Project funded under the Shift2Rail Joint Undertaking
Grant Agreement n°881826

LINX4RAIL

Project Title:	**System architecture and Conceptual Data Model for railway, common data dictionary and global system modelling specifications**
Starting date:	2019-12-01
Duration in months:	36
Call (part) identifier:	S2R-CFM-IPX-CCA-01-2019
Grant agreement no:	881826

Deliverable D5.7

[Interim report on governance and deployment strategy]

Deliverable	
Responsible partner	**SNCF Réseau**
Revision:	**6.0**
Document Status:	**Issued**
Due date:	**31.05.2021**
Actual date:	**23.06.2021**
Dissemination Level:	**PU**

Table of Contents

1 History of changes

N°	Changes	Leader
0.1	Initial draft (September 2020)	JB Simonnet
0.2	Integration of comments from DB, TD, SMO, HRS, CAF (dec 2020)	JB Simonnet
1.0	General definition (integration of comments from CD, NR, TVK, TD)	JB Simonnet
1.1	Global coherency and clean lay-out	C. Chéron
2	Clean version (integration of SNCF R comments)	C. Chéron
3	Integration of comments from DB, Siemens, Thales, Trafikverket	C. Chéron/JB. Simonnet
4	Validation by the members of the LinX4Rail task 5.4	C. Chéron/JB. Simonnet
5	Integration of the comments of the Shift2Rail JU project officer	C. Chéron/JB. Simonnet
6	Validation by the members of the LinX4Rail task 5.4	C. Chéron/JB. Simonnet

2 Authors

		Details of contribution
Author(s)	**SNCF** Christophe Chéron, Jean-Baptiste Simonnet **SNCF Réseau** Pierre-Etienne Gautier	First draft
Contributor(s)	**Hitachi STS** Fabrizio Cosso Giuseppina Formato	
	Bombardier Patrik EKMAN Mikael DANIELSSON	
	CAF José Antonio QUINTANO	
	Trafikverket Andreas WIK Jan BYSTRÖM	
	DLR Christian RAHMIG Lucas SCHUBERT	
	Thales Klaus MINDEL Bettina DÖTSCH	
	Siemens Ralf KAMINSKY Robert GROSSER	
	DB Netz Ralph MÜLLER Bernd Eberts Dorothée Becher **DB AG** Molley Morgan	
	Network Rail Nicola FURNESS Imtithal AZIZ	
	Alstom Benoît BIENFAIT Stéphane BESURE	
	Mermec Francesco INZIRILLO Giuseppe PAGLIARULO	
	Kontron Ulrich Geier	
	AZD Peter GURNIK Michal PAVEL	
	EUG Michel Ruesen	

3 Summary

This document proposes to capitalise examples of industrial architectures and provide first foundation for setting up shared principles on the governance of the European railway system architecture and conceptual model developed in LinX4Rail project. The objective is to complement the technical reports prepared in LinX4Rail prepared in LinX4Rail WP5 for the European railway system architecture and LinX4Rail WP2, WP3 and WP4 for the Common Data Model (CDM) and put it into a dynamic perspective with governance considerations. The principle proposed in this document can be already implemented, as much as possible, in the governance of LinX4Rail project (e.g. task 5.2 is now open to sector participants outside the LinX4Rail consortium), and more extensively through the implementation of the System Pillar envisaged for Europe's Rail JU.

There are various governance needs for a system architecture to be an asset for railway transformations: setting an achievable ambition, accelerating solutions, facilitating use. A clear governance set up and principles must be defined, in particular to reconcile an early profitability with the overall sector efficiency. To maximise the effectiveness of the railway system architecture, accountability for architecture design will be the ground for sector wide ownership. The railway system architecture framework can be a pier for productivity, if it is supported by an executive governance, open coordination, agile development and independent evaluation.

A sector dynamic on the European railway system architecture is starting with the LinX4Rail project. With the broad and diverse community involved in LinX4Rail, the rail system architecture becomes a global sector discussion. With the perspective open through different Linx4Rail activities, a longterm roadmap for European rail system is emerging. There is the potential and key opportunity for the railway sector (e.g. RUs, IMs, manufacturers/suppliers, institutions), to structure a governance that will increase the relevance and quality of railway services, operation and assets. Independence and openness shall be guiding principles for architecting activities to profit to the wide sector and the end customers (passengers & rail freight clients). There can be a pragmatic path for a progressive implementation of the architecture governance. As a first step, a simple architecture governance in S2R and its successor would support better collaboration and alignment mechanism.

4 List of abbreviations

Abbreviation	Definition
CDM	Common/Conceptual Data Model
DART	discoverable, accessible, reusable, and transparent https://osiglobal.org/2016/06/23/report-from-the-what-is-open-workgroup/
EC	European Commission
ERA	European Union Agency for Railways
EULYNX	Standardisation organisation of EU railways and infrastructure managers for the model-based specification of CCS subsystems and associated interfaces
ERJU	Europe's Rail Joint Undertaking
IFC	Industry Foundation Classes
IM	Infrastructure Manager
KPI	Key Performance Indicator
OCORA	Open Control Command and signaling On-board architecture
OSI	Open Systems Interconnection
RCA	Reference CCS Architecture
RU	Railway Undertaking

5 Introduction

The general purpose of this document is to define governance principles for the Railway System Architecture and the Common Data Model (CDM) which are defined in a first step by the LinX4Rail project, and which will be an important source for the System Pillar within the new Europe's Rail Joint Undertaking. Indeed, an architecture is usable only if it is governed. Linx4Rail project can initiate architecture descriptions, their value still rely on how it is endorsed by the project members and even more globally, how it can become a committed consensus on a sector scale. This intermediate report looks therefore at principles for governing Linx4Rail work on architecture, it identify needs towards a sector process allowing to adopt a rail system architecture delivering added value for all European stakeholders.

As part of the governance process a structure for sustainable maintenance of the Railway System Architecture and the CDM will be provided. Key attributes and challenges to be considered are the open structure, shared and well defined ownership and organisational independence respecting existing corporative organisations.

The purpose of this document is to:

- Define the main motivations for setting up a railway system governance,
- Determine driving principles for an executive governance of the rail system in Europe,
- Identify main needs to be satisfied when structuring the mission of governing the railway system architecture,
- List the key governance activities and set foundation for efficient governance process,
- Explore what are the main drivers for implementing an architecture governance,
- Start the setup of CDM governance
- Give reference to industrial architecture approaches from various origins.

6 Architecture governance needs

6.1 Motivations for a European railway system architecture governance

While Railway system needs continuity of operation, there is a need to continuously introduce new and better services, a need to continuously replace assets, due to wear, obsolescence or answer to new expectations, like cost reductions. Developing an architecture requires that partners have clear, well-aligned objectives. the governance should create the conditions for clear objectives and processes, leading to fast decision-making.

The architecture can be a tool to manage system consistency and integrity only if it is supported by a sustainable organisation beyond R&D projects. Governance, including the role of design authority, may be developed in a stepwise approach, using EU policy as enabler and optimising contributions from the scarce sector expert resources. On the long run, the European Railway system architecture may need to be hosted by a specific organisation on a sector scale as for instance a foundation. Common interest and European knowledge should be driven by such if supported by sustainable processes and funding.

Building architecture for the railway system must embed migration considerations. Both, the legacy and the on-going developments within the railway industry must be acknowledged. The need for coordination on an EU scale is growing and there is a unique opportunity, when setting a governance, to catalyse and enhance the value of initiatives contributing to some views or parts of the architecture (e.g. ETCS, FRMCS, RCA, OCORA, EULYNX, Ontorail…).

The governance of the architecture should serve a purpose. In addition to the architecture development performed in LinX4Rail task 5.2, aligning on common objectives (e.g. common business objectives as defined in task 5.1) for moving forward on a European railway system architecture will give the ground for an executive governance. Some key principles and a mind map have been agreed during the task 5.4 meeting of the 22/2/2021 in order to support common understanding of the purpose of the architecture (annex 1).

