EURAIL System Pillar SEMP

System Engineering Management Plan

Revision	1.0
Document Status	Endorsed
Date	30.11.2022

IMPORTANT NOTE

The document contains the definition of working rules and arrangements (processes, methods, tools) for the System Pillar engineering work.

This version 1 of the SEMP is aimed at enabling the SP teams to start work.

Some important decisions have been proposed about the way of working and are listed in this main document. These major decisions are marked with this sign: !

The document has been developed by the SEMP team, commented on by the Central Modelling Service and Domain Leads of the System Pillar, and approved by the System Pillar Core Group.

At the SP Steering Group November 2022 it was agreed to:

- Endorse the approval of the SEMP Version 1 document.
- Take note of the SEMP Version 1 Annexes as a working basis and starting point for the SEMP refinement process.
- Endorse the SEMP Version 1 for starting the work in the System Pillar teams.
- Note that the Central Modelling Service will refine and update the SEMP including the Annexes, based on the experience of implementation, and on the list of open points in the last chapter of this document.
- For Mirror Groups, it is noted that the process is subject to continued consideration by the ROC and RSI sector organisations. Changes may be proposed to the process on an ad hoc basis, to be considered as appropriate by the System Pillar Steering Group.

1 Status of the document and Annexes

This SEMP version 1 is used for the start of the System Pillar. It includes the currently necessary description of workflows and methods. It will be extended and refined over time by the Central Modelling Team, including based on lessons learned from implementation.

The main discussion points from the review and remaining open points are set out in Sections 11 and 12.

The review for this document was done in SP Coregroup, Domain Leads, and the Central Modelling Team.

2 References and Annexes

[1] System Pillar Common Business Objectives (Sept. 2022)

[2] Europe's Rail Governance (October 2022)

[3] Europe's Rail Masterplan (2022)

[4] Europe's Rail Multiannual Workplan (2022)

221017 SP SEMP V0.9.docx
Annex A - Abbreviations Roles and Teams.docx
Annex B Architectural principles.docx
Annex C - Workflow concept and rules.docx
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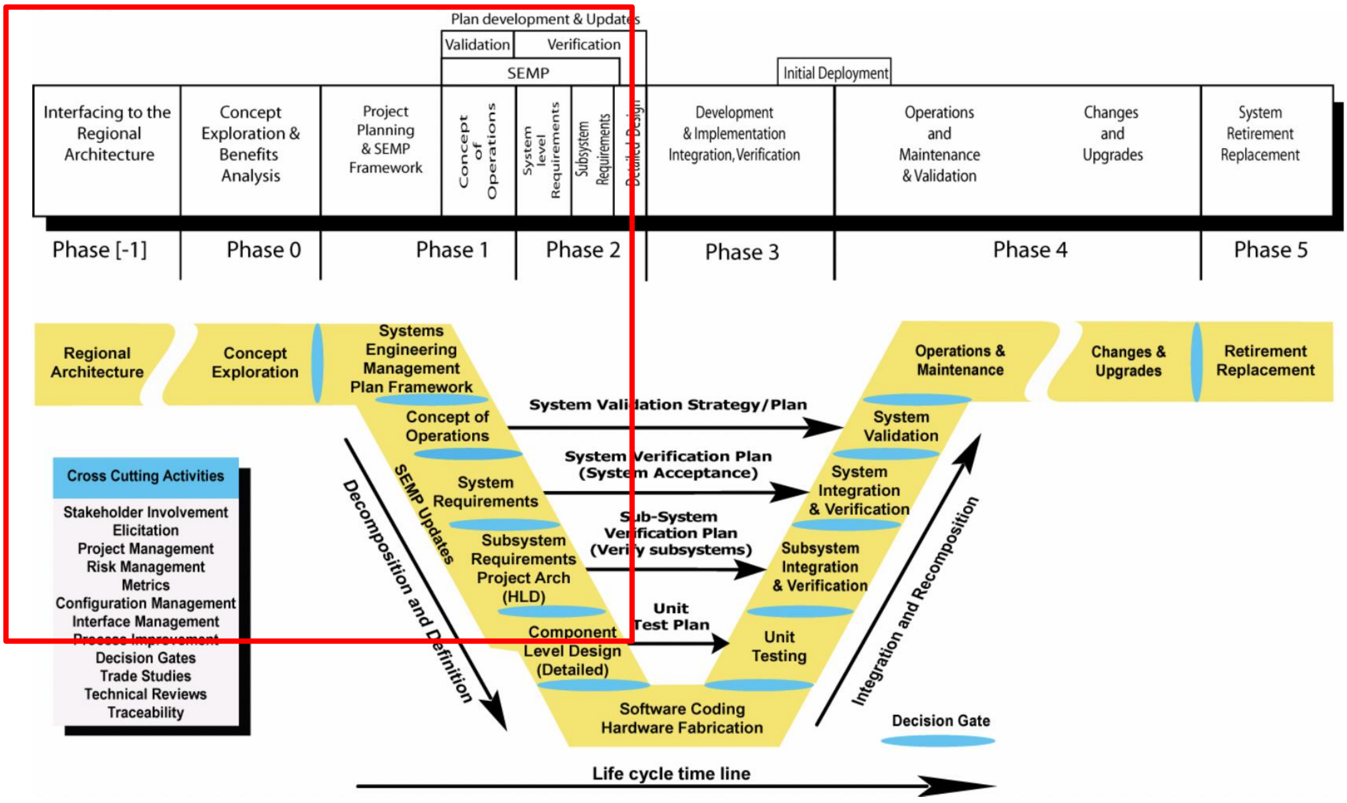
Annex M - System Level 1-4 ARCADIA method
Annex R - Rules for writing textural Requirements.pdf
Annex S - System Level 5 Modelling Standard for SysML.pdf
Annex T - Tool requirements.docx

3 Purpose, Scope and of the SEMP

The SP System Engineering Management Plan defines the workflow rules and arrangements, methods, and tool usage for all specification related activities in the System Pillar. The scope covers the following phases (red frame):

