Semantics in railway

A story for showcasing the **Semantic Network Infrastructure**
from **Vienna University of Business and Economics (WU)**

Shahrom Sohi and **Dragomir** Balan

Who are we?

Shahrom Sohi – **WU PhD researcher** specializing in reusing data for railways, with a focus on semantics and data models as cross-border enablers.

Special thanks to:

Dragomir Balan – WU Digital Economy Graduate, lead of Industry LAB 24-25 – Digital Twin of Railway Infrastructure with ERA ontology.


ÖBB
ÖBB DIGITAL TWIN
INFRA Semantic Data Interoperability
ebcont
Status Quo
Desired State
Problem
SCHIG
SCHIG
ÖBB
ÖBB
Objectives
Deriving Data Stories from the Integration of Rail Data
30%
↑70%
400+

WUxÖBB Research Industry Lab

5/6 students from **Digital Economy** Master at WU per group.

4 topics/year

The WUxÖBB research project

The project aim was to **test-case** the **ERA ontology** while testing the PoolParty (Software) system, using support from ÖBB as example, **introducing Transport Semantics.**

3 months duration of the project

4 Digital Economy Master students

*Thanks to **Tofigh Ghoraischi**, for providing support for the **ÖBB example data**.*

Something about the research project collab.

Support and help from ÖBB for WU Research Semantics in Railway:

Data Integration Prototypes,

Railway **Open Data**,

Transport Analysis - **Park and Ride**,

Passenger **Forecasting**,

Maintenance costs **Forecasting**,

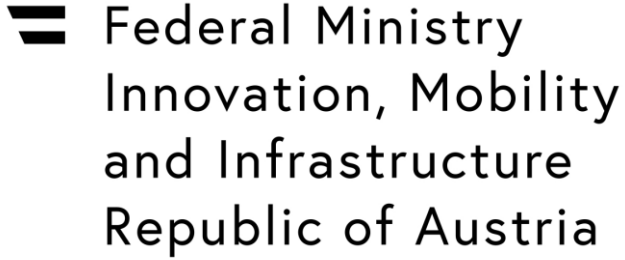
LLM for contract management,

LLM for Railway Accidents Reporting.

Something about the research project collaboration

BMIMI (Federal Ministry for Innovation, Mobility and Infrastructure)

Endowed Professorship for Data-Driven Knowledge Generation



The journey of the course

Familiarise on **Ontologies**

Finding **the data** to integrate

Common students' **pain points**

Data stories and **prototype**

Ontology

Ontology
is Big rule’s book,

Ontology,

is Big rule's book,

that helps organize and describe things.

Ontology,

Big rule's book,

that helps organize and describe things, in a way that both humans and computers can understand.

ERA Ontology has

Concepts (Classes) – The main things in a system “**Track**” ,“**Station**” “**Signal**” , a “**Tunnel**”

Properties (Attributes) – The characteristics of these things a **Track** has a **“gauge”** and “**speed limit**” , and a ”**overhead line”**

Relationships – How things are connected “a **Track connects** two **Stations**”

Rules – Constraints and logic “An **Austrian track** must have on **1435 mm gauge**”).