6.2 Some examples of industrial architecture – Their respective management/governance – Lessons to be captured

An inventory of some key industry sources (annex 2) that should be capitalised when shaping the concept of a rail system architecture governance has been proposed.

Recently some members of the task raised the potential benefit in using the NATO architecture framework for the governance description. In addition, some of them consider as a potential advantage to discuss the topic of joint ownership based on the proposal of AUTOSAR which have defined different kind of partnerships.

In the following works of the LinX4Rail task 5.4, the aim will be to complement, refine and derive from these reference practices a systematic identification of key principles and requirements for an executive rail system architecture governance framework. It will then be proposed in the following deliverable D5.8 Final report on governance and deployment strategy.

6.3 Principles for governing an architecture

In the future, the effective implementation of an executive sector architecture governance should be provided by the System Pillar. In addition to other inputs from different initiatives, LinX4Rail deliverables, in particular this one, will help to prepare and feed the System Pillar.

Architecting the railway system may involve directive, coordinative and supportive approaches, it must anyhow find a collaborative path between experts, stakeholders and institutions. Unless it comes to safety, security or interoperability issue, the architecture development and demonstration should however not be about authoritative decision but rather an investment driven mechanism, with a strong focus on cost reduction for end customers, by increasing productivity of current assets (e.g. capacity increases) and reducing unitary lifecycle costs, as is the case in other sector architecture initiatives. This includes the aim of interoperability and increased modularity and exchangeability of components which can be secured with a reference architecture. As benefits, while architecture mechanism will allow to develop better interoperability requirements, architecture should open flexibility for implementation.The Architecture implementation will be market driven, supported by regulations and customer demands. It should be adopted because it secures early benefit and paves the way towards a SERA, not because it allows to answer to an obligation. Various enforcement approach supporting the architecture governance and implementation therefore needs to be considered. To gain agility and effectiveness, the architecture processes shall be supplementary to regulatory decisions. Independence is also of concern for designing the architecture. An independent evaluation mechanism would increase quality and confidence in the architecture deliverable.

For the architecture to be relevant, it should target to be applicable for the whole sector, incorporating the strictly necessary local needs in the most flexible way, e.g. by a simple software configuration, minimising development costs and required capital investment. Openness shall be a basic principle, in order to ensure sector wide inclusion, but the Architecture responsibility is with railway operators first as they are generally in Europe state owned assets and represent long term invest and implementation decisions by their owners. Openness would allow capturing good practice from sector initiatives, local deployments and other sectors. Openness does not always require open-source practice. Openness for the railway system architecture should be about a transparent and controlled process in which every stakeholder can input its contribution, keeping when necessary its proper intellectual property rights if this does not compromise interoperability and modularity. The responsibility for the correct and fair implementation of the contribution of all stakeholders remains with the railways. The DART framework defined by the OSI[1] should be used to further develop governance targets and KPIs related to openness.

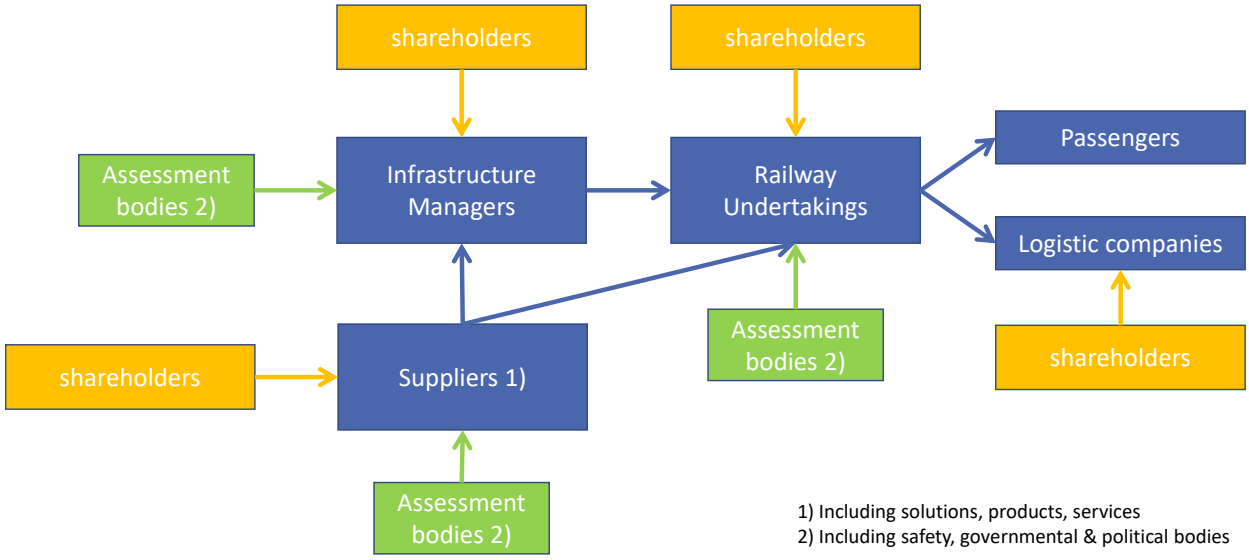
Harmonisation and standardisation of both, operation and assets, shall be a target, in order to allow an efficient use of scarce resources but also increase quality and speed of industrial development through a larger market open by European railway system architecture. Harmonisation should be done as long as it drives simplicity and performance as what has been initiated in e.g. TSIs, LinX4Rail, RCA, OCORA.

Each activity for the architecture shall be governed under agreed and transparent principles. The “Design Authority”, an external body to the architect team, should be in charge of checking that activities are performed according to these principles. Most probably, several design authorities will need to be involved, depending however on the finally agreed scope of the railway system architecture. Different responsibilities and roles for design authorities are to be identified, taking into account the roles already allocated to ERA or other national/European institutions. The need for new design authorities in relation to architecture segments or for the development and implementation of architecture modules should be investigated to maximise the relevance and sustainability of the architecture. The main issue today is to set up governance principles that will allow an open and inclusive dialogue but also effective progress.

[1] See http://osiglobal.org/2018/06/08/is-the-open-spectrum-a-better-way-to-get-open/ : DART = Discoverable, Accessible, Reusable, Transparent

6.4 Governance implementation needs

6.4.1 Identification of stakeholders



Stakeholders along the value creation network

The relevant stakeholders[2] are all those who have concerns in the railway system: End customers, EC, ERA, RUs, IMs, manufacturers/suppliers as illustrated in the picture below, and their representative organisations and initiatives (e.g. UNIFE, UIC, CER, EIM, EUG, RCA, EULYNX, OCORA).

To ensure ownership, the sector governance of the architecture should properly involve the relevant stakeholders. Ways to organise transparent & balanced evaluation remains an open question in the sector. RUs, IMs, manufacturers are by principle the main stakeholders but more globally all the organisations that contribute to the system definition should be architecture stakeholders.

Clear architecture roles must be allocated. Stakeholders are involved according to their natural roles and responsibilities.

Their involvement depends on the level/view/part of architecture considered: not all stakeholders need to be involved in each architecture development and decision process. There is a need to distinguish between strategic governance, technical governance, data governance. Each stakeholder may have a specific role to play for the different governance, development and implementation activities.

6.4.2 Concerns of stakeholders

This document targets an architecture, which is broadly accepted by all stakeholders. This will be the case if their concerns[3] are adequately considered in the architecture design. The stakeholders' concerns drive the architecture and should be made transparent to support a mutual understanding and an efficient decision process. The description of the "Common Business Objectives" (see [1]) made a big step towards this target. The acknowledgement of each other's interest is a solid ground for collaboration maximising value. On the basis of this document we collectively assess the identified technical topics and elaborate recommendations for further progress.