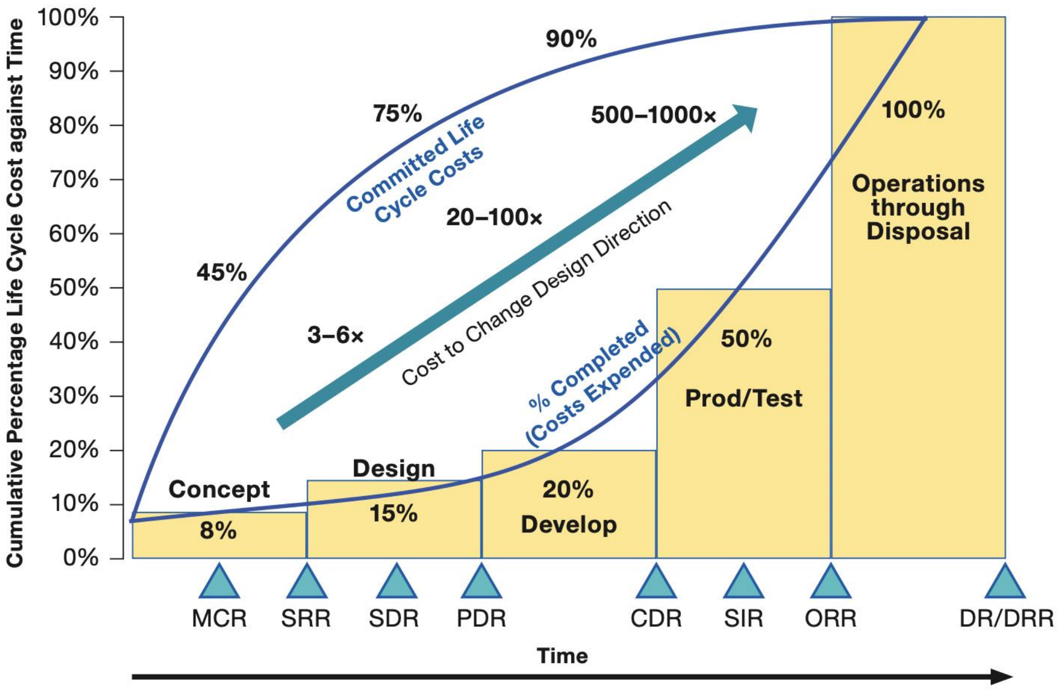


(from "System Engineering Guidebook for intelligent transport systems", V2, 2007)

Concerning "detailed component level design" only the detailed technical description of standard interfaces and operational processes is in scope of the engineering process that is described in this SEMP and the current SP standardisation scope.

The horizontal back arrows describe necessary outputs of the SP engineering work.

! Engineering activities in the SP shall include work steps concerning economical and risk assessment and optimisation for all phases of product lifecycle, including those beyond the scope of SP activities. The engineering process for the SP shall optimize the full life cycle of the systems, the market interaction processes (e.g., product/asset management, procurement, or integration effort), and shall take future developments into account (assure architecture quality concerning changes/extensibility) to avoid expensive design changes in later stages. It shall also allow implementors, integrators and users of the system to define and optimize their own processes.



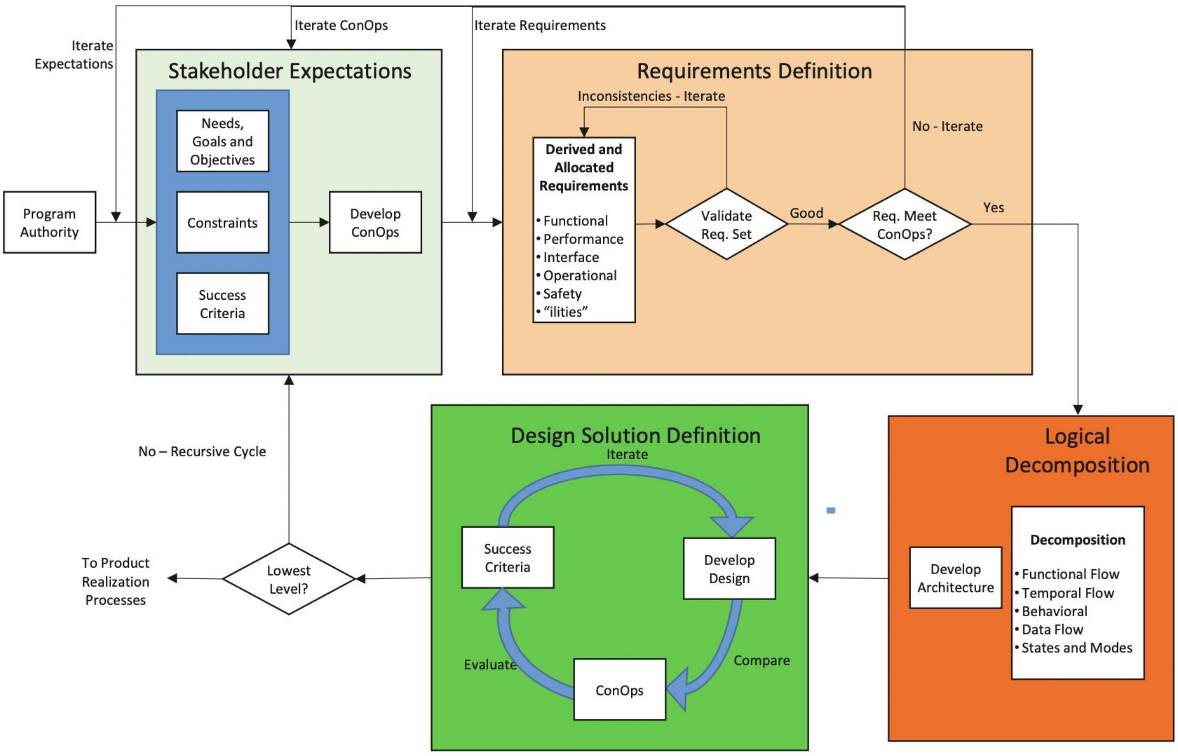
MCR	Mission Concept Review	**CDR**	Critical Design Review
SRR	System Requirements Review	**SIR**	System Integration Review
SDR	System Definition Review	**ORR**	Operational Readiness Review
PDR	Preliminary Design Review	**DR/DRR**	Decommissioning/Disposal Readiness Review

Adapted from INCOSE-TP-2003-002-04, 2015

4 Management system

4.1 Management interdependencies

The overall engineering management process follows this basic approach:



(From NASA Systems Engineering handbook 2020, for illustration)

4.2 Policies

a. The basis of this SEMP is the Europe's Rail Governance and process handbook [2].
b. All work results of the SP engineering process shall be openly accessible and freely usable without restrictions, but compliant to legal export restrictions.

4.3 Roles and responsibilities

- The governance roles are defined in Europe's Rail Governance and process handbook [2], https://rail-research.europa.eu/wp-content/uploads/2022/10/EU-Rail-Governance-and-Process-Handbook.pdf.
- To inform the development process, certain strategic decisions are needed. These will be taken in the System Pillar Steering Group or EU-Rail/SP Core Group.
- In addition, the roles inside of the engineering process are explained in the following Annexes:
  i. Annex C defines, *inter alia*, the rules for allocating work items to organisational teams and the importation of existing models, for example from the System Pillar ramp up process.

ii. Annex D defines in the processes, which team is responsible for which engineering process
iii. Annex A defines "functional teams" (e.g., for requirements, architecture or operations) which are coordinating the break down and allocation of engineering work, if no rule from Annex C or D can be applied. The members of the functional teams come from the SP domains, and are moderated by the Central Modelling Team or its delegates.

