Transmodel in RDF?

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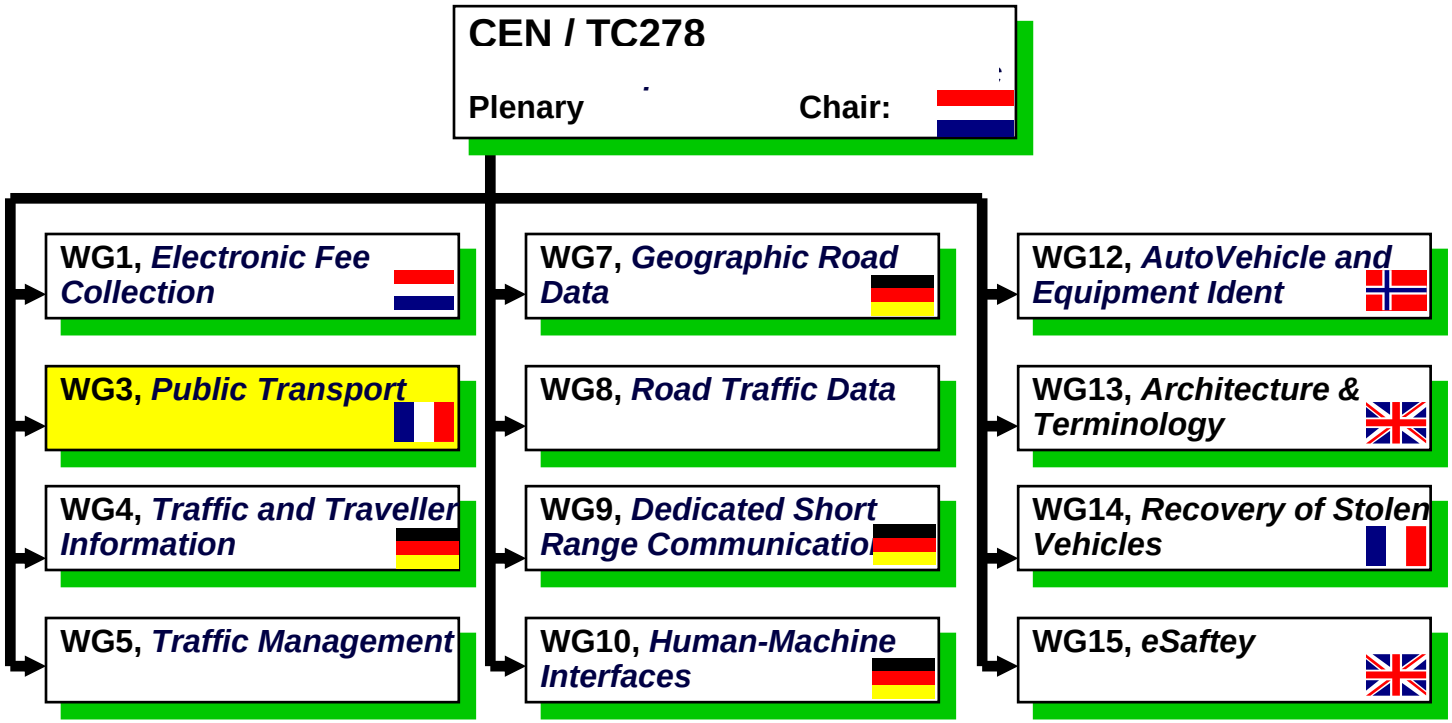
Data4PT has received funding from the European Union's DG for Mobility and Transport under grant agreement No MOVE/B4/SUB/2019-104/CEF/PSA/SI2.821136

Introduction

Context: CEN European Committee for Standardisation
CEN Technical Committee 278 – Intelligent transport Systems



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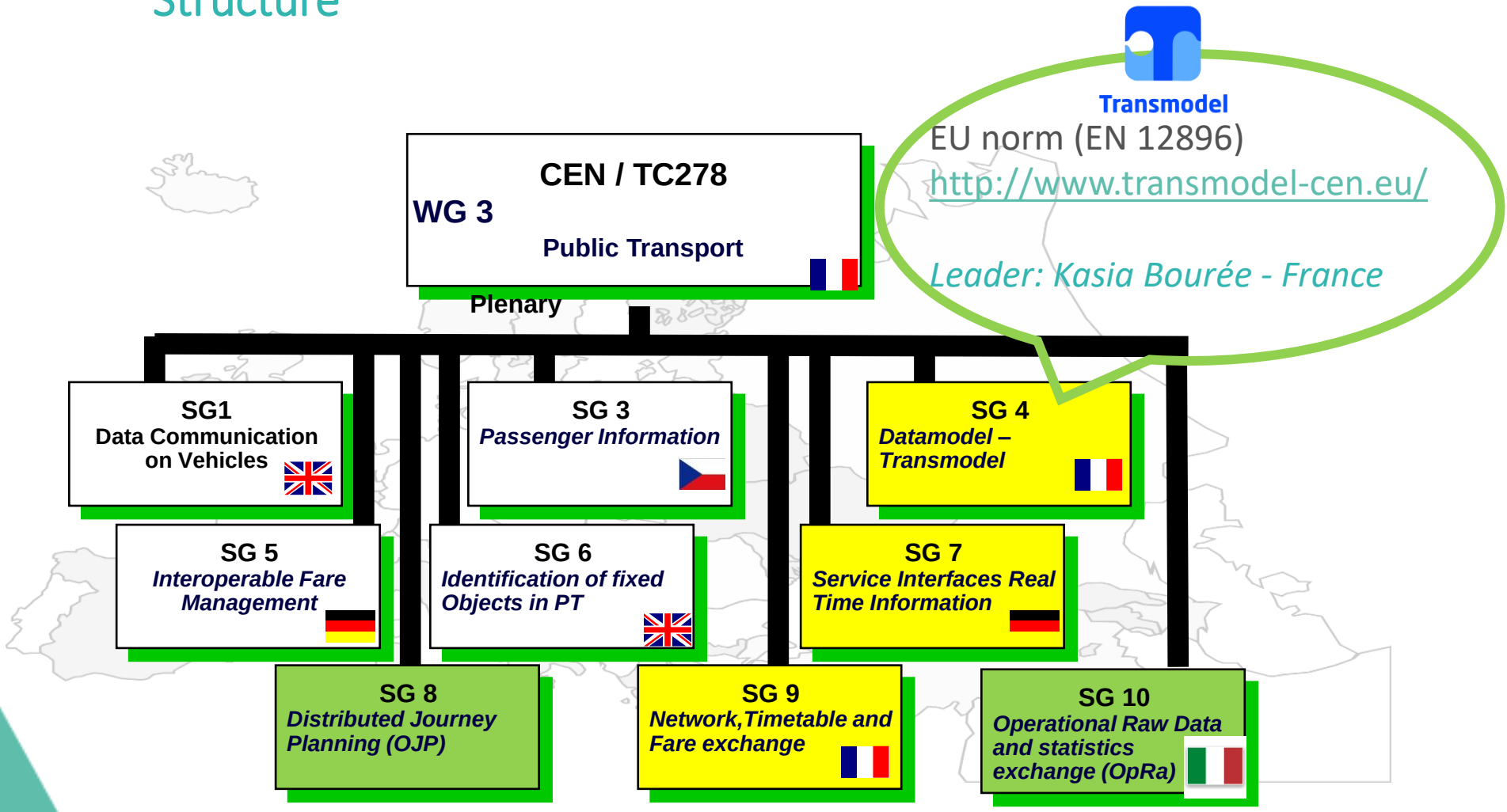
CEN TC 278 WG 3 - Public Transport (PT) Structure