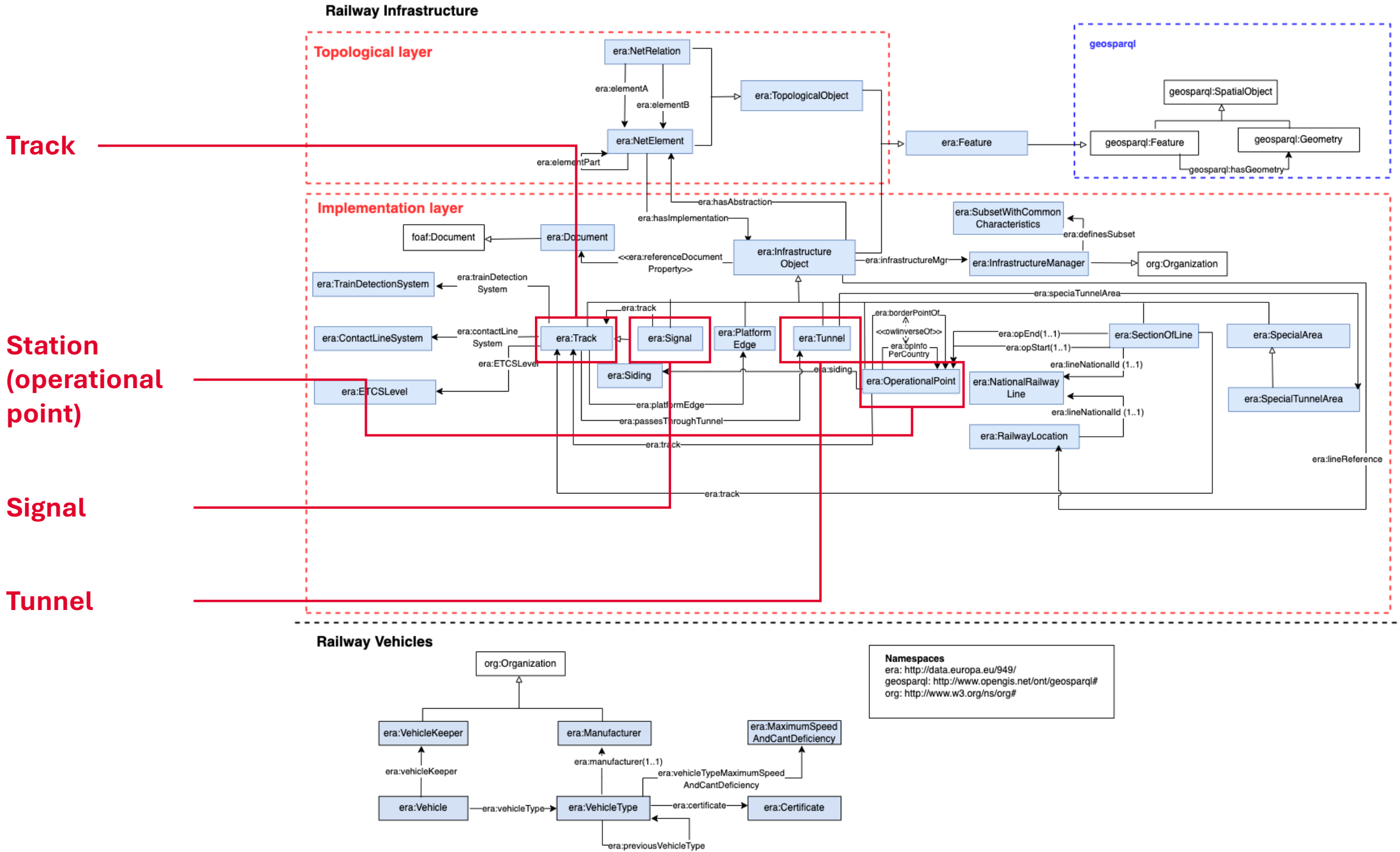
ERA Ontology has

Concepts (Classes) – The main things in a system **“Track”**, **“Station”** **“Signal”** , a **“Tunnel”**

Properties (Attributes) – The characteristics of these things a **Track** has a **“gauge”** and **“speed limit”**, and a **”overhead line”**

Relationships – How things are connected “a **Track** **connects** two **Stations**”

Rules – Constraints and logic “An **Austrian** **Track** must have on **1435 mm** **gauge**”).


Railway Infrastructure
Topological layer
era:NetRelation
era:elementA
era:elementB
era:TopologicalObject
era:NetElement
era:elementPart
era:Feature
geosparql
geosparql:SpatialObject
geosparql:Feature
geosparql:Geometry
geosparql:hasGeometry
Implementation layer
era:hasAbstraction
era:hasImplementation
era:SubsetWithCommon Characteristics
era:definesSubset
foaf:Document
era:Document
<<era:referenceDocument Property>>
era:Infrastructure Object
era:infrastructureMgr
era:InfrastructureManager
org:Organization
era:TrainDetectionSystem
era:trainDetection System
era:speciaTunnelArea
era:track
era:borderPointOf
<<owlinverseOf>>
era:opInfo PerCountry
era:ContactLineSystem
era:contactLine System
era:Track
era:Signal
era:Platform Edge
era:Tunnel
era:opEnd(1..1)
era:opStart(1..1)
era:SectionOfLine
era:SpecialArea
era:ETCSLevel
era:Siding
era:siding
era:OperationalPoint
era:lineNationalId (1..1)
era:NationalRailway Line
era:platformEdge
era:passesThroughTunnel
era:RailwayLocation
era:SpecialTunnelArea
era:lineReference
Railway Vehicles
org:Organization
era:VehicleKeeper
era:Manufacturer
era:MaximumSpeed AndCantDeficiency
era:manufacturer(1..1)
era:vehicleKeeper
era:vehicleTypeMaximumSpeed AndCantDeficiency
era:Vehicle
era:vehicleType
era:VehicleType
era:certificate
era:Certificate
era:previousVehicleType
Namespaces
era: http://data.europa.eu/949/
geosparql: http://www.opengis.net/ont/geosparql#
org: http://www.w3.org/ns/org#
Track
Station (operational point)
Signal
Tunnel

Nominal track gauge[op]

IRI: http://data.europa.eu/949/wheelSetGauge

Value expressed in millimetres that identifies the track gauge. The allowed values for this property belong to the SKOS Concept Scheme http://data.europa.eu/949/concepts/nominal-track-gauges/NominalTrackGauges