4.4 Risk Management

a. Project Risk Management is executed by the SP Coregroup for the SP level, and by the domain leads for the scope of the domain work.
b. As already defined by the SP Governance, the risk related to engineering processes are split into three roles fullfilling Cenelec Phase 3 as well as Common Safety Methods
   i. The PRAMSS team designs the targets, policies, top requirements and generic engineering concepts for a risk area (like security). For all risk areas the responsibility for a "mitigation by design" is executed in all engineering processes and teams, according to the guidelines of the PRAMSS team.

Risk-related special systems that provide risk mitigation on network level (like security monitoring systems or access management systems) are developed in specific system domains (like task 2, transversal systems)

   ii. The specification shall simplify safety approvals for specific applications in the railways. But currently it is not planned to achieve a full safety approval for a generic application specification (processes and systems) on SP level. The pro and con to achieve this in a later stage will be analysed by the PRAMSS team.

4.5 Quality Management

A quality assurance process will be developed and established by the Coregroup, supported by the Modelling Service. This includes

- A role structure for quality control and assurance
- A quality management process, that incl. quality gates linked to milestones and releases, which are managed by the Coregroup and Domains

The basic quality improvement process, that will be used from the start, is described in Annex C (Chapter 18 reviews and approvals, based on automated ALM processes, Application Lifecycle Management).

4.6 Training

The training of SEMP content (processes, methods, tools) will be provided by the modelling service team. It will include

- The SEMP documentation
- eLearning Videos

- Contact partners who can give live tool trainings

4.7 Context (legal, partner, economical, political)

The context of the SP engineering process is defined by the Europe's Rail Governance and process handbook [2].

4.8 Stakeholder

The list of stakeholders is defined by the members of the System Pillar Steering group and their delegates or speakers.

4.9 Stakeholder needs

Stakeholder needs are defined by valid input channels, which are

- Decided SP Common Business Objectives as the top-level of the requirement tree
- Requirements proposed by any party and approved in the SP decision process according to SP governance

4.10 Mirror groups: Sector involvement into the engineering process

! The sector involvement and decision process is described in [2]. The SEMP adds details concerning the "domain mirror groups" to the involvement process. Their role is described in the last chapter of Annex A. The basic principles are:

a. Mirror groups can be established on the Rail Operator side (ROC) and the Rail Industry side (RSI) independently, or also together. Also members from other sectors, from technological research companies, universities or any other area of experts are possible mirror group members, if they can contribute to the process.
b. Mirror groups enable the involvement of additional experts
    a. to contribute to the deliverables of the domain
    b. to align the sector organisation, ensuring the sector buy-in and input, supporting the planning and reviewing process for the domain.
    c. ensure, that the later decision process is based on a good range of sector input and experienced opinions
c. Domain Leads are mutually deciding and organising the work assignment and involvement of and interaction with the concerned mirror groups. Mirror group member can be fixed or temporary contributors. In this case they are completely integrated into the domain work process
d. Mirror group member can represent a company or body, or just bring in their personal experience

Structure, size, and form of the mirror groups are based on the proposal of the domain leads and decided by the ROC and RSI sector organizations (SP Steering Group members). Mirror groups can also be joint groups for several domains. They can be joint teams for railway and suppliers, or separate. Domains, together with the mirror groups, strive for consensus without slowing down the process. Mirror groups shall bring positions of their respective sector into the work of the Domain teams, in order to ease the work and discussion in the Domain team and maximize sector acceptance. If consensus in the Domain team cannot be achieved before a given due date, the dissent is documented and brought to a decision via System Pillar Governance process [2].

To note: the process is subject to continued consideration by the ROC and RSI sector organisations. Changes may be proposed to the process on an ad hoc basis, to be considered as appropriate by the System Pillar Steering Group.

4.11 Standards and norms

The engineering process shall apply to engineering norms and standards, where applicable. Especially the following shall be used as a working basis (to be completed):

- ISO/IEC/IEEE 15288 [2015]
- IEEE Std 828-2012 – IEEE Standard for Configuration Management in Systems and Software Engineering
- ISO/IEC 12207 – IEEE Std 12207-2008. ISO/IEC/IEEE Standard for Systems and Software Engineering – Software Life Cycle Processes
- ISO/IEC/IEEE 15289-2015. Systems and software engineering – Content of life-cycle information items (documentation)
- ISO/IEC 15939 – IEEE Std 15939-2008. Systems and software engineering – Measurement process
- ISO/IEC/IEEE 16326-2009. ISO/IEC/IEEE Systems and Software Engineering – Life Cycle Processes t – Project Management
- ISO/IEC TR 24774-2010 Systems and Software Engineering – Life Cycle Management – Guidelines for Process Description
- ISO/IEC TR 24748-1-2010. Systems and software engineering – Life cycle management – Part 1: Guide for life cycle management
- ISO/IEC TR 24748-2-2011. Systems and software engineering – Life cycle management – Part 2: Guide to the application of ISO/IEC 15288 (System life cycle processes)
- ISO/IEC TR 24748-3-2011. Systems and software engineering – Life cycle management – Part 3: Guide to the application of ISO/IEC 12207 (Software life cycle processes)
- ISO/IEC TR 90005-2008. Systems engineering – Guidelines for the application of ISO 9001 to system life cycle processes
- ISO/IEC/IEEE 24765-2010. Systems and software engineering – Vocabulary
- ISO/IEC/IEEE 29148-2011. Systems and software engineering – Life cycle processes – Requirements engineering
- ISO/IEC 15026-1-2014. Systems and Software Engineering – Systems and Software Assurance – Part 1: Concepts and Vocabulary
- ISO/IEC 15026-2-2011. Systems and Software Engineering – Systems and Software Assurance – Part 2: Assurance Case
- ISO/IEC 15026-3-2013. Systems and Software Engineering – Systems and Software Assurance – Part 3: System Integrity Levels
- ISO/IEC 15026-4-2013. Systems and Software Engineering – Systems and Software Assurance – Part 4: Assurance in the Life Cycle
- ISO/IEC/IEEE 42010-2011. ISO/IEC/IEEE Systems and software engineering – Architecture description.
- EN 50126-1 Railway applications – The Specification and Demonstration of Reliability, Availability, Maintainability and Safety (RAMS) – Part 1: Generic RAMS Process
- EN 50126-2 Railway applications – The Specification and Demonstration of Reliability, Availability, Maintainability and Safety (RAMS) – Part 2: Systems Approach to Safety
- EN 50128 Railway applications – Communication, signalling and processing systems – Software for railway control and protection systems
- EN 50129 Railway applications – Communication, signalling and processing systems – Safety related electronic systems for signalling
- EN 50159 Railway applications – Communication, signalling and processing systems – Safety related communication in transmission systems
- TS 50701 Railway applications – Cybersecurity
- EN IEC 62443 Security for industrial automation and control systems
- ISO21500 Project Management
- ISO/IEC/IEEE 24641 - Systems and Software engineering — Methods and tools for model-based systems and software engineering
- ISO/IEC/IEEE 21839 - Systems and software engineering — System of systems (SoS) considerations in life cycle stages of a system
- ISO/IEC/IEEE 21840 - Systems and software engineering - Guidelines for the utilization of ISO 15288 in the context of system of systems (SoS)