[2] Definition according to IEC 42010: Individual, team, organization, or classes thereof, having an interest in a system

[3] Definition according to IEC 42010: Interest in a system, relevant to one or more of its stakeholders

6.4.3 Scope of architecture description

The architecture description is the main product of the LinX4Rail task 5.2 activities, this work is being developed based on existing models (e.g. S2R, Eulynx, RCA, OCORA, …) and will provide a clearly defined system of system architecture

6.4.4 Progressive Refinement

The development of an architecture description for our railway "system-of-system" will be very demanding and complex. To manage this challenge, we should start with high level description (high granularity, simple overview) models and refine it stepwise, removing gradually the abstraction and genericity in the model.

6.4.5 Efficient design process

Rail system architecture design activities should be organized along major system structures and throughout technology lifecycle. The work could be performed for substructures in parallel, supplemented by alignment activities. To benefit from the specific competences of all stakeholders, they should drive the architecture design of their competence areas, in cooperation with the other concerned stakeholders.

6.4.6 Alignment with System Pillar of ERJU

This paper focuses on the identification of governance principles and requirements applicable for architectural activities. In parallel, the organisation of the System Pillar of ERJU is under development. Even though LinX4Rail runs ahead of ERJU and has its own governance mechanism within S2R JU and in collaboration with sector institutions and initiatives, the LinX4Rail governance (as described in the Grant agreement and the Consortium agreement) will become an important experience for ramping up the System Pillar, deliverables and processes may have to be adapted to be integrated into the wider System Pillar governance principles, as far this is possible.

6.5 Architecture process to be governed

The governance should allow that strategic desired outcomes for the architecture activities and deliverables are defined and managed. Considering the variety of railway stakeholders in Europe, but also the need for ownerships on individual and collective decision, the governance of the railway system architecture will have to consider several processes.

Based on the approach proposed in the NATO architecture framework and ISO/IEC/IEEE 42020, some key architecture process can be identified. They will require specific governance principles, roles and responsibilities:

- Governing the architecture in order to favour its implementation and value,
- Managing the progressive definition of the architecture in order to deliver early values,
- Developing architecture description with openness and independence,
- Evaluating architecture description to support ownership for architecture decisions,
- Enabling architecture definition and use.

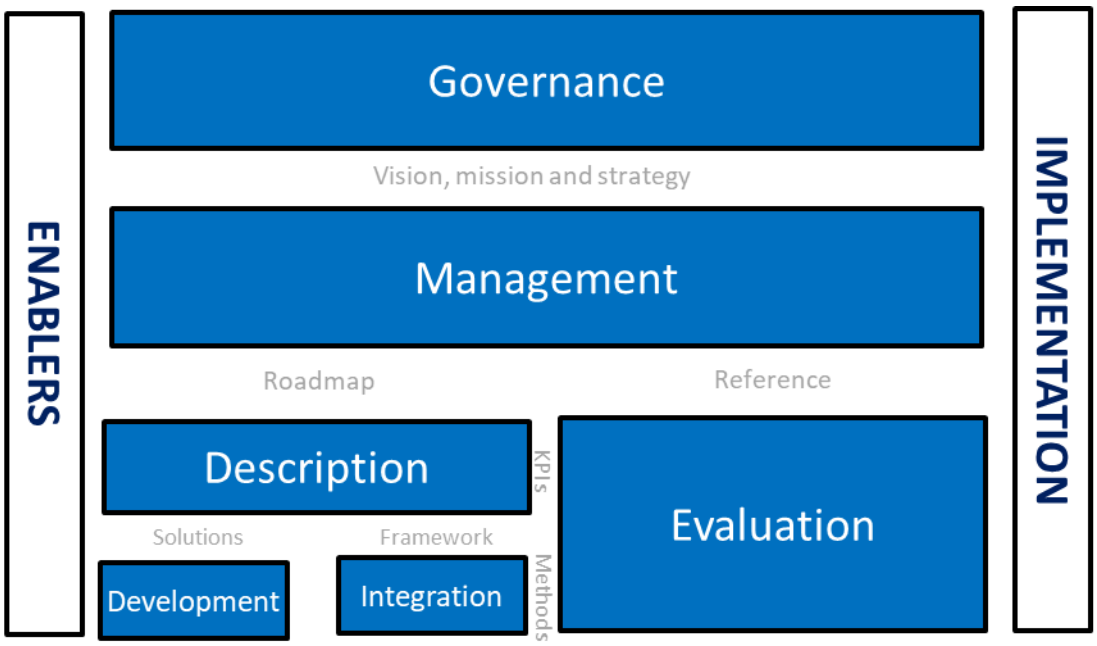


Figure 1: Main architecture processes that have to be governed

For each of the main architecture activities to be addressed governance principles can be identified:

- **Governance** covers the strategic activities controlling architecture according to enterprise (e.g. in Shift2Rail the consortium, in the future System pillar, the sector) directions and objectives. In order to enable the architecture development and implementation, *governance shall*
    - commit stakeholders and institutions
    - allow for executive decision
    - Refine and maintain vision and mission of the architecture, including principles and rules compliant with LinX4Rail grant agreement and soon with the objectives set up in the master plan of the Europe's Rail JU
    - Be accountable for resources and planning
- Architecture **Management** is a process to plan, run and monitor architectures along their life cycle. The objective is to have the architectures developed according to consensual direction with regards to stakeholders' expectations. *Management shall*
    - Commit empowered professionals
    - Allow for effective coordination
    - Define a realistic roadmap
    - Be accountable of qualitative outputs of the architecture
    - Allow efficient and effective conflict solving
- Architecture **Description** process aims to be compliant to ISO/IEC/IEEE 42010. *Description shall*
    - Commit empowered experts and formal proofing
    - Allow for agile delivery
    - Define a framework and solutions
    - Be accountable for performance and support through expert communities
- Architecture **Evaluation** process aims to be compliant to ISO/IEC/IEEE 42020 and ISO/IEC/IEEE 42030. *Evaluation shall*
    - Involve a representative group of experts representing sector interest
    - Allow for transparency and ownership
    - Define reference solution
    - Be accountable for applicability of the solutions

- The purpose of the Architecture **Enablement** process is to develop, maintain and improve the enabling capabilities, services and resources needed in performing the other architecture processes. This could involve the acquisition or development of these capabilities, services and resources, if needed. *Enablement shall*:
    - Engage all committed railway actors
    - Allow for speed
    - Support financing, empowerment and legal consistency
- Architecture **Implementation** is the process for using architecture description and sharing feedback on the application and effect. *Implementation shall*
    - Engage suppliers, RUs, IMs, authorities, financing bodies…
    - Allow for sustainable business
    - Define productive and collaborative industry
    - Be accountable for feedback on use

6.6 Generic governance processes

Decision making principles should allow identifying desirable reference solutions that are compatible with the architecture and screen out solutions that can increase lifecycle costs or introduce critical inconsistencies. As a matter of principle, decisions should be consensual on a sector scale (non objection principle), based on a mechanism which delivers such consensus, or a decision/recommendation where this is not possible. When a dispute is arising, a recognized design authority shall be involved to avoid uncontrolled impact of the lack of decisions. EC/ERA should be involved as escalation board if consensus cannot be reached. This should support the process described in Article 93 paragraph 1 of the SBA.

The architecture governance should allow to commit resources on a planning and to coordinate the actions necessary for building successive architecture releases. Every release should offer consistent definition of the railway system architecture. The successive release will allow expanding architecture descriptions and enhancing their usability. Configuration and change management must be organised in order to manage compatibility and non-regression between architecture building block and also to enable a progressive adaptation of the architecture (e.g. when a new functionality or technology is introduced). The governance of the architecture shall enable as much as possible forwards and backwards compatibility between assets in order to deliver reliable but also evolving system capabilities.

The definition of the architecture must take into account that not every actor will have the same need at the same time. While the architecture should provide a global approach, it should not be restrictive on local and specific implementation. Certain aspects of the architecture have to be mandatory (e.g. interoperability parameters, safety and security requirements), while other must allow for various implementation. The architecture can only be implemented if its flexibility is well governed.

The governance of the architecture should compile maturity information. The technical readiness of railway solutions should be measured. The market readiness should also be monitored both in terms of supply (industrial readiness) and demand (deployment readiness). The architecture governance should allow an efficient compilation of scientific, industrial and operators' communities knowledge as well as other sectors that can be useful.

