System Pillar Common Business Objectives

Document Status	Version 1 - final
Date	25/07/2022

1 History of Changes

Nr.	Changes	Leader
01	Initial Draft	Frédéric Bernaudin
02	General structure and scope updated	Frédéric Bernaudin
03	Updated following Strategy circle meeting	Frédéric Bernaudin
04	Updated following Strategy circle meeting	Frédéric Bernaudin

2 Purpose of the document and target group

This document sets out the Common Business Objectives (CBO) – targets and improvements - to guide the development of the outputs of the System Pillar within Europe's Rail Joint Undertaking.

The CBO are aligned to the impacts identified in the EU-Rail Master Plan.

The CBO defined and agreed in this document will be the criteria to form strategic decisions taken in the System Pillar. For example:

- The mediation processes to be employed to reach sector consensus will refer to and draw on the CBO.
- Operational process harmonization steps and improvements (as basis for the architecture) will be derived directly from the CBO

The CBO have been derived from existing relevant work, which provides a broad and consistent basis for the CBO defined.

3 Source documents

The following primary inputs have been used to elaborate this document. They are:

1. Europe's Rail Joint Undertaking Report on preparation of the System Pillar
2. LINX4RAIL: Deliverable D5.1 Identification of Common Business Objectives for the existing and future Railway System
3. ERRAC Rail 2030 Research and innovation priorities
4. 18C044-1WHITE PAPER REFERENCE CCS ARCHITECTURE BASED ON ERTMS
5. RCA "A.P.M.": APS / PE / MAP Advanced trackside protection, plan execution and map data management – Business strategy, targets, and problem definition
6. UNISIG Concept for the evolution of the on-board CCS architecture
7. OCORA-TWS04-010_FVA-Introduction.pdf
8. OCORA-BWS03-010 Introduction to OCORA
9. Multi Annual Work Programme – MAWP
10. Annual Work Programme -- AWP
11. A compelling vision for the target railway system – ERA
12. "Development of a concept for the EU-wide migration to a digital automatic coupling system (DAC) for rail freight transportation" Final Report 29/06/2022

4 The ambitious objectives for Europe's Rail

4.1 Prerequisites

The ambitious objectives of Europe's Rail entail the need for the transformation of the railway system, (including processes and IT), towards a digitalised, connected, more automated, interoperable, and modular technical railway system. Moreover, European railway systems should lead technologically on a global scale and foster Europe's competitiveness and result in a joint global leadership of the European railway sector. To achieve these ambitions a new way of collaboration including a common and holistic architecture is needed.

The objectives of the System Pillar as set out in the Single Basic Act are to develop a unified operational concept and a functional, safe and secure system architecture, with due consideration of cyber-security aspect for integrated European rail capacity and traffic management, command, control and signalling systems and other subsystems (i.e., Energy, Rolling Stock, ...), including, inter alia, automated train operation which shall ensure that research and innovation is targeted on commonly agreed and shared customer requirements and operational needs and is open to evolution. This includes:

- the definition of the services, functional blocks, and interfaces which form the basis of rail system operations;
- the development of associated specifications, including interfaces, functional and non-functional requirement specifications, and system requirements specifications to feed, inter alia, into Technical Specifications for Interoperability established pursuant to Directive (EU) 2016/797 or standardisation processes to lead to higher levels of digitalisation and automation.
- ensuring the system is maintained, error-corrected and able to adapt over time and ensure migration considerations from current architectures;
- ensuring that the necessary interfaces with other modes, as well as with metro and trams or light rail systems, are assessed and demonstrated, in particular for freight and passenger flows;

The EU Rail JU Multi-Annual Work Programme states: “A successful System Pillar will:

- Ensure clarity of roles and resources with the aim of speeding up and making more systematic the development of coherent and compatible products, standards, and specifications, while ensuring their independent assessment for safe, secure, performant and interoperable operations.

The EU Rail Multi Annual Work Programme states the System Pillar requests “the CCS+ task is to develop the operational concept(s) and functional system architecture for a genuine integrated European CCS system, supported by a model-based systems architecting & engineering approach, beyond the current specifications in the CCS TSI, with much greater standardisation and much less variation than at present. This integrated CCS system shall on the one hand deliver unrestricted movement of trains, on the other hand, it shall create a single market for rail components”

Railways are managing and operating the system with the responsibility to perform in a way that is matching the ambitious goals set by society and politics. Overall, it is the Railways that must deliver a competitive SERA with the help of the EC System Pillar. Therefore, the Railways have the responsibility to ensure that the modules are updated and maintained over lifetime. Suppliers’ contributions are vital to these ambitions in developing and delivering high quality, competitive assets and services in Europe and beyond. Together, we advance the technological basis - considerably within ER JU - and enable the integration of these technologies in the railway system in a joint way - the System Pillar. Hence, a collaborative approach is mandatory.

The System Pillar must cover migration plans that would bridge research and innovation, industrialisation and deployment of innovative technologies, operational concepts and overall solutions. The System Pillar will endeavour to simplify and reduce the costs for the different stages in deployment for the target system including authorisation procedures to ensure safety and security.

The future railway system will be based on networks equipped with radio based ERTMS and the highest grades of automation.

Getting a performant system architecture right and providing the specifications for interfaces and sub-systems (modules) with high quality will be key, whilst paying attention to providing evolvable solutions.