- ISO/IEC/IEEE 21841 - Systems and software engineering - Taxonomy of systems of systems
- ISO/IEC/IEEE 42020 - Software, systems and enterprise — Architecture processes ==> to consider later on
- ISO/IEC/IEEE 42030 - Software, systems and enterprise — Architecture evaluation framework ==> to consider later on
- EN 50128 - Railway applications - Communications, signalling and processing systems - Software for railway control and protection systems
- EN 50657 - Railways Applications - Rolling stock applications - Software on Board Rolling Stock
- Output format for hazard/risk analysis is based on ISO 31000, ISO Guide 73, and especially EN50126/IEC 62278 (quantitative Risk analysis)

5 System Pillar Output

The output of the SP for system standardization tasks is defined in the EURAIL Multiannual Workplan (MAWP):

Deliverables

1. As-is CCS+ analysis
   a. Operational assets & pain points (including safety considerations)
   b. Functional, logical & physical assets & pain points
2. Target CCS+ concept of operations
   a. Stakeholders and stakeholder needs
   b. Nominal & degraded use cases & operational scenarios (including safety considerations)
   c. Nominal & degraded business processes, rules & objects (including safety considerations)
3. Target CCS+ system architecture
   a. Functional, logical, physical architecture
      a. System requirements
      b. Interface specifications (FiS/FFFiS)
   b. Dysfunctional architecture (key FMECA & FTA)
      a. System requirements
      b. Interface specifications (FiS/FFFiS)
   c. CCS+ data structure and semantic rules
      a. System requirements
      b. Interface specifications (FiS/FFFiS)
4. **Standardisation and TSI input plan**
5. CCS+ architecture migration roadmap
   a. Impact & gap analyses
   b. Proposed stable operation & architecture states
   c. Proposed migration routes
6. Methods & tools for CCS+ processes & architectures (to be consistent with task 1)

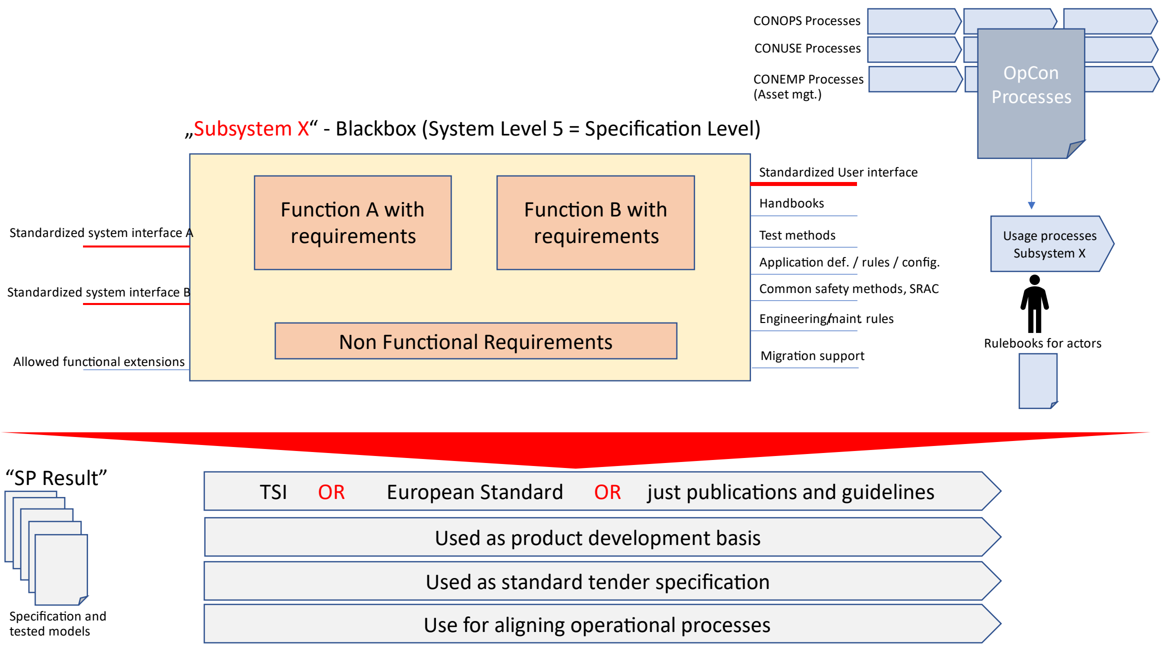
Services

1. Communication / online forum
2. Publication / knowledge & documentation management
3. Support to certification / authorisation
4. Support to TSI CCS/OPE change management process

Form

1. Concepts
   a. Business concept papers
   b. Architectural concepts
2. Descriptions and requirements
   a. Operational scenario & business process descriptions
   b. Architecture, data and dysfunctional models
   c. Traced/assessed needs & requirements
   d. Release and change descriptions (CCM)
3. Assessments & tests
   a. Cost/benefit analysis
   b. Test cases and means
   c. Maturity records (pilot projects)
4. Specifications & standard
   a. TSI impact analysis, TSI CR specification, TSI update proposal (incl. T&M)
   b. Draft standard descriptions (FRS & SRS)
   c. Interface specifications (FiS / FFFiS)

In a nutshell, the two main outputs are subsystem [1]specifications and operational process specifications.



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[1] The term «subsystem» shall not be confused with the subsystems in the TSI. In the ARCADIA standard the subsystems are those systems, that have standard interfaces (System Level 5).

To ensure the results of the SP can be used as input for standardisation and tenders, a high precision and quality is expected.. To assure this, quality assurance processes which involves the relevant technical key experts from sector stakeholders (Railways, Suppliers, ERA) and automated model checking methods (as defined in Annex C Chapter 22) will be applied. Cooperation with SP-external demonstrator or pilot projects will also be used to increase the quality of the results.