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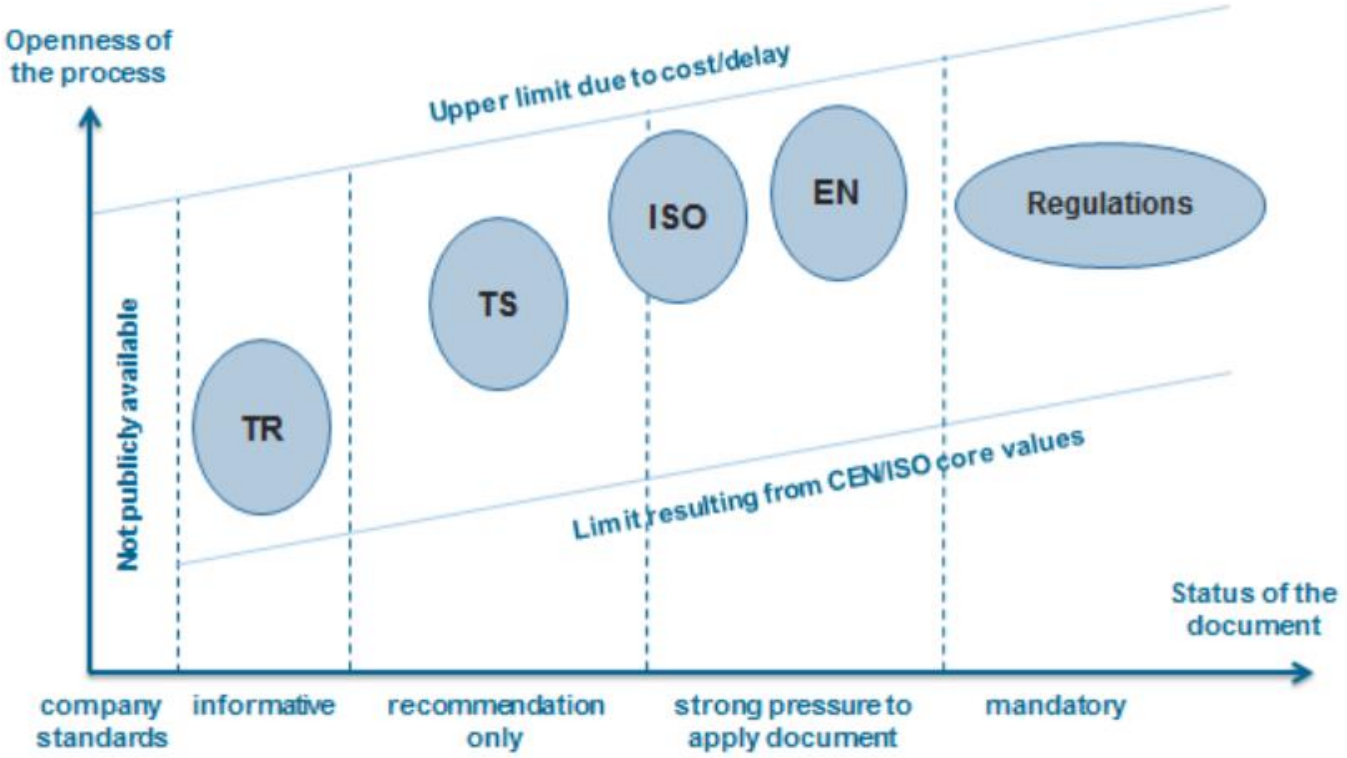
CEN method of work



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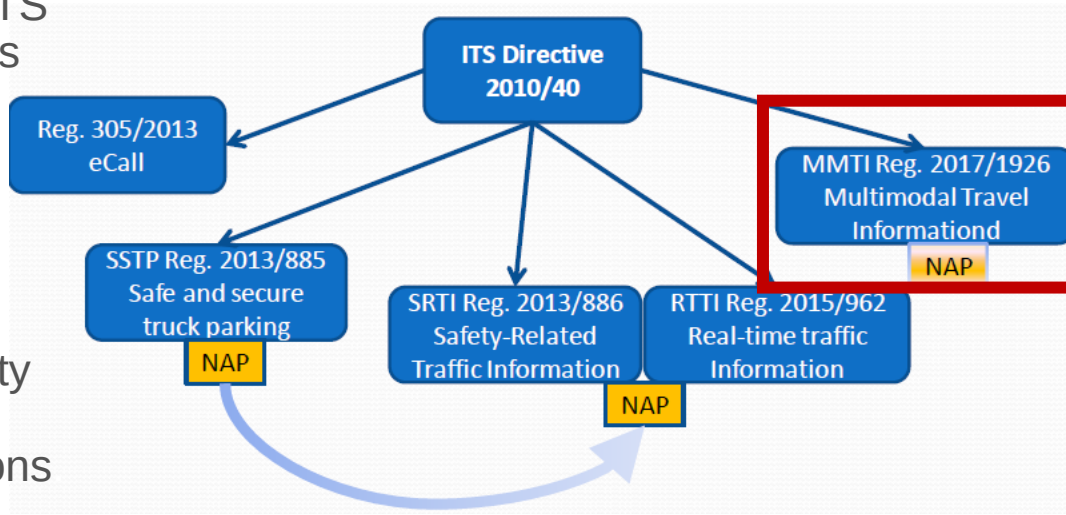
ITS EU directive 2010/40 Delegated Regulations

- Establish a framework for coordinated and effective deployment and use of ITS within Member States (MS) and across borders;
- Develop specifications necessary to ensure the compatibility, interoperability and continuity for the deployment and operational use of ITS for priority actions



