EUROPEAN UNION AGENCY FOR RAILWAYS

Moving Europe towards a sustainable and safe railway system without frontiers.

Guide on the application of the common specifications of the register of Infrastructure

According to art. 7 and the Annex of Commission Implementing regulation (EU) 2019/777 of 16 May 2019 on the common specifications for the register of railway infrastructure, as amended by Commission Implementing Regulation (EU) 2023/1694 of 10 August 2023

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0. DOCUMENT INFORMATION

0.1. Amendment Record

Table 1: Status of the document.

Version Date	Author(s)	Section Number	Modification Description
Guide version 1.0 16/12/2014	ERA-IU	all	First publication. This version is the basis of the iteration 2 of release 1.1. Modifications since 28/08/2014 are on the word version in track changes.
Guide Version 1.1 11/06/2015	ERA-IU		This version is the basis of the iteration 2 of release 1.1 available on ERA website since June 2015. Introduction of a new OP type (private siding), of a Set attribute. Introduction of a Set attribute to manage link between some parameters. The changes underlined in blue were accepted in the RINF joint group meeting of April 2015 and apply in the RINF CUI available for test in ERA environment and "production" from ERA website. The changes underlined in green were accepted in the RINF joint group meeting of April 2015. The dates of application are indicated in corresponding footnotes. The file with track changes since 16/12/2014 presenting the differences with version 1.0 is available on ERA extranet.
Guide Version 1.2 7/04/2016	ERA-IU		**This version is the basis of the iteration 2 of release 1.1.1** available on ERA website since end of March 2016. Cleaning up of previous modifications left visible. Deletion or Update of some parameters format. The list of modifications to the previous version of the guide is available in 4.4 "List of amendments".
Guide Version 1.2.1 19/01/2017	ERA-IU		**This version of the guide corresponds to the RINF currently available (RINF CUI File version 1.3).** Correction of Inconsistences with the CUI in production. Cleaning up when relevant. Modification of format of parameter 1.1.1.3.7.11 "SOL Track Parameter CTD_MinAxleLoad". Update using the new format. The list of modifications to the previous version of the guide is available in 4.4 "List of amendments".
Guide Version 1.2.2 20/06/2018	ERA-IU		**This version of the guide corresponds to the RINF currently available (RINF CUI File version 1.3.4).** The list of modifications to the previous version of the guide is available in 4.4 "List of amendments".
Draft Guide Version 1.4 19/03/2019	ERA AAM		**Update according draft new RINF regulation (19/03/2019).** **To support the feedback of users before official publication.**
Draft Guide Version 1.4.2 04/04/2019	ERA AAM		**Update according to comments received on Draft Guide Version 1.4.2 (04/04/2019) (listed in 5.6 / table 9).**
Draft Guide Version 1.4.3 21/06/2019	ERA AAM		**Update according to comments received on previous Draft Guide Versions (listed in 5.6 / table 9).**

Table 1: Status of the document.

Version Date	Author(s)	Section Number	Modification Description
Guide Version 1.5 29/07/2019	ERA AAM		Update, main modifications listed in 5.7List of amendments to Guide Version 1.4.3 (table 10).
Guide Version 1.5.2.1 17/02/2020	ERA AAM		Modifications listed in 5.8, Table 12.
Guide Version 1.5.2.2 30/06/2020	ERA AAM		Modifications listed in 5.8, Table 13.
Guide Version 1.5.2.3 15/10/2020	ERA AAM		Modifications listed in 5.8, Table 14.
Guide Version 1.5.2.4 30/03/2021	ERA EXO		Modifications listed in 5.8, Table 15.
Guide Version 1.5.2.5 17/06/2021	ERA EXO		Modifications listed in 5.8, Table 16.
Guide Version 1.5.2.6 25/10/2021	ERA EXO		Modifications listed in 5.8, Table 17.
Guide Version 1.6.0 17/06/2022	ERA EXO		Update, modifications listed in 5.9, Table 18.
Guide Version 1.6.1 24/02/2023	ERA EXO		Modifications listed in 5.9, Table 19.
Guide version 3.1.0 31/03/2025	ERA OPD	All	This version corresponds to the RINF Regulation amendment EC Implementing Regulation (EU) 2023/1694 of 10 August 2023

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1. SCOPE OF THIS GUIDE

1.1. Scope

This document provides information on the application of the common specifications for the register of railway infrastructure as referred to in the Interoperability Directive [4], Art. 49(5).

This document does not introduce any new legally binding advice. It serves as a clarification tool for legal documents issued for RINF without however dictating in any manner compulsory procedures to be followed and without establishing any legally binding practice.

The guide needs to be read and used only in conjunction with the RINF Regulation **and the Technical Annex of this guide.** It is intended to facilitate the application of the regulation, but it does not substitute it.

The guide is publicly available and it will be regularly updated to reflect progress related to system evolution and to changes of the TSIs and European standards. The reader should refer to the website of the ERA for information about its latest available edition.

2. Content of the guide

This Guide is the basic document for all participants of the process of building RINF on a European scale:

- the infrastructure managers (IMs) – collect and submit the data of their respective networks for publication into RINF, ensuring the accuracy, completeness, consistency and timeliness of the submitted data
- the national registration entities (NREs) – which may be designated by the Member States to act as point of contact between ERA and the infrastructure managers in the view of assisting and coordinating the infrastructure managers of their territory, provided that this does not put at risk the availability of data in accordance with Article 5 of RINF Regulation.

The target audience of this guide is not limited to data providers only. Its content is relevant for other stakeholders in the railway sector, not designated as data providers (i.e. mainly railway undertakings, vehicle keepers, applicants for safety authorisations, etc.), ensuring that all parties have a clear understanding of the content of RINF and its related use cases.

The guide delivers the extended definitions of all the objects and parameters of the RINF. It provides guidance on the most common situations and solutions advised for modelling the railway network.

Examples and variety of possible solutions should support and unify constructions of registers of different MS of the EU.

This guide also delivers wide description of parameters, including their format, utility and explanation.

The instructions for use of the RINF via access to RINF application are published as User Manual of RINF application – they are not included in this guide.

2.1. Reference documents

Table 2: Reference documents

Ref.	Document Reference	Official Journal	Last Modification	Version/ Comment	Acronym
[1]	Commission implementing Decision 2011/633/EU of 15 September 2011 on the common specifications of the register of railway infrastructure	L 256, 1.10.2011	15.09.2011	repealed	
[2]	Commission implementing Regulation (EU) 2019/773 of 16 May 2019 on the technical specification for interoperability relating to the operation and traffic management subsystem of the rail system within the European Union and repealing Decision 2012/757/EU	LI 139/5	10.08.2023		OPE TSI/TSI OPE
[3]	Directive (EU) 2016/798 of the European Parliament and of the Council of 11 May 2016 on railway safety (recast)	L 138/102	23.10.2020		Safety Directive
[4]	Directive 2016/797 of the European Parliament and of the Council of 11 May 2016 on the interoperability of the rail system within the European Union (recast) amended by Directive (EU) 2020/700 of the European Parliament and of the Council of 25 May 2020	L 165/27, 27.05.2020	27.05.2020		Interoperability Directive, IOD
[5]	Commission Implementing Regulation (EU) 2023/1695 of 10 August 2023 on the technical specification for interoperability relating to the control-command and signalling subsystems of the rail system in the European Union and repealing Regulation (EU) 2016/919 (Text with EEA relevance)	L 222/380, 8.9.2023			CCS TSI
[6]	Regulation (EU) No 913/2010 of the European Parliament and the Council of 22 September 2010 concerning a European rail network for competitive freight.	OJ L 276, 20.10.2010	13.06.2024		

Table 2: Reference documents

Ref.	Document Reference	Official Journal	Last Modification	Version/ Comment	Acronym
[7]	Document 'Interfaces between CCS trackside and other subsystems' referenced as Index 77 in the list of mandatory specifications (Annex A) of the revised CCS TSI for HS and CR adopted by a Commission Implementing Decision (EU) 2019/776	27/05/2019	2023	ERA/ERTMS/033281 V5.0	
[8]	List of CSS Class B systems	27/05/2019	11/06/2019	ERA_TD_2011-11	
[9]	Decision 2008/232/EC TSI relating to the Rolling Stock subsystem of the trans-European HS rail system	L 84, 26.03.2008	23.07.2012	Commission Decisions 2008/232/EC and 2011/291/EU are repealed	HS RS TSI
[10]	Decision 2011/229/EU TSI "Rolling stock – noise"	L 99, 13.02.2011	23.07.2012	repealed	
[11]	Commission Regulation (EU) No. 321/2013 of March 2013 TSI Freight Wagons	L 104, 12.04.2013	10.08.2023		WAG TSI
[12]	Decision 2011/275/EU TSI relating to the infrastructure subsystem of the trans-European conventional rail system	14.05.2011		Decisions 2008/217/EC and 2011/275/EU are repealed with effect from 1 January 2015.	CR INF TSI
[13]	Decision 2008/217/EC TSI relating to the Infrastructure subsystem of the trans-European HS rail system	L 77, 19.03.2008		Decisions 2008/217/EC and 2011/275/EU are repealed with effect from 1 January 2015.	HS INF TSI
[14]	Regulation 62/2006/EC TSI "Telematics Applications for Freight"	L 13, 18.01.2006	Regulation 280/2013 22.03.2013	repealed	
[15]					

Table 2: Reference documents

Ref. Document Reference	Official Journal	Last Modification	Version/ Comment	Acronym
[16] Decision 2011/291/EU TSI LOC&PAS of the trans-European conventional rail system	L139, 26.05.2011	23.07.2012	Commission Decisions 2008/232/EC and 2011/291/EU are repealed	CR LOC&PAS TSI
[17] Decision 2008/284/EC TSI Energy trans-European HS rail system	L 104, 14.04.2008	Decision 2012/464/EU	Decisions 2008/284/EC and 2011/274/EU are repealed with effect from 1 January 2015.	HS ENE TSI
[18] Commission Regulation (EU) No 454/2011 of 5 May 2011 on the technical specification for interoperability relating to the subsystem 'telematics applications for passenger services' of the trans-European rail system.	L 123, 12.05.2011	16.05.2019		TAP TSI
[19] Decision 2008/163/EC TSI SRT trans-European HS and conv. rail system	L 64, 07.03.2008		Repealed with effect from 1 January 2015.	
[20]				
[21] Framework Mandate to the European Railway Agency for the Performance of Certain Activities under Directives 96/48/EC and 2001/16/EC				
[22] Commission Recommendation 2014/881/EU of 18 November 2014 on the procedure for demonstrating the level of compliance of existing railway lines with the basic parameters of the technical specifications for interoperability	L 356 12.12.2014			
[23] ERA Document about practical arrangements for transmitting interoperability document (ERA/INF/10-2009/INT)	NA	27.08.2009	Version 0.1	

Table 2: Reference documents

Ref. Document Reference	Official Journal	Last Modification	Version/ Comment	Acronym
[24] Regulation (EU) No 1315/2013 of the European Parliament and of the Council of 11 December 2013 on Union guidelines for the development of the trans-European transport network and repealing Decision No 661/2010/EU	L 348/1, 20.12.2013		Repealed by Regulation (EU) 2024/1679 of 13 June 2024	
[25] RINF XML Data Validation Guide			ERA Document	
[26] Commission Implementing Decision 2014/880/EU of 26 November 2014 on the common specifications of the register of railway infrastructure and repealing Implementing Decision 2011/633/EU	L 356 12.12.2014		Repealed by Commission Implementing Regulation (EU) 2019/777 of 16 May 2019	RINF Decision
[27] Commission Regulation (EU) No 1299/2014 of 18 November 2014 on the technical specifications for interoperability relating to the 'infrastructure' subsystem of the rail system in the European Union	L 356 12.12.2014	10.08.2023		INF TSI
[28] Commission Regulation (EU) No 1301/2014 of 18 November 2014 on the technical specifications for interoperability relating to the 'energy' subsystem of the rail system in the Union	L 356 12.12.2014	10.08.2023		ENE TSI
[29] Commission Regulation (EU) No 1300/2014 of 18 November 2014 on the technical specifications for interoperability relating to accessibility of the Union's rail system for persons with disabilities and persons with reduced mobility	L 356 12.12.2014	10.08.2023		PRM TSI
[30] Commission Regulation (EU) No 1302/2014 of 18 November 2014 concerning a technical specification for interoperability relating to the 'rolling stock — locomotives and passenger rolling stock' subsystem of the rail system in the European Union	L 356 12.12.2014	10.08.2023		LOC&PAS TSI

Table 2: Reference documents

Ref. Document Reference	Official Journal	Last Modification	Version/ Comment	Acronym
[31] Commission Regulation (EU) No 1303/2014 of 18 November 2014 concerning the technical specification for interoperability relating to 'safety in railway tunnels' of the rail system of the European Union	L 356 12.12.2014	08.01.2024		SRT TSI
~~[32] Draft Commission Decision amending Commission Decision 2012/88/EU on the technical specification for interoperability relating to the control-command and signalling subsystems of the trans-European rail system~~			~~pending publication~~	
[33] Commission Regulation (EU) No 1305/2014 of 11 December 2014 on the technical specification for interoperability relating to the telematics applications for freight subsystem of the rail system in the European Union and repealing the Regulation (EC) No 62/2006	L 356 12.12.2014		repealed	TSI TAF
[34] Directive 2012/34/EU of the European Parliament and of the Council of 21 November 2014 establishing a single European railway area	L 343/32, 14.12.2012			
[35] Regulation n° 1304/2014 of 26 November 2014 on the technical specification for interoperability relating to the subsystem 'rolling stock — noise' amending Decision 2008/232/EC and repealing Decision 2011/229/EU amended by Commission Regulation (EU) 2019/774 of 16 May 2019	L 356 12.12.2014	10.08.2023		TSI NOI
[36] COMMISSION IMPLEMENTING REGULATION (EU) 2019/777 of 16 May 2019 on the common specifications for the register of railway infrastructure and repealing Implementing Decision 2014/880/EU, amended by COMMISSION IMPLEMENTING REGULATION (EU) 2023/1694 of 10 August 2023	L222/88 08.09.2023	10.08.2023		RINF Regulation
[37] COMMISSION REGULATION (EU) No 1305/2014 of 11 December 2014 on the technical	L 108/19			TAF TSI

Table 2: Reference documents

Ref.	Document Reference	Official Journal	Last Modification	Version/ Comment	Acronym
	specification for interoperability relating to the telematics applications for freight subsystem of the rail system in the European Union as amended by Commission Implementing Regulation (EU) 2021/541 of 26 March 2021	29.3.2021			
[38]	Commission Implementing Regulation (EU) 2023/1694 of 10 August 2023 amending Regulations (EU) No 321/2013, (EU) No 1299/2014, (EU) No 1300/2014, (EU) No 1301/2014, (EU) No 1302/2014, (EU) No 1304/2014 and Implementing Regulation (EU) 2019/777	L 222/88 8.9.2023			

2.2. Definitions of expressions, abbreviations and acronyms

2.2.1. Specific definitions

This section provides general definitions. The following table provides a list of terms used in this guide and their definitions. Mainly these terms have been already defined in the relevant legal documents; in these cases the source of the definition is indicated.

Table 3: Definitions

Term	**Definition/ Source**
Basic parameter	*Any regulatory, technical or operational condition which is critical to interoperability and is specified in the relevant TSIs*. (Article 2 (12) of Directive EU/2016/797)
Conformity	According to Article R1 (12), Annex 1 of Decision 768/2008/EC it corresponds to the fulfilment of specified requirements by a product, process, service, system, person or body.
Conformity assessment	... *the process demonstrating whether specified requirements relating to a product, process, service, subsystem, person or body have been fulfilled*. (Article 2(41) of Directive EU/2016/797)
Conformity assessment body (ERA Ontology ref.)	*…a body that has been notified or designated to be responsible for conformity assessment activities, including calibration, testing, certification and inspection; a conformity assessment body is classified as a 'notified body' following notification by a Member State; a conformity assessment body is classified as a 'designated body' following designation by a Member State.* (Article 2(42) of Directive EU/2016/797)
Infrastructure Manager (ERA Ontology ref.)	... any body or firm responsible for the operation, maintenance and renewal of railway infrastructure on a network, as well as responsible for participating in its development as determined by the Member State within the framework of its general policy on development and financing of infrastructure; (Article 3 (2) of Directive 2012/34/EU of the European Parliament and of the Council establishing a single European railway area)
National Registration Entity	*Entity which might be designated by MSs to act as point of contact between ERA and the infrastructure managers in the view of assisting and coordinating the infrastructure managers of their territory, provided that this does not put at risk the availability of data in accordance with Article 4 of RINF Regulation.*
National Safety Authority	*(a) the national body entrusted with the tasks regarding railway safety in accordance with this Directive;* *(b) any body entrusted by several Member States with the tasks referred to in point (a) in order to ensure a unified safety regime;* *(c) any body entrusted by a Member State and a third country with the tasks referred to in point (a) in order to ensure a unified safety regime, provided that the Union has concluded an agreement to this effect with the third country concerned or that that Member State has concluded such agreement in accordance with an empowerment granted by the Union to that effect; (Article 3(7) of Directive EU/2016/798)*
Notified body (ERA Ontology ref.)	See: Conformity Assessment Body

Table 3: Definitions

Term	Definition/ Source
Open point	According to Article 4(6) of Directive EU/2016/797, when "...*certain technical aspects corresponding to the essential requirements cannot be explicitly covered in a TSI, they shall be clearly identified in an annex to the TSI as open points...*"
Placing in service	*...all the operations by which a subsystem is put into its design operating state*. (Article 2 (19) of Directive EU/2016/797)
Railway Undertaking (ERA Ontology ref.)	... *a railway undertaking as defined in point (1) of Article 3 of Directive 2012/34/EU, and any other public or private undertaking, the activity of which is to provide transport of goods and/or passengers by rail on the basis that the undertaking is to ensure traction; this also includes undertakings which provide traction only*. (Article 2(45) of Directive EU/2016/797)
Register of Infrastructure (RINF)	The Register of Infrastructure referred to in Article 49 of Directive EU/2016/797 *states the values of the network parameters of each subsystem or part subsystem concerned, as set out in the relevant TSI* and *may stipulate conditions for the use of fixed installations and other restrictions*. The *values of the parameters recorded in the register of infrastructure shall be used in combination with the values of the parameters recorded in the vehicle authorisation for placing on the market to check the technical compatibility between vehicle and network*.
Specific case	... *any part of the rail system which needs special provisions in the TSIs, either temporary or permanent, because of geographical, topographical or urban environment constraints or those affecting compatibility with the existing system, in particular railway lines and networks isolated from the rest of the Union, the loading gauge, the track gauge or space between the tracks and vehicles strictly intended for local, regional or historical use, as well as vehicles originating from or destined for third countries*. (Article 2 (13) of Directive (EU) 2016/797)

2.2.2. Abbreviations and acronyms

Table 4a: Abbreviations and acronyms

ABBREVIATION / ACRONYMS	FULL TEXT
AC	Alternating Current
ADD	Automatic Dropping Device
AWS	Amazon Web Service
CCS	Command Control and Signalling (Trackside, in the context of this document[1])
CEN	European Committee for Standardisation (Comité Européen de Normalisation
CENELEC	European Committee for ELECtrotechnical Standardisation (Comité Européen de Normalisation ELECtrotechnique)
CR	Conventional Rail
DC	Direct Current
DeBo	Designated Body
EC	European Commission
EDOR	ERTMS Data Only Radio (modem)
EEA	European Economic Area
EEC	European Economic Community
EIRENE	European Integrated Radio Enhanced NEtwork
EN	European standard
ENE	Energy
ERA	European Union Agency for Railways, also called “the Agency”
ERADIS	European Union Agency for Railways, Database of Interoperability and Safety
ERATV	European Register of Authorised Types of Vehicles
ERTMS	European Rail Traffic Management System
ETCS	European Train Control System
ETS	European Telecommunications Standard
EU	European Union
FRMCS	Future Railway Mobile Communication System
FRS	Functional Requirements Specification of ERTMS
GPRS	General Package Radio Service
GPS	Global Positioning System
GSM-R	Global System for Mobile communications- Railway
GUI	Graphical User Interface
HS	High Speed
IC	Interoperability Constituent
IM	Infrastructure Manager
INF	Infrastructure
IOD	Interoperability Directive
ISO	International Organisation for Standardisation
KG	Knowledge Graph
LM	Location Marker
LP	Location Point
MS	EU or EEA Member State

[1] *Unless otherwise stated, the CCS subsystem concerns the trackside implementation.*

Table 4a: Abbreviations and acronyms

ABBREVIATION / ACRONYMS	FULL TEXT
NAP	Normaal Amsterdams Peil
NID_XUSER	Identity of User Design Authority
NoBo	Notified Body
NB-Rail	Coordination group of Notified Bodies
NRE	National Registration Entity
NSA	National Safety Authority
NTC	National Train Control (system)
NYA	Not Yet Available
OC	Organisation Code
OCL	Overhead Contact Lines
OP	Operational Point
OSRM	Open Source Routing Machine
PRM	Persons with Reduced Mobility
PLC	Primary Location Code
SLC	Subsidiary Location Code
RA	Route Availability
RBC	Radio Block Center
RCC	Route Compatibility Check
RDF	Resource Description Framework
REC	Railway Emergency Call
RFC	Railway Freight Corridor
RINF	Register of Infrastructure
RML	RDF (Resource Description Framework) Mapping Language
RST	Rolling Stock
RTC	ERA Railway Terminology Collection
RU	Railway Undertaking
SD	Safety Directive
SHACL	Shapes Contraint Language
SKOS	Simple Knowledge Organization System
SM	Stop Marker
SoL	Section of Line
SRS	System Requirements Specifications of ERTMS
SRT	Safety in Railway Tunnels
TAF	Telematic Application for freight services
TAP	Telematic Application for passengers services
TEN-T	Trans-European Transport Network
TP	Train Protection
TSI	Technical Specifications for Interoperability
UAT	User Acceptance Testing
UIC	International Union of Railways (Union Internationale des Chemins de fer)
URI	Uniform Resource Identifier
WG	Working Group
WP	Working Party
XML	Extensible Markup Language
XSD	XML Schema Definition

Table 4b: Abbreviations and acronyms used in XML tags

ABBREVIATION / ACRONYMS	FULL TEXT
CBP	Control-Command Brake Parameters
CCD	Control-Command Complaint Detection
CDE	Control-Command Declaration
CEI	Control-Command Electromagnetic Interferences
CLD	Control-Command Line-Side Degraded
COP	Control-Command Other Parameters
CPE	Control-Command Protection ETCS
CPO	Control-Command Protection Other
CRG	Control-Command Radio (GSMR, FRMCS)
CRS	Control-Command Radio System Other
CTD	Control-Command Train Detection
CTS	Control-Command Transition System
ECS	Energy Contact System
EDE	Energy Declaration
EOS	Energy OCL Separation
EPA	Energy Pantograph
IDE	Infrastructure Declaration
HIS	Infrastructure Health and Safety
ILL	Infrastructure Line Layout
ILR	Infrastructure Load Resistance
IPL	Infrastructure Platform
IPP	Infrastructure Performance Parameters
ISC	Infrastructure Switches and Crossings
ITP	Infrastructure Track Parameters
ITS	Infrastructure Train Servicing
ITU	Infrastructure Tunnel

3. CLARIFICATIONS ON THE RINF

3.1. Scope and purpose of the RINF

3.1.1. General scope

The general scope for RINF corresponds to the scope of the Interoperability Directive [4] as implemented by each Member State and shall include the elements of Annex I.1 of IOD.

In this context, Member States may have excluded (copied from Chapter I > Art 1.4 of IOD):

(a) privately owned railway infrastructure, including sidings, used by its owner or by an operator for the purpose of their respective freight activities or for the transport of persons for non-commercial purposes;
(b) infrastructure reserved for a strictly local, historical or touristic use;
(c) light rail infrastructure occasionally used by heavy rail vehicles under the operational conditions of the light rail system, where it is necessary for the purposes of connectivity of those vehicles only.

3.1.2. Technical scope

RINF specifications concern data about the following **structural**, non-mobile **subsystems** of the Union rail system (copied from Annex II, 1.(a) of IOD) :

- infrastructure,
- energy,
- trackside control-command and signalling.

Due to the interface with the three subsystems above to “align locations for infrastructure description with locations used in the Union for information exchange in telematics applications.” ([38] Art. 6 (1)e), the data model also accomodates the following **functional areas** (copied from Annex II, 1.(b) of IOD):

- telematics applications for passenger and freight services.

3.1.3. Purpose

The type of data describing the infrastructure is the functional purpose of the RINF as defined in point 2.2 “Specific requirements for the register of infrastructure” in the Annex of the RINF Regulation.

a) The value of the parameters to be used to check the technical compatibility between vehicle and route are corresponding to “design” values. These values need to be up to date when the design or nominal values evolve (e.g. opening of a new line of a new station, electrification of an existing line, upgrade of the maximal speed of an existing line) to allow a RU to:
   - Develop technical specifications for vehicle design for new or upgraded vehicles;
   - Identifying the vehicles compatible with the planned route/path and its operational conditions;
   - Facilitate the design of rolling stock and the feasibility check of train services.

b) The type of data intended to facilitate the verification of the technical compatibility between a fixed subsystem and the network into which it is incorporated and to monitor the progress of interoperability of railway fixed installations.
c) These values need to be up to date to allow a RU to plan the train composition and to perform the route compatibility check on the attributed route/path before starting the service operation.
d) The information necessary to assist the RUs in building their Route Book. The topological description of RINF is used when relevant to locate infrastructure elements/equipments.