When the architecture development in LinX4Rail task 5.2 has already a governance in place, long term architecture governance needs must be considered. Governance principles and process described in this document should give a common basis of knowledge helping to set up appropriate mechanism in the System Pillar.

At the end the governance should allow to:

- Ensure the sustainability, desirability and feasibility of the architecture with evolving sector needs,
- Build a dynamic industrial ecosystem bringing suppliers and operators together, notably through economically viable industrial solutions and rail transport operations,
- Enable complementarity of architecture decision towards regulatory decisions,
- Facilitate migration, notably through standardisation and self-configurable off the shelf reference solution,
- Trigger adaptation or new development of the technical tools necessary for railway business (e.g., Capella, Scade, Doors…).

6.7 Governance for the Conceptual Data Model (CDM)

Given the progress on CDM framework and the opportunity to start common understanding on broader architecture governance needs, that de facto and implicitly touch CDM, the focus of LinX4Rail T5.4 workshop was on the overall architecture, without, yet, considering the specific needs and impact for the governance of the CDM. It will be proposed in the following deliverable D5.8 Final report on governance and deployment strategy. However, it will be taken into account that the CDM evolution is dependent on external initiatives: IFC, EULYNX, RCA, OntoRail, RSM, railML and that appropriate long-term relationships must be defined with the organisations developing and maintaining these initiatives. The ramp up of System pillar as a sector process and kick off of Europe's rail JU, on top of the 4th railway package arrangements at ERA, are the opportunity to clarify an overall data governance that will have to support the CDM.

6.8 Discussion paper – Working principles for the sustainable maintenance and development of the system architecture / CDM

In order to ease the definition of the governance of the architecture and the CDM, a discussion paper was worked from December 2020 to March 2021 by the members of the task 5.4. This paper (annex 3) establishes some working principles for the sustainable maintenance and development of the system architecture / CDM.

6.9 Towards a smooth implementation of the architecture governance

The governance process shall consider the diversity of organisations involved in the railway business. It should consider the need for:

- Regulated and voluntary implementation,
- Universal and investment driven mechanism,
- Political and industrial (manufacturers + operators) initiative.

In order to make architecture choices acceptable by all, the governance process will have to be transparent and supported by clear rights and obligations such as Intellectual property (e.g. publication as EU public license). Well-defined governance enables the architecture to be a tool to support trust, ownership and collaboration while avoiding duplication and divergences on a sector scale.

Clarifying the governance require to clarify the architecture deliverables and vice versa. In a first step (this report and initial activities in LinX4Rail), architecture and governance implementation drivers (i.e. purpose, objectives, principles and requirements) must be better identified. Organisation process could then be enhanced, notably through the preparation and execution of the Europe's Rail JU System Pillar. For instance, the governance of the architecture shall not only look at efficiency aspect but will also need to consider sustainability and inclusion. With today's European comitology and the launch of the LinX4Rail

project, there is now an architecture development structure being deployed. However, not all aspects of efficient architecture governance are yet available.

The governance of the architecture should not only set the target but care to structure the work: clarity on sector working structure allow to leverage organisation capacity in technical working groups that will deliver the architecture. The governance should also organise and address dissemination aspects of the various architecture elements:

- A framework allowing to collect information and provide methodologies and tools,
- Precise description of railway solutions and models for their interaction,
- Clear ownerships and collaboration process for dynamic definition and adaptation of solutions,
- Guidance and recommendation for use of reference solutions.

The architecture governance shall help to develop and promote new scientific and technical knowledge on the railway system objects, on their interrelations and interactions.

Further steps can be taken for enhanced European railway system governance:

- The system pillar is needed for an executive governance and effective sector coordination,
- It could organise an independent assessment of architecture solutions,
- It would allow setting up a delivery mechanism involving empowered experts and organisation, notably thanks to EU funding policies.

Drive and control implementation of standards following the common architecture

7 Conclusions and proposals for next steps

Main findings and proposal for moving forward with the rail system architecture governance:

- Distinguish governance, management, development and evaluation processes
- Governance is to adopt a reference architecture on a given level of granularity, it is also to manage organisational capacity to make the architecture work
- The governance shall support the maintenance and evolution of the architecture based on agreed principles in order to manage future innovations.
- The governance of the architecture should allow to manage adaptation of the rail system architecture description, its CDM and related methodologies.
- Architecture should feed regulatory and standardisation processes, but the railway system architecture should also allow flexible and voluntary implementation solution, supplementary to the regulatory and standardisation framework
- Various sector bodies and groups must be involved in the governance and development of the architecture, decision mechanism should be consensus based with escalation, when ever needed, to System Pillar steering group, ERA or other relevant authorities
- The governance need to supervise that the architecture outcomes are traced to and driven by common sector business objectives and a roadmap governed today by Shift2Rail Executive Director program board and from the start of Europe's Rail JU System Pillar steering group.

Lessons learnt from industry architecture governance in place: An architecture is liveable if there is an organisation able to manage the evolution of the topic.

- A need for a core group of industry stakeholders,
- A foundation / an independent organisation for revision & maintenance as a recurring question,
- A large-scale architecture development involves a mix of public bodies (e.g. ERA) and industry stakeholders (i.e. Suppliers, IMs, RUs),
- Governance has standards managed by World standardisation bodies,

(see also annex 2)

Further steps are needed to:

- Collectively identify and learn about architecture governance good practice from other sectors
- Shape governance processes, roles, responsibilities and actors involved in particular to ensure the:
    - Ownership and independence for architecture decisions,
    - Profitability and effectiveness of the architecture work,
    - Openness and sustainability of the architecture framework,
    - Ability to manage transition from the existing legacy system to the future European Rail System Architecture thus paving the way for system evolution, including harmonization of operations.
- These points will be developed in a proposal for a management plan for the development and maintenance of the Architecture (See annex 4). This Management plan will be further developed in the fore coming period with the ambition of providing input for the ramp-up of the System Pillar.
- Find the right path and interactions between stakeholders for an enhanced European railway system governance to be executive.
    - Allocation of roles (association, stakeholder, experts) for contributing to the scope and governance of the rail system activities
    - Refine main interaction of governance activities within and outside the System Pillar
    - Identify interfaces and cross fertilization opportunities between System Pillar and Innovation Pillar

8 References

[1] Deliverable 5.1 Identification of Common Business Objectives for the existing and future Railway System, Rev. 3.1.1 - LNX-T51-D-THD-005-01 LINX4RAIL_TASK 5.1 COMMON BUSINESS OBJECTIVES V3.1.1

