EULYNX Initiative

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EULYNX Concept

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Eu.Con.3	Info	[Eu.Doc.6] EULYNX Concept CENELEC Phase: 1 Version: 2.0 (2.A) EULYNX Baseline Set: 3 Approval date: 27.11.2019
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Eu.Con.4	Head	## 1.2 Impressum
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		S.A. Infrabel Väylä (FTIA) Network Rail ÖBB Infrastruktur AG ProRail B.V. Rete Ferroviaria Italiana (RFI) SBB AG Société Nationale des Chemins de Fer Français (SNCF) SŽ-Infrastruktura, d.o.o. (SŽ) Trafikverket
Eu.Con.6	Info	Responsible for this document: EULYNX Project Management Office www.eulynx.eu
Eu.Con.122	Info	Copyright EULYNX Partners All information included or disclosed in this document is licensed under the European Union Public Licence EUPL, Version 1.1.
Eu.Con.7	Head	**1.3 Purpose**
Eu.Con.8	Info	This document presents the concept and scope of EULYNX. It describes the rationale for standardisation, the goals of EULYNX and introduces the modular system concept defined by EULYNX.
Eu.Con.9	Info	The EULYNX Concept is a Phase 1 document according to [EN 50126].
Eu.Con.10	Head	**1.4 Applicable standards and regulations**
Eu.Con.11	Info	A list of applicable standards and regulations used in EULYNX is listed in the EULYNX Reference document list [Eu.Doc.12].
Eu.Con.19	Head	**1.5 Applicable documents**
Eu.Con.107	Info	The current versions of documents used as input or related to this document are listed in the EULYNX Documentation Plan [Eu.Doc.11]. The relationships between the documents are displayed in the Appendix A1 Documentation plan and structure [Eu.Doc.11_A1].
Eu.Con.15	Head	**1.6 Terms and abbreviations**
Eu.Con.16	Info	The terms and abbreviations are listed in the EULYNX Glossary [Eu.Doc.9].
Eu.Con.115	Head	**1.7 Variability management**
Eu.Con.114	Info	This document is valid for the complete EULYNX System. Variability management is not used in this document.

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ID	Type	Requirement
Eu.Con.117	Head	**1.8 Definition of object types**
Eu.Con.118	Info	The following definition for object types is applied in this document:
Eu.Con.119	Info	• "Req" - This denotes a mandatory requirement.
Eu.Con.120	Info	• "Info" - This denotes additional information to help understand the specification. These objects do not specify any additional requirements.
Eu.Con.121	Info	• "Head" - This denotes chapter headings.
Eu.Con.20	Head	**2 Rationale for EULYNX**
Eu.Con.102	Head	**2.1 Objective**
Eu.Con.23	Info	The main focus of EULYNX is to standardise technical interfaces of signalling systems in order to open markets, accelerate innovations and gain economies of scale effects.
Eu.Con.26	Info	EULYNX provides the framework for close cooperation between Infrastructure Managers to support the aim of standardisation.
Eu.Con.100	Head	**2.2 Standardisation benefits and constraints**
Eu.Con.21	Info	Standardisation of technical systems particularly on a European level is one of the most powerful measures to manage interoperability, improve efficiency and therefore reduce costs of the entire ecosystem. For signalling systems this standardisation takes into consideration different national operational rules, commercial interests, languages and other differences.
Eu.Con.101	Head	**2.3 Life cycle approach**
Eu.Con.22	Info	Lifecycle cost targets and a shared market approach are the objectives of the European Infrastructure Managers (IM). The need is to change, maintain, renew and update the technical systems in a competitive way whilst converging the individual IMs' needs towards European harmonised requirements. This places the Infrastructure Managers as the system integrators into a position which provides them with a choice of various suppliers for different subsystems during the systems life cycle. This approach should be followed in new projects or when modifying existing system functionality or infrastructure layouts. Also maintenance related activities will benefit from this. IM's join their market force in order to improve competition between suppliers and accelerate innovations for signalling systems, with the purpose of reducing life cycle costs.
Eu.Con.112	Req	Due to different life expectancy of individual subsystems, the replacement shall be allowed on individual basis.
Eu.Con.99	Info	Results of previous European initiatives concerning interlocking system standardisation (e.g. Euro-Interlocking, INESS and ERTMS) provide a basis. This also provides an opportunity for the supply industry, as results can be reused in several markets. This creates a win-win situation for all involved.

