidence required for the TSI with respect to the train control functionality Capable to combine different sources and types of evidence and synthesize an overall view about fitness for purpose or constraints and limitations of the On-Board application Overall software understanding and perspective including the general railway environment Understanding the requirements of EN 50128

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Table 14 – continued from previous page

CAT3: CENELEC Roles/Competences for OpenETCS application software project			
Code	Role	Responsibilities (**To be revised**)	Competences
assessor (ASR)	Assessor	Develop an assessment plan and communication with safety authority and client organization Evaluate the assessment of the software process and of the software according to CENELEC requirements and the assigned SIL Assess the project team and the organization competences for the sw development Evaluate the Verification & Validation activities and the supporting evidences Evaluate quality management systems adopted for the sw development Evaluate the changes management and the Configuration Management Systems and their use Identify and assess risk in terms of any deviation from the sw requirements in the evaluation report Ensure the evaluation Plan is implemented Performs independent checks of: The development process (audits) and the products safety functions (spot checks) during different development phases. Should perform audits, based on the Safety plan, of the Quality and Safety management systems of the Supplier, the Infrastructure owner and the Operator and be convinced that these systems works The Assessor can also perform spot checks on detailed technical issues to see that safety functions are correctly implemented. The safety functions key documentation (Hazard Log, Safety Requirements and Safety Case) should be examined too. Give an opinion on the validity of sw developed for its intended use detailing any constraints, application conditions and observations for risk control appropriate Develop an assessment report and maintain records about the assessment process	Competences in the railway domain and technology specifically concerning On-Board systems Acceptance/License from a recognized safety authority Continually gained sufficient level of experience in the safety principles and the application of these principles within the railway domain Competence to evaluated that a suitable method or combination of methods in a given context have been applied Understanding the relevant safety, human resource, technical and quality management processes to fulfill the requirements of the EN 50128 Competence in assessment approaches/ methods Capable to combine different sources and types of evidence and synthesize an overall view about fitness for purpose or constraints and limitations of the On-Board application Overall software understanding and perspective including the general railway environment Ability to judge the adequacy of all development processes (like quality management, configuration management, validation and verification processes) Understanding the requirements of EN 50128

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Table 14 – continued from previous page

CAT3: CENELEC Roles/Competences for OpenETCS application software project			
Code	Role	Responsibilities (**To be revised**)	Competences
CM	Configuration Manager	Responsible for the configuration management plan [24] System configuration management owner Establish that all sw components are clearly identified and have independent versions within the system configuration management Prepare the published release notes mentioning incompatible versions of sw components	Competences in software configuration management Understanding the requirements of EN 50128

D CAT3: CENELEC Roles and Competence Matrix for OpenETCS Tool Chain product

Table 15. CAT3: CENELEC Roles/Competences for OpenETCS Tool Chain product

CAT3: CENELEC Roles/Competences for OpenETCS Tool Chain product			
Code	Role	Responsibilities (**To be revised**)	Competences
PM	OpenETCS project Manager	Guarantee the required competence for the project is covered by the effective committers Identify which roles are needed for the project Verify that at least one person has been identified per project role ensure the independence of the roles according to CENELEC ensure compliance with the quality management system Responsible to guarantee progress according to scheduled plans devote sufficient resources to perform the task, including security tasks responsible for the delivery and implementation of the software ensure the compliance and the delivery of security requirements provide enough time for proper implementation and enforcement of security tasks approve full and partial products to be delivered by the development process ensure that records and traceability are maintained throughout the decision making and project ensure that it has appointed an appropriate validator for the project according to cenelec	**(To be fulfilled)**

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Table 15 – continued from previous page

CAT3: CENELEC Roles/Competences for OpenETCS Tool Chain product			
Code	Role	Responsibilities (**To be revised**)	Competences
RQM	Requirement manager	Responsible for the Software requirement specification Establishes and maintain traceability to and from the system-level requirements ensure that tool chain and derived specifications requirements are under system configuration and changes management control. ensure consistency and completeness of the tool chain requirements specification develop and maintain documents related to tool chain requirements	**(To be fulfilled)**

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Table 15 – continued from previous page