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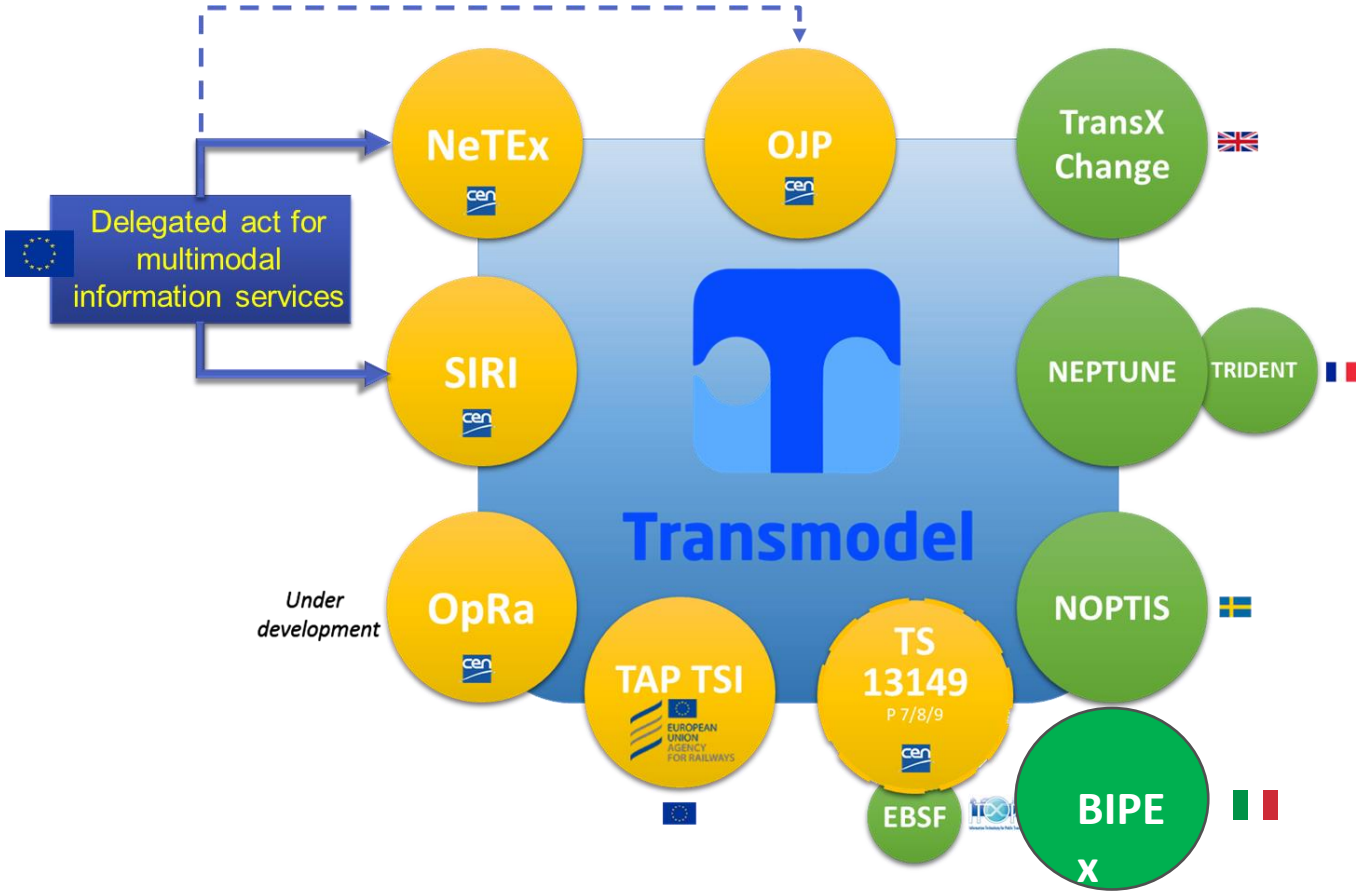
MMTI Delegated Regulation 1926/2017
CEN Standards context



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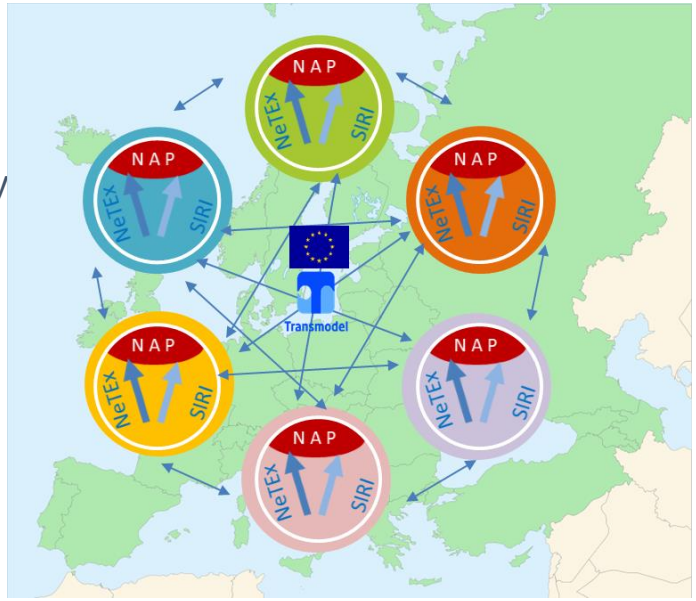
European regulation for multimodal travel information publication

Transmodel has to be viewed in the context of the European ITS Directive 2010/40/E, in particular the Priority Action A i.e. the Delegated Regulation 2017/1926 , supplementing the European Directive 2010/40/EU with regard to the provision of **EU-wide multimodal travel information (MMTIS)** services.

The Priority Action A establishes the list of specifications necessary for accessibility, exchange and update of standardised travel and traffic data to ensure the provision of MMTIS in the EU.

Member states are asked to develop **National Access Points** for the gathering, storing and exchange of a range of data categories



Public Transport static data exchange shall use the CEN data exchange standard NeTEx (CEN/TS 16614) based on the underlying conceptual data reference model (Transmodel, EN 12896).

…And SIRI for dynamic information.