Moreover, in the future developments the RINF will contain all Primary Location Codes (PLC) and Subsidiary Location Codes (SLC) which are needed for the purpose of telematics data exchange as specified in the TAF TSI [37] and TAP TSI [18].

3.2. Out of scope

Until further clarifications from the other TSI working groups,

- for the temporary capacity restrictions the real time communication between the IMs and RUs should be the main communication channel.
- for the issue of the urgent situations, any adequate mean can be used by IMs such as telematic messages or even orally in the field, but the communication mean of emergency situation is not addressed so far in RINF.
- The description of the infrastructure on the so-called nano-level (the level needed to technically design the railway system, while not being in the scope of railway operations), is not in scope of this Guide, as it was not in scope of the TWGs.

3.3. Overview of the ERA Vocabulary/Ontology

The Article 7a introduces a new term in the RINF Regulation text, the ERA Vocabulary, defined as “a Technical Document issued by the Agency pursuant to Article 4(8) of Directive (EU) 2016/797, establishing human and machine readable data definitions and presentations and linked quality and accuracy requirements for each data element (ontology) of the rail system.”

The ERA Vocabulary (also referred to as and from now on ERA Ontology) is a semantic framework mandated under the Article 7a of the RINF Regulation and developed to ensure the harmonisation of railway data representation, in particular for the railway infrastructure data. It provides a structured vocabulary for describing railway assets, their properties, and relationships, ensuring interoperability across systems and it serves as a foundational data model for RINF.

The ERA Ontology covers the full scope of railway infrastructure date required under RINF Regulation, including:

- the core infrastructure elements: tracks, operational points, sections of line, etc.
- the technical parameters: gradient, speed, axle load, energy profiles, train detection systems etc.
- topology representation: net elements and relations between them
- geospatial and temporal metadata: location, positionsing, validity dates

The ERA Ontology incorporates controlled taxonomies using Simple Knowledge Organisation System (SKOS), to standardise terminology and ensure consistent data interpretation. The SKOS concepts represent predefined terms for infrastructure attributes (e.g. types of operational points, types of train detection systems, gauging profiles, categories of line, etc.). It also adheres to Shapes Constraint Language (SHACL) rules to enforce data quality and compliance with the RINF Regulation. Some of the functions that SHACL ensures are:

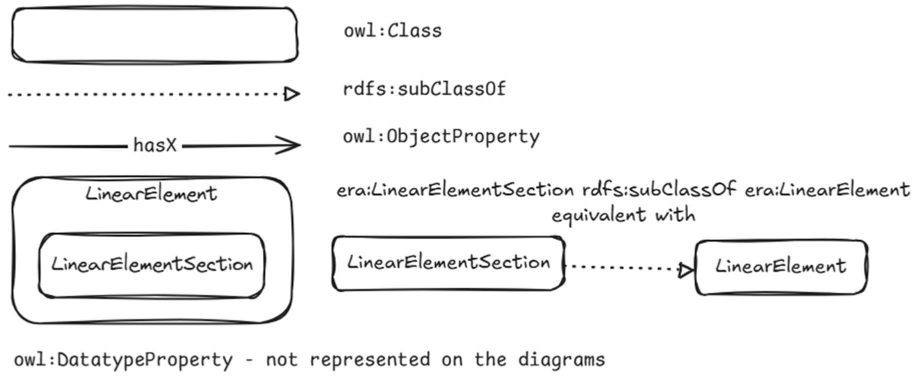
- mandatory parameters from Table 1 are provided
- data types and data formats are correct
- conditional dependencies are respected

To comply with the Article 7a of the RINF Regulation, the data must be structured using RDF and aligned with the ERA Ontology.

3.4. Description of features of the RINF

The list of defined elements of the railway network in the RINF Regulation Annex > point 3.1 resulted in the following elements implemented in the RINF.

To easily read the diagrams along the current document, we are using the following representations:



3.4.1. Logical representation of the relations between infrastructure elements

In the ERA ontology, several concepts are defined for railway elements which are connected as in the figure below:

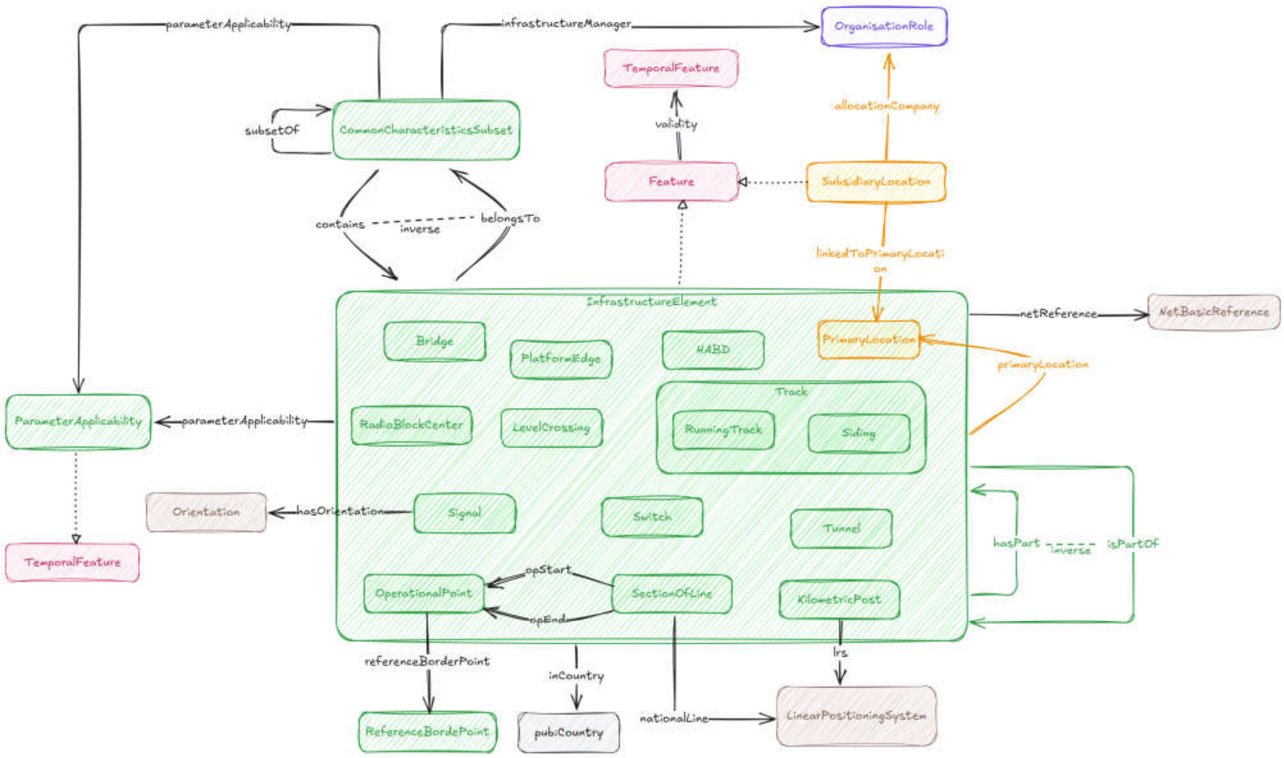


Figure 1 - Logical relations between concepts in the ERA ontology

3.4.1.1. Infrastructure elements

An 'infrastructure element' is a generic term used to refer any physical railway asset or component that is part of the railway system, integral to its operation, safety, and explicitly managed by Infrastructure Managers. The railway system in the scope of this Guide is composed of the non-mobile subsystems as defined under Annex II of the Interoperability Directive.

Examples of infrastructure objects:

- ✓ (INF) Tracks – on which trains run, sections of line
- ✓ (CCS) Signalling system – switches, signals (commonly: trackside CCS)
- ✓ (INF, PRM) Areas where passengers board – stations, platforms
- ✓ (INF) Structures that allow trains to cross obstacles – bridges, tunnels
- ✓ (INF) Crossings where roads intersect with railway tracks – level crossings
- ✓ Maintenance Facilities - Depots, workshops etc. as operational points

3.4.1.2. Running track

A running track means any track used for train service movements; passing loops and meeting loops on plain line or track connections only required for train operation are not published. “Loop” as defined in TSI OPE, Appendix J: "Track, connected to the main track, used for passing, crossing and stabling."

In a station, not only main tracks of a station are ‘Running tracks’ according to RINF, but also all additional tracks where passenger trains stop at platforms or where freight trains over-pass group of tracks with platforms.

3.4.1.3. Bridge

It is a structure constructed for the exclusive purpose of carrying railroad traffic across an obstruction.

Although (especially mobile) bridges are safety critical infrastructure elements, the RINF Regulation does not specifically mention the data needed for describing them. Some cases have been identified where it is needed to have the definition of bridges in order to define non-stopping areas, big metal mass, resistance to traffic load, RCC (resonance waves), etc. Whenever the information about a bridge is not relevant for the operators, the IMs may choose to exclude this information in their RINF data sets.

3.4.1.4. Level crossing

A level crossing is, as defined in Safety Directive [3], any level intersection between a road or passage and a railway, as recognised by the infrastructure manager and open to public or private users. Passages between platforms within stations and passages over tracks for the sole use of employees. The latter part can be optionally provided.

It shall be used for the implementation of the ETCS trackside or to identify potential collision scenarios. If the trackside does not implement any solution to cover defective LXs (which are normally protected by means of a technical system), then drivers will be required to comply with instructions received from other sources.

3.4.1.5. Platform edge

Platform for the purpose of RINF is understood as a platform edge, therefore the platoform identification concerns only the part of the structure neighbouring to the track (interfaced with trains).

In case when normal platform numbering concerns the whole structure between two tracks, the ‘RINF platform’ must be labelled using the platform number and the track ID to which the specific edge belongs.

3.4.1.6. Siding

A siding is regarded as a single/simple track and can be private (not operated by the IM).

Sidings are all those tracks where running trains in service movements ends and which are not used for operational routing of a train. According to RINF, a siding is any track which “delivers support” for the traffic but is not part of managed traffic.

3.4.1.7. Signal

A railway signal to be registered in the RINF must be understood from its context in the TSI OPE, Appendix D.2 (Elements the infrastructure manager has to provide to the railway undertaking for the Route Book), where is mentioned:

- 2.2 Line diagram >> 2.2.3 Location, type and name of all fixed signals relevant for trains
- 2.3 Station/Yard/Depot diagrams >> 2.3.3 Location, type and identification of fixed signals that protect danger points

A Signal in the RINF-context is therefore any installation which can – in a quasi-permanent2 manner – indicate or announce an authority to proceed to the driver. If the information is given indirectly (via the onboard), then (stop/location) marker boards should be registered in RINF, with balise groups as a fall-back. Marker boards different from markers, which are physical, informative indications next to the track and cannot be used for signalling purposes.

When it allows a route through an OP – protected by the interlocking system and operated possibly by a safety procedure -, it must be assigned to that OP. In that case, the question on distance to danger points relates to the concept of Supervised Location.

When it does not permit a route through an OP, but for instance ensures capacity and train inter-distance on a SoL, it must be assigned to a SoL.

Signals – for the purposes in the RINF - can be of type (ERA Railway Terminology Collection, 2024):

- (Group) Intermediate signal: A fixed signal which informs the driver about the state of the next signal.
- (Group) Exit signal: A main signal that is intended for trains leaving a station.
- (Group) Home/Entry signal: A main signal, intended for trains entering a station.
- (Group) Protection signal: A fixed signal protecting safe access to a non-occupied part of a section of line. It can be permissive if a procedure exists to access that part when occupied.

Main signal is defined as a fixed signal intended for train movements capable of showing a 'danger aspect' and one or more 'proceed aspects'. In some cases main signals at danger are valid for shunt movements.

A signal is a Group Signal (any type) if it functions for origins on several tracks, instead of only one. A typical example of a group exit signal is the signal controlling exit of a shunting yard, each track mostly having an intermediate signal.

3.4.1.8. Switch

A switch, as defined in INF TSI [27] (Appendix S, Table 48), is a unit of track comprising two fixed rails (stock rails) and two movable rails (switch rails) used to direct vehicles from one track to another track.

A switch has a unique code within the area of the rail-network managed by an infrastructure manager.

[2] *Coloured warning or stopping flags are not in RINF, as are moving block EoMA's. The authority should be considered delivered by a system attaining a sufficient safety integrity level.*

A switch can be operated left to right leading or vice versa manually or by means of a (group of) electrical controlled point machine(s) or by a point machine with hand crank.

To geographically locate a switch, the beginning of the movable tongue (blade near the point machine) can be used. Geographical information for the switches is not required, but the data model allows volonteers to include it.

3.4.1.9. Tunnel

A railway tunnel, as defined in SRT TSI [31], is an excavation or a construction around the track provided to allow the railway to pass for example higher land, buildings or water. The length of a tunnel is defined as the length of the fully enclosed section, measured at rail level. A tunnel in the context of the TSI SRT is 0.1km or longer.

'Tunnel' is understood in RINF as the special area of the track with special conditions, and it is a separate entity from the tracks passing through it. So, parameters concerning a tunnel are associated with the tunnel itself, rather than being duplicated for each track.

3.4.1.10. Hot Axle Box detector

Hot axle box detection is a "Route compatibility check interface" in App.D1 OPE-TSI (Parameters for the vehicle and train compatibility over the route intended for operation).

Hot box/hot wheel detection systems are used to detect the heat emission of a bearing shortly before failure due to overheating, but not to predict foreseeable hazards.

The location of hot axle box detection equipment shall be shown in the route book, where the signals associated with this equipment shall also be shown

3.4.1.11. Railway (national) lines or routes

Railway line or route operated within a Member State.

A line or route is a sequence of one or more sections of line, which connects operational points.

A national railway line or route is thus a connection between two locations within a Member State and identified on its entire length by an administrative identifier provided by the competent national authority. In some countries, lines are numbered, in others they are given the locality names of start and end points. Other naming conventions may exist.

3.4.1.12. Operational points

An operational point (OP) means any location for train service operations, where train services may begin and end or change route, and where passenger or freight services may be provided; operational point also means any location at boundaries between Member States or infrastructure managers.

To ensure the precise identification and positioning of the operational points, they are represented both geographical (spatial) and geometrical (topological)

On a global (GIS) map, an operational Point is understood as a point without dimensions, attributed with generic parameters and with objects described by their own parameters. The OP is independent from the notion of line. An OP is not described by belonging to one or several lines. Only SoLs are linked to lines.

An OP will be presented by so called 'centre point' on a global map. This centre point is defined by the IM providing the data (note that it is not always in the centre of the OP area) and determines the geographical coordinates (and the kilometre from the start of the railway line) of OP.

For the purpose of the RINF, the following types of OPs have been defined:

1. Station – large or major railway node with several functions, important for international traffic, basic for national railway system;
2. Passenger terminal – station with dominating function of service for passenger traffic, serving as a central hub for passengers, often integrating rail operations with intermodal transport networks and large-scale passenger facilities, including ticketing, waiting areas, and other passenger services;
3. Freight terminal – station dominantly serving for loading and unloading of freight trains;
4. Depot or workshop – group of tracks used by depot or workshop for rolling stock maintenance;
5. Train technical services – group of tracks for servicing trains (parking, washing, etc.);
6. Passenger stop – or halts – small OP consisting of at least one platform, normally serving mostly for local passenger services, without routing, dispatching, or train management facilities;
7. Junction – OP consisting of at least one turnout, normally used mostly for changing direction of trains, with reduced or not existing other functions;
8. Border point – located in the point where a border between MSs meets a railway line;
9. Shunting yard – group of tracks used for shunting trains, mostly related to freight traffic;
10. Switch - OP consisting of only one switch and the area around it delimited and protected by entry signals, normally used for changing direction of trains, with reduced or not existing other functions;
11. Domestic border point – designated location on the main lines where the infrastructure responsibilities transition between IMs.

Principles:

For the implementation of the RINF Regulation and the needs of the 4th Railway Package, RINF should display every operational point allowing to describe a route corresponding to a service operated by a RU. Moreover, as defined by RINF Regulation " 'operational point'(OP) means any location for train service operations, where train services may begin and end or change route and where passenger or freight services may be provided; it includes locations at boundaries between Member States or infrastructure managers;".

In parallel, the implementation of the TAF/TAP TSIs has promoted the definition of Primary Location Codes (PLC) and Subsidiary Location Codes (SLC) . Primary locations are considered distinct infrastructure elements which may be in the railway network area of an operational point, or located along a section of line. In consequence, primary locations will be related to either operational points or sections of line.

Provision of subsidiary locations is not required by the RINF Regulation, it is available in the ERA Ontology and can be stored in RINF on a voluntary basis and therefore some explanations follow in paragraph 3.4.1.17.

As a conclusion,

- Regarding OP type "Border point"
  For these OPs between two MS, bilateral agreements have to be achieved concerning name and their location. The list of borders points is agreed between IMs and managed by the Agency. The list is in 5.2. Any changes to the data in this list must be requested from the Agency by the IM or nominated NRE responsible for the network where the border point is located and managed.
- Regarding OP type "Domestic border point"
  It is Located exactly in the point where a border between IMs meets a railway line. Their OP ID and other attributes is managed by agreement between the concerned neighbouring infrastructure managers.
  It is necessary to use the correct OP ID to ensure the continuity of the network. Specific problems may be met in case of large stations or nodes. Then IM may divide such station into several OPs with different types.

It could be useful to take in account of the existence of "PrimaryLocation Codes" already defined for the use of the TAP/TAF TSIs before defining OP for the RINF needs.

It is mandatory to select OP "Border point".

Fig 3. Below provides an example of Border points between three MS.

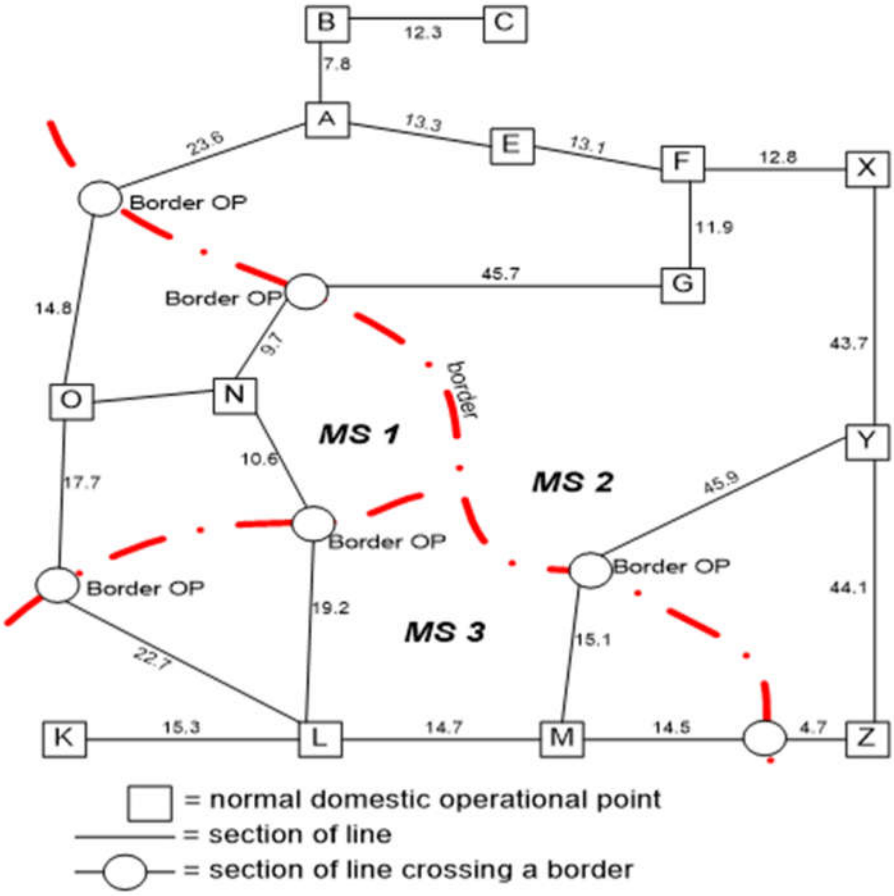


Figure 2 - International macro railway network with SoL lengths (D. KES)

The same type of agreements will have to be achieved at national level in order to determinate the border points between several IMs and to be able to merge several datasets in a single national one.

3.4.1.13. Sections of line

A section of line means the part of line between adjacent operational points and may consist of several tracks and trackside elements.

A line is a continuous chain of sections of lines and operational points when except beginning and end of a line, the OP at end of a SoL is the OP at start of consecutive SoL.

A single SoL may be settled to be a line at its own. As each SoL is described separately, number of tracks and values of related parameters may be different on different SoL of the same line.

A section of line may be part of only one national railway line.

It is important to underline that in one SoL may be included tracks only of the same line. When two different lines are running in parallel – passing by the same OPs - data on tracks of each line has to be published in two separate SoLs.

The topological representation of the OPs at the ends of a section of line ensures the track connectivity and a consistent geographical representation of the network with OPs and SOLs.

SoL which is a single track connecting two OPs within a big node (when this big node has been divided into several OPs) has a reduced set of parameters. Such track is indicated as 'Link' in parameter 1.1.0.0.0.6 'Nature of Section of Line'. Only the group 1.1.0.0.0 'Generic information' must be completed.

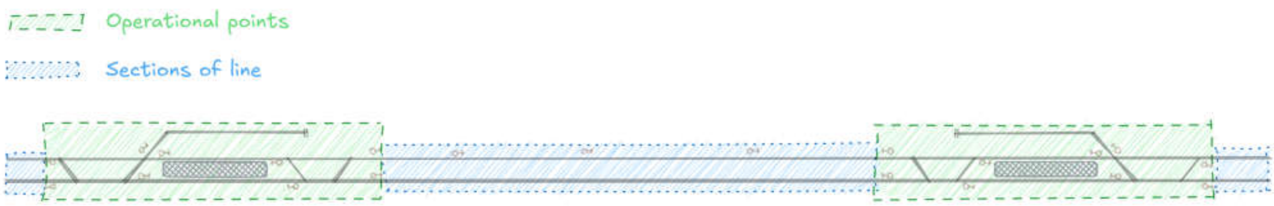


Figure 3 - Section of Line (SoL) between two Operational Points (OP)

In the above image, the grean area covers the scope of the OP parameters and other OP composing infrastructure elements (e.g. tracks, sidings, platforms, signals, etc.) parameters, while the blue area represent the scope of the section of lines and the underlying infrastructure element with their technical characteristics.

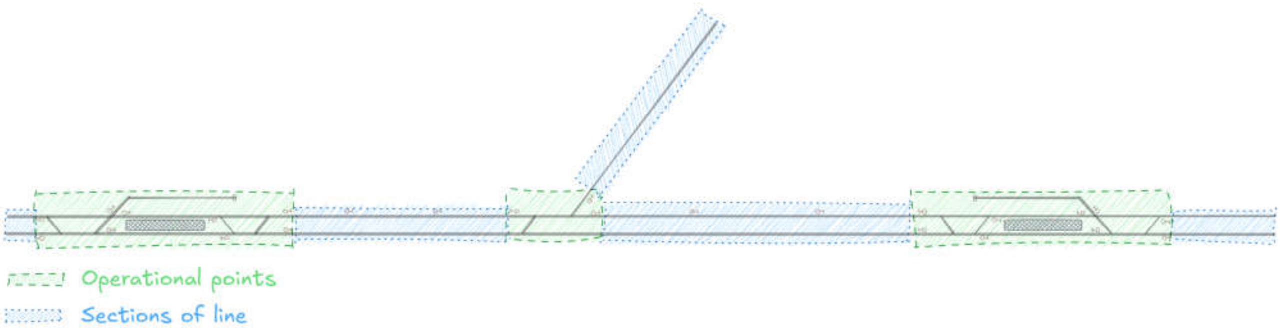


Figure 4 - Demarcation of operational points and sections of line

3.4.1.14. Radio Block Center (RBC)

An RBC is a centralised safety unit that receives train position information via radio and sends movement authorities via radio to trains, hence controlling ETCS train movements within its area of control.

In the ERA ontology an era:RadioBlockCenter is classified as an `era:InfrastructureElement` and it may consist of multiple tracks (`era:hasPart` property).

The operating area of an RBC are all the tracks, which are supervised by this RBC. Tracks on which the RBC hand-over is foreseen, should be linked to by both RBCs and could link to the two controlling RBC's. The exact handover location is not encoded in RINF.

When requested by the ETCS on-board, the driver shall enter, re-enter or re-validate the driver identification, the train running number, the ETCS level, the radio network identification and the RBC identification and phone number.

An RBC is described by:

- Identification number (era:rbcID)
- Phone number (era:rbcPhone)

The area supervised by the RBC are all the tracks where parameter 1.1.1.3.2.1 (ETCS Level) is set as '2' and needs not be filled in elsewhere.

3.4.1.15. Signal(s) grid

The use of this infrastructure element is **optional.**

Signals Grid is (part of) an operational point in which basic subsystem functions are realized by a group of infrastructure elements belonging together from an operational or technical standpoint.

Example: some switches and signals in a grid are controlled together by the interlocking during normal operation. Grouping these together may provide business continuity information.

Example: within the operational point, some electrified tracks are fed through separate catenary feeders than others. Grouping these together adds relevant operational information in the case of works or disturbances on those grids.

3.4.1.16. Primary location

Primary Location is a place used by IM to define a path for a train in TAF/TAP TSI framework/messages. This location is a rail point inside the rail network where train starts, ends, stops, or runs through or change line. This location must be managed by an Infrastructure Manager (IM) identified by their organisation code.

Primary locations are for example: stations, yards, halts, handover points, border points, open access terminals.

Primary locations are identified by single and unique Primary Location codes. Primary location code is allocated based on processes defined by national entity. Primary location codes are used in any kind of TAF/TAP communication.[3]

Primary locations are considered distinct infrastructure elements which may be in the railway network area of an operational point, or located along a section of line. In consequence, primary locations will be related to either operational points or sections of line.