CAT3: CENELEC Roles/Competences for OpenETCS Tool Chain product			
Code	Role	Responsibilities (**To be revised**)	Competences
DES	Designer	Transform software requirements on acceptable solutions Derive the requirements for the system and software architecture Identify the key design issues that must be resolved to support successful development of the software Allocate the tool chain and derived requirements to the chosen architecture components and interfaces Maintain requirement traceability for the software architecture's requirements, and to and from software requirements Identify suitable derived requirements that address the effectiveness and cost of life-cycle phases following development, such as production and operation Develop and maintain design documentation Ensure that the design documents are under system configuration and changes management control. Design or select design methods and support tools Apply principles and suitable design standards Develop component specifications if it is applicable	**(To be fulfilled)**

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Table 15 – continued from previous page

CAT3: CENELEC Roles/Competences for OpenETCS Tool Chain product			
Code	Role	Responsibilities (**To be revised**)	Competences
IMP	Implementer	Transform design solutions in data, source code, models and / or other design representations Apply design principles Apply specific rules for data preparation/codification Perform analysis to verify intermediate results Develop and maintain implementing documents comprising the methods, types of data, models and listings applied Maintain traceability to and from the design Maintain the generated or modified data/codes/models under system configuration and changes management control.	**(To be fulfilled)**
TST	Tester	Ensure the test activities planning Develop tests specification (goals and cases) Ensure traceability of test objectives to specified software requirements Ensure traceability of test cases to the specified tests objectives Ensure that the planned tests are implemented and performed Identify deviations from the expected results and record in the test reports Communicate deviation to the authority in charge of the changes management for evaluation and decision making Record the results reports Select the equipment for testing the software	**(To be fulfilled)**

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Table 15 – continued from previous page

CAT3: CENELEC Roles/Competences for OpenETCS Tool Chain product			
Code	Role	Responsibilities **(To be revised)**	Competences
INT	Integrator	Manage the integration process using software baselines Develop sw and sw /hw integration test specification for sw components based on the specifications and on the designer's components architecture Develop and maintain records of the integration activities Identify integration anomalies; record them and communicate them to the authority in charge of the changes management for evaluation and decision making Develop a report of components and the overall system integration covering the integration results	**(To be fulfilled)**
VER	Verifier	Develop a SW Verification Plan Check the documented test suitability (completeness, coherency, relevance, traceability) with the verification objectives Identify anomalies, evaluate in terms of the risk, record them and communicate them to the authority in charge of the changes management for evaluation and decision making Manage the verification process (revision, integration and testing) and ensure the independence of the activities as needed Develop a verification report with the results of the verification activities	**(To be fulfilled)**

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Table 15 – continued from previous page

CAT3: CENELEC Roles/Competences for OpenETCS Tool Chain product			
Code	Role	Responsibilities (**To be revised**)	Competences
VAL	Validator	Develop a Validation Plan specifying the main tasks and activities for the sw validation Agree on the Validation Plan with the assessor Review Sw requirements in relation to their intended use/environment Ensure sw fulfil all sw requirements Evaluate the assessment of the software process and of the software according to CENELEC requirements and the assigned SIL Review the verification and tests correctness, consistency and suitability Check the correctness, consistency and suitability of the test cases and executed tests Ensure that all validation plan activities are carried out Review and classify deviations, evaluate in terms of the risk, record them and communicate them to the authority in charge of the changes management for evaluation and decision making Provide recommendation about sw suitability Record Validation Plan deviations Conduct audits, inspections or reviews of the overall project at various stages of development as may be appropriate Review and analyse validation reports of the previous sw Check whether the developed solutions are traceable to the sw requirements Ensure that records associated hazardous situations and nonconformances are reviewed Ensure that all dangerous situations are appropriately resolved Develop a Validation Report Express their agreement or disagreement about the sw version	**(To be fulfilled)**

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Table 15 – continued from previous page