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Eu.Con.103	Head	**2.4 Specification method**
Eu.Con.27	Info	For historic reasons many differences in legacy signalling systems exist. As a consequence, harmonisation of different requirements often seems to be impossible without directly affecting operational processes and compatibility with technical equipment. Therefore a dedicated method for standardisation is defined. Input from the participants is collected, structured and classified. Experts in the relevant domains provide a system architecture and system requirements so that the objectives of cost reduction by digitisation and compatibility with the existing control-command and signalling subsystems can be achieved by common review and verification. On the long term, a higher level of standardisation will emerge, enabling a significant reduction in life cycle costs of signalling systems. EULYNX is applying MBSE (model based system engineering) and therefore pathmaker in terms of specification quality.
Eu.Con.104	Head	**2.5 EULYNX dialogue**
Eu.Con.29	Info	The railway sector may actively contribute to the improvement and evolution of this architecture as well as to all EULYNX standards openly published on the EULYNX website. EULYNX fosters this dialogue actively.
Eu.Con.30	Head	**3 Scope of EULYNX**
Eu.Con.31	Info	EULYNX provides the generic reference architecture of the control-command and signalling subsystems.
Eu.Con.33	Info	This reference architecture is specified by infrastructure managers as well as consultation with certain suppliers through involvement in similar projects in Europe. In this architecture, processes are considered with the aim of the system accomplishing its intended functions, the exchange of data between the subsystems. Where needed, the definition also comprises the subsystems that will be implemented in the design (hardware, software, facilities, a.o.). The scope also includes security.
Eu.Con.34	Req	The reference architecture applies in the whole lifecycle of the system according to [EN 50126].
Eu.Con.35	Info	The reference architecture addresses the needs and concerns of the stakeholders: • the European infrastructure managers; • the suppliers of signalling systems and subsystems; • the train operators; • the safety authorities; • the European Railway Agency; • others (users, notified bodies, independent safety assessors, engineering bureaus, further standardisation organisations, contractors, etc.).
Eu.Con.37	Head	**4 System concept**
Eu.Con.38	Head	**4.1 Strategy of reference architecture**
Eu.Con.110	Info	The reference architecture shall support suppliers development and future solutions to achieve a future oriented railway infrastructure in Europe.

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ID	Type	Requirement
Eu.Con.39	Req	EULYNX assumes that the top layer of the railway system consists of a centralised traffic control layer, which controls the operation and capacity in a centralised way. On a level lower, interlocking systems and radio block centres establish the locking and releasing of train routes in a safe way. On the lowest level wayside objects contribute to this task, like serving points, signals, level crossings, movable bridges, etc.
Eu.Con.40	Req	Within the modular concept the separation of information and energy supply is a basic paradigm. An IP-network and a "power-bus" for distributed energy supply determine the "Points of Service" for information supply and "Points of Power" for energy supply in a decentralised system.
Eu.Con.43	Req	The reference architecture allows IP-based communication using closed and open networks.
Eu.Con.44	Req	The reference architecture supports a system design that is based on components off the shelf (COTS) and mass industry solutions also used in other industries.
Eu.Con.45	Req	Maintenance efficiency and system optimisation shall be improved by providing a modern architecture and standardised diagnostic system.
Eu.Con.46	Req	EULYNX provides standard interfaces and defined categories of functions aiming on integration of plug-and-play components into the signalling system. A very detailed implementation prescription, including software and hardware architecture, will not be in the scope of this standard, as this may either be in conflict with the variability management or with the intended flexibility of manufacturers to apply various different design solutions.
Eu.Con.128	Info	EULYNX considers the following standardisation goals, listed according to priority: • Functional requirements which are visible at the interface • Technical requirements of the interface, telegram structure • Identification of the subsystem and the configuration data • Requirement for the maintenance and diagnostics • Physical requirements of the subsystems • Environmental requirements • Power supply
Eu.Con.129	Info	The standardisation objectives may differ per each IM according to possible scenarios: • Exchangeability of hardware (object controllers) is not required. This mainly applies to interfaces between adjacent systems (RBC, CC, LX). • Exchangeability of hardware (object controllers) is required with a purpose to provide a choice of various suppliers for different subsystems during the system life cycle. This scenario is applicable for modifications to system functionality and layout changes, as well as to partial renewals of the system. • Exchangeability of hardware (object controllers) is required with a purpose to provide a choice of various suppliers for different subsystems during the system life cycle as well as for the purpose of maintenance. This scenario caters for modifications and partial renewals. To further support maintenance related activities, this scenario enables exchanging individual object controllers independent of the supplier, also for corrective maintenance, for example replacing a faulty object controller with one from a different supplier.
Eu.Con.47	Head	**4.2 Modular system concept**