4.2 Challenges

The transformation of the rail system to achieve the ambitious policy and sector goals starts from recognizing the significant challenges that the future rail system needs to address. As identified in the EU Rail Master Plan, key challenges are:

Changing customer requirements **Political, demographic, technological and market trends are changing the needs of passenger and freight customers.** **These shifts, along with disruptive events like the COVID-19 pandemic, require rail to be more flexible than in the past.** **A customer-centric rail system means offering reliable services that are reactive to demand, adaptable to customer requests, and accessible for all passengers alike.**
Need for improved performance and capacity **In order to deliver an overall more sustainable transport system, rail must be able to accommodate increased demand. New infrastructure will be necessary in certain areas, but the vast bulk of future increased capacity must leverage existing infrastructure, through a systemic digitalisation and automation of operations.**
High cost **Rail is currently often more expensive compared to other transport modes, in some cases reflected on the intermediaries or passengers/users.** **To be more competitive and support future increased usage, rail must deliver more cost-efficient solutions and services compared to today.**
Climate change adaptation and environmental sustainability **Rail is the most sustainable form of motorised transport. Increased use of rail is necessary to fulfil European climate neutral mobility and transport, while ensuring environment protection objectives.** **In addition, steps have to be taken to further improve the climate and environmental (e.g., reduce the noise) footprint of rail.** **Rail services and networks must also become more resilient against the impacts of climate change.**
Legacy systems and obsolescence **Rail system assets have very long lifecycles and are based on global and European requirements; additionally, legacy national requirements still survive.** **The incompatibility of certain national requirements between EU Member States in conjunction with long life cycles results in market fragmentation, and greater complexity in introducing new functions in a coordinated way, while causing largely an escalation of costs.** **Rail must move to one European network with stronger implementation of the objective of having an increasingly integrated Single European Rail Area (SERA) - and be more flexible to introduce and scale up new technological and operational solutions to deliver new and improved client-oriented services.**
Interaction with other modes

Rail networks and the services associated to them in some contexts link well with other transport modes. But such integration must be improved to better serve the needs of customers, and make rail central to future mobility and a more attractive mode overall.

Increased competitiveness

The European rail supply industry is world leading. However, it faces many challenges at global level.

Innovative solutions, conceived, designed, and developed jointly creating new products to be deployed at European level will strengthen the competitiveness of the European rail supply industry, including its SMEs, providing major opportunities for system integrated solutions to be deployed at global level.

4.3 The impacts of EU-Rail

Based on the challenges facing the rail sector, the targeted impacts of EU-Rail as defined in the EU Rail Master Plan are:

	Meeting evolving customer requirements EU-Rail will support the delivery of much more flexible approaches to planning and traffic management of rail services, and seamless operations, allowing rail to better serve customer needs.
	Improved performance and capacity Through the development of cutting edge technologies and improved harmonised operational rules designed to be implemented across the whole EU rail system, EU-Rail will help increase capacity and make best use of available assets.
	Reduced costs EU-Rail outputs are expected to help improve the efficiency of the rail system and reduce overall lifecycle costs, including on less used lines.
	More sustainable and resilient transport EU-Rail will contribute to a more sustainable transport and mobility system by enabling an increase in the use of rail services, and improving the sustainability and resilience of the rail sector itself.
	Harmonised approach to evolution and greater adaptability EU-Rail will work with the sector in coordinating on a common and interoperable evolution of the system, with a greater level of harmonisation, to support an overall adaptable Single European Rail Area, improving the rate of deployment of new technologies.
	Reinforced role for rail in European transport and mobility EU-Rail work will support smart and cost-efficient rail connectivity, key to future sustainable mobility systems, to deliver better services for passengers and freight.

	Improved EU rail supply industry competitiveness Increasing the R&I intensity of the European rail supply industry will enhance its capacity to retain its global leadership. By supporting the transformation of the current rail system into a central transport mode of tomorrow's European mobility, EU-Rail will build unique capabilities in the European rail industry, including its SMEs, supporting its position in global markets.

4.4 The System view

The vision of the European railway system is to enable full end-to-end services and inter-modality with freedom for passengers and freight to travel domestically and internationally within the Single European Railway area. This will include end-to-end journeys with through-ticketing and more efficient connection of the railway with other transport modes.

The Sustainable and Smart Mobility Strategy articulates the pathways towards digitalising and greening the transport sector and sets specific milestones for the railway sector. This is a major reason for the railway sector to undergo such a significant transformation - increasing its capacity, performance and cost effectiveness for passenger and goods transport, enabling an increase in the use of rail transport, and reducing further the greenhouse gas emissions of the railway sector itself. To achieve this change, the sector needs less complexity, higher grade of automation, information integrity, simplicity and flexibility for continuous modular optimisation.

Despite advances on the harmonisation of certain critical interfaces, railways across Europe do not operate in the same manner and use a variety of technical systems which are neither integrated nor interoperable. European rail systems are often bespoke and country or system specific, and thus adds system complexity making change more time consuming and costly.

Ultimately, this fragmented approach undermines the performance and competitiveness of the European rail system as well as of the European railway supply industry in global markets.

It needs to come away from this fragmented approach to strengthen the market with large scale deployment of leading-edge developments.

The purpose of reinforcing the system view within EU-Rail is to provide governance, resources, and outputs to allow the sector to coordinate and converge on the evolution of the system through:

- Defining the fundamental design principles and a layered functional architecture for rail as an interoperable system (as has been used for decades in many industries such as aviation, defence, energy, and telecoms).
- Harmonising this system architecture approach at European level, including standardized rail operation, as well as standardized interfaces and related functions communication and data exchange including with other modes of transport.
- Considering the migration path from current systems to the future system.

The system view aims to mirror best practice from other complex fields in order to simplify and speed up the introduction of innovation into the railway system, supporting improvements to interoperability, capacity, productivity and quality of rail operations and business.

This work does not start from zero. Valuable initiatives, both within the current S2R and outside, address the evolution of the rail system. Fundamental design principles of open network architectures and standardized interfaces have already emerged from this work.

To be successful, this effort needs to be supported by a well-balanced regulation

- Leaving behind the perpetuation of national specific systems, technologies and develop technologies and approach at European level.
- Providing a legal framework that offers enough flexibility and room for the research for innovative solutions, the development of solid and mature products and a certification regime that facilitates an efficient time to market

Facilitating the introduction of state of the art interoperable solutions based on harmonised operating rules avoiding separate national assessments in terms of technical compatibility, end-to-end operation or safety. ETCS equipment planning and engineering rules for stations and lines should be standardised to support deeper operational rule harmonisation.

The system view will underpin the overall work of EU-Rail, and will be developed based on the CBO defined in this document.