Is defined by
http://data.europa.eu/949/

Term status
stable

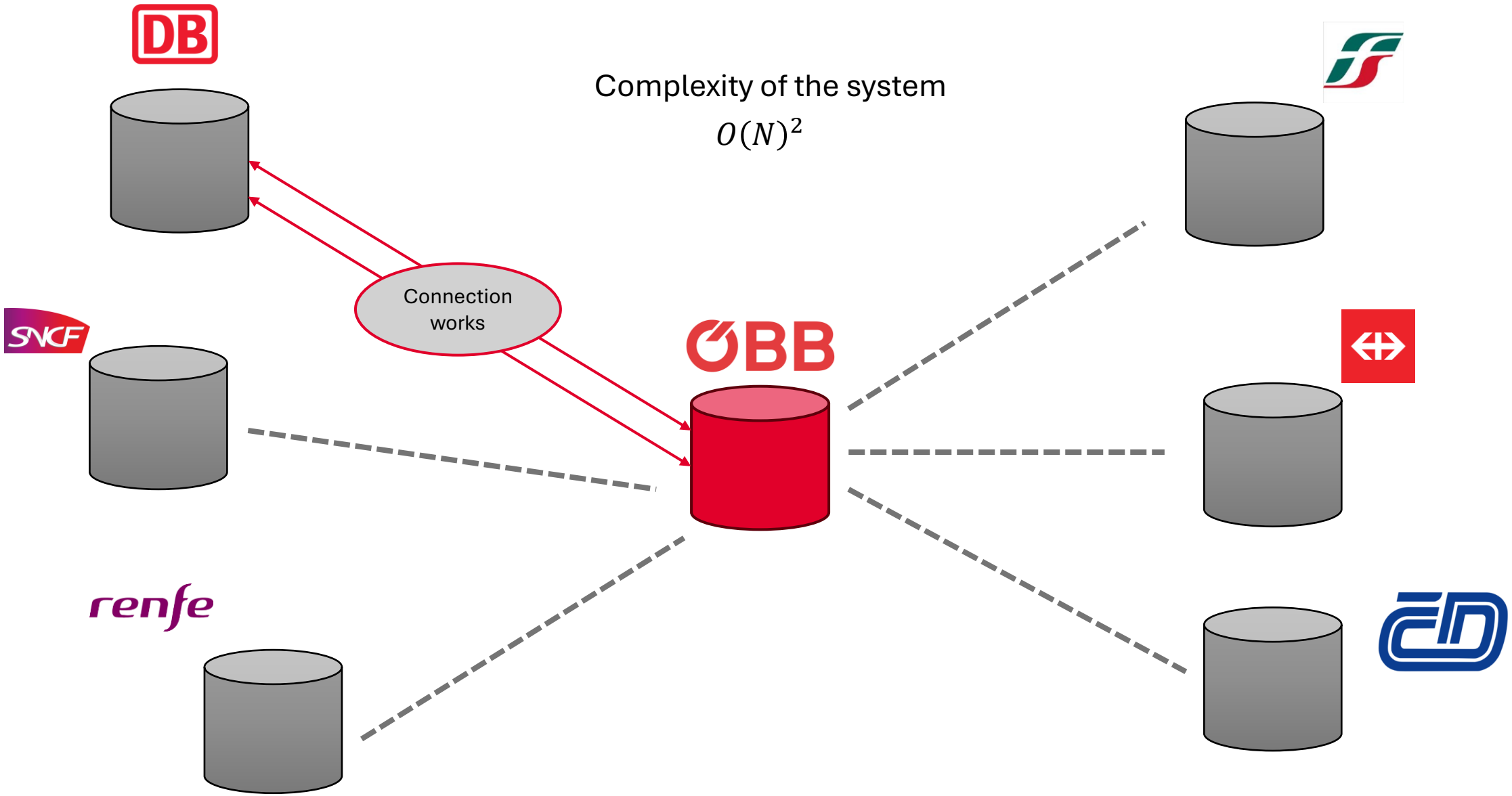
Rinf index
1.1.1.1.4.1
1.2.1.0.4.1

EraTV index
4.1.3