[2] ISO/IEC/IEEE42010

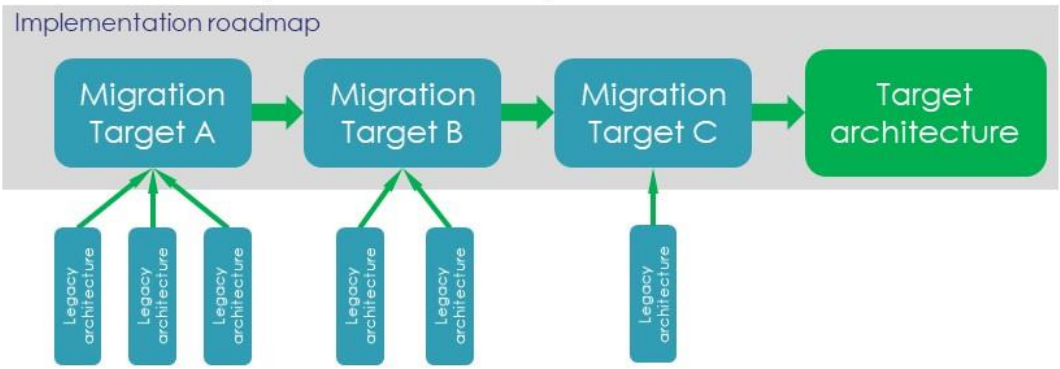
9 Annexes

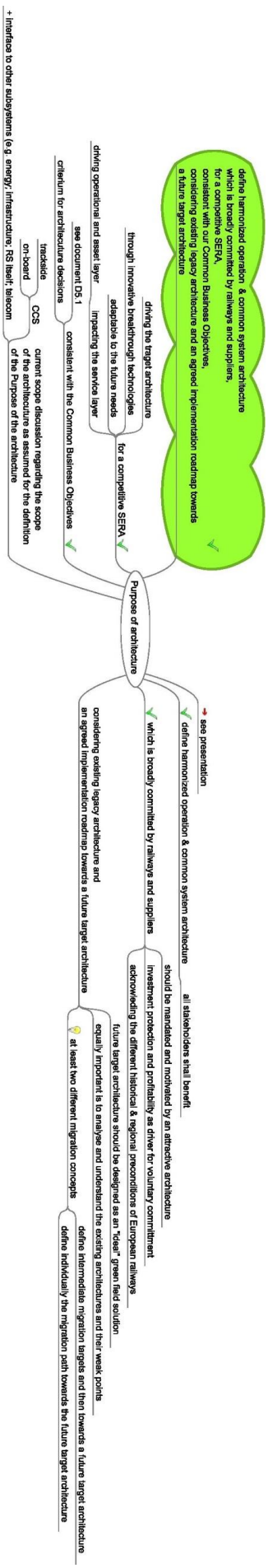
9.1 Annex 1 – Purpose of the architecture

Purpose of architecture:

Define harmonized operation and common system architecture,
which is broadly committed by railways and suppliers,
for a competitive SERA,
consistent with our Common Business Objectives,
considering existing legacy architectures and an agreed implementation roadmap towards a future target architecture

For illustration of implementation roadmap:




define harmonized operation & common system architecture
which is broadly committed by railways and suppliers,
for a competitive SERA,
consistent with our Common Business Objectives,
considering existing legacy architecture and an agreed implementation roadmap towards
a future target architecture
driving the traget architecture
through innovative breakthrough technologies
adeptable to the future needs
for a competitive SERA
driving operational and asset layer
impacting the service layer
see document D5.1
criterium for architecture decisions
consistent with the Common Business Objectives
trackside
on-board
CCS
current scope discussion regarding the scope
of the architecture as assumed for the definition
of the Purpose of the architecture
+ insterface to other subsystems (e.g. energy; infrastructure; RS itself; telecom
Purpose of architecture
see presentation
define harmonized operation & common system architecture
all stakeholders shall benefit
should be mandated and motivated by an attractive architecture
investment protection and profitability as driver for voluntary commitment
acknowledging the different historical & regional preconditions of European railways
which is broadly committed by railways and suppliers
future target architecture should be designed as an "ideal" green field solution
equally important is to analyse and understand the existing architectures and their weak points
considering existing legacy architecture and
an agreed implementation roadmap towards a future target architecture
at least two different migration concepts
define intermediate migration targets and then towards a future target architecture
define individually the migration path towards the future target architecture

9.2 Annex 2 – Some examples of industrial architecture – Their respective management/governance

This section provides public information about architecture initiatives out of the Rail sector in order to support a common culture on architecture governance. The applicability of the elements should be further analysed and adapted in order to fit to the rail context. The abstracts presented in this section will be challenged and built upon during the next stage of task 5.4 activities.

9.2.1 Architecture Framework in the Defence domain

DODAF[4]

The Department of Defense Architecture Framework (DoDAF) is an architecture framework for the United States Department of Defense (DoD) that provides visualization infrastructure for specific stakeholders concerns through viewpoints organized by various views. These views are artefacts for visualizing, understanding, and assimilating the broad scope and complexities of an architecture description through tabular, structural, behavioural, ontological, pictorial, temporal, graphical, probabilistic, or alternative conceptual means. The current release is DoDAF 2.02.

This Architecture Framework is especially suited to large systems with complex integration and interoperability challenges, and it is apparently unique in its employment of "operational views". These views offer overview and details aimed to specific stakeholders within their domain and in interaction with other domains in which the system will operate.

MOD Architecture Framework[5]

The MOD Architecture Framework (MODAF), supported by the UK Ministry of Defence, is a set of rules that support defence planning and change management activities.

Overview

The Ministry of Defence Architecture Framework (MODAF) is an internationally recognised enterprise architecture framework developed by the Ministry of Defence (MOD) to support defence planning and change management activities. It does this by enabling the capture and presentation of information in a rigorous, coherent and comprehensive way that aids the understanding of complex issues.

NATO Architecture Framework

According to the NATO Topic page on Interoperability: Connecting NATO's Forces:[6]

> *NATO's interoperability policy defines the term as the ability for Allies to act together coherently, effectively and efficiently to achieve tactical, operational and strategic objectives. Specifically, it enables forces, units and/or systems to operate together and allows them to share common doctrine and procedures, each others' infrastructure and bases, and to be able to communicate. Interoperability reduces duplication, enables pooling of resources, and produces synergies among the 28 Allies, and whenever possible with partner countries.*

See

- "Framework for NATO Industry Engagement"[7]
- "TADIC TRANSATLANTIC DEFENCE TECHNOLOGICAL AND INDUSTRIAL COOPERATION"

[4] https://dodcio.defense.gov/Library/DoD-Architecture-Framework/
https://en.wikipedia.org/wiki/Department_of_Defense_Architecture_Framework
[5] https://www.gov.uk/guidance/mod-architecture-framework
[6] http://www.natolibguides.info/interoperability
[7] https://diweb.hq.nato.int/indrel/Pages/Default.aspx

- [8] Defence Investment – Defence Investment Division Web Portal

NATO Architecture Framework, Version 49

The aim of the NATO Architecture Framework Version 4 (NAFv4) is to provide a standard for developing and describing architectures for both military and business use. It provides a standardized way to develop architecture artefacts, by defining Methodology (how to develop architectures and run an architecture project), Viewpoints (conventions for the construction, interpretation and use of architecture views for communicating the enterprise architecture to different stakeholders), Meta-Model (the application of commercial meta-models identified as compliant with NATO policy), and a Glossary, References and Bibliography.

The NATO Architecture Framework is a substantial achievement for the Architecture Capability Team under the Consultation, Command and Control Board.

NATO's C3 Board is the senior multinational policy body in the area of Consultation, Command and Control (C3), reporting to and advising the North Atlantic Council and Defence Planning Committee on all C3 policy matters. C3 focus areas are information sharing and interoperability, which include issues such as cyber defence, information assurance and joint intelligence, surveillance and reconnaissance.

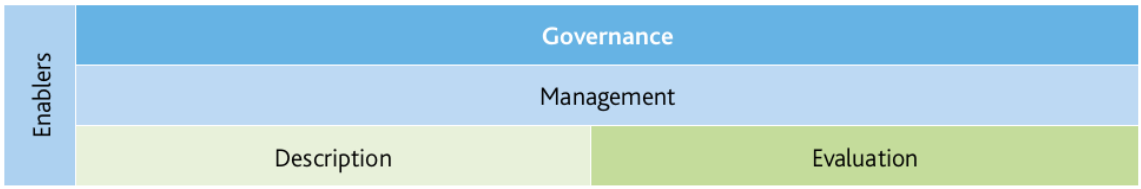
Main architecture processes

5.6.1 A first description of process, activities and tasks related to Architecture definition is provided by ISO/IEC/IEEE 15288. A more detailed explanation is given in this section with identification of 5 processes that could be performed by different organizations and projects within an Enterprise.

5.6.2 This description of processes is close to the ISO/IEC/IEEE 42020

.

Figure 2-2: Architecture Processes



5.6.2.1 Architecture processes can run concurrently, even if the governance and management directions circulate in down-flows and operation reports in up-flows

5.6.2.2 Architecture description and evaluation are interleaved to regularly state about quality and distance to expectation.

5.6.2.3 The enabling activities are transverse to other architecture processes. They ensure seamless consistency of services and data within the architecting environment.