[3] Sector Handbook for the Communication between Railway Undertakings and Infrastructure Managers 9.3.3 / page 71

3.4.1.17. Subsidiary location

Subsidiary location must be linked to a Primary Location and specifies in more detailed way part, attributes, or usage of Primary location. It may be also a non-rail point or a rail point that is not managed by an Infrastructure Manager (IM). It may be defined by entity having company code according to their needs. The Subsidiary location is optional and dependent upon business needs.4

There are Subsidiary locations that are important for RU/IM communication as specifying part of Primary location e.g. from timetable construction point of view (like Track, Platform, Signal, etc.). These Subsidiary locations to be coded by responsible IM to ensure clarity. Additional Subsidiary locations are for example: Loading Points, Switches, Buildings, Border Point Codes, etc.

The Subsidiary location is identified by a subsidiary location code. Subsidiary location and subsidiary location codes can be used in data communication among involved parties based on company agreement or Network Statement. Each Subsidiary location is attributed to allocating company based on company code. It has to be used always in addition to the primary location code of the Primary location, in which the Subsidiary location is situated or which it refers to.

Provision of secondary locations is not required by the RINF Regulation, it remains available on a voluntary basis.

3.4.2. Subset of elements with common technical characteristics

Multiple infrastructure elements often share the same technical characteristics. Whenever there are technical characteristics shared by several infrastructure objects, RINF allows grouping such elements into subsets, to reduce redundancy and to ensure consistency.

The relational diagram would be the following:

[4] Sector Handbook for the Communication between Railway Undertakings and Infrastructure Managers 9.3.3 / page 72

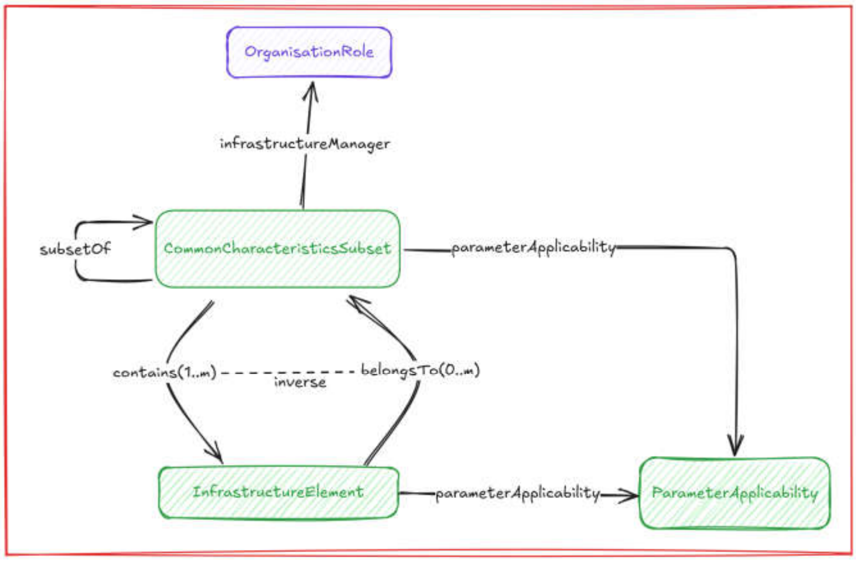


Figure 5 - Subset of elements with common characteristics

An example of RDF Turtle serialization during data provision:

```
@prefix era: <http://data.europa.eu/949/> .
@prefix era-categ: <http://data.europa.eu/949/concepts/line-category/rinf/> .
@prefix era-cls: <http://data.europa.eu/949/concepts/contact-line-systems/rinf/> .
@prefix era-ten: <http://data.europa.eu/949/concepts/ten-classification/rinf/> .
@prefix era-gauge: <http://data.europa.eu/949/concepts/nominal-track-gauges/rinf/> .
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@prefix xsd: <http://www.w3.org/2001/XMLSchema#> .
@prefix ex: <http://example.org/ns/> .


ex:track1 a era:Track, era:InfrastructureElement;
    rdfs:label "test track 1";
    era:belongsTo era:similarTracks .

ex:similarTracks a era:CommonCharacteristicsSubset;
    era:lineCategory era-categ:10;
    era:wheelsetGauge era-gauge:30;
    era:tenClasification era-ten:30;
    era:maximumPermittedSpeed "250"^^xsd:double;
    era:contactLineSystem [a era:ContactLineSystem;
                                era:contactLineSystemType era-cls:10 ] .
```

The `era:belongsTo` property of an infrastructure element is not limited to only one instance of a subset of common characteristics. This property is optional if there is no instance of the subset with common characteristics, or if the infrastructure element has a particular description which cannot be found in any of the common characteristics defined. There is an inconsistency if the combined set of technical characteristics is not in accordance with the full validation of the object.

An equivalent serialization of the same example abote in RDF/XML is displayed below:

```
<?xml version="1.0" encoding="utf-8" ?>
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
         xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
         xmlns:era="http://data.europa.eu/949/">

  <rdf:Description rdf:about="http://example.org/ns/track1">
    <rdf:type rdf:resource="http://data.europa.eu/949/Track"/>
    <rdf:type rdf:resource="http://data.europa.eu/949/InfrastructureElement"/>
    <rdfs:label>test track 1</rdfs:label>
    <era:belongsTo rdf:resource="http://data.europa.eu/949/similarTracks"/>
  </rdf:Description>

  <era:CommonCharacteristicsSubset rdf:about="http://example.org/ns/similarTracks">
    <era:lineCategory rdf:resource="http://data.europa.eu/949/concepts/line-category/rinf/10"/>
    <era:wheelsetGauge rdf:resource="http://data.europa.eu/949/concepts/nominal-track-gauges/rinf/30
"/>
    <era:tenClasification rdf:resource="http://data.europa.eu/949/concepts/ten-classification/rinf/3
0"/>
    <era:maximumPermittedSpeed rdf:datatype="http://www.w3.org/2001/XMLSchema#double">250</era:maxim
umPermittedSpeed>
    <era:contactLineSystem>
      <era:ContactLineSystem>
        <era:contactLineSystemType rdf:resource="http://data.europa.eu/949/concepts/contact-line-sys
tems/rinf/10"/>
      </era:ContactLineSystem>
    </era:contactLineSystem>
  </era:CommonCharacteristicsSubset>
</rdf:RDF>
```

3.4.3. *Infrastructure elements composition*

The railway infrastructure is composed of multiple interconnected elements, creating a hierarchical structure where some elements are made up of related components. An infrastructure element can be an independent entity like track, platform, signal, etc., or can be composed of other elements (e.g., a station that includes tracks, platforms, or signals). The inverse is also applicable, an infrastructure element can be a component of a larger structure (e.g., a switch can be a part of a station or of a section of line).

To maintain a meaningful data representation, the following 2 properties are used:

- `era:hasPart` – to define that one infrastructure element is composed of another
- `era:isPartOf` – the inverse relationship, indicating that an element belongs (fully or partially) to another larger element.

Examples:

❖ A station may contain several tracks, platforms, and signals

```
era:OP_Station_X era:hasPart era:Track_1
era:OP_Station_X era:hasPart era:Platform_1
era:Track_2 era:isPartOf era:OP_Station_X
```

❖ A section of line may include multiple tracks or other specific elements

```
ex:SoL_25 era:hasPart ex:Track_4
ex:SoL_25 era:hasPart ex:LevelCrossing_7
```

❖ A Radio Block Center (RBC) may be responsible for multiple sections of line.

```
ex:RBC_A era:hasPart ex:SoL_12
ex:SoL_12 era:isPartOf ex:RBC_A
```

3.4.4. *Reuse of external ontologies*

The ERA ontology reuses some concepts already defined in external ontologies to define functionalities like:

- Temporal characteristics (validity dates and applicability periods)
- Geographical representation of items derived from the era:Feature class
- Unique references for the organisations (infrastructure manager for RINF).

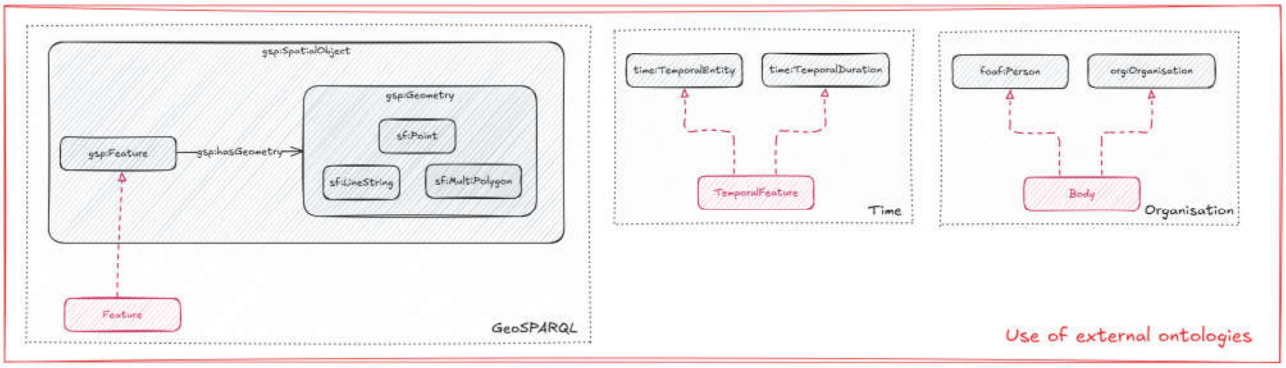


Figure 6 - External ontologies reused by ERA ontology data model

Temporal aspect of the infrastructure is represented through the `era:TemporalFeature` concept. It acts as an interface between the concepts that can be described with temporal characteristics and the Time Ontology[5]. era:TemporalFeature is a subclass of `time:TemporalEntity` and `time:TemporalDuration`. Extra details about the method of representing date intervals or durations are provided in chapter ***Error! Reference source not found. Error! Reference source not found.****, page* ***Error! Bookmark not defined.*****.Error! Reference source not found.**

The geographical representation is achieved by reusing the GeoSPARQL Ontology[6] which provides the necessary functions to allow provision of geographical coordinates and geographical shapes to all concepts derived from `era:Feature`, which is a sub-class of `gsp:Feature`.

3.4.5. Topological and geographical representation of the infrastructure

The topology and the geographical representation of the railway network are important aspects of the management of railway infrastructure and the ontology based RINF data model integrates these elements.

The main concept in the topology is the **net element** which represents the building block of the railway network. There are 2 types of net elements: the (curvi-)**linear elements** and **non-linear elements**.

[5] `@prefix time: <http://www.w3.org/2006/time#>`

[6] `@prefix geo: <http://www.opengis.net/ont/geosparql#>`

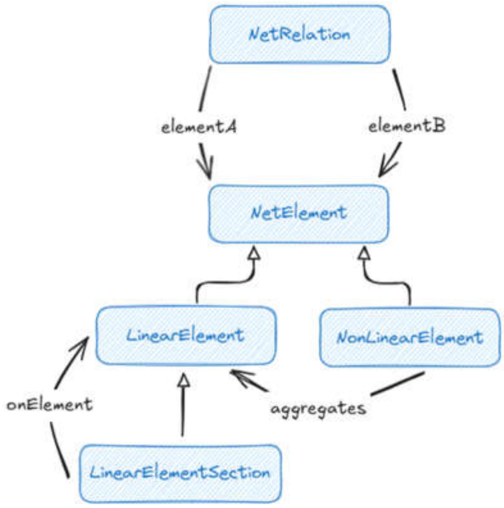


Figure 7 - Schematic representation of the topology concepts

The **linear elements** are used to model elements that follow a specific path (such as tracks) and are defined with a length. Unlike other models that use abstract intrinsic coordinates (e.g., 0 to 1), this ontology uses length as the primary metric. Although the ontology does not explicitly define an "origin" for linear elements, we assume that every linear element starts at an offset of 0, the direction being given by the increasing distances along its length.

A **linear element section** is a finer granularity of a linear element, representing a specific portion of it. This concept is introduced to address the cases when a linear element needs to be split such as a part of it is used by a net referencing (more in the paragraph describing the positioning on the network). By using **start** and **end offsets** measured from origin of the element in ascending order, sections eliminate the need for intrinsic coordinates and instead rely on distances along the linear element.

Connectivity and the navigability between consecutive linear elements are resolved by using **net relations**. It models how different elements are related to each other, representing a transition from one element to another.

Net relations specify where two linear elements connect. This could be at the origin of one element, the end of another, or even at specific offsets along their lengths. For example, two tracks might connect at a junction, with one ending at offset 1500 and the other beginning at offset 0.

NetRelation explicitly models these connections by linking two linear elements (**elementA** and **elementB**) and defining their physical or logical relationship.

Net relations also specify the permitted directions of travel:

- AB: Trains can move from element A to element B.
- BA: Trains can move from element B to element A.
- Both: Movement is bidirectional.
- None: No movement is allowed between the two elements.

To make this even more precise, net relations include information about whether the connection is at the origin of each element. For example, a relation might indicate that Track A ends at its origin (offset 0) and connects to Track B at its start (isOnOriginOfElementA and isOnOriginOfElementB).

Non-linear elements complement the linear structure by serving as connection or interaction points. They represent features such as stations, depots, or complex junctions. They often serve as aggregation points for linear elements, where multiple tracks meet or like logical entities that support operations like passenger boarding or train storage. These elements may optionally aggregate linear elements.

3.4.5.1. Examples of defining topology

Representing the topology of a switch:

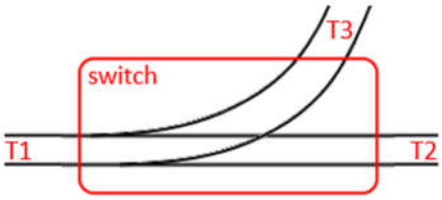


Figure 8 - Representation of a switch

The unit of track representing the switch, allows changing the direction and direct vehicles from one track to another track. In the topology, each track is defined as an `era:LinearElement`, while the switch component is defined as an `era:NonLinearElement`.
In the , we assume that there is a bi-directional traffic allowed between tracks T1 and T2, same as between T1 and T3. Given this assumption, we are able to represent the topology of these linked elements.

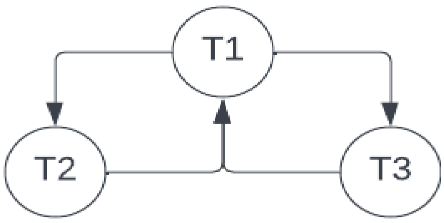


Figure 9 - A graph representation of the switch

The nodes in the graph from are the tracks, while the number of edges are all the possible combinations of navigability provided by the switch. To be able to identify all combinations and achieve the result above, we can use a logical navigability matrix:

	T1	T2	T3
T1	-	1	1
T2	1	-	0
T3	1	0	-

, where on the rows there are incoming elements, and as columns there are outgoing elements.

- Whenever there is the possibility to go from one element to another, we insert value 1
- Value 0 means that there is no possibility to go directly from one element to another (e.g. from T2 towards T3 as well as in the opposite direction)
- A dash is used whenever the same element is on the row and the column.

All positive values will be translated into edges between the nodes of the graph.

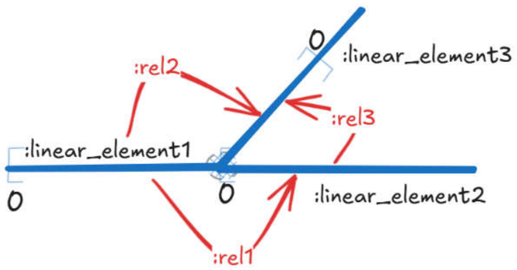


Figure 10 - Visual representation of topology elements of a switch

The final RDF in Turtle representation of this example is shown in the snipped below:

```
@prefix : <http://example.com/ns/> .
@prefix era: <http://data.europa.eu/949/> .
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@prefix xsd: <http://www.w3.org/2001/XMLSchema#> .
@prefix era-nv-rinf: <http://data.europa.eu/949/concepts/navigabilities/rinf/> .

:t1 a era:Track;
    era:netReference [
        a era:NetLinearReference;
        era:hasSequence (:linear_element1)   #for simplicity the track is equivalent to the topology
element in length
    ] .
:t2 a era:Track;
    era:netReference [
        a era:NetLinearReference;
        era:hasSequence (:linear_element2)
    ] .
:t3 a era:Track;
    era:netReference [
        a era:NetLinearReference;
```

```
        era:hasSequence (:linear_element3)
    ].
:switch a era:Switch;
    era:netReference [
        a era:NetPointReference;
        era:hasTopoCoordinate [
            a era:TopologicalCoordinate;
            era:onLinearElement :linear_element1;
            era:offsetFromOrigin "10"^^xsd:integer
        ]
    ].

:linear_element1 a era:LinearElement;
    era:lengthOfNetLinearElement "100"^^xsd:integer.
:linear_element2 a era:LinearElement;
    era:lengthOfNetLinearElement "100"^^xsd:integer.
:linear_element3 a era:LinearElement;
    era:lengthOfNetLinearElement "100"^^xsd:integer.
:switchTopo a era:NonLinearElement.

#navigability defined by net relations
:rel1 a era:NetRelation;
    era:elementA :linear_element1;
    era:elementB :linear_element2;
    era:isOnOriginOfElementA "false"^^xsd:boolean ;
    era:isOnOriginOfElementB "true"^^xsd:boolean ;
    era:navigability era-nv-rinf:Both.      #circulation available in both directions
:rel2 a era:NetRelation;
    era:elementA :linear_element1;
    era:elementB :linear_element3;
    era:isOnOriginOfElementA "false"^^xsd:boolean ;
    era:isOnOriginOfElementB "false"^^xsd:boolean ;
    era:navigability era-nv-rinf:AB.        #circulation in one direction (A to B)
:rel3 a era:NetRelation;
    era:elementA :linear_element2;
    era:elementB :linear_element3;
    era:isOnOriginOfElementA "true"^^xsd:boolean ;
    era:isOnOriginOfElementB "false"^^xsd:boolean ;
    era:navigability era-nv-rinf:None.      #no navigation
```

The equivalent serialization of the above example in RDF/XML is displayed in the text below:

```
<?xml version="1.0" encoding="utf-8" ?>
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
         xmlns:ns0="http://data.europa.eu/949/">
```

```
  <rdf:Description rdf:about="http://example.com/ns/t1">
    <rdf:type rdf:resource="http://data.europa.eu/949/Track"/>
    <ns0:netReference>
      <ns0:NetLinearReference>
        <ns0:hasSequence>
          <rdf:Description>
            <rdf:first rdf:resource="http://example.com/ns/linear_element1"/>
            <rdf:rest rdf:resource="http://www.w3.org/1999/02/22-rdf-syntax-ns#nil"/>
          </rdf:Description>
        </ns0:hasSequence>
      </ns0:NetLinearReference>
    </ns0:netReference>
  </rdf:Description>

  <ns0:Track rdf:about="http://example.com/ns/t2">
    <ns0:netReference>
      <ns0:NetLinearReference>
        <ns0:hasSequence>
          <rdf:Description>
            <rdf:first rdf:resource="http://example.com/ns/linear_element2"/>
            <rdf:rest rdf:resource="http://www.w3.org/1999/02/22-rdf-syntax-ns#nil"/>
          </rdf:Description>
        </ns0:hasSequence>
      </ns0:NetLinearReference>
    </ns0:netReference>
  </ns0:Track>

  <ns0:Track rdf:about="http://example.com/ns/t3">
    <ns0:netReference>
      <ns0:NetLinearReference>
        <ns0:hasSequence>
          <rdf:Description>
            <rdf:first rdf:resource="http://example.com/ns/linear_element3"/>
            <rdf:rest rdf:resource="http://www.w3.org/1999/02/22-rdf-syntax-ns#nil"/>
          </rdf:Description>
        </ns0:hasSequence>
      </ns0:NetLinearReference>
    </ns0:netReference>
  </ns0:Track>

  <ns0:Switch rdf:about="http://example.com/ns/switch">
    <ns0:netReference>
      <ns0:NetPointReference>
        <ns0:hasTopoCoordinate>
          <ns0:TopologicalCoordinate>
            <ns0:onLinearElement rdf:resource="http://example.com/ns/linear_element1"/>
            <ns0:offsetFromOrigin
rdf:datatype="http://www.w3.org/2001/XMLSchema#integer">10</ns0:offsetFromOrigin>
          </ns0:TopologicalCoordinate>
        </ns0:hasTopoCoordinate>
      </ns0:NetPointReference>
    </ns0:netReference>
  </ns0:Switch>

  <ns0:LinearElement rdf:about="http://example.com/ns/linear_element1">
    <ns0:lengthOfNetLinearElement
rdf:datatype="http://www.w3.org/2001/XMLSchema#integer">100</ns0:lengthOfNetLinearElement>
  </ns0:LinearElement>

  <ns0:LinearElement rdf:about="http://example.com/ns/linear_element2">
    <ns0:lengthOfNetLinearElement
rdf:datatype="http://www.w3.org/2001/XMLSchema#integer">100</ns0:lengthOfNetLinearElement>
  </ns0:LinearElement>

  <ns0:LinearElement rdf:about="http://example.com/ns/linear_element3">
    <ns0:lengthOfNetLinearElement
rdf:datatype="http://www.w3.org/2001/XMLSchema#integer">100</ns0:lengthOfNetLinearElement>
  </ns0:LinearElement>

  <ns0:NonLinearElement rdf:about="http://example.com/ns/switchTopo">
  </ns0:NonLinearElement>
```

```
  <ns0:NetRelation rdf:about="http://example.com/ns/rel1">
    <ns0:elementA rdf:resource="http://example.com/ns/linear_element1"/>
    <ns0:elementB rdf:resource="http://example.com/ns/linear_element2"/>
    <ns0:isOnOriginOfElementA
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">false</ns0:isOnOriginOfElementA>
    <ns0:isOnOriginOfElementB
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</ns0:isOnOriginOfElementB>
    <ns0:navigability rdf:resource="http://data.europa.eu/949/concepts/navigabilities/rinf/Both"/>
  </ns0:NetRelation>

  <ns0:NetRelation rdf:about="http://example.com/ns/rel2">
    <ns0:elementA rdf:resource="http://example.com/ns/linear_element1"/>
    <ns0:elementB rdf:resource="http://example.com/ns/linear_element3"/>
    <ns0:isOnOriginOfElementA
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">false</ns0:isOnOriginOfElementA>
    <ns0:isOnOriginOfElementB
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">false</ns0:isOnOriginOfElementB>
    <ns0:navigability rdf:resource="http://data.europa.eu/949/concepts/navigabilities/rinf/AB"/>
  </ns0:NetRelation>

  <ns0:NetRelation rdf:about="http://example.com/ns/rel3">
    <ns0:elementA rdf:resource="http://example.com/ns/linear_element2"/>
    <ns0:elementB rdf:resource="http://example.com/ns/linear_element3"/>
    <ns0:isOnOriginOfElementA
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">true</ns0:isOnOriginOfElementA>
    <ns0:isOnOriginOfElementB
rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">false</ns0:isOnOriginOfElementB>
    <ns0:navigability rdf:resource="http://data.europa.eu/949/concepts/navigabilities/rinf/None"/>
  </ns0:NetRelation>

</rdf:RDF>
```

The same result can be achieved at a higher level of topology representation.

Representing the topology of an operational point:

An operational point can be represented as an area between the entry signals, as in the figure below.

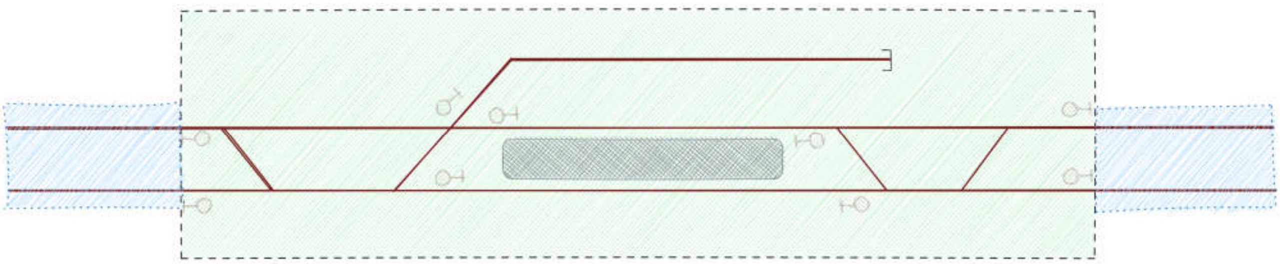


Figure 11 - representation of the area occupied by the operational point

The topogy of the operational point in this case is given by a set of linear elements, which have defined net relations, creating thus the possible navigability and connectivity options.

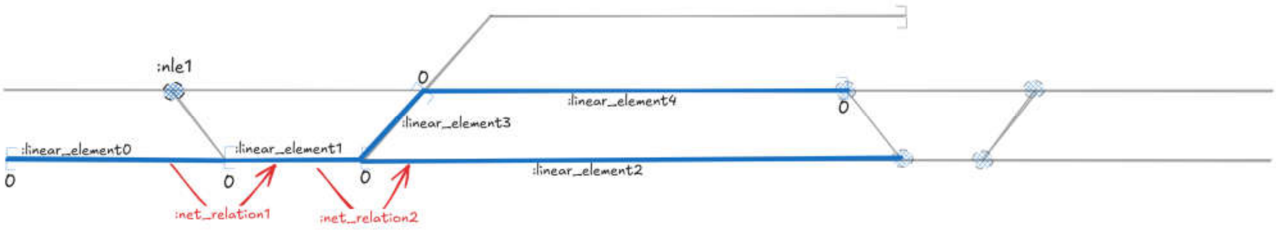


Figure 12 - defining topology elements inside and operational point

3.4.6. Advanced GeoSPARQL analysis

The integration of GeoSPARQL with the geographical representation classes enables advanced spatial queries and analyses. For example, spatial relationships such as containment, intersection, and proximity can be easily queried using GeoSPARQL functions.