5 Common Business Objectives

The CBO are derived from the identified impacts from the EU-Rail Master Plan, see chapter 4.3, and are based on the importance of delivering an overall system view, strengthening the delivery of the SERA.

The Master Plan impacts are used to derive the common business objectives.

For each Master Plan impact

- A contextual description is provided
- The high level objectives to achieve this impact are described (for example the objectives listed in section 5.1)
- The common business objectives are the listed steps necessary to achieve these high level objectives. (for example the common business objectives listed in 5.1.1)

The CBO have been derived from a consolidated view of the source documents.

The business objectives described in the following chapters have to be managed in combination and not in isolation e.g. increased cost efficiency and quicker rollout of solutions with increased performance shall be achieved in a combined way. Pure cost reductions will not lead to higher system performance and without an accelerated rollout it will take too long to achieve a relevant modal shift.

5.1 Meeting evolving customer requirements

The vision of the European railway system is to allow domestic and international passengers and freight to travel by rail easily and based on their needs across the whole Single European Rail Area.

The objective is to:

- Strengthen the ability to sustain a given service quality, punctuality, and safe operation
- Leverage on real-time information and data sharing to provide accurate status within the full transport system (end-to-end) and allow an overall optimization of the transport offer
- Enable railways to deploy digital solutions by simplifying the access to information available in the standardized architectures

The delivery of these objectives will provide an attractive and convenient service allowing real-time, tailored services providing a punctual, reliable, safe, secure, and cost-efficient service for citizens and businesses.

5.1.1 Strengthen the ability to sustain a given service quality, punctuality, and safe operation

1. Completeness of planning –.Making sure all trains are timetabled and making sure that the operational plan can be updated on demand (real time). {completeness of planning and live update}
2. Adequate level of information to enable plan optimisation and increase the sum of RU train path request can be accommodated in a reliable timetable. Extend, coordinate this information with other entities. {enhanced information for plan optimisation}
3. Rapid responses to capacity requests and planning changes. {rapid response to capacity request}
4. Continuous supervision and detection of conflicts and resolution potentially leveraging on data sharing. {continuous supervision}
5. Reducing the impact of disturbances - intelligent incident handling as well as process and functional assistance of works enabling a smooth operation. {smart/assisted incidence handling}
6. Improving train and trackside availability, reliability and performance (example ETCS Level 3 and ATO) {availability, robustness, reliability}
7. Improving freight train composition, operation and capacity allocations of paths, stabling tracks (f.e. waiting for terminal slots) and shunting (yard) work. (i.e., by introducing DAC and FDFTO[1] features) {efficient train compositioning and integrity monitoring}
8. Every use should be planned, with different details during time, to sustain quality. All trains for passengers or every movement/use of track also on stabling tracks and movement to and on yards. The latter makes the plan complete. It shall also consider the use of infra for maintenance. {enhanced information for plan optimisation}
9. All trains for passengers or every movement/use of track also on stabling tracks and movement to and on yards. It is also about use of infra for maintenance. Every use should be planned to sustain quality. In different details during time.{enhanced information for plan optimisation}

[1] DAC = Digital Automatic Coupler / FDFTO = Full Digital Freight Train Operations (part of FA 5 project)

5.1.2 Leverage on real-time information and data sharing to provide accurate status within the full transport system (end-to-end) and allow an overall optimization of the transport offer

1. Provide to customer rapid alerts of traffic congestion, including rerouting options {rapid deviation information/solution}
2. Leverage on the emergence of new transports- and communication possibilities allowing cities and regions to propose agile multimodal mobility-as-a-service solutions for passengers and freight operators. {multi-modal mobility}
3. Develop tools for public administrations which can be leveraged by different stakeholders to stimulate new types of services. {tools support new services}
4. Provides valuable information to optimize the layout of stations. {analytical information for passenger flow/incidents}
5. Provides valuable information to refine the procedures for incidents. {analytical information for passenger flow/incidents}
6. Provide connectivity and data streams to enable end-to-end journeys, through-ticketing and integrated connection of the railway with other transport modes. { multi-modal connections} {SERA}
7. Provide reference data which is highly reliable, updated automatically, that can be used by the whole sector and accessed by its systems. {reliable European reference data}

5.1.3 Enable railways to deploy digital solutions by simplifying the access to information available in the standardized architectures

Digital technologies are the enablers to realized customer-specific digital solutions in the railway sector. Digital technologies generate large amounts of information that shall be organized and exchanged to deliver customer value. The System Pillar introduces standardized architectures which also shall provide in the physical architecture a simplified and standardized access to the information available on its standardized interfaces. This includes the specification of

1. Standardized description methods for information access methods and interfaces
2. Definitions for operational processes for the business2business information exchange
3. Standardized specifications for information services that are in scope of the System Pillar

5.2 Improved performance and capacity

Demand for railway services is expected to continue to grow in the long-term given population growth, increasing road congestion and the growing demand for decarbonized transport. {increase capacity}

Through the development of cutting-edge technologies and improved and harmonised operational processes and rules designed to be implemented across the whole EU rail system, capacity and performance can be significantly improved, and interoperability strengthened. {new technologies, harmonized processes}

An increase in capacity can be used to provide more train services, to reduce or optimize investments in costly physical infrastructure extensions. This capacity effectively adds value for rail customers and offers a key element of sustainable and universally accessible concept of mobility as a service.