! The level of details of the output is chosen to fulfil the targets defined in the decided Common Business Objectives of the System Pillar:

1. To avoid unnecessarily deviating operational requirements of different customers the harmonized operational specification (incl. user interface standardisation) and rule books shall have a very high precision to support a binding harmonisation process and generic product developments that will completely fit to all customer orders and need no extensions inside of the standardisation scope. This does not exclude to have situation specific operational variants (for scalability, migration, or technical reasons) inside of the standardized operational specification. This precision shall be applied for an operational standardisation scope that is derived from the real needs for standard products and operational interoperability.

   Annex H1/H2 is not part of the SEMP. It shows an example as a starting basis for the discussion of the level of preciseness, although they are considered as being not already precise enough. It shall be assessed especially by supplier, if this level of precision already fulfils the precision target described before.

2. The interface specifications (incl. validation methods or engineering rules) shall be precise enough (e.g., all 7 System Layers of the Open Systems Interconnection Model) and validation/testing means shall be provided to assure an easy replacement of products and product interoperability that are developed according to it.

6 Working Style and working culture in the System Pillar

The System Pillar results are needed for several pending activities in the sector. These are for example large rollout programs, the developments in the Innovation Pillar, or the ongoing change and enhancement work for at least TSI OPE and TSI CCS, and perhaps other TSIs. To achieve a fast, efficient, and result oriented work culture in the System Pillar, the teams are encouraged to apply a working style that allows parallel work and professional team management. This includes the following aspects:

- Single tasks assigned to single persons or very small groups
- Issues are tracked (transparent), work is planned in short cycles (agile sprints, or waterfall planning with short term milestones in certain projects)
- Single-person authoring, reviews by domain teams members and organized mirror groups
- All persons take over tasks, which means it should be transparent, which person is currently working on what task
- Involvement of all relevant team members in a meeting by the team lead, that can contribute to the discussion points
- "Fail fast", create fast first simple versions (see "design thinking") and minimal viable results or specifications, for early use by subsequent processes
- Deliver often, make available for feedbacks early
- Result-driven moderation
- Establish (small) focus groups for specific topics only and resolve once topic is solved
- Avoid in working meetings (but review or decision meetings are different)…
    - Unprepared meetings
    - Large groups for content discussion and brainstormings. Group meetings should be used for coordination and feedback to the authors.
    - Large group meetings in general, use small subgroups
    - Unclear tasks or unclear form of results
    - Tasks without due date or author commitment
    - "Silent listeners" (in most meetings) or just "participating commenters and advisors" in working sessions (better provide video recording or protocols)
    - Persons in the team having no assigned task or waiting

For a continuous optimisation process, performance reflection sessions will be organised by the Coregroup, which also deliver the inputs for optimising organisation and SEMP.

7 SP Engineering Processes

The engineering processes are described in Annex A, B, C, D.

Annex A describes abbreviations for the teams names. The main decision aspects in this context are the role definitions and role allocations in chapter 3 and 4, as well as the role of the "functional teams".

Annex B explains the analytical path of the architecting process and defines the terminology (ontology), that will be used in the System Pillar for the engineering process. This document was already reviewed in the sector in June 2022.

Annex D describes as an overview the main process steps concerning input, role owner and action, and output. The main decisions in this context are the assignments of process responsibilities in the so called SIPOC tables. Since not much process details are described for now, a deeper review of the process definitions is not recommended for the start, except the process responsibilities. These will be refined in a next step in a collaboration of modelling service and domain teams.

A general and important policy concerning process definitions is: If a process is not already defined, the domains shall organize it by themselves on a provisional basis – and not wait. Coregroup and Central Modelling Teamshall just be informed. Additional process definitions might be included into the SEMP at a later stage.

Annex C describes an "industrialized" engineering workflow ("factory belt") from the perspective of the work item breakdown and flow including assignments to teams and approval processes. (Introduction videos for the understanding: SP Team collaboration and engineering processes, SP Organisation, Systems of Systems architecture and granularity)

Situation

For large specification organisations the workflow management needs to be organized in an "industrial" but also "always consistent" way. Parallel work on complex issues needs an efficient and systematic working principle.

Work needs to be allocated in many different teams without "losing the trace" or the coherence. Redundant work of isolated teams creates inconstant operational processes and redundant or incompatible architectures.

Dependencies (traces) "run" across the full architecture downwards, upwards and cross all systems. The same function or logical component can have different requirements e.g. coming from ATO and ATP, being revealed over time.

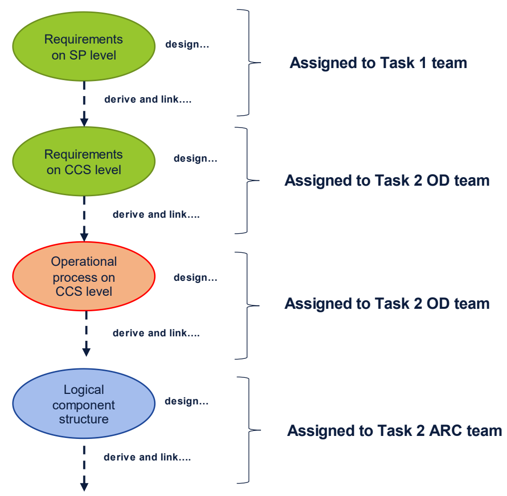
Everything changes and architecting needs time. Processes get refined, interface specifications grow over time. It is not possible directly at the start to create stable contracts and then isolate the teams. Stable specification release that describe a MVP need a first complete derivation of all relevant traces.

Teams have different scopes – processes, systems, system levels.

SP workflow principle (KANBAN based)

- All work items in standardisation scope are stored in a central ALM system
- External "editor tools" for the ALM data are usable, if they can be synchronized "transaction safe" (incompatible parallel changes impossible)
- Work items are derived step-by-step in a rule-based way (SEMP)
- "Upwards" linking (ex-post derivation) is also possible, if bottom up work needs to be integrated and is compatible (derivation, language, etc.).
- Work items are assigned to teams or persons in a digitally controlled workflow of the ALM, that also creates the transparency for all "traces"
- The assignment is done by criteria: Work item type, work item System Level, work item logical component, work item process category.
- A flexible structure of assignment criteria allows the parallel work of any amount of teams in SP, in IP, or externally.