Examples of SPARQL queries:

1. Querying tracks within a specific area

```
SELECT ?track
WHERE {
    ?trackLe a era:LinearElement ;
            era:topologyOf ?track;
           era:location ?trackLocation .
    ?track a era:Track.
    ?trackLocation geo:asWKT ?trackWKT .
    ?area a era:AreaLocation ;
          geo:asWKT "POLYGON ((30 10, 40 40, 20 40, 10 20, 30 10))"^^geo:wktLiteral .
    FILTER(geof:sfWithin(?trackWKT, "POLYGON ((30 10, 40 40, 20 40, 10 20, 30
10))"^^geo:wktLiteral))
}
```

The query above presents a use case of using a Geosparql function for finding intersecting elements (in this case tracks) within a given area location.

2. Finding switches near a specific point

```
SELECT ?switch
WHERE {
    ?switchLink a era:LinearElementLink ;
            era:topologyOf ?switch;
            era:location ?switchLocation .
    ?switch a era:Switch.
    ?switchLocation geo:asWKT ?switchWKT .

    FILTER(geof:distance(?switchWKT, "POINT (30 10)"^^geo:wktLiteral) < 1000)
}
```

This query presents a sample of locating switchs from a given point within a radius of 1km.

3.4.7. Positioning and locating infrastructure elements

As previously mentioned, the infrastructure element are independently described with their characteristics. But this is not enough to provide full information about the network.

The basic schematic data model construction is represented as depicted in Figure 13 - Positioning data model below:

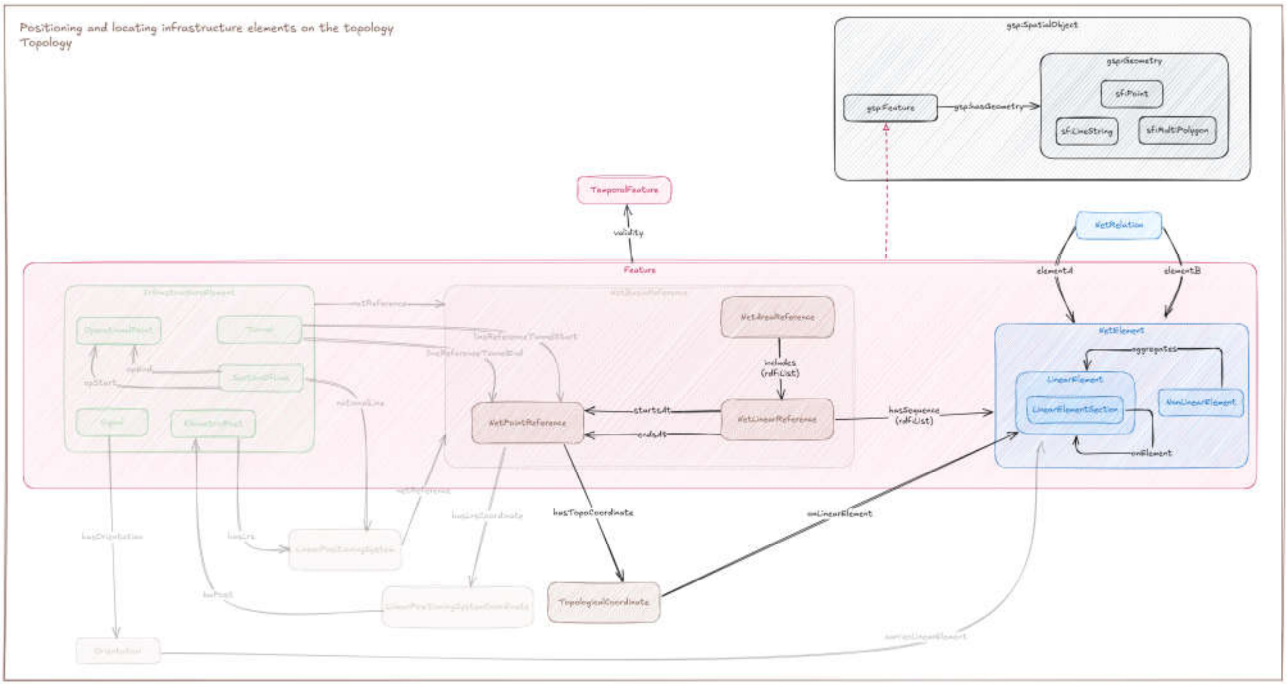


Figure 13 - Positioning data model

The Positioning and Locating Infrastructure Elements layer in the ontology serves as the bridge between the railway topology and external geospatial ontologies, such as GeoSPARQL, and functional descriptions of infrastructure elements. This part of the ontology addresses a critical need: accurately referencing physical locations and connecting railway elements to their spatial representation. By doing so, it enables seamless integration with spatial data, maps, schemas, and positioning systems.

In railway operations, the ability to precisely locate infrastructure elements—whether it's a track section, a signal, or a station—is essential. Positioning helps answer questions like:

- Where is a specific linear element or section located in the real world?
- How can we align the digital representation of the network with physical coordinates or maps?
- How do we connect geospatial data with railway-specific features?

At the centre of this layer is the concept of a **NetBasicReference**, a subclass of **era:Feature** (a generic entity in the ontology). The NetBasicReference acts as the entry point for associating topology elements with spatial and geometric data. This is where geospatial positioning systems (e.g., GPS, GIS-based systems) intersect with the railway-specific model.

The hasGeometry property provides a direct link to geospatial data. For example, it can reference a geo:Point that specifies a precise latitude and longitude, or a more complex geometry like a line or polygon for broader features.

Positioning in the railway network involves not just tracks and sections but also points, segments and areas. The ontology addresses this need with two specialized subclasses of NetBasicReference.

The **NetPointReference** is used to reference specific points within the network. These could include:

- The location of a signal, switch, or speed limit sign.
- Points where two tracks intersect or diverge.

Each NetPointReference includes:

- A Topological Coordinate to define its position relative to a linear element.
- An appliesToDirection property that indicates whether the reference is valid in the normal, reverse, or both directions along the linear element. This is critical for entities like signals.

The **NetLinearReference** is designed to describe linear segments of the network. It uses:

- A start and end topological coordinate to define the segment's boundaries.
- A sequence of linear elements (encoded as a list) to describe the path through the topological network.

This level of detail supports operations that require knowledge of entire track segments, such as route planning or infrastructure analysis. By linking segments to their topological and spatial context, the model provides a complete picture of how these elements fit within the network.

NetAreaReference aggregates multiple linear references.

The ontology supports two complementary approaches for locating elements:

- Topological Positioning
- Linear Positioning

These approaches address different needs while remaining interoperable.

Topological positioning relies on the network structure to determine where an element is located. It uses concepts like **Topological Coordinates** to describe positions in terms of their relationship to linear elements. The **TopologicalCoordinate** provides a way to pinpoint locations along linear elements without relying on external geospatial data:

- It specifies the Linear Element (e.g., a track or corridor) the position is associated with.
- The offsetFromOrigin property defines the distance from the start (origin) of the linear element. This makes it possible to reference specific points along a track using real-world measurements, such as "500 meters from the start of net element A."

To enhance topological positioning, the TopologicalCoordinate can optionally include an LRS (Linear Positioning System) Coordinate, which provides a richer context for referencing locations. This is particularly useful when working with national or regional linear referencing systems, where locations are defined using:

- Kilometer Posts: Named reference points along the line.

- Offsets from Kilometer Posts: Precise distances (e.g., "500m past KP 10").

By integrating these optional elements, the ontology supports both general and highly specific positioning needs.

The LinearPositioningSystemCoordinate builds on the topological coordinate by introducing a more structured way to reference locations using:

- The LinearPositioningSystem it belongs to (e.g., a national rail reference system).
- Kilometer Post Names for human-readable reference points.
- Offsets from Kilometer Posts to provide precise distances within the positioning system.

This concept bridges the gap between local, track-specific positioning (offsets) and standardized referencing systems used for national or regional railway operations. For example, a track section described as "KP 24+100" (100 meters past kilometer post 24) can be directly mapped to its real-world location.

3.4.8. Technical characteristics

Some RINF parameters are to be structured in groups of subsystems

- INF,
- ENE,
- CCS trackside.

Or in some cases, depend only on one subsystem and not the combination with others.

Example: the operational maximum speed can depend on the CCS system in operation, while several systems are implemented on the OP/SoL.

Within a SoL the technical characteristics are provided for each element of the SoL whenever applicable. Data provided for each parameter are valid for the whole element described:

- from the start OP to the end OP of a SoL for a “running track”; except if “location point” is used;
- inside the OP for a “siding”.

Installations located along the tracks are attached to the tracks.

3.4.9. Elements of an operational point

In an OP, only few parameters related to infrastructure subsystem are included. **For the other parameters related to infrastructure subsystem energy and command control and signalling subsystems, it is assumed that, in an OP, the same parameter regarding CCS and ENE are corresponding to those of neighbouring SoLs (permitting at least to enter to the center of OP).**

It is worth adding that platform is the installation for providing passengers’ access to trains – this is not the construction for loading or unloading freight trains.

It is very important for RINF to have a unique identification for each OP (OP ID). OP ID is the code composed from country code and alphanumeric OP code developed by MS or IM. We suggest using those number or abbreviations which are applied in route books or in documentation of the IM. In case of absence of such sources the coding system within the MS may be developed specially for RINF.

Finally, one or several "PLC" can exist in the OP area.

Contrary to the RINF Regulation, the parameter 1.2.0.0.0.3 "OP primary location code" will become obsolete, since the primary locations are provided as separate infrastructure element. The correspondence between the operational points and primary locations is to be identified through the geographical location and the position on the topology.

3.4.10. General information about parameters of RINF

Parameters collected in RINF are mainly:

a) Generic data – valid at different level – SoL, OP, running track, siding, etc.
b) Data related to specific subsystems – for INF, ENE and trackside CCS;
c) Data for performance parameters, for objects (tunnel, platform) or for providing references of certificates (declarations).
d) Rules and restrictions.
e) Route book related parameters.

Organisation of parameters in RINF is presented in table 1 of the annex to the RINF Regulation.

It is important to underline that it is permitted to repeat certain parameters or groups of parameters. The concept of **subset of common characteristics** can be used.

Also, when several data relating to the same parameter co-exist, then this parameter may be repeated. For example, when there are several "EC intermediate statement of verification" (ISV) declarations for a single subsystem concerning the same track, then this parameter may be repeated so many times as many declarations concern this track.

But please be aware, not all parameters may be repeated. The ontology properties representing the parameters which are receiving an unique value are called functional. In the Technical Annex, this information is flagged as "**Functional property (Unique Value): functional**". The contrary means that the property may have more than one allowed value.

For the purpose of the RINF, the appropriate value of a parameter has to be the most critical from all values met along the whole track of the SoL, the Operational point and the network.

It means, in general, when a parameter has several values in a same SoL and the **RINF application does not authorise its repetition, the most restrictive value of the parameter on the specific track is the RINF value for this parameter on this track.**

Some values of some parameters may not exist – like 'Tunnel identification', 'EC declaration of verification', etc. Then that parameters can be flagged as "not applicable".

In case of several parallel tracks, a set of data is to be published separately to each pair of rails to be operated as separate track (the whole set of parameters for the separate track has to be delivered – be careful then with the track identification).

In case of multiple ENE and/or CCS subsystems, the ability to repeat the relevant of parameters allows to describe these particularities of a running track.

3.4.11. Collecting data with (pre)defined validity and applicability

IMs can provide information concerning the future values of RINF elements and their parameters. To accomplish this, two concepts are defined:

- Validity dates
- Applicability period

3.4.11.1. Validity dates

Validity dates can be applied to the infrastructure objects: Operational Point, Section of Line, Track, Siding, Tunnel and Platform edge, (or any other physical objects that are described by RINF). These objects could therefore have 2 validity dates: **validity start date** and **validity end date**. It is not mandatory to provide these attributes unless the object is created or definitively closed. Validity represents the ~~age~~ operability in a time frame of the infrastructure object. In general, it is expected that the validity dates of the infrastructure objects do not change often. For the RU/user, the validity dates mean that the object is operational for route compatibility check and for train operation (i.e. capacity can be requested and train can run).

The following situations could be described with validity dates:

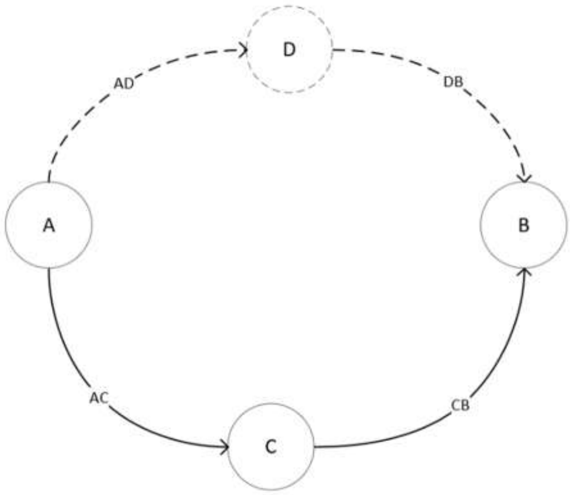
- New infrastructure element is put into service – IM will provide a validity start date for it.
- An infrastructure element is decommissioned or taken out of service – IM will provide a validity end date for it.
- A new infrastructure element is put into service for a defined time interval – IM will provide both validity dates for it.
- Infrastructure element already in operation
    - Past validity start date could be provided, if known. If no past validity start date is provided, that means that the infrastructure element is in operation.
    - Future validity end date could be provided. If no future validity end date is provided, that means that the infrastructure element is foreseen to be in operation for a "long time".

  - o No validity dates should be applied in case of existing elements without any decommissioning or taking out of service foreseen.

Some validation rules will be applied:

- ➢ Validity end date provided before the date of data publishing is not accepted.
- ➢ Validity start date cannot be higher than the validity end date.

In case of a temporary closure of an infrastructure object, if it is planned to be reopened, this change in the validity is to be reflected in the topology of the object. A temporary closure is understood by any changes which can lead to the stopping of the operations or services on that object. The validity dates would remain unchanged, as long as the infrastructure object will come back to operation.



A very simplistic example on the topology graph, in the image above, the linear element A is connected to linear element B through C. If there is a temporary closure of any of the linear element link AC, CB or the linear element C, than, in order to ensure that the connection between A and B is maintained, another path needs to be taken, namely A->D->B . The new path, if it is newly introduced, it will have at least one date of the start of validity.

When an infrastructure element is subject to a temporary restriction (one track in a station, stopping the train at some platforms, etc), only the topology on that level is affected. The connection between the topology nodes and the relations between them being subject of the validity dates information provision. At the same time, the topology between the elements on a higher level should not be affected.

An infrastructure element is considered valid if it has no validity date attributes or if the current date (or the date when data is queried) falls into the available validity interval of the element.

3.4.11.2. Applicability period

Applicability period defines the date interval in which a characteristic of an infrastructure element is applicable. This interval can be applied for any of the technical characteristics or general information of infrastructure elements. This helps identifying planned changes applied to technical parameters over time. Therefore, a parameter can have two applicability dates: **applicable from** and **applicable until**. It is not mandatory to provide both applicability date attributes unless there is a temporary change in the parameter value.

If the change in the parameter value is permanent (e.g. after upgrading), the previous value receives an 'applicable until date' and the new value receives a 'applicable from date'

If no applicability date attributes are provided, then the default applicability for the values is given by the validity dates of the infrastructure object described by the given values. The applicability should always be used in conjunction with the validity dates.

If, after the return to operation of a previously temporary closed infrastructure object, some of the technical characteristics changed, the new values should be followed by the 'applicable from date' attribute.

The following situations can be described with applicability intervals:

- Nominal value(s) for a parameter
  - No applicability dates if no change is foreseen.
  - "Applicable until" can be provided whenever a change (of any type) is foreseen.
  - "Applicable from" should be provided whenever a new nominal value becomes applicable.
- Temporary value(s) for a parameter
  - Both "applicable from" and "applicable until" dates should be provided

How to read applicability dates:

- No applicability dates – the provided value is the nominal parameter value.
- Only "applicable until" – the nominal value is applicable until the provided date and a new value is expected after the expiration of applicability. "Not applicable" parameter can also follow this date.
- Only "applicable from" – the provided value becomes the nominal parameter value. This can be applied even if the parameter was not applicable before the provided date.
- Both "applicable from" and "applicable until" – this suggests a temporary change of the nominal value of parameter. The applicability interval should fall into the validity dates of the parent element.

The parent element refers to the infrastructure elements on which a technical characteristic (parameter) is applicable in a interval.

The applicability dates could be applied for parameters marked as "not applicable", whenever there is a change in the applicability status.

In case of 'linked' parameters (described in 2.6 Relations between parameters), when the "set" attribute is used, and at least one applicability date is provided (applicable from, applicable until, or both), all the parameters in the group should be applied the same applicability date(s), along with the "set" attribute.

Whenever in the table of parameters there is rule that a parameter value should not be repeated, this needs to be read as "not repeatable in a defined applicability interval".

In the case of a change in the value of a parameter, there need to be an information on the type of the new value. The "Value type" will have different possible options: "nominal", "planned temporary restriction", "permanent restriction", "planned temporary closure".

Example of addressing applicability and validity dates using ERA Ontology:

```
@prefix era: <http://era.europa.eu/949/> .
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
@prefix time: <http://www.w3.org/2006/time#> .
@prefix xsd: <http://www.w3.org/2001/XMLSchema#> .
@prefix era-param: <http://data.europa.eu/949/concepts/parameterApplicability/> .

era:track1 a era:RunningTrack;
    era:validity [
        a era:TemporalFeature;
        #only validity start date. The is no planned permanent closure, so no validity end date
        time:hasBeginning/time:inXSDDateTime "2000-01-01"^^xsd:date;

    ];
    era:maximumPermittedSpeed "250"^^xsd:integer;
    era:parameterApplicability [
        a era:ParameterApplicability;
        era:ofParameter era:maximumPermittedSpeed;
        era:parameterValue "50"^^xsd:integer;
        #the type of the new value (50) is ‘Planned temporary restriction’
        era:parameterValueType era-param:PTR;
        time:hasBeginning/time:inXSDDateTime "2025-01-01"^^xsd:date;
        time:hasEnd/time:inXSDDateTime "2025-05-31"^^xsd:date;
    ].
```

Some validation rules will be applied:

- “Applicable from” should not be lower that validity start date of the parent element (if defined).
- “Applicable until” should not be greater that validity end date of the parent element (if defined).
- “Applicable from” – “Applicable until” should be a valid date interval, even if it is one day (equal values)

3.4.11.3. Temporal features in the data model

The temporal features could be applied to several other concepts:

- In the topology, the era:validity is a property of the topological objects
- The era:validity can be a property of a geographical information
- The era:validity property can be applied to any infrastructure object
- The era:ParameterApplicability is a concept addressing the temporal property of a technical characteristic. It is linked to the infrastructure object through the era:parameterApplicability property

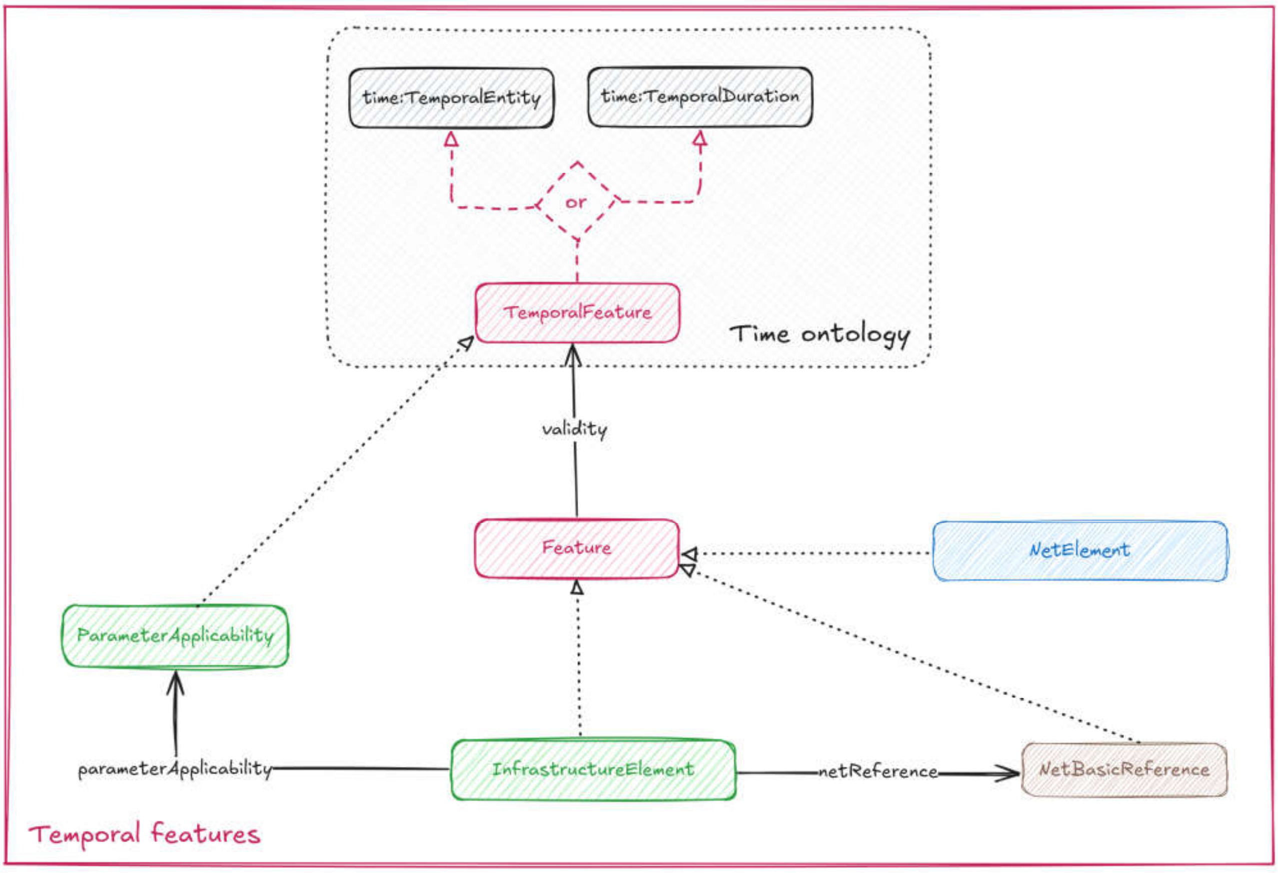


Figure 14 - Ontology concepts involved into the description of temporal features

To address the temporal feature, the time ontology[7] is imported into the ERA ontology, as in the picture above.

To demonstrate the above figure, an example of how provision validity dates and applicability periods can be used is described in the RDF serialization below. The example defines a track with validity dates from 1999-12-30 until 2075-12-30 (UTC time), with a restriction speed to 50km/h from 2025-01-01 until 2025-12-30. Additionally, the track provides some technical characteristics for line category, wheelset gauge or maximum permitted speed.

```
#example of validation dates and applicability period
@prefix era-param: <http://data.europa.eu/949/concepts/parameterApplicability/> .

:mainValidityInterval a era:TemporalFeature;
    time:hasBeginning [
        a time:Instant;
        time:inXSDDateTimeStamp "1999-01-01:T00:00:00Z"^^xsd:dateTimeStamp
    ];
    time:hasEnd [
```

[7] https://www.w3.org/TR/owl-time/

```
        a time:Instant;
        time:inXSDDateTimeStamp "2075-12-30:T00:00:00Z"^^xsd:dateTimeStamp
    ] .

:applicabilityForSpeed a era:ParameterApplicability, era:TemporalFeature;
    era:ofParameter era:maximumPermittedSpeed ;
    era:parameterValue "50"^^xsd:integer;
    era:parameterValueType era-param:PTR;   #Planned temporary restriction
    time:hasBeginning [
        a time:Instant;
        time:inXSDDateTime "2025-01-01:T00:00:00Z"^^xsd:dateTimeStamp
    ] ;
    time:hasEnd [
        a time:Instant;
        time:inXSDDateTime "2025-12-31:T00:00:00Z"^^xsd:dateTimeStamp
    ] .

:t1 a era:Track, era:InfrastructureElement, era:Feature;
    rdfs:label "test track 1"; #general track information
    era:validity :mainValidityInterval;  #validity of the track
    #technical characteristics
    era:wheelsetGauge era-gauge:30;  #1435
    era:lineCategory era-categ:10; #P1    era:tenClassification era-ten:10;  #core pass
    era:maximumPermittedSpeed "300"^^xsd:integer;
    #...more parameters
    era:parameterApplicability :applicabilityForSpeed.  #temporal limitation
```

3.5. Route Compatibility Check

As per Annex B of [37], article 2.1 the register of infrastructure shall support the following process:

a) check before the use of authorized vehicles in accordance with Article 23 of Directive (EU) 2016/797;

Article 23 reads as *(b) that the vehicle is compatible with the route on the basis of the infrastructure register, the relevant TSIs or any relevant information to be provided by the infrastructure manager free of charge and within a reasonable period of time*.

TSI OPE article 4.2.2.5.1b reads that the infrastructure manager shall provide the information for route compatibility as defined in Appendix D1 through RINF.