Delivering a higher capacity railway requires a system approach. Capacity is impacted by many factors including signalling, train, track, passenger flow and dwell time management. {system approach}

The objective is to:

- Increase capacity utilisation of the rail
- Increase transport capacity agility
- Reduce the dwelling time between trains
- Reduce the traveling and transit time
- Better predict capacity needs of infrastructure
- Make more efficient capacity use of lower used lines

5.2.1 Increase capacity utilisation of the rail

1. CCS to increase numbers of trains per hour. {precise control of traffic flow}{short train-ahead time}
   TMS/CMS (Capacity Management System)[2] to enable more efficient infrastructure usage. {deep/optimized plan OBJ}OBJOBJ) {OBJ}

5.2.2 Increase transport capacity agility

1. Maximise space in vehicles that can be commercially deployed or integrate systems in a given (cramped) physical environment. {vehicle: commercial space}

2. For rail freight - modular, freight wagon designs to allow a seamless and efficient horizontal change of goods and loading units. {wagon: efficient change of goods}

3. Long-term planning processes need to consider future capacity requirements. {predict capacity needs}

5.2.3 Reduce the dwelling time between trains

1. Optimize the vehicle design and performance parameters. (eg braking curves optimization and braking performance, Localisation accuracy, Movement Authority automated extensions). {vehicle design/performance}
2. Support ETCS L3 functionalities (end of train, train length, integrity) for freight trains (i.e., through introduction of DAC/FDFTO[1]). {efficient train compositioning and integrity monitoring}}

5.2.4 Reduce the travelling and transit time

1. Improving timetable structure, the regulatory framework, railway network topology, and Automatic Train Operations optimisation. {optimize timetables} {optimize regulation} {optimize topology} {ATO}
2. Reducing the human element in train operation. {automation of systems}
3. Unmanned train operation on, at least selected, sections of heavy rail networks, especially high traffic density lines, or for specific transportation functions like shunting. {ATO}{automated shunting}

[2] CMS or DCM (Digital Capacity Management) is a sector-initiated concept which has been launched for several years by European institutions.

5.2.5 Better predict capacity needs of infrastructure

1. Better prediction of demand needs to support future investment. {predict capacity needs}
2. Bringing flexibility to adjust viable railway service in regard of capacity. {flexible use of infra capacity}

5.2.6 Make more efficient capacity use of lower used lines

1. Improve efficiency of RUs to move the volume of passengers and freight according to end customer needs in real time. {RU transport efficiency/volume/timing}
2. Maintain lower used lines availability and compatibility for main line recovery situation, enabling affordable solution that achieves the compatibility requirement. {systems: extensible capacity, scalability}.

5.3 Reduced costs

The ability to reduce total cost within the rail system is a precondition for railway business continuity in an intense intermodal competition.

Whole life cost matters - the pure purchase price of single asset components is normally not the main cost driver in a system, (typically < 20 % of the life cycle cost), rather whole life costs must be considered.

For deployment and change within railway systems, cost is a constraint to adaptation and faster deployment. For digital solutions, there is a need to allow flexibility, scalability, and the ability to migrate as business needs change. Affordable system updates are an enabler for rapid system modernisation, ensuring continuous increase of rail performance. IT deployments that amortise over a 40-year period (e.g. the lifespan of a train) are not an option.

The objective is to:

- Reduce life cycle cost
- Deliver affordable system updates
- Produce solutions that are economically attractive

5.3.1 Reduce life-cycle cost

1. The system design shall support the removal of trackside asset and promote effective solutions. {less trackside assets}
2. The system design shall implement features that allow an independence of lifecycles and compatibility as well as release steps on both sides of an interface ("connect old to new"). Technical obsolescence shall lead most often to "simple exchange" and reduced need for system test. {independent lifecycle} {simple exchange}
3. A clear approach to managing the whole life cycle of assets (too often Capex are assessed more important than potentially more attractive Opex) – including asset construction, engineering, commissioning, authorisation, maintenance, obsolescence, upgrades, and decommissioning. {automate lifecycle processes}

4. Ensure 'right first time' interoperability and delivery and mitigate the risk of debug and re-work costs, including reusable safety cases, adequate documentation, knowledge and training dissemination, and incorporation of lessons learned. {reusable right first time work}
5. Processes are oriented along an ever-changing system. {changeability}

5.3.2 Deliver affordable system updates

1. Changeability and upgradeability shall ensure business continuity along the life-cycle with optimised investment scheme. {changeability} {upgradeable system design}
2. The system design shall anticipate the need for updates at minimum effort as a driver to optimize the economic migration path towards future solutions. {upgradeable system design}
3. Due to widely varying obsolescence timescales as typical for digital systems, an affordable life cycle cost and the capability to manage system integration of components, with clear objective of reasonable system updates of SW and digitalized system, is a crucial objective. {simplified integration} {simple regular SW upgrades}

5.3.3 Produce solutions that are economically attractive

1. Reduce the effort to plan, install, operate and use asset components through functional richness (e.g. configuration automation), automation, upwards and cross compatibility (dependencies limit life span), and on non-functional properties like robustness {automate lifecycle processes} {independent lifecycle}
2. The economic viability has to consider the full lifecycle cost considering both Capex + Opex from railways and suppliers' points of view. {overall CAPEX/OPEX optimisation}
3. Increase market size (cost efficiency and quality) for standardized solution and through regular update of standardized modular components. {increase market size by standardisation}

5.4 More sustainable and resilient transport

Increasing robustness and performance will allow the rail industry to meet customer expectations with improved capacity, greater network availability and greater environmental sustainability.

With an increasing number of devices connected to the internet, security and resilience needs to be robust, security is paramount with digitisation. With systems becoming more software and data based, the risk of a cyber-attack is increasing. This has the potential to bring large parts of the network to a standstill if not designed effectively. (eg Security update shall be possible when needed without revisiting safety case and other approval process, segregation and modularity of vital, non-vital part of the system)

The objective is to:

- Manage more efficient energy consumption
- Support implementation of smart energy infrastructure
- Improve availability and reliability/robustness
- Improve railway footprint for better acceptance and integration of transport systems in populated areas
- Propose proper cyber-security regulations and standards
- Enhance circular economy (eg material recycling)
- Support working condition transition phase and social acceptance

5.4.1 Manage more efficient energy consumption

1. Less energy consumption. {efficient energy use}
2. Better use of energy. {efficient energy use}
3. Sustainable materials should be widely adopted, and renewable energy sources should be used. {sustainable materials} {renewable energy sources}
4. Implement of new light materials, new technical solutions for non-electrified lines {light materials} {new solution for non-electrified lines}