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ID	Type	Requirement
Eu.Con.48	Info	The EULYNX reference architecture defines a modular system with subsystems and interfaces to be specified and standardised.
Eu.Con.50	Req	The modular structure shall be defined in a way to manage complementing or conflicting IM-specific requirements by applying the variability management.
Eu.Con.51	Req	Modules shall be fit for integration into the signalling system solely based on interface and function specifications provided by EULYNX.
Eu.Con.52	Req	The modular structure of EULYNX reference architecture defines wayside objects like points and signals as subsystems with controllers with standardised interfaces to command and control wayside objects.
Eu.Con.116	Req	The subsystems with controllers shall contain sufficient intelligence in order to support the following goals: • enable harmonisation and European wide implementation by apportionment of functionality between interlocking system core and between object controllers (strong core does not enable harmonisation) • management of security aspects • supporting preventive maintenance through intelligent object controllers
Eu.Con.53	Req	Additional or even conflicting IM-specific requirements shall be managed as IM-specific configuration.
Eu.Con.54	Req	The subsystems in the EULYNX reference architecture shall be able to process fail safe reactions even if the communication is interrupted.
Eu.Con.74	Head	**4.3 Reference architecture**
Eu.Con.80	Head	**4.3.1 General**
Eu.Con.77	Info	The EULYNX specifications contain two types of objects: • interface requirements mandatory to meet the EULYNX objectives of interoperable equipment; • information objects which provide supporting information and are not mandatory for implementation.
Eu.Con.78	Info	Different types of architectures are described: • physical architecture, including identified interfaces • functional architecture, including identified interfaces • non-functional architecture • implementation architecture
Eu.Con.79	Info	A change in one architecture type may have consequences in one or more of the other architecture types.
Eu.Con.76	Info	The standardisation level does not encompass a fully harmonised operational concept. However, requirements are provided about how the system operates, where in the operating environment the system will be distributed, how long the system must operate and how effective the system’s performance must be.

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Eu.Con.81	Head	**4.3.2 Physical architecture**
Eu.Con.86	Info	Many subsystems spread over a countrywide network are combined with centralised subsystems. The physical architecture represents these subsystems, expressed as nodes that constitute the system and their connectivity and their links.
Eu.Con.87	Info	The physical architecture gives a minimal set of rules governing the arrangement, interaction, and interdependence of the parts or elements required that a conformant system satisfies a specified set of requirements.
Eu.Con.88	Info	Based on the physical architecture also engineering specifications can be derived, and it must be possible to connect to the existing infrastructure.
Eu.Con.82	Head	**4.3.3 Functional architecture**
Eu.Con.89	Info	The functional architecture defines a standard apportionment of functions to the subsystems of the EULYNX System and to the adjacent systems.
Eu.Con.90	Info	The interfaces in the development scope of EULYNX are defined in the document EULYNX System Definition [Eu.Doc.7].
Eu.Con.84	Head	**4.3.4 Non-functional architecture**
Eu.Con.83	Info	Standard non-functional aspects are those that play a role in more than one subsystem or interface, such as standard requirements concerning: • RAMS; • performance; • monitoring; • IP-based communication; • security.
Eu.Con.85	Head	**4.3.5 Implementation architecture**
Eu.Con.91	Info	The implementation architecture encompasses commissioning, maintenance and decommissioning.