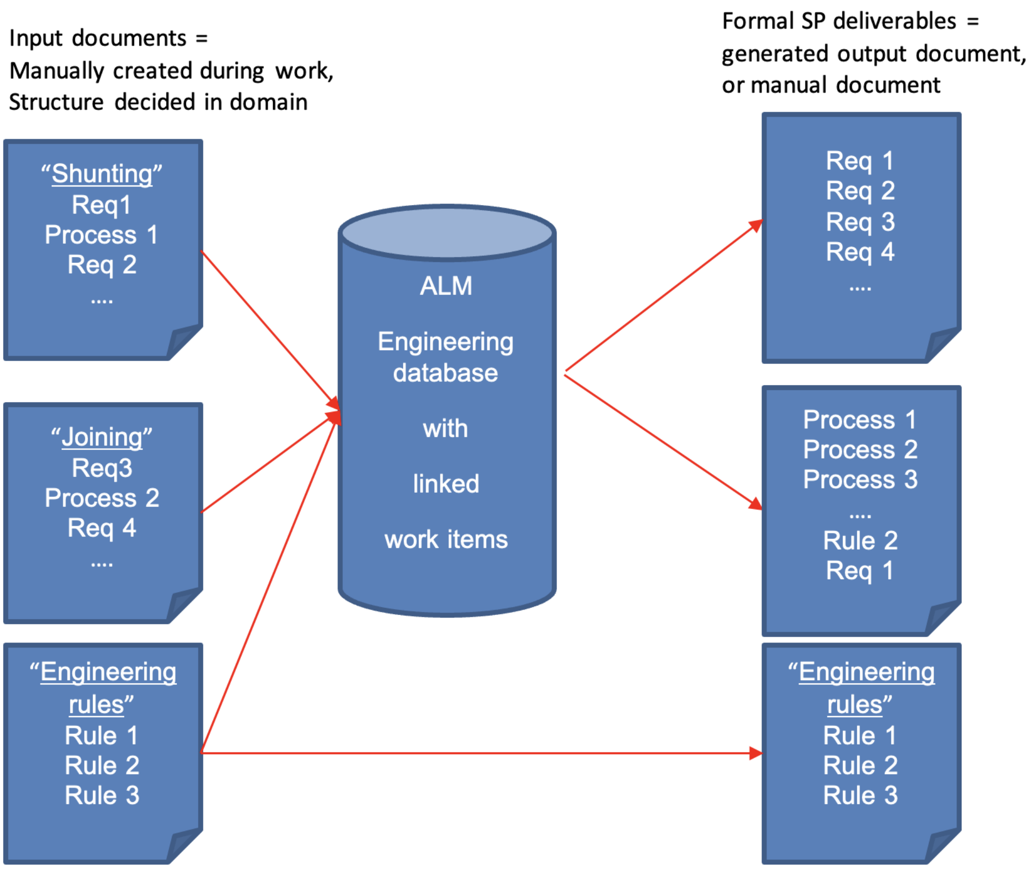
Work item "trace" (indicative excerpt)



The set of all traces together is called a "model".

! Important aspects of Annex C, that especially shall be decided for the System Pillar start are:

a. The internal engineering process is organized on work item level to allow a maximum of parallel work, target oriented prioritisation and traceability, and simplified change management
b. The workflow rules are implemented as automated "digital factory belts" (digital workflows) in the ALM system (which is the master content system) for all types of work items.
c. For every work item type there is a standard assignment rule in which team it has to be worked out (ANNEX C chapter 7).
d. The major workflow sequence follows this hierarchy:
   I. Requirements management process
   II. Operational design process
   III. Analytical architecting (System Level 1-4)
   IV. Technical specification (System level 5)
   V. Application condition specification
e. The requirements management process breaks down the needed Railway System capabilities and the common business objectives down to system requirements in a traceable way.
f. Outputs of the ALM process are generated or manual documents that are linked to the traces in the ALM system.



g. Progress reports are done based on
   a. Weekly automated progress statistics for the work item traces
   b. Delivered documents compliant to milestones (release dates)

h. SP-external teams that are contributing to the architecting process should ideally align to the principles in this document to minimise overlap or divergent work. If they work "offline" or in parallel, there is a high risk that the effort for integrating their results into the central engineering database is as high as their initial development and larger changes of the SP-external results can occur. (see Chapter "Uplinking" in Annex C). The translation work and impact analysis is the task of the external contributor, the SP will check and validate his impact analysis and integration proposal and will implement the model integration.

i. SP-external specification (e.g. TSI) is referenced as documents. Parts of it can be translated to ALM work items if SP is planning to contribute to the specification.

8 Design Methods

The SEMP defines in Annex M,R,S a set of design methods that are mandatory for the content in the engineering database and used MBSE frameworks. These design methods define notation, language/ontology, and structure of specifications. If SP-external contributions (except existing laws or standards) are not compliant to these methods, they cannot be integrated without translation work because of technical reasons. The translation can create an undesirable and effort for the contributor for every release.

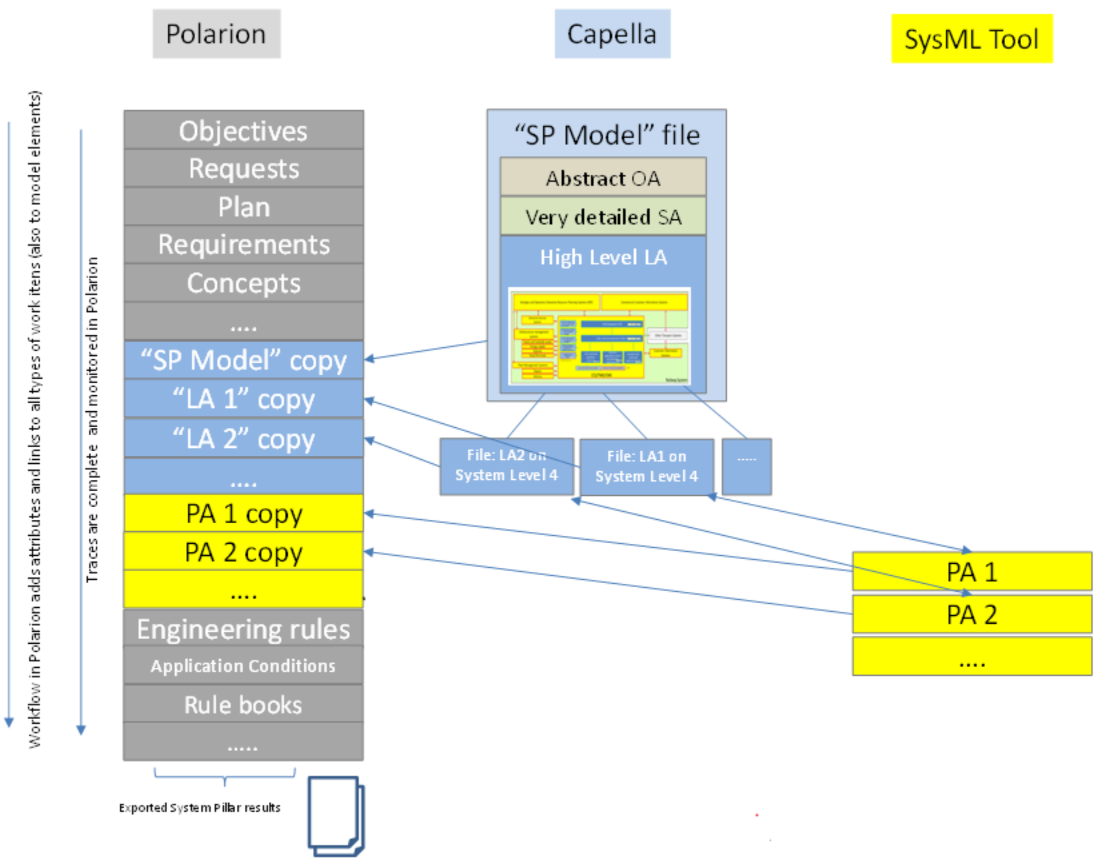
The main decisions concerning the used methods are:

a. For the description of operational or system requirements the rules in Annex R are applied strictly. For common business objectives or customer requirements they are a guideline.
b. For analytical architecting on System Level 1-4 the rules of Annex M (compliant to ARCADIA method) shall be applied. Further additional methods or improvements will be defined by the CMS team. Rationale: The focus lies on functional modelling and intuitive fast learning curves, where ARCADIA has its strength
c. For technical specification on System Level 5 the method is defined in Annex S, which is a mandatory and specific way to model with the SysML notation. Further additional methods or improvements will be defined by the CMS team.

9 Tools and infrastructure

The SEMP V1 will make use of a temporary/basic tool architecture for the start of the SP ("basic platform"). Additionally, the requirements for the target platform are described in Annex T. The basic platform will include

- ALM: Polarion. All engineering work items to be created here, or synced to it.
- Modelling: Capella. SysML tool not decided yet, to be evaluated for the target platform
- Collaboration, non-papers, file sharing: Atlassian (Jira, Confluence) and MS Teams
- The basic architecture of the tool setup will be in the beginning:
  (some of the synchronisations to be developed, OA = operational analysis, SA = System Analysis, LA = Logical architecture, PA = Physical architecture)



Polarion can be freely configured concerning workflow, work item types, and work item link rules. The decision for the SEMP V1 workflows (Annex C) is used for the configuration.

Since no specification work on System Level 5 is expected for the first months, the integration of the SysML design platform can be evaluated for the target platform (except Trackside Asset CS domain, which will continue using the existing EULYNX platform until the target platform becomes available).

! The requirements for the SP target platform are described in Annex T. The main decision in the current stage is to align about the general structure and features of the target platform.

10 Starting the SP workflows

! The steps to start the SEMP workflows in the System Pillar are:

a. **Configuration of the ALM** system based on the decided SEMP

b. **Training of processes and tools**: Modelling Service with Domain teams. During the training the processes will also be discussed and refined. The meetings will be planned and arranged during the kick offs between Coregroup and Domain Leads. The main method for training will be to discuss the SEMP in sessions and to provide eLearning videos.

c. **Initial imports into the ALM System**: Important material from the ramp up project (single selected files, CBO, operational vision, high level logical architecture) will be imported by the Coregroup/Modelling Service into the ALM system according to the "Uplinking" rules in Annex C chapter 20.

d. **First prioritisation**: After the initial agreement between Coregroup and domain leads about the milestones per domain, the imported work items in the ALM will be used for detailed prioritisation (e.g. of the operational capabilities). The prioritisation is proposed by the domain leads to the Coregroup.

e. **Finalize import process**: The first task of all teams is to import additional sector work according to the "Uplinking" rules in Annex C chapter 20, which was registered during the SP ramp up process. As explained in chapter 20, all work that is not already decided in the SP Steering group, needs to be imported in the status "proposal" and will run through the full approval and decision process.

   Imported Text documents (Polarion) are structured into "proposed work items" (explained in the coming eLearning videos), before the review process starts. Imported models (Capella) are reviewed in the domain teams, before they a reintegrated and "uplinked". Detailed instructions for "Uplinking" external models will be provided by the Central Modelling Teamin a next step.

f. **Onboarding for all team members**: The imported specification is reviewed especially by the new team members, and a common understanding is created in the teams.

g. **Start to work along the own "work item queues"**: Since all imported work items are assigned and prioritized, the normal workflow starts – everybody works along his queue of work items.

h. **Prioritized "closing of gaps"**. In the beginning there will be several gaps in the work item traces because of the several independent content that was imported. The Coregroup and the Central Modelling Teamwill prioritize the process to close all gaps for all proposed sub-models to close the gaps and get valid work item traces.

! The intention is to start the SEMP workflows as fast as possible and without too long method discussions, to be able to deliver the results of a first iteration in the beginning of the System Pillar work in 2023.

The work in the SP should focus on working on the content with best knowledge using the methods which are available. These methods are changed or improved over time continuously and the CMS team makes sure that pure method changes do not have an impact on the content (and content decision).

If it is identified that during method improvement content must be improved as well, then this must be done working together with the responsible people of CMS team and domains. This allows that the SP workflow can be fast and can deliver results, but also allows the CMS team to improve the method and overall results.

11 Major discussion points during review

The following issues created discussions during the review process.

11.1 Mirror Group Members integrated into domain work process like domain members?

a. Some of the railway partners state that the working capacity of contributors in the mirror group is strongly needed to reach the goals. There is no reason to reject this working capacity. For this they need to be integrated in the normal domain working process.
b. Some of the supplier partners have the opinion, that there should be a difference between nominated domain members and contributors coming from the mirror group.

11.2 Who is nominating the mirror groups?

a. In the current version the domain leads propose the mirror group members, and the sector bodies finally agree on the memberships.
b. The discussion during the review process was related to how open the mirror groups are. Since they are not "voting" (all single opinions are always carried to the decision process), the idea is to be completely open. Even cross-sector contributors or people coming from universities shall be welcome.
c. There were concerns that the mirror groups grow too large. On the other side, all supporting capacities and knowledge shall be welcome.

11.3 Is everything decided at Steering group level?

a. The concern was raised about the capacity of the Steering Group for decision processes and the speed of the development work.
b. As defined in the EURAIL governance, working teams can propose solutions and work with transparent working hypothesis to achieve the right speed, but in the end all results need to be confirmed along the EURAIL governance.