5.4.2 Support Implementation of smart energy infrastructure

1. Develop on board and line-side energy storage technologies and charging technologies. (eg overhead line in cheap area, Hybrid solutions including batteries, electrification, trackside (axle load)…) {energy storage and charging}
2. Facilitate the synergies between rail power supply, road usage, stations… {multi-modal energy synergies}

5.4.3 Improve availability and reliability/robustness

Reliability, availability and maintainability (RAM) of the railway system and its components can be increased but only in line with more standardized rules & regulations, harmonized operational rules and considerations of an overall attractive business case for RU, IM and supply industry through:

1. Rationalise trackside and onboard assets portfolio, as they are complex to maintain and diagnose, with many failure modes related to the harsh environment in which they are situated. {availability: less assets}
2. Improving robustness: with the increase of data and software complexity, operation of systems is becoming vulnerable and the general criteria of "robustness" should express a systems effectiveness to resist operational downgrades or weather conditions beyond the specified environmental conditions. {system robustness} {robustness against weather}
3. System adaptability shall allow resilience vis à vis the impact of climate change (landslide, floods, etc.). {robustness against weather}
4. Digitized maintenance processes interaction, reduce voice communication steps. {automated field force communication}
5. Shortened and stable robust process with tool-based assistance as much as possible to address any changes including handling of degraded situations. (eg. All manual documentation and exchange beginning from route compatibility check, pre-planning of movement, detailed planning of movement and operational rescheduling must be automated). {operations/maintenance: assisted systems}

5.4.4 Improve railway footprint for better acceptance and integration of transport systems in populated areas

1. Where appropriate to the system pillar activities, facilitate the reduction of noise, vibration and carbon emissions and others in order to increase social acceptance in urban environments and beyond. {reduce noise} {reduce vibration} {reduce carbon emissions}

5.4.5 Propose proper cyber-security strategy and standards

1. Suitable levels of cyber-security, following a risk-based approach should be integral to all systems. {suitable cyber-security levels}

2. The railway's local environment is also subject to cyber-security-building measures. {local environment cyber security}
3. Cyber-Security measures are non-invasive, not interfering with the travel experience. {non invasive/noticeable cyber security}

5.4.6 Enhance circular economy (eg material recycling)

1. Where appropriate to the system pillar activities, Sustainable and reusable materials should be widely adopted {sustainable materials}

5.4.7 Support working condition transition phase and social acceptance

1. Consider changed level of skills per person in general
2. Enhance the attractiveness of the job

5.5 Harmonised approach to evolution and greater adaptability

The vision of the European railway system is to enable full end-to-end services and intermodality, and freedom for passengers and freight to travel domestically and internationally in the Single European Railway area with end-to-end journeys, with through-ticketing and with more efficient connection of the railway with other transport modes. The promotion and extension of interoperability is central to this goal.

The evolution of railway signalling systems was driven by national, historical, economical, industrial, operational and safety requirements.

Differences in operation are one of the key root causes for complexity as well as product diversity and therefore are a major cost driver. The harmonization of operational principles where economically possible – in particular under cab signalling and radio-based ETCS is key to achieve generic CCS and TMS solutions, minimize national requirements and reduce life cycle cost. It is therefore success critical that country specific laws, rules & regulations and specific preferences will be harmonized, reduced and implemented.

Bespoke solutions for individual railway systems create high complexity and long timescales to develop systems. Railway systems can move away from bespoke solutions, towards a harmonised architecture that will reduce development effort. Short timescales with reduced time to market are crucial for upgrades to the future system. The time to fix an issue is also relevant when it comes to adaptations related to error correction or security patching. This is also relevant for continuously enhancing the system.

A standardized architecture on the basis of such harmonisation could expand market relevance and reduce cost and project risk.

The objective is to:

- Harmonize operations (including for example in shunting yards) and strengthen interoperability
- Standardize architecture

- Increase flexibility and adaptability of systems
- Optimize Safety strategies and standards
- Facilitate the transition from legacy systems

5.5.1 Harmonise operations (among others on main lines and in shunting yards) and strengthen interoperability

Differences in operation are one of the key root causes for complexity as well as product diversity and therefore are a major cost driver. The harmonization of operational principles under cab signalling and radio-based ETCS is key to achieve generic CCS and TMS solutions, minimize national requirements and reduce life cycle cost. The objective is to:

1. Deliver a common and sufficiently detailed set of operational rules – enabling the use of based on radio-based ERTMS alone systems – to support a much greater degree of operational harmonisation, including functions beyond CCS such as traffic management and capacity management, train composition (considering for example DAC/FDFTO[1]) or energy management. To reach this high ambition processes, security, safety considerations and operational message/data exchanges (i.e. text messages, written orders) both for nominal but also degraded operation will be harmonised, allowing that unique operational and engineering requirements are set to standardized CCS, CMS and TMS systems, products and services. {operational harmonisation} {unique requirements}

5.5.2 Standardize architecture

1. Defining the fundamental design principles and process for adopting a functional architecture for rail as a system, with a focus on CCS, CMS and TMS supporting the implementation of the SERA (Single European Railway Area) {SERA}
2. Defining in-train system architecture for (loco-hauled) freight trains with standardised interfaces to CCS, CMS and TMS and other affected elements of the full railway system. {efficient train compositioning}
3. Harmonising this system architecture approach at European level, including standardisation of interfaces, communications and data exchange. {standardized architecture}
4. Achieving an efficient granularity of the architecture and the best way how to exploit the content (e.g. TSIs, standards, guidelines). {overall CAPEX/OPEX optimisation}
5. The standardise architecture must rely on robust, comprehensive and sustainable architecture framework. {robust, comprehensible, sustainable framework}
6. Achieving modularity, at the right level, that allows room for innovation “between interfaces”, and that, at the same time, reduces costs, by not reassessing the whole system when a module is changed or updated.