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1. Transmodel in brief

Transmodel main features

Transmodel : short name for the European Standard "**Public Transport Reference Data Model**" (EN 12896)

- **Common language & data structures to describe semantics** of the Public Transport domain**:**
- considers a number of public transport features for information and service management
- includes concepts, properties & links between concepts

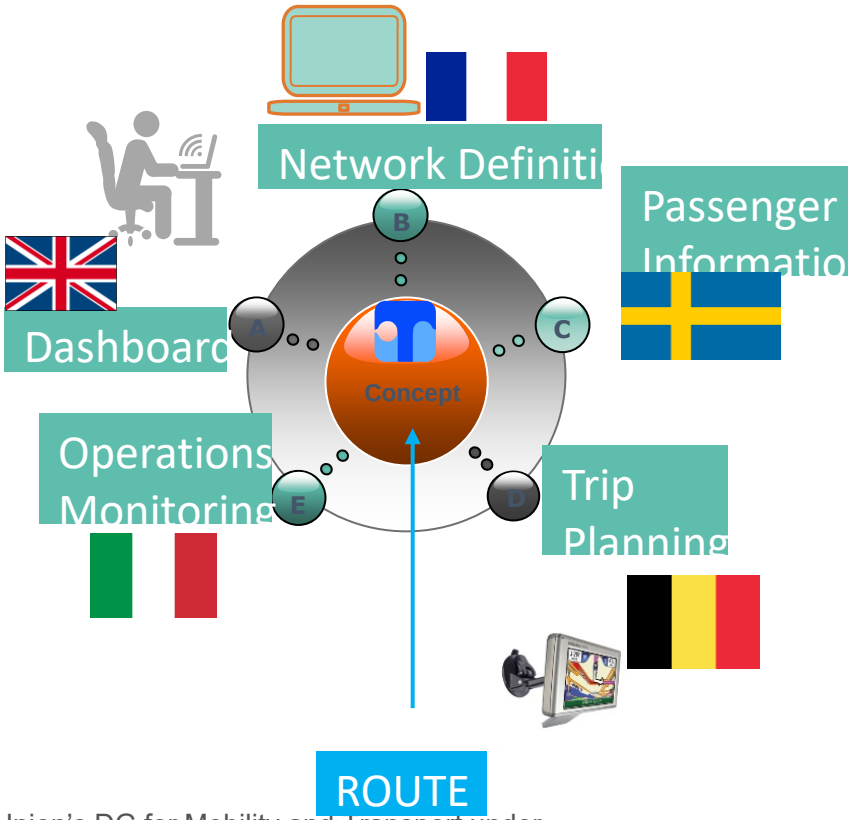
- **Multimodality:** describes aspects covered by conventional public transport, including flexible transport but also alternative modes

- **Interoperability** between the information processing systems of transport operators

Transmodel facilitates

- connecting applications/systems
- communication between operators, authorities and software suppliers

Transmodel keyword: **semantic interoperability**



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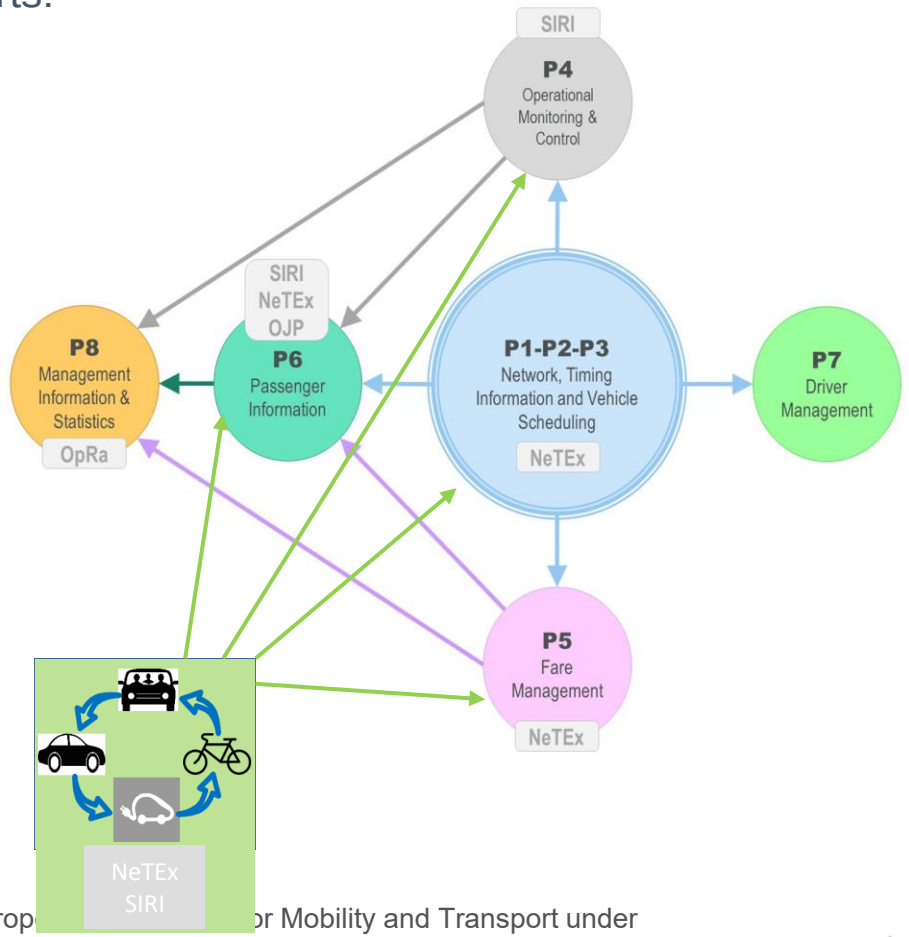
Transmodel framework is composed of 10 key parts

Transmodel covers most of the Public Transport domains. The overall model is divided into 10 parts:

1. Common Concepts
2. Public Transport Network
3. Timing Information & vehicle scheduling
4. Operations Monitoring & Control
5. Fare Management
6. Passenger Information
7. Driver Management
8. Management Information & Statistics
9. Informative documentation (TR)
10. Alternative modes – renewed publication



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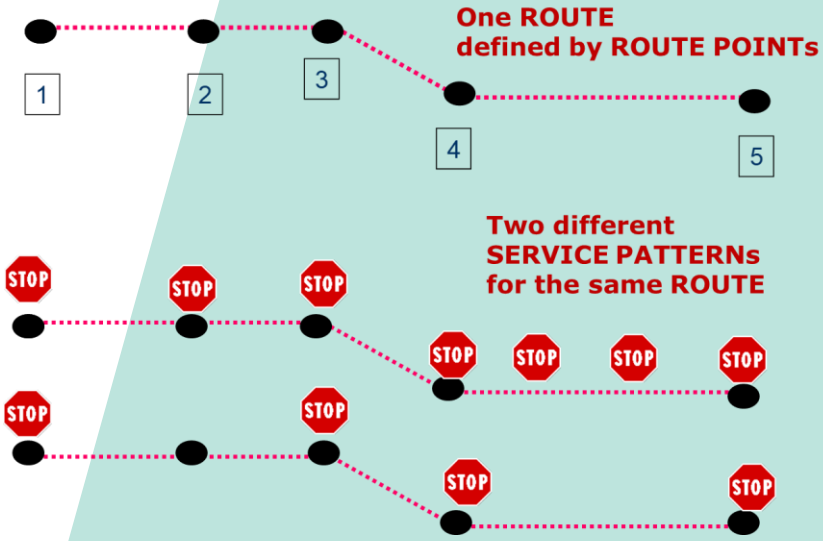
Part 2: Network description

Transmodel **Part 2 :** Public Transport Network

- Working Paths of vehicles defined using JOURNEY PATTERNs - ordered lists of SCHEDULED STOP POINTs and TIMING POINTs on a single ROUTE;
- Itinerary defined through the concept of ROUTE that represents a schematic vehicle path through the network
- Connection i.e. physical and spatial possibility for a passenger to change from one public transport vehicle to another to continue the trip, CONNECTION is a passenger view of a transfer.
- Network restrictions and constraints represented in Transmodel by a range of concepts: OVERTAKING POSSIBILITY, IMPOSSIBLE MANOEVRE, MEETING RESTRICTION, etc
- Includes Flexible Network.