Architecture Governance

5.7.1 Governance covers the strategic activities controlling architecture according to enterprise directions and objectives. The main architecture governance activities include:

- *establish capability for architecture governance,*
- *establish strategic desired outcomes for the architecture portfolio,*
- *evaluate coherency of architecture roadmaps toward desired outcomes,*

[8] https://diweb.hq.nato.int/Pages/default.aspx
[9] https://www.nato.int/cps/en/natohq/topics_157575.htm

- *provide directions for the architecture portfolio and the related activities,*
- *monitor the enterprise's portfolio of architectures and the related activities to ensure compliance with the governance directions, and*
- *Decide on necessary corrective actions and iterate.*

5.7.2 This process is normally under responsibility of enterprise entities in charge of the consistency of architectures across projects of the enterprise. This consistency concurs to the overall governance of activities and assets of the whole enterprise.

The Open Group Architecture Framework TOGAF

The Open Group Architecture Framework (TOGAF)[10] is a framework for enterprise architecture that provides an approach for designing, planning, implementing, and governing enterprise information technology architecture. TOGAF is a high-level approach to design. It is typically modelled at four levels: Business, Application, Data, and Technology. It relies heavily on modularization, standardization, and already existing, proven technologies and products.

TOGAF was developed starting 1995 by The Open Group, based on United States Department of Defence's TAFIM. As of 2016, The Open Group claims that TOGAF is employed by 80% of Global 50 companies and 60% of Fortune 500 companies.

TOGAF is a registered trademark of The Open Group[11]

The Open Group is an industry consortium that seeks to "enable the achievement of business objectives" by developing "open, vendor-neutral technology standards and certifications". It has over 625 members and provides a number of services, including strategy, management, innovation and research, standards, certification, and test development. It was established in 1996 when X/Open merged with the Open Software Foundation.

The Open Group is the certifying body for the UNIX trademark, and publishes the Single UNIX Specification technical standard, which extends the POSIX standards. The Open Group also develops and manages the TOGAF standard, which is an industry standard enterprise architecture framework. [4]

The over 625 members include a range of IT vendors and buyers as well as government agencies, including, for example, Capgemini, Fujitsu, Oracle, HPE, Orbus Software, IBM, Huawei, Philips, U.S. Department of Defence, NASA. There is no obligation on product developers or vendors to adopt the standards developed by the association.

It is to be noted that TOGAF is the architecture framework as applied by RCA.

9.2.2 Architecture initiatives in the civil domain

AUTOSAR[12]

AUTOSAR (**AUT**omotive **O**pen **S**ystem **AR**chitecture) is a worldwide development partnership of vehicle manufacturers, suppliers, service providers and companies from the automotive electronics, semiconductor and software industry.

It is an alliance of OEM manufacturers, Tier 1 automotive suppliers, semiconductor manufacturers, software suppliers, tool suppliers and others. Considering the different automotive E/E architectures in the current and future markets, the partnership established a de-facto open industry standard for an automotive software architecture. It will serve as a basic infrastructure for the management of functions within both future applications and standard software modules.

[10] https://www.opengroup.org/togaf https://en.wikipedia.org/wiki/The_Open_Group_Architecture_Framework
[11] https://www.opengroup.org/ https://en.wikipedia.org/wiki/The_Open_Group
[12] https://www.autosar.org/, https://en.wikipedia.org/wiki/AUTOSAR

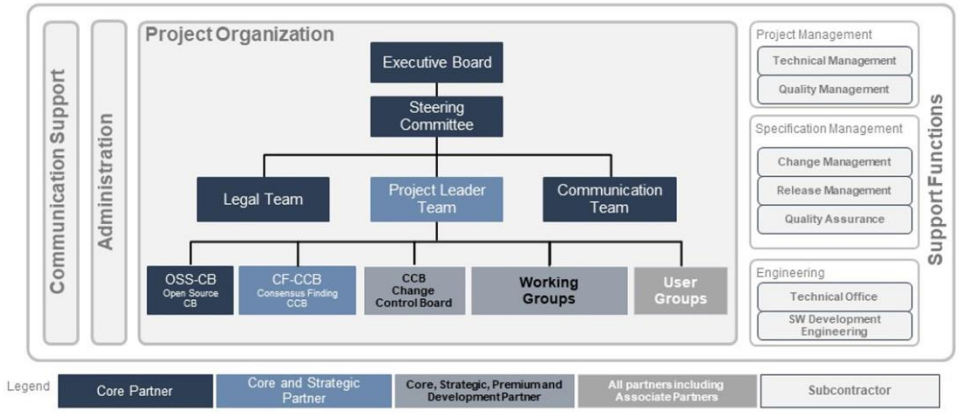
AUTOSAR is registered in München as a Gesellschaft bürgerlichen Rechts (GbR) by the German law.

Concepts and goals

It provides a set of specifications that describes basic software modules, defines application interfaces and builds a common development methodology based on standardized exchange format. Basic software modules made available by the AUTOSAR layered software architecture can be used in vehicles of different manufacturers and electronic components of different suppliers, thereby reducing expenditures for research and development and mastering the growing complexity of automotive electronic and software architectures.

Based on this guiding principle, AUTOSAR has been devised to pave the way for innovative electronic systems that further improve performance, safety, and environmental friendliness and to facilitate the exchange and update of software and hardware over the service life of the vehicle. It aims to be prepared for the upcoming technologies and to improve cost-efficiency without compromising quality.

Organisation and governance



Partners

AUTOSAR defined six different levels of membership. The contribution of partners varies depending on the type of partnership.

- **Core Partners**

Nine companies founded the AUTOSAR partnership to consolidate the expertise of partner companies in the automotive industries and define an automotive open system architecture standard to support the needs of future in-car applications.

BMW group, Bosch, Continental, Daimler, Ford, GM, PSA Groupe, Toyota, Volkswagen Group

It comprises also

- **Strategic Partner**
- **Premium Partners (58 on the 3.5.2020)**
- **Development partners**
- **Associate partners**

Attendees

The core Partners are responsible for organization, administration and control of the AUTOSAR development partnership. Within this core, the Executive Board defines the overall strategy and roadmap. The Steering Committee manages day-to-day non-technical operations and admission of partners, public relations and contractual issues. The Chairman and Deputy of Chairman, appointed for one year, represent the Steering Committee for that purpose. The AUTOSAR Spokesperson takes over the communication with the outside world.

Strategic Partners are appointed for a period of two years from the circle of Premium Partners and support the project leader team in the various technical, organizational and everyday processes. They also give new strategic inputs to the project leader round.

Premium and Development members contribute to work packages coordinated and monitored by the Project Leader Team established by the Core Partners. Associate partners are making use of the standard documents AUTOSAR has already released. Attendees are currently participating with Academic collaboration and non-commercial projects.

As of mid-2019, more than 270 companies participate in the AUTOSAR development partnership.

OPC[13]

OPC (stands for Open Platform Communications**) technologies** were created to allow information to be easily and securely exchanged between diverse platforms from multiple vendors and to allow seamless integration of those platforms without costly, time-consuming software development. This frees engineering resources to do the more important work of running the business.

There are more than 4,200 suppliers who have created more than 35,000 different OPC products used in more than 17 million applications. The estimate of the savings in engineering resources alone is in the billions of dollars.

OPC is the interoperability standard for the secure and reliable exchange of data in the industrial automation space and in other industries. It is platform independent and ensures the seamless flow of information among devices from multiple vendors.

The **OPC standard** is a series of specifications developed by industry vendors, end-users and software developers. These specifications define the interface between Clients and Servers, as well as Servers and Servers, including access to real-time data, monitoring of alarms and events, access to historical data and other applications. They are mainly developed for open connectivity of industrial automation devices and systems, such as industrial control systems and process control generally

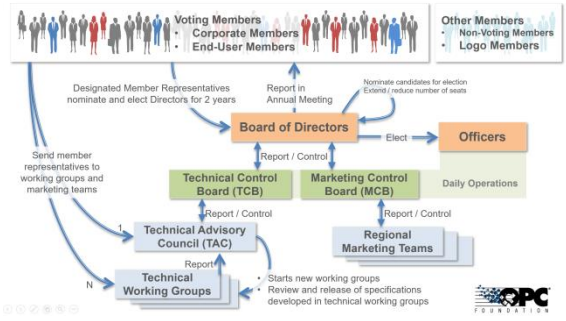
OPC Foundation: The Industrial Interoperability Standard™

The mission of the OPC Foundation (an industry consortium) is to manage a global organization in which users, vendors and consortia collaborate to create data transfer standards for multi-vendor, multi-platform, secure and reliable interoperability in industrial automation.