Appendix D1 reads that in order to ease the RCC process, and in relation to the parameters – "Traffic load and load carrying capacity of infrastructure" and "Train detection system"-, the Infrastructure manager should provide through the parameter 1.1.1.5.1 and 1.1.1.5.2 the list of vehicle types and vehicles compatible with a route already existent. Since the ontology for the vehicles (the EVR ontology extension) is not yet completed and contrary to the definitions of these parameters in the RINF Regulation, RINF will accept the prosivion of values for the two parameters as structured documents (for example CSV, Excel, etc.), which should contain the list of EVNs and vehicle type IDs compatible with the infrastructure element belonging to the route. In addition, to simplify the data provision, a sub set of elements with common characteristics could be created for a route, which will contain as common characteristics the 2 parameters, then refer this subset on the infrastructure elements belonging to the route.

The list of parameters in Appendix D1 is grouped in parameters linked to:

- the InfraSubsystem domain such as: the family of the load capability parameters, the gauging parameter, the minimum radius of vertical curve hollow and vertical curve crest, the family of hot axle box detector parameters, running characteristics, wheelset parameters, minimum curve, braking, weather conditions, train length, platform heigh, fire safety category in tunnels and the standard combined transport profile numbers for swap bodies, roller units, containers and semitrailers.
- the EnergySubsystem domain such as: voltages and frequencies, regenerative braking, current limitation and family of pantograph parameters.
- the CCSSubsystem domain such as: the family of train detection systems parameters, ETCS, GSM-R and Class B parameters

For grouping and searchability purposes an annotation property has been added to those parameters involved in the RCC process **era:usedInRCCCalculations**.

The provision of this technical parameters (Functional/Implementation block in the next Fig.) has been mainly per era:Track element. However, the current ontology design enables the provision of the technical parameters only once simplifying this way the data provision. is the case of adding parameters to a SubsetWithCommonCharacteristics and using the era:contains (or the inverse era:belongsTo) properties to refer to those infrastructure elements which have thos technical characteristics in common.

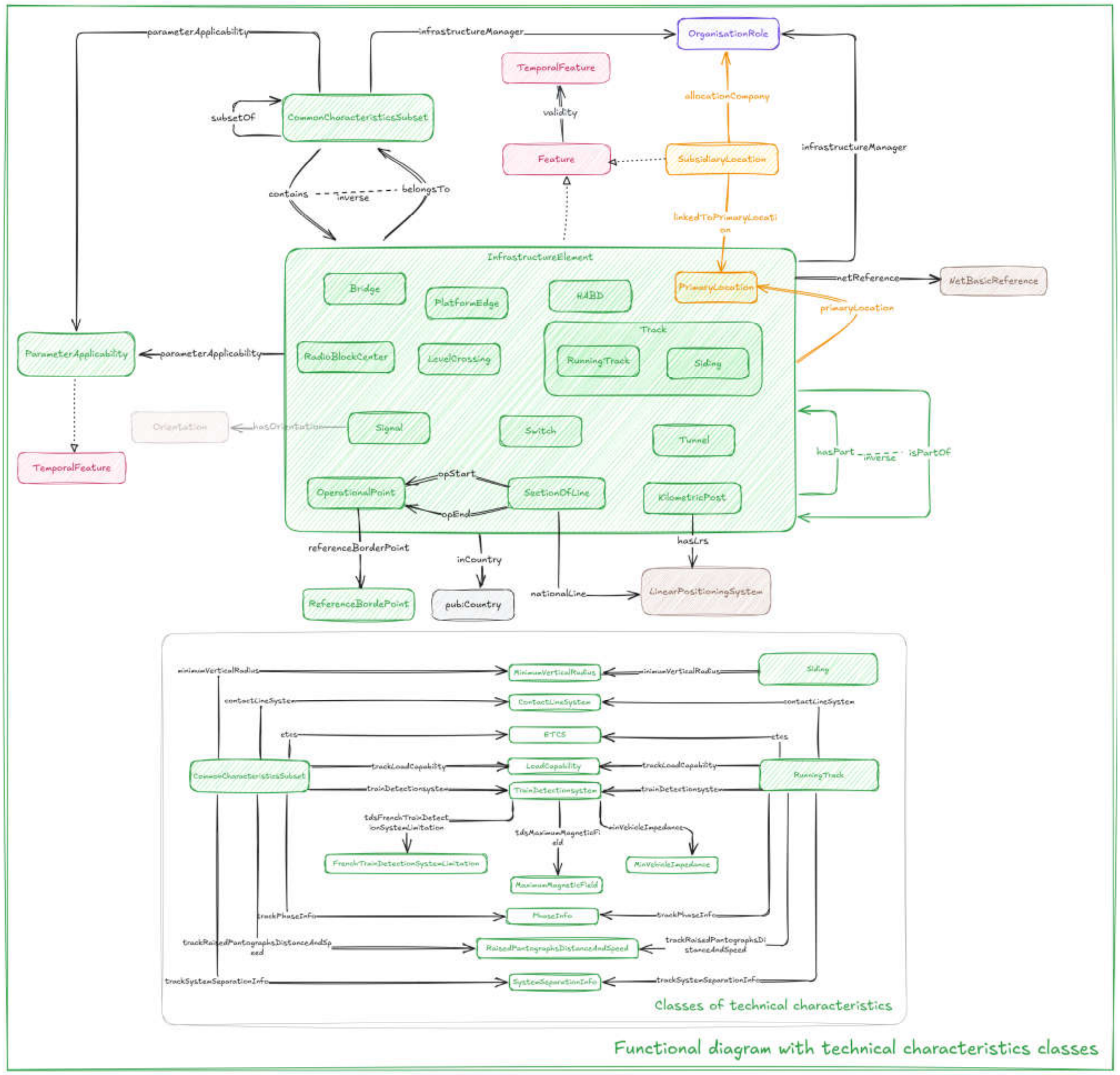


Figure 15 - Functional diagram with technical characteristics classes

Apart from the provision of the technical characteristics detailed in the Annex D1 of the TSI OPE, the second key data provision block engaged in the RCC process is the Topology block.

To achieve the route calculation in version 3.0 of the ERA ontology, the Topology data was generated automatically during the XML to RDF transformation by creating the corresponding NetElement and NetRelation granting full connectivity between all the incoming tracks within an OperationalPoint.

In version 3.1, the topology layer will not be automatically generated so it needs to be provided by the Infrastructure Manager. In principle, all the RunningTracks need to have a era:NetLinearReference as a layer over the topology era:LinearElement(s), bounded by 2 era:NetPointReferences duly populated as to ensure a connectivity layer between the infrastructure elements and, in this way, to offer routing capability from Operational Point A to Operational Point B. See Topology block detail in the next picture.

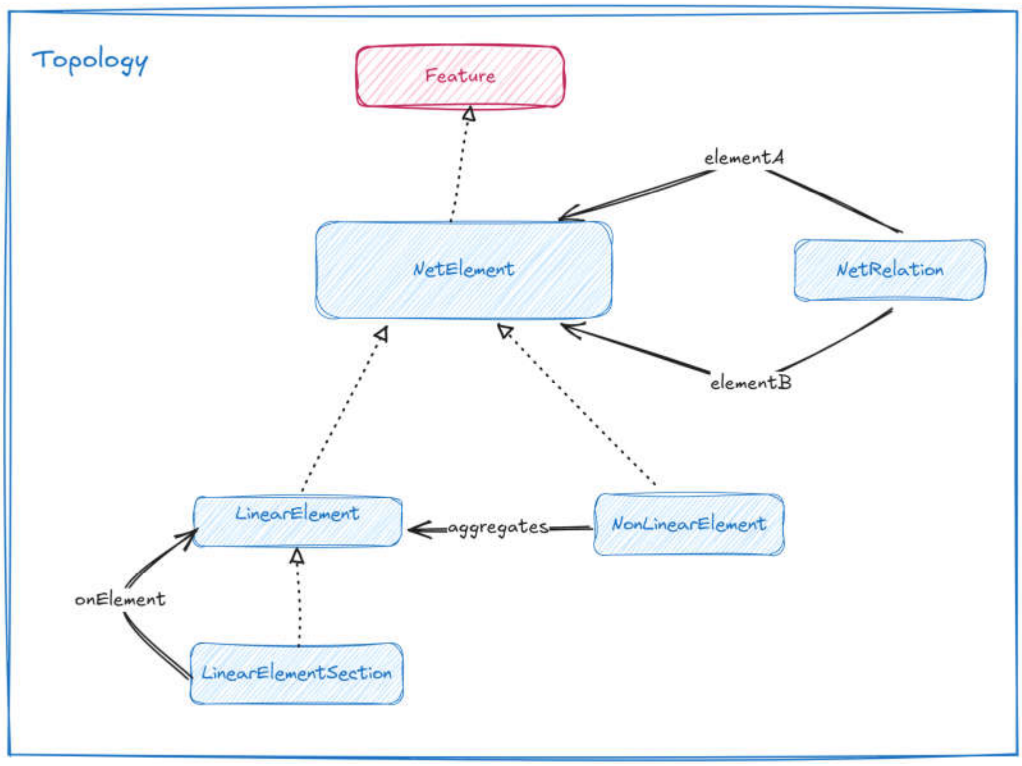


Figure 16 - Topology concepts

An example of describing the position of a running track over the topology is presented in the image below:

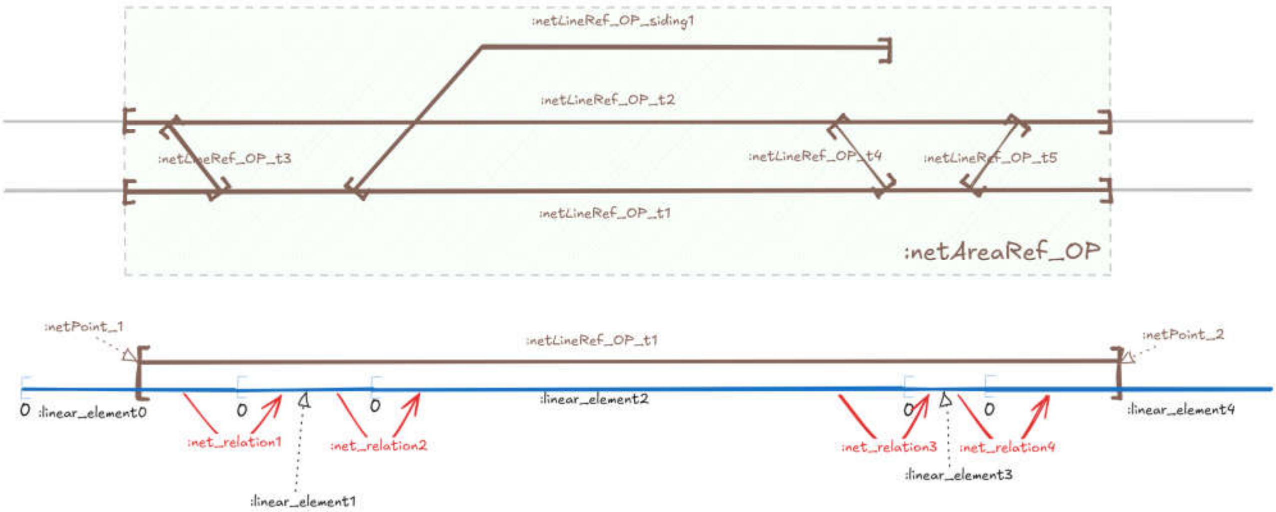


Figure 17 - track representation as linear reference over topology items

3.6. Route Book

As per Annex B of [37], article 2.1 the register of infrastructure shall support the following process.

(h) compilation of the Route Book referred to in Appendix D2 to Implementing Regulation (EU) 2019/773 in accordance with Article 6(2);

For grouping and searchability purposes an annotation property has been added to those parameters involved in the RouteBook process era:tsiOPEAppendixD2Index (Note: currently Appendix D2 index).

Within these set of parameters in Appendix D2, there are:

A. general common properties or technical characteristic such as OperatingLanguage (1.1.0.0.1.2/1.2.0.0.0.8)- common value for a route or network - or means of communication with the traffic management/control centre in normal degraded and emergency situations (at Network level).

B. Technical characteristics such as MaximumPermittedSpeed and Normal running direction at (Track Level) or OperationalRegime (at Section of line level).

All these infrastructure elements - in order to properly appear represented in the routebook- , need to have duly populated :

- their Position in regards to a carrier object (Running Track – link with the Topological layer)
- their Km Point in relation to one or multiple RailwayLines

The image below provides a visual example of how a platform and signals are positioned in relation to a linear referencing system, such as a main line, using Linear Positioning System Coordinates

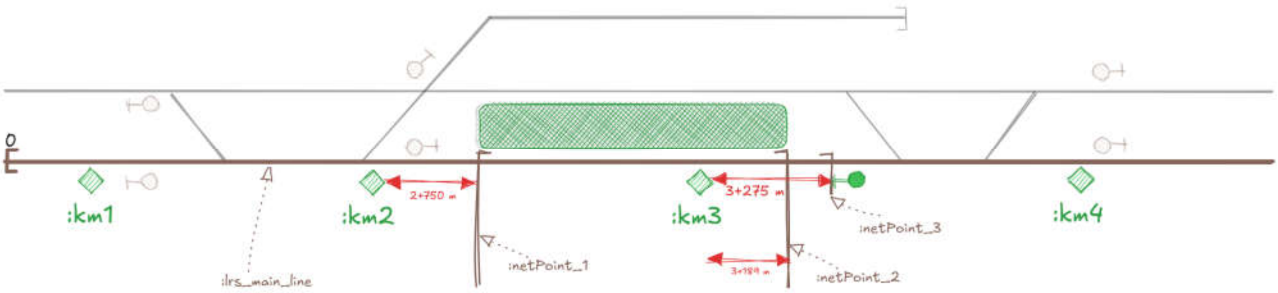


Figure 18 - Example of positioning in relation to a main line

- All these instractructure elements (running tracks included) are also geo spatial objects (MultiPoligon, linearString or Point) so consequently they could have their geo information populated as to be represented in any map using standard map libraries. Nevertheless, the RINF Regulation does not mention any obligation in provision of geographical information for these elements, but the data model allows it, on voluntary basis.

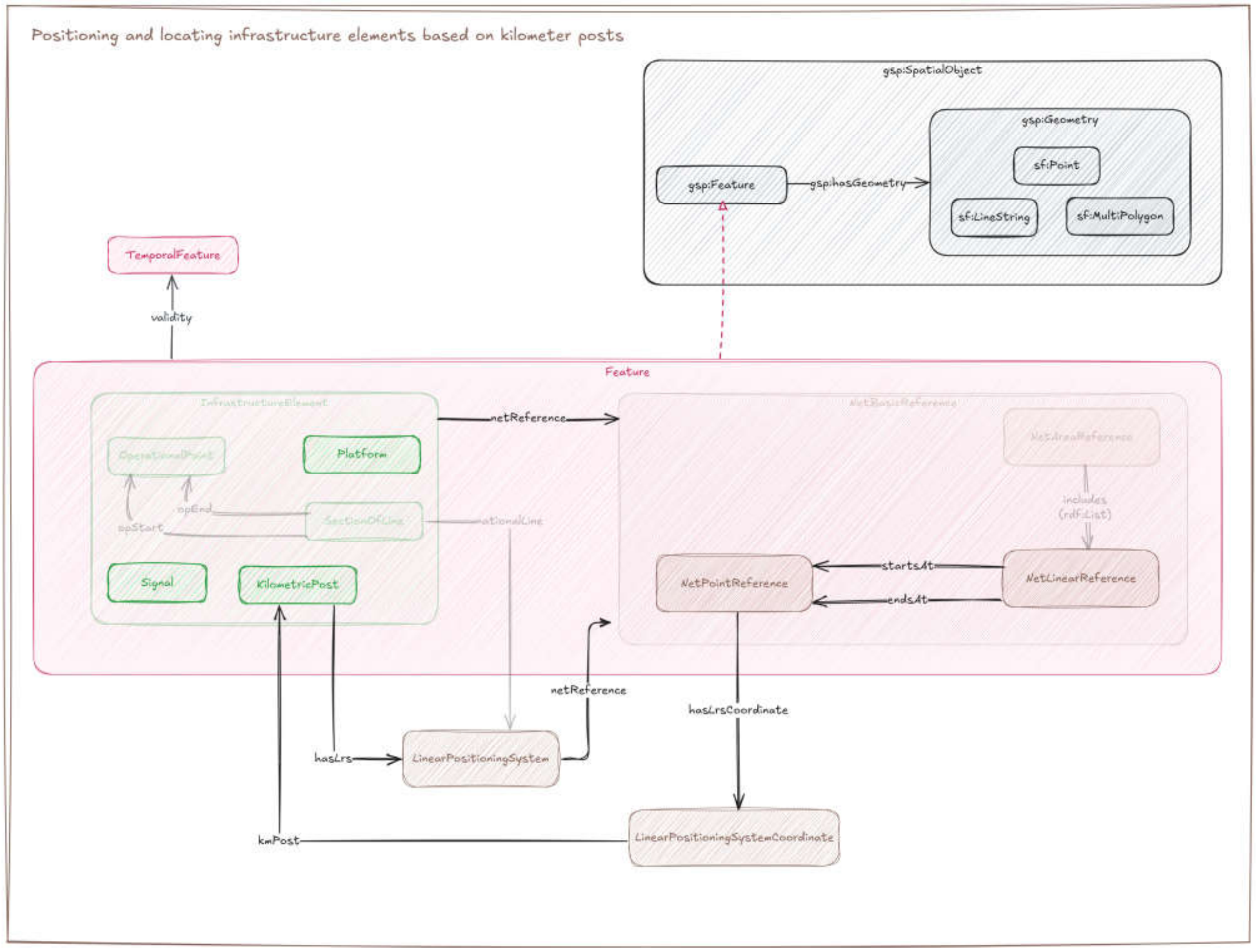


Figure 19 - Isolation of ontology concepts used for positioning based on km posts

C. Other areas such as:

In Well-Known Text (WKT), an area is usually a POLYGON with the longitude/latitude. An example of an area can be described with the following set of points «POLYGON ((7.0002481 46.2295171, 7.5 45, 8.0002481 45.2295171, 7.0002481 47.2295171)), that can visible online with a tool such as the WKT visualizer at https://wktmap.com. There are situations in which a geographical area defined as a polygonal area is not the same as a topological area. This is the case of the era:NetAreaReference, which is a list of separate era:LinearReferences (as curvi-linear representations over the topology).

Here is a WKT example, which may be considered as a representation of an area in Milano: GEOMETRYCOLLECTION (LINESTRING (9.17456 45.468664, 9.172962 45.46992, 9.172484 45.470522, 9.171964 45.471037), LINESTRING (9.175038 45.468408, 9.173005 45.469958, 9.17249 45.470451, 9.171932 45.471004), LINESTRING (9.175075 45.468442, 9.173085 45.469995, 9.172758 45.470259, 9.171959 45.470996), LINESTRING (9.175172 45.468479, 9.172264 45.47074), LINESTRING (9.175204 45.468517, 9.173042 45.470199, 9.172286 45.470733), LINESTRING (9.175301 45.46857, 9.173369 45.470044, 9.172924 45.470353, 9.172028 45.471053), LINESTRING (9.175333 45.468607, 9.173439 45.470074, 9.172704 45.470597), LINESTRING (9.175419 45.468649, 9.173525 45.470135, 9.172023 45.471068), LINESTRING (9.175467 45.468694, 9.173563 45.470157, 9.172801 45.470639, 9.172103 45.471068), LINESTRING (9.175547 45.468739, 9.173638 45.470191, 9.172779 45.470605))

- non stopping areas (1.1.1.3.14.1, 1.1.1.3.14.2, 1.1.1.3.14.3, 1.1.1.3.14.5,
  - Specific type of signal non-stopping-area plus the length of the non stopping area
- Industrial risks (1.1.0.0.1.1), - WellKnownText Polygons
  - SpecialArea class

era:SpecialArea SKOS or SpecialAreaLocationTypes SKOS

values
"nonstopping areas", "sanding test areas", "industrial risk areas", "lowered pantograph areas" and "neutral section"

3.7. Characteristics of RINF parameters

All technical characteristics are described in the Technical Annex. It provides tables with clarification on:

- the requirements
- data presentation
- ontology concepts involved
- list of possible values (SKOS values)
- Applicability
- Repeatability
- XML name – used for the backward compatibility with the XML data provision and with data already provided and compatible with the initial regulation content.

The validation of the requirements, data presentation, applicability and repreatability is a process consisting on a set of SHACL validation rules to which the ERA ontology adheres to ensure compliance with the RINF regulation and described further and in detail in the Technical Annex for each ontology property.

A series of RINF parameters are characterized by units of measurement. When applicable, the UK, in respect to Northern Ireland, must convert imperial units to metric units.

3.8. Parameter groups hierarchy

The list below indicates the hierarchy of main parameter groups and subgroups.

The RINF parameters are organised by their index number, provided in the RINF regulation, as follows:

1. **MEMBER STATE**
   - **1.1 SECTION OF LINE**
     - **1.1.0.0.0 Generic information**
       - 1.1.0.0.0.1 **SOLIMCode** / IM's Code

1.1.0.0.0.2 **SOLLineIdentification** / National line identification
1.1.0.0.0.3 **SOLOPStart** / Operational Point at start of Section of Line
1.1.0.0.0.4 **SOLOPEnd** / Operational Point at end of Section of Line
1.1.0.0.0.5 **SOLLengt**h / Length of section of line
1.1.0.0.0.6 **SOLNature** / Nature of Section of Line

1.1.0.0.1 Route book specific parameters (Specifical technical characteristics)

1.1.0.0.1.1 Industrial risks — locations where it is dangerous for the driver to step out
1.1.0.0.1.2 Operating language
1.1.0.0.1.3 Operational regime

1.1.1 SOLTrack / RUNNING TRACK

1.1.1.0.0 Generic information

1.1.1.0.0.1 **SOLTrackIdentification** / Identification of track
1.1.1.0.0.2 **SOLTrackDirection** / Normal running direction
1.1.1.0.0.3 Lineside indications of distance (frequency, appearance and positioning)

1.1.1.0.1 Topology information

1.1.1.0.1.1 Accurate geographical description
1.1.1.0.1.2 Tracks connectivity to operational points

1.1.1.1 Infrastructure subsystem

Parameters below until 1.1.1.2 belong to the group of infrastructure parameters

1.1.1.1.1 IDE / Declarations of verification for track

1.1.1.1.1.1 **IDE_ECVerification** / EC declaration of verification for track (INF)
1.1.1.1.1.2 **IDE_EIDemonstration** / EI declaration of demonstration for track (INF)

1.1.1.1.2 IPP / Performance parameters

1.1.1.1.2.1 **IPP_TENClass** / TEN classification of track
1.1.1.1.2.1.2 **IPP_TENGISID** / TEN GIS identity – to be deprecated
1.1.1.1.2.2 **IPP_LineCat** / Category of line
1.1.1.1.2.3 **IPP_FreightCorridor** / Part of a Railway freight corridor
1.1.1.1.2.4 **IPP_LoadCap** / Load Capability
1.1.1.1.2.4.1 **IPP_NCLoadCap** /National classification for load capability
1.1.1.1.2.4.2 **IPP_HSLMCompliant**/Compliance of structures with the High Speed Load Model (HSLM) dynamic load model
1.1.1.1.2.4.3 **IPP_StructureCheckLoc**/Railway location of structures requiring specific checks
1.1.1.1.2.4.4 **IPP_StructureCheckDocRef** /Document with the procedure(s) for static and dynamic route compatibility checks
1.1.1.1.2.5 **IPP_MaxSpeed** / Maximum permitted speed
1.1.1.1.2.6 **IPP_TempRange** / Temperature range
1.1.1.1.2.7 **IPP_MaxAltitude** / Maximum altitude
1.1.1.1.2.8 **IPP_SevereClimateCon** / Existence of severe climatic conditions

1.1.1.1.3 ILL/ Line layout

1.1.1.1.3.1.1 **ILL_Gauging** / Gauging
1.1.1.1.3.1.2 **ILL_GaugeCheckLoc** / Railway location of particular points requiring specific checks
1.1.1.1.3.1.3 **ILL_GaugeCheckDocRef** / Document with the transversal section of the particular points requiring specific checks
1.1.1.1.3.4 **ILL_ProfileNumSwapBodies** / Standard combined transport profile number for swap bodies
1.1.1.1.3.5 **ILL_ProfileNumSemiTrailers** / Standard combined transport profile number for semi-trailers
1.1.1.1.3.5.1 **ILL_SpecificInfo** / Specific information
1.1.1.1.3.6 **ILL_GradProfile** / Gradient profile
1.1.1.1.3.7 **ILL_MinRadHorzCurve** / Minimum radius of horizontal curve
1.1.1.1.3.8 Standard combined transport profile number for containers
1.1.1.1.3.9 Standard combined transport profile number for roller units

1.1.1.1.4 ITP / Track parameters

1.1.1.2.2.1.3 **ECS_Umax2**/Umax2 for the French network
1.1.1.2.2.2 **ECS_MaxTrainCurrent** / Maximum train current
1.1.1.2.2.3 **ECS_MaxStandstillCurrent** / Maximum current at standstill per pantograph
1.1.1.2.2.4 **ECS_RegenerativeBraking** / Permission for regenerative braking
1.1.1.2.2.4.1 **ECS_RegBrakingConditions** / Conditions applying in regards to regenerative braking
1.1.1.2.2.5 **ECS_MaxWireHeight** / Maximum contact wire height
1.1.1.2.2.6 **ECS_MinWireHeight** / Minimum contact wire height

1.1.1.2.3 EPA / Pantograph

1.1.1.2.3.1 **EPA_TSIHeads** / Accepted TSI compliant pantograph heads
1.1.1.2.3.2 **EPA_OtherHeads** / Accepted other pantograph heads
1.1.1.2.3.3 **EPA_NumRaisedSpeed** / Requirements for number of raised pantographs and spacing between them, at the given speed
1.1.1.2.3.4 **EPA_StripMaterial** / Permitted contact strip material