CAT3: CENELEC Roles/Competences for OpenETCS Tool Chain product			
Code	Role	Responsibilities **(To be revised)**	Competences
ASR	Assessor	Develop an evaluation Plan Evaluate the assessment of the software process and of the software according to CENELEC requirements and the assigned SIL Assess the project team and the organization competences for the sw development Evaluate the Verification & Validation activities and the supporting evidences Evaluate quality management systems adopted for the sw development Evaluate the changes management and the Configuration Management Systems and their use Identify and assess risk in terms of any deviation from the sw requirements in the evaluation report Ensure the evaluation Plan is implemented Performs independent checks of: The development process (audits) and the products safety functions (spot checks) during different development phases. Should perform audits, based on the Safety plan, of the Quality and Safety management systems of the Supplier, the Infrastructure owner and the Operator and be convinced that these systems works The Assessor can also perform spot checks on detailed technical issues to see that safety functions are correctly implemented. The safety functions key documentation (Hazard Log, Safety Requirements and Safety Case) should be examined too. Give an opinion on the validity of sw developed for its intended use Develop an evaluation report and maintain records about the evaluation process	**(To be fulfilled)**

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Table 15 – continued from previous page

CAT3: CENELEC Roles/Competences for OpenETCS Tool Chain product			
Code	Role	Responsibilities **(To be revised)**	Competences
CM	Configuration Manager	Responsible for the configuration management plan [24] System configuration management owner Establish that all sw components are clearly identified and have independent versions within the system configuration management Prepare the published release notes mentioning incompatible versions of sw components	**(To be fulfilled)**

E Methods & Tools for Application Software

Software Requirements Specification Phase				
Code	Method/Technique	SIL 4	Applied (Yes/No)	Details and References
1	Formal Methods	HR	Yes	*Include details and references to external documents when if necessary*
2	Modelling	HR	Yes	*Include details and references to external documents when if necessary*
3	Structured Methodology	HR	Yes	*Include details and references to external documents when if necessary*
4	Decision Table	HR	Yes	*Include details and references to external documents when if necessary*
Justification: **(To be fulfilled)**				
Justification how Methods & Techniques are compliance with CENELEC				

Table 16. Software Requirements Specification Phase

Table 17. Software Architecture Phase

Software Architecture Phase				
Code	Method/Technique	SIL 4	Applied (Yes/No)	Details and References
1	Defensive Programming	HR	Yes	*Include details and references to external documents when if necessary*
2	Fault Detection & Diagnosis	HR	Yes	*Include details and references to external documents when if necessary*
3	Error Correcting Codes	-	Yes	*Include details and references to external documents when if necessary*
4	Error Detecting Codes	HR	Yes	*Include details and references to external documents when if necessary*
5	Assertion Programming	HR	Yes	*Include details and references to external documents when if necessary*
6	Safety Bag Techniques	R	Yes	*Include details and references to external documents when if necessary*
7	Diverse Programming	HR	Yes	*Include details and references to external documents when if necessary*

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Table 17 – continued from previous page

Software Architecture Phase				
Code	Method/Technique	SIL 4	Applied (Yes/No)	Details and References
8	Recovery Block	R	Yes	*Include details and references to external documents when if necessary*
9	Backward Recovery	NR	No	*Include details and references to external documents when if necessary*
10	Forward Recovery	NR	No	*Include details and references to external documents when if necessary*
11	Re-try Fault Recovery Mechanisms	R	Yes	*Include details and references to external documents when if necessary*
12	Memorising Executed Cases	HR	Yes	*Include details and references to external documents when if necessary*
13	Artificial Intelligence - Fault Correction	NR	No	*Include details and references to external documents when if necessary*
14	Dynamic Reconfiguration of software	NR	No	*Include details and references to external documents when if necessary*
15	Software Error Effect Analysis	HR	Yes	*Include details and references to external documents when if necessary*
16	Fault Tree Analysis	HR	Yes	*Include details and references to external documents when if necessary*
17	Information Hiding	-	Yes	*Include details and references to external documents when if necessary*
18	Information Encapsulation	HR	Yes	*Include details and references to external documents when if necessary*
19	Fully Defined Interface	M	Yes	*Include details and references to external documents when if necessary*
20	Formal Methods	HR	Yes	*Include details and references to external documents when if necessary*

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Table 17 – continued from previous page