Transmodel PT Network = Service Infrastructure

- **Implementation as NeTEx Part 1**



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Part 5: Fare Management

Transmodel **Part 5: Fare Management** deals with all aspects relevant to Fares in Public Transport Service like:

- Access Rights defined through the elements of a fare system (rules to access PT) and relevant parameters (quantitative, validity, usage, etc);

- Fare Products as combination of Access Rights, materialized as
- Travel Documents and grouped into
- Sales Offer Packages to be distributed/sold to the customers;

- Controls are applied to the access rights present on the fare media in order to be able to:
- to validate the use of the access rights and/or
- to identify an offence to be reported on blacklists
- Elementary price elements linked to the access rights, fare products and sales packages.

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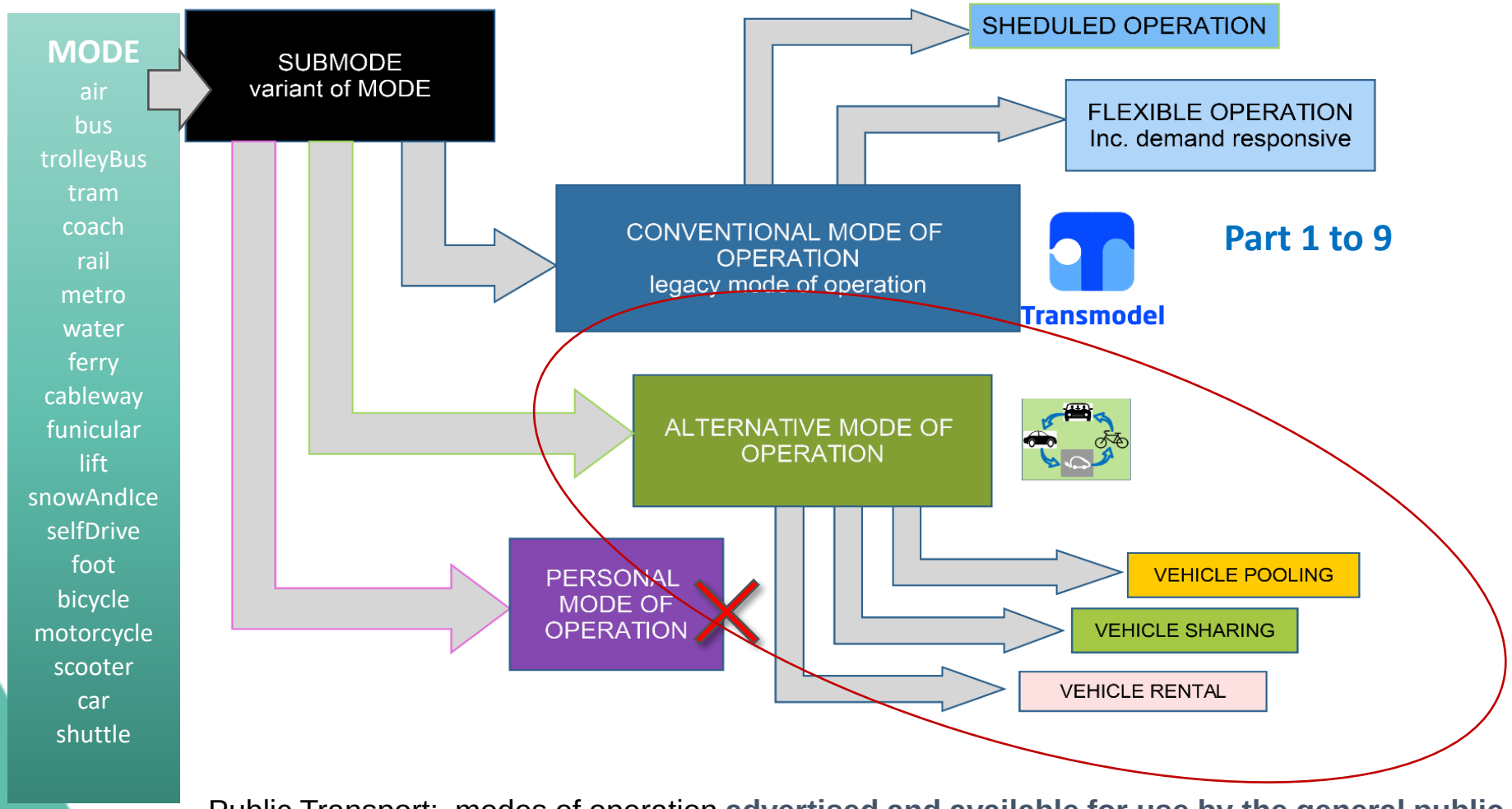
Transmodel – Part 10: Alternative Modes

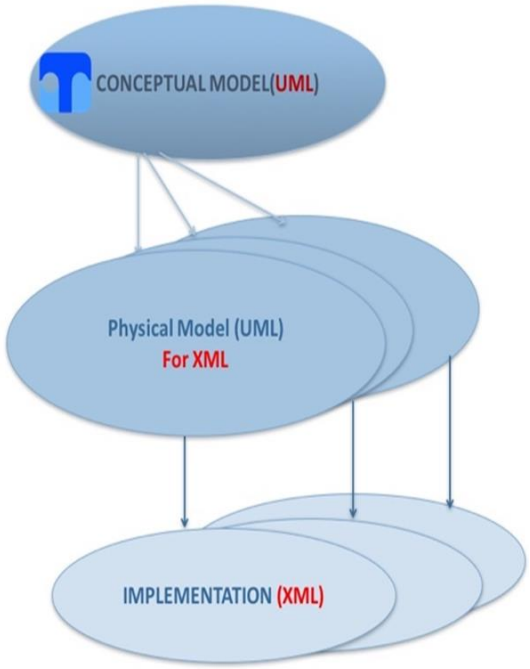


Public Transport: modes of operation **advertised and available for use by the general public**

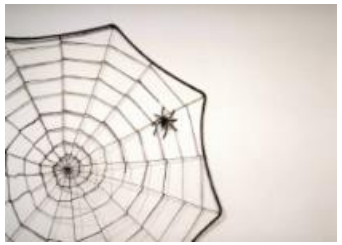
Methodology: model-driven design

Object–oriented modelling method UML 2 is used for describing, specifying, documenting and visualizing the conceptual data model.