1.1.1.2.4 EOS / OCL separation sections

1.1.1.2.4.1.1 **EOS_Phase** / Phase separation
1.1.1.2.4.1.2 **EOS_InfoPhase** / Information on phase separation
1.1.1.2.4.2.1 **EOS_System** / System separation
1.1.1.2.4.2.2 **EOS_InfoSystem** / Information on system separation
1.1.1.2.4.3 **EOS_DistSignToPhaseEnd**/Distance between signboard and phase separation ending

1.1.1.2.5 ERS / Requirements for rolling stock

1.1.1.2.5.1 **ERS_PowerLimitOnBoard** / Current or power limitation on board required
1.1.1.2.5.2 **ERS_ContactForce** / Contact force permitted
1.1.1.2.5.3 **ERS_AutoDropRequired** / Automatic dropping device required
1.1.1.2.5.4 Document with restriction related to power consumption of specific electric traction unit(s)
1.1.1.2.5.5 Document with restriction related to the position of Multiple Traction unit(s) to comply with contact line separation

1.1.1.3 Control-command and signalling subsystem

Parameters below until 1.1.1.4 belong to the group of CCS parameters

1.1.1.3.1 CDE / Declarations of verification for track

1.1.1.3.1.1 **CDE_ECVerification** / EC declaration of verification for track relating to compliance with the requirements from TSIs applicable to control, command signalling subsystem
1.1.1.3.1.2 **CDE_ReqErrorCorrections** / ERTMS error corrections required for the onboard

1.1.1.3.2 CPE / TSI compliant train protection system (ETCS)

1.1.1.3.2.1 **CPE_Level** / ETCS level
1.1.1.3.2.2 **CPE_Baseline** / ETCS baseline
1.1.1.3.2.3 **CPE_Infill** / ETCS infill necessary for line access
1.1.1.3.2.4 **CPE_InfillLineSide** / ETCS infill installed lineside
1.1.1.3.2.5 **CPE_NatApplication** / ETCS national packet 44 application implemented
1.1.1.3.2.6 **CPE_RestrictionsConditions** / Existence of operating restrictions or conditions
1.1.1.3.2.8 **CPE_IntegrityConfirmation** / Train integrity confirmation from on-board necessary for line access
1.1.1.3.2.9 **CPE_SystemCompatibility** / ETCS system compatibility
1.1.1.3.2.10 **CPE_MVersion** / ETCS M_version
1.1.1.3.2.11 **CPE_SafeConsistLength** / Safe consist length information from on-board necessary for access the line and SIL
1.1.1.3.2.12 **CPE_CanTransmitTCs** / Is the ETCS trackside engineered to transmit Track Conditions
1.1.1.3.2.12.1 **CPE_TransmittedTCs** / Track conditions which can be transmitted
1.1.1.3.2.13 **CPE_LXProcedure** / ETCS trackside implements level crossing procedure or an equivalent solution
1.1.1.3.2.14 **CPE_SSPUsesCantDef** / Cant Deficiency used for the basic SSP
1.1.1.3.2.14.1 **CPE_OtherCatDef** / Other Cant Deficiency train categories for which the ETCS trackside is configured to provide SSP
1.1.1.3.2.15 **CPE_RBCRejectReasons** / Reasons for which an ETCS Radio Block Center can reject a train
1.1.1.3.2.16 **ETCS National Values**

1.1.1.3.2.16.1 **CPE_DNVROLL** / D_NVROLL
1.1.1.3.2.16.2 **CPE_QNVEMRRLS** / Q_NVEMRRLS
1.1.1.3.2.16.3 **CPE_VNVALLOWOVTRP** / V_NVALLOWOVTRP
1.1.1.3.2.16.4 **CPE_VNVSUPOVTRP** / V_NVSUPOVTRP
1.1.1.3.2.16.5 **CPE_DNVOVTRP** / D_NVOVTRP
1.1.1.3.2.16.6 **CPE_TNVOVTRP** / T_NVOVTRP
1.1.1.3.2.16.7 **CPE_DNVPOTRP** / D_NVPOTRP
1.1.1.3.2.16.8 **CPE_TNVCONTACT** / T_NVCONTACT
1.1.1.3.2.16.9 **CPE_MNVCONTACT** / M_NVCONTACT
1.1.1.3.2.16.10 **CPE_MNVDERUN** / M_NVDERUN
1.1.1.3.2.16.11 **CPE_QNVDRIVERADHES** / Q_NVDRIVER_ADHES
1.1.1.3.2.16.12 **CPE_QNVSBTSMPERM** / Q_NVSBTSMPERM
1.1.1.3.2.16.13 **CPE_NVBRAKEMOD** / National Values used for the brake model
1.1.1.3.2.17 **CPE_IDPhone & CPE_IDRBC** / ID and phone number of ERTMS/ETCS Radio Block Center
1.1.1.3.2.18 **CPE_BigMetalMass** / Big Metal Mass
1.1.1.3.2.19 ETCS system version 2.2 or 3.0 functionalities to be required in the next 5 years

1.1.1.3.3 CRG / TSI compliant radio (RMR)

1.1.1.3.3.1 **CRG_Version** GSM-R version
1.1.1.3.3.2 **CRG_NumActiveMob** / Number of active GSM-R mobiles (EDOR) or simultaneous communication session on board for ETCS level 2 needed to perform radio block centre handovers without having an operational disruption
1.1.1.3.3.3 **CRG_OptionalFunctions** / Optional GSM-R functions
1.1.1.3.3.3.1 **CRG_AdditionalnetworkInfo** / Additional information on network characteristics
1.1.1.3.3.3.2 **CRG_GPRSForETCS** / GPRS for ETCS
1.1.1.3.3.3.3 **CRG_GPRSAreaOfImpl** / Area of implementation of GPRS
1.1.1.3.3.4 **CRG_Needof555** / Use of group 555
1.1.1.3.3.5 **CRG_RoamingAgreement** / GSM-R networks covered by a roaming agreement
1.1.1.3.3.6 **CRG_RoamingPublic** / Existence of roaming to public networks
1.1.1.3.3.7 **CRG_RoamingPublicDetails** / Details on roaming to public networks
1.1.1.3.3.8 **CRG_GSMRNoCoverage** / No GSMR coverage
1.1.1.3.3.9 **CRG_RadioCompVoice** / Radio system compatibility voice
1.1.1.3.3.10 **CRG_RadioCompData** / Radio system compatibility data
1.1.1.3.3.11 **CRG_ForcedDeReg** / GSM-R network is configured to allow forced de-registration of a functional number by another driver
1.1.1.3.3.12 **CRG_RadioNID** / Radio Network ID

1.1.1.3.4 CCD / Train detection systems defined based on frequency bands

1.1.1.3.4.1 **CCD_TSITrainDetection** / Existence of train detection system fully compliant with the TSI
1.1.1.3.7.1.1 **CTD_DetectionSystem** / Type of train detection system
1.1.1.3.4.2 **CCD_FreqBandsDet** / Frequency bands for train detection
1.1.1.3.4.2.1 **CCD_InterferenceImax** / Maximum interference current
1.1.1.3.4.2.2 **CCD_TCVehicleImpedance** / Vehicle Impedance
1.1.1.3.4.2.3 **CCD_ACMagFieldMax** / Maximum magnetic field

1.1.1.3.5 CPO / Train protection legacy systems

1.1.1.3.5.3 **CPO_LegacyTrainProtection** / Train protection legacy system

1.1.1.3.6 CRS / Radio Legacy systems

1.1.1.3.6.1 **CRS_Installed** / Other radio systems installed (Radio Legacy Systems)

1.1.1.3.7 CTD / Train detection systems not fully compliant with the TSI

1.1.1.3.7.1.2 **CTD_TCCheck** / Type of track circuits to which specific checks are needed
1.1.1.3.7.1.3 **CTD_TCCheckDocRef** / Document with the procedure(s) related to the type of track circuits declared in 1.1.1.3.7.1.2
1.1.1.3.7.1.4 **CTD_TCLimitation**/Section with train detection limitation

1.1.1.3.8 CTS / Transitions between systems

1.1.1.3.8.1 **CTS_SwitchProtectControlWarn** / Existence of switch over between different protection, control and warning systems while running

1.1.1.3.8.1.1 **CTS_SwitchProtectConditions** / Special conditions to switch over between different class B train protection, control and warning systems

1.1.1.3.8.2 **CTS_SwitchRadioSystem** / Existence of switch over between different radio systems

1.1.1.3.8.2.1 **CTS_SwitchRadioConditions** / Special instructions to switch over between different radio systems

1.1.13.8.3 **CTS_SwitchProtectAB** / Special technical conditions required to switch over between ERTMS/ETCS and Class B systems

1.1.1.3.9 CEI / Parameters related to electromagnetic interferences

1.1.1.3.9.1 **CEI_TSIMagneticFields** / Existence and TSI compliance of rules for magnetic fields emitted by a vehicle

1.1.1.3.9.2 **CEI_TSITractionHarmonics** / Existence and TSI compliance of limits in harmonics in the traction current of vehicles

1.1.1.3.10 CLD / Line-side system for degraded situation

1.1.1.3.10.1 **CLD_ETCSSituation** / ETCS level for degraded situation

1.1.1.3.10.2 **CLD_OtherProtectControlWarn** / Other train protection, control and warning systems for degraded situation

1.1.1.3.11 CBP / Brake related parameters

1.1.1.3.11.1 **CBP_MaxBrakeDist** / Maximum braking distance requested

1.1.1.3.11.2 **CBP_AddInfoAvailable** / Availability by the IM of additional information

1.1.1.3.11.3 **CBP_BrakePerfDocRef**/ Documents available by the IM relating to braking performance

1.1.1.3.12 (Intentionally blank)

1.1.1.3.13 Automated Train Operation (ATO)

1.1.1.3.13.1 **ATO_GradeAutomation** / ATO Grade of Automation

1.1.1.3.13.2 **ATO_SysVer** / ATO System version

1.1.1.3.13.3 **ATO_CommSystem** / ATO communication system

1.1.1.3.14 SIG / Signals

1.1.1.3.14.1 **SIG_Name** / Name of Signal

1.1.1.3.14.2 **SIG_Type** / Type of Signal

1.1.1.3.14.3 **SIG_LocDir**/ Location and orientation

1.1.1.3.14.4 **SIG_RelDistDP** / Relative distance to the danger point

1.1.1.3.14.5 **SIG_NSTALength** / Length of the non-stopping area

1.1.1.3.14.6 **SIG_GeoLocation** / Geographical location of signal

1.1.1.4 Rules and restriction

1.1.1.4.1 **RUL_LocalRulesOrRestrictions** / Existence of rules and restrictions of a strictly local nature

1.1.1.4.2 **RUL_LocalRulesOrRestrictionsDocRef** /Reference of the documentsDocuments regarding the rules or restrictions of a strictly local nature available by the IM

1.1.1.5 Vehicles for which Route compatibility is verified

1.1.1.5.1 List of vehicle types already identified as compatible with Traffic load and load carrying capacity of infrastructure and train detection systems

1.1.1.5.2 List of vehicles already identified as compatible with Traffic load and load carrying capacity of infrastructure and train detection systems

1.2 OPERATIONAL POINT

1.2.0.0.0 Generic information

1.2.0.0.0.1 **OPName** / Name of Operational point

1.2.0.0.0.2 **UniqueOPID** /Unique OP ID

1.2.0.0.0.3 O**PTafTapCode** / OP TAF TAP primary code

1.2.0.0.0.4 **OPType** / Type of Operational Point

1.2.0.0.0.4.1 **OPTypeGaugeChangeover** / Type of track gauge changeover facility

1.2.0.0.0.5 **OPGeographicLocation** / Geographical location of Operational Point
1.2.0.0.0.6 **OPRailwayLocation** / Railway location of Operational point
1.2.0.0.0.7 Schematic overview of the operational point in digital form
1.2.0.0.0.7.1 Schematic overview of the operational point
1.2.0.0.0.7.2 Digital schematic overview
1.2.0.0.0.8 Operating language

1.2.1 OPTrack / RUNNING TRACK

1.2.1.0.0 Generic information

1.2.1.0.0.1 **OPTrackIMCode** / IM's Code
1.2.1.0.0.2 **OPTrackIdentification** / Identification of track

1.2.1.0.1 IDE / Declarations of verification for track

1.2.1.0.1.1 **IDE_ECVerification** / EC declaration of verification for track relating to compliance with the requirements from TSIs applicable to infrastructure subsystem
1.2.1.0.1.2 **IDE_EIDemonstration** / EI declaration of demonstration (as defined Recommendation 2014/881/EU) relating to compliance with the requirements from TSIs applicable to infrastructure subsystem

1.2.1.0.2 IPP / Performance parameters

1.2.1.0.2.1 **IPP_TENClass** / TEN classification of track
1.2.1.0.2.2 **IPP_LineCat** / Category of Line
1.2.1.0.2.3 **IPP_FreightCorridor** / Part of a Railway freight corridor

1.2.1.0.3 ILL / Line layout

1.2.1.0.3.4 **ILL_Gauging** / Gauging
1.2.1.0.3.5 **ILL_GaugeCheckLoc/**Railway location of particular points requiring specific checks
1.2.1.0.3.6 **ILL_GaugeCheckDocRef** /Document with the transversal section of the particular points requiring specific checks

1.2.1.0.4 ITP / Track Parameters

1.2.1.0.4.1 **ITP_NomGauge** / Nominal track gauge
1.2.1.0.4.2 Use of eddy current brakes
1.2.1.0.4.3 Use of magnetic brakes

1.2.1.0.5 OPTrackTunnel / Tunnel

1.2.1.0.5.1 **OPTrackTunnelIMCode** / IM's Code
1.2.1.0.5.2 **OPTrackTunnelIdentification** / Tunnel identification
1.2.1.0.5.3 **ITU_ECVerification** / EC declaration of verification for tunnel relating to compliance with the requirements from TSIs applicable to railway tunnel
1.2.1.0.5.4 **ITU_EIDemonstration** / EI declaration of demonstration (as defined Recommendation 2014/881/EU) for tunnel relating to compliance with the requirements from TSIs applicable to railway tunnel)
1.2.1.0.5.5 **ITU_Length** / Length of tunnel
1.2.1.0.5.6 **ITU_EmergencyPlan** / Existence of emergency plan
1.2.1.0.5.7 **ITU_FireCatReq** / Fire category of rolling stock required
1.2.1.0.5.8 **ITU_NatFireCatReq** / National fire category of rolling stock required
1.2.1.0.5.9 **ITU_ThermAllowed**/Diesel or other thermal traction allowed
1.2.1.0.5.10 Existence of walkways
1.2.1.0.5.10.1 Location of walkways
1.2.1.0.5.11 Existence of evacuation and rescue points
1.2.1.0.5.11.1 Location of evacuation and rescue points

1.2.1.0.6 OPTrackPlatform / Platform

1.2.1.0.6.1 **OPTrackPlatformIMCode** / IM's Code
1.2.1.0.6.2 **OPTrackPlatformIdentification** / Identification of platform
1.2.1.0.6.3 **IPL_TENClass** / TEN Classification of platform
1.2.1.0.6.4 **IPL_Length** / Usable length of platform

1.2.1.0.6.5 **IPL_Height** / Height of platform
1.2.1.0.6.6 **IPL_AssistanceStartingTrain** / Existence of platform assistance for starting train
1.2.1.0.6.7 **IPL_AreaBoardingAid** / Range of use of the platform boarding aid
1.2.1.0.6.8 Curvature of the platform

1.2.1.0.7 Contact line system
1.2.1.0.7.1 Permission for charging electric energy storage for traction purposes at standstill
1.2.1.0.7.2 Permitted conditions for charging electric energy storage for traction purposes at standstill

1.2.1.0.8 Signal
1.2.1.0.8.1 Name of signal
1.2.1.0.8.2 Type of signal
1.2.1.0.8.3 Location and orientation
1.2.1.0.8.4 Relative distance of the danger point
1.2.1.0.8.5 Geographical location of signal

1.2.1.1 Control – command and signalling subsystem
1.2.1.1.1 TSI compliant train protection system (ETCS)
1.2.1.1.1.1 European Train Control System (ETCS) level
1.2.1.1.1.2 ETCS baseline
1.2.1.1.1.3 ETCS infill necessary for line access
1.2.1.1.1.4 ETCS infill installed line-side
1.2.1.1.1.5 ETCS national packet 44 application implemented
1.2.1.1.1.6 Existence of operating restrictions or conditions
1.2.1.1.1.8 Train integrity confirmation from on-board (not from driver) necessary for line access
1.2.1.1.1.9 ETCS system compatibility
1.2.1.1.1.10 ETCS M_version
1.2.1.1.1.11 Safe consist length information from on-board necessary for access the line and SIL
1.2.1.1.1.12 Is the ETCS trackside engineered to transmit Track Conditions
1.2.1.1.1.12.1 Track conditions which can be transmitted
1.2.1.1.1.13 ETCS trackside implements level crossing procedure or an equivalent solution
1.2.1.1.1.14 Cant Deficiency used for the basic SSP
1.2.1.1.1.14.1 Other Cant Deficiency train categories for which the ETCS trackside is configured to provide SSP
1.2.1.1.1.15 Reasons for which an ETCS Radio Block Center can reject a train
1.2.1.1.1.16 ETCS National Values
1.2.1.1.1.16.1 D_NVROLL
1.2.1.1.1.16.2 Q_NVEMRRLS
1.2.1.1.1.16.3 V_NVALLOWOVTRP
1.2.1.1.1.16.4 V_NVSUPOVTRP
1.2.1.1.1.16.5 D_NVOVTRP
1.2.1.1.1.16.6 T_NVOVTRP
1.2.1.1.1.16.7 D_NVPOTRP
1.2.1.1.1.16.8 T_NVCONTACT
1.2.1.1.1.16.9 M_NVCONTACT
1.2.1.1.1.16.10 M_NVDERUN
1.2.1.1.1.16.11 Q_NVDRIVER_ADHES
1.2.1.1.1.16.12 Q_NVSBTSMPERM
1.2.1.1.1.16.13 National Values used for the brake model
1.2.1.1.1.17 ID and phone number of ERTMS/ETCS Radio Block Center
1.2.1.1.1.18 Big Metal Mass
1.2.1.1.1.19 ETCS error corrections required for the on-board
1.2.1.1.1.20 ETCS system version 2.2 or 3.0 functionalities to be required in the next 5 years
1.2.1.1.2 TSI compliant radio (RMR)

1.2.1.1.2.1 GSM-R version
1.2.1.1.2.2 Number of active GSM-R mobiles (EDOR) or simultaneous communication session on board for ETCS level 2 needed to perform radio block centre handovers without having an operational disruption
1.2.1.1.2.3 Optional GSM-R functions
1.2.1.1.2.3.1 Additional information on network characteristics
1.2.1.1.2.3.2 GPRS for ETCS
1.2.1.1.2.3.3 Area of implementation of GPRS
1.2.1.1.2.4 GSM-R use of group 555
1.2.1.1.2.5 GSM-R networks covered by a roaming agreement
1.2.1.1.2.6 Existence of GSM-R roaming to public networks
1.2.1.1.2.7 Details on GSM-R roaming to public networks
1.2.1.1.2.8 No GSMR coverage
1.2.1.1.2.9 Radio system compatibility voice
1.2.1.1.2.10 Radio system compatibility data
1.2.1.1.2.11 GSM-R network is configured to allow forced de-registration of a functional number by another driver
1.2.1.1.2.12 Specific constraints imposed by the GSM-R network operator on ETCS on-board units only able to operate in circuit-switch
1.2.1.1.2.13 Radio Network ID

1.2.1.1.3 Train detection systems defined based on frequency bands

1.2.1.1.3.1 Existence of train detection system fully compliant with the TSI:
1.2.1.1.3.1.1 Type of train detection system
1.2.1.1.3.2 Frequency bands for detection
1.2.1.1.3.2.1 Maximum interference current
1.2.1.1.3.2.2 Vehicle impedance
1.2.1.1.3.2.3 Maximum magnetic field

1.2.1.1.4 Train protection legacy systems

1.2.1.1.4.1 Train protection legacy system

1.2.1.1.5 Radio legacy systems

1.2.1.1.5.1 Other radio systems installed (Radio Legacy Systems)

1.2.1.1.6 other train detection systems

1.2.1.1.6.1 Type of track circuits or axle counters to which specific checks are needed
1.2.1.1.6.2 Document with the procedure(s) related to the type of train detection systems declared in 1.2.1.1.6.1
1.2.1.1.6.3 Section with train detection limitation

1.2.1.1.7 Transitions between systems

1.2.1.1.7.1 Existence of switch over between different protection, control and warning systems while running
1.2.1.1.7.1.1 Special conditions to switch over between different class B train protection, control and warning systems
1.2.1.1.7.2 Existence of switch over between different radio systems
1.2.1.1.7.2.1 Special instructions to switch over between different radio systems
1.2.1.1.7.3 Special technical conditions required to switch over between ERTMS/ETCS and Class B systems

1.2.1.1.8 Parameters related to electromagnetic interferences

1.2.1.1.8.1 Existence and TSI compliance of rules for magnetic fields emitted by a vehicle
1.2.1.1.8.2 Existence and TSI compliance of limits in harmonics in the traction current of vehicles

1.2.1.1.9 Line-side system for degraded situation

1.2.1.1.9.1 ETCS level for degraded situation
1.2.1.1.9.2 Other train protection, control and warning systems for degraded situation

1.2.1.1.10 Automated Train Operation (ATO)

1.2.1.1.10.1 ATO Grade of Automation
1.2.1.1.10.2 ATO System version
1.2.1.1.10.3 ATO communication system

1.2.2 OPSiding / SIDING

1.2.2.0.0 Generic information

1.2.2.0.0.1 **IM's Code** / IM's Code
1.2.2.0.0.2 **OPSidingIdentification** / Identification of siding
1.2.2.0.0.3 **IPP_TENClass** / TEN classification of siding

1.2.2.0.1 IDE / Declaration of verification for siding

1.2.2.0.1.1 **IDE_ECVerification** / EC declaration of verification for siding (INF)
1.2.2.0.1.2 **IDE_EIDemonstration** / EI declaration of demonstration for siding (INF)

1.2.2.0.2 IPP / Performance parameter

1.2.2.0.2.1 **IPP_Length** / Usable length of siding

1.2.2.0.3 Line layout

1.2.2.0.3.1 **ILL_Gradient** / Gradient for stabling tracks
1.2.2.0.3.2 **ILL_MinRadHorzCurve** / Minimum radius of horizontal curve
1.2.2.0.3.3 **ILL_MinRadVertCurve** / Minimum radius of vertical curve

1.2.2.0.4 ITS / Fixed installations for servicing trains

1.2.2.0.4.1 **ITS_ToiletDischarge** / Existence of toilet discharge
1.2.2.0.4.2 **ITS_ExternalCleaning** / Existence of external cleaning facilities
1.2.2.0.4.3 **ITS_WaterRestocking** / Existence of water restocking
1.2.2.0.4.4 **ITS_Refuelling** / Existence of refuelling
1.2.2.0.4.5 **ITS_SandRestocking** / Existence of sand restocking
1.2.2.0.4.6 **ITS_ElectricShoreSupply** / Existence of electric shore supply

1.2.2.0.5 OPSidingTunnel / Tunnel

1.2.2.0.5.1 **OPSidingTunnelIMCode** / IM's Code
1.2.2.0.5.2 **OPSidingTunnelIdentification** / Tunnel identification
1.2.2.0.5.3 **ITU_ECVerification** / EC declaration of verification for tunnel relating to compliance with the requirements from TSIs applicable to railway tunnel
1.2.2.0.5.4 **ITU_EIDemonstration** / EI declaration of demonstration (as defined Recommendation 2014/881/EU) for tunnel relating to compliance with the requirements from TSIs applicable to railway tunnel
1.2.2.0.5.5 **ITU_Length** / Length of tunnel
1.2.2.0.5.6 **ITU_EmergencyPlan** / Existence of emergency plan
1.2.2.0.5.7 **ITU_FireCatReq** / Fire category of rolling stock required
1.2.2.0.5.8 **ITU_NatFireCatReq** / National fire category of rolling stock required
1.2.2.0.5.9 Existence of walkways
1.2.2.0.5.9.1 Location of walkways
1.2.2.0.5.10 Existence of evacuation and rescue points
1.2.2.0.5.10.1 Location of evacuation and rescue points

1.2.2.0.6 ECS / Contact line system

1.2.2.0.6.1 **ECS_MaxStandstillCurrent**/Maximum current at standstill per pantograph

1.2.3 Rules and restriction

1.2.3.1 **RUL_LocalRulesOrRestrictions** / Existence of rules and restrictions of a strictly local nature
1.2.3.2 **RUL_LocalRulesOrRestrictionsDocRef** /Documents regarding the rules or restrictions of a strictly local nature available by the IM

1.2.4 Navigability

1.2.4.1 Internal connection

3.9. Relations between parameters

The Technical Annex of this guide (see 5.1) provides information on relationships between parameters. Parameters are mandatory if applicable. The “applicability” of parameters can depend on value in relation to TSI or value of other primary parameters. E.g.:

- parameter 1.1.0.0.0.1 (“IM Code“) is applicable in all cases and mandatory
- 1.1.2.2.6 (“Minimum contact wire height”) is applicable (“Y”) only if “Overhead contact line (OCL)” is selected in 1.1.1.2.2.1.1 and then mandatory to be provided.

The guide provides also explanation on the “specific applicability” of some of them.

Furthermore, Table 1 of the RINF Regulation defines 2 types of deadlines for data provision:

- Fixed deadlines, typically by **16 March 2019 at the latest**, after which the provision of parameters is **mandatory.**
- Flexible deadlines, set **12 months after the publication of the current Article 7 Guide**.