Software Architecture Phase				
Code	Method/Technique	SIL 4	Applied (Yes/No)	Details and References
21	Modelling	HR	Yes	*Include details and references to external documents when if necessary*
22	Structured Methodology	HR	Yes	*Include details and references to external documents when if necessary*
23	Modelling supported by computer aided design and specification tools	HR	Yes	*Include details and references to external documents when if necessary*
Justification: **(To be fulfilled)**				
Justification how Methods & Techniques are compliance with CENELEC				

Table 18. Software Design and Implementation Phase

Software Design and Implementation Phase				
Code	Method/Technique	SIL 4	Applied (Yes/No)	Details and References
1	Formal Methods	HR	Yes	*Include details and references to external documents when if necessary*
2	Modelling	HR	Yes	*Include details and references to external documents when if necessary*
3	Structured Methodology	HR	Yes	*Include details and references to external documents when if necessary*
4	Modular Approach	M	Yes	*Include details and references to external documents when if necessary*
5	Components	HR	Yes	*Include details and references to external documents when if necessary*
6	Design and Coding Standards	M	Yes	*Include details and references to external documents when if necessary*
7	Analysable Programs	HR	Yes	*Include details and references to external documents when if necessary*

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Table 18 – continued from previous page

Software Design and Implementation Phase				
Code	Method/Technique	SIL 4	Applied (Yes/No)	Details and References
8	Strongly Typed Programming Language	HR	Yes	*Include details and references to external documents when if necessary*
9	Structured Programming	HR	Yes	*Include details and references to external documents when if necessary*
10	Programming Language	HR	Yes	*Include details and references to external documents when if necessary*
11	Language Subset	HR	Yes	*Include details and references to external documents when if necessary*
12	Object Oriented Programming	R	Yes	*Include details and references to external documents when if necessary*
13	Procedural Programming	HR	Yes	*Include details and references to external documents when if necessary*
14	Metaprogramming	R	Yes	*Include details and references to external documents when if necessary*
Justification: **(To be fulfilled)**				
Justification how Methods & Techniques are compliance with CENELEC				

Table 19. Verification and Testing Phase

Verification and Testing Phase				
Code	Method/Technique	SIL 4	Applied (Yes/No)	Details and References
1	Formal Proof	HR	Yes	*Include details and references to external documents when if necessary*
2	Static Analysis	HR	Yes	*Include details and references to external documents when if necessary*
3	Dynamic Analysis and Testing	HR	Yes	*Include details and references to external documents when if necessary*

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Table 19 – continued from previous page

Verification and Testing Phase				
Code	Method/Technique	SIL 4	Applied (Yes/No)	Details and References
4	Metrics	R	Yes	*Include details and references to external documents when if necessary*
5	Traceability	M	Yes	*Include details and references to external documents when if necessary*
6	Software Error Effect Analysis	HR	Yes	*Include details and references to external documents when if necessary*
7	Test Coverage for code	HR	Yes	*Include details and references to external documents when if necessary*
8	Functional/ Black-box Testing	M	Yes	*Include details and references to external documents when if necessary*
9	Performance Testing	HR	Yes	*Include details and references to external documents when if necessary*
10	Interface Testing	HR	Yes	*Include details and references to external documents when if necessary*
Justification: **(To be fulfilled)**				
Justification how Methods & Techniques are compliance with CENELEC				

Table 20. Integration Phase

Integration Phase				
Code	Method/Technique	SIL 4	Applied (Yes/No)	Details and References
1	Functional and Black-box Testing	HR	Yes	*Include details and references to external documents when if necessary*
2	Performance Testing	HR	Yes	*Include details and references to external documents when if necessary*
Justification: **(To be fulfilled)**				
Justification how Methods & Techniques are compliance with CENELEC				

Table 21. Overall Software Testing Phase

Overall Software Testing Phase				
Code	Method/Technique	SIL 4	Applied (Yes/No)	Details and References
1	Performance Testing	M	Yes	*Include details and references to external documents when if necessary*
2	Functional and Black-box Testing	M	Yes	*Include details and references to external documents when if necessary*
3	Modelling	R	Yes	*Include details and references to external documents when if necessary*
Justification: **(To be fulfilled)**				
Justification how Methods & Techniques are compliance with CENELEC				