5.5.3 Increase flexibility and adaptability of systems

1. Flexible approach shall allow the incorporation of emerging technologies and apply innovative new solutions as they become available to meet increasing customer demands and provide a competitive level playing field for suppliers.
2. Adaptive design is a prerequisite for continuously fulfilling capacity and performance requirements besides being vital for sustained levels and quality of train services. {systems: extensible capacity, scalability}

3. Regulatory framework that supports speedy technology development and implementation processes is a critical condition for adaptive design. {flexible regulation supports development}

5.5.4 Optimize safety strategies and standards

1. Safety critical elements of a system should be optimized and simplified through design by moving away from bespoke solutions. The development of these parameters facilitates a common approach to safety and security. {simplified standard safety components}
2. Simulation and modelling tools are needed to accurately calculate and validate the performance of systems with an incorporated robust PRAMSS framework controlling for the development process and the RAMSS change impact analysis for changes inside of the life cycle. {validated system performance} {robust PRAMSS framework}
3. The safety logic shall have a generic approval and authorisation in which it is proven that it just needs a reliable input of topology information and train information and will assure safety on this basis. {safety logic with generic safety approval}
4. The exchange of components or connection of new subsystems under production shall happen without a new safety case or preparation processes. {seamless and selective exchange of components under production}
5. An authorised vehicle can be operated everywhere on compliant infrastructure without local integration test. {vehicle is interoperable without local integration test}

5.6 Reinforced role for rail in European transport and mobility

To allow the railway to be competitive with other modes of transport, quick adaptation is necessary to keep up with public demand. One amongst other reasons for the slow progress of European innovation projects is the lengthy stakeholder consultation and management processes involved in decision making on changes, combined with a persistent shortage of qualified resources.

Systems interfaces should be highly standardized and promote interoperability within the SERA. The evolution of this should be centrally managed to ensure coherence and consistency of system performance.

Tender specifications should reflect a greater standardisation leading to less interpretation and differentiation in outcome, reducing production and unplanned costs as well as improving project delivery. In any case European-wide reusability of existing and proven solutions will be most effective to reduce effort and cost at all ends.

With an increase in harmonisation and modularity supported by clearly specified interfaces, enabled by fully harmonised operational rules and a seamless intermodal transport regime the ability to procure pre-certified standard systems in a competitive market is important. Products with offered life cycle support, system integration and service level agreements should ease the burden of procurement and on the same hand enlarge the addressable market size of the certified product and the market share of EU-Rail in the European transport market.

The objective is to:

- Improve methods and tooling

- Reduce the system complexity by optimal design to ease regulatory compliance
- Enable fast migration and roll out
- Achieve overall comprehensive assessment (features, Capex, Opex, I&C etc.) of solutions
- Bring freight traffic to the next level (among others by introduction of DAC/FDFTO[2])

5.6.1 Improve methods and tooling

1. Working methods and associated tooling, based on MBSE, should support the fast development and rollout of solutions while at the same time safeguarding quality requirements. {fast high-quality development}
2. Rules and procedures and a code of behaviour shall define, amongst others, an efficient decision and working methodology. {efficient decision and working methodology}

5.6.2 Reduce the system complexity by optimal design to ease regulatory compliance

1. Develop systems which allow clear and simple tender procedures {systems allow simpler tender procedures}
2. Creating the conditions to limit terms & condition complexity, reuse contract standards and provide room for innovation {reusable and simpler contract standards}
3. Simplify not only the complexity and certification of products but also impacts on the general supply chain including services like planning, engineering, installation, commissioning, and maintenance. {simplify certificates and their impacts}

5.6.3 Fast migration and Rollout

1. Incremental deployments that increase complexity and costs, need to be replaced by an efficient and coordinated migration strategy, based on adaptable systems. {efficient migration based on adaptable systems}
2. Generic solutions for simple repeatable design, testing and commissioning reducing deployment times, reducing project delivery costs and getting solutions to the customer sooner. {simple repeatable DevOps}
3. Development of viable migration paths for all stakeholders from current systems to support the delivery of the target system and architecture. {viable migration paths}
4. Protecting investments through backwards and forwards compatibility where technically feasible and economically viable for railways (RU, IM suppliers, and also customers (end-users) and investors (public or private)). {viable forward/backward compatibility}
5. Improving time to market. {reduced time to market}

5.6.4 Achieve overall comprehensive assessment (features, Capex, Opex, I&C etc.) of solutions

1. Avoiding Capex bias when assessing Total cost of Ownership (CAPEX+OPEX) created by the architecture {overall CAPEX/OPEX optimisation}
2. Achieving the capability for the operator (RU or IM) to make use of all pertinent information allowing the system to be operated properly and evolved throughout its life-cycle. {automate operators knowledge management}

5.6.5 Bring freight traffic to the next level (among others by introduction of DAC/FDFTO[2])

1. Freight traffic will only be able to cope with the increased transport demands resulting from modal shift to rail according to the EU smart mobility strategy, when operations become highly digitalised and automated. One possible solution is the introduction of an interoperable DAC (with standardized mechanical, pneumatical, electrical and data coupling) and successive implementation of FDFTO features (e.g., train inauguration, automatic brake test, ep-brake). {efficient train compositioning and integrity monitoring}
2. Updating planning and allocation paths, stabling tracks, shunting yard when changes are needed. For example make turn-around times for round trips shorter, to be able to fast replan all reserved infra usage when delays and changes in runs or terminal slots occur. {efficient train compositioning and integrity monitoring}

5.7 Improved EU rail supply industry competitiveness

Increasing the R&I intensity of the European rail supply industry will enhance its capacity to retain its global leadership.