To support this mission, the OPC Foundation:

- Creates and maintains **specifications**
- **Ensures compliance** with OPC specifications via **certification testing**
- Collaborates with industry-leading **standards organizations**

The **OPC organisation and governance**[14]



OPC FOUNDATION is a non profit corporation organized under the laws of the State of Arizona.

The Board of Directors is composed of representatives of Mitsubishi Electric, ascolab, Siemens AG, BECKHOFF, Honeywell Process Solutions, Yokogawa, SAP,

[13] https://en.wikipedia.org/wiki/OPC_Foundation, https://opcfoundation.org/

[14] https://opcfoundation.org/about/opc-foundation/organization/

Microsoft, ABB, Schneider Electric, Rockwell Automation

Short history

The OPC Foundation started in 1994, as a task force comprising five industrial automation vendors (Fisher-Rosemount, Rockwell Software, Opto 22, Intellution, and Intuitive Technology), with the purpose of creating a basic OLE for Process Control specification. OLE is a technology developed by Microsoft Corporation for the MS Windows operating system. The task force released the OPC standard in August 1996. The OPC Foundation was chartered to continue development of interoperability specifications and includes manufacturers and users of devices instruments, controllers, software and enterprise systems.

Figures

Over 750 OPC Foundation members and thousands of OPC-compliant products.

OPC Foundation members vary greatly, from small system integrators to the world's largest automation and industrial suppliers.

It is to be noted that EULYNX applies OPC-UA.

OSI model

The Open Systems Interconnection model (OSI model)[15] is a conceptual model that characterises and standardises the communication functions of a telecommunication or computing system without regard to its underlying internal structure and technology. Its goal is the interoperability of diverse communication systems with standard communication protocols. The model partitions a communication system into abstraction layers.

A layer serves the layer above it and is served by the layer below it. For example, a layer that provides error-free communications across a network provides the path needed by applications above it, while it calls the next lower layer to send and receive packets that constitute the contents of that path.

The model is a product of the Open Systems Interconnection project at the International Organization for Standardization (ISO).

Standards documents

The OSI model was defined in ISO/IEC 7498 which consists of the following parts:

- ISO/IEC 7498-1 The Basic Model
- ISO/IEC 7498-2 Security Architecture
- ISO/IEC 7498-3 Naming and addressing
- ISO/IEC 7498-4 Management framework

ISO/IEC 7498-1 is also published as ITU-T Recommendation X.200.

[15] https://en.wikipedia.org/wiki/OSI_model

9.3 Annex 3 – Governance principles for the sustainable maintenance and development of the system architecture / CDM

Disclaimer: This paper presents elements discussed and agreed in LinX4Rail T5.4 on governance principles that should support LinX4Rail activities and the further ERJU System pillar to run efficiently. The purpose is to enable early positive impact on daily Sector works on common architecture management and governance including standardisation aspects.

The purpose of this paper is to allow the architecture outcomes to be effective (i.e. define high level principles and targets). Ways to maximise architecture work efficiency are to be further discussed, in particular taking into account the outcomes of Task 5.2 and Task 5.3. Specific engineering methods supporting the architecture may be reflected in another document or a future release of this document (e.g. architecture engineering as an aspect and important enabler for digital continuity across the sector).

Problem statement:

Uptake of innovation, on a service, operation and technical level, whilst keeping and further improving interoperability, performance and efficiency is the objective of building a European Rail System Architecture.

TSIs are not sufficient to ensure this target in particular when it come to a more digitised railway system. Therefore, it is desired, with LinX4Rail to build around the existing initiatives a standardized, coherent and comprehensive railway system architecture to meet the objective above.

Some views on working principles

(Version 19/02/2021)

The foundation of this paper is that today there is no overall sector mechanism for developing and maintaining the railway system architecture fit for deployment and operation purpose. The assumption is that a success condition for the system pillar will be to implement an executive governance for the railway system architecture, CCS being a priority area for the railway system architecture description.

At the time of the further definition of the System Pillar in the framework of the future partnership Europe's Rail JU, the participants of the WP5.4 want to raise some issues of interest for its further definition regarding governance of the future European Rail System Architecture.

What are the architecture design needs and objectives?

The following activities have to be considered: ,

- Specification (Purpose, Scope, Boundaries, Requirements)
- development,
- support of the implementation
- and maintenance.

The architecture governance is about a framework, including deployment and enforcement aspects, not just about a delivery mechanism.

The building basis is business oriented (i.e. support common business objectives, clear CBA). The work effectiveness is guaranteed by the market uptake of the relevant results (e.g. architecture priorities depending on identified market and interoperability needs).

Architecture work shall aim to facilitate the standardization and deployment of state-of-the-art technology leading to reduction of life cycle costs (CAPEX and OPEX), in line with competing modes of transport.

Agility of architecture development and upgrade is essential.

The governance should allow to manage, on a sustainable basis, a dynamic roadmap towards the system architecture including engineering processes, modelling, collaboration and tooling as enablers.

The global management of the short term architecture activities must be driven by a long term view:

- Deliverables are needed for short and long term migration purposes. The architecture governance shall support short term decisions towards an evolvable **target system**
- **The architecture management has to anticipate** the need for migration at different speeds in different countries. The governance, in the short and over the long term, is driven by common sector objectives.
- An evaluation mechanism is established to consider the overall system benefit (Cf. LinX4Rail WP5.1-Common business objectives).
- **Decision-making** processes shall be based on transparency and accountability mechanisms and must be efficient. These are prerequisites to gain credibility, robustness and traceability.
- Long term maintenance of the architecture as ways to publish should be further investigated. Compatibility management needs to be considered in this investigation.
- Adequate approach for faster approval process (including conformity assessment) is a strategic issue to be supervised in the governance taking into account the opportunity to automate the verification process.
- Design principles guide architecture activities. Competence and availability of experts are driving the speed and impact of the architecture. The governance must organise necessary ressources.

Who are the system stakeholders?

All those who have concerns in the railway system : EC, ERA, RUs, IMs, suppliers,…

To ensure ownership, the sector governance of the architecture should properly involve the relevant stakeholders. Ways to organise transparent & balanced evaluation remains an open question in the sector. RUs, IMs, manufacturers are by principle the main stakeholders but more globally all the organisations that contribute to the system definition should be architecture stakeholders.

Clear architecture roles must be allocated. Stakeholders are involved according to their natural roles and responsibilities.

Their involvement depends on the level/view/part of architecture considered: not all stakeholders need to be involved in each architecture development and decision process. There is a need to distinguish between strategic governance, technical governance, data governance. Each stakeholder may have a specific role to play for the different governance, development and implementation activities.

How should stakeholders be involved?

Individual companies, RCA, EULYNX, OCORA, EUG, UNIFE, UIC (FRMCS) and the representative organisations are potential participants of such governance. They shall have direct responsibility for the technical and business consequences of their decisions.

Skills and proven experience in model-based systems engineering should be paramount for the participation.

What should be the role of the regulator/authority (ERA/EC)?

ERA and EC are system stakeholders with specific concerns.

It should manage robustness of applicability and assess ability of the System Pillar products. It should furthermore monitor the quality, timely delivery and comprehensiveness of System Pillar products. Finally, it should serve as escalation body when there is a conflicting issue that cannot be solved within the System Pillar. It should also supervise the progress in terms of time and quality and take necessary actions if needed in order to ensure sufficient progress.