- Conceptual model is implementation independent (Transmodel)
- Multiple physical models for different target implementations may be derived from one conceptual model
  - Example : NeTEx XML Physical design
- Implementation is derived from physical model
  - Example: NeTEx XML Schema



Transmodel



NeTEx

Applicability: 4 key use cases

1. Specification of Information Architecture

Transmodel may be used

- as a strategic guide for system planning and evolution
- as the basis for the specification and acquisition of individual systems

e.g. definition of the structure/contents of data held in system databases or to be exchanged.

2. Specification of a Database

Transmodel can serve as a starting point for the definition of a database schema, used for the physical implementation of databases

3. Specification of an Interface

Public transport organisations may need to define interfaces between applications or data exchanges with other organisations.
In either case, the reference data model can be used to help design the interfaces.

4. Mapping of transport data specifications

As a semantic standard reference, Transmodel is a stable reference for the mapping of data standards

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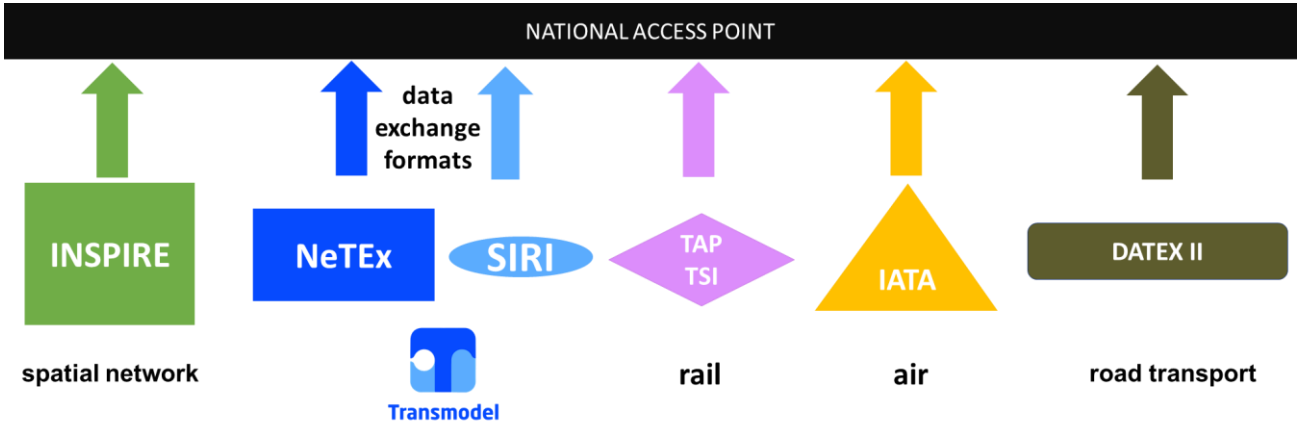
2. Mapping problem

Data Categories in the European Regulation for Traveller Information

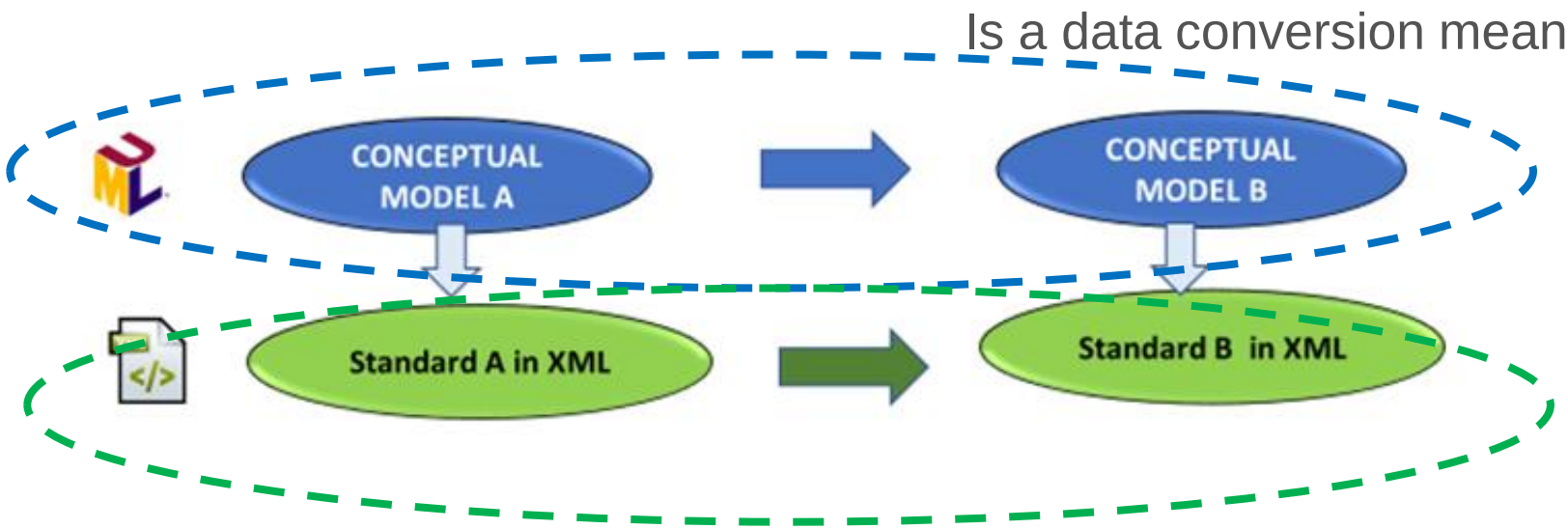
- List of Data Categories to be published using specific standard formats is provided in the Regulation 2017/1926.
- A **Data Category** : named **set of data**.
- The same Data Category may be modelled and/or published, by means of two or more standards/specifications : **the different standards overlap**

➡ **how to describe the overlap? how to reconcile data modelled/published using different standards?**



When are mappings useful?