When a fixed deadline applies, the corresponding parameters must be provided. In the case of flexible dealine, the applicability flag **"NYA" (Not Yet Available)** is accepted, unlike in the case of fixed deadlines.

Three groups of parameters need to be used with a “Set” attribute each time the ”parent” parameter is repeated with a different value. They have to be provided at the level of each track in a SoL.

As long as the XML data set are supported, the XML attribute called “Set” must be declared at the parent and children level with the same keyword value.

The parameters represented by a set group have to be declared for each “parent” present on a track, the applicability and values are entered for each system described.

Even though all the parameters are set in the XML file to applicable=”N” or “NYA”, the RINF application still requires the ‘Set’ attribute to be declared and populated.

The principles for the use of the set attribute are:

- Any string of characters can be used as value of a set but it must be different from one set to another;
- The value of a given set must be unique in a given track.

The parameters represented by a set group have to be declared for each system present on a track, the applicability and values are entered for each system described.

Even though all the parameters are set in the XML file to applicable=”N”, the RINF application still requires the ‘Set’ attribute to be declared and populated.

In the ERA ontology, these relationships have been modeled differently. Instead of relying on the “Set” attribute, which is the XML attribute defined by the RINF XML schema, the ontology uses classes. These classes serve as domain of the properties that represent the RINF parameters. The benefit of this approach is that it provides a more structured and semantically rich way to express the relationships.

For example:

- Each type of contact line declared (parameter 1.1.1.2.2.1.1: ECS_SystemType / Type of contact line system) corresponds to a class era:ContactLineSystem. This class acts as the domain for properties such as ECS_VoltFreq, ECS_TSIVoltFreq, and ECS_Umax2.
- Similarly, ETCS levels (parameter 1.1.1.3.2.1: CPE_Level / ETCS level) are modeled as distinct classes, which are the domain for properties like CPE_Baseline.

The ontology eliminates the need for manually managing "Set" attributes, replacing it with a more formalized and maintainable representation of data relationships.

The principles for the use of the "Set" attribute remain relevant only in the context of data provision through an XML using the RINF XML schema, but it becomes obsolete when the provision will be done entirely in RDF.

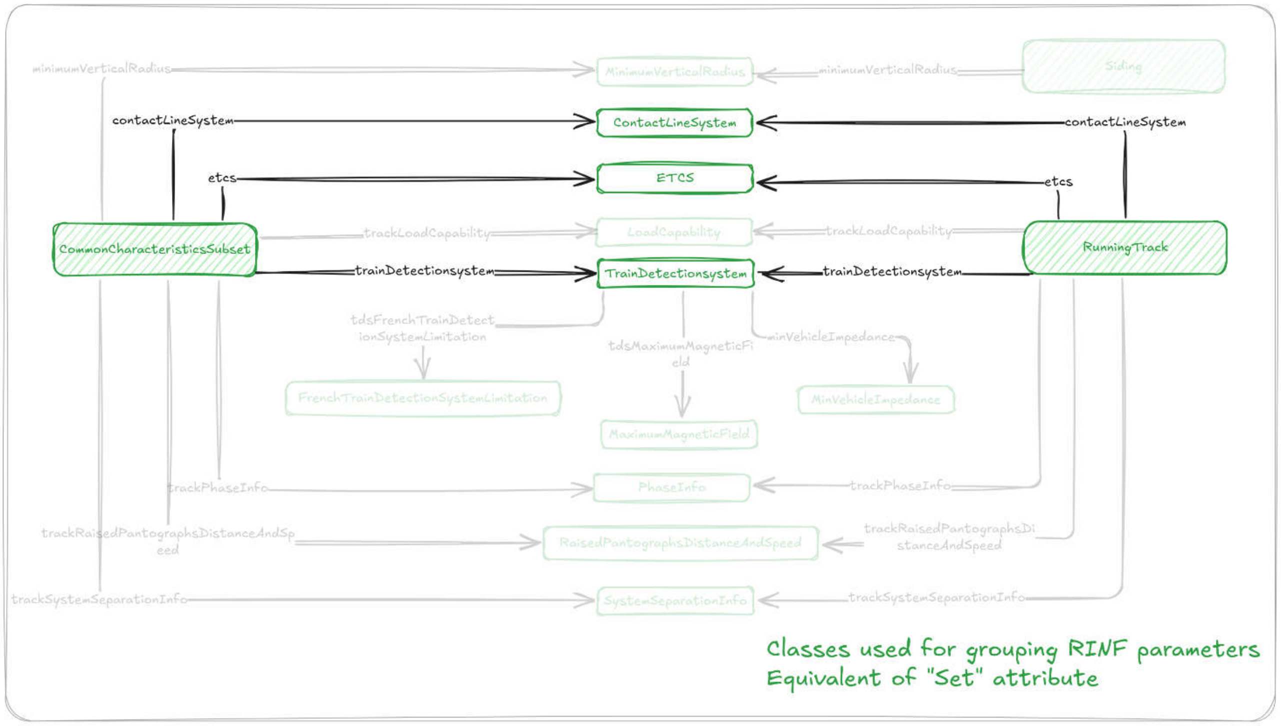


Figure 20 - Different classses used to group parameters

The groups of "linked" parameters are the followings:

1. **Contact line system**

   For each type of contact line system, a new instance of the of the **era:ContactLineSystem** class will have to be created (this is the equivalent of using the Set attribute in the XML schema). For this instance the following set of parameters has to be provided:

   1.1.1.2.2.1.1 **ECS_SystemType** / Type of contact line system

1.1.1.2.2.1.2 **ECS_VoltFreq** / Energy supply system (voltage and frequency)
1.1.1.2.2.1.3 **ECS_Umax2**/Umax2 for the French network
1.1.1.2.2.2 **ECS_MaxTrainCurrent** / Maximum train current
1.1.1.2.2.3 **ECS_MaxStandstillCurrent** / Maximum current at standstill per pantograph
1.1.1.2.2.4 **ECS_RegenerativeBraking** / Permission for regenerative braking
1.1.1.2.2.4.1 **ECS_RegBrakingConditions** / Conditions applying in regards to regenerative braking
1.1.1.2.2.5 **ECS_MaxWireHeight** / Maximum contact wire height
1.1.1.2.2.6 **ECS_MinWireHeight** / Minimum contact wire height

```
era:track1 a era:Track ;
    era:contactLineSystem era:OCL, era:ThirdRail .  # a track with 2contact line systems

era:OCL a era:ContactLineSystem ;
    era:contactLineSystemType era-skos-cls:10 ;  # Overhead contact line (OCL)
    era:energySupplySystem era-skos-ene:AC10 ;  # AC 25kV-50Hz
    era:notApplicable era:umax2 ;  # mark parameter as not applicable
    era:maxTrainCurrent "4000"^^xsd:integer ;  # 4000Amp
    era:maxCurrentStandstillPanthograph "300"^^xsd:double ;  # 300A
    era:conditionalRegenerativeBrake era-skos-regb:10 ;  # allowed
    era:conditionsAppliedRegenerativeBraking [ a era:Document ;
                                               foaf:name "IG02042.pdf"@en ;
                                               era:documentUrl
"http://data.europa.eu/api/documents/download?id=70bc3b48f7601118873abc6a4856e06a869cbd48" ] ;
    era:minimumContactWireHeight    "5.8"^^xsd:double;
    era:maximumContactWireHeight    "6"^^xsd:double.

era:ThirdRail a era:ContactLineSystem ;
    era:contactLineSystemType era-skos-cls:20 ; #Third rail
    era:notYetAvailable era:energySupplySystem, era:umax2, era:maxTrainCurrent; #not yet
available values
    era:conditionalRegenerativeBrake era-skos-regb:20 .  #not allowed
```

2. TSI compliant train protection system (ETCS)

For each TSI compliant train protection system (ETCS) a new instance of the of the **era:ETCS** class will have to be created (this is the equivalent of using the Set attribute in the XML schema). For this instance the following set of parameters has to be provided:

1.1.1.3.2.1 **CPE_Level** / ETCS level
1.1.1.3.2.2 **CPE_Baseline** / ETCS baseline

3. Train detection system

For each train detection system a new instance of the of the **era:TrainDetectionSystem** class will have to be created (this is the equivalent of using the Set attribute in the XML schema). For this instance the following set of parameters has to be provided:

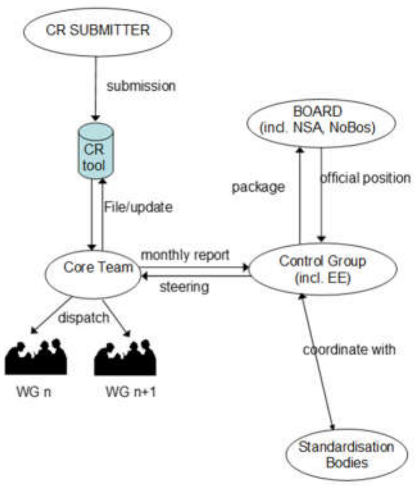
1.1.1.3.7.1.1 **CTD_DetectionSystem** / Type of train detection system

1.1.1.3.4.2 **CCD_FreqBandsDet** / Frequency bands for train detection
1.1.1.3.4.2.1 **CCD_InterferenceImax** / Maximum interference current
1.1.1.3.4.2.2 **CCD_TCVehicleImpedance** / Vehicle Impedance
1.1.1.3.4.2.3 **CCD_ACMagFieldMax** / Maximum magnetic field
1.1.1.3.7.1.2 **CTD_TCCheck** / Type of track circuits to which specific checks are needed
1.1.1.3.7.1.3 **CTD_TCCheckDocRef** / Document with the procedure(s) related to the type of track circuits declared in 1.1.1.3.7.1.2
1.1.1.3.7.1.4 **CTD_TCLimitation**/Section with train detection limitation

3.10. Governance process of the items for RINF (Technical Annex)

According to the article 2(6) of the RINF Regulation, the Agency has set up a group (“RINF Working Group”) composed of representatives of the infrastructure managers which coordinates, monitors and supports the implementation of this Regulation into the RINF Application. This group shall also support the future development of this Regulation. National registration entities designated under Article 5 of RINF Regulation shall have the right to participate in line with their tasks and scope of activities. As appropriate, the Agency shall invite experts and representative bodies.

As the table of parameters in the Technical Annex will be mirrored in the ERA Vocabulary (a subset), it will be evolving together with the ERA Vocabulary which will be implementing a Change Control Management (CCM) procedure. That is to say that all Change requests related to it will be processed via the ERA Vocabulary CCM in accordance with the figure below as follows:



- The entry point for introducing change requests (CRs) is the “Issues” section of the official repository at GitHub - Interoperable-data.
- The designated core team will be working on the version based on the Change requests log in cooperation with the exeprts via WGs (such as the RINF WG)
- The Agency’s Team working on TSIs will be the Control Group that will ensure that the ERA Vocabulary remains aligned with TSIs and other Regulations.
- The Board will be taking an official position (Approve/Reject) on the draft version of the ERA Vocabulary before publication.

4. PRINCIPAL RULES FOR THE RINF APPLICATION

4.1. Main principles

The principles listed below form the basis of the functional and non-functional requirements of the RINF system.

a) The RINF application is a web-based application that is available over the Internet.
b) Only the RINF data specified in the RINF regulation have to be provided by the IMs to the RINF application.
c) RINF application will allow the data provision of the full network on an IM
d) RINF application will support the introduction of partial changes on the infrastructure (new elements, new technical characteristics, etc.)
e) All previously existing data (from previous datasets, full or partial) shall be stored for 2 years from the date of data publication and will not be available through the RINF application.
f) No information can be provided in the RINF datasets about railway infrastructure which is no longer in service. Within the RINF dataset, the IMs have the possibility to provide the following types of time-related information:
    a. Information about the currently existing railway infrastructure
    b. Information about railway infrastructure that will come into service in the future
    c. Information about currently existing railway infrastructure that will cease to operate in the future
g) No actual documents or other file attachments are included in the RINF datasets, but only references to documents.
h) Reference documents upload is supported
i) The RINF application will allow RUs to be notified when there is a change in RINF data upon demand (subscription).

In order to ensure compliance with the provision in article 4, paragraph 1 of the RINF Regulation, it is strongly suggested to the IMs to define verification processes and procedures to ensure accuracy, completeness, consistency and timeliness of the submitted data.

4.2. Governance

4.2.1. General

Governance is an important aspect to be considered for the implementation and the future operation of RINF. This can be divided in three major areas:

- Governance for the **implementation of the RINF system**, including the business processes, software development, the testing and validation, and implementation of the various sub-systems that will provide the RINF set of data.
- Governance for the **maintenance of the RINF system**, in order to guarantee the availability and integrity of RINF data.

- Governance of the **ERA Vocabulary (in the Technical Annex)**, as described in section Governance process of the items for RINF (Technical Annex).

4.2.2. Registers at Member State level

Roles and responsibilities are defined in the RINF Regulation :

- article 2 for ERA and the infrastructure managers,
- article 3 for the Member States,
- article 4 for the IM sregarding the collection and the insertion of the data ensuring the accuracy, completeness, consistency and timeliness of data in the RINF Application,.
- article 5 for the NREs, that may be designated to act as point of contact between ERA and the infrastructure managers in the view of assisting and coordinating the infrastructure managers of their territory (provided that this does not put at risk the availability of data in accordance with Article 4 of RINF Regulation).

4.2.3. Responsibilities

Each IM managing infrastructure falling in the scope of the Interop Directive and/or with a valid safety authorisation are responsible for:

- **Collecting, maintaining and submitting** infrastructure data to RINF knowledge graph, in compliance with the RINF Regulation;
- Ensuring regular updates through partial (or full) datasets, to reflect the changes in the infrastructure or its technical characteristics, ensuring data availability and timeliness;
- Implementing proper processes to ensure **accuracy, completeness and consistency** of the published data, recognising the impact of the data quality on railway safety and taking measures to prevent inaccuracies;
- Preparing the datasets by applying data quality assurance mechanisms, including validation checks before submissions;
- Follow-up with ERA relating to any issues on failing validation or upload;
- Manage the data on their domestic border points;
- Cooperate with NREs to facilitate a smooth data submission process.

When designated by member states, the NREs have the following responsibilities:

- Act as intermediaries between the IMs and ERA;
- Support and coordinate the IMs within their member state to ensure that the data is submitted according to the RINF Regulation.

In addition, NREs may assist IMs in fulfilling their obligations, by using the RINF application to act on their behalf, ensuring that no infrastructure data is missing due to limited resources of the IMs.

ERA will be responsible for the following:

- Provide relevant documentation relating to maintenance and evolution of RINF.
- Manage the list of MS border points
- Provide validation mechanism for the IMs to check the quality of their datasets before submitting them to the knowledge graph
- Facilitate the dataset uploading, through a web interface available to IM users (or to any designated NRE, which will impersonate the IMs in their member states)
- Advise the responsible IM of any problem
- Provide notification mechanism to RUs on data updates.
- Provide visibility on quality of upload process toward NREs, and on quality of data towards users.
- Manage and publish a clear timeline in cooperation with the WG to manage the changes in the RINF system and artefacts (such as this Application guide, Technical Annex, Validation guide etc.). This should implement the RINF regulation and the deadlines set within.

Responsibility for the correctness and integrity of RINF data lies with the IM. ERA shall finally check the validity of the submitted RINF data in terms of its conformity with the RINF data quality rules. Non-valid RINF data will be rejected by ERA.

4.3. System Architecture

The ERA Register of Infrastructure (RINF) is the main tool for describing the static rail network characteristics and capabilities as required by the Directive (EU) 2016/797 on rail Interoperability, including all the relevant information for the Route Compatibility, and the Route Book.

The RINF software application is a web-based application facilitating at European level the access to the data of national registers of railway infrastructure. The access rights of the RINF User to the data depend on the role that is assigned to the user upon the creation of her/his profile.

The RINF software application enables the provision and search of information regarding the characteristics and capabilities of operational points and sections of lines that belong to the static rail network. RINF allows users to describe: Operational Points (OP) representing stations, junctions, etc; Section of Lines (SoL) describing the characteristics of tracks which link Operational Points together. This information can be provided as a complete dataset in XML format by infrastructure managers (IMs), or via partial updates in RDF, and is internally maintained as an RDF Knowledge Graph. The RINF System also provides a Route Compatibility Check (RCC) functionality where the objective is to check whether a certain railway vehicle can travel the route between two operational points. The information on vehicle types is originated from the European Registry Authorized Type of Vehicle (ERATV).

The main types of users of this System are:

- **Data providers**. They are authenticated in the system, and are mainly responsible for the provision of railway infrastructure data. They also have access to some special functionalities that are not accessible to all types of users. They can be further classified into:

    ○ **Infrastructure managers**. Those that are responsible for managing a railway infrastructure (e.g., ADIF in Spain)

○ **National registration entities**. Member State may designate a national registration entity to act as point of contact between the Agency and the infrastructure managers in the view of assisting and coordinating the infrastructure managers of their territory provided that this does not put at risk the availability of data. In the case the infrastructure managers without capacity to populate RINF, the NRE could decide to take over the role of completing this task on their behalf. To ensure that this process is correctly implemented in the RINF application, the NRE must inform ERA in advance about those IMs they would like to impersonate.

- **RRU Users**. A RRU user is a representative of a Railway Undertaking that registered himself/herself in view of obtaining a certificate each time the export of characteristics from a search is intended to be used by the railway undertaking in accordance with Article 23(1) of Directive (EU) 2016/797
- **IM Users**. An IM user is a person designated by an Infrastructure Manager.
- **Admin Users**. Users that are in charge of the administrative tasks associated to the maintenance of the RINF application.
- **Standard users**. Anybody who has interest in exploring the data available in RINF or using any of the functionalities provided by the RINF application. These users are not authenticated.

The main types of user-facing functionalities of the system are:

- Dataset management, focused on allowing data providers (IMs and NREs) to manage the data assets that correspond to the railway infrastructure that they are in charge of.
- Notification management, focused on providing notifications to users on changes in the data that may affect them.
- Search, allowing access to the railway infrastructure information stored as an RDF Knowledge Graph.
- Route Compatibility Check (RCC), to check whether a certain railway vehicle can travel the route between two operational points.
- SPARQL query , via an endpoint for running queries on the information available in the RDF Knowledge Graph.

Besides these functionalities, an ontology and a set of corresponding SKOS thesauri are also published, providing the conceptual overview of the RINF information model. Together with this ontology and SKOS thesauri, several other artefacts are generated that can be used in the process of knowledge graph creation and validation, such as RML mappings and SHACL shapes.

The main components deployed are the following:

- **General landing page**. Its purpose is to provide the landing page of RINF, which is accessible at https://data-interop.era.europa.eu/ (production environment)
  One additional test environment will be made available and comunicatd to the data providers
- **Dataset management**. The purpose of all of this functionality is to provide support for the management of datasets by data providers. It contains several images, following a micro-service approach, that are in charge of different steps of the dataset management process, especially on the processes of dataset validation (XML and SHACL), knowledge graph generation, partial dataset merges and KG publication.

- **Notification management**. The purpose of this functionality is to provide support for the management of notifications to data providers and other types of users, which are sent whenever there are changes in the knowledge graph, detailing the differences with respect to the previous published version.
- **Search**. The purpose of this functionality is to provide support for the search application, which allows querying the knowledge graph for the information available on it, including operational points and sections of line.
- **Route compatibility check**. The purpose of this functionality is to provide support for the Route Compatibility Check application, which allows searching for routes between two operational points (including the possibility of adding intermediate points) and determining whether a vehicle or group of vehicles are compatible with the infrastructure available in that route.
- **Vocabulary**. The purpose of this image is to provide support for the publication of the ERA vocabulary, including its OWL implementation, the set of SKOS thesauri referenced from the vocabulary and the associated SHACL shapes.
- **Other horizontal systems**. The purpose of these images is to provide horizontal support for the management of operational data that is required beyond the railway infrastructure data available in the knowledge graph. For instance, this contains data on the status of datasets that are uploaded in the system, as well as details on the notifications.

There are different statuses on which a dataset can go through, as described in the following diagrams, depending on whether the dataset is a full (see left diagram in Figure 22 - Status and status transitions during the lifecycle of full datasets (left) and partial datasets (right).) or partial see see right diagram in Figure 22) dataset. All steps in the processes depicted in these diagrams are manually launched by users, except for the merge of partial datasets with existing datasets, which is done automatically when a partial dataset is uploaded.

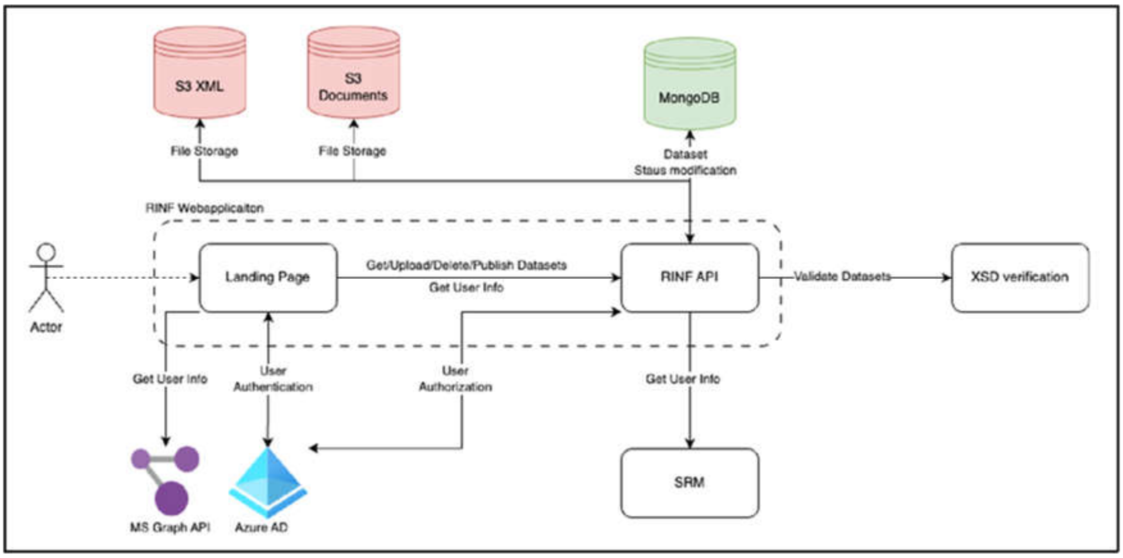


Figure 21 - Components and external systems involved in the dataset management subsystem

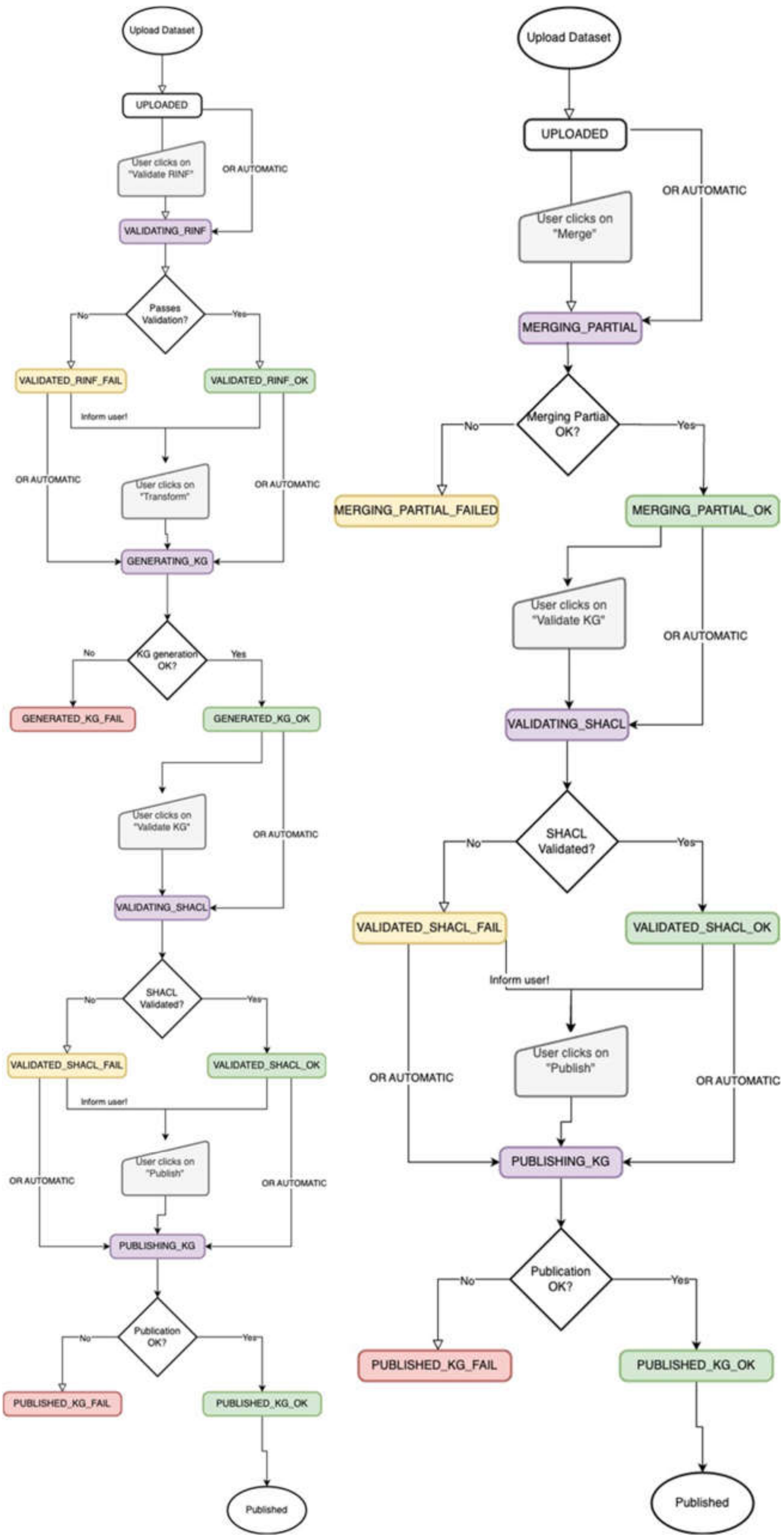


Figure 22 - Status and status transitions during the lifecycle of full datasets (left) and partial datasets (right).