Strengthening the current rail system into a central transport mode of tomorrow's European mobility, will build unique capabilities in the European rail industry, including its SMEs, supporting its position in global markets

The objective is to:

- Make future railway system attractive for different actors inside and outside Europe.
- leverage on an European rail technical expertise for other regional areas
- Secure profitability and grant freedom to invent and roll out innovative solutions
- Create and foster standardized know-how to secure support throughout the lifecycle

5.7.1 Make future railway system attractive for different actors inside and outside Europe

1. Strengthening and streamlining a common, efficient, systematically coherent and simplified but rigorous binding normative framework across the EU. {efficient normative framework}
2. "Full" reusability of all types of products and artefacts which simplifies considerably current bureaucratic steps (prove once, cross-references, describe once, just reference, a request for authorisation could theoretically be a "one-pager" with references. Etc.). {full reusability}
3. Capitalize on rapid return of experience and high reliability. {rapid return of experience}
4. Promote a more attractive labour market for all stakeholder. {attractive labour}

5.7.2 Leverage on European rail technical expertise for other regional areas

1. Facilitate European railway system adoption worldwide. {worldwide adoption}
2. Maintain and further develop the capabilities for safe products, safe operation and an exemplary safety culture in the railway sector and comprehensively respond to unexpected behaviours. {comprehensive incidence management}
3. Guarantee the compatibility of subsystems and components e.g. with the aid of standardized interfaces. {standardized architecture}

5.7.3 Secure profitability and grant freedom to invent and roll out innovative solutions. {roll out innovation}

5.7.4 Create and foster standardized know-how to secure support throughout the lifecycle {standard know how}

6 Common Business Objective in the development of SP outputs

The challenge to achieve these high level objectives is complex and multifaceted that it can only be tackled in a collaborative way. Collaboration should be seen a success factor of the rail sector regarding the following aspects:

- Take into account the key competences of the stakeholders for an optimized allocation of roles and responsibilities, making maximum use of scarce resource,
- Ensure availability of qualified personnel by attracting more talents by an innovative railway sector and
- Accepting the need for a positive impact on the business of all concerned stakeholders. This is a basic condition to achieve a sustainable support of RU s, IM s and suppliers for the implementation of a related subject. In case of conflicts, measures shall be taken to achieve a better balance of the individual business impacts.

As a follow-up to the definition of these CBOs relevant targets together with relevant indicators to monitor progress may be developed during the programme period. These targets would take into account the ones already specified in the Master Plan. The references will be taken from the results of the planned work on the As-Is situation along with roles and responsibilities in delivering on the CBOs

From chapter 5, the list of individual common business objectives has been identified and been allocated key words in light grey to ease traceability, for example:

5.1.1 Strengthen the ability to sustain a given service quality and punctuality 1. Completeness of planning –.Making sure all trains are timetabled and making sure that the operational plan can be updated on demand (real time). {completeness of planning and live update}

In this example the key words are: {Completeness of planning and live update}

The CBOs are to be used to guide decision making within the System Pillar, and inform the development of the operational work within the System Pillar, within which there are three different areas: the concept of operations, the concept on how to use the system and the concept of employment of the system.

The operational processes and changes proposed will be mapped to the CBO, and their impact defined. This process will link the operational process improvements to the defined CBO.

If required, the CBO list can be amended if individual CBOs need to be changed, added or removed.

The full list of CBO in compressed format is as follows:

7 Process applied to produce this document

The process to derive the CBO was as follows:

- Documents reviewed
- Screening against criteria proposed by the rail sector
- First CBO produced
- Synthesis and revision to remove overlaps
- Organisation according to the EU Rail Master Plan impacts.

At first; the identified rail sectors documents are screened with LINX4RAIL Common Business Objective criteria proposed by the rail sector. A first list of business objectives with redundancies, overlapping is established. Then this list is synthetized and ordered according to the challenge and impact identified in Europe's rail master plan. The outcome of the process is provided in chapter 5 EU-Rail CBO.

The documents/materials reviewed were:

1. Europe's Rail Joint Undertaking Report on preparation of the System Pillar

   In line with the Sustainable and Smart Mobility Strategy, the ambition of the Union and Member States, with the support of ERA and Shift2Rail JU, is to create a modern harmonised robust and reliable interoperable European railway system. Such a system is necessary for the rail sector to better address customer needs, maintain safety and digital security, improve operational efficiency and performance, reduce costs, support European rail supply industry competitiveness and increase the speed of adoption of performance-enhancing improvements.

2. LINX4RAIL : Deliverable D5.1 Identification of Common Business Objectives for the existing and future Railway System

   The LINX4RAIL project aims amongst others at proposing a first railway system architecture, integrating the innovation coming from Shift2Rail (S2R) Research and Innovation activities. Managing this alignment should be performed not only according to technical aspects, but also according to business objectives.

3. ERRAC Rail 2030 Research and innovation priorities

The key activities of the Vision are customer-centric and market/demand driven. The benefits accrue only if there is market uptake of the new products and services. So, the vision places a strong emphasis not only on the technical developments within the research and innovation process but also on all the other related factors which need to align to ensure successful deployment and implementation. These include a continuing comprehension of changing transport market trends and their drivers, which affect demand for railway services, and the introduction of appropriate and timely authorisation, standardisation and regulatory processes, which affect the speed of delivery to the market.

4. 18C044-0CWHITE PAPER REFERENCECCS ARCHITECTURE BASED ON ERTMS

   The Reference CCS Architecture (RCA), developed using formalised methods, is the enabler for clear and unambiguous interface definitions. It is aimed to provide generic safety approvals (plug & play), a modular split of work, independent development of components (allowing for technical evolution), an important quality step in the specification of operators' needs towards the supply industry and the strengthening of this supply industry.

5. RCA "A.P.M.": APS / PE / MAP Advanced trackside protection, plan execution and map data management – Business strategy, targets, and problem definition

   This document explains the motivation, targets, the basis of the business case and basic strategies of the evolutions and innovations of the trackside CCS (control-command and signalling) subsystem of the rail system.

6. UNISIG Concept for the evolution of the on-board CCS architecture

   This document describes the UNISIG considerations on the evolution of the on-board CCS subsystem as defined by the CCS TSI in close collaboration with UNIFE members from vehicle manufacturers, UNITEL and Shift2Rail CONNECTA.

7. OCORA-TWS04-010_FVA-Introduction.pdf

   This document aims to provide the reader with a comprehensive reference to the approach the OCORA members envisage to achieve the objectives defined in the OCORA Memorandum of Understanding. These objectives concentrate on enabling the rapid automation and digitalisation of rail products and services in order to reduce total cost of ownership, increase productivity and customer value and control investment and operational risks.