11.4 How are approvers selected?

a. The term "approval" is used in the SEMP workflow with a special meaning (coming from tool terminology). "Approvers" are experts, mandated persons (e.g. from sector bodies) or persons with roles in the System Pillar (e.g. domain leads or Coregroup) who are asked to express an opinion on a piece of work. It does not imply that their approval is required for progress. The history and status "of all approvals" is always visible as a list of single opinions and assessments.
b. The target of the approval process is, a) to get enough expert experience for the decision process and b) to assure the sector involvement
c. The discussion was raised on how approvers shall be selected and managed. It is assumed that the sum of all mirror groups will exceed some hundred persons.
d. The current proposal in the SEMP is
    i. Minimum: Domain and mirror Group as approvers.
    ii. Optional: Coregroup will define where they want to be involved into approval processes to assure the overall consistency
    iii. Sector bodies define additional mirror group members, that also shall be approvers.

e. The alternative is that only the sector bodies design and manage the mirror group members and their continuous change.

11.5 Level of detail of operational standardization

a. The SEMP assumes, that if an operational process needs to be standardized, the description shall be precise enough.
b. Several inputs questioned the feasibility and need of strict harmonisation.

11.6 Integration into the SP of external contributions

a. The basic problem is that merging the results of parallel work processes on large engineering documentation is a very large effort, if they come from isolated approaches and processes. Merging means to do a complete impact analysis for every changed element that is imported to the standardization specification. For every release. And before of that, it has to be translated to the language, notation, structure, ontology and functional approach of the standardization specification.
b. Due to existing resources the SP teams should not be assumed to be able to translate and import large external inputs. External contributors should expect to carry the main workload for this process.

11.7 Why not use SysML for System Level 1-5 as usual in the industry – why use ARCADIA for System Level 1-4?

a. The argumentation of the SEMP team is the following: Analytical (functional) architecting and technical specification are different work areas, and it is quite usual to use different methods. ARCADIA is a strong tool and appreciated in supporting functional modelling even together with stakeholders, where SysML profiles have their biggest weaknesses. This is the reason, why ARCADIA was derived from SysML, to solve some major problems in functional modelling. But ARCADIA is just designed for architecting, it has not enough language and method scope for technical specifications on System Level 5. ARCADIA and SysML share 90% of their language description, so they are not "two completely different methods". Even if we change the strategy to "pure SysML" notation (creating that SysML profile and method would take quite a while), the SysML profile for the deferent System Levels would make the same differentiation between architecting and technical specification.

b. The alternative is to use only SysML, create an SysML profile and working method for the different System levels (will take some months), procure professional SysML tools (additional cost) and train all modelers in the defined working method (slightly higher complexity in the architecting process).

12 Open points for further refinement in the next SEMP version

1. Describe the decision preparation process for the standardisation granularity decisions

2. Are there any ERA guidelines for a systems engineering project that we need to follow/refere to?
3. Chapter 5: In order to fulfill Phase 4 we need to proof that the vaildation of the requirements specs took place. We should make it very clear how this is achieved with the proposed process (explicit chapter)
4. Emphasize in the process description that according to chapter 5 the economic risk assessment and all types of risk mitigation are done in all domain's processes.
5. PRAMSS team: Review and optimize chapter 6.4
6. Check the completeness of Chapter 6.11 (Standards and norms)
7. Some readers miss the "change management process". It is defined in Annex C (happens on work item level), but the description should be more explicit.
8. Assign responsibilities in Chapter 6 to actors more precisely
9. Design and discuss events and detail process for the outputs (Task 3 asked)
10. Discussion of optimisation of role names, for example:
    - Rename Operational Designer to Railway Operations Expert: Ensures that the operational needs of the current and future railway system are represented.
    - Rename System Architect to Architect: Define and manage the architecture based on the requirements. Define and improve the requirements in collaboration with the experts and overall life cycle in mind.
    - Rename Modeler to Systems Engineer: Defining and managing the operational concept, the architecture and the requirements for complex systems in collaboration with the railway expert, taking into account the entire system life cycle. Focuses on the application of thinking, methods, processes and procedures. Maps the architecture, behaviour and other identified specific requirements into the project-specific tools.

      Rename Method designer to Method and Tool Specialist -> Develop and deploy state-of-the-art systems engineering methods in order to support the Systems Engineer with the use of the tool
11. The term "System Level" shall be renamed to "System Layer" in all documents (not to be confused with OSI System Layers which mean something different).
12. Refinement of the NASA V diagram – more detailed explanation
13. Add links to references, set up a common central reference list and comman glossary in Polarion
14. The processes OpCon, CONOPS, CONUSE And CONEMP must be defined (probably not in Annex D, as they are no engineering processes). Also the relation between CONEMP and Asset management must be explained.
15. Check/compare/merge SysML guide from EULYNX and Connecta, define a refinmentment of Annex S
16. Check if SysML tool is needed/can be integrated already in the basic platform (Domains like computing environment need it).
17. Annex M (preliminary) to be refined (some links are not clear), method to be approved.
18. The economic assessment method needs to be refined
19. Mitigations for tools dependencies to be implemented
20. Section 4.1 addresses, correctly, the MBSE ontology but ignores the need for ontologies covering the engineering activities in general, the railway system itself (domain ontology), and its external interfaces. Reference to LinX4Rail WP2 should be inserted. Note: various publications deal with added value of ontologies in MBSE.

21. Annex B, 4.9.2.1 Design guidelines; Subsystems shall follow a strict inheritance model: to be explained. I guess it is about avoiding re-definitions that are legal in UML, but break the inheritance principle.
22. Annex B, 4.9.2.2 " The system must be powerful enough to handle the growing rail traffic of the future …": This requirement is valid only if the "future traffic growth" can be sourced from some document. Please add.
23. Annex B, 4.9.2.2, "…and to be able to perform the computation within fractions of a second." This requirement is invalid until the context is provided.
24. Annex B, 4.9.2.2, Q7 Scalability P/CR+ Scalability should be up and down, so system can be (locally? temporarily?) adapted to worsening conditions or shrinking demand, rather than shut down and never reactivated.
25. Add "definition of done" to the work item attributes and process definitions
26. Full description of the quality assurance and management process incl. the different roles.
27. Check correct usage of team names (e.g. "Central Modelling Service").
28. Optimise references to SEMP pictures and text, after the SEMP is imported to Polarion
29. Describe "import, translation, and uplinking" of external contributions to the SP model (SP standardisation scope) more in detail.
30. Refinement of the process to mark work items as "suspect"
31. The output processes to standardisation and TSI shall be described more in detail
32. The requirements in Annex T shall be prioritized (essential/optional)
33. Methods to check the completeness of all capabilities shall be defined