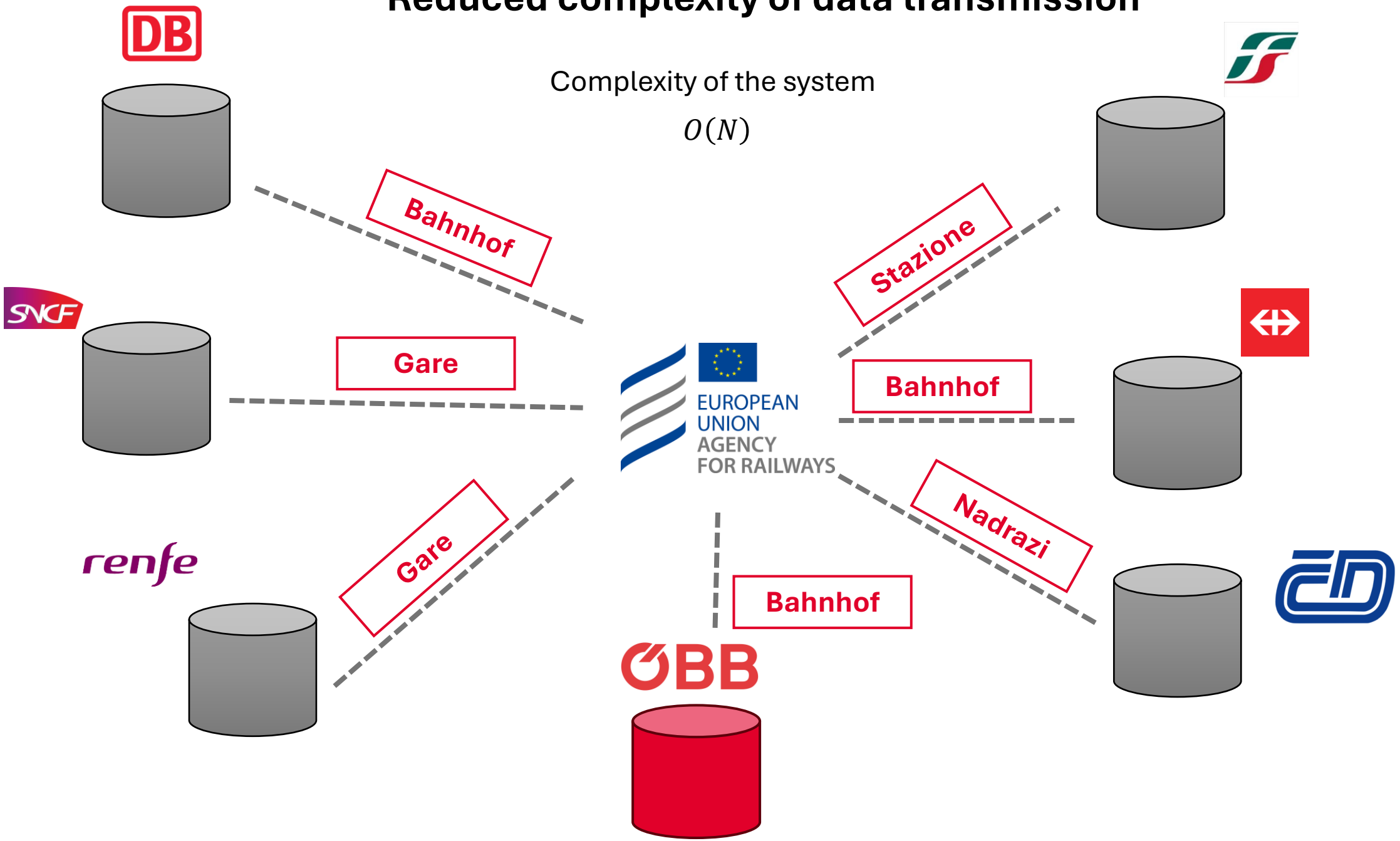
has characteristics: functional

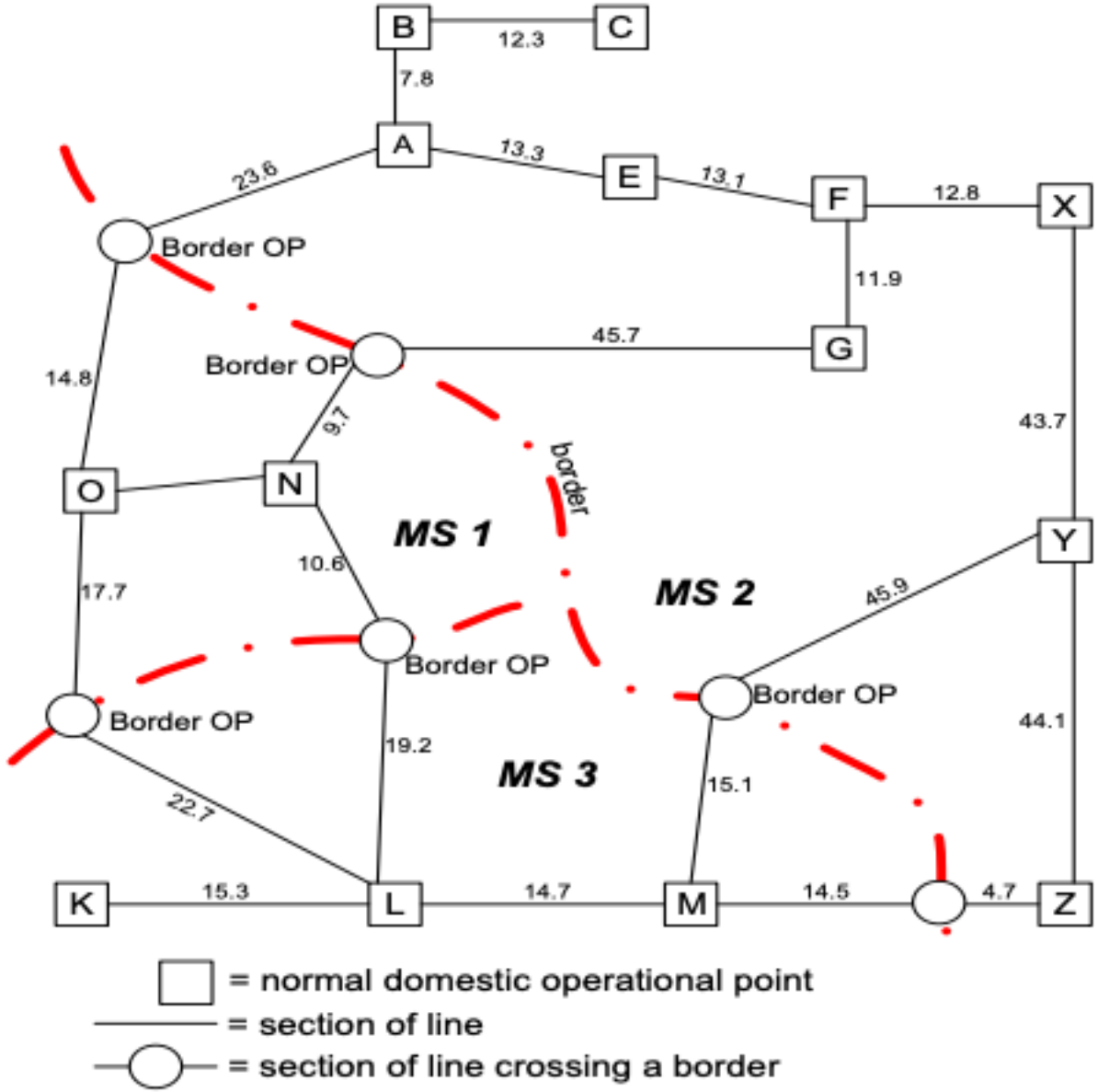
has domain
Track [c] **or** Vehicle Type [c]

has range
Concept [c]