ERA should be comprehensively involved at a content level. Results are crucial to improve the quality of the regulation and to pave the way towards "automated authorisation". A certain level of commitment/constraint for usage of results will be required for certain aspects, therefore a deep ERA involvement is necessary to ensure efficient process to enable innovation.

Governance implementation needs

The **prerequisites** for efficient and effective work in the System Pillar are:

- Broad acceptance and commitment by the stakeholders to apply the architecture, the needs for voting and bindingness of the SP decisions is an issue to further clarify (e.g. when there is a need for vote, ERA should become the moderator of further discussions)
- Concerns adequately considered → internal and external concerns are logged, discussed and concluded. ERA and EC are informed and may intervene on own initiative.
- Transparency for mutual understanding → all drafts are published on the web, changes are traceable
- A decision process supported by Common Business Objectives → where there is no unanimous acceptance, LINX4Rail D5.1 shall be applied under the supervision of EC

The **scope** and purpose of the architecture is defined[16] and agreed upfront by the governance, what's inside and what's outside of the "system-of-system" architecture. What do we want to achieve with the architecture? When and how to use it?

The architecture will be designed by a progressive refinement:

- The governance select the use case driving the description of architecture objects and their relation.
- Governance allow to adopt tools and methodology to support architecture design. Along iteration, the governance is informed about progress made in the analysis and optimisation of system behaviour. Governance should prioritise the development of simulation models.
- The methodology (e.g. semantic rules, layering…) and process (e.g. tools, change control…) is refined and approved along the iteration of the architecture.
- Standards for methods and process are governed in order to maximise the relevance of the architecture, caring also to minimize costly rework of existing architecture description.
- The governance shall ensure that the architecture model must become the reference for the system definition. As needed textual requirements are derived from the model (e.g. for maintaining TSI provisions).
- The architecture trace sector decisions for standardised solutions in the service, operation and resource layers. The sector decisions allow for better collaboration and better competition among suppliers and operators.

The management and execution of design process should target efficienciency:

- Design activities are carried out along major system structures and layers,
- Design decisions shall be economically viable for all concerned stakeholders
- Substructures are considered in parallel to refine and consolidate definition with alignment on adjacent part of the architecture,
- Stakeholders shall be involved in the design process by considering their competence and role in the value chain
- Existing models (e.g. S2R, Eulynx, RCA…) are compiled and evaluated. They are as much as possible reused to avoid work and rework. When an existing architecture must be reworked, ad hoc escalation may be needed (e.g. L54R T5.3)

Architecture design processes

[16] the current definition of the purpose can be found in Annex 1

Governance is based on some principles:

- Consensus and openness for architecture to maximise added value for the sector
- Transparency and European ownership (e.g. EUPL)
- Accountability for executive architecture decisions
- Commitment to implement architecture decisions

The **Architecture management** plans, runs and monitors the architecture along its life cycle.

The **Architecture description process** has:

- To be compliant to ISO/IEC/IEEE 42010,
- open, transparent and compliant with agreed processes in order to deliver predictability.

The **Architecture Evaluation process** shall:

- be compliant to ISO/IEC/IEEE 42020 and ISO/IEC/IEEE 42030,
- lead to sector consensus in order to facilitate uptake.
- alignment with the vision of the future railway system by EC.

The **Architecture Enablers** are the following:

- Target system defined,
- Roadmap mutually agreed,
- Resources to support the activities are available,
- Methods and tools as e.g. TD 2.7 recommendations
- Data models (EULYNX Data Model, IfC, TOPO4, Railtopomodel, ...)
- Existing work in the CCS domain (ETCS, EULYNX, OCORA, RCA, Argos, FRMCS, ...)
- Agreed data model (e.g. CDM based on EULYNX, TOPO 4, RailML and Railtopomodel)

LinX4Rail – A support for the architecture prefiguration

This Shift2Rail LinX4Rail project prepares a 1st functional architecture release, integrating input from IP2 TD2.2, OCORA, RCA and EULYNX. The project prefigures and allows to experiment the process for releasing an architecture. These releases should be used as input for future relevant activities within the ERJU.

The identified Common Business Objectives represent the concerns of the 3 stakeholders that are RUs, IMs and manufacturers.

It ensures converging visions on the target system on converging solutions that are being deployed based on a given architecture release.

It prepares the CDM as a sector tool supporting the architecture.

The architecture potentials in terms of sector innovations and deployment are further explored.

Pending actions

The need for a modelling, engineering, collaboration and testing standard (EMCT) for the railway system architecture work is widely recognised. For example, LinX4Rail Task 5.1 requests the definition and specification of “Decoupling” (HW/SW) and “plug & play”.

LinX4Rail Task 5.2 is considered to be the place for collaboration on these pending actions and delivering a consensual proposal based on available contributions. It is also seen to be the addressee for related pending questions below, before the shadow committee takes office.

Pending questions

Some questions remain pending in this definition phase, which shall be taken up by the preparation group/shadow committee initiated by the EC:

- How to get a broad consensus about the purpose and the application (implementation) of the architecture?
- A better understanding about each stakeholder needs and concerns to further improve in order to best set up synergies.
- A fair balance between systematic (starting from services provided) and parallel development of architecture layer, associated to the need to move away from pure asset level, using services to open new ways to operate.
- Migration and transition management from legacy systems.
- Compatibility management principles.
- Development of the sector competence/skills.
- Intellectual property considerations (defining borders between open source and proprietary work).
- The need of a supporting shared platform and sector tools for development/validation/information sharing.
- A model-based tendering/procurement process. It raises the interest of a holistic approach for the overall value chain.
- What needs for and how to identify relevant Design authorities.
- What handover/decoupling between architecture definition and system development in order to keep architecture and system stability while enabling the migration towards innovative solutions: the role of the architecture is to ease system evolution on a given level of granularity.
- What working arrangement to ensure permanent link and consistency between System and innovation pillar outcomes.

We define in the paper principles about the architecture governance, not the way it is designed and engineered. Knowing how the architecture can be controlled is a prerequisite for defining an architecture process in which the people feel confident and can effectively contribute and own.

9.4 Annex 4 – Proposal for a management plan

The development of the architecture should be supported by a management plan.

During the second semester 2021, LinX4Rail should allow to deepen analysis on the mains tensions, opportunities and enablers, to implement an executive governance, supporting the standardisation and rapid deployment of the Europe's rail architecture and its CDM. The development of a management plan should allow to find common understanding on the relevant objectives, governance needs and enablers that will allow to guide the architecture and CDM to a sector success.

Building common understanding and benchmarking within the sector and from others are key for constructive collaboration. While developing a management plan, this document will be enhanced with the identification of further key principles (e.g. lesson learnt from architecture examples, as those defined in the defence sector, Autosar, SESAR, RCA, OCORA), and requirements for an executive sector governance for Europe's rail architecture.

Proposed structure for a management plan:

Purpose of the document

- what is the problem we try to resolve (problem statement)?
- objectives (Purpose of setting up governance for the rail system architecture and CDM): end goal creating an architecture and CDM with an effective governance for multi-stakeholders with clear role, responsibilities, structure that withstand the test of time and manage effectively to ensure decision making and avoid bottle neck that takes into stakeholder needs

Rail system architecture and CDM objectives

- Purpose of the rail system architecture
- CDM as a support in the overall rail system architecture
- Manage consistency between architecture and CDM
- Architecture stakeholders

Setting up the European rail architecture system governance

- Deliverables of the railway system architecture
- Governance principles, activities and comittees
- Governance processes
- Allocation of roles and responsibilities
- Role of the authorities (system, technical, design)

Setting up the CDM governance

- Deliverables of the CDM
- Governance principles, activities and committees
- Governance processes
- Allocation of roles and responsibilities
- Role of the authorities (system, technical, design)

Governance enablers

- Synchronization and integration of Shift2Rail projects, sector initiatives
- Link with external partners (ERA, Ontorail, TRP, IFC, railML, RSM, …)
- CDM

Conclusion and next steps:

- Milestones in relation to ongoing architecture development
- From LinX4Rail projects to System Pillar process