Table 22. Software Analysis Techniques Phase

Software Analysis Techniques Phase				
Code	Method/Technique	SIL 4	Applied (Yes/No)	Details and References
1	Static Software Analysis	HR	Yes	*Include details and references to external documents when if necessary*
2	Dynamic Software Analysis	HR	Yes	*Include details and references to external documents when if necessary*
3	Cause Consequence Diagrams	R	Yes	*Include details and references to external documents when if necessary*
4	Event Tree Analysis	R	Yes	*Include details and references to external documents when if necessary*
5	Software Error Effect Analysis	HR	Yes	*Include details and references to external documents when if necessary*
Justification: **(To be fulfilled)**				
Justification how Methods & Techniques are compliance with CENELEC				

Table 23. Software Quality Assurance Phase

Software Quality Assurance Phase				
Code	Method/Technique	SIL 4	Applied (Yes/No)	Details and References
1	Accredited to EN ISO 9001	HR	Yes	*Include details and references to external documents when if necessary*
2	Compliant with EN ISO 9001	M	Yes	*Include details and references to external documents when if necessary*
3	Compliant with ISO/IEC 90003	R	Yes	*Include details and references to external documents when if necessary*
4	Company Quality System	M	Yes	*Include details and references to external documents when if necessary*
5	Software Configuration Management	M	Yes	*Include details and references to external documents when if necessary*
6	Checklists	HR	Yes	*Include details and references to external documents when if necessary*
7	Traceability	M	Yes	*Include details and references to external documents when if necessary*
8	Data Recording and Analysis	M	Yes	*Include details and references to external documents when if necessary*
Justification: **(To be fulfilled)**				
Justification how Methods & Techniques are compliance with CENELEC				

Table 24. Software Maintenance Phase

Software Maintenance Phase				
Code	Method/Technique	SIL 4	Applied (Yes/No)	Details and References
1	Impact Analysis	M	Yes	*Include details and references to external documents when if necessary*
2	Data Recording and Analysis	M	Yes	*Include details and references to external documents when if necessary*
Justification: **(To be fulfilled)**				
Justification how Methods & Techniques are compliance with CENELEC				

Table 25. Data Preparation Techniques Phase

Data Preparation Techniques Phase				
Code	Method/Technique	SIL 4	Applied (Yes/No)	Details and References
1	Tabular Specification Methods	R	Yes	*Include details and references to external documents when if necessary*
2	Application specific language	R	Yes	*Include details and references to external documents when if necessary*
3	Simulation	HR	Yes	*Include details and references to external documents when if necessary*
4	Functional testing	M	Yes	*Include details and references to external documents when if necessary*
5	Checklists	M	Yes	*Include details and references to external documents when if necessary*
6	Fagan inspection	R	Yes	*Include details and references to external documents when if necessary*
7	Formal design reviews	HR	Yes	*Include details and references to external documents when if necessary*
8	Formal proof of correctness (of data)	HR	Yes	*Include details and references to external documents when if necessary*
9	Walkthrough	HR	Yes	*Include details and references to external documents when if necessary*
Justification: **(To be fulfilled)**				
Justification how Methods & Techniques are compliance with CENELEC				

Table 26. Quality mechanisms for Safe deployment

Quality mechanisms for Safe deployment	Technique & Approach
Software Self-identification Mechanisms (9.1.4.11)	**(To be fulfilled)**

Table 26 – continued from previous page

Quality mechanisms for Safe deployment	Technique & Approach
Error detection and/or avoidance mechanisms during deployment process (store, transfer, transmission and/or duplication of code operations) (9.1.4.20)	**(To be fulfilled)**
Automatic detection and safe management of incompatible components/versions (9.1.4.8, 9.1.4.9)	**(To be fulfilled)**
Provision of appropriate and accurate diagnostic information	**(To be fulfilled)**
Safe Roll back capabilities	**(To be fulfilled)**

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[1] CENELEC. EN50128 railway applications - communication, signalling and processing systems - software for railway control and protection systems, June 2011.

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[7] ERTMS. UNISIG subset 023, glossary of terms and abbreviations.

[8] ERTMS. UNISIG subset 026, system requirements specification - baseline 3, January 2010.

[9] International Organization for Standardization.

[10] Ainhoa Gracia. Document control process.

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