From a system perspective, in terms of the partial updates (inserts or deletes), the following figure summarises the steps of the data processing pipeline followed in this case. As we can see, when the user uploads a partial dataset (with inserts or deletions), this dataset gets merged with the full knowledge graph dataset that is stored in the S3 bucket, as follows:

- For partial datasets with inserts, the new quads are added to the RDF file containing the full knowledge graph.
- For partial datasets with deletions, the corresponding quads are removed from the RDF file containing the full knowledge graph.

Once this merge is made, the new file with the full RDF knowledge graph is uploaded to the

S3 bucket, and the next step is that it can proceed to the validation based on SHACL shapes.

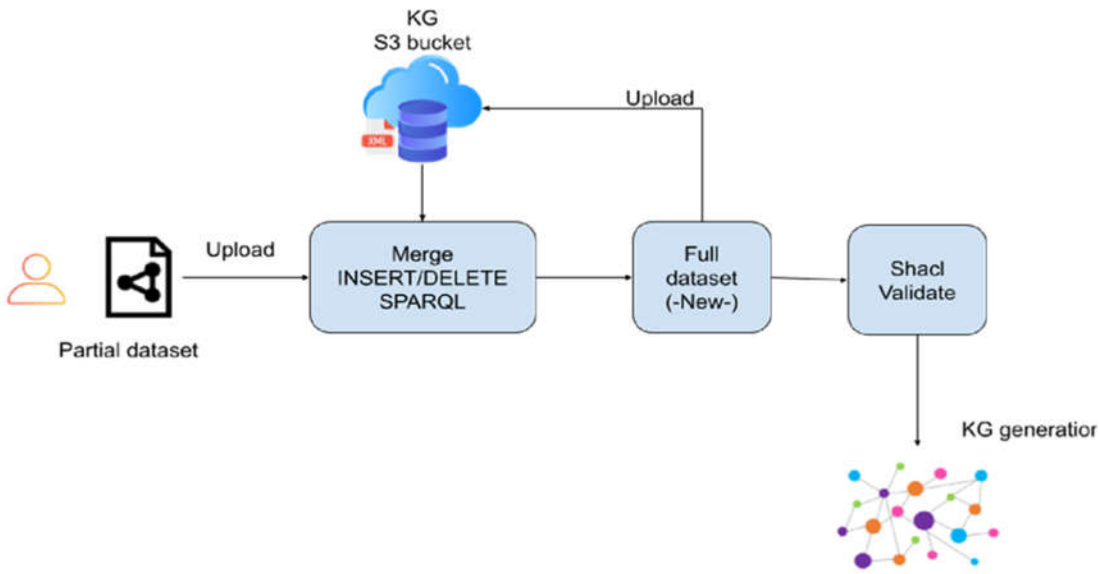


Figure 23 - Steps of the data processing pipeline for partial datasets

4.3.1. URIs generation and patterns

Uniform Resource Identifiers (URIs) aim at identifying any data, concept or object to be published and be de-referenceable on the Web. They are unique identifiers for the objetcts generated in the KG and must follow a pattern by your organisation. The current data management accepts full data upload in RDF. Hence, an IM might decide to generate URIs owned by her organisation including the generation of Hash URIs and canonical URIs. In the following, we briefly describe those two concepts and details will be made available in our Github and the RINF User Manual.

4.3.1.1. Hash URIs pattens and generation

SoLs and OPs and their elements, tracks, platforms, sidings and tunnels may include validity dates in order to specify future plans. Each of these has their own set of parameters. Thus, a resource (URI) must be created for each although the physical element is the same one.

These URIs are Hash URIs because the last portion of the URI is a Hash value. The input to the Hash function is the element's unique key. The Keys for each type of infrastructure element are described in the section "Hash keys" of this documentation. They have been generated using the function sha1. The ERA ontology exposes the value of era: hashSource in the KG.

In general, for all the elements there exists three cases for input keys: (1) with validity dates, (2) with no validity dates, (3) with only validity start date, (4) with only validity end date. We describe the keys for all these cases for OperationalPoint, but it applies equally to all other elements.

Hash URI pattern:

http://data.europa.eu/949/functionalInfrastructure/<class-infrastructure-element>/<hash-value>

Example:
http://data.europa.eu/949/functionalInfrastructure/tracks/bcb6271b0bd5714058cb37179069777722058501 where:

- <class-infrastructure-element> is "tracks"
- <hash-value> is "bcb6271b0bd5714058cb37179069777722058501" which was generated using the OP id, OP type, the track id, and the validity dates.

Hash URIs generation:

In order to generate a Hash URI a hash key needs to be input to the hash function SHA-1 (Secure Hash Algorithm 1). A Python script that implements the sha1 function is described as follows:

```
import hashlib

def sha1_encrypt(input_string):
    # Create a new SHA-1 hash object
    sha1_hash = hashlib.sha1()

    # Update the hash object with the input string
    sha1_hash.update(input_string.encode('utf-8'))

    # Get the hexadecimal representation of the digest
    encrypted_string = sha1_hash.hexdigest()

    return encrypted_string

# Example usage
input_string = "MT12345/2024-01-01_2024-12-31/Track 1/2024-01-01_None/Platform 2/None_None"
encrypted_string = sha1_encrypt(input_string)
print("Original string:", input_string)
print("SHA-1 encrypted string:", encrypted_string)
```

Hash key patterns should be formed as indicated below:

OperationalPoint

(1) URI with validity dates:

{UOPID}+{OPType}+{ValidityDateStart}+{ValidityDateEnd}

(2) URI with no validity dates:

{UOPID}+{OPType}+{None}+{None}

(3) URI with only validity start date

{UOPID}+{OPType}+{ValidityDateStart}+{None}

(4) URI with only validity start date

{UOPID}+{OPType}+{None}+{ValidityDateEnd}

Border points URI

{country}+{EUXXXXX}+{OPType}+{ValidityDateStart}+{ValidityDateEnd}

OPTrack

{UOPID}+{OPType}+{OPValidityDateStart}+{OPValidityDateEnd}+{OPTrackIdentification}+{Track_ValidityDateStart}+{Track_ValidityDateEnd}

OPTrackTunnel

{UOPID}+{OPType}+{OPValidityDateStart}+{OPValidityDateEnd}+{OPTrackIdentification}+{Track_ValidityDateStart}+{Track_ValidityDateEnd}+OPTrackTunnelIdentification+{TunnelValidityDateStart}+{TunnelOPValidityDateEnd}

OPTrackPlatform

{UOPID}+{OPType}+{OPValidityDateStart}+{OPValidityDateEnd}+{OPTrackIdentification}+{Track_ValidityDateStart}+{Track_ValidityDateEnd}+{OPTrackPlatformIdentification}+{PlatfValidityDateStart}+{PlatfValidityDateEnd}

OPSiding

{UOPID}+{OPType}+{OPValidityDateStart}+{OPValidityDateEnd}+{OPSidingIdentification}+{ValidityDateStart}+{ValidityDateEnd}

OPSidingTunnel

{UOPID}+{OPType}+{OPValidityDateStart}+{OPValidityDateEnd}+{OPSidingIdentification}+{OPSValidityDateStart}+{OPSValidityDateEnd}+{OPSidingTunnelIdentification}+{tunnel_ValidityDateStart}+{tunnel_ValidityDateEnd}

SectionOfLine

{SOLineIdentification}+{SOLOPStart}+{SOLOPEnd}+{ValidityDateStart}+{ValidityDateEnd}

SOLTrack

{SOLineIdentification}+{SOLOPStart}+{SOLOPEnd}+{ValidityDateStart}+{ValidityDateEnd}+{SOLTrackIdentification}+{track_ValidityDateStart}+{track_ValidityDateEnd}

SOLTunnel

{SOLineIdentification}+{ValidityDateStart}+{ValidityDateEnd}+{SOLTrackIdentification}+{ValidityDateStart}+{ValidityDateEnd}+{SOLTunnelIdentification}+{SOLTunnelStart_Longitude}{SOLTunnelStart_Latitude}+{SOLTunnelEnd_Longitude}+SOLTunnelEnd_Latitude}

4.3.1.2. Canonical URIs

A Canonical URI exists for each element representing its basic URI without considering its validity dates. Each infrastructure element's resource has a pointer to its canonical URI.

Canonical URI generic pattern:

http://data.europa.eu/949/functionalInfrastructure/<class-infrastructure-element>/<id-infrastructure-element>

Example: http://data.europa.eu/949/functionalInfrastructure/tracks/DE0HDSU_auf Anfrage_181996 where:

- <class-infrastructure-element> is "tracks"
- <id-infrastructure-element> is "DE0HDSU_auf Anfrage_181996" which concatenates the OP unique id and the Track's id

Canonical URIs patterns per class object

- OperationalPoint

http://data.europa.eu/949/functionalInfrastructure/operationalPoints/{UOPID}

- Border points URI:

http://data.europa.eu/949/functionalInfrastructure/operationalPoints/{country}/{EUXXXXX}

- OPTrack

http://data.europa.eu/949/functionalInfrastructure/tracks/{UOPID}_{OPTrackIdentification}

- OPTrackTunnel

http://data.europa.eu/949/functionalInfrastructure/tunnels/{UOPID}_{OPTrackIdentification}_{OPTrackTunnelIdentification}

- OPTrackPlatform

http://data.europa.eu/949/functionalInfrastructure/platformsEdges/{UOPID}_{OPTrackIdentification}_{OPTrackPlatformIdentification}

- OPSiding

http://data.europa.eu/949/functionalInfrastructure/sidings/{UOPID}_{OPSidingIdentification}

- OPSidingTunnel

http://data.europa.eu/949/functionalInfrastructure/tunnels/{UOPID}_{OPSidingIdentification}_{OPSidingTunnelIdentification}

- SectionOfLine

http://data.europa.eu/949/functionalInfrastructure/sectionsOfLine/{SOLLineIdentification}_{SOLOPStart}_{SOLOPEnd}

- SOLTrack

http://data.europa.eu/949/functionalInfrastructure/tracks/{SOLLineIdentification}_{SOLOPStart}_{SOLTrackIdentification}_{SOLOPEnd}

- SOLTunnel

http://data.europa.eu/949/functionalInfrastructure/tunnels/{SOLTunnelIdentification}_{SOLTunnelStart_Longitude}{SOLTunnelStart_Latitude}_{SOLTunnelEnd_Longitude}{SOLTunnelEnd_Latitude}

We encourage the readers for more details on URIs pattern to check a dedicated section of the RINF User manual and ERA Github.

4.3.2. KG validation steps

Finally, the following figure summarises the steps that are done for the two types of validations that are performed on datasets that are uploaded, considering the different types of datasets that can be uploaded (full XML and partial RDF datasets). As we can see, for XML files, an XSD-based validation is performed prior to the KG generation step, which makes use of RML mappings that have been developed together with the ontology. Then, for the RDF generated, or for the datasets that result from merging the partial RDF datasets with the full RDF dataset, a SHACL-based validation is performed, which can finally lead to the publication of the knowledge graph.

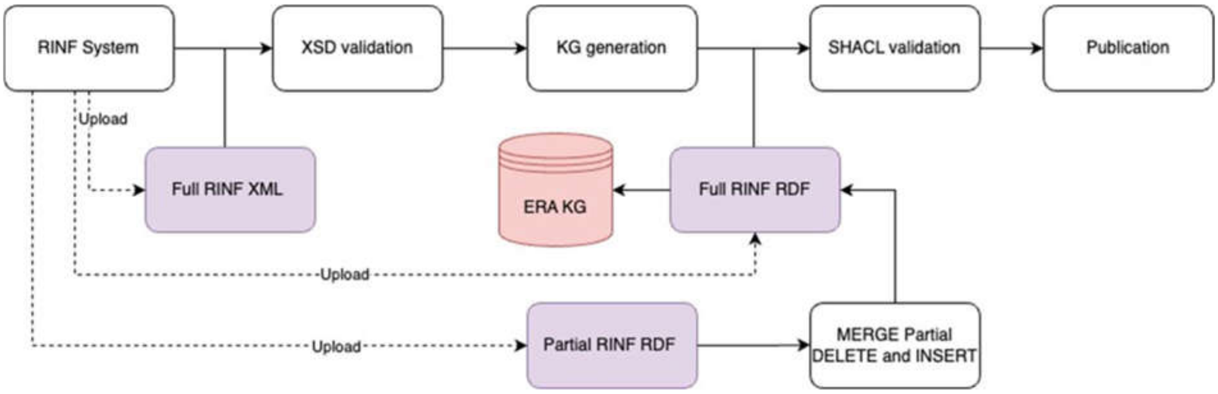


Figure 24 - Validation (XSD-based and SHACL-based), KG generation and publication steps for datasets

4.3.3. KG generation steps

The KG generation steps are focused on creating a knowledge graph using the Resource Description Framework (RDF). RDF is a standard for representing data in the form of triples, which are made up of a subject, predicate, and object. The subject is the resource that the data is about, the predicate is the relationship between the subject and object, and the object is the value of the relationship.

The ERA knowledge graph is stored in Virtuoso. Triple stores can be used to query RDF data in a variety of ways, such as finding all of the resources that are related to a particular resource or finding all of the resources that have a particular property. They are used particularly by the search and RCC applications.

As for the process that is followed for KG generation when a new XML file is uploaded in the system, this is depicted in Figure 24 - Validation (XSD-based and SHACL-based), KG generation and publication steps for datasets. The XML file is retrieved via the dataset manager, together with the RML mappings for XML files that are available in the corresponding repository. The KG component is in charge of three main steps:

- Pre-processing of the XML files in order to generate the NetElements that have not been provided explicitly in the XML files, which will be used to complete the KG and to feed later the route generation system (OSRM) that is used by the RCC application. ● Execution of the RML mappings that transform the XML data into RDF.
- Post-processing of the resulting RDF data in order to obtain canonical URIs for all the relevant elements (operational points, sections of line, tracks, etc.) that consider the latest valid version of that element, without validity dates in the URI.

Once the RDF data is generated, this is stored in the corresponding S3 bucket.

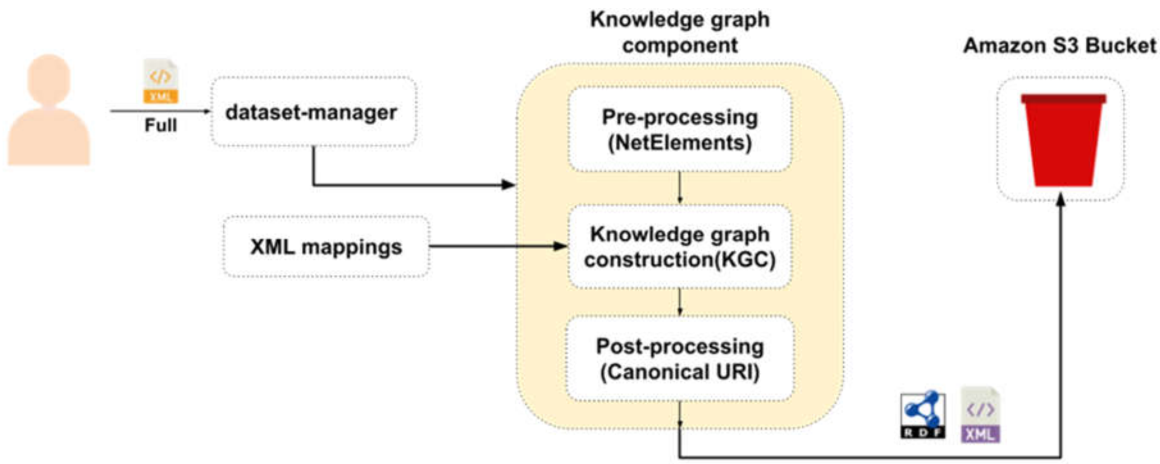


Figure 25 - KG generation components

4.3.4. Notification management system

The notification management system is in charge of providing all the functionalities that users will need to manage notifications (creation, modification, deletion) as well as sending notifications to users when changes in the knowledge graph are made that affect the elements for which they created notifications.

It contains a subsystem that is dedicated to managing knowledge graph updates, in the sense that everytime new data is uploaded into the knowledge graph, it detects which elements have been added, modified or deleted to keep a complete change log. This change log is used by the notification system to send the messages with the data changes made in the knowledge graph to users that create notifications related to those elements.

The following requirements are supported by the notification management system:

- The system has to detect changes in the KG.
- RRU users can manage the notifications that they want to receive (creating and deleting them, and listing and searching for them). When they create these notifications, they can decide whether they want to focus on changes in IM organisations data, lines or regions.
- The system sends notifications when changes are made in the KG, including those that affect subscriptions and RCC certificates.

The following subcomponents are part of the notification management system (implemented in the daemon repository, which is responsible for the main functionalities related to change detection in knowledge graphs and notification generation and sending):

- **GraphDiff**. This component obtains two RDF knowledge graphs from the corresponding S3 bucket. These two files correspond to the version that was published before the changes and to the latest one that is being published. The component obtains the differences in the RDF triples between them, providing them in two sets: those triples that have been added and those triples that have been removed.
- **ChangeSummary**. This component takes the two sets of differences that have been calculated by the previous component and generate compact descriptions of the changes for those components that are being tracked (currently implemented for sections of line, operational points, tracks and vehicle types, although this last one is not being used afterwards).
- **NotificationGenerator**. This component generates the notifications that will be sent to RRU users based on their subscriptions.
- **NotificationSender**. This component is responsible for sending the notifications that have been prepared by the previous component, by e-mail.

Besides, this system allows searching for the items to which a user will subscribe and managing the subscriptions from users. This functionality is implemented in the repositories for notifications (focused on the frontend) and for notification-backend (focused on the backend), with the following main components:

- **SearchHint**. It provides support for the hints that are provided to users when they are looking for specific elements whose changes they want to subscribe to.
- **Persistence**. This component provides support for the registration (and in general, for the management) of notification subscriptions in the MongoDB database.

4.3.5. Search application

The Search RINF Data application allows searching for operational points (OPs) and sections of lines (SoLs) with certain parameters for each elements in the data of national registers of railway infrastructure. The results of the search are displayed in two manners: as a results table with the data (which can be exported in several formats) and inside a map where the elements are shown.

The user-facing functionalities of the search application, including the way in which different filters can be provided (for textual and map-based functionalities, as well as for special aspects like validity dates) are described in the RINF user manual. A further description of these functionalities is out of the scope of this architecture document.

Figure 26 provides a high-level sequence diagram with the interactions with external systems (namely, the Virtuoso triple store where the queries that are generated by users via the user interface are being evaluated).

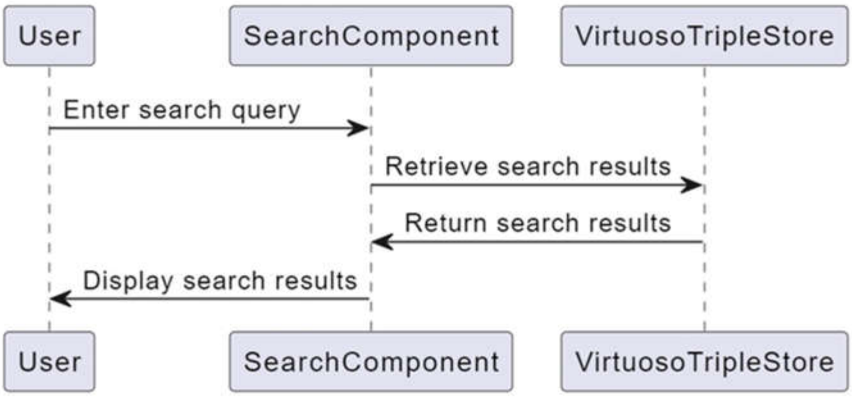


Figure 26 - Sequence diagrams associated to the search application, with the interaction with external systems (Virtuoso triple store)

4.3.6. Route Compatibility Check

The Route Compatibility Check application checks if a certain railway vehicle (read as a locomotive unit, passenger car, wagon, etc.) of an authorized type of vehicle, can travel the route from operational point A to operational point B (possibly via several other operational points specified by users). Each route is composed of tracks belonging to sections of lines, with their parameters.

The user-facing functionalities of this application are described in the RINF user manual. A further description of these functionalities is out of the scope of this architecture document.

Figure 27 provides a high-level sequence diagram with the interactions with external systems

(namely, the OSRM route planner for building routes between two operational points, and the Virtuoso triple store where compatibility check queries are being evaluated). As it can be observed in the sequence diagram, once the vehicle and route information are input in the user interface, a first interaction with OSRM happens where the route is calculated and displayed on the map. Then, a second set of queries are performed on the Virtuoso triple store to check the compatibility of the vehicle with the infrastructure elements that are part of that route.

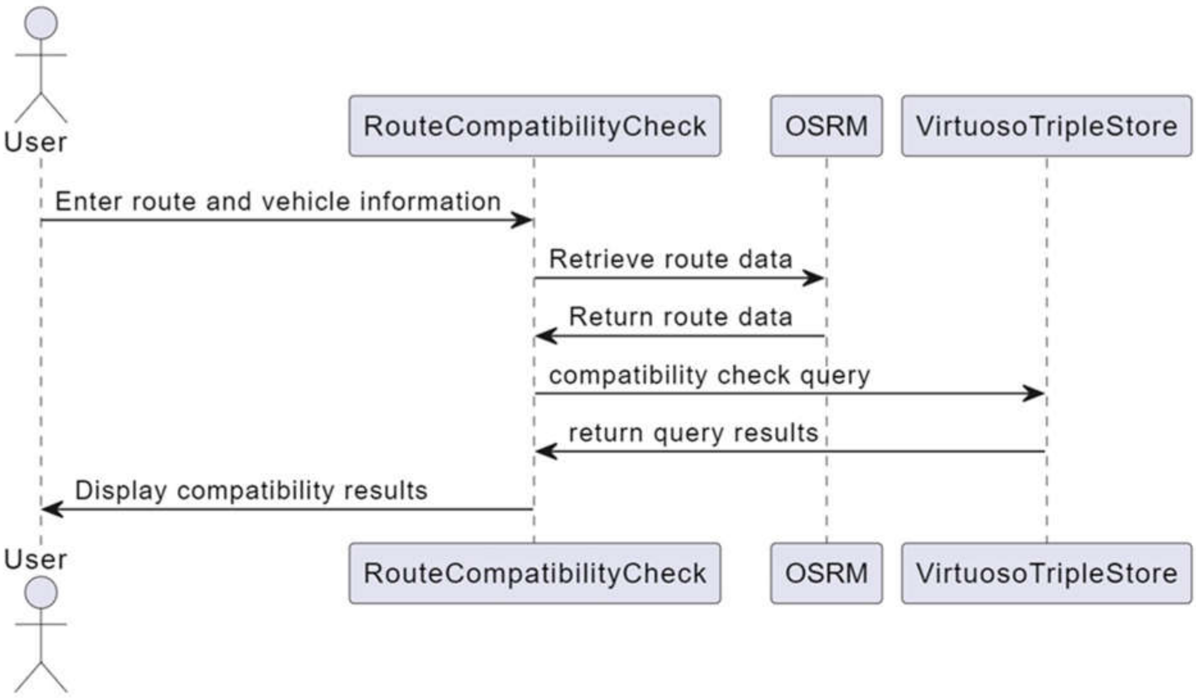


Figure 27 - High-level sequence diagrams associated to the RCC application, with the interaction with external systems (OSRM and Virtuoso triple store)

4.4. Data Upload & Validation & import Module (Data Management)

The RINF Data Asset Management module is a functionality of the RINF application that will be used by the IMs for uploading, validating their RINF datasets and data publishing.

The rules of validation of the submitted datasets are described in the "RINF Data Validation Guide" available via the RINF extranet specific page. The SHACL validation rules and the corresponding validation messages will be provided in the Technical Annex of this Application Guide.

The process of data asset management and the overall functionality are described and maintained in the RINF application user manual[9] .

To allow IMs getting familiarised with the RINF application and to allow them to test sets or subsets of data, without any commitment on the data completeness, one extra environment[10] will be made available. Any IM will be granted access upon request to ERA.

[9] URL to be provided to the user manual
https://data-interop.era.europa.eu/RINF-User%20Manual%20v4%20production.pdf
https://uat.ld4rail.fpfis.tech.ec.europa.eu/RINF-User%20Manual%20v6.1.pdf

[10] https://uat.ld4rail.fpfis.tech.ec.europa.eu/

5. APPENDICES

5.1. List of infrastructure technical characteristics

The list of all technical characteristics, along with their definitions, descriptions, and applicability conditions, is provided in the Technical Annex of this guide.

The technical Annex can be explored at this address:

https://data-interop.era.europa.eu/era-vocabulary/rinf-appGuide/index-en.html

5.2. List of Border points

The list of border points has been developed by the Agency on the basis of information and agreement from NREs (during their former role).

In order to be updated, any change shall be justified and agreed by the relevant IMs (or any nominated NRE), sent to ERA for the numbering (if needed) of the border point and published by ERA.

The table is available in our website at https://www.era.europa.eu/sites/default/files/2025-03/rinf_border_points.zip. There is always a possibility to obtain the RDF from ERA Knowledge Graph.