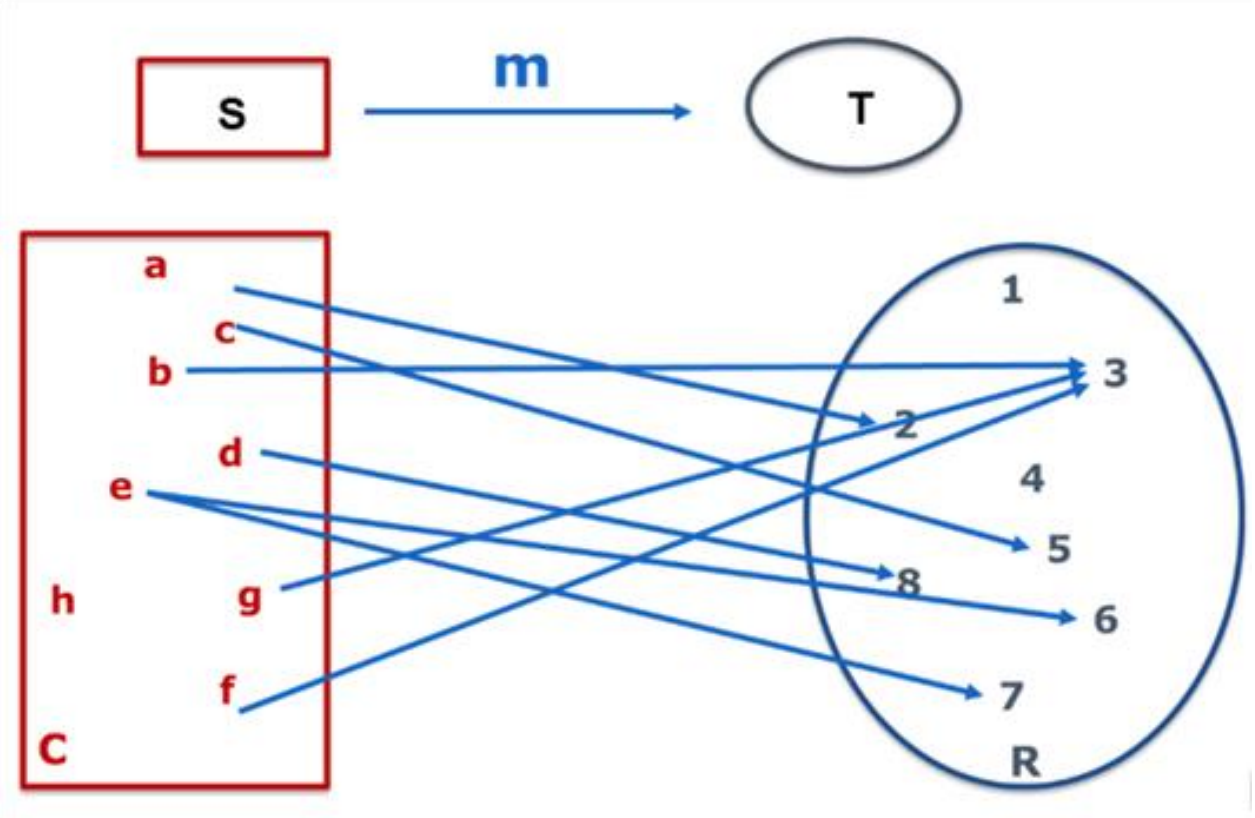
To clarify:
Are two data specifications (models) semantically equivalent?
Is it possible to replace model A by model B without loss of information?



Important: consider similar abstraction levels
mappings between (conceptual) data models as they are implementation independent

What is an Entity Mapping?

- An entity mapping is defined as an (oriented) correspondence ***m*** between a 'source' data model S and a 'target' data model T.

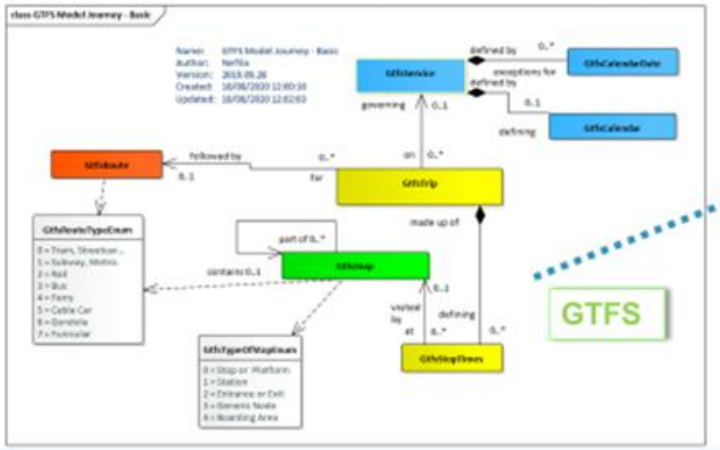


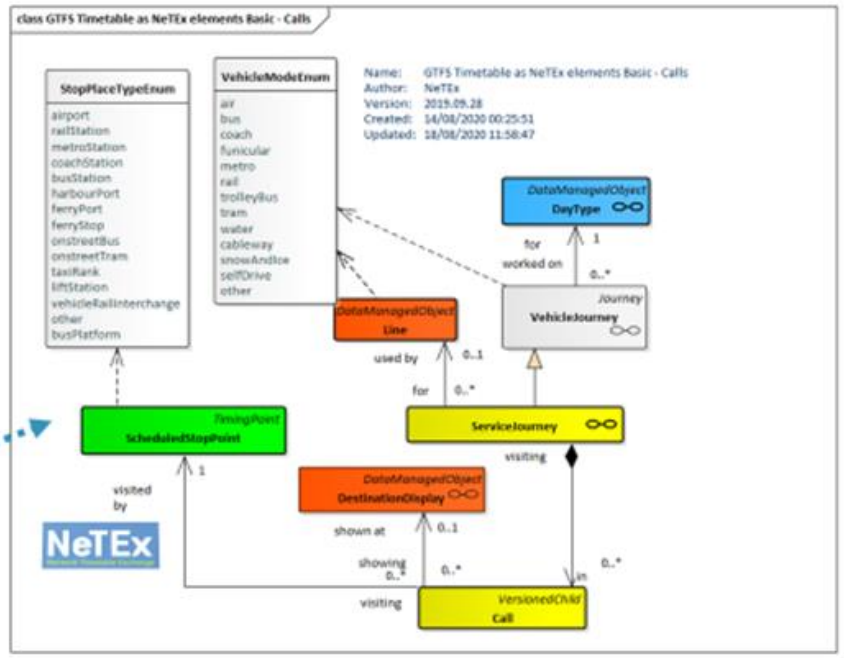
High-level mapping of terms with visualisation of comparative models

Mapping GTFS Trips to NeTEx Journeys

Easy!