Complexity of the system
$O(N)^2$
Connection works
DB
SNCF
ÖBB
renfe

Reduced complexity of data transmission





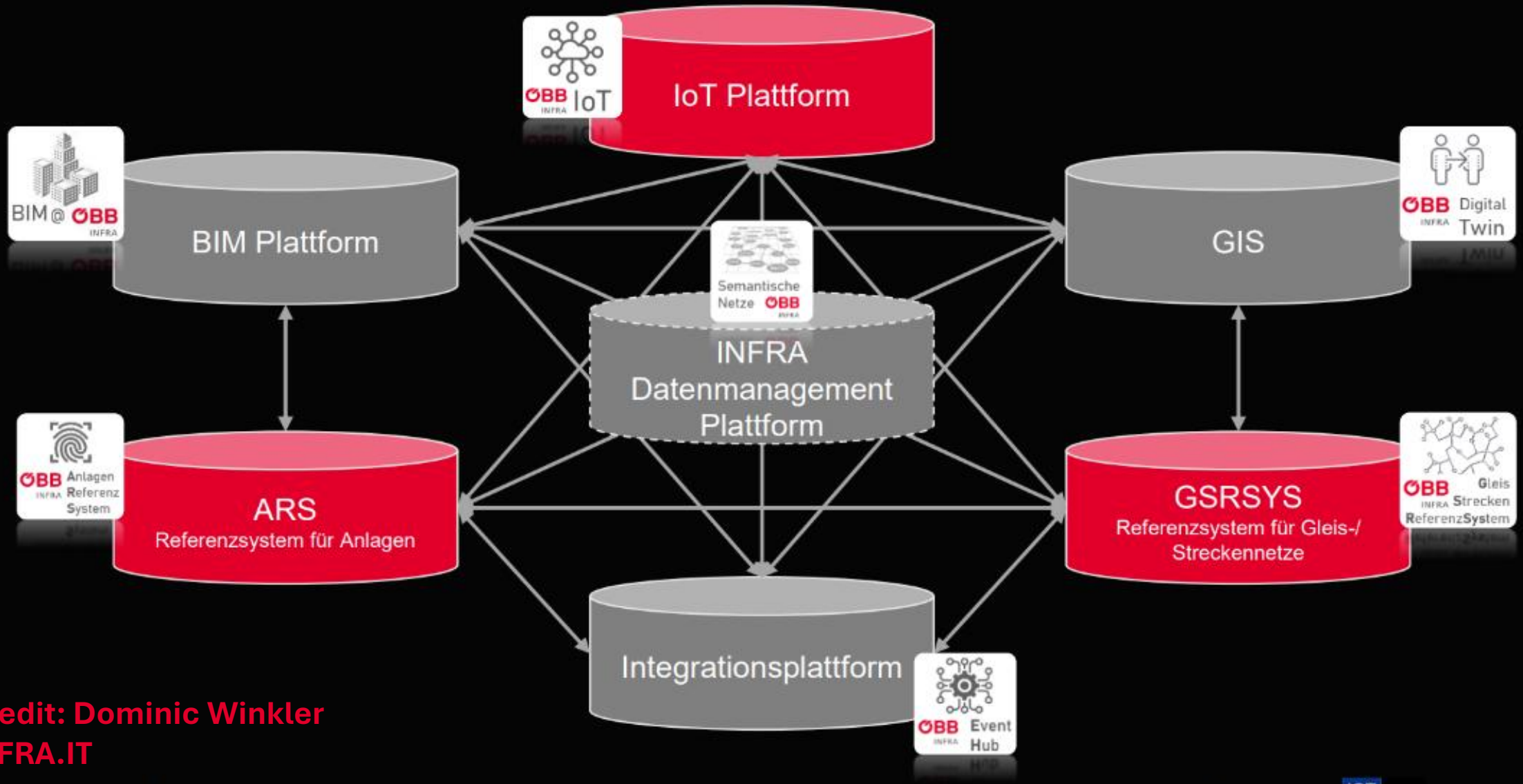
Credit: ERA

International macro railway network with Section of Line lengths

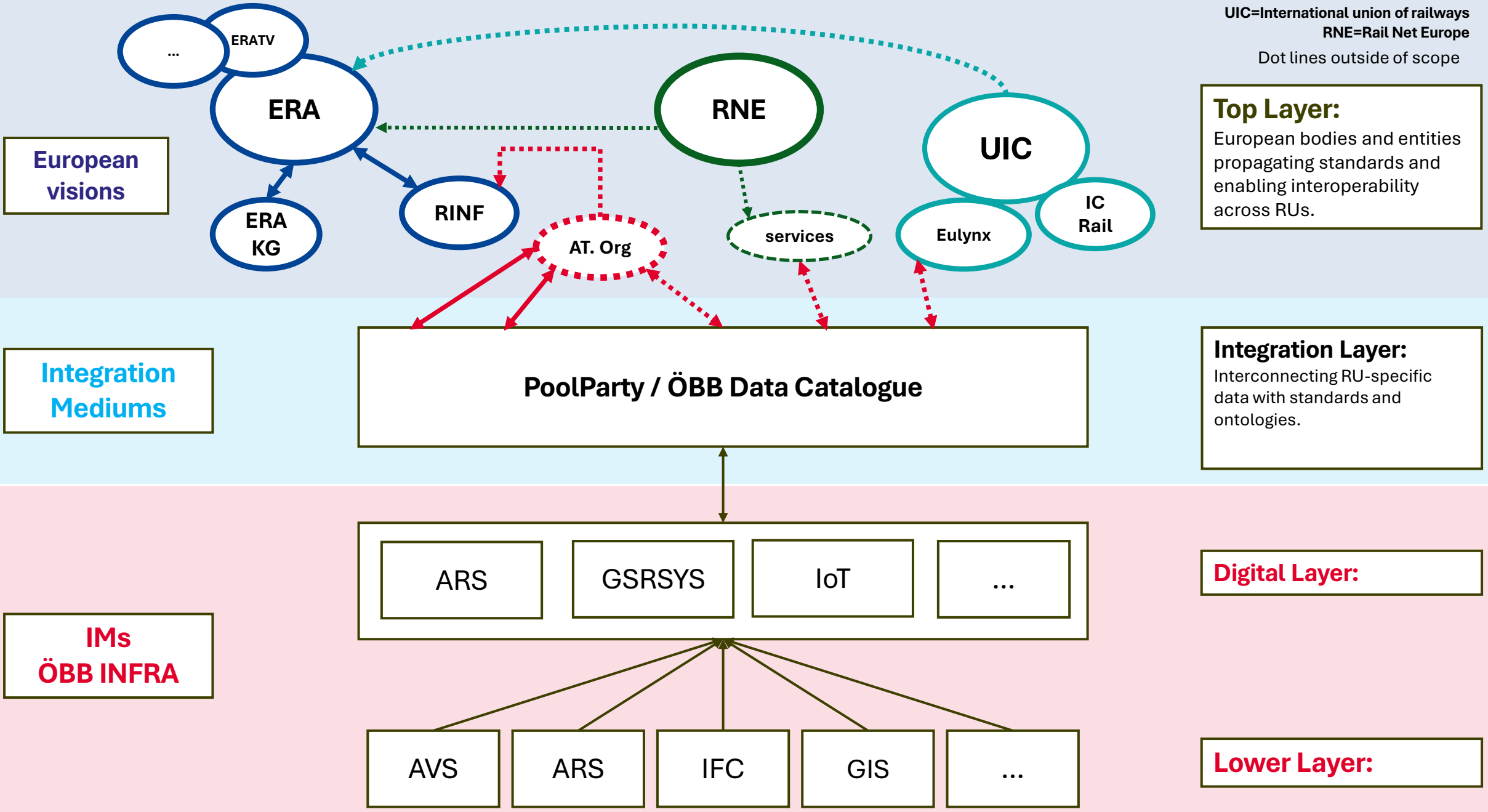
MS: Member State

Systeme des Railway Digital Twins

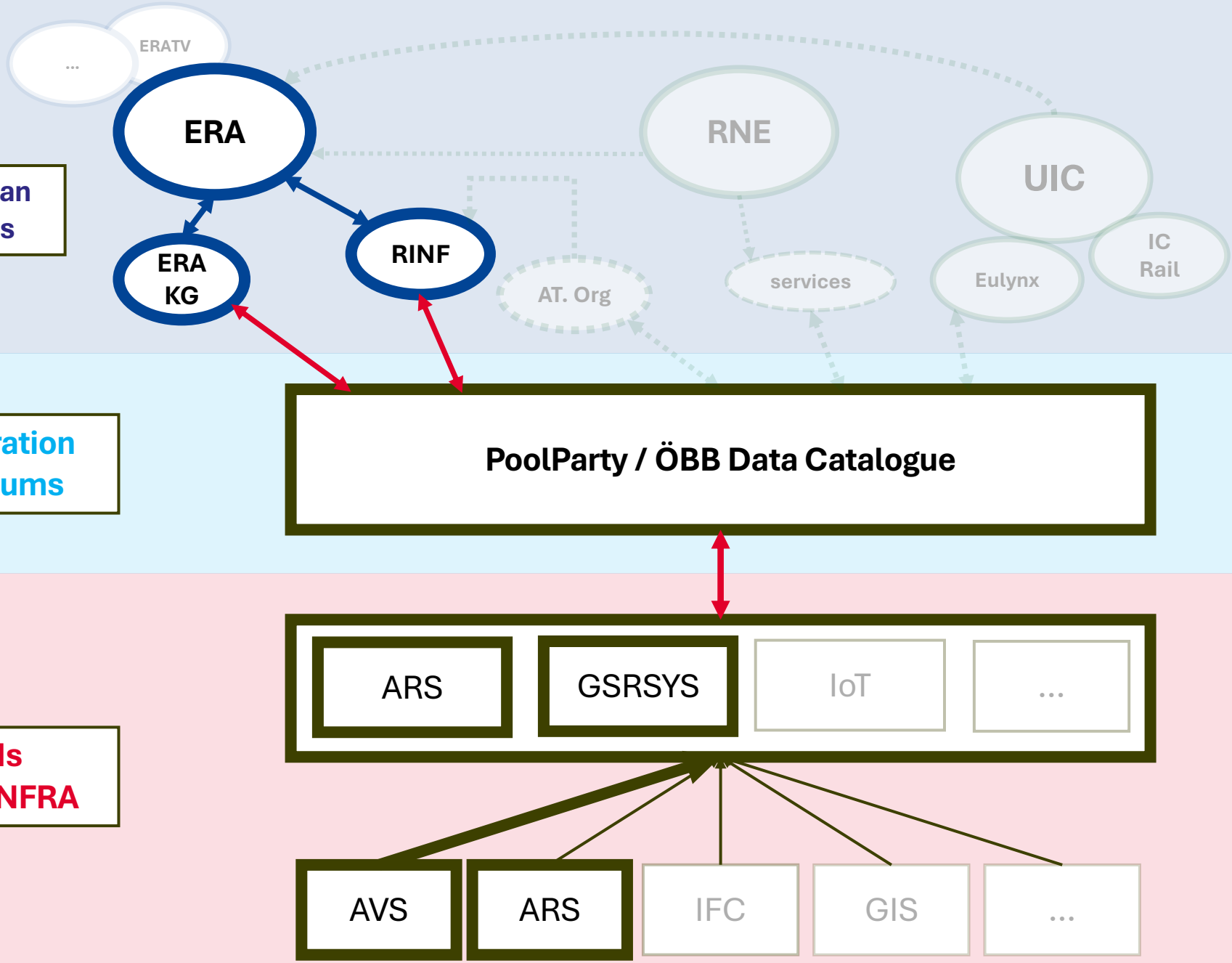
INTEGRIERTE SYSTEMLANDSCHAFT



Credit: Dominic Winkler
INFRA.IT


UIC=International union of railways