8. OCORA-BWS03-010 Introduction to OCORA

   This document aims to provide the reader with a comprehensive reference to the approach the OCORA members envisage to achieve the objectives defined in the OCORA Memorandum of Understanding. These objectives concentrate on enabling the rapid automation and digitalisation of rail products and services in order to reduce total cost of ownership, increase productivity and customer value and control investment and operational risks.

9. Multi Annual Work Programme – MAWP

In accordance with the SBA, EU-Rail has defined in its Master Plan2 its priority research and innovation activities, overall system architecture and harmonised operational approach, including large-scale demonstration activities and flagship areas.

10. Annual Work Programme – AWP

This Work Programme shall be read in conjunction with the EU-Rail's Master Plan (MP)2 and MultiAnnual Work Plan (MAWP)3 , both adopted on 1 March 2022 by the Governing Board (hereinafter also GB).

11. A compelling vision for the target railway system – ERA

The Agency's Compelling vision outlines the future paths towards the evolving target railway system. It provides details on the main elements of the target railway system. Under financial arrangements, key enablers are highlighted such as:

- Harmonised principles for assessing infrastructure projects between modes
- Optimise the allocation of risks and liabilities e.g. by inclusion of incentives for private parties to take preventive action against risks
- Defined mechanism to balance the total costs (capital, operating, maintenance, renewal, external costs) against the total societal benefits (private and social)
- Considering projects dependencies with land use planning/ urban planning (smart cities)/mobility planning
- Identifying the most cost effective balance between: make or buy, own or lease, human resources or automation

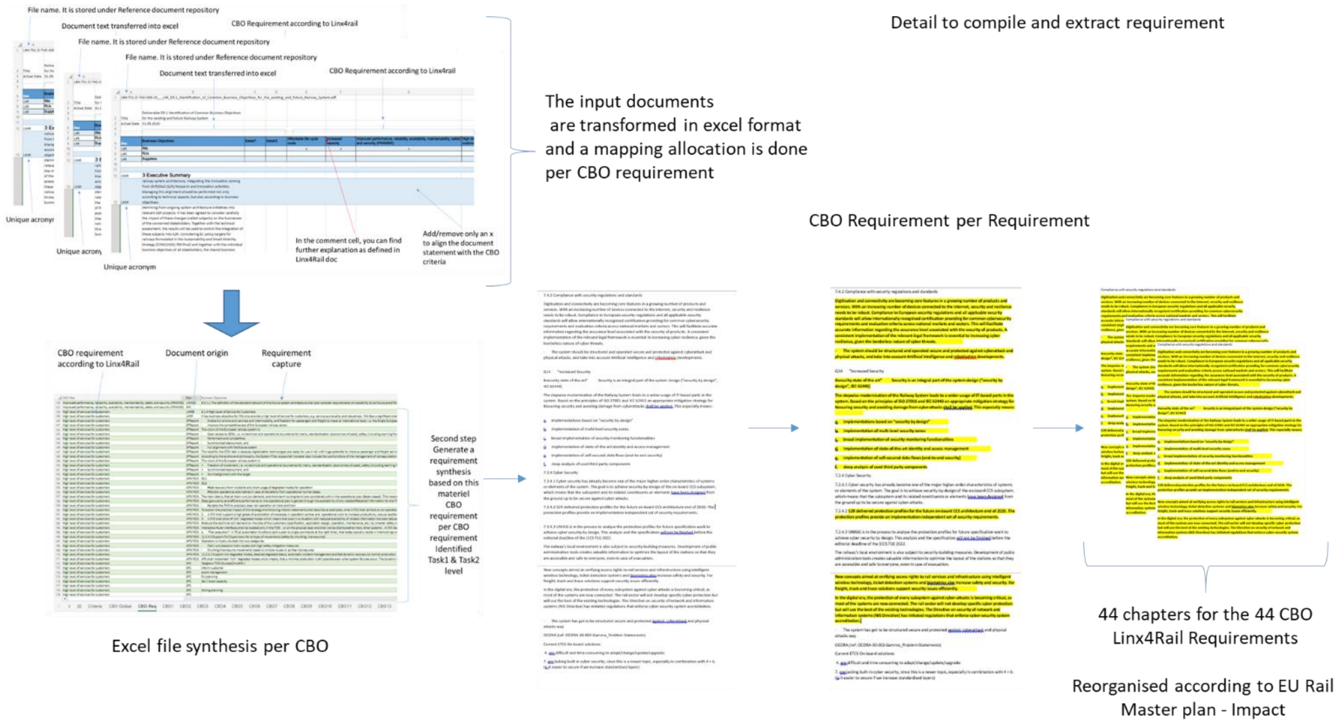
12. "Development of a concept for the EU-wide migration to a digital automatic coupling system (DAC) for rail freight transportation" Final Report 29/06/2022

Many RUs in the RFT sector do not have sufficient earnings to finance an extensive modernisation process, such as the migration to the DAC, on their own. For this reason, this study consider EU-wide financial support for rail freight transport to be a key factor in the success of the conversion to the DAC.

13. 2100513 Problem Statement

This problem statement will also steer the preparation works for the system pillar in order to achieve its goal as defined in the SBA, i.e. 'the System Pillar of the Europe's Rail Joint Undertaking should enable the sector to converge on a single operational concept and system architecture, including the definition of the services, functional blocks, and interfaces, which form the basis of rail system operations. It should provide the overall framework to ensure that research targets customer requirements and operational needs that are commonly agreed and shared customer requirements and operational needs.'

If required, we can complement the work with other input considered as bringing an added value by the stakeholders.



After a first step to extract the CBO requirement from the input document, a reallocation has been done based on the “common railway sector business objectives” proposed in Linx4Rail. This outcome is then used to sort the CBO sub-objectives according to the main criteria defined in the European Master Plan taking into account the whole rail system (Task 1 & Task 2).

The attached excel file is providing the outcome of this work.

Synthesis CBO work.xlsx

8 End of Document