- You say route, we say line…
- You say trip, we say journey…
- You say stop_times, we say call…
- You say headsign ,we say destination display





Similar entities have same colours

Systematic Entity Mapping (example): Addresses

CORRESPONDENCE OF ADDRESSES: NeTEx (Contributor) / INSPIRE (Reference)									QUALIFICATION OF THE CORRESPONDENCE (mark with 'x')						
#	NeTEx Class	A	NeTEx Class Attribute Relationship	NeTEx Class Attribute type Simple Type Complex type Enumeration	NeTEx multiplicity	Description (as in the NeTEx Class)	INSPIRE correspondence indication; comments	Corresponding INSPIRE class/attribute	Exact correspondence to INSPIRE class [1:1]	Exact correspondence to INSPIRE attribute [1:1]	NeTEx class not present in INSPIRE	NeTEx attribute not present in INSPIRE	A set of elements of NeTEx corresponds to one element in INSPIRE [N:1]	One element of NeTEx corresponds to a set of elements in INSPIRE [1:N]	Other
1	Address					An Address of a PLACE.	A NeTEx address can be mapped to INSPIRE to multiple instances of the AddressComponent FT, which is in turn an aggregation of the Address FT, and to multiple instances of the locator attribute of the Address FeatureType (FT)	Address, AddressComponent, AdminUnitName, AddressAreaName, PostalDescriptor, ThoroughfareName						x	
2			id	AddressIdType	[1]	Identifier of an ADDRESS.		Address.inspireId AddressComponent.inspireId						x	
3			ShortName	MultilingualString	[0..1]	Short name of an ADDRESS.	"name" (whose data type is geographicalName) is an attribute of the 4 subtypes of AddressComponent FT (AdressUnitName, AddressAreaName, PostalDescriptor, ThoroughfareName).	AdminUnitName.name and AdminUnitName.level and/or AddressAreaName.name and/or PostalDescriptor.name and/or ThoroughfareName.name						x	
4			CountryRef	CountryEnum	[0..1]	COUNTRY for ADDRESS. (codes according to ISO 3166-1)	The Address FT has the following constraint: "An address shall have an admin unit address component spatial object whose level is 1 (Country)." But INSPIRE has not any country code attribute.	AdminUnitName.name and AdminUnitName.level=1							x
5			PlaceRef	PlaceRef	[0..1]	Reference to PLACE associated with ADDRESS.	In some INSPIRE extended (therefore not yet endorsed) schemas (e.g. BU) there are FTs having an association called "address" to AddressRepresentation, which is a DataType of the Address theme, allowing to add AddressRepresentation attributes to an "addressable object"	AddressRepresentation (DataType)						x	
6	PostalAddress			Address		POSTAL ADDRESS inherits from ADDRESS.	Each NTX attribute may be mapped to one or more AddressComponent FT (supertype of PostalDescriptor FT), in combination with the locator attribute of the Address FT.	Address, AddressComponent, AddressUnitName, AddressAreaName, PostalDescriptor, ThoroughfareName						x	
7			id	PostalAddressIdType	[1]	Identifier of POSTAL ADDRESS.		Address.inspireId AddressComponent.inspireId						x	
8			HouseNumber	xsd:normalizedString	[0..1]	House or building number of POSTAL ADDRESS.		Address.locator>AddressLocator.designator> LocatorDesignator.designator and Address.locator>AddressLocator.designator> LocatorDesignator.type = 'buildingIdentifier' or 'addressNumber' or '...'						x	
9			BuildingName	xsd:normalizedString	[0..1]	Building name of POSTAL ADDRESS.		Address.locator>AddressLocator.name>LocatorName.name and Address.locator>AddressLocator.name>LocatorName.type = 'buildingName'		x					
10			AddressLine1	xsd:normalizedString	[0..1]	First line of POSTAL ADDRESS.	In INSPIRE a NeTEx address line may be mapped to one or more AddressComponent FT (supertype of PostalDescriptor FT), in combination with the locator attribute of the Address FT.						x	
11			AddressLine2	xsd:normalizedString	[0..1]	Second line of POSTAL ADDRESS.	In INSPIRE a NeTEx address line may be mapped to one or more AddressComponent FT (supertype of PostalDescriptor FT), in combination with the locator attribute of the Address FT.						x	
12			Street	xsd:normalizedString	[0..1]	Street name of POSTAL ADDRESS.		ThoroughfareName.name		x					
13			Town	xsd:normalizedString	[0..1]	Town of POSTAL ADDRESS.		AdminUnitName.name AdminUnitName.level						x	
14			Suburb	xsd:normalizedString	[0..1]	Suburb of POSTAL ADDRESS.		AddressAreaName.name		x					
15			PostCode	PostCodeType	[0..1]	Postcode.		PostalDescriptor.postCode and/or PostalDescriptor.postName						x	
16			PostCodeExtension	xsd:normalizedString	[0..1]	Postcode extension.		PostalDescriptor.postCode and/or PostalDescriptor.postName						x	
17			PostalRegion	xsd:normalizedString	[0..1]	Postal Region.		AdminUnitName.name AdminUnitName.level						x	
18			Province	xsd:normalizedString	[0..1]	Postal Province.		AdminUnitName.name AdminUnitName.level						x	
19			RoadAddressRef	RoadAddressRef	[0..1]	ROAD ADDRESS associated with POSTAL ADDRESS.		AddressComponent.inspireId>Identifier.versionId							x
20	RoadAddress			Address		ROAD ADDRESS inherits from ADDRESS.	Only some of the NeTEx attributes may be mapped to INSPIRE using the ThoroughfareName FT (subtype of AddressComponent FT)	ThoroughfareName							x
21			id	RoadAddressIdType	[1]	Identifier of a ROAD ADDRESS.		Address.inspireId AddressComponent.inspireId						x	
22			RoadNumber	xsd:normalizedString	[0..1]	Number of ROAD.	In INSPIRE road number is included in the road name	ThoroughfareName.name							x
23			RoadName	xsd:normalizedString	[0..1]	Name of ROAD.		ThoroughfareName.name		x					
24			BearingCompass	CompassEnum	[0..1]	Compass bearing of ROAD at point of ADDRESS.	missing					x			
25			BearingDegrees	xsd:integer	[0..1]	Bearing in degrees at point of ADDRESS.	missing					x			
26			OddNumberRange	xsd:normalizedString	[0..1]	Odd number range of ADDRESS.	missing					x			
27			EvenNumberRange	xsd:normalizedString	[0..1]	Even number range of ADDRESS on the road.	missing					x			

Mappings: workflow

1. To agree on the **Reference standard/model**.
2. To determine the **relevant sub-models** and their boundaries, for ex. to extract the relevant model parts and or to re-engineer the conceptual models,
3. To consider **the scope** of the models/standards considered,
4. To record the Entity Mapping in the **mapping table** considering the semantics of the main concepts (definitions),
5. To carry out a detailed comparison (attributes, relationships) using the **Mapping Table**.
6. To **qualify** each correspondence (each row of the mapping table)

The result of this process helps specifying converters…

3. Identified issues of the current mapping method

How could the ontology development group help???

Current mapping relies on human expertise: ‘Manual’ process

https://data4pt-project.eu/wp-content/uploads/2021/03/Data4PT-Methodology-for-comparing-data-standards.pdf

Automated tools would be needed to help data conversion

- Use standard reference models R according to their scope (e.g. Transmodel, Inspire, etc) respecting the EU Regulations
- Render the data models machine readable
- Provide tools for data (model) mappings : e.g. D_1 with R , D_2 with R, D_N with R
- Semantic equivalence of D_1 and D_2 ?

Data conversion is meaningful….

Thank you for your attention

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