RNE=Rail Net Europe
Dot lines outside of scope
European visions
Integration Mediums
IMs ÖBB INFRA
...
ERATV
ERA
ERA KG
RINF
RNE
AT. Org
services
UIC
Eulynx
IC Rail
PoolParty / ÖBB Data Catalogue
ARS
GSRSYS
IoT
...
AVS
ARS
IFC
GIS
...
Top Layer:
European bodies and entities propagating standards and enabling interoperability across RUs.
Integration Layer:
Interconnecting RU-specific data with standards and ontologies.
Digital Layer:
Lower Layer:

Dot lines outside of scope



European visions

Integration Mediums

IMs ÖBB INFRA

Top Layer:
European bodies and entities propagating standards and enabling interoperability across RUs.

Integration Layer:
Interconnecting RU-specific data with standards and ontologies.

Digital Layer:

Lower Layer:

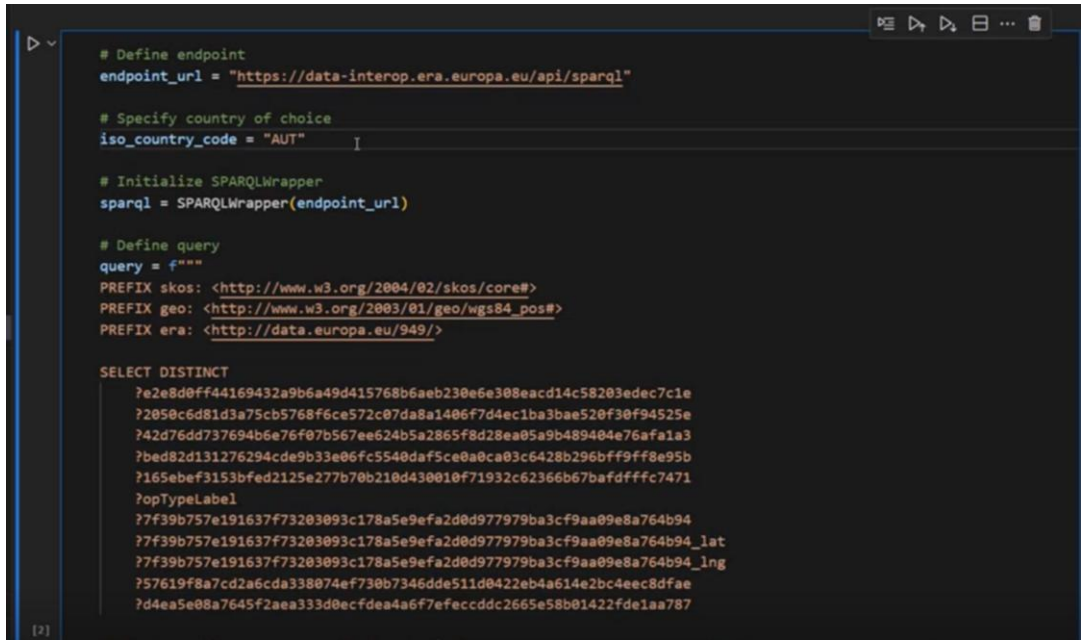
First steps

Focus on the **main railway concepts**

E.g. **tracks, tunnels, border points**

Using **data dumps** from Infrastructure Open Data Portal.