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ID	Type	Requirement
Eu.Con.92	Info	When the planning is considered, the implementation can be split into: • Data Preparation, which concerns the planning and design of a specific application of a signalling system; • Safety Assurance requirements (safety cases, verification, validation); • The roll out plan (general description about what / where / when shall be implemented on a level to be clear for the government, public, press) and will be in the responsibility of each infrastructure manager; • Migration (detailed description about what / where / when shall be implemented to understand which function will be realised where and when, often in different phases, transitions in states, with different phase names; on expert level) will be in the responsibility of each infrastructure manager; • Integration (a description about what / where / when shall be implemented, how technical, functional and operational issues meet each other) will be in the responsibility of each infrastructure manager.
Eu.Con.59	Head	**5 System development process**
Eu.Con.93	Info	The responsibility of the Infrastructure managers in the system development process is within Phases 1-4 and Phases 9-10 according to [EN 50126], with a shared responsibility with the industry in Phase 5.
Eu.Con.95	Info	System development in EULYNX is defined in detail in the document System engineering process [Eu.Doc.27].
Eu.Con.94	Info	The responsibility of the Infrastructure managers encompasses: • requirements management; • formal modelling; • tooling selection; • configuration management; • variability management; • verification and validation; • change management.
Eu.Con.60	Req	The development of EULYNX interface specifications is performed by gathering the functional requirements from all of the partners involved in that interface. A dynamic model of the interface is then created using the SysML modelling language, implemented on a proprietary software tool. The model can be tested to ensure its behaviour is as expected in response to the input messages. The models are based on the subsystems and interfaces defined by the EULYNX System Definition [Eu.Doc.7].
Eu.Con.105	Info	The EULYNX development method in brief is: functions - use cases - modelling - validation.
Eu.Con.55	Head	**6 Variability**
Eu.Con.56	Req	As the interlocking principles are slightly different among European countries, variability management must be applied in the whole development process using the standard reference architecture.

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ID	Type	Requirement
Eu.Con.57	Info	Each infrastructure manager (IM) involved in a EULYNX cluster provides IM-specific requirements relevant to the development of that subsystem. Traceability of those requirements back to their national source (Notified National Technical Rules, IM-specific requirements, standards, etc) is the responsibility of each infrastructure manager.
Eu.Con.58	Info	Variability management in EULYNX is defined in detail in the document Variability and configuration management [Eu.Doc.28].
Eu.Con.96	Head	**7 Data Preparation**
Eu.Con.97	Req	Data Preparation delivers a standard data format for conventional and ERTMS-compliant interlockings to support the exchange of interlocking planning data between infrastructure managers and external parties, such as engineering firms and suppliers.
Eu.Con.98	Info	The standard data format can be filled with the data from databases, and / or converted from the other specific data formats from tooling of infrastructure managers. Infrastructure managers have already invested in developing own data formats and tooling, therefore it is a precondition that they maintain to use their previous investments. This leads to requirements for conversion to the standard way of description.
Eu.Con.67	Head	**8 Assurance**
Eu.Con.68	Head	**8.1 Assurance process**
Eu.Con.69	Req	The EULYNX assurance activity consists of: • independent confirmation that the architecture and the modelling process are adequate and complete; • a generic safety assurance process, applied in each EULYNX cluster, demonstrating that both the work process followed and the outputs of that work are complete and adequate for use by each of the partner members • independent review of the assurance plan and process • independent audit of the assurance outputs
Eu.Con.111	Info	EULYNX encourages the reuse of previous experience from reference implementations (CSM reference system path [CSM]).
Eu.Con.70	Info	The reference architecture and the system engineering process shall be created by the expert judgement of the respective cluster members. The independent review of the outputs of these 2 clusters will be carried out by both inspection of the documentation and by review of a career description of the cluster project members.
Eu.Con.71	Info	Assurance of the interface cluster project outputs will be facilitated by a checklist to allow the cluster leader to record successful completion of each step. Each cluster will be subject to independent audit to ensure correct application of the process.
Eu.Con.72	Head	**8.2 EULYNX outputs**
Eu.Con.73	Req	The outputs to the supply industry are complete in terms of requirements and can be used as a valid input to safety cases for equipment created with EULYNX compatible interfaces.

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