Integrate with **existing ontologies** e.g. GEO from w3.org



What students have found important

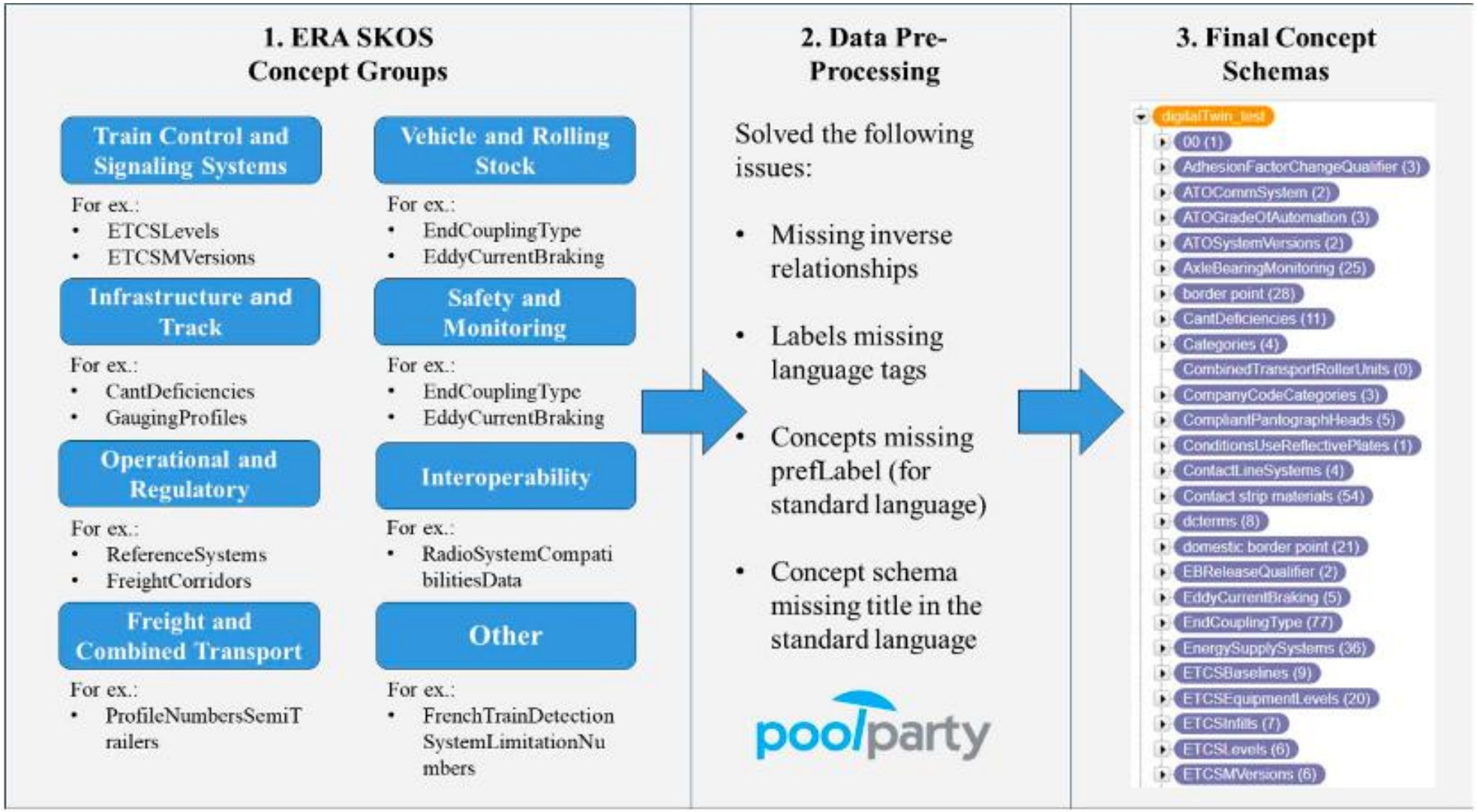
“The SPARQL Wrapper library was used to query the ERA endpoint and retrieve OP and SoL data.”

“Data cleaning needed before the uploading of the data, we have executed a script that converts Excel files into the “trig” format as required by PoolParty”

“The incorporation of canonical URIs and SKOS constituted a crucial step in the conversion process.”

from WUxÖBB Industry Lab 24 students report

Main steps of the project



Prototype data stories

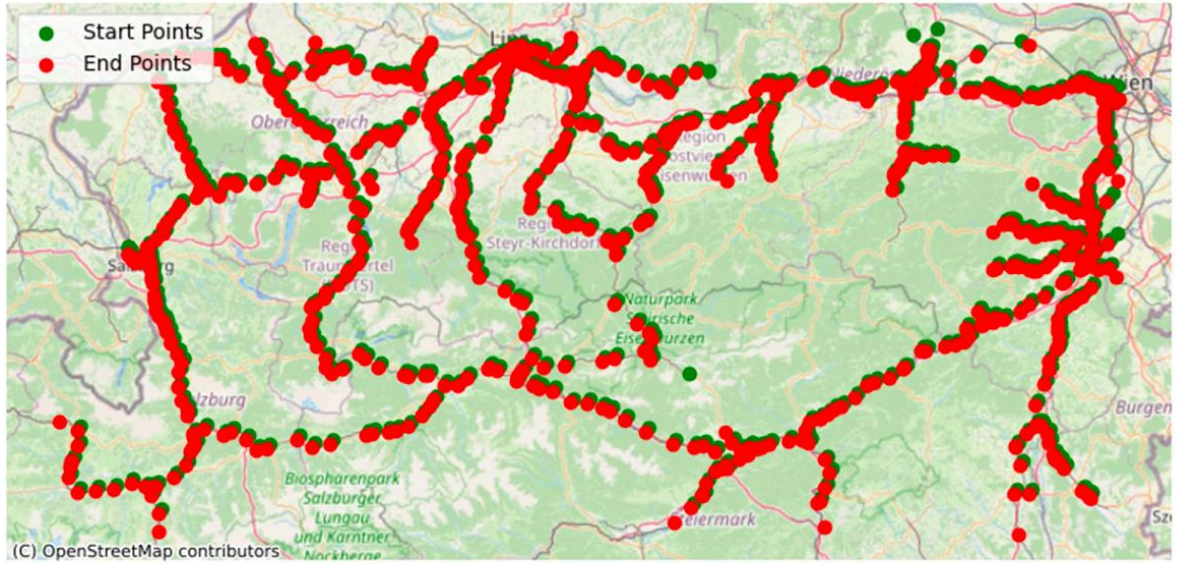


Figure 8: Austrian Section of Lines

Figure 9: Austrian Border Points

Credit: WUxÖBB Industry Lab 24 Balan Dragomir, Patricia Haumer, Katharina Pöcher, Daniel Pastera – Supervised by Shahrom Sohi

What have been built

Showcase the pool party prototype

Final remarks

This was a **student prototype** to introduce semantic web to Digital Economy Students.

It is possible to already work with **ERA Ontology** using **Open Data** and Integrate Multiple Countries.

Use cases can go beyond the representation of infrastructures e.g. International Mapping Service information sharing to customers

Feel free to contact us!

Shahrom Sohi
shahrom.sohi@wu.ac.at

Dragomir Balan
dragomir.balan@s.wu.ac